APPENDIX H - Part 2

Stakeholder outreach and comment information.

From: noreply@discussion.community on behalf of SWFWMD WebBoards
To: Doug Leeper
Subject: Re: Peer Review Panel Teleconference - April 27, 2020
Date: Wednesday, April 29, 2020 10:24:30 AM

SWFWMD WebBoards

Carollo Engineers, Inc. has replied to a topic.

Peer Review Panel Teleconference - April 27, 2020

Posted Apr 29 in the Minimum Flows for the Lower Peace River and Lower Shell Creek category

Hello,

I think Table 6-8 (in the MFL draft report) does not make sense. It says "Summary of allowable percent reduction" in the caption but "Allowable Flow Release" in the table. Can someone explain "allowable flow release" please? It sounds like during Block 1, 87% of the flow is allowed to be released, which seems odd if Block 1 is low flow. Also, I cannot find this language (allowable flow release) in any other MFL (FAC 40D-8).
I think Table 3 (in the recovery strategy) makes much more sense.

MFL Report.jpg

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MFL Recovery.jpg

DISTRICT NOTE:
IMBEDDED IMAGE (JPG FILE)
INCLUDED ON PAGE 443 BELOW

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Table 6-8. Summary of allowable percent reduction in flow for Lower Shell Creek based on flow measured at the outfall of Hendrickson Dam and withdrawals from Shell Creek Reservoir by the City of Punta Gorda.

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Table 3: Summary of allowable percent reductions for Lower Shell Creek based on flow measured at the outfall of the Hendrickson Dam and previous day withdrawals from the reservoir.

Flow Range	Allowable Flow Reduction from Baseline Flows
Block 1 (0-56 cfs)	13%
Block 2 (>56 – 137 cfs)	23%
Block 3 (>137 cfs)	40%

From: Yonas Ghile
To: Eric DeHaven; Randy Smith; Chris Zajac; Doug Leeper; Xinjian Chen
Subject: FW: Shell Creek baseline flows
Date: Wednesday, April 29, 2020 3:26:28 PM

Hi all

I just heard back from Laura. She spoke to the City and they said every day RO use

1. 4 mgd in Block 1
2. 2 mgd in Block 2 and 3

That's good news. Will set up a meeting soon to discuss the results of this scenario

Thank you

From: Laura Baumberger <LBaumberger@carollo.com>
Sent: Wednesday, April 29, 2020 3:21 PM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>
Subject: RE: Shell Creek baseline flows

Yonas,

I just spoke to the City. Please see slight modification below.

Thanks,
Laura

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Wednesday, April 29, 2020 3:17 PM
To: Laura Baumberger <LBaumberger@carollo.com>; Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>
Subject: RE: Shell Creek baseline flows

Thank you Laura I will start running these scenario and will let you when I am done.

From: Laura Baumberger <LBaumberger@carollo.com>
Sent: Wednesday, April 29, 2020 10:14 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>
Subject: RE: Shell Creek baseline flows

Yonas,

I left the City a voicemail but have not heard back yet. I am almost certain they will operate in this fashion, if you want to get started on model updates:

1. RO, reservoir, PR - in that order
2. Constant use of RO
   - ~~3~~ 4 mgd in Block 1
   - 2 mgd in Blocks 2 and 3

I will update you with any changes after I speak with the City.

Thanks,
Laura

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Tuesday, April 21, 2020 3:46 PM
To: Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Hi Sarah,

Laura said that she is going to talk the city and provide us information needed to modify the current operation of the model. Especially, for B1, we need to know how they will plan to operate the reservoir and RO. Here are some examples:

1. RO, reservoir, PP in order
2. %RO and %reservoir (e.g. 80%RO & 20%reservoir)
3. Constant use of RO (e.g. 3 mgd)

Once I got that kind of information, it will take me a couple days to modify the model and may be 3-5 days for internal discussion with District team. I would say 1 week after we get the information.

Thanks

From: Sarah Burns <sburns@carollo.com>
Sent: Tuesday, April 21, 2020 3:10 PM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Hi Yonas,

Thanks for the call today. We have found the HSW report on the baseline flows and are reviewing.

Do you know when you might have the recovery model modified to have RO utilized before the reservoir?

Thanks!
Sarah

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Monday, April 13, 2020 11:49 AM
To: Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Sarah

I just want to Doug Leeper in the meeting but he has a meeting in the morning. Can we do it in the afternoon or on 21st from 9-10 am?

Thanks

From: Yonas Ghile
Sent: Monday, April 13, 2020 11:38 AM
To: Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Ok, I am going set up Teams meeting from 10 -11 am on the 22nd.

Thank you

From: Sarah Burns <sburns@carollo.com>
Sent: Monday, April 13, 2020 11:21 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Let's do the morning of the 22nd…anytime. Let me know if you would like me to send a Teams invite!

Thanks,
Sarah

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Monday, April 13, 2020 9:30 AM
To: Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Yonas
Unfortunately, I am running tight this week. How about next Week? I am open from April 22 – 24.

Thank you

From: Sarah Burns <sburns@carollo.com>
Sent: Monday, April 13, 2020 9:26 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: Shell Creek baseline flows

Hi Yonas,

Can we set up a time this week to go through the baseline flows spreadsheet? Let me know a few times that will work for you.

Carollo uses Microsoft Teams, but I believe we did a Webex last time. Do you have a preference?

Victoria from our Orlando office will join as well.

Thanks!
Sarah

From: Victoria Steinnecker
To: Doug Leeper; Yonas Ghile
Subject: Peace Rive/Shell Creek MFL
Date: Thursday, April 30, 2020 4:07:47 PM

Hello,

Hope you are well!

I was wondering if the "Proposed Recovery Strategy for the Lower Shell Creek – Draft Report" was published. I have a copy, but I cannot find it on Google. Either way, I think the date on the front is wrong and it does not match the date on the second page. I think all government documents are accessible to the public, so I wanted to let you know.

Also, I left a comment on the Web Forum that I am afraid may have gotten missed. Perhaps I should have emailed directly. I'm not 100% on the whole public process/Sunshine Law stuff. Anyway, it is below.

I think Table 6-8 (in the MFL draft report) does not make sense. It says "Summary of allowable percent reduction" in the caption but "Allowable Flow Release" in the table. Can someone explain "allowable flow release" please? It sounds like during Block 1, 87% of the flow is allowed to be released, which seems odd if Block 1 is low flow.
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Best,

Victoria Steinnecker, EI
Staff Professional
200 East Robinson Street, Suite 1400 | Orlando, FL 32801
P 407.377.2671 | **M** 850.485.0318
carollo.com

From:	Yonas Ghile
To:	Victoria Steinnecker; Doug Leeper
Subject:	RE: Peace Rive/Shell Creek MFL
Date:	Thursday, April 30, 2020 4:24:52 PM

Victoria

The recovery strategy report is not published on the District's website as it is not part of the MFL development. The recovery strategy report is an initial draft, it hasn't been updated for a while. Once we agree with the City on the implementation of the proposed MFL, we will modify it.

I agree, Table 6-8 caption will be changed from "allowable percent of reduction" to "required flow release".

Thank you

From: Victoria Steinnecker <vsteinnecker@carollo.com>
Sent: Thursday, April 30, 2020 4:08 PM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Subject: Peace Rive/Shell Creek MFL

Hello,

Hope you are well!

I was wondering if the "Proposed Recovery Strategy for the Lower Shell Creek – Draft Report" was published. I have a copy, but I cannot find it on Google. Either way, I think the date on the front is wrong and it does not match the date on the second page. I think all government documents are accessible to the public, so I wanted to let you know.

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Best,

Victoria Steinnecker, EI
Staff Professional
200 East Robinson Street, Suite 1400 | Orlando, FL 32801
P 407.377.2671 | **M** 850.485.0318
carollo.com

From:	Amoah, Kat
To:	Doug Leeper
Cc:	Fury, Jon; Hight, Jason; Goff, Jennifer; Conservation Planning Services; thomas.graef; Lambert, Carla
Subject:	FWC"s Comments on Lower Peace River Shell Creek System MFL
Date:	Monday, May 4, 2020 2:27:30 PM
Attachments:	Lower Peace River Shell Creek System MFL.pdf

Please find attached FWC's comments on the above-referenced project. You will **not** receive a hard-copy version of this letter unless requested.

If you wish to reply to our comments, please send your reply to:

ConservationPlanningServices@myFWC.com

Kat Amoah, AA III
Office of Conservation Planning Services
850-410-5272

May 4, 2020

Doug Leeper
Program Lead
Southwest Florida Water Management District
Springs and Environmental Flows Section
2379 Broad Street
Brooksville, FL 34604
Doug.Leeper@WaterMatters.org

RE: Lower Peace River and Lower Shell Creek System Minimum Flows and Levels Draft Report and Appendices, Southwest Florida Water Management District, DeSoto, and Charlotte Counties

Dear Mr. Leeper:

Florida Fish and Wildlife Conservation Commission (FWC) staff have reviewed the above referenced minimum flows and levels (MFL) report and appendices for the Lower Peace River and Lower Shell Creek Systems. The following comments and recommendations are provided as technical assistance during your review of the draft MFL under Chapter 373, Florida Statutes, and in accordance with FWC's authorities under Chapter 379, Florida Statutes.

Executive Summary

This report summarizes proposed minimum flows for the Lower Peace River and Lower Shell Creek developed as part of a comprehensive reevaluation of minimum flows previously established for the Lower Peace River. For minimum flow purposes, the Lower Peace River is defined as the river segment from the U. S. Geological Survey Peace River at Arcadia, Florida gage downstream to Charlotte Harbor. Lower Shell Creek is defined as the segment of the creek that extends from the Hendrickson Dam at Shell Creek Reservoir to the confluence of Shell Creek with the Lower Peace River.

The Southwest Florida Water Management District (District) previously developed minimum flows for the Lower Peace River and drafted proposed minimum flows for Lower Shell Creek in 2010. In July 2010, minimum flows for the Lower Peace River were adopted into District rules that became effective in August 2010. The established Lower Peace River minimum flows rule requires the reevaluation of the minimum flows within five years of their adoption to incorporate additional ecological data. In response to this timeline, the District completed an initial reevaluation of the minimum flows in 2015 and has currently scheduled completion of a more comprehensive reevaluation for 2020.

In support of the comprehensive reevaluation described in this report, proposed minimum flows for the Lower Peace River, and Lower Shell Creek were developed using the best information available, as required by the Florida Statutes, and were based on all relevant environmental values identified in the Florida Water Resource Implementation Rule for consideration when setting minimum flows.

For the comprehensive minimum flows reevaluation, the District: updated hydrologic data sets used in the analyses; re-mapped the bathymetry of the Lower Peace River; Lower Myakka and Charlotte Harbor; produced a LiDAR-based high-resolution digital elevation model for the area; refined a hydrodynamic model used to predict salinity, water level and temperature in the system; and expanded application of the hydrodynamic model to the entire Charlotte Harbor. In addition, habitat modeling for a number of estuarine dependent fish species and Blue Crab, water quality analysis, and floodplain inundation analysis for the upper portion of the Lower Peace River were conducted.

Baseline flow records used for the minimum flows analyses were developed for the Lower Peace River and Lower Shell Creek to account for decreases and increases (from excess agricultural runoff) in gaged flows that were associated with surface and groundwater withdrawals. The Lower Peace River baseline flow record extended from 1950 through 2014, and the Lower Shell Creek baseline flows extended from 1966 through 2014. Flow-based blocks corresponding to periods of low (Block 1), medium (Block 2), and high (Block 3) flows based on the annual 75%, and 50% exceedance of the baseline flow records were identified to develop proposed minimum flows for the river and creek.

The Lower Peace River and Lower Shell Creek were modeled as one system, "the Lower Peace/Shell System," to appropriately characterize the strong hydrologic interactions between the river, creek, and Charlotte Harbor. Block-specific percent-of-flow reductions associated with significant harm thresholds based on a 15 percent reduction in the most sensitive assessed habitat were used to develop proposed minimum flows for the system. Environmental resources or goals assessed for the development of the minimum flows included: maintenance of biologically relevant salinities with water volumes, shoreline lengths and bottom areas associated with salinities ranging from 2 to 20 practical salinity unit (psu); inundation of floodplain wetlands; habitats for selected fish species and Blue Crab; and water quality.

These analyses indicated that the < 2 psu salinity zone was the most sensitive criterion to flow reductions inthe Lower Peace/Shell System. Based on this criterion, proposed minimum flows in the Lower Peace River and Lower Shell Creek were determined for each flow-based block as percentages of baseline flows. This approach also permitted identification of allowable percent-of-flow reductions that can be used to describe the proposed minimum flows. The proposed minimum flows were developed with consideration of and are protective of all relevant environmental values identified for consideration in the Water Resource Implementation Rule when establishing minimum flows and levels.

Proposed allowable percent-of-flow reductions in the Lower Peace River were defined for each block as percentage reductions in the total combined baseline flow at the Peace River at Arcadia (USGS No. 02296750), Joshua Creek at Nocatee (USGS No. 02297100) and Horse Creek near Arcadia (USGS No. 02297310) gage sites. Results from model run conducted to evaluate relationships between flows and environmental criteria in the Lower Peace/Shell System did not exhibit breakpoints or inflections. However, a low flow threshold of 130 cfs was identified as an operational, minimum flow criterion for the Lower Peace River to assist in maintaining freshwater conditions at the withdrawal point of the Peace River Manasota Regional Water Supply Authority (PRMRWSA). This low flow threshold of 130 cfs has been included in currently established minimum flows for the Lower Peace River and successfully implemented for permitted withdrawals by the PRMRWSA since 2010.

Minimum flows status assessments for the Lower Peace River were conducted based on the best available information, using block-specific and five-year and ten-year moving mean and median flow statistics. The assessment results indicated that the proposed minimum flows for the Lower Peace River are being met and are also expected to be met over the next 20 years. Development of a recovery strategy or specific prevention strategy associated with adoption of the proposed minimum flows for the Lower Peace River is, therefore, not necessary. If approved by the District Governing Board, the proposed minimum flows identified in this report for the Lower Peace River will replace the currently adopted minimum flows for the river included in District rules. Similar to the minimum flows proposed for the Lower Peace River, proposed minimum flows for Lower Shell Creek are block-based minimum flows that specify allowable reductions in baseline flows into Shell Creek Reservoir.

Based on the best available information, the proposed minimum flows for Lower Shell Creek are not being met and would continue not to be met during the next 20-year planning horizon. In coordination with the City of Punta Gorda, the District has accordingly prepared a draft recovery strategy to achieve the proposed minimum flows for Lower Shell Creek and prevent the flows from falling below the proposed minimum flows during the next 20 years. The draft recovery strategy also ensures provision of sufficient water supplies for all existing and projected water demands of the City of Punta Gorda.

Climate change, structural alterations, and other changes in the watershed could potentially affect flow characteristics, and additional information relevant to minimum flows development may become available in the future. Therefore, the District is committed to periodic reevaluation and, if necessary, revision of minimum flows for Lower Peace River and Lower Shell Creek.

Comments and Recommendations

Overall, FWC staff appreciates the job the District has done in using the best information available to reevaluate the recommended minimum flows and levels for the Lower Peace River and Lower Shell Creek Systems. The majority of the analyses used to determine MFL targets are scientifically sound and should be protective of fish and wildlife and their habitats. The District's collection and use of additional data from the systems areappreciated, and FWC staff support the District's change to a new flow-based block regime for determining MFLs in both systems and evaluating the potential effects of sea level rise. Staff acknowledge this document focuses on the zone of low salinity (oligohaline) as the target for MFL development and believe this river stretch is very important to fish and wildlife. Environmental conditions upstream often affect the dynamics of the ecosystem downstream, and a healthy estuary represents a continuum from freshwater to marine. Staff also endorses the percent-of-flow method for regulating consumptive use because it maintains all aspects of the natural flow regime (i.e., timing, duration, magnitude, and seasonality of flow events), which are important for the maintenance of ecological function.

The zone of low salinity and the lowermost non-tidal freshwater stretches could be better characterized by drawing from work the District funded on fish assemblages in the Peace River during the past decade. This work investigated the oligohaline stretch of the Peace River, characterized fish assemblages in each of three river sections used in previous MFLs (lower, middle and upper river) and defined habitat and diet of large predatory fishes (common snook, largemouth bass, and Florida gar) in three river sections (lower, middle and upper river). Additionally, a long period of record (eight years) was used to relate mean annual river flows to the abundance and condition of a representative large-bodied fish, common snook. This is among the most comprehensive fish work conducted for a river system in Florida, which is important since the Peace River MFL tends to serve as a model for other MFLs in Florida. Unfortunately, this work is not well summarized in the document.

The FWC's fish community data in the Lower Peace River and Charlotte Harbor areas (Appendix E) was well summarized in the report; however, fish assemblages should also be characterized throughout the freshwater portions of the river in order to provide for a more thorough background that may be relevant to future MFL documents. A dedicated section on the importance of floodplain inundation would be ideal (see below). Also, it would be useful to outline habitat parameters that are important to protect in the freshwater portions of the river (e.g., snags and overhanging vegetation). Although hydrologic modeling found the oligohaline zone to be more sensitive to inflow-related changes, it is still important to summarize fisheries data related to the freshwater portions of rivers, especially since maintenance of floodplain connectivity is a resource of concern.

In Section 5.4 Resources of Concern for Determining Minimum Flows, the importance of floodplain inundation and connectivity to the mainstem of the Peace River is acknowledged as one of three resources of concern for the MFL – "Maintenance of seasonal hydrologic connections between the river channel and floodplain to ensure the persistence of floodplain structure and function." However, background text supporting this concern and later describing the results of modeling related to floodplain inundation in the document is lacking and should be emphasized more. It could be said that floodplain inundation has a profound effect on the distribution and condition of large piscivores.

Since the first MFL was adopted, District staff have been proactive in obtaining information related to the effects of high inflow events. The FWC's work was focused on helping to fill this data gap. The District followed up with detailed vegetation surveys to determine what was being flooded during high inflow periods. However, the area of river selected for study appears to be more influenced by tides than by seasonal floodwaters. The FWC's studies of large sportfish show that common snook are heavily using the mainstem areas just downstream of SR 760 (Nocatee Road) around Johnson and Bee Gum lakes and several other unnamed floodplain waterbodies. These areas connect seasonally to the river and provide habitat for prey production; much of this prey eventually ends up in the main stem of the river for large predators to consume during the fall. New information regarding the importance of floodplain inundation has recently come to light from our region and in other countries where researchers are seeing that timing, as well as duration, of flood events, are important ecological factors. The identification of threshold levels of floodplain inundation (i.e., targets) would be very useful in the Peace River.

Staff supports the protection of salinity-based habitats as an effective method for protecting a diverse array of species and preventing significant harm to environmental values in the Lower Peace River and Lower Shell Creek Systems. However, since it was determined that the water volume associated with the < 2 psu habitat zone was the most sensitive salinity-habitat criterion, it would be helpful to include a table or graphic, subsequent to table 6-4, showing the percent decrease in water volume associated with the 1-40% flow reductions from just this salinity zone (< 2 psu) to highlight the 13, 23 and 40% flow reduction thresholds from Blocks 1-3. It is not currently clear, based only on Table 6-4, if the water volume relationship in habitats < 2 psu are affected linearly or non-linearly with percent flow reductions.

While the benthic macroinvertebrate summaries in this document are important, recent benthic community data in this document is lacking. Benthic communities have proven to be valuable as indicators of environmental health, primarily because they are relatively immobile and can be abundant. Benthic macroinvertebrates are very important ecologically because they serve as prey for many fishes, motile crustaceans, and even birds. Furthermore, benthic macroinvertebrates have been shown to be sensitive indicators of salinity.

In Section 4.1.1 Shoreline Vegetation, description of shoreline vegetation communities is made using information collected in 1988 and 1989, which is over 30 years ago. Additionally, the map shown in Figure 4-1 is also 30 years old. While this historical information has value, it would be helpful to include more recent vegetation community data and maps for comparative purposes.

In Appendix E, the modeling only includes data collected from 1996 to 2013, but the FWC FIM program collected fish data during 2016, according to Section 4.2.1. This report does not address changes from 2013 to 2016. It would be helpful to include the latest data available in this report and during modeling in order to improve MFL development.

Finally, at the end of this letter, FWC staff provided references for your review and consideration, which support the importance of freshwater flows for fish communities and fish population dynamics in oligohaline environments, several of which were conducted on the Peace River.

In closing, FWC staff appreciates the opportunity to review the proposed MFL documents and looks forward to working with the District throughout the final approval process. If you have specific technical questions regarding the content of this letter, please contact Eric Johnson at (863) 648-3809 or by email at eric.johnson@MyFWC.com. For all other inquiries may be directed to ConservationPlanningServices@MyFWC.com.

Sincerely,

Jon R Fury

Jon Fury, Director
Division of Freshwater Fisheries Management

Lower Peace River Shell Creek System MFL 2020_41486_05042020

Suggested literature

Blewett, D.A., P.W. Stevens, and M.E. Call. 2013. Comparative ecology of euryhaline and freshwater predators in a subtropical river. Florida Scientist 76:166-190.

> "Both euryhaline and freshwater predators had affinities for structure (e.g., snags) and ate similar prey (predominantly crayfish Procambarus spp. and brown hoplo Hoplosternum littorale)."

Blewett, D.A., P.W. Stevens, J. Carter. 2017. Ecological effects of river flooding on abundance and body condition of a large, euryhaline fish. Marine Ecology Progress Series 563: 211-218.

> "Over the 8-year record, mean annual abundance and body condition of snook were positively related to mean annual river flow (R2 = 0.88) and the number of days that river level exceeded a specific threshold (R2 = 0.70), respectively."

Call, M.E., D.R. Sechler, P.W. Stevens, D.A. Blewett, S. Canter, and T.R. Champeau. 2013. Freshwater fish communities and habitat use in the Peace River, Florida. Florida Scientist 76:150-164.

> "The habitat affinities of fishes identified in this study should be useful to resource managers for modeling biotic responses to changes in river water levels and habitat availability."

Stevens, P.W., M.F.D. Greenwood, and D.A. Blewett. 2013. Fish assemblages in the oligohaline stretch of a southwest Florida river during periods of extreme freshwater inflow variation. Transactions of the American Fisheries Society 142:1644-1658.

> "During a dry period, the oligohaline fish assemblage became more similar to the assemblage of the lower river mouth. Reductions in the abundance of species characteristic of the oligohaline stretch were offset by increases in the abundance of Bay Anchovy Anchoa mitchilli. This study provides information to managers that can be used in the restoration of oligohaline waters by identifying characteristic fishes in the oligohaline stretch of a large river, providing insight into how this river section functions as fish habitat, and determining the changes in fish assemblages that occur during low freshwater inflow conditions."

Baustian, J.J., and B.P. Piazza. 2019. Hydrologic connectivity and backswamp water quality during a flood in the Atchafalaya Basin, USA. River Research and Applications 2019:1-6. DOI: 10.1002/rra.3417.

Kozak, J.P., M.G. Bennett, B.P. Piazza, and J.W.F. Remo. 2016. Towards dynamic flow regime management for floodplain restoration in the Atchafalaya River Basin, Louisiana. Environmental Science and Policy 64:118-128.

Rabuffetti, A.P., L.A. Espinola, E. Abrial, M.L. Amsler, M.C.M. Blettler, M.F. Eurich, and E.G. Eberle. 2019. Commercial fisheries in a mega unregulated floodplain river: Assessment of the most favourable hydrological conditions for its preservation. Journal of Fish Biology 2019:1-15. DOI: 10.1111/jfb.14184.

> "Analysing more than eight decades (1935–2016) of information on the most frequent and abundant commercial species in conjunction with hydrological levels and temperature, our results show that spring–summer floods of a certain magnitude (c. 6 m) and durations (> 80 days) are crucial for sustaining commercial fisheries."

From:	Doug Leeper
To:	Amoah, Kat
Cc:	Fury, Jon; Hight, Jason; Goff, Jennifer; Conservation Planning Services; thomas.graef; Lambert, Carla; Michelle.Sempsrott@MyFWC.com; Eric Nagid (eric.nagid@MyFWC.com); Stasey.Whichel@MyFWC.com; Ryan Hamm (Ryan.Hamm@MyFWC.com); Eric.Sutton@myFWC.com; Phillip Stevens (Philip.Stevens@MyFWC.com); Dave Blewett (dave.blewett@MyFWC.com); eric.johnson@myFWC.com; Yonas Ghile; Xinjian Chen; Kristina Deak; Chris Anastasiou; Chris Zajac; Randy Smith; Eric DeHaven; Adrienne E. Vining; Mike R. Bray
Subject:	RE: FWC"s Comments on Lower Peace River Shell Creek System MFL
Date:	Tuesday, May 5, 2020 4:15:00 PM
Attachments:	Fury 2020-FFWCC Comms_Lower Peace_Shell MFLs.pdf

Thank you Kat. District staff will be reviewing the comments in Mr. Fury's letter and we will contact Eric Johnson with inquiries regarding the FWC's comments.

Doug Leeper
MFLs Program Lead
Environmental Flows and Assessments Section
Natural Systems & Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street (U.S. Hwy. 41 South)
Brooksville, FL 34604-6899
352-796-7211, Ext. 4272
1-800-423-1476, Ext. 4272
Doug.leeper@watermatters.org

From: Amoah, Kat <Kat.Amoah@MyFWC.com>
Sent: Monday, May 4, 2020 2:27 PM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Fury, Jon <jon.fury@MyFWC.com>; Hight, Jason <Jason.Hight@MyFWC.com>; Goff, Jennifer <jennifer.goff@MyFWC.com>; Conservation Planning Services <conservationplanningservices@MyFWC.com>; thomas.graef <thomas.graef@myfwc.com>; Lambert, Carla <carla.Lambert@MyFWC.com>
Subject: FWC's Comments on Lower Peace River Shell Creek System MFL

Please find attached FWC's comments on the above-referenced project. You will **not** receive a hard-copy version of this letter unless requested.

If you wish to reply to our comments, please send your reply to:

ConservationPlanningServices@myFWC.com

Kat Amoah, AA III

Office of Conservation Planning Services
850-410-5272

From:	Doug Leeper
To:	vsteinnecker@carollo.com
Cc:	FootPrintsPRR; Shellie Ferreira-Lee; Chris Zajac
Subject:	RE: SWFWMD Public Records Request - Victoria Steinnecker - Priority List for MFLs Public Records Requ...
Date:	Thursday, May 7, 2020 9:43:00 AM
Attachments:	SWFWMD MFLs Priority Lists 1999-2010.pdf

Hi Victoria:

- To fully address your recent request, I've attached Southwest Florida Water Management District Minimum Flows and Levels Priority Lists and Schedules from 1999 through 2010.
- Let me know if you have any questions or need anything else.

Doug Leeper
MFLs Program Lead
Environmental Flows and Assessments Section
Natural Systems & Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street (U.S. Hwy. 41 South)
Brooksville, FL 34604-6899
352-796-7211, Ext. 4272
1-800-423-1476, Ext. 4272
Doug.leeper@watermatters.org

From: FootPrintsPRR <FootPrints.PRR@swfwmd.state.fl.us>
Sent: Tuesday, April 28, 2020 10:43 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: SWFWMD Public Records Request - Victoria Steinnecker - Priority List for MFLs Public Records Requ...

When replying, type your text above this line.

Notification of Issue Change
The following changes have been made to this Issue: *canRead:agentRoles, Changed Title, Changed Issue data or Contact data, Escalated: Set Start Date & Status, Changed Status to Under 7 days old from NewRequest, Escalated: Send Acknowledgement Email, Escalation email sent: vsteinnecker@carollo.com, Escalation email sent: footprints.pm@watermatters.org, canRead:allRoles.*

Workspace:	Public Records Request
Issue:	Victoria Steinnecker - Priority List for MFLs Public Records Request
Issue Number:	33757

Priority:	Medium	**Status:**	Under 7 days old
Date:	04/28/2020	**Time:**	10:43:03
Creation Date:	04/28/2020	**Creation Time:**	09:04:54
Created By:	noreply.webmaster@swfwmd.state.fl.us		

Description:
Entered on 04/28/2020 at 9:04:54 AM EDT (GMT-0400) by noreply.webmaster@swfwmd.state.fl.us:
Description=Hello,
I am looking for the Priority List and Schedule for Minimum Flows and Levels for the years 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, and 2009; basically all years from 2000 to 2009.
Is this information available somewhere or can you please provide it?
Thank you!
Permit Type=[webform_submission:values:permit_type]
Permit Number=
Project Name=
Issuing Permit Office=[webform_submission:values:issuance]
Info Needed=
Other/Comments=

Current Assignees: Document Services

CC(s): (this edit only) Doug.Leeper@swfwmd.state.fl.us

Issue Information:

Internal Request: Off

Contact Information:

vsteinnecker@carollo.com

Last Name:	Steinnecker	**First Name:**	Victoria
Email Address:		**Phone:**	850-485-0318
City:	Orlando		

From:	Yonas Ghile
To:	Laura Baumberger
Cc:	Victoria Steinnecker; Sarah Burns; Chris Zajac; Doug Leeper; Eric DeHaven; Randy Smith
Subject:	RE: Shell Creek baseline flows
Date:	Friday, May 8, 2020 4:58:39 PM

Laura

Thank you for your email. I just started working on it, but the week of May 18 is too early for the District to meet with the City. Please make a schedule for the first week of June if it works for your team and the City.

Have a nice weekend

Yonas

From: Laura Baumberger <LBaumberger@carollo.com>
Sent: Friday, May 8, 2020 2:55 PM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>
Subject: RE: Shell Creek baseline flows

Yonas,

Wanted to check in and see how things are going with the model updates. We are having a meeting with the City next week (just Carollo and the City) to discuss a few items with them.

I'm trying to find a meeting date the week of May 18 that works for them to meet with you and others at SWFWMD. Will keep you posted on that.

Thanks,
Laura

From: Laura Baumberger
Sent: Wednesday, April 29, 2020 3:21 PM
To: 'Yonas Ghile' <Yonas.Ghile@swfwmd.state.fl.us>; Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>
Subject: RE: Shell Creek baseline flows

Yonas,

I just spoke to the City. Please see slight modification below.

Thanks,
Laura

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Wednesday, April 29, 2020 3:17 PM
To: Laura Baumberger <LBaumberger@carollo.com>; Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>
Subject: RE: Shell Creek baseline flows

Thank you Laura I will start running these scenario and will let you when I am done.

From: Laura Baumberger <LBaumberger@carollo.com>
Sent: Wednesday, April 29, 2020 10:14 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>
Subject: RE: Shell Creek baseline flows

Yonas,

I left the City a voicemail but have not heard back yet. I am almost certain they will operate in this fashion, if you want to get started on model updates:

1. RO, reservoir, PR - in that order
2. Constant use of RO
    - ~~3~~ 4 mgd in Block 1
    - 2 mgd in Blocks 2 and 3

I will update you with any changes after I speak with the City.

Thanks,
Laura

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Tuesday, April 21, 2020 3:46 PM
To: Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Hi Sarah,

Laura said that she is going to talk the city and provide us information needed to modify the current operation of the model. Especially, for B1, we need to know how they will plan to operate the reservoir and RO. Here are some examples:

1. RO, reservoir, PP in order
2. %RO and %reservoir (e.g. 80%RO & 20%reservoir)
3. Constant use of RO (e.g. 3 mgd)

Once I got that kind of information, it will take me a couple days to modify the model and may be 3-5 days for internal discussion with District team. I would say 1 week after we get the information.

Thanks

From: Sarah Burns <sburns@carollo.com>
Sent: Tuesday, April 21, 2020 3:10 PM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Hi Yonas,

Thanks for the call today. We have found the HSW report on the baseline flows and are reviewing. Do you know when you might have the recovery model modified to have RO utilized before the reservoir?

Thanks!
Sarah

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Monday, April 13, 2020 11:49 AM
To: Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Sarah

I just want to Doug Leeper in the meeting but he has a meeting in the morning. Can we do it in the afternoon or on 21st from 9-10 am?

Thanks

From: Yonas Ghile
Sent: Monday, April 13, 2020 11:38 AM
To: Sarah Burns <sburns@carollo.com>

Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Ok, I am going set up Teams meeting from 10 -11 am on the 22nd.

Thank you

From: Sarah Burns <sburns@carollo.com>
Sent: Monday, April 13, 2020 11:21 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Let's do the morning of the 22nd…anytime. Let me know if you would like me to send a Teams invite!

Thanks,
Sarah

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Monday, April 13, 2020 9:30 AM
To: Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Yonas
Unfortunately, I am running tight this week. How about next Week? I am open from April 22 – 24.

Thank you

From: Sarah Burns <sburns@carollo.com>
Sent: Monday, April 13, 2020 9:26 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: Shell Creek baseline flows

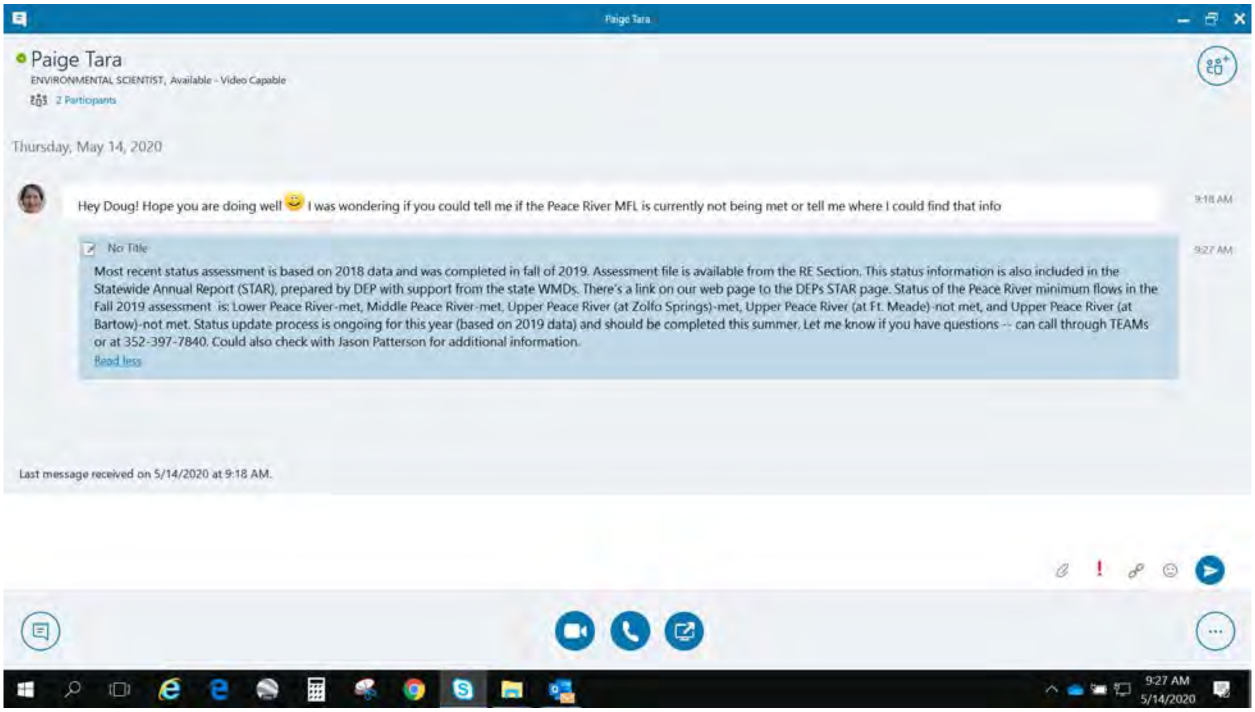
Hi Yonas,

Can we set up a time this week to go through the baseline flows spreadsheet? Let me know a few times that will work for you.

Carollo uses Microsoft Teams, but I believe we did a Webex last time. Do you have a preference?

Victoria from our Orlando office will join as well.

Thanks!
Sarah


Paige Tara
Paige Tara
ENVIRONMENTAL SCIENTIST, Available - Video Capable
2 Participants
Thursday, May 14, 2020
Hey Doug! Hope you are doing well I was wondering if you could tell me if the Peace River MFL is currently not being met or tell me where I could find that info
9:18 AM
No Title
Most recent status assessment is based on 2018 data and was completed in fall of 2019. Assessment file is available from the RE Section. This status information is also included in the Statewide Annual Report (STAR), prepared by DEP with support from the state WMDs. There's a link on our web page to the DEPs STAR page. Status of the Peace River minimum flows in the Fall 2019 assessment is: Lower Peace River-met, Middle Peace River-met, Upper Peace River (at Zolfo Springs)-met, Upper Peace River (at Ft. Meade)-not met, and Upper Peace River (at Bartow)-not met. Status update process is ongoing for this year (based on 2019 data) and should be completed this summer. Let me know if you have questions -- can call through TEAMs or at 352-397-7840. Could also check with Jason Patterson for additional information.
Read less
9:27 AM
Last message received on 5/14/2020 at 9:18 AM.
9:27 AM
5/14/2020

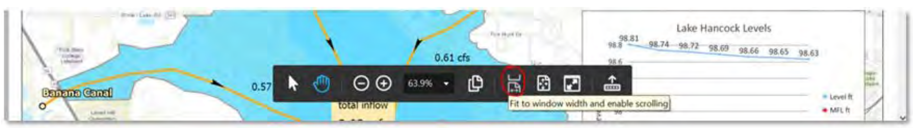
From:	Doug Leeper
To:	Paige Tara
Subject:	FW: Upper Peace River Status Report - 05/14/2020
Date:	Thursday, May 14, 2020 9:29:00 AM
Attachments:	UPRSummaryV2_05132020.pdf image001.png

Here's the latest weekly (or biweekly) status report for the Upper Peace River. This is not the same as the annual status determination report that I messaged you about.

Doug Leeper
MFLs Program Lead
Environmental Flows and Assessments Section
Natural Systems & Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street (U.S. Hwy. 41 South)
Brooksville, FL 34604-6899
352-796-7211, Ext. 4272
1-800-423-1476, Ext. 4272
Doug.leeper@watermatters.org

From: Taylor D. Lankford <Taylor.Lankford@swfwmd.state.fl.us>
Sent: Thursday, May 14, 2020 9:09 AM
To: Dave Testerman <David.Testerman@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>; Janie Hagberg <Janie.Hagberg@swfwmd.state.fl.us>; Mike Bartlett <Mike.Bartlett@swfwmd.state.fl.us>; Scott Letasi <Scott.Letasi@swfwmd.state.fl.us>; Lei Yang <Lei.Yang@swfwmd.state.fl.us>; Patrick Casey <Patrick.Casey@swfwmd.state.fl.us>; Jerry Mallams <Jerry.Mallams@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Catherine Wolden <Catherine.Wolden@swfwmd.state.fl.us>; Darrin Herbst <Darrin.Herbst@swfwmd.state.fl.us>; Ahmed H. Hamed <Ahmed.Hamed@swfwmd.state.fl.us>; Will Vangelder <William.VanGelder@swfwmd.state.fl.us>; Dawn Turner <Dawn.Turner@swfwmd.state.fl.us>; Miguel Gonzalez <Miguel.Gonzalez@swfwmd.state.fl.us>; Robin Bailey <Robin.Bailey@swfwmd.state.fl.us>; Brian Starford <Brian.Starford@swfwmd.state.fl.us>; Terese G. Power <Terese.Power@swfwmd.state.fl.us>; Mark Fulkerson <Mark.Fulkerson@swfwmd.state.fl.us>; RJ Dowling <Robert.Dowling@swfwmd.state.fl.us>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>
Cc: Jennette Seachrist <Jennette.Seachrist@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>
Subject: Upper Peace River Status Report - 05/14/2020

See attached **UPR Status Report V2** – Daft version that we are still working through some issues (dates seem to be off for some reason). Best if viewed using the fit to window width and enable scrolling pdf option:



All information is pulled directly from USGS and our SCADA system, programmed using Python in ArcGIS Pro, the data is dynamically updated based on the selection of a report date (05/13/2020 for example). I think it provides a nice visual overview and fixes the data to real locations in space. Some additional modules have yet to be added including lake level projections (Remaining Storage Days till 97.6 ft as seen in the current report) and information related to P-11 gate adjustments. This type of report can also be applied to other systems within the District if anyone is interested.

Original Status Report for 05/14/2020

Upper Peace River Status Report - 05/14/2020 *Previous Report Date: 05/11/2020*

Status

Around 0.24 inches of rain was observed at the P-11 structure over the past seven days. Lake levels are around **98.54 NGVD29-ft**. P-11 Weir Gate 2 continues to be adjusted to supplement flows at the MFL gage stations, **all stations above MFLs, monitoring flows at Ft Meade and Zolfo Springs**. Cell levels at the Wetland Treatment System (WTS) are on the lower end; pumping to WTS continues periodically for pump integrity purposes. About a 40% chance of rain tomorrow (5/15/2020). Staff will continue to monitor flows and provide structural recommendations to Operation's staff.

Actions since last report:

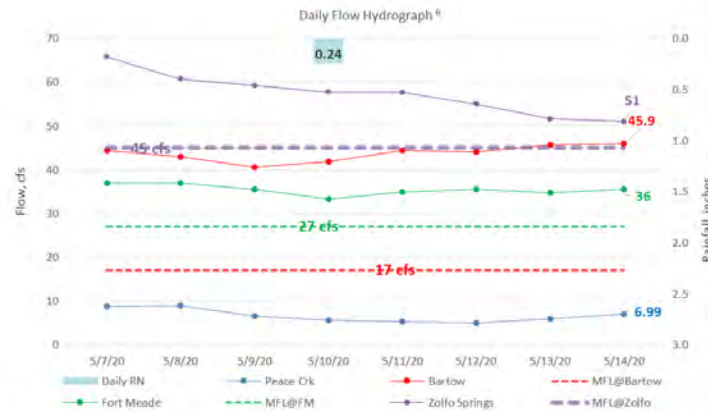
Adjustment of P-11 Weir Gate 2; pumping to the Wetland Treatment System

Scheduled Action:

Refinement of P-11 Weir Gates; Monitor lake levels, tributary inflows, and flow rates downstream

Flow Data (cfs) - 05/14/2020

Lake Tributary Inflow [1]	2
WTS Outfall [2]	0.0
P-11 Discharge [3]	41.0
Peace Creek near Bartow [4]	7
Peace River @ Bartow [4]	46
Peace River @ Fort Meade [4]	36
Peace River @ Zolfo Springs [4]	51

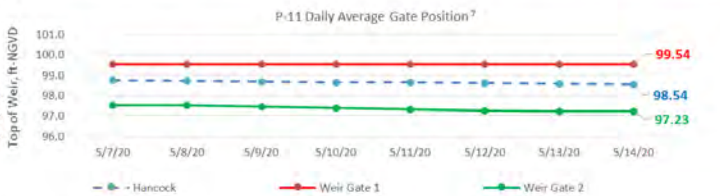


Based on Past 30 Days of Lake Level Data

Remaining Storage Days till 97.6 ft	48 Days
P-11 Closure Date	6/30/2020
Bartow, cfs Above MFL	**28.9**
Fort Meade, cfs Above MFL	**8.5**
Zolfo Springs, cfs Above MFL	**6**

Stage Data (ft-NGVD29) [5]

Lake Hancock	98.54		
WTS Cell 1	117.24	Depth	7.62 "
WTS Cell 2	115.87	Depth	9.18 "
WTS Cell 3	113.12	Depth	6.24 "



Infrastructure Check

P-11: Weir Gate 2 fully functional; Weir Gate 1 repaired and undergoing remote operation testing.

WTS: Structures staff repaired the leaking gates at the outfall structure (Cell 3 gates) on 01/17/2020.

Note: *WTS = Wetland Treatment System, PLC = Programmable Logic Controller, or SCADA gauge;* **Upper Peace River MFLs**: 17 cfs @Bartow; 27 cfs@Fort Meade; 45 cfs@Zolfo Springs

Until noted otherwise, the data related to the footnotes below are recorded on 05/14/2020

[1] Sum of tributary flows reported for the USGS gauges: Banana-Hancock Canal nr Highland City, Saddle Creek at SR 542 nr Lakeland, and Lake Lena Run nr Auburndale.

[2] Wetland Treatment System outfall flow from SCADA.

[3] Estimated using weir formula given gate elevations settings. A 0.15-ft tolerance was considered in weir flow estimate.

[4] The last reported USGS 15-minute data at the release of the status report was used.

[5] Cell stages/depths are average of inflow and outflow stages and depths if both are available.

[6] Rainfall read from SCADA from the site near P-11. Daily total were used for the chart.

[7] Full open position for weir gates 1 and 2 = 96 ft; close-up position for weir gates 1 and 2 = 100 ft.

Taylor Lankford, E.I.
Engineering and Watershed Management Section
Water Resources Bureau
Southwest Florida Water Management District
2379 Broad Street, Brooksville, FL 34604
(352) 796-7211 ext. 4338
Email: Taylor.Lankford@swfwmd.state.fl.us
http://www.swfwmd.state.fl.us/

From:	Taylor D. Lankford
To:	Dave Testerman; Randy Smith; Janie Hagberg; Mike Bartlett; Scott Letasi; Lei Yang; Patrick Casey; Jerry Mallams; Doug Leeper; Yonas Ghile; Gabe I. Herrick; Catherine Wolden; Darrin Herbst; Ahmed H. Hamed; Will Vangelder; Dawn Turner; Miguel Gonzalez; Robin Bailey; Brian Starford; Terese G. Power; Mark Fulkerson; RJ Dowling; Chris Zajac
Cc:	Jennette Seachrist; Eric DeHaven
Subject:	Upper Peace River Status Report - 05/14/2020
Date:	Thursday, May 14, 2020 9:09:47 AM
Attachments:	UPRSummaryV2_05132020.pdf image004.png

See attached **UPR Status Report V2** – Daft version that we are still working through some issues (dates seem to be off for some reason). Best if viewed using the fit to window width and enable scrolling pdf option:

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Original Status Report for 05/14/2020

Upper Peace River Status Report - 05/14/2020

Previous Report Date: 05/11/2020

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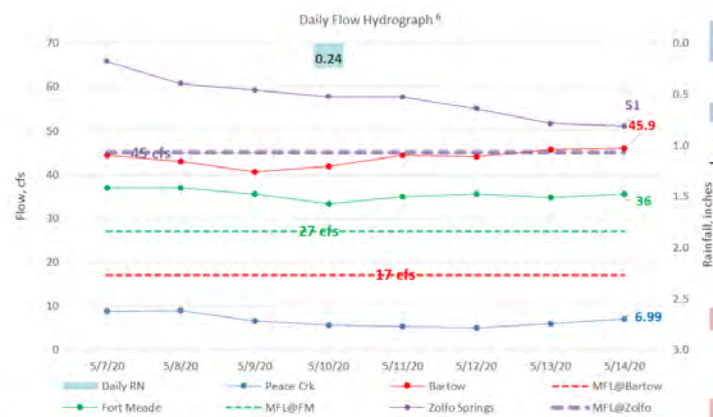

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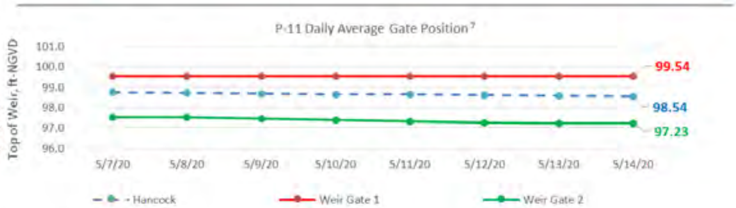

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Note: *WTS = Wetland Treatment System, PLC = Programmable Logic Controller, or SCADA gauge;* **Upper Peace River MFLs**: 17 cfs @Bartow; 27 cfs@Fort Meade; 45 cfs@Zolfo Springs

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[2] Wetland Treatment System outfall flow from SCADA.

[3] Estimated using weir formula given gate elevations settings. A 0.15-ft tolerance was considered in weir flow estimate.

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[5] Cell stages/depths are average of inflow and outflow stages and depths if both are available.

[6] Rainfall read from SCADA from the site near P-11. Daily total were used for the chart.

[7] Full open position for weir gates 1 and 2 = 96 ft; close-up position for weir gates 1 and 2 = 100 ft.

Taylor Lankford, E.I.
Engineering and Watershed Management Section
Water Resources Bureau
Southwest Florida Water Management District
2379 Broad Street, Brooksville, FL 34604
(352) 796-7211 ext. 4338
Email: Taylor.Lankford@swfwmd.state.fl.us
http://www.swfwmd.state.fl.us/

From:	Sid Flannery
To:	Doug Leeper
Subject:	Fwd: Revised Draft BL MF paper
Date:	Friday, May 22, 2020 6:43:28 AM
Attachments:	Draft52 BL MF TEXT (5-17-20).docx Draft52 BL MF TABLES (5-17-20).docx Draft52 BL MF FIGURES (5-17-20) G.docx

Doug,

See below - will copy you on Monday. How on earth did Table 2 get in there - don't believe it was in earlier drafts. Also, in my opinion this paper does not present nearly enough information for it to be touting the percent of flow method. Is more misleading than helpful. I think those statements can be quickly and easily edited.

The the latest version of the paper, figures, and tables are attached. I understand Rubec needs to resubmit it by June 2 - plenty of time.

Sid

---------- Forwarded message ---------
From: **Sid Flannery** <sidflannery22@gmail.com>
Date: Thu, May 21, 2020 at 5:18 PM
Subject: Re: Revised Draft BL MF paper
To: <peterrubec@cs.com>
Cc: Yonas.Ghile@swfwmd.state.fl.us <Yonas.Ghile@swfwmd.state.fl.us>, Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us> <Xinjian Chen > <Xinjian.Chen@swfwmd.state.fl.us>, joan.browder@noaa.gov <joan.browder@noaa.gov> <joan.browder@noaa.gov > <joan.browder@noaa.gov>, joanabrowder@gmail.com <joanabrowder@gmail.com> <joanabrowder@gmail.com > <joanabrowder@gmail.com>, christi.santi@myfwc.com <christi.santi@myfwc.com> <christi.santi@myfwc.com > <christi.santi@myfwc.com>, richard.flamm@myfwc.com <richard.flamm@myfwc.com>

Hello Peter and others,

I will be able to review the latest draft of the manuscript this weekend and will reply on Monday at the latest. Preliminarily, it looks like Table 2 is new from the previous draft. I don't think it is needed as I don't believe that output from those scenarios were provided to you for HSM modeling. It is also misleading as the final minimum flow scenario has three flow reduction percentages established for low, medium, and high flows in each water body (four in the Peace counting the low flow cutoff).

Other than flows, I expect my technical comments to be minor, or more likely none at all. However, I think some of the language in the abstract and conclusions could be quickly and efficiently modified to not defend the percent of flow method so much. Instead, the language could be quickly modified to conclude this is paper shows how HSM mapping and modeling can generally be used to assess the effect of freshwater inflow reductions. I'll explain why by Monday.

Sid

On Thu, May 21, 2020 at 11:42 AM <peterrubec@cs.com> wrote:

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> Subject: RE: Revised Draft BL MF paper
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> **Sent:** Tuesday, May 19, 2020 9:47 PM
> **To:** Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; sidflannery22@gmail.com; joan.browder@noaa.gov; joanabrowder@gmail.com; christi.santi@myfwc.com; peterrubec@cs.com; richard.flamm@myfwc.com
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Everyone: Please send more suggestions.

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Email: peterrubec@cs.com
Tel. 727-327-9226

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I need to resubmit prior to June 5th. Please send me your comments as soon as possible.

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Tel. 727-327-9226
Email: peterrubec@cs.com

From:	Doug Leeper
To:	Sid Flannery
Cc:	Yonas Ghile; Xinjian Chen
Subject:	FW: Revised Draft BL MF paper
Date:	Friday, May 22, 2020 8:42:00 AM
Attachments:	Draft52 BL MF TEXT (5-17-20).docx Draft52 BL MF TABLES (5-17-20).docx Draft52 BL MF FIGURES (5-17-20) G.docx

Big thanks, Sid. I will have to look at this next week.

Doug Leeper
MFLs Program Lead
Environmental Flows and Assessments Section
Natural Systems & Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street (U.S. Hwy. 41 South)
Brooksville, FL 34604-6899
352-796-7211, Ext. 4272
1-800-423-1476, Ext. 4272
Doug.leeper@watermatters.org

From: Sid Flannery <sidflannery22@gmail.com>
Sent: Friday, May 22, 2020 6:42 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: Fwd: Revised Draft BL MF paper

Doug,

See below - will copy you on Monday. How on earth did Table 2 get in there - don't believe it was in earlier drafts. Also, in my opinion this paper does not present nearly enough information for it to be touting the percent of flow method. Is more misleading than helpful. I think those statements can be quickly and easily edited.

The the latest version of the paper, figures, and tables are attached. I understand Rubec needs to resubmit it by June 2 - plenty of time.

Sid

---------- Forwarded message ---------
From: **Sid Flannery** <sidflannery22@gmail.com>
Date: Thu, May 21, 2020 at 5:18 PM
Subject: Re: Revised Draft BL MF paper
To: <peterrubec@cs.com>
Cc: Yonas.Ghile@swfwmd.state.fl.us <Yonas.Ghile@swfwmd.state.fl.us>, Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us> <Xinjian Chen > <Xinjian.Chen@swfwmd.state.fl.us>, joan.browder@noaa.gov <joan.browder@noaa.gov> <joan.browder@noaa.gov > <joan.browder@noaa.gov>, joanabrowder@gmail.com <joanabrowder@gmail.com>

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From:	Doug Leeper
To:	"Sid Flannery"
Subject:	RE: Revised Draft BL MF paper
Date:	Saturday, May 23, 2020 7:44:00 AM

thanks

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From: Sid Flannery <sidflannery22@gmail.com>
Sent: Friday, May 22, 2020 11:38 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: Fwd: Revised Draft BL MF paper

see below - you were not copied on the recent email exchanges, but will plug you in next week. Yonas and Xinjian agree with me on taking Table 2 out. Will copy you next week's communications.

Sid

---------- Forwarded message ---------
From: **Xinjian Chen** <Xinjian.Chen@swfwmd.state.fl.us>
Date: Fri, May 22, 2020 at 11:13 AM
Subject: RE: Revised Draft BL MF paper
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>, Sid Flannery <sidflannery22@gmail.com>, peterrubec@cs.com <peterrubec@cs.com>
Cc: joan.browder@noaa.gov <joan.browder@noaa.gov> <joan.browder@noaa.gov > <joan.browder@noaa.gov>, joanabrowder@gmail.com <joanabrowder@gmail.com> <joanabrowder@gmail.com > <joanabrowder@gmail.com>, christi.santi@myfwc.com <christi.santi@myfwc.com> <christi.santi@myfwc.com > <christi.santi@myfwc.com>, richard.flamm@myfwc.com <richard.flamm@myfwc.com>

Hi Peter,

I agree with Yonas and Sid to delete Table 2.

Thanks,

XinJian

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Friday, May 22, 2020 11:07 AM
To: Sid Flannery <sidflannery22@gmail.com>; peterrubec@cs.com
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; joan.browder@noaa.gov <joan.browder@noaa.gov> <joan.browder@noaa.gov > <joan.browder@noaa.gov>; joanabrowder@gmail.com <joanabrowder@gmail.com> <joanabrowder@gmail.com > <joanabrowder@gmail.com>; christi.santi@myfwc.com <christi.santi@myfwc.com> <christi.santi@myfwc.com > <christi.santi@myfwc.com>; richard.flamm@myfwc.com
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Peter
I agree with Sid, Table 2 is misleading and it shouldn't be added in your paper. XinJian run his hydrodynamic model from 0 % to 40% withdrawal to calculate the 15% reduction in isohaline habitats. The Hydrodynamic model output used in the HSM model was based on the proposed minimum flows (13% in B1, 23%in B2 and 40% in Block 3). Please delete the table and mention in in the hydrodynamic model section that "the hydrodynamic model was run from 2007 through 2014 for 0% to 40% withdrawal scenarios to determine the minimum flows that protect 85% of the salinity habitats.

Table 3 has also two misleading information.

1. the percent reduction in flows (Column 4 and column 8) is not needed as percent of flow is applied on daily basis for each block (not on seasonal averages). The change in flows between BL and MF is enough.

2. You should either add a foot note to the table 3 that "there is a 400 cfs limit in LPR that was not applied here to determine maximum impact of withdrawals", or alternatively we have to update the information with the 400 cfs withdrawal limit.

Please let me know if you have any question.
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From:	Doug Leeper
To:	Sid Flannery
Cc:	Yonas Ghile; Xinjian Chen; Chris Zajac
Subject:	FW: Rubec flow data
Date:	Saturday, May 23, 2020 1:13:00 PM

Sid:

- The Figure below from Yonas shows baseline and minimum flow records. For this "true" minimum flows record, a 400 cfs cap was applied.
- As you know, and we have discussed with Peter, the "minimum flow" scenario that Peter used for his habitat suitability modeling did not include the 400 cfs cap.

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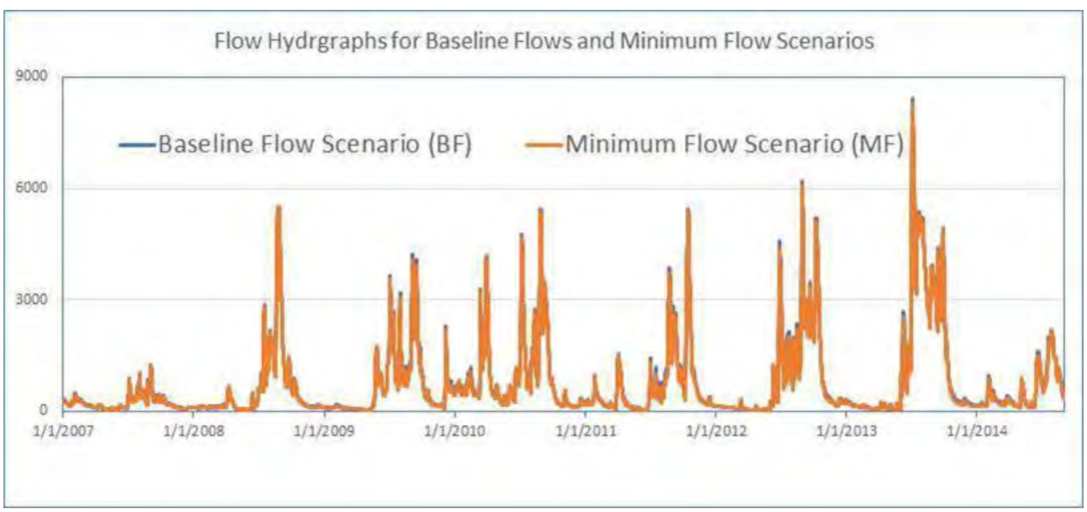
Subject: RE: Rubec flow data



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Sent: Saturday, May 23, 2020 12:48 PM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>

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From:	Doug Leeper
To:	Sid Flannery
Cc:	Yonas Ghile; Xinjian Chen; Chris Zajac
Subject:	FW: Rubec flow data
Date:	Saturday, May 23, 2020 1:13:00 PM

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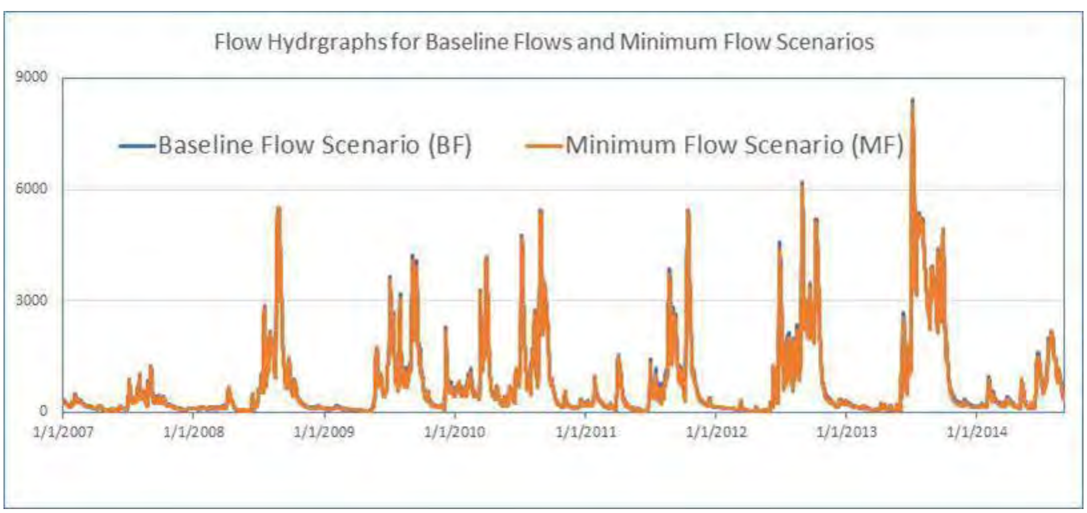

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From:	Doug Leeper
To:	Sid Flannery; Yonas Ghile
Cc:	Xinjian Chen; Chris Zajac
Subject:	did not get emails
Date:	Saturday, May 23, 2020 2:56:00 PM

Folks:

- Something is wrong with my email account.
- I listened to a voicemal from Sid, logged into my email account on my District laptop, opened an email from Sid that started with something like…"I know…." and then poof, the email was gone.
- Suspect this may have happened with a second email that Yonas indicated he was going to send me earlier after I sent an email after getting a call from Sid.
- Sid's email is not in my clutter or junk email folders… it's just gone.
    - Not kidding, the dog did not eat my homework.
- So, can you resend – try again.

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From:	Sid Flannery
To:	Doug Leeper
Subject:	Fwd: FW: Rubec flow data
Date:	Saturday, May 23, 2020 3:12:15 PM
Attachments:	Seasonal flow average Table from Rubec power point file with Sid numbers in second slide.pptx

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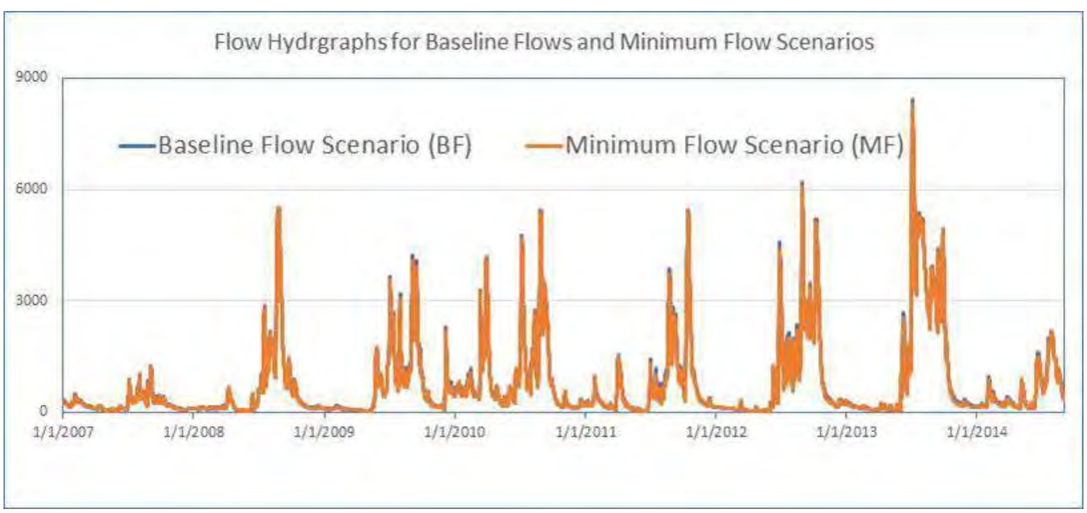

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Seasonal mean Baseline, mean Minimum Flows and Difference in Flows in Lower Peace River and Lower Shell Creek from 2007 to 2014

	Lower Peace River			Lower Shell Creek		
Season	Mean Baseline Flows (cfs)	Mean Minimum Flows (cfs)	Difference in Flows (cfs)	Mean Baseline Flows (cfs)	Mean Minimum Flows (cfs)	Difference in Flows (cfs)
Jan-Mar	278	258	20	67	39	28
Apr-Jun	374	356	18	152	92	59
Jul-Sep	1897	1825	72	814	520	294
Oct-Dec	627	592	35	216	141	75

Daily flow reductions limited to maximum value of 400 cfs

1

Sid's numbers

	Lower Peace River			Lower Shell Creek		
Season	Mean Baseline Flows (cfs)	Mean Minimum Flows (cfs)	Difference in Flows (cfs)	Mean Baseline Flows (cfs)	Mean Minimum Flows (cfs)	Difference in Flows (cfs)
Jan-Mar	277	233	44	69	51	17
Apr-Jun	372	298	74	153	99	53
Jul-Sep	1896	1581	314	814	490	324
Oct-Dec	630	523	107	218	137	81

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2

From:	Doug Leeper
To:	Sid Flannery
Cc:	Yonas Ghile; Xinjian Chen; Chris Zajac
Subject:	RE: FW: Rubec flow data
Date:	Saturday, May 23, 2020 3:29:00 PM
Attachments:	Seasonal flow average Table from Rubec power point file with Sid numbers in second slide.pptx

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- Copying Yonas and XinJian on this response, so they are aware of your questions.
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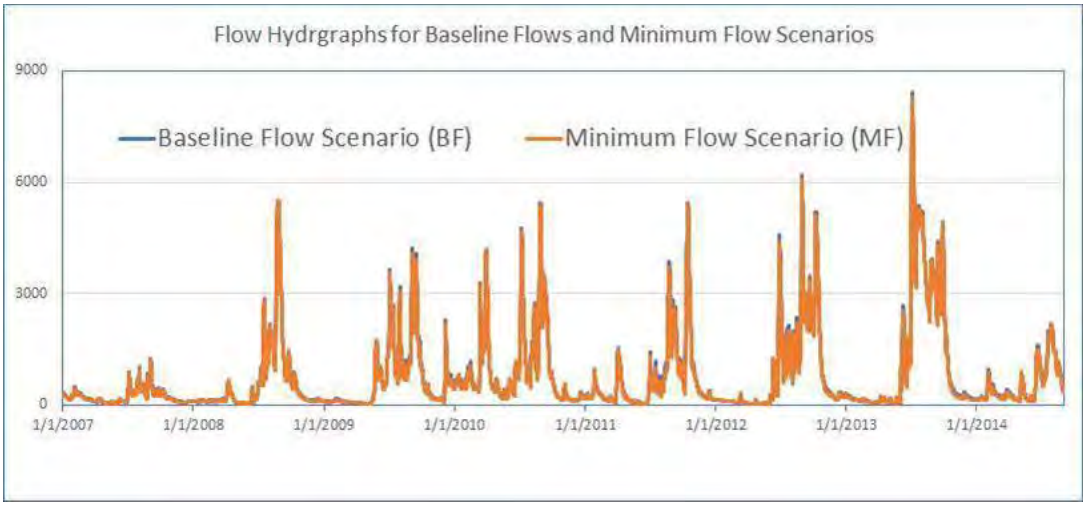

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Cc:	Yonas Ghile; Xinjian Chen; Chris Zajac
Subject:	Re: FW: Rubec flow data
Date:	Saturday, May 23, 2020 4:17:27 PM

Yes, the caption can be revised once it resolved if the 400 cfs limit applies to the total three gages you refer to or if Shell is included in the 400 cfs limit as well. I am bailing out now, this is cutting into my day drinking - see photo.

Actually can check any responses later.

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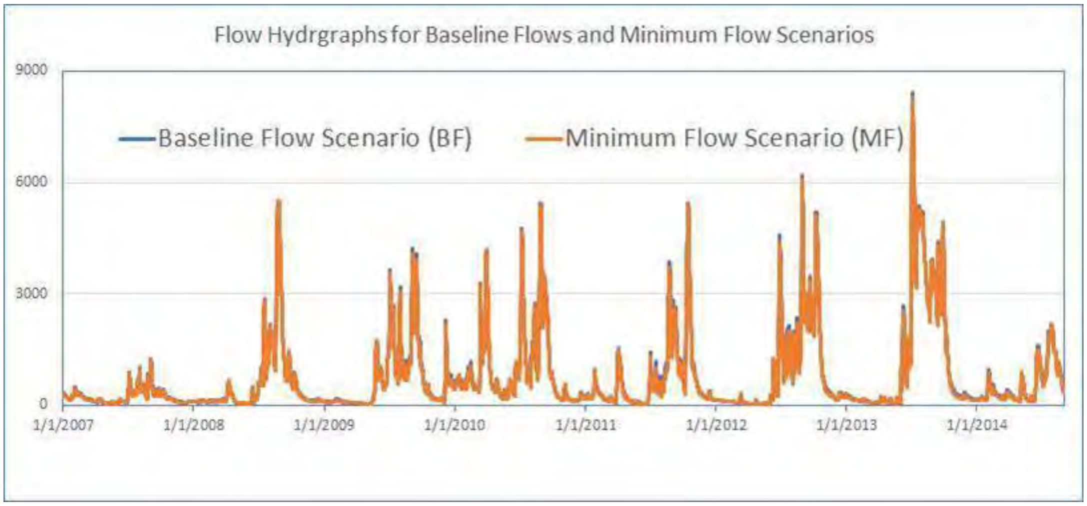

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To:	Sid Flannery; Doug Leeper
Cc:	Xinjian Chen; Chris Zajac
Subject:	RE: FW: Rubec flow data
Date:	Saturday, May 23, 2020 11:11:26 PM
Attachments:	Updated slide_yg.pptx

Sid, thanks for your review. There was a typo error in the MF scenario for Jul-Sep average value (1825 instead of 1582)-that caused the 72 cfs difference. However, there are slight differences between your numbers and my numbers for both systems. The differences could be due to.

LPR

1. **MFL application**: Probably you applied 13% when flow < 297 cfs, 23% when flow <622 and 40% when flow >622 cfs (maximum 400 cfs).
   There are days in which full withdrawal is not allowed. For e.g. if flow is 650 cfs, withdrawal is not 260 cfs (40% of 650 cfs). It is 171 cfs (650-622 cfs +23% of 622 cfs). To withdraw 40%, the flow should be at or above 1037 cfs. This approach is more conservative than the above one. Please refer the proposed MFLs table in the MFLs report for more information.
2. There could be evaluation period difference. Initially I run the model for longer period but in the attached file I run it from 01/01/2007 – 08/31/2014- to match the hydrodynamic modeling
3. I am not sure if you have got the baseline flows adjusted based on PRIM model – but this has not significant impact
4. Withdrawal is calculated based on previous flow day- not significant impact

SC

We have a reservoir routing model that calculates the actual MFL release required based on city's withdrawals, seepage, inflows and the proposed MFL. In the table I sent to Peter I have used the model and run it for a longer period, I have calculated the MF scenario now based on the proposed MFL only for 01/01/2007 – 08/31/2014. The slight difference between your number and my number could be due to:

1. Baseline flow record difference
2. Withdrawal is calculated based on previous flow day

My recommendation to Peter is not the table, it is a median daily hydrograph (3 slide in the attached file) that shows clearly the difference between BL and MF. But Peter does not want to use it.

Please review the updated table and let me know if you have any question. I am going send it to Peter tomorrow.
Have a nice weekend!

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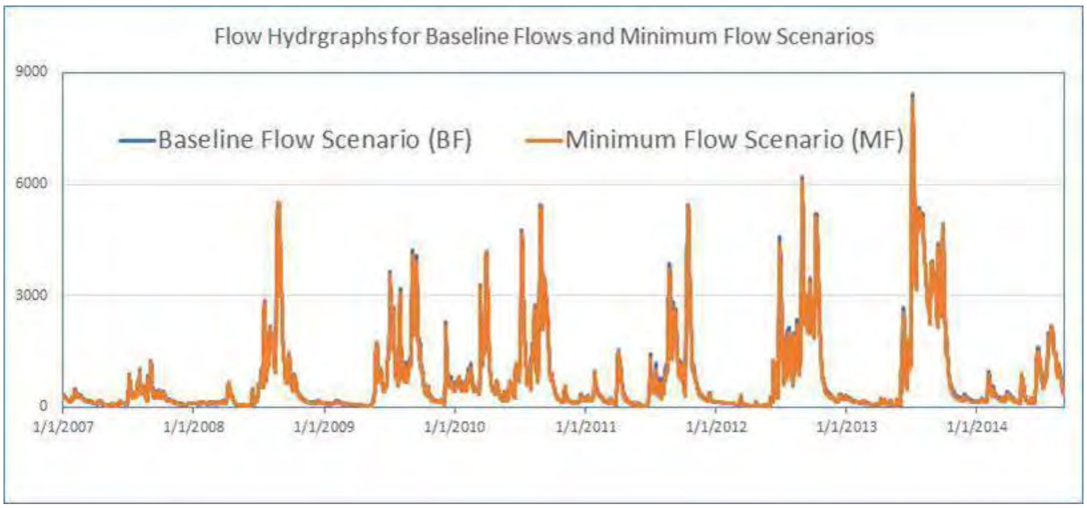

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Updated Yonas Number

Season	Lower Peace River			Lower Shell Creek		
	Mean Baseline Flows (cfs)	Mean Minimum Flows (cfs)	Difference in Flows (cfs)	Mean Baseline Flows (cfs)	Mean Minimum Flows (cfs)	Difference in Flows (cfs)
Jan-Mar	277	227	50	67	47	20
Apr-Jun	372	292	80	150	91	59
Jul-Sep	1898	1576	322	807	494	313
Oct-Dec	533	455	78	199	132	67

Daily flow reductions limited to maximum value of 400 cfs

1

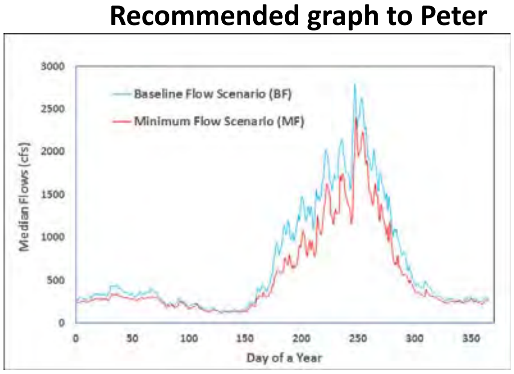
Sid's numbers

Season	Lower Peace River			Lower Shell Creek		
	Mean Baseline Flows (cfs)	Mean Minimum Flows (cfs)	Difference in Flows (cfs)	Mean Baseline Flows (cfs)	Mean Minimum Flows (cfs)	Difference in Flows (cfs)
Jan-Mar	277	233	44	69	51	17
Apr-Jun	372	298	74	153	99	53
Jul-Sep	1896	1581	314	814	490	324
Oct-Dec	630	523	107	218	137	81

Daily flow reductions limited to maximum value of 400 cfs

2

Recommended graph to Peter



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3

From:	Sid Flannery
To:	Yonas Ghile
Cc:	Doug Leeper; Xinjian Chen; Chris Zajac
Subject:	Re: FW: Rubec flow data
Date:	Sunday, May 24, 2020 8:47:14 AM

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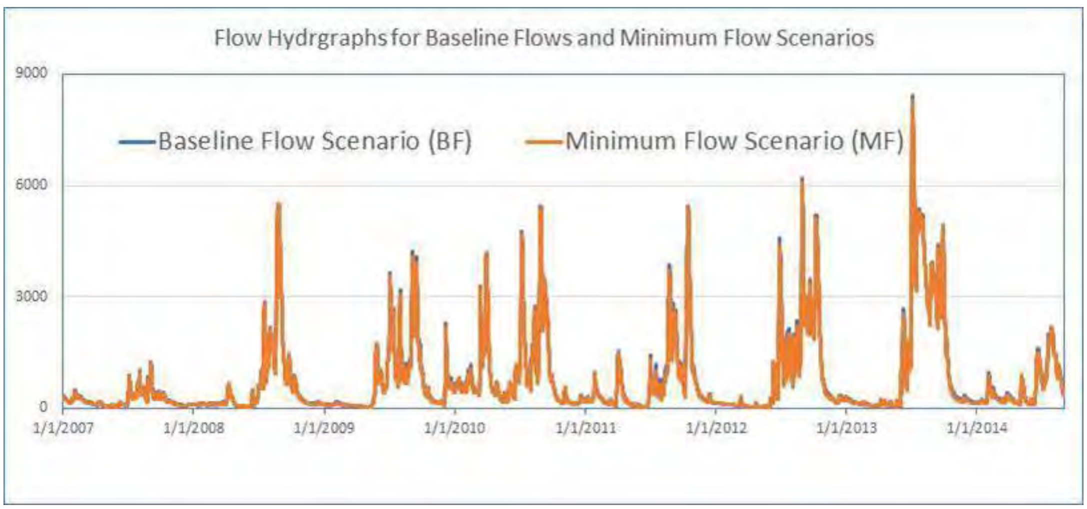

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Subject:	Hydrograph for Rubec"s power presentation
Date:	Sunday, May 24, 2020 12:04:20 PM
Attachments:	Lower Peace Minimum Flows 2007-2014 from Sid.xls Two Lower Peace hydrographs.pptx

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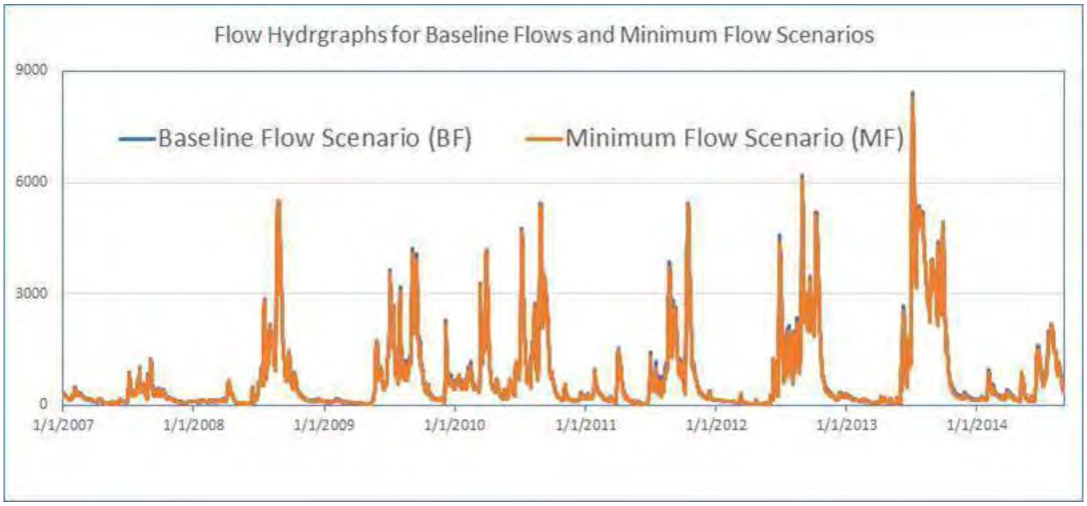

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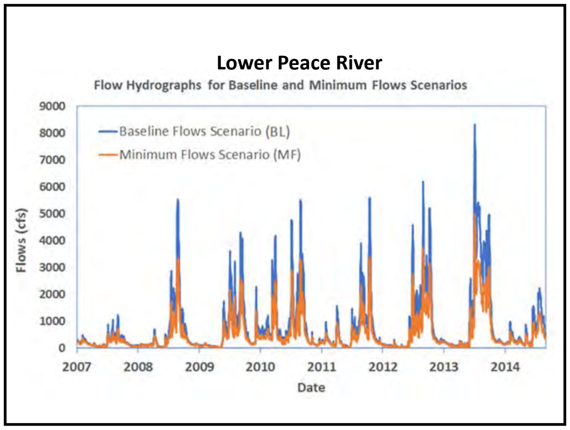
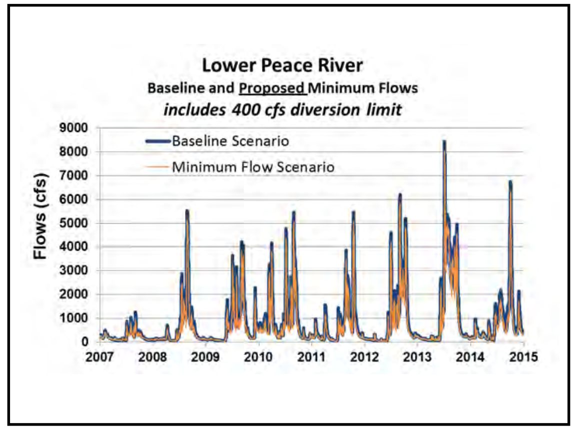


Lower Peace River
Flow Hydrographs for Baseline and Minimum Flows Scenarios
Baseline Flows Scenario (BL)
Minimum Flows Scenario (MF)
Flows (cfs)
Date

1



Lower Peace River
Baseline and Proposed Minimum Flows
includes 400 cfs diversion limit
Baseline Scenario
Minimum Flow Scenario
Flows (cfs)

2

From:	Doug Leeper
To:	Sid Flannery; Yonas Ghile
Cc:	Xinjian Chen; Chris Zajac
Subject:	RE: Hydrograph for Rubec"s power presentation
Date:	Sunday, May 24, 2020 2:27:00 PM

Hey all:

- Checked back in at 2 pm today (Sunday), folks.
- Read emails sent yesterday after I checked out, as well as today's emails.

Here's my two-cents:

- Agree someone of some of us from the District should be on the symposium/conference call to "chime-in" and address any questions concerning our proposed minimum flows.
- Also agree that it would be good for Peter to show hydrograph of the baseline and alternate or "potential minimum flows" scenarios that he used for the habitat suitability modeling, show a figure that displays the baseline flows and the actual proposed minimum flow (with a 400 cfs cap on Peace withdrawals), and note that the proposed minimum flows (with the 400 cfs cap) more closely mimic the baseline flows.
    - That is, he should emphasize that the differences in habitat suitability that he modeled (baseline vs. the alternate scenario) are greater than the differences that would be expected between baseline conditions and conditions associated with implementation of the minimum flows that we are actually proposing.

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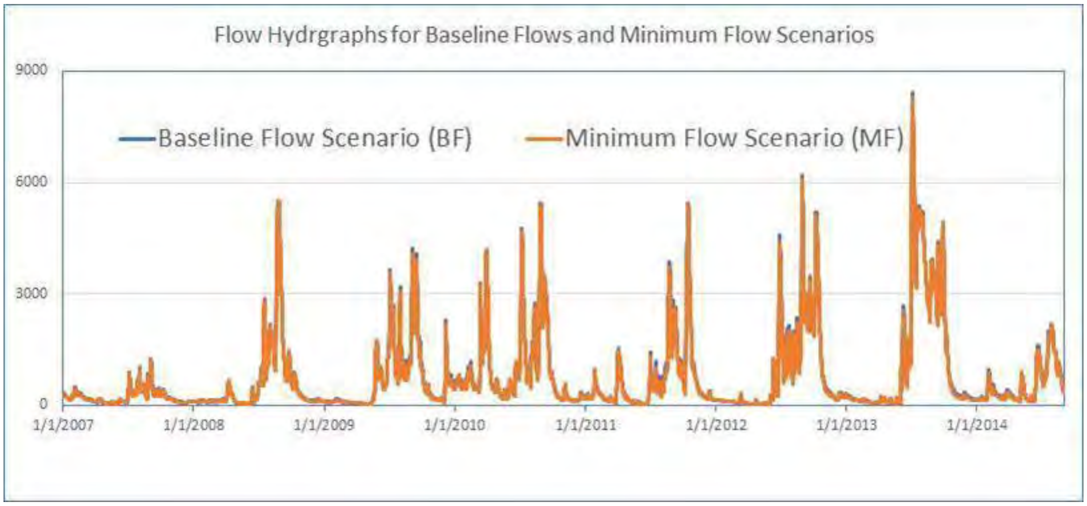

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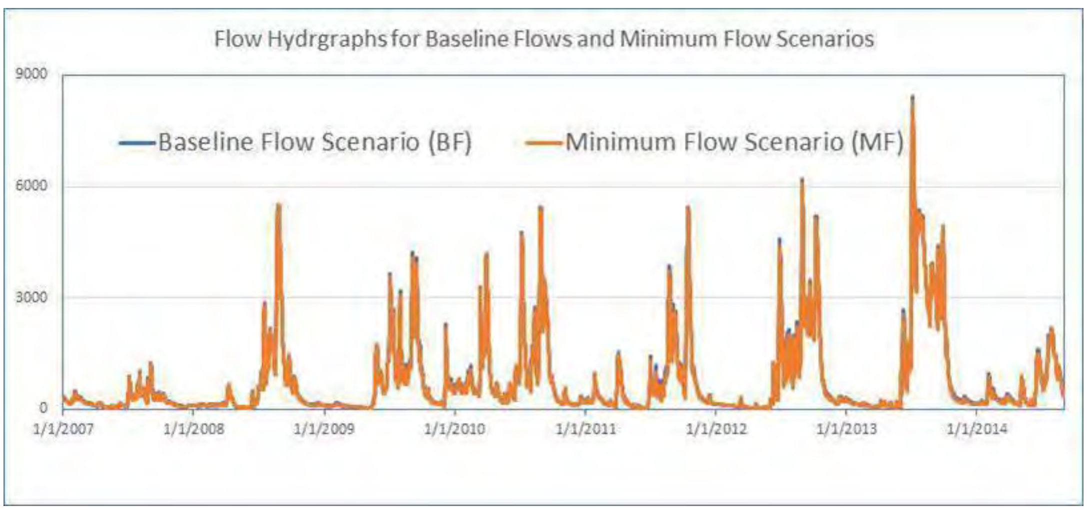

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Date:	Sunday, May 24, 2020 12:18:03 PM

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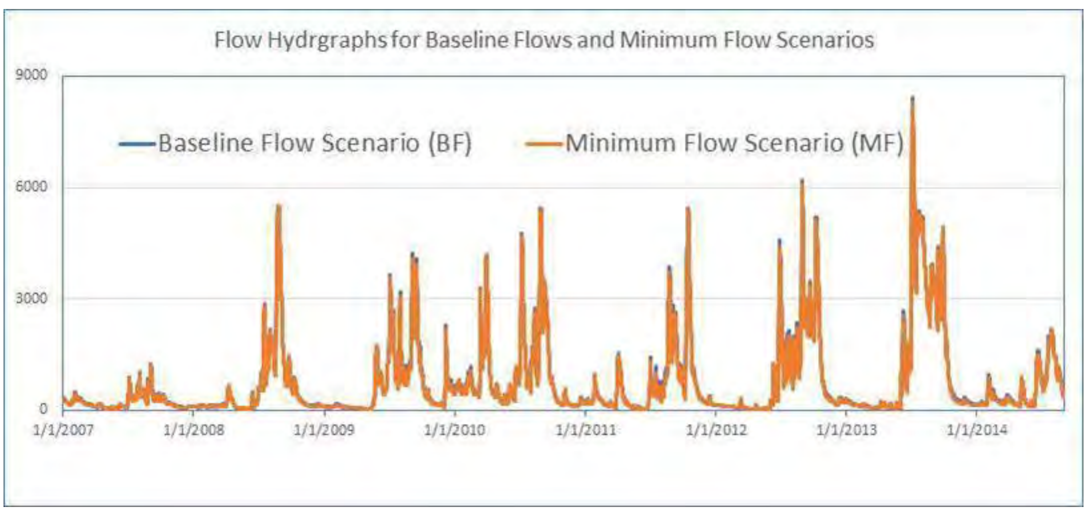

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Environmental Flows and Assessments Section

Natural Systems & Restoration Bureau

Southwest Florida Water Management District

2379 Broad Street (U.S. Hwy. 41 South)

Brooksville, FL 34604-6899

352-796-7211, Ext. 4272

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Doug.leeper@watermatters.org

From:	Sid Flannery
To:	Yonas Ghile
Cc:	Doug Leeper; Xinjian Chen; Chris Zajac
Subject:	Re: Hydrograph for Rubec"s power presentation
Date:	Sunday, May 24, 2020 12:16:06 PM

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Subject: Re: FW: Rubec flow data

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Sent: Saturday, May 23, 2020 12:58 PM
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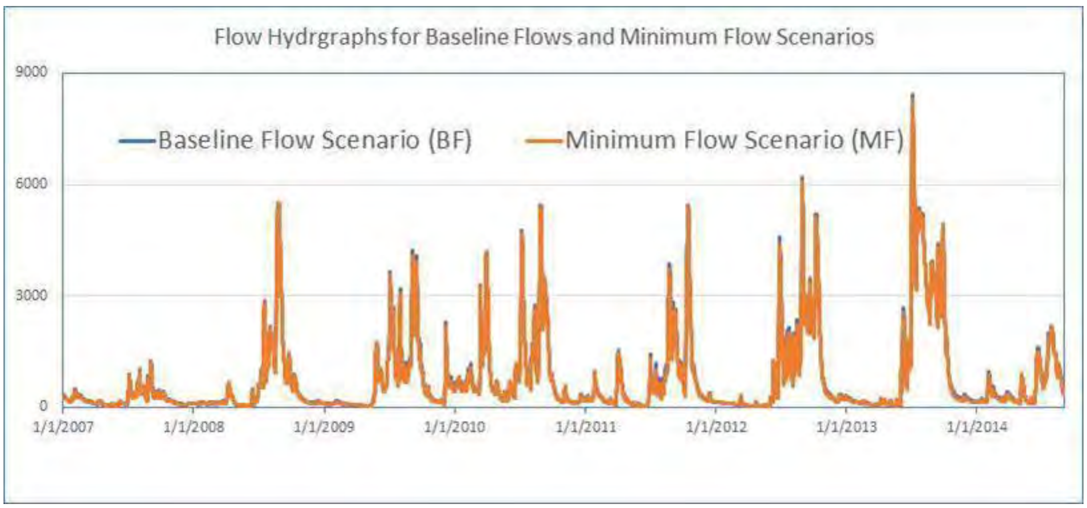
Subject: RE: Rubec flow data



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Date:	Sunday, May 24, 2020 2:35:00 PM

OK – I see now we all are in agreement. Thanks.

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Subject: Re: Hydrograph for Rubec's power presentation

That would be the second in addition to the first, as you describe, to point out the difference in the two applications (HSM modeling vs. proposed minimum flow)

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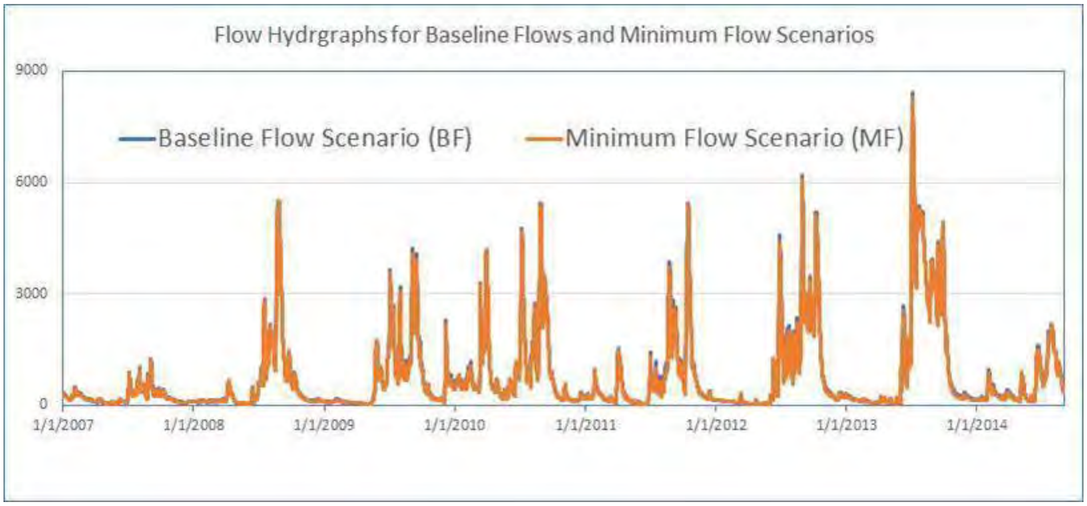

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Yes, I sent the second hydrograph to Peter and he agreed to use the two hydrographs and discuss the scenario his analyses were based on involved more water taken from the river than the proposed minimum flows. He may not use the average flow tables as they are a bit tedious to explain and he may be pressed for time. This all seems to have worked out pretty well.

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> Hey all:
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> - Checked back in at 2 pm today (Sunday), folks.
> - Read emails sent yesterday after I checked out, as well as today's emails.
>
> Here's my two-cents:
>
> - Agree someone of some of us from the District should be on the symposium/conference call to "chime-in" and address any questions concerning our proposed minimum flows.
> - Also agree that it would be good for Peter to show hydrograph of the baseline and alternate or "potential minimum flows" scenarios that he used for the habitat suitability modeling, show a figure that displays the baseline flows and the actual proposed minimum flow (with a 400 cfs cap on Peace withdrawals), and note that the proposed minimum flows (with the 400 cfs cap) more closely mimic the baseline flows.
>   - That is, he should emphasize that the differences in habitat suitability that he modeled (baseline vs. the alternate scenario) are greater than the differences that would be expected between baseline conditions and conditions associated with implementation of the minimum flows that we are actually proposing.
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>
> I see also where your revised numbers for the other seasons in the Peace have changed from the previous table and now look much more plausible, as the differences in the averages between baseline and minimum flows seemed to be too low before. The values in your updated table and my values are now much closer. I am not concerned about the differences at this point.

I did do the calculations as you described below for the 650 cfs example, with one clarification. I think you left out below that the difference between 650 and 622 cfs should be multiplied by 0.4 (hey it was late Saturday night). At least that is how I read Table 6-7 on page 116 in the minimum flows report. I think that is really a positive step and glad the District has implemented that. I also calculated the percent withdrawals on preceding day flow but that has almost no effect on long term averages.

There are some other factors that could affect our differences in the numbers, such as I extended my values through all of 2014, I did not use the PRIM baseline flows for Peace, and how I corrected the baseline flow record Shell Creek for withdrawals. Again, I'm not concerned about these factors as the values now look much closer.

One thing I want to verify is the 400 cfs diversion limit was employed on the Lower Peace, but not Shell Creek. Is that correct? If so, the bottom caption in Peter's slide should be clear on that.

BTW - Either today or tomorrow I hope to submit to Peter some review comments on his manuscript and will copy all. As I mentioned in an email on Friday, I don't expect to have any purely technical comments, but some of the language needs to be revised to not be such a sell job for the percent of flow method. Due to space concerns, this paper does not have room to do the percent of flow method justice. The presentation of average flows, which did not employ the 400 cfs diversion limit for the Peace is kinda misleading, but can be lived with if there is a qualifier in the text. Peter's work is a good demonstration of how his modeling approach can be generally used to assess the effects of changes in freshwater inflows, but not as a defense of the percent of flow method. Over-reaching on that without sufficient detail reads like bad science and bad resource management. This can all be avoided and will require only small wording changes as I will describe in my review comments.

Thanks very much,

Sid

On Sat, May 23, 2020 at 11:11 PM Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>

wrote:

Sid, thanks for your review. There was a typo error in the MF scenario for Jul-Sep average value (1825 instead of 1582)-that caused the 72 cfs difference. However, there are slight differences between your numbers and my numbers for both systems. The differences could be due to.

LPR

1. **MFL application**: Probably you applied 13% when flow < 297 cfs, 23% when flow <622 and 40% when flow >622 cfs (maximum 400 cfs).

There are days in which full withdrawal is not allowed. For e.g. if flow is 650 cfs, withdrawal is not 260 cfs (40% of 650 cfs). It is 171 cfs (650-622 cfs +23% of 622 cfs). To withdraw 40%, the flow should be at or above 1037 cfs. This approach is more conservative than the above one. Please refer the proposed MFLs table in the MFLs report for more information.

2. There could be evaluation period difference. Initially I run the model for longer period but in the attached file I run it from 01/01/2007 – 08/31/2014- to match the hydrodynamic modeling
3. I am not sure if you have got the baseline flows adjusted based on PRIM model – but this has not significant impact
4. Withdrawal is calculated based on previous flow day- not significant impact

SC

We have a reservoir routing model that calculates the actual MFL release required based on city's withdrawals, seepage, inflows and the proposed MFL. In the table I sent to Peter I have used the model and run it for a longer period, I have calculated the MF scenario now based on the proposed MFL only for 01/01/2007 – 08/31/2014. The slight difference between your number and my number could be due to:

1. Baseline flow record difference
2. Withdrawal is calculated based on previous flow day

My recommendation to Peter is not the table, it is a median daily hydrograph (3 slide in the attached file) that shows clearly the difference between BL and MF. But Peter does not want to use it.

Please review the updated table and let me know if you have any question. I am going send it to Peter tomorrow.

Have a nice weekend!

From: Sid Flannery <sidflannery22@gmail.com>
Sent: Saturday, May 23, 2020 2:28 PM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>
Subject: Re: FW: Rubec flow data

Doug and others,

I am aware of the 400 cfs diversion limit issue and understand that the table that Yonas sent Peter had the 400 cfs diversion limit applied. A ppt file with the original numbers Yonas sent and some numbers I calculated is attached.

One possible complexity that may have caused me confusion is how was the 400 cfs maximum flow reduction is applied

What caught me as odd when talking with Peter on the phone this morning was the very low difference in flows in the Peace River for July - September - an average baseline flow of 1896 cfs and only 72 cfs available for withdrawal. That really looks weird going before the public. See the large difference for the same season in Shell Creek, which had less than half the baseline flow. Maybe these numbers are plausible if the Shell Creek flow reductions were applied first, then the remaining flow reductions up to 400 cfs were applied to the Peace. That is all I can think of.

The second slide are numbers I calculated with the 400 cfs limit applied individually for Peace and Shell. I realize now that might not be right.

So, how was the 400 cfs total withdrawal limit applied between Shell and Peace?   I would think the 400 cfs issue would be less pronounced in the low flow season, which in this study was January - March. My and Yonas's numbers differ in other seasons especially for the Peace, but I have not applied 400 cfs total between the two streams.

Regardless, the low low difference numbers in the Peace seem odd. Need to check the method and at a minimum explain why this occurs. If Peter had that explanation before his presentation that should suffice.

Sid

On Sat, May 23, 2020 at 1:14 PM Doug Leeper <Doug.Leeper@swfwmd.state.fl.us> wrote:

Sid:

- The Figure below from Yonas shows baseline and minimum flow records. For this "true" minimum flows record, a 400 cfs cap was applied.
- As you know, and we have discussed with Peter, the "minimum flow" scenario that Peter used for his habitat suitability modeling did not include the 400 cfs cap.

Doug Leeper

MFLs Program Lead

Environmental Flows and Assessments Section

Natural Systems & Restoration Bureau

Southwest Florida Water Management District

2379 Broad Street (U.S. Hwy. 41 South)

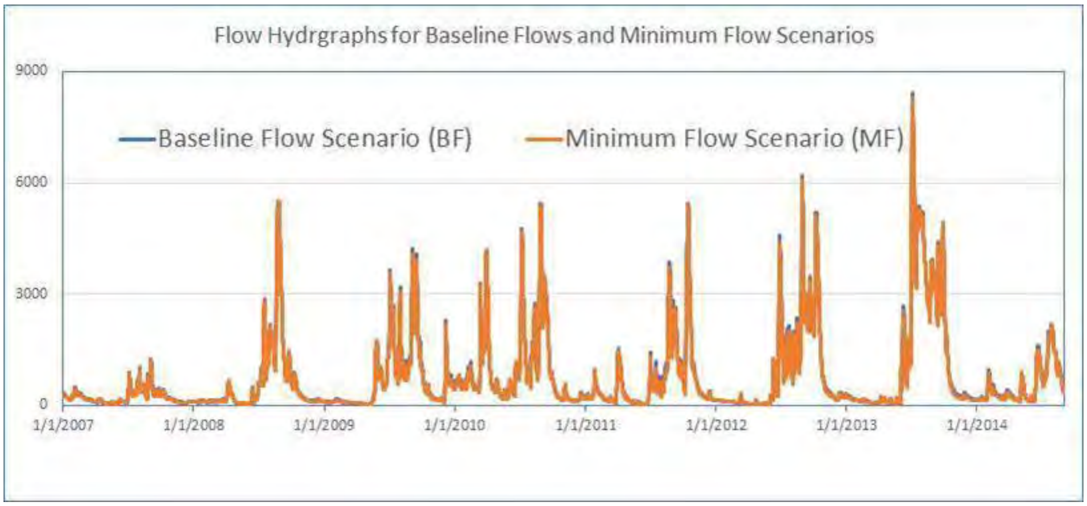
Brooksville, FL 34604-6899

352-796-7211, Ext. 4272

1-800-423-1476, Ext. 4272

Doug.leeper@watermatters.org

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Saturday, May 23, 2020 12:58 PM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: RE: Rubec flow data



From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Saturday, May 23, 2020 12:48 PM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>
Cc: Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Sid Flannery <sidflannery22@gmail.com>
Subject: Rubec flow data

- Sid just IM'd me on Facebook and called me to note that Peter Rubec plans to submit a powerpoint file for a CHNEP meeting today (a day late) --- and that he thinks there is a serious flaw in the information.

- Sid noted that Peter indicated Yonas sent him a file recently with time-series of baseline and minimum flow condition flows for the Lower Peace River and Lower Shell Creek…and that Peter was using the data to prepare average flow values for and compare the two records.

Sid thinks the data area incorrect, and is planning to work up the data over the next hour or so, forward the information to me so I can provide it to Yonas, and ask us to send it to Peter today so he can update his slides and submit them today.

Doug Leeper

MFLs Program Lead

Environmental Flows and Assessments Section

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Brooksville, FL 34604-6899

352-796-7211, Ext. 4272

1-800-423-1476, Ext. 4272

Doug.leeper@watermatters.org

From:	Nicole Iadevaia
To:	"Amanda Kahn"; "Ashlee Edwards- Sarasota County Public Works Department"; "Betty Staugler"; "Dan Schabilion"; "Dave Sumpter - Wildlands Conservation"; "David Blewett - Florida Fish and Wildlife Conservation Commission"; "David Ceilley - Johnson Engineering, Inc."; "David Nellis - Nellis Enterprises"; "Devon Moore"; "Don Duke - FGCU"; "Erin Campbell"; "Ernesto Lasso de la Vega - Lee County Hyacinth Control District"; "Francis Lugo"; "Greg Blanchard - Manatee County Parks and Natural Resources Dept."; "Holly Milibrandt"; "Jamie Scudera"; "Jeff Devine - WCIND"; "Jim Beever"; "Justin Saarinen-"; "Kevin Kalasz - USFWS"; "Kraig Hankins - City of Cape Coral"; Lizanne Garcia; "Mark Sramek"; "Melynda Brown - DEP Charlotte Harbor AP"; "Patty Metz - USGS"; "Rae Burns"; "rbartleson@sccf.org"; "Rick Armstrong"; "Sam Stone"; "Steve Suau"; "Tabitha Biehl"; "Thornton Shelley - Mosaic"; ""Yesenia Escribano - FL Dept of Agriculture - Office of Water Policy"; "Roger Copp"; "Robert Weisberg"; "Fikoski, Kim"; "Kemmerer, Mike"; "Andrew.Pope@MyFWC.com"; "Kirk Martin"; "Church Roberts"; Mark Walton; "Lenz, Barry"; "Escribano, Yesenia"; "Daniel Roberts"; Lizanne Garcia; "Terri Holcomb"; "Margaret Wuerstle"; Chris Anastasiou; Doug Leeper; Yonas Ghile; Randy Smith; "chadd@fmbgov.com"; "Maya Robert - City of Cape Coral"
Cc:	Jennifer Hecker
Subject:	CHNEP TAC Meeting Follow Up
Date:	Friday, May 1, 2020 12:41:33 PM
Attachments:	image001.png

Dear Technical Advisory Committee Members and Meeting Attendees,
Coastal & Heartland National Estuary Partnership would like to thank the meeting presenters, TAC Co-Chair Justin Saarinen, and everyone who participated in our spring TAC meeting. A copy of the meeting PowerPoint and select video presentations are now available at https://www.chnep.org/technical-advisory-commitee. The video presentations include recent research from Dr. Robert Weisberg, College of Marine Science, University of South Florida: The Coastal Ocean Circulation Influence on the 2018 West Florida Shelf *K. brevis* Red Tide Bloom and Roger Copp, Water Science Associates, on the Charlotte Harbor Flatwoods Hydrological Restoration Planning project.

We would also like to take a moment to welcome our new TAC Co-Chair Devon Moore, and thank the outgoing Co-Chair Lizanne Garcia. Please reach out to CHNEP staff if you have a topic for discussion or presentation for the next TAC meeting scheduled for August 13, 2020.
Wishing you good health,

COASTAL & HEARTLAND NATIONAL ESTUARY PARTNERSHIP of Central and Southwest Florida

Nicole Iadevaia
Research & Outreach Manager
Coastal & Heartland National Estuary Partnership
326 West Marion Ave.
Punta Gorda, FL 33950
941-575-3313
Toll-free 866-835-5785
www.CHNEP.org

From:	James Guida
To:	Doug Leeper
Cc:	Yonas Ghile; Chris Zajac
Subject:	RE: Anticipated MFL Adoption Date - Lower Peace/Shell Creek
Date:	Wednesday, May 27, 2020 4:11:39 PM

Thanks Doug!

Jim

James P. Guida, P.G.
Principal
Progressive Water Resources, LLC
6561 Palmer Park Circle
Sarasota, Florida 34238
Email: jguida@prowatersource.com
Office: (941) 552-5657
Cell: (941) 706-5042

Please note that PWR is continuing to operate at full capacity and is capable of serving all of our Client's needs during this unfortunate event. We have implemented a variety of new operational procedures to ensure the health and safety of our staff and Clients, and are stricty following the CDC and FDOH guidelines. If there is anything we can do to assist, please do not hesitate to contact us.

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Wednesday, May 27, 2020 4:10 PM
To: James Guida <jguida@prowatersource.com>
Cc: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>
Subject: RE: Anticipated MFL Adoption Date - Lower Peace/Shell Creek

Currently anticipated for October.

Doug Leeper
MFLs Program Lead
Environmental Flows and Assessments Section
Natural Systems & Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street (U.S. Hwy. 41 South)
Brooksville, FL 34604-6899
352-796-7211, Ext. 4272
1-800-423-1476, Ext. 4272
Doug.leeper@watermatters.org

From: James Guida <jguida@prowatersource.com>
Sent: Wednesday, May 27, 2020 2:15 PM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: Anticipated MFL Adoption Date - Lower Peace/Shell Creek

Hi Doug!

I understand the District's goal is to adopt the above MFL this year. What month do you expect adoption to occur?

Thanks!

Jim

James P. Guida, P.G.
Principal
Progressive Water Resources, LLC
6561 Palmer Park Circle
Sarasota, Florida 34238
Email: jguida@prowatersource.com
Office: (941) 552-5657
Cell: (941) 706-5042
Please note that PWR is continuing to operate at full capacity and is capable of serving all of our Client's needs during this unfortunate event. We have implemented a variety of new operational procedures to ensure the health and safety of our staff and Clients, and are stricty following the CDC and FDOH guidelines. If there is anything we can do to assist, please do not hesitate to contact us.

From:	Laura Baumberger
To:	Yonas Ghile
Cc:	Victoria Steinnecker; Sarah Burns; Chris Zajac; Doug Leeper; Eric DeHaven; Randy Smith
Subject:	RE: Shell Creek baseline flows
Date:	Thursday, June 4, 2020 10:53:50 PM

Thanks, Yonas. I sent an MS Teams invite for this meeting.

Please forward us the updated model ahead of the meeting, as soon as it is ready for us to review. We have a meeting with the City on June 16, and it would be beneficial for us to have the updated model prior to that, if possible.

Thanks,
Laura

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Thursday, June 4, 2020 4:15 PM
To: Laura Baumberger <LBaumberger@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>
Subject: RE: Shell Creek baseline flows

Hi Laura,

June 25, from 2pm - 4Pm works for District team (Doug Leeper, Chris Zajac, Randy Smith, Eric DeHaven and myself). I will be presenting the results of the RO/reservoir operation recommended by the City.

Thank you

From: Laura Baumberger <LBaumberger@carollo.com>
Sent: Wednesday, May 27, 2020 11:17 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>
Subject: RE: Shell Creek baseline flows

Yonas,

Please see times below that work for Carollo and the City. Let me know if any of these work and then I can send out an MS Teams meeting invite.

June 17: after 2pm

June 18: after 2pm
June 22: between 1-3pm
June 23: anytime
June 24: anytime
June 25: after 2pm

Thanks,
Laura

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Tuesday, May 19, 2020 4:33 PM
To: Laura Baumberger <LBaumberger@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>
Subject: RE: Shell Creek baseline flows

Laura

Most of our team cannot make it in the first week of June, plus we need some more time to look at the scenarios results. Please reschedule the meeting with the city to the week of June 15.

Thank you

From: Laura Baumberger <LBaumberger@carollo.com>
Sent: Tuesday, May 19, 2020 11:50 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>
Subject: RE: Shell Creek baseline flows

Yonas,

Below is the City's and Carollo's availability for the first week of June. Please let me know if either of these will work for the District. If not, we can propose some options the following week.

- June 2nd after 11:30 am
- June 3rd after 3:00 pm

Thanks,
Laura

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Friday, May 8, 2020 4:59 PM
To: Laura Baumberger <LBaumberger@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>
Subject: RE: Shell Creek baseline flows

Laura

Thank you for your email. I just started working on it, but the week of May 18 is too early for the District to meet with the City. Please make a schedule for the first week of June if it works for your team and the City.

Have a nice weekend

Yonas

From: Laura Baumberger <LBaumberger@carollo.com>
Sent: Friday, May 8, 2020 2:55 PM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>
Subject: RE: Shell Creek baseline flows

Yonas,

Wanted to check in and see how things are going with the model updates. We are having a meeting with the City next week (just Carollo and the City) to discuss a few items with them.

I'm trying to find a meeting date the week of May 18 that works for them to meet with you and others at SWFWMD. Will keep you posted on that.

Thanks,
Laura

From: Laura Baumberger
Sent: Wednesday, April 29, 2020 3:21 PM
To: 'Yonas Ghile' <Yonas.Ghile@swfwmd.state.fl.us>; Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>
Subject: RE: Shell Creek baseline flows

Yonas,

I just spoke to the City. Please see slight modification below.

Thanks,
Laura

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Wednesday, April 29, 2020 3:17 PM
To: Laura Baumberger <LBaumberger@carollo.com>; Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>
Subject: RE: Shell Creek baseline flows

Thank you Laura I will start running these scenario and will let you when I am done.

From: Laura Baumberger <LBaumberger@carollo.com>
Sent: Wednesday, April 29, 2020 10:14 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>
Subject: RE: Shell Creek baseline flows

Yonas,

I left the City a voicemail but have not heard back yet. I am almost certain they will operate in this fashion, if you want to get started on model updates:

1. RO, reservoir, PR - in that order
2. Constant use of RO
    - ~~3~~ 4 mgd in Block 1
    - 2 mgd in Blocks 2 and 3

I will update you with any changes after I speak with the City.

Thanks,
Laura

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Tuesday, April 21, 2020 3:46 PM
To: Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Hi Sarah,

Laura said that she is going to talk the city and provide us information needed to modify the current operation of the model. Especially, for B1, we need to know how they will plan to operate the reservoir and RO. Here are some examples:

1. RO, reservoir, PP in order
2. %RO and %reservoir (e.g. 80%RO & 20%reservoir)
3. Constant use of RO (e.g. 3 mgd)

Once I got that kind of information, it will take me a couple days to modify the model and may be 3-5 days for internal discussion with District team. I would say 1 week after we get the information.

Thanks

From: Sarah Burns <sburns@carollo.com>
Sent: Tuesday, April 21, 2020 3:10 PM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Hi Yonas,

Thanks for the call today. We have found the HSW report on the baseline flows and are reviewing. Do you know when you might have the recovery model modified to have RO utilized before the reservoir?

Thanks!
Sarah

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Monday, April 13, 2020 11:49 AM
To: Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Sarah

I just want to Doug Leeper in the meeting but he has a meeting in the morning. Can we do it in the afternoon or on 21st from 9-10 am?

Thanks

From: Yonas Ghile
Sent: Monday, April 13, 2020 11:38 AM
To: Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Ok, I am going set up Teams meeting from 10 -11 am on the 22nd.

Thank you

From: Sarah Burns <sburns@carollo.com>
Sent: Monday, April 13, 2020 11:21 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Let's do the morning of the 22nd…anytime. Let me know if you would like me to send a Teams invite!

Thanks,
Sarah

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Monday, April 13, 2020 9:30 AM
To: Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Yonas
Unfortunately, I am running tight this week. How about next Week? I am open from April 22 – 24.

Thank you

From: Sarah Burns <sburns@carollo.com>
Sent: Monday, April 13, 2020 9:26 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: Shell Creek baseline flows

Hi Yonas,

Can we set up a time this week to go through the baseline flows spreadsheet? Let me know a few times that will work for you.

Carollo uses Microsoft Teams, but I believe we did a Webex last time. Do you have a preference?

Victoria from our Orlando office will join as well.

Thanks!
Sarah

From: Yonas Ghile
To: Laura Baumberger
Cc: Victoria Steinnecker; Sarah Burns; Chris Zajac; Doug Leeper; Eric DeHaven; Randy Smith
Subject: RE: Shell Creek baseline flows
Date: Friday, June 5, 2020 11:02:17 AM

Thanks Laura

I will send you the spreadsheet model soon.

Yonas

From: Laura Baumberger <LBaumberger@carollo.com>
Sent: Thursday, June 4, 2020 10:54 PM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>
Subject: RE: Shell Creek baseline flows

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Subject: RE: Shell Creek baseline flows

Hi Laura,

June 25, from 2pm - 4Pm works for District team (Doug Leeper, Chris Zajac, Randy Smith, Eric DeHaven and myself). I will be presenting the results of the RO/reservoir operation recommended by the City.

Thank you

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Subject: RE: Shell Creek baseline flows

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June 18: after 2pm
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Thanks,
Laura

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Tuesday, May 19, 2020 4:33 PM
To: Laura Baumberger <LBaumberger@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>
Subject: RE: Shell Creek baseline flows

Laura

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Thank you

From: Laura Baumberger <LBaumberger@carollo.com>
Sent: Tuesday, May 19, 2020 11:50 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>

Subject: RE: Shell Creek baseline flows

Yonas,

Below is the City's and Carollo's availability for the first week of June. Please let me know if either of these will work for the District. If not, we can propose some options the following week.

- June 2nd after 11:30 am
- June 3rd after 3:00 pm

Thanks,
Laura

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Friday, May 8, 2020 4:59 PM
To: Laura Baumberger <LBaumberger@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>
Subject: RE: Shell Creek baseline flows

Laura

Thank you for your email. I just started working on it, but the week of May 18 is too early for the District to meet with the City. Please make a schedule for the first week of June if it works for your team and the City.

Have a nice weekend

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Subject: RE: Shell Creek baseline flows

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Subject: RE: Shell Creek baseline flows

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I just want to Doug Leeper in the meeting but he has a meeting in the morning. Can we do it in the afternoon or on 21st from 9-10 am?

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Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Ok, I am going set up Teams meeting from 10 -11 am on the 22nd.

Thank you

From: Sarah Burns <sburns@carollo.com>
Sent: Monday, April 13, 2020 11:21 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Let’s do the morning of the 22nd…anytime. Let me know if you would like me to send a Teams invite!

Thanks,
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Sent: Monday, April 13, 2020 9:30 AM
To: Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Yonas
Unfortunately, I am running tight this week. How about next Week? I am open from April 22 – 24.

Thank you

From: Sarah Burns <sburns@carollo.com>
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Subject: Shell Creek baseline flows

Hi Yonas,

Can we set up a time this week to go through the baseline flows spreadsheet? Let me know a few times that will work for you.

Carollo uses Microsoft Teams, but I believe we did a Webex last time. Do you have a preference?

Victoria from our Orlando office will join as well.

Thanks!
Sarah

From:	Yonas Ghile
To:	Eric DeHaven; Chris Zajac; Doug Leeper; Randy Smith
Subject:	RE: Shell Creek baseline flows
Date:	Friday, June 5, 2020 1:45:07 PM

Please see the draft email and let me know if you have any question. I am going send it with the updated model today or on Monday after I finish reviewing the model.

Hi Laura and Sarah and Victoria

Per request of the City RO/reservoir recommended operation for withdrawal, the model has been updated (attached). The model has three scenarios:

1. Recovery strategy Scenario- the water supply reliability & MFL condition under No MFL scenario
2. MFL Scenario- the water supply reliability & MFL condition under MFL scenario
3. MFL Scenario Limit- the water supply reliability & MFL condition under MFL scenario with limit. This allows you to put a limit to MFL release (e.g. 50 mgd, 20 mgd etc) and then you can compare it to the MFL scenario (step 2). The Limit you put is on Cell P3.

    Note: This third scenario is work in progress. Currently, we are running different scenarios to assess how limiting MFL release scenarios would potentially impact the isohaline habitats in the estuary.

Please let me know if you have any question or If you would like me to demonstrate the formulas in the spreadsheet.

Thank you

From: Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>
Sent: Friday, June 5, 2020 9:17 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>
Subject: RE: Shell Creek baseline flows

That's good with me as well – Randy/Chris, any concerns?

Eric DeHaven, P.G.
Southwest Florida Water Management District
Assistant Director, Resource Management Division
7601 HWY 301N Tampa FL 33637
(813) 985-7481 X2118

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>

Sent: Friday, June 5, 2020 9:15 AM
To: Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>
Subject: RE: Shell Creek baseline flows

Ok, I will review it and send it today or on Monday. May be I will set up a short meeting with Carollo (next week) to demonstrate the new RO/reservoir operation in the spreadsheet model.

Thanks

From: Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>
Sent: Friday, June 5, 2020 8:59 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>
Subject: RE: Shell Creek baseline flows

Yes, I think we should provide it.

Eric DeHaven, P.G.
Southwest Florida Water Management District
Assistant Director, Resource Management Division
7601 HWY 301N Tampa FL 33637
(813) 985-7481 X2118

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
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To: Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>
Subject: RE: Shell Creek baseline flows

Chris/Randy/Eric

Please see the email below from Laura. Should I sent the updated version of the model to her ahead of their meeting with City on June 16?

Thanks

From: Laura Baumberger <LBaumberger@carollo.com>
Sent: Thursday, June 4, 2020 10:54 PM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>

Subject: RE: Shell Creek baseline flows

Thanks, Yonas. I sent an MS Teams invite for this meeting.

Please forward us the updated model ahead of the meeting, as soon as it is ready for us to review. We have a meeting with the City on June 16, and it would be beneficial for us to have the updated model prior to that, if possible.

Thanks,
Laura

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Subject: RE: Shell Creek baseline flows

Hi Laura,

June 25, from 2pm - 4Pm works for District team (Doug Leeper, Chris Zajac, Randy Smith, Eric DeHaven and myself). I will be presenting the results of the RO/reservoir operation recommended by the City.

Thank you

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Subject: RE: Shell Creek baseline flows

Yonas,

Please see times below that work for Carollo and the City. Let me know if any of these work and then I can send out an MS Teams meeting invite.

June 17: after 2pm
June 18: after 2pm
June 22: between 1-3pm
June 23: anytime

June 24: anytime
June 25: after 2pm

Thanks,
Laura

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Tuesday, May 19, 2020 4:33 PM
To: Laura Baumberger <LBaumberger@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>
Subject: RE: Shell Creek baseline flows

Laura

Most of our team cannot make it in the first week of June, plus we need some more time to look at the scenarios results. Please reschedule the meeting with the city to the week of June 15.

Thank you

From: Laura Baumberger <LBaumberger@carollo.com>
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Victoria from our Orlando office will join as well.

Thanks!
Sarah

From: Angel Martin
To: Doug Leeper
Subject: Comments--Peer review--Lower Peace River and Lower Shell Creek
Date: Monday, June 8, 2020 3:54:32 PM

Concerning the Scientific Peer Review Panel Meeting for the Proposed Minimum Flows for the Lower Peace River and Lower Shell Creek, I offer the following two general comments.

1. Make the discussion and associated figures and tables as clear as possible. Make certain that the decreasing, increasing, and no trends are clearly defined and associated with the appropriate confidence interval—assume that a 5% (0.05) is clearly defined. Be consistent with these terms. For example, both decreasing and declining trends are used in the document.
2. Please include in the text discussion, where appropriate, that there is uncertainty in the determination of the 15% threshold for significant harm. Additional data collection and analysis may be used in adjusting this value either higher or lower. Uncertainty needs to be discussed in the assignment of Minimum flows and Levels.

Please contact me if you need any additional information or clarification. Thank you for the opportunity to comment.

____

Angel Martin
813-767-6944

DL

Moderator
107 posts

Doug Leeper
a few seconds ago

Comments from Angel Martin provided via email to Doug Leeper, as a follow-up to oral comments provided during the June 8, 2020 peer review panel teleconference.

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Angel Martin

From:	Yonas Ghile
To:	Laura Baumberger
Cc:	Victoria Steinnecker; Sarah Burns; Chris Zajac; Doug Leeper; Eric DeHaven; Randy Smith
Subject:	RE: Shell Creek baseline flows
Date:	Tuesday, June 9, 2020 6:30:47 PM
Attachments:	Updated model_Shell Creek.xlsx

Hi Laura and Sarah and Victoria

Attached is the updated spreadsheet model. It has 3 scenarios:

1. Recovery strategy Scenario- water supply reliability & MFL condition under No MFL scenario
2. MFL Scenario- water supply reliability & MFL condition under MFL scenario
3. MFL Scenario Limit- water supply reliability & MFL condition under MFL scenario with limit. This allows you to put a limit to MFL release (e.g. 50 mgd, 20 mgd etc) and then you can compare it to the MFL scenario (step 2). The Limit you put is on Cell P3.

    Note: This third scenario is work in progress. Currently, we are running some scenarios to assess how limiting MFL release scenarios would potentially impact isohaline habitats in the estuary.

Please let me know if you have any question or If you would like me to demonstrate the formulas in the spreadsheet.

Thank you

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Sent: Friday, June 5, 2020 11:02 AM
To: Laura Baumberger <LBaumberger@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>
Subject: RE: Shell Creek baseline flows

Thanks Laura

I will send you the spreadsheet model soon.

Yonas

From: Laura Baumberger <LBaumberger@carollo.com>
Sent: Thursday, June 4, 2020 10:54 PM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
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Sent: Wednesday, May 27, 2020 11:17 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>
Subject: RE: Shell Creek baseline flows

Yonas,

Please see times below that work for Carollo and the City. Let me know if any of these work and then I can send out an MS Teams meeting invite.

June 17: after 2pm
June 18: after 2pm
June 22: between 1-3pm
June 23: anytime
June 24: anytime

June 25: after 2pm

Thanks,
Laura

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Tuesday, May 19, 2020 4:33 PM
To: Laura Baumberger <LBaumberger@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>
Subject: RE: Shell Creek baseline flows

Laura

Most of our team cannot make it in the first week of June, plus we need some more time to look at the scenarios results. Please reschedule the meeting with the city to the week of June 15.

Thank you

From: Laura Baumberger <LBaumberger@carollo.com>
Sent: Tuesday, May 19, 2020 11:50 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>
Subject: RE: Shell Creek baseline flows

Yonas,

Below is the City's and Carollo's availability for the first week of June. Please let me know if either of these will work for the District. If not, we can propose some options the following week.

- June 2nd after 11:30 am
- June 3rd after 3:00 pm

Thanks,
Laura

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Friday, May 8, 2020 4:59 PM
To: Laura Baumberger <LBaumberger@carollo.com>

Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>
Subject: RE: Shell Creek baseline flows

Laura

Thank you for your email. I just started working on it, but the week of May 18 is too early for the District to meet with the City. Please make a schedule for the first week of June if it works for your team and the City.

Have a nice weekend

Yonas

From: Laura Baumberger <LBaumberger@carollo.com>
Sent: Friday, May 8, 2020 2:55 PM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>
Subject: RE: Shell Creek baseline flows

Yonas,

Wanted to check in and see how things are going with the model updates. We are having a meeting with the City next week (just Carollo and the City) to discuss a few items with them.

I'm trying to find a meeting date the week of May 18 that works for them to meet with you and others at SWFWMD. Will keep you posted on that.

Thanks,
Laura

From: Laura Baumberger
Sent: Wednesday, April 29, 2020 3:21 PM
To: 'Yonas Ghile' <Yonas.Ghile@swfwmd.state.fl.us>; Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>
Subject: RE: Shell Creek baseline flows

Yonas,

I just spoke to the City. Please see slight modification below.

Thanks,
Laura

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Wednesday, April 29, 2020 3:17 PM
To: Laura Baumberger <LBaumberger@carollo.com>; Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>
Subject: RE: Shell Creek baseline flows

Thank you Laura I will start running these scenario and will let you when I am done.

From: Laura Baumberger <LBaumberger@carollo.com>
Sent: Wednesday, April 29, 2020 10:14 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>
Subject: RE: Shell Creek baseline flows

Yonas,

I left the City a voicemail but have not heard back yet. I am almost certain they will operate in this fashion, if you want to get started on model updates:

1. RO, reservoir, PR - in that order
2. Constant use of RO
    - ~~3~~ 4 mgd in Block 1
    - 2 mgd in Blocks 2 and 3

I will update you with any changes after I speak with the City.

Thanks,
Laura

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Tuesday, April 21, 2020 3:46 PM
To: Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Hi Sarah,

Laura said that she is going to talk the city and provide us information needed to modify the current operation of the model. Especially, for B1, we need to know how they will plan to operate the reservoir and RO. Here are some examples:

1. RO, reservoir, PP in order
2. %RO and %reservoir (e.g. 80%RO & 20%reservoir)
3. Constant use of RO (e.g. 3 mgd)

Once I got that kind of information, it will take me a couple days to modify the model and may be 3-5 days for internal discussion with District team. I would say 1 week after we get the information.

Thanks

From: Sarah Burns <sburns@carollo.com>
Sent: Tuesday, April 21, 2020 3:10 PM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Hi Yonas,

Thanks for the call today. We have found the HSW report on the baseline flows and are reviewing. Do you know when you might have the recovery model modified to have RO utilized before the reservoir?

Thanks!
Sarah

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Monday, April 13, 2020 11:49 AM
To: Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Sarah

I just want to Doug Leeper in the meeting but he has a meeting in the morning. Can we do it in the afternoon or on 21st from 9-10 am?

Thanks

From: Yonas Ghile
Sent: Monday, April 13, 2020 11:38 AM
To: Sarah Burns <sburns@carollo.com>

Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Ok, I am going set up Teams meeting from 10 -11 am on the 22nd.

Thank you

From: Sarah Burns <sburns@carollo.com>
Sent: Monday, April 13, 2020 11:21 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Let's do the morning of the 22nd…anytime. Let me know if you would like me to send a Teams invite!

Thanks,
Sarah

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Monday, April 13, 2020 9:30 AM
To: Sarah Burns <sburns@carollo.com>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: RE: Shell Creek baseline flows

Yonas
Unfortunately, I am running tight this week. How about next Week? I am open from April 22 – 24.

Thank you

From: Sarah Burns <sburns@carollo.com>
Sent: Monday, April 13, 2020 9:26 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Cc: Victoria Steinnecker <vsteinnecker@carollo.com>; Laura Baumberger <LBaumberger@carollo.com>
Subject: Shell Creek baseline flows

Hi Yonas,

Can we set up a time this week to go through the baseline flows spreadsheet? Let me know a few times that will work for you.

Carollo uses Microsoft Teams, but I believe we did a Webex last time. Do you have a preference?

Victoria from our Orlando office will join as well.

Thanks!
Sarah

From:	Sid Flannery
To:	Doug Leeper
Subject:	Rubec"s paper submitted
Date:	Monday, June 15, 2020 9:34:23 AM
Attachments:	Rubec Paper, UMCF-2019-0072.R1_Proof_hi 6-08-20.pdf Rubec2 Reply to reviewers (6-12-20) submitted.pdf

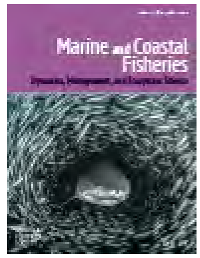
Hello Doug,

Attached is the final version of the draft paper that Peter Rubec submitted to the journal Marine and Coastal Fisheries.   I don't expect you need it or will read it, but also attached is his reply to the reviewers.

Both Joan Browder and I spent considerable time reviewing the paper and the response to reviewers and Peter accepted most of our suggested edits. Yonas also made the very helpful suggestion that percent reduction values in averaged seasonal flows be removed from Table 2.

Between you and me, Joan's and my comments were fairly time consuming and improved the paper considerably.   After my 2002 paper with Peebles and Montgomery, this is the only the second time the percent-of-flow approach has been described in the journal literature.   It was important that it not be misrepresented and Peter really needed some help on how to explain, or not try to explain, some of its elements.

Sid



Habitat Suitability Modeling and Mapping to Assess the Influence of Freshwater Withdrawals on Spatial Distributions and Population Numbers of Estuarine Species in the Lower Peace River and Charlotte Harbor, Florida

Journal:	*Marine and Coastal Fisheries*
Manuscript ID	UMCF-2019-0072.R1
Manuscript Type:	Article
Keywords:	spatial modeling, habitat suitability, mapping, water management, population estimation, In-Stream Flow

Habitat Suitability Modeling and Mapping to Assess the Influence of Freshwater Withdrawals on Spatial Distributions and Population Numbers of Estuarine Species in the Lower Peace River and Charlotte Harbor, Florida

Peter J. Rubec[1*], Christi Santi[2], Xinjian Chen[3], Yonas Ghile[4]

1, 2-Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, 100 Eighth Ave. SE, St. Petersburg, Florida 33701, USA. peterrubec@cs.com, Christi.Santi@myfwc.com

3, 4-Southwest Florida Water Management District, 2379 Broad Street, Brooksville, Florida 34604, USA. Xinjian.Chen@swfwmd.state.fl.us,Yonas.Ghile@swfwmd.state.fl.us

Abstract-The Southwest Florida Water Management District is reevaluating adopted Minimum Flow regulations for the lower Peace River and its largest tributary lower Shell Creek, which flow to the Charlotte Harbor estuary. Habitat suitability modeling (HSM) and mapping of fish and invertebrate species life stages were used to seasonally predict changes in spatial distributions and population numbers associated with freshwater withdrawals. Seasonal salinity grids and temperature grids from 2007-2014 derived from values predicted by hydrodynamic modeling were similar between Baseline (i.e., flows not affected by water withdrawals) and Minimum Flows (flows associated with water withdrawals). Depth grids, bottom type grids, and seasonal dissolved oxygen grids, derived from sampling data collected by fisheries-independent monitoring from 1996 to 2013 were held constant between the two scenarios. Seasonal HSMs were applied to 28 fish and invertebrate species life stages with affinities for low or moderate salinity. Salinity was the most significant factor in seasonal models for species life stages. The seasonal HSM maps produced were similar between Baseline and Minimum Flows for each species life stage. Most seasonal estimates of population numbers under Minimum Flows were less than the estimates for the Baseline condition, indicating some impact on population numbers associated with flow reductions. Reductions in population numbers under Minimum Flows ranged from 0.3 to 21% with 3 out of 28 seasonal comparisons exceeding 15% and 12 others between 5% and 15% loss. While other factors can also influence species abundance, these results demonstrate how output from hydrodynamic modeling can be applied to HSM analyses and mapping to estimate spatial changes in habitat areas and population numbers for the life stages of fish and invertebrate species in relation to changes in salinity distributions in an estuarine system.

*Corresponding author: peterrubec@cs.com

The assessment and management of freshwater inflow to estuaries has received increased emphasis in recent decades to account for the important ways that freshwater inflow affects physical, chemical, and biological processes and the resources of estuaries, including relationships with the productivity of sport and commercial fisheries (Drinkwater and Frank 1994, Longley 1994, Estevez 2002, Montagna et al. 2002, Powell et al. 2002, Gillson 2011, Adams 2014). Alber (2002) proposed a conceptual model to support management of freshwater inflows by establishing inflow standards that help protect resources and functions of estuaries. The management approach can be inflow-based (flow is kept within some prescribed bounds under the assumption that taking too much away is bad for biological resources), condition-based (inflow standards are set in order to maintain specified conditions in the estuary), or resource-based (inflow standards are set based on the requirements of specific resources). Each approach is carried out by regulating freshwater inflow.

In 1972, the Florida Legislature directed the five Florida water management districts to establish minimum flows and levels (MFLs) for rivers and streams within their boundaries (Section 373.042, Florida Statutes). As currently defined by statute, "the minimum flow for a given watercourse shall be the limit at which further withdrawals would be significantly harmful to the water resources or the ecology of the area". The water management districts have taken different approaches to comply with the legislation (Alber 2002).

The Southwest Florida Water Management District (SWFWMD), due to its responsibility to permit the consumptive use of water and the legislative mandate to protect water resources from "significant harm", has established Minimum Flows (MF) for the free-flowing lower Peace River, which drains into Charlotte Harbor on the southwest coast of Florida (SWFWMD 2010). The District has been conducting a reevaluation of the MF and developing new ones for the lower portion of Shell Creek, a tributary to the lower Peace River that enters the river 12 kilometers upstream of the river mouth. The Peace River and Shell Creek are both used for municipal water supplies. To evaluate MF, historic freshwater withdrawals were added back into the flow records for each source and other hydrologic adjustments were made to create a Baseline (BL) flow record that reflects natural flow conditions. A variety of analytical approaches were then used to evaluate the effects of different daily flow reductions on salinity, water quality and various biological parameters in the tidal reaches of these tributaries and Charlotte Harbor to determine the total amount of water than can be available for withdrawal without causing significant harm to environmental resources (SWFWMD 2020). As part of this overall effort, our study was conducted to evaluate predicted changes in the habitat and abundance for a number of species life stages across the study area that would result from the MF.

Fundamental to the approach used for development of MFLs is the realization that a freshwater flow regime is necessary to protect the ecology of both riverine and estuarine systems (SWFWMD 2010). The initial step in this process requires an understanding of historic and current flow conditions to assess the extent to which water withdrawals or other anthropogenic factors have affected flows. It has been demonstrated that flow declines in the Peace River can be ascribed to both climatic variation and anthropogenic effects (PBS&J 2007, SWFWMD 2010).

Short-term studies of benthic macro-invertebrates, fish and nektonic invertebrate communities in relation to physical habitat, salinity and freshwater inflow were summarized by SWFWMD (2010). SWFWMD has also sponsored surveys to relate distributions and relative abundance of phytoplankton, zooplankton, larval fish and larval macro-invertebrate communities to salinity and water temperature changes associated with freshwater inflow and other habitat variables in the lower Peace River and Shell Creek (Peebles 2002a, Vargo et al. 2004, Atkins North America 2014, Janicki Environmental 2015). Regression analyses indicated that larval stages of 20 fish and invertebrate species displayed different distributional responses to changes in freshwater inflow in the lower Peace River (Peebles and Burghart 2013). While all larval stages shifted downstream in response to increased inflow, some were located farther downstream than others.

Studies found that conditions change seasonally, and the locations of fish and invertebrate species life stages vary along the salinity gradient in the lower Peace River (Greenwood et al. 2004; Idelberger and Greenwood 2005; Greenwood 2007; Peebles et al. 2007; Call et al. 2011, 2013; Stevens et al. 2013). Based on seine and trawl sampling, Greenwood et al. (2004) found that early life stages of 14 fish and invertebrate species had differing responses to freshwater inflow in the lower Peace River. However, none of these studies used geographic information systems (GIS) to map seasonal changes in spatial distributions of species life stages in the lower Peace River. While numerous agencies have fisheries-independent monitoring (FIM) programs, most do not use the data collected to estimate population numbers for the species found in the estuaries they monitor. One exception pertaining to freshwater inflow using FIM data with GIS is a study conducted in Tampa Bay by Whaley et al. (2016).

A new approach for estimating population numbers was developed by the Fish and Wildlife Research Institute (FWRI). The approach conducted Habitat Suitability Modeling (HSM) with delta-type generalized additive models (GAMs) associated with GAMLSS software in R to create maps of species distributions and abundance. Using GIS, environmental data points collected by FIM were interpolated to create habitat grids. Gear-corrected (GC) catch-per-unit-effort (CPUEs) from fitted splines and graphs derived from the HSMs were assigned to corresponding cells in the habitat grids to create seasonal grids containing predicted GC-CPUEs for 87 species life stages. The GC-CPUE grids were then averaged to create HSM maps, which provided a means to visualize the spatial distribution of mean GC-CPUEs by zones. Population number estimates were derived from the mean GC-CPUEs associated with the HSM zones. The approach was first applied to seasons and species for Tampa Bay (see Rubec et al. [2016a] example for summer juvenile pink shrimp, *Farfantepenaeus duorarum*). This approach was applied to the Charlotte Harbor system during phase 1 of the present study (Rubec et al. 2019).

In the present research, the main concern was how to tie this HSM-GIS approach to assessment of impacts of freshwater withdrawals on biological resources in the lower Peace River and Charlotte Harbor. The first step was to map seasonally temperature and salinity conditions in the lower Peace River and Charlotte Harbor associated with BL (phase 2-no water withdrawals) and with MF (phase 3-water withdrawals). A second step was to estimate seasonally relative population numbers from the HSM maps to determine the impacts of water withdrawals on early life stages of fish and invertebrate species (biological resources). The third step was to use the HSM maps to spatially elucidate species life history patterns and compare these findings with published literature. Since the abundance of species life stages change between seasons and across years, modeling and mapping methods were required to separate climatic effects from the effects associated with water withdrawals.

METHODS

Fisheries-Independent Monitoring

The main source of data for early life stages of fish species and blue crab has been FIM data collected by the Fish and Wildlife Research Institute (FWRI) in the Charlotte Harbor study area (**Figure 1**). FIM sampling has been conducted north of Pine Island, in geographic segments A, B and C in Charlotte Harbor, M in the lower Myakka River and the Lower P segment of the lower Peace River and lower Shell Creek. Seasonal data extracted from the FIM database for 1996 to 2013 included catch numbers, effort, environmental data for temperature (T), salinity (S), dissolved oxygen (O) and depth (D), date, latitude/longitude, and associated gear types. The Upper P segment in the lower Peace River, north of its confluence with Shell Creek, was not part of long-term FIM. For this segment, we used FIM data collected during two special studies conducted by Greenwood et al. (2004) from April 1997 to March 1998 and by Call et al. (2011) from July 2007 to June 2010.

Bottom types (B) at FIM sampling locations were extracted from a National Oceanic and Atmospheric Administration (NOAA) fishing chart created in 1989. The NOAA map is based on mud/sand distributions determined using a plumb line dropped onto the bottom to assess the firmness of bottom sediments at stations across the estuary. When we initiated the present study in 2015, the NOAA sediment map was the best information available. Bottom types should be characterized by sediment analysis of benthic grab samples. The only recent sediment data available for the study area was associated with fewer than 10 grab samples. A grab sampling survey is needed to better characterize the spatial distribution of sediment types in the Charlotte Harbor study area.

The T, S, O, D, B data at FIM sampling locations were used with HSM to relate CPUEs to environmental conditions. The HSM analyses and mapping methods using FIM data have been described in more detail in a report (Rubec et al. 2018) and recent paper (Rubec et al. 2019).

Sampling gears used in the study area from 1996 to 2013 included a 21.3-m circular bag seine (gear 20), a 21.3-m boat bag seine (gear 23), a 183-m haul seine (gear 160), and a 6.1-m otter trawl (gear 300). A 61-m haul seine (gear 180) for sampling in the lower Peace River was added in 2007. **Table 1** lists the gear types used for the HSM analyses with mean CPUEs ordered from high to low, the total number of FIM samples by season, and the percent of zeros present in seasonal datasets for each species life stage.

Four three-month seasons were chosen to reflect the seasonal changes in water temperature, rainfall, and freshwater inflow in the region (PBS&J 1999, Flannery et al. 2002). Water temperatures and freshwater inflows are greatest in the summer (July–September), which typically has the highest rainfall. The fall (October–December) has declining water temperatures and declining freshwater inflow, often followed by a minor increase in inflow during the winter (January–March) due to rains associated with cold fronts. However from 2007 to 2014, the winters were unusually dry and had the lowest average inflow of the four seasons. The spring (April–June) has rising water temperatures and typically includes the lowest inflows, although inflows usually increase in mid-June as the rainy season begins.

Habitat Mapping

A bottom type grid/map was created with polygons coded for mud, sand and submerged aquatic vegetation (SAV). Bottom types for mud and sand were digitized by FWRI as polygons from the NOAA fishing chart for Charlotte Harbor (Rubec et al. 2019). Seagrass coverages in Charlotte Harbor were derived from images obtained using aerial photography conducted every two years since 2002 (Photo Science and Kaufman 2013). Most of the imagery was collected during the winter. The imagery for SAV showed little or no change in the spatial extent of SAV from 2002 to 2013. Based on good water clarity, we chose the 2012 coverage as being most representative of the spatial extent of SAV. A bottom type grid was created using ArcGIS (Esri 2014).

Bathymetry data derived from a sonar survey in 2012 by Wang (2013) were obtained from the District for the Charlotte Harbor study area. Additional data for Gasparilla Sound were obtained from NOAA for areas where data were not present in the SWFWMD dataset (Rubec et al. 2018). This included data obtained from hydrographic surveys conducted by NOAA in 1955 and 1956. The NOAA and SWFWMD data were merged into a single point feature class. Large backwaters and canals with no bathymetry data were removed. Some smaller backwaters were included. The bathymetry data points were interpolated in ArcGIS using empirical Bayesian kriging (Krivoruchka 2012). The output raster grid for bathymetry was clipped to the water extent within the study area.

We extracted averaged surface and bottom dissolved oxygen data from the FIM database using SAS. Point data collected from 1996 to 2013 at FIM sampling stations were interpolated in ArcGIS using empirical Bayesian kriging associated with the Geostatistical Analyst 10.3 extension to create seasonal dissolved oxygen grids (Esri 2014). The seasonal dissolved oxygen grids were clipped to the same spatial extent as the bathymetry grid and bottom type grid, with each grid containing about 1.9 million total 15 x 15 m cells. Since the methods are fairly complicated a diagram is included outlining the methods (**Figure 2**).

Hydrodynamic Modeling Using Two Flow Scenarios

The effects of changes in freshwater inflow to the estuary were evaluated for the years 2007 to 2014 using the percent-of-flow approach in which various percentage flow reductions were applied to daily flows in the baseline flow record (Flannery el al. 2002, SWFWMD 2010, 2020). Based on other analyses that assessed changes in the volume, area and shoreline length of various salinity zones, a minimum flow scenario was created by SWFWMND in which daily flow reduction percentages were applied within three flow ranges for both the lower Peace River and Shell Creek, ranging from 13% of low flows to 40% of high flows (SWFWMD 2020). On the lower Peace River a low flow cutoff was also employed that prohibits any withdrawals, which was in effect 26% of the days during the study period, while the 40% limit for high flows was applied to 22% of the days.

A hydrograph of daily flows in the lower Peace River for the BL and MF scenarios is presented in **Figure 3**. Average flows in cubic feet per second (cfs) by season across years are presented for these flow scenarios in the lower Peace River and lower Shell Creek (**Table 2**). The reductions in average flows for each of the four seasons were strongly influenced by large differences in daily flows between the BL and MF scenarios during periods of high flow within each season. Smaller flow reductions, both in terms of differences in daily flows and percent daily flow reductions, occurred during most of the year. The SWFWMD later added a maximum flow reduction rate of 400 cfs between BL and MF in the lower Peace River, which was not included nor simulated in our study.

To simulate the effects of these flow reductions on salinity distributions in tributary rivers, a dynamically coupled 3D-2DV model similar to that used in previous MFL evaluations (Chen 2007), was developed (Chen 2018). The UnLESS model, which dynamically couples LAMFE and UnLESS3D, was applied to greater Charlotte Harbor (**Figure 4**) using 4790 grids in the horizontal plane and 17 layers in the vertical direction to discretize the 3D simulation domain and 311 grids and 17 layers to discretize the 2DV simulation domain. The simulation domain for greater Charlotte Harbor included tidally influenced sections of the lower Peace River, lower Myakka River and lower Shell Creek, Gasparilla Sound, Pine Island Sound, Matlacha Pass, a downstream portion of the Caloosahatchee River, and an offshore area extending about 20-30 km into the Gulf of Mexico. The tidally influenced sections included a 34.2 km section of the lower Peace River, a 38.6 km section of lower Myakka River, and a 10 km section of lower Shell Creek.

While the greatest changes in salinity and temperature distributions were mostly within the tidal rivers, the area modeled using UnLESS included greater Charlotte Harbor to eliminate the effect of barriers from predictions for salinity and temperature patterns in the tidal portion of the rivers. Salinity and temperature fields were simulated in greater Charlotte Harbor and its major tributaries from 2007 to 2014 for both the BL and MF scenarios. Twenty-four simulations were run with different percent flow reductions for the lower Peace River and Shell Creek to determine the proposed minimum flows.

Seasonal values for predicted salinity and temperature derived from UnLESS were averaged by FWRI across years (2007-2014) for both BL and MF in the Charlotte Harbor study area north of Pine Island. Then, the point data were interpolated using kriging to create seasonal temperature grids and seasonal salinity grids with the same cell size and spatial extent as the bathymetry grid, bottom type grid and seasonal dissolved oxygen grids. For the spatial analyses, we held the bathymetry, bottom type, and seasonal dissolved oxygen grids constant between BL and MF. The seasonal temperature grids and seasonal salinity grids changed between BL and MF.

Estuarine Species Life Stages

Eight species life stages were selected based on the criterion that they exhibit preferences for low or moderate salinity and have been found to be abundant in the Charlotte Harbor study area (Rubec et al. 2018). Six species life stages exhibited affinities for low salinity in a previous HSM study in Tampa Bay and Charlotte Harbor (Rubec et al. 2016b). These species were seasonally analyzed by early-juvenile (EJ), juvenile (J) and adult (A) life stages (**Table 3**). Hogchoker and blue crab were added based on studies by Peebles (2002a) and Greenwood et al. (2004). For these two species, juvenile and adult life stages were combined (JA) and analyzed together.

Peebles (2002a) and Greenwood et al. (2004) recognized estuarine residents, which reproduce in the estuary and remain there during all life stages. For the present study, estuarine residents refer to species life stages for Hogchoker (*Trinectes maculatus*), Sand Seatrout (*Cynoscion arenarius*), blue crab (*Callinectes sapidus*), Southern Kingfish (*Menticirrhus americanus*), and Bay Anchovy (*Anchoa mitchilli*) which are abundant in the Charlotte Harbor study area during most seasons of the year (**Table 3**). Estuarine transients, such as Red Drum (*Sciaenops ocellatus*) and Spot (*Leiostomus xanthurus*) leave the estuary to spawn in the Gulf of Mexico (Stevens et al. 2013). Since early life stages of the species mentioned are abundant in Florida estuaries during most seasons; they are considered to be estuarine dependent (Peebles 2005).

Habitat Suitability Modeling

The gear-correction (GC) of CPUEs for different gear types was originally used in 2001 associated with habitat suitability index models for Tampa Bay and Charlotte Harbor (Rubec et al. 2001). The CPUEs were standardized by the ratio of each gear's mean CPUE to the gear with the highest mean CPUE to create GC-CPUEs. This approach has been used with previous HSM studies in Tampa Bay and Charlotte Harbor (Rubec et al. 2016a, 2016b, 2019). Gear corrections are presently computed within the R-based HSM software being used by FWRI.

In the present study, seasonal delta-gamma GAMs were developed that relate GC-CPUEs to environmental data collected in Charlotte Harbor. We used the online R-based program *gamlss* (Rigby and Stasinopoulos 2005, Stasinopoulos and Rigby 2007) designed for datasets with a surplus of zero catch values (i.e., zero-inflated data) that was previously applied to FIM data from Tampa Bay (Rubec al. 2016a). Log-transformed cubic smoothing splines were fit to non-zero (+CPUE) data (MU) and logit transformed splines fit to probability of zero occurrence (P=0) data (NU) across environmental gradients for both Full and Reduced models. Then, the spline data were back-transformed and the two components multiplied (MU x NU) to derive seasonal GC-CPUE splines across gradients for water temperature, salinity, dissolved oxygen and depth. Histograms were created for categorical variables with mean GC-CPUEs by bottom type, gear type, and year. Predictions based on the combined MU and NU models account for uncertainty in predicted GC-CPUEs. Further details about the modeling methods are presented elsewhere (Rubec et al. 2016a, 2016b, 2018, 2019).

First, a Full model (i.e., all predictor variables included) was fit using the penalized B-spline. Next, 31 Reduced models were developed comprised of various combinations of 1 to 5 environmental factors, each with a different Akaike information criterion (AIC). The model with the lowest AIC was chosen as the final Reduced model. Depending on selectivity for the size of the species life stage being analyzed, not all gear types were used for each HSM analysis (i.e., if a gear type did not catch any individuals of the species life stage being analyzed, that gear type was not included in the final analysis).

The delta-gamma GAMs developed using Reduced models are not spatial. A second part of the R program developed by FWRI (GAMLSS) used GC-CPUEs derived from fitted cubic smoothing splines to assign GC-CPUEs to a data set representing the centers of the cells associated with the habitat grids, according to latitude and longitude. Unique combinations of values for T, S, O, D, and the three categorical variables were available for each grid cell. The GC-CPUEs associated with the cell coordinates were then averaged to create a dataset with mean GC-CPUEs. Seasonal mean GC-CPUE datasets for each species life stage were then imported into ArcGIS and continuous GC-GPUE grids created across the estuary. Since the Florida Fish and Wildlife Conservation Commission is a public agency, people can obtain the R code from FWRI using the email address: GISLibrarian@MyFWC.com.

Zonal Grids Used to Create HSM Maps

Using the ArcGIS Spatial Analyst Slice tool, the continuous GC-CPUE grids were assigned to four habitat suitability zones by the Jenks natural breaks classification method (Jenks 1967). The natural breaks method associated with the Slice tool specifies “that the classes will be based on natural groupings inherent in the data”. Break points are identified by choosing the class breaks that best group similar values and that maximize the differences between classes. This provided an objective means of partitioning continuous GC-CPUE grids into four zones for each species life stage for the BL scenario. HSM zones for MF were created using the same natural breaks that were calculated for BL. Seasonal HSM maps were created from the zonal grids for each species life stage associated with BL and with MF (Rubec et al. 2018). Each HSM map has four habitat suitability zones: Low, Moderate, High, and Optimum, representing predicted mean GC-CPUEs increasing across the HSM zones.

Validation Graphs

Several external validation studies involving the reciprocal transfer of fitted splines between Tampa Bay and Charlotte Harbor were conducted previously (Rubec et al. 2001, 2016b). The number of environmental factors included were varied in both the within and transfer habitat suitability analyses. The transfer analyses included the transfer of fitted splines from Tampa Bay to Charlotte Harbor. When similar within and transfer splines representing fitted GC-CPUEs across environmental gradients were used with the Charlotte Harbor habitat grids, similar seasonal HSM maps were produced for the Charlotte Harbor study area. This required separate HSM analyses to produce seasonal within HSM maps and seasonal transfer HSM maps. Considering the time required, we decided it was not feasible to do external validations for each species life stage for both BL and MF during the present study. The internal validations were considered to be sufficient.

Gear standardized FIM data (observed GC-CPUEs), for species life stages within each season, were spatially joined to the zonal grid data using ArcGIS to create internal validation datasets. Each FIM data point was joined to the closest habitat point within 50 meters. We validated each model by overlaying the observed data onto predicted HSM zones to create validation graphs for each season (Rubec et al. 2018). Increasing trends in mean observed GC-CPUE across the zones indicated spatial agreement between mean observed GC-CPUEs and mean predicted GC-CPUEs within HSM zones.

Validation graphs with increasing mean observed GC-CPUEs across four zones, Low to Optimum, were scored as 1.0. When the mean observed GC-CPUEs exhibited increasing trends across the Low to High HSM zones instead of across all four zones, they were scored as 0.5.

Computation of Zonal Areas and Population Numbers

Tables were created for each species life stage respectively for BL and MF that present mean GC-CPUEs (no/m^2) and zonal areas (m^2) for each seasonal HSM zone. The study area is comprised of 1,906,683 total 15 x 15 m cells with a total area of 429,003,675 m^2. Changes in percent zonal area (A) were calculated as relative difference between percent areas for Baseline and Minimum Flows: (%$A_{baseline}$ – %$A_{minimum}$) / %$A_{baseline}$.

Zonal population number estimates by season for each species life stage were derived by multiplying mean GC-CPUEs (no/m^2) by the areas (m^2) associated with the HSM zones. Total population numbers in the study area were then estimated for each season by summing the zonal population estimates.

Confidence Intervals

The R program developed by FWRI (GAMLSS) computed confidence intervals around Owens Plots, around fitted splines and associated with validation datasets allowing assessment of uncertainty in the GC-CPUE data. The population number estimates were not computed by the delta-gamma GAMs used with the HSM. They were derived from the GC-CPUEs from fitted splines applied to datasets containing the central coordinates of cells in the habitat grids. After the GC-CPUEs associated with the cell coordinate were averaged, the datasets were imported into ArcGIS in order to produce continuous GC-CPUE grids. Then, the continuous GC-CPUE grids for each species life stage were partitioned to produce seasonal HSM maps. Due to the averaging, the estimated population numbers derived from the GC-CPUE grids do not have confidence intervals.

RESULTS

Habitat Maps

Seasonal dissolved oxygen maps derived from FIM data were created (Rubec et al. 2018**).** Time-invariant maps for bathymetry and bottom type, derived from data obtained from SWFWMD and NOAA, were also created (Rubec et al. 2018, 2019). Seasonal salinity maps (**Figure 5**) and seasonal temperature maps (**Figure 6**) for BL were produced (Rubec et al. 2018). Salinity and temperature maps also were created for MF, but are not shown here because they appear similar to the BL maps. The percent changes within zones obtained by subtracting percent salinity for MF from percent salinity for BL were mostly <1% for salinity ranges up to 20 psu and <4 % for higher salinity ranges up to 35 psu (**Table 4**). The percent changes within zones obtained by subtracting percent temperature for MF from percent temperature for BL were <0.5 % for temperature ranges up to 30^{o}C and <3 % for higher temperature ranges up to 34^{o}C (Rubec et al. 2018**)**.

Statistical Table of Reduced HSM

Seasonal Full and Reduced delta-gamma GAMs were produced for each species life stage (**Table 5**) and were used as the basis of both BL and MF mapping. Final Reduced models have the lowest AICs and contain the best combinations of environmental variables. Salinity (S) is significant, based on high abundance (GC-CPUEs) at low salinity ranges, for species life stages during most seasons on both the MU and NU sides of the models. Temperature (T) is significant for some seasonal species life stages. However, there is no seasonal preference for temperature with most species life stages. Depth (D), dissolved oxygen (O), Mud, and SAV are less significant for most species life stages. But, these environmental variables are included in many of the final seasonal HSMs.

Fitted Splines and Histograms From HSM

Fitted splines and histograms of abundance by salinity for JA-Hogchoker in the spring are based on output from the Full delta-gamma GAM (**Figure 7**). The graphs illustrate relationships between abundance and the environmental variables included in the Full model. There is a marked preference for salinities <5 psu and temperatures >30^{o}C. The broader fitted splines for dissolved oxygen and depth suggest these environmental factors may not be as significant. This was confirmed with the statistical output during spring for the Reduced model (**Table 5**).

Because salinity was significant for most resident species life stages (**Table 5**) and was the variable of greatest interest in comparing MF to BL, we plotted seasonal abundance by salinity splines together to facilitate comparisons of abundance within and between species (**Figure 8**). JA-Hogchoker exhibited highest abundance at salinities <5 psu for all four seasons. The abundance for J-Sand Seatrout peaked near 7 psu during four seasons. The abundance for JA-blue crab peaked at 10 psu in fall and winter, at 8 psu in spring and <5 psu in summer. The abundance for EJ-Southern Kingfish peaked at 15 psu in fall, and near 18 psu during winter, spring and summer. The abundance by salinity relationships for A-Bay Anchovy were similar during all four seasons with peaks for the fitted GC-CPUEs near 18 psu.

JA-Hogchoker were abundant at the lowest range of salinities (<5 psu) in the Upper P segment during four seasons (**Figure 8**). J-Sand Seatrout and JA-blue crab were also found at low salinities in the Upper P and Lower P segments at somewhat higher salinity ranges than the JA-Hogchoker. EJ-Southern Kingfish and A-Bay Anchovy were abundant in the Lower P segment of the river. The Optimum zones derived from HSM analyses indicate that each species was most abundant at different salinity ranges proceeding downstream. The species order from low to higher salinities is JA-Hogchoker, J-Sand Seatrout, JA-blue crab, EJ-Kingfish, A-Bay Anchovy, EJ-Red Drum, EJ-Spot. The salinity ranges selected by each species life stage were determined from analyses done in 2017 during the first phase of the present study (Rubec et al. 2019).

EJ-Red Drum abundance peaked near 18 psu in fall and <10 psu during winter and spring (**Figure 8**). But, there are also increasing relationships associated with the GC-CPUE by salinity splines during winter and spring at salinities >30 psu. The fitted GC-CPUE spline for EJ-Red Drum in summer indicates they were most abundant over a broad range of salinities <20 psu.

During winter, the GC-CPUE by salinity spline for EJ-Spot indicates they were most abundant at salinities ranging from 5 to 25 psu (**Figure 8**). In spring, the abundance by salinity spline decreases at salinities ranging from 0.1 to 20 psu, then increases at salinities >30 psu. In summer, the abundance by salinity spline for EJ-Spot declines at salinities ranging from 0.1 to 10 psu, then increases at salinities >20 psu. During fall, the abundance spline increases at salinities >30 psu.

HSM Maps

Seasonal BL and MF HSM maps for eight species life stages were created (Rubec et al. 2018) but only the BL maps are shown here because the MF maps are so similar. In most cases for resident species, predicted Optimum zones occurred in low or moderate salinity segments of the lower Peace River/lower Shell Creek and lower Myakka River, rather than in Charlotte Harbor.

JA-Hogchoker

Seasonal HSM maps for JA-Hogchoker associated with BL show Optimum zones of abundance in the Upper P segment during all seasons **(Figure 9).** During fall, winter and spring dry seasons, the Optimum zones contract within the upper portion of the Upper P segment, then expand throughout the Upper P segment during the summer rainy season. For both BL and MF, the spatial extent of Optimum zones expanded during the summer (Rubec et al. 2018). Close examination reveals that the Optimum zone for MF contracts slightly associated with water withdrawals during the summer.

J-Sand Seatrout

Seasonal HSM maps for J-Sand Seatrout (Rubec et al. 2018) are so similar between BL and MF that it is difficult to visually discern whether there is any effect of water withdrawals. The HSM maps show J-Sand Seatrout occurring in both the Upper P and Lower P segments during fall. Small blue polygons representing the Optimum zone are present in Upper P during the winter. In spring, the Optimum zones expand indicating J-Sand Seatrout become very abundant throughout the Upper P and Lower P segments. During summer, the Optimum zone shrinks, while the northern part of Charlotte Harbor has High abundance (green polygon). However, there is also a small Optimum zone near the mouth of Charlotte Harbor during the summer.

JA-blue crab

The Optimum zone in the BL HSM map for JA-blue crab during winter is situated in the Upper P and Lower P segments of the lower Peace River and in the lower Myakka River (**Figure 10**). In spring, JA-blue crabs still are abundant in the rivers, but the Optimum zone diminishes in area. In summer, the Optimum zone expands in the two rivers and into northern Charlotte Harbor. The Optimum zone contracts in the fall and is present in the Lower P segment.

EJ Southern Kingfish

The Optimum zones in BL and MF HSM maps for EJ-Southern Kingfish indicate they were most abundant in the Lower P segment of the lower Peace River during all seasons (Rubec et al. 2018). The Optimum zones expand in the river during winter with High abundance in the northern part of Charlotte Harbor. There is a contraction of the spatial extents of High and Optimum zones in the maps during spring for both scenarios. During summer, the Optimum and High zones expand, possibly in relation to higher freshwater inflows. In summer, the Optimum zone in the river for MF is visibly smaller than the Optimum zone associated with BL.

A-Bay Anchovy

The seasonal BL HSM maps for A-Bay Anchovy (**Figure 11**) are very similar to the seasonal HSM maps associated with MF (Rubec et al. 2018)**.** The Optimum zones for both scenarios expand during summer from the rivers into Charlotte Harbor in shallow water areas (<2 m) associated with increases in freshwater inflow.

EJ-Red Drum

Based on Optimum zones in BL and MF HSM maps, EJ-Red Drum during the fall were most abundant over SAV in segments A and B in Charlotte Harbor and in the Lower P segment of the lower Peace River (Rubec et al. 2018). In winter, the Optimum zones shift upriver into the Upper P segment. But, EJ-Red Drum were also abundant in segment B near the mouth of the estuary. During spring, the Optimum zones shift downstream into Lower P and into the northern and central parts (segments A and B) of Charlotte Harbor in shallow water over SAV. In summer, the Optimum zones for BL and MF indicate they were most abundant in Lower P. But, High zones (shown in green) in the HSM maps indicate they also were prevalent in deeper water of segment A in northern Charlotte Harbor. During summer, there no longer is an Optimum zone in segment B near the mouth of the estuary.

EJ-Spot

The Optimum zone in the BL HSM map for EJ-Spot in winter (**Figure 12**) indicates they were abundant in the lower Peace River and in shallow areas in the northern part of Charlotte Harbor. During spring, the Optimum zone situated in the Upper P segment may be due to an affinity by EJ-Spot for low salinity. Optimum zones for summer indicate some EJ-Spot still were present in Upper P at low salinities, with the rest of the population present in segment B near the mouth of the estuary where high salinities were found. In fall, small Optimum zones are located in segment B near the mouth of the estuary.

Validation

We validated the delineation of HSM zones for each species life stage by confirming that seasonal mean observed GC-CPUEs increased across four zones (**Table 6**). Consequently, most species life stages received a validation score of 1.0. An example validation graph is presented here for A-Bay Anchovy in the fall for MF (**Figure 13**).

For JA-Hogchoker, three out of four seasons have validation scores of 0.5 during spring, summer and fall for both BL and MF (**Table 6**). Lower mean observed GC-CPUEs were associated with the Optimum zone in comparison to the High zone in the validation graphs.

Zonal Areas and Population Numbers

The example provided shows how spring zonal areas and population number estimates were derived for A-Bay Anchovy with BL and MF (**Table 7**). Total spring population numbers estimated for A-Bay Anchovy for BL is 2,098,463,644 and for MF is 1,995,985,434.

Population Numbers by HSM Zones

Seasonal population numbers by HSM zones were estimated for each species life stage and total population numbers derived by summing the estimates across the zones for BL and MF (**Table 8**). Percentage changes in population numbers between BL and MF indicate that total population numbers declined between 0.3% and 21%. Although percentage declines are <15% for most species, reductions in estimated total population numbers exceed 15% for JA-Hogchoker in spring (19.0%), J-Sand Seatrout in spring (21.0%) and EJ-Southern Kingfish in summer (17.5%). Total population numbers for A-Bay Anchovy in summer increased by 1.1% and decreased during the other seasons. Total population numbers between BL and MF for EJ-Spot decreased during winter (1.5%) and spring (1.7%) and increased by 4.8% in summer and by 7.8% in fall. Summer and fall were the seasons when EJ-Spot left the estuary and estimated population numbers were low.

In most cases, there are higher seasonal percent population numbers of fish/crabs in the Moderate and High zones than in the Optimum zones (**Table 9**). This is because the Moderate and High zones have larger zonal areas than the Optimum zones. Since population numbers were derived by multiplying mean GC-CPUEs (no/m^2) by zonal areas (m^2), it was possible to obtain higher estimates for percent population numbers for the Moderate and High zones, despite these zones having lower mean GC-CPUEs than those estimated for the Optimum zones.

DISCUSSION

The Peace River is not impounded and is free-flowing along its length, while Shell Creek is impounded by a low head structure located 10 kilometers upstream of its confluence with the Peace. However, water is infrequently taken from storage in this small impoundment, so freshwater flows to lower Shell Creek largely follow the normal seasonal pattern for southwest Florida. Also, corrections to the flow records for both systems were made for existing withdrawals and other anthropogenic impacts to flow, so the Baseline flow record examined in this study and the corresponding salinity distributions predicted from the hydrodynamic model reflect natural seasonal variations in the region. This allowed for the assessment of changes in fish habitat and abundance due to freshwater withdrawals that are representative of four seasons in southwest Florida, with the caveat that flows during the winter were unusually low due to climatic conditions during the study period.

The abundance by salinity relationships for resident species were similar across seasons for JA-Hogchoker, J-Sand Seatrout, JA-blue crab, EJ-Southern Kingfish and A-Bay Anchovy indicating that each species life stage has a preferred salinity range, which does not change much between seasons (**Figure 7**). This was previously verified by overlaying Optimum zones from HSM grids onto the salinity grids and extracting the salinity ranges by season (Rubec et al. 2019).

Most of the seasonal HSM maps for species life stages show an expansion of their spatial distributions in the lower Peace River during summer that is associated with higher freshwater inflows. In most cases, Optimum zones of abundance expanded to match the expansion of low and moderate salinity zones during the high-flow summer months (**Figure 5**).

Optimum zones of abundance of JA-Hogchoker for BL were found in the Upper P segment during all four seasons (**Figure 9**). Similar seasonal HSM maps for JA-Hogchoker were found for MF (Rubec et al. 2018). For both scenarios, the spatial extent of Optimum zones expanded within the Upper P segment during the summer. Validation scores for JA-Hogchoker during spring, summer and fall were 0.5 for both BL and MF (**Table 6**). Since the Optimum zones occur at low salinity (<5 psu), reduced freshwater inflows due to water withdrawals appear to be detrimental to JA-Hogchoker. Insufficient FIM samples in the Upper P segment, associated with the special studies, may account for mean observed GC-CPUEs within Optimum zones being lower than in the High zones. It may also be because the Optimum zones in HSM maps for BL and MF, using salinity and temperature grids derived from hydrodynamic modeling, have smaller areas than the Optimum zones predicted from the phase 1 analyses of FIM data (Rubec et al. 2019). In that study, the validation scores for JA-Hogchoker were 1.0 for all four seasons. Peebles and Greenwood (2009) used spatial abundance quantiles to demonstrate impingement by Hogchoker <31 mm SL on Shell Creek's estuarine dam associated with a reduction of 3-day mean freshwater inflow and the loss of low salinity habitat. JA-Hogchoker caught in seines also showed evidence of crowding below the dam.

J-Sand Seatrout were abundant in the lower Peace and lower Myakka Rivers during spring and less abundant in Charlotte Harbor during summer, fall and winter (Rubec et al. 2018). The summer HSM maps have a small Optimum zone near the mouth of the estuary, which might indicate that they move out of Charlotte Harbor in summer and later spawn in the Gulf of Mexico (Cowan and Shaw 1988). Another possibility is that juvenile Sand Seatrout grow to adult size in Charlotte Harbor during the summer, and adults spawn in the lower part of the estuary during winter (Purtlebaugh and Rogers 2007, Knapp and Purtlebaugh 2008). Peebles (2002a) found post-flexion larvae and juvenile Sand Seatrout in the lower Peace River and Shell Creek during spring. Some spawning evidently took place there; but most post larvae and juveniles were believed to originate from higher salinity areas in Charlotte Harbor.

Optimum zones for JA-blue crab during all seasons were in the tidal portions of the Peace and Myakka Rivers (**Figure 10**). Literature reviewed by Gandy et al. (2011) indicates that immature females seek low salinity areas in estuaries (<15 psu) where they subsequently mate with mature males. When mating occurs in the spring and summer, the interval between mating and egg extrusion is about two months. When mating occurs in the fall and winter, spawning occurs during the following spring. Freshwater inflows are highest in the summer and lowest in the winter; so it is interesting that JA-blue crab in our study were most abundant in expanded Optimum zones during those seasons. The expansion of the Optimum and High zones in the lower Peace River during winter and summer appears to be partly related to peaks in recruitment of juvenile blue crab during winter and summer.

In their analysis of inter-annual trends in abundance of blue crab, Flaherty and Guenther (2011) found that immature and adult blue crab indices of abundance and commercial landings were high in Tampa Bay in 1998 in association with increased rainfall during the 1997-1998 El Niño. This was followed by a reduction in the abundance of immature blue crabs in 2002 corresponding to lower-than-average river inflows from late 1998 through to the beginning of 2002. They noted that reduced rainfall and freshwater diversions had the potential to adversely affect recruitment and survival of young crabs in the estuary. From 2003 to 2004, there was a dramatic increase in blue crab recruitment and a steady rise in adult abundance and commercial landings in Charlotte Harbor that appears to be linked to increases in inflows above historic means.

The distribution of EJ-Southern Kingfish in the lower Peace and Myakka Rivers during all seasons (Rubec et al. 2018) and in the northern part of Charlotte Harbor during winter and summer suggests expanded geographic ranges in Optimum and High zones during winter and summer that may be related to spawning during fall and spring either in the estuary or in the Gulf of Mexico. A marked contraction of the Optimum zone is apparent for MF in comparison with the Optimum zone for BL, associated with water withdrawals during the summer.

Peters and McMichael (1987) found two size groups of early life stages of Red Drum were present Tampa Bay, probably based on recruitment to the estuary during different years. They remained in the estuary for about three years before moving into the Gulf of Mexico. In Charlotte Harbor, fitted splines indicate EJ-Red Drum were most abundant at salinities ranging from 10-20 psu in the fall and at salinities <10 psu during winter and spring (**Figure 8**). Based on Optimum zones in HSM maps for BL and MF, EJ-Red Drum recruited during the fall were most abundant over SAV in northern Charlotte Harbor and in the Lower P segment of the lower Peace River (Rubec et al. 2018). In winter, they moved upstream to the Upper P segment. During spring, they moved downstream into the Lower P segment and into segment A in northern Charlotte Harbor. In summer, the Optimum zones show they were most abundant in the Lower P segment. But, the High zones for summer indicate they also were prevalent in deeper water within segment A. The Optimum zones indicate that larger Red Drum, probably recruited two years earlier, were present in segment B near the mouth of the estuary during fall, winter, and spring. Their absence in segment B during the summer suggests they moved out of Charlotte Harbor into the Gulf of Mexico.

Seasonal HSM maps show that EJ-Spot were abundant in the lower Peace River during winter and spring (**Figure 12)**. The fitted abundance splines by salinity and Optimum zones in the HSM maps indicate that most EJ-Spot left Charlotte Harbor in summer and fall starting at an age of about 6 months. The movement out of Charlotte Harbor starting in summer was unexpected; since peaks in larval abundance in the Gulf of Mexico suggest that Spot leave Louisiana estuaries to spawn in the Gulf of Mexico during fall and winter (Cowan and Shaw 1988).

The Optimum zones in seasonal HSM maps for the resident species life stages indicate they had high abundances within salinity ranges found in the lower Peace River. This could be due to habitat affinities for low or moderate salinities. However, it does not explain why the estuarine transients (EJ-Red Drum, EJ-Spot) were most abundant in the Upper P section of the river during winter and spring, respectively. It seems likely that freshwater inflows to the river introduce nutrients that enhance production of phytoplankton, zooplankton and larval fish that are exploited by early life stages of estuarine fish and invertebrates (Peebles 2002a, 2002b, 2005; Flannery et al. 2002). The relationships between species abundance and low or moderate salinities may be indicative of food availability created by nutrients and organic materials entering the lower Peace River associated with flows from upstream (Rubec et al. 2019).

Optimum zones for A-Bay Anchovy show their prevalence in the lower Peace River during all seasons (**Figure 11**). Their Optimum zones expanded into northern Charlotte Harbor in summer for both BL and MF and were apparently related to the expansion of low to moderate salinity zones associated with increased freshwater inflows (**Figure 5**). A-Bay Anchovy was the most populous species life stage with their population numbers estimated to be five to six orders of magnitude greater than those of the other species life stages represented in the study (**Table 8**). Similar seasonal HSM maps and population number estimates for J-Bay Anchovy were produced for the BL and MF scenarios (Rubec et al. 2018) that are not presented in this paper.

These estimates look reasonable for a species known to aggregate in great numbers. Bay Anchovy filter plankton from the water through their gills. Hence, it is reasonable to assume that their population numbers in the lower Peace River are related more to the flow-related abundance of plankton in the river tied to the influx of nutrients, than directly to salinity. Studies by Peebles et al. (1996, 2007) and Peebles (2002b) have demonstrated relationships between spatial distributions and abundance of A-Bay Anchovy and larval prey, such as copepod larval abundance, tied to salinities behind frontal zones of river-plumes in Tampa Bay.

The population number estimates for species life stages averaged across years (2007-2014) in the present study are substantially lower than those estimated across years (1996-2013) during the first phase of this study (Rubec et al. 2019). Since the same FIM data were used to create seasonal HSMs for species life stages in both studies, the differences in population estimates appear to be related to the habitat grids. The depth, bottom type and dissolved oxygen grids used were the same in both studies. Hence, the lower population estimates in the present study must be related to the seasonal temperature grids and seasonal salinity grids derived from data produced by the hydrodynamic model and used for the BL and MF analyses. The most likely explanation is that the higher population estimates are related to higher rainfalls prior to 2007, which influenced the seasonal salinity grids created for the previous study (Rubec et al. 2019). There were higher than average rainfalls in 1998, 2003 and 2004 (Flaherty and Guenther 2011).

Water managers have focused on the oligohaline segment of the lower Peace River as their MFL management target as the low salinity zones there are most sensitive to change (SWFWMD 2010, 2020). The present study found that seasonal salinity maps for BL in the Charlotte Harbor study area are very similar to those for MF (Rubec et al. 2018). Seasonal temperature maps are very similar for the two scenarios. Despite seasonal water withdrawals associated with MF, the predicted seasonal salinity grids and seasonal temperature grids do not differ substantially between BL and MF. Since other environmental variables (depth, bottom type, dissolved oxygen) were kept constant, the similarities of salinity and temperature grids within each season largely explain why seasonal HSM maps associated with BL and MF were so similar within the Charlotte Harbor study area.

In the present study, there is an effect of seasonal water withdrawals on total population numbers associated with MF in comparison to BL (**Table 8**). The differences in percent population numbers between BL and MF range between an increase of 7.8 % for EJ-Spot in fall to a decline of 21.0% for J-Sand Seatrout in summer. Declines in percent population numbers for JA-Hogchoker varied between 11.5% in fall and 19.0% in spring. J-Sand Seatrout and EJ-Kingfish losses were of similar magnitude to JA-Hogchoker—over 10% in three of four seasons. By percent, A-Bay Anchovy population number losses associated with MF appear low, although by sheer numbers, their losses were huge.

We have illustrated a spatial HSM approach to predict and compare population numbers of selected species life stages of fish and crabs in the lower Peace River-Charlotte Harbor system under two water management scenarios, BL and the accepted MF. The approach was successful in quantifying small differences and revealed sizeable differences in seasonal population numbers for some species life stages that would not have been detectable otherwise. Habitat suitability models linked to GIS provide meaningful quantitative comparisons to assist water managers with their decisions and help to explain the impacts of water withdrawals on biological resources to policy makers and the interested public. Our study found there were small reductions in habitat areas and population numbers associated with MF in comparison to BL across the study area, indicating the percent-of-flow approach for regulating daily freshwater withdrawals was effective at preventing unacceptable biological impacts resulting from spatial shifts of salinity distributions in the estuary.

The HSM-GIS approach, while providing population estimates and their change with changes in salinity patterns, does not account for species interactions including predation and other factors. For example in Apalachicola Bay, the impacts of minimum flows have been analyzed using ecosystem-based models and observed to have significant negative impacts on oyster populations due to high salinities associated with increasing oyster disease and predation (Livingston 1997). The HSM approach also does not evaluate the effects of changes in freshwater inflow on nutrient inputs and trophic interactions that can affect food webs and overall ecosystem productivity. Thus, using the HSM approach in isolation without other models, ecological considerations and habitat quality (e.g. contaminants) could result in erroneous conclusions and/or unintended consequences for particular species. Optimally, this HSM-GIS approach should be accompanied by trophic-based ecosystem modeling conducted in the Charlotte Harbor study area, with data derived from other studies and data collection efforts. However, various constraints do not currently allow ecosystem modeling to be used to support the management of daily water withdrawals by SWFWMD, which require immediate attention.

Salinity and temperature are major factors affecting the distribution of fish species and communities in estuaries and the availability of FIM data in the study area allowed for the determination of HSM zones, ranging from Low to Optimum, for the life stages of various important species. When combined with salinity and temperature predictions output from a hydrodynamic model, the HSM-GIS approach allowed the assessment of spatial changes of species life stages and population numbers across the Charlotte Harbor estuarine system. Using these tools, potential impacts to fish habitats and abundance near and far from the location of the freshwater flow reductions can be evaluated, allowing resource managers to focus their attention on zones of the estuary that are most vulnerable to change, providing sensitive indicators so that adverse impacts to the resources of the estuary can be avoided.

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TABLE 1.Summary of FIM samples used with final HSM analyses listing species life stages by season, gear types included, total number of samples and percent zero CPUEs included in each seasonal dataset.

Life Stage by Species	Season	Gears Ordered High to Low CPUEs	Number of Samples	Percent Zeros
Juvenile + Adult	Fall	23,300,180,20,160	3008	75.3
Hogfish	Summer	23,300,180,20,160	3105	71.7
	Spring	23,300,180,20,160	3116	79.5
	Winter	23,300,180	1746	71.9
Juvenile	Fall	23,300,20	2370	82.8
Sand Seatrout	Summer	300,23,20	2446	74.9
	Spring	300,23,20	1754	87.5
	Winter	300,23,20,160	2751	96.1
Juvenile + Adult	Fall	23,20,300,180,160	3008	67.1
blue crab	Summer	23,300,20,160	3020	75.5
	Spring	23,300,20,180,160	3116	72.8
	Winter	23,20,300,180,160	2832	63.3
Early-Juvenile	Fall	23,300,20	2370	83.5
Southern Kingfish	Summer	23,300,20,160	3020	88.2
	Spring	23,20,300	2505	83.2
	Winter	300,23,20	2271	92.6
Adult	Fall	23,20,300	2370	63.8
Bay Anchovy	Summer	20,23,300	2446	70.1
	Spring	23,20,300	2505	62.7
	Winter	23,20,300	2271	67.5
Early-Juvenile	Fall	23,20,180,160	2021	72.4
Red Drum	Summer	23,20,180,160,300	3105	94.3
	Spring	180,23,160	1500	87.4
	Winter	23,180,160,300	2226	84.1
Early-Juvenile	Fall	160,300,23	2368	98.6
Spot	Summer	23,300,160	2414	93.7
	Spring	23,180,300,20,160	3116	88.3
	Winter	23,20,180,300,160	2832	84.6

TABLE 2. Seasonal mean Baseline Flows, mean Minimum Flows and Difference in Flows in lower Peace River and lower Shell Creek from 2007 to 2014.

	Lower Peace River			Lower Shell Creek		
Season	Mean Baseline Flows (cfs)	Mean Minimum Flows (cfs)	Difference in Flows (cfs)	Mean Baseline Flows (cfs)	Mean Minimum Flows (cfs)	Difference in Flows (cfs)
Jan-Mar	277	203	74	51	36	15
Apr-Jun	363	245	118	133	86	47
Jul-Sep	1902	1180	722	808	506	302
Oct-Dec	536	361	175	193	130	63

TABLE 3. Size ranges for species life stages: A= adult, J=juvenile, EJ= early juvenile, JA=juvenile+adult. Size ranges are by standard length (mm) for fish species and by carapace width (mm) for blue crab.

Species Life Stage	Size Range
JA-Hogchoker	10-100
J-Sand Seatrout	10-149
JA-blue crab	10-150
EJ-Southern Kingfish	10-119
A-Bay Anchovy	30-60
EJ-Red Drum	10-299
EJ-Spot	10-149

TABLE 4. Seasonal changes in percent of total area by salinity ranges between grids for Baseline (BL) and Minimum Flows (MF). Percent change decreasing (black font), increasing (red font).

Season	Fall			Winter		
Salinity Range (psu)	Percent BL	Percent MF	Percent Change	Percent BL	Percent MF	Percent Change
0.01-5	2.7	2.5	0.2	1.1	0.9	0.2
5.01-10	1.9	1.8	0.1	1.4	1.6	0.2
10.01-15	2.4	2.3	0.1	1.6	1.5	0.1
15.01-20	5.2	4.1	1.1	2.6	2.4	0.2
20.01-25	20.7	17.4	3.3	7.2	6.2	1.0
25.01-30	44.5	47.0	2.5	40.2	38.5	1.7
30.01-35	22.6	25.1	2.5	45.9	48.9	3.0

Season	Spring			Summer		
Salinity Range (psu)	Percent BL	Percent MF	Percent Change	Percent BL	Percent MF	Percent Change
0.01-5	0.7	0.6	0.1	5.2	4.6	0.6
5.01-10	2.0	1.9	0.1	2.6	2.1	0.5
10.01-15	1.7	1.7	0.0	3.8	3.2	0.6
15.01-20	2.6	2.4	0.2	10.6	7.8	2.8
20.01-25	7.0	5.8	1.2	31.6	28.9	2.7
25.01-30	38.9	37.3	1.6	34.5	38.0	3.5
30.01-35	47.1	50.4	3.3	11.7	15.4	3.7

TABLE 5. Statistical significance of factors determined from delta-gamma GAMs for species life stages in the lower Peace River and Charlotte Harbor. P≤0.0001=***, P≤0.001=**, P≤0.05=*, P>0.05 and P≤0.10=ns (non-significant), blank spaces=factors not in models. Environmental factors: S=salinity, T=temperature, O=dissolved oxygen, D=depth, Mud=mud, SAV=submerged aquatic vegetation, Season: FL=fall, SM=summer, SP=spring, WN=winter. MU=part of model with + GC-CPUEs, NU=part of model with zero frequency of occurrence.

	J-Bay Anchovy				A-Bay Anchovy				JA-blue crab				JA-Hoghoker			
	FL	SM	SP	WN	FL	SM	SP	WN	FL	SM	SP	WN	FL	SM	SP	WN
MU																
S	**	***	**		**	***	**		*	***	***	***	***	***	***	***
T									***	**	**			***	**	*
O	***				***			ns		ns		**	***	***	*	*
D		*	*			*	*		**				ns			
Mud		*				*			***			**		***	*	
SAV	*		***		*		***				*			ns		
NU																
S	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
T	***	*			***	*		***	***						***	
O		***		**		***										**
D			***				***		***	*	*	***				
Mud	*		ns		*		ns				***	**	ns		***	***
SAV													***	***		

	EJ-Red Drum				EJ-Kingfish				EJ-Spot				J-Sand Seatrout			
	FL	SM	SP	WN	FL	SM	SP	WN	FL	SM	SP	WN	FL	SM	SP	WN
MU																
S	*				*	***	***	**	***	*	**		***	***		***
T	*		*								***		**			
O		ns			ns				***	*						
D	*							**	***			**	***	***		***
Mud		*										**				**
SAV	ns	***	ns						***	**	*					
NU																
S		**		***	***		***	***	*	*			***	***	***	***
T							***		**	ns	***	***	**	*	***	*
O			ns	ns							*					
D	***		***	ns									ns			**
Mud		ns			**	*	*	***			ns		***		***	*
SAV	*	ns		ns		ns	**	*		ns				ns		

TABLE 6. Seasonal validation scores for mean GC-CPUEs versus HSM zones associated with Baseline (BL) and Minimum Flows (MF). Increasing across four zones=1, increasing across three zones=0.05.

Season	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer
Flow Condition	BL	BL	BL	BL	MF	MF	MF	MF
Species Life Stage								
JA-Hogchoker	0.5	1	0.5	0.5	0.5	1	0.5	0.5
J-Sand Seatrout	1	0.5	1	1	1	0.5	1	1
JA-blue crab	1	1	1	1	1	1	1	1
EJ-Southern Kingfish	1	1	1	1	1	1	1	1
A-Bay Anchovy	1	1	1	1	1	1	1	1
EJ-Red Drum	1	1	1	1	1	1	1	1
EJ-Spot	1	1	1	1	1	1	1	1

TABLE 7. Example for Adult Bay Anchovy in spring showing how zonal areas and population numbers were estimated for each HSM zone for Baseline and for Minimum Flows respectively.

Baseline HSM Zone	Mean GC-CPUE no/sq m	Number of Cells	Zonal Area sq m	Percent Of Total Area	Population Number
Low	0.20858391	1290759	290420775	67.70	60577100
Moderate	8.78987151	306395	68938875	16.07	605963854
High	16.70502530	182731	41114475	9.58	686818345
Optimum	26.11693299	126798	28529550	6.65	745104346
TOTAL		1906683	429003675	100.00	2098463644
Minimum Flows HSM Zone	**Mean GC-CPUE no/sq m**	**Number of Cells**	**Zonal Area sq m**	**Percent Of Total Area**	**Population Number**
Low	0.19516414	1316360	296181000	69.04	57803911
Moderate	8.77852331	295483	66483675	15.50	583628491
High	16.70134253	173896	39126600	9.12	653466749
Optimum	25.76348587	120944	27212400	6.34	701086283
TOTAL		1906683	429003675	100.00	1995985434

TABLE 8. Changes in total population numbers estimated between Baseline and Minimum Flows in lower Peace River/Shell Creek and Charlotte Harbor. Percent changes in population numbers between Baseline and Minimum Flows: decreasing (black font), increasing (red font).

Species Life Stage	Season	Population Number Baseline	Population Number Minimum Flows	Percent Change Population Number
JA-Hogchoker	Fall	701,377	620,900	11.5
	Winter	553,351	482,250	12.9
	Spring	126,269	102,233	19.0
	Summer	124,983	109,281	12.6
J-Sand Seatrout	Fall	983,889	863,283	12.3
	Winter	16,827	14,446	14.2
	Spring	2,999,378	2,369,853	21.0
	Summer	4,257,044	4,388,843	3.1
JA-blue crab	Fall	337,046	315,665	6.3
	Winter	5,577,933	5,338,615	4.3
	Spring	204,920	189,248	7.7
	Summer	93,881	89,385	4.8
EJ-Southern Kingfish	Fall	480,831	414,399	13.8
	Winter	289,190	267,599	7.5
	Spring	289,894	255,701	11.8
	Summer	177,108	146,191	17.5
A-Bay Anchovy	Fall	409,669,579	386,497,346	5.7
	Winter	1,114,145,755	1,069,235,403	4.0
	Spring	2,098,463,644	1,995,985,434	4.9
	Summer	275,313,382	278,372,737	1.1
EJ-Red Drum	Fall	12,599,998	12,357,379	1.9
	Winter	2,771,344	2,762,907	0.3
	Spring	363,119	363,129	0.0
	Summer	265,019	250,736	5.4
EJ-Spot	Fall	6,153	6,635	7.8
	Winter	107,931	106,339	1.5
	Spring	783,736	770,237	1.7
	Summer	58,781	61,605	4.8

TABLE 9. Seasonal percent of population numbers by HSM zones for species life stages in the lower Peace River/Shell Creek and Charlotte Harbor for Baseline (BL) and for Minimum Flows (MF).

Species Life Stage	Season / HSM Zone	Fall %BL	Fall %MF	Winter %BL	Winter %MF	Spring %BL	Spring %MF	Summer %BL	Summer %,MF
JA-Hogchoker	Low	0.3	0.3	9.2	11.0	0.0	0.0	0.0	0.0
	Moderate	37.4	39.9	48.4	51.1	43.4	45.6	30.4	29.2
	High	44.9	41.4	27.3	25.1	36.5	36.3	30.6	29.1
	Optimum	17.4	18.3	15.1	12.9	20.1	18.0	39.0	41.7
J-Sand Seatrout	Low	2.8	3.4	7.0	7.6	0.2	0.2	10.5	14.5
	Moderate	57.6	53.7	51.5	48.1	25.7	27.3	37.9	41.7
	High	26.9	28.8	28.3	30.4	35.8	32.3	43.8	35.8
	Optimum	12.8	14.1	13.2	13.9	38.4	40.3	7.8	8.0
JA-blue crab	Low	0.0	0.0	16.4	17.3	0.0	0.0	27.5	30.0
	Moderate	30.9	33.3	26.7	27.2	28.2	26.6	26.7	27.1
	High	48.8	46.6	26.8	25.9	42.8	45.4	24.7	24.1
	Optimum	20.4	20.1	30.3	29.6	29.0	28.0	21.1	18.8
EJ-Southern	Low	0.00	0.00	3.2	3.6	0.0	0.0	19.0	23.8
Kingfish	Moderate	28.9	29.7	33.1	35.6	37.7	39.3	28.5	29.8
	High	52.2	52.3	40.0	39.9	51.1	52.2	33.4	29.9
	Optimum	18.9	18.0	23.7	20.9	11.3	8.6	19.0	16.5
A-Bay	Low	6.9	7.4	11.9	12.2	2.9	2.9	8.2	6.7
Anchovy	Moderate	27.6	27.3	29.8	29.9	28.9	29.2	25.7	23.9
	High	26.5	26.0	26.5	25.8	32.7	32.7	27.4	36.4
	Optimum	39.0	39.3	31.8	32.2	35.5	35.1	38.7	33.0
EJ-Red	Low	0.3	0.3	0.0	0.0	0.0	0.0	21.0	23.0
Drum	Moderate	21.0	21.6	29.6	29.4	31.9	31.9	22.4	24.2
	High	40.4	42.3	38.7	38.6	34.1	34.1	44.5	42.7
	Optimum	38.3	35.7	31.8	32.0	34.0	34.0	12.1	10.1
EJ-Spot	Low	33.2	29.9	12.7	13.0	34.7	35.4	28.0	23.6
	Moderate	35.2	36.6	23.9	24.2	32.2	33.0	41.9	39.7
	High	22.1	22.4	33.7	34.5	19.3	19.3	24.1	29.5
	Optimum	9.5	11.1	29.8	28.3	13.8	12.3	6.1	7.2

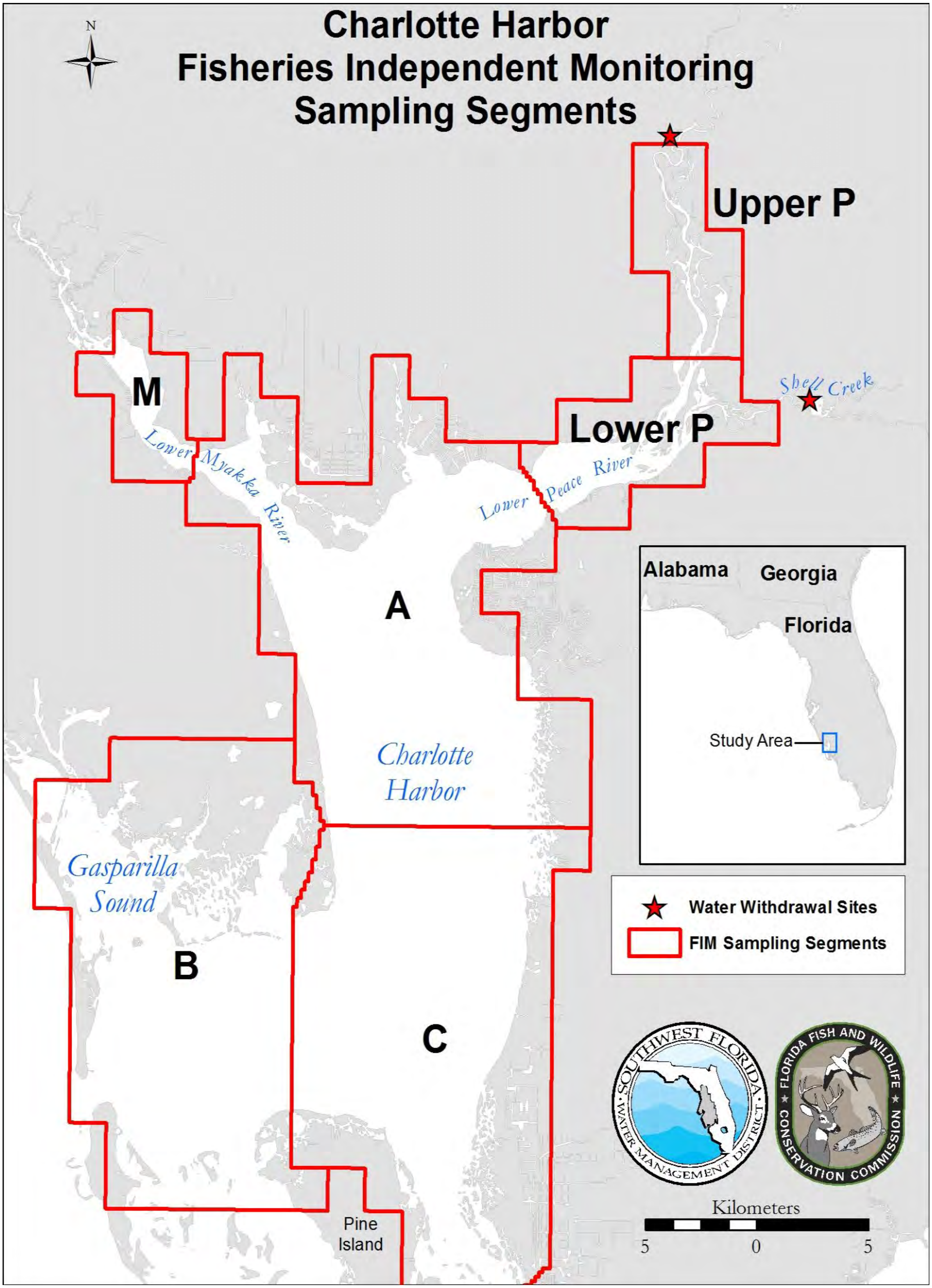

FIGURE 1. Sampling segments associated with fisheries-independent monitoring within the lower Peace River and Charlotte Harbor. Sampling with the Upper P segment was associated with two special studies.

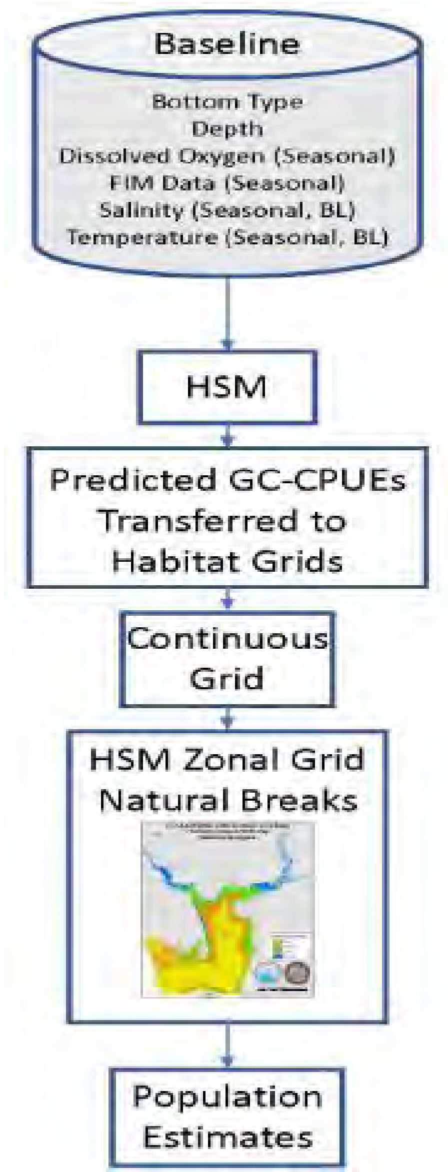

FIGURE 2. Flow diagram outlining the process by which habitat suitability modeling (HSM) was conducted to relate gear-corrected (GC) catch-per-unit-effort (CPUEs) to environmental variables. The GC-CPUEs from fitted splines were transferred to the habitat grids. By averaging t GC-CPUEs associated with the habitat grids, continuous GC-CPUE grids were created for each species life-stage. Using natural breaks, seasonal HSM grids were created. Mean GC-CPUEs associated with HSM zones were multiplied by zonal areas to obtain zonal population numbers and summed to derive total population number estimates for Baseline Flows. The process was repeated to derive population number estimates for Minimum Flows.

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FIGURE 3. UnLESS model mesh used for greater Charlotte Harbor hydrodynamic modeling. Green rectangular tiles are model grids for the 3D simulation domain, while 2DV grids are bounded by cross sections drawn with yellow lines.

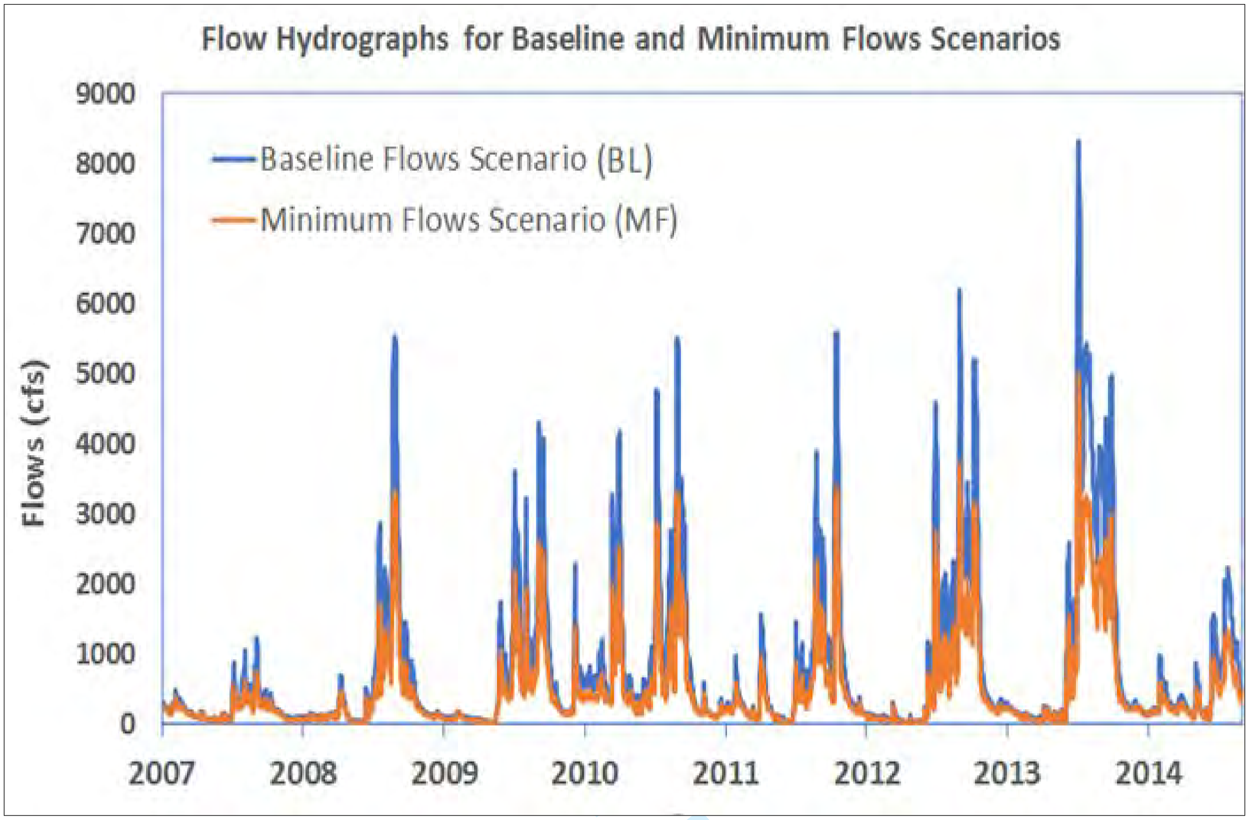

FIGURE 4. Daily flow hydrograph by year for Baseline (blue) and Minimum Flows (red) conditions in the lower Peace River system.

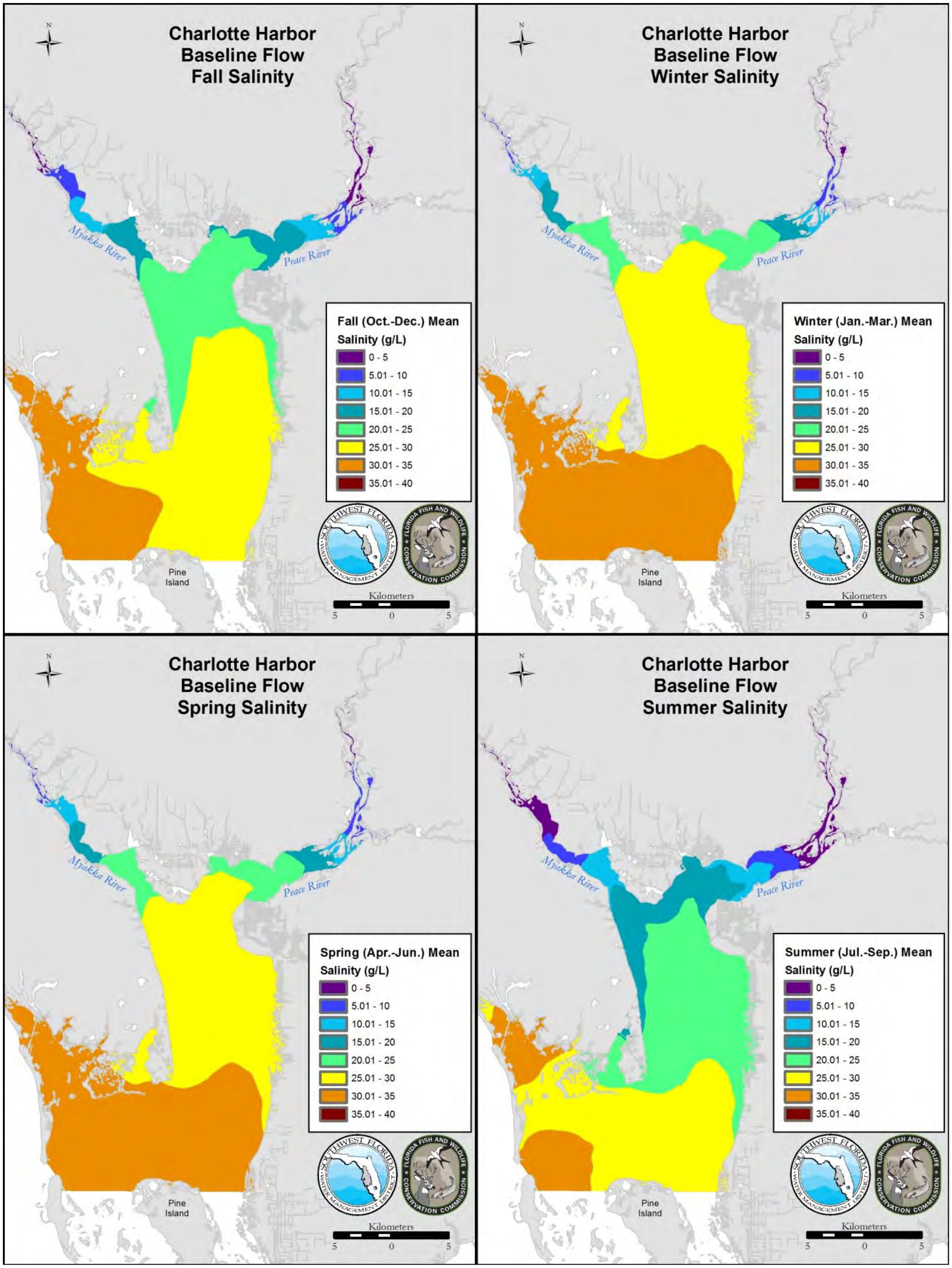

FIGURE 5. Seasonal maps for salinity created from Baseline data derived using hydrodynamic modeling.

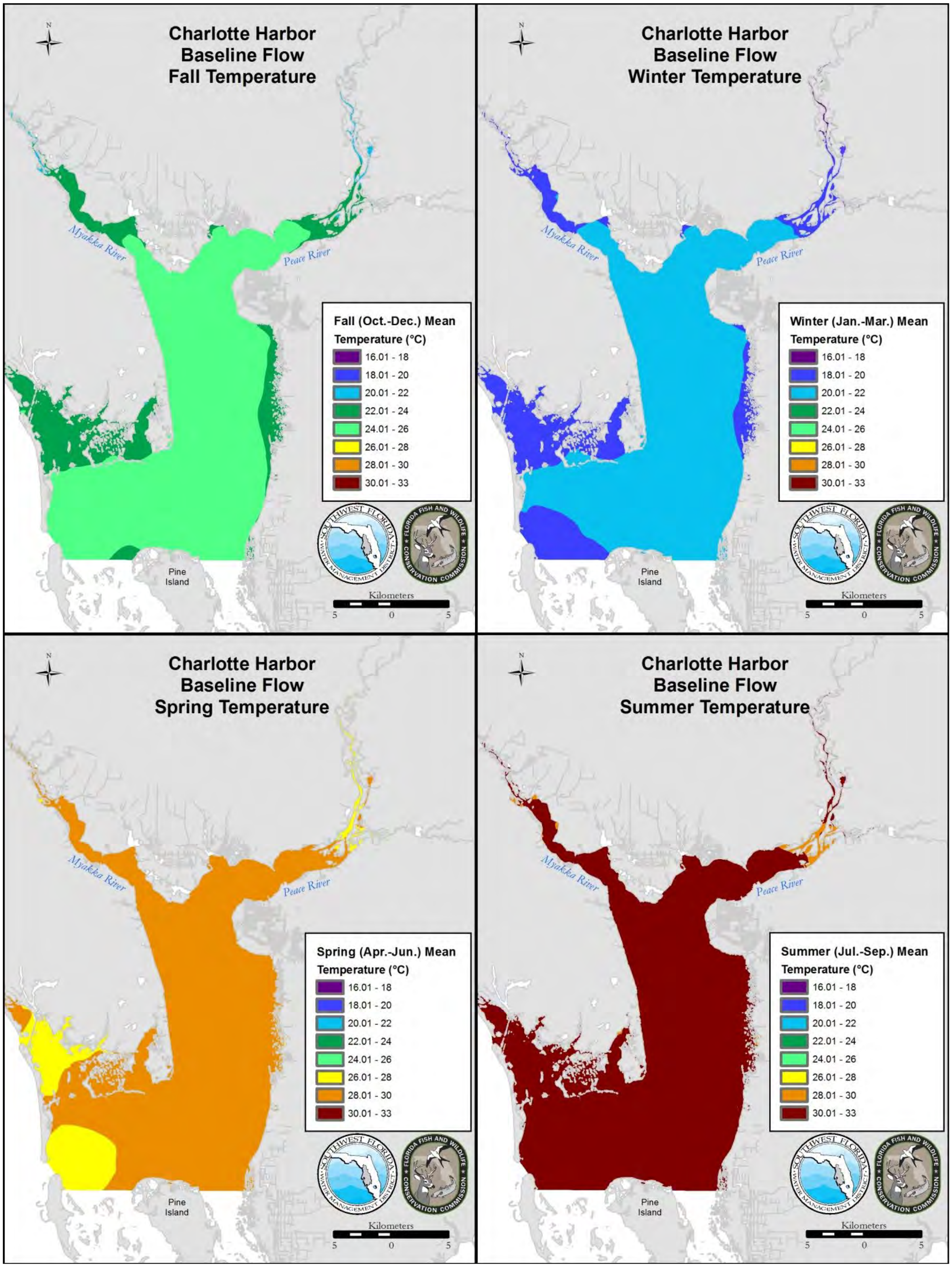

FIGURE 6. Seasonal maps for temperature created from Baseline data derived using hydrodynamic modeling.

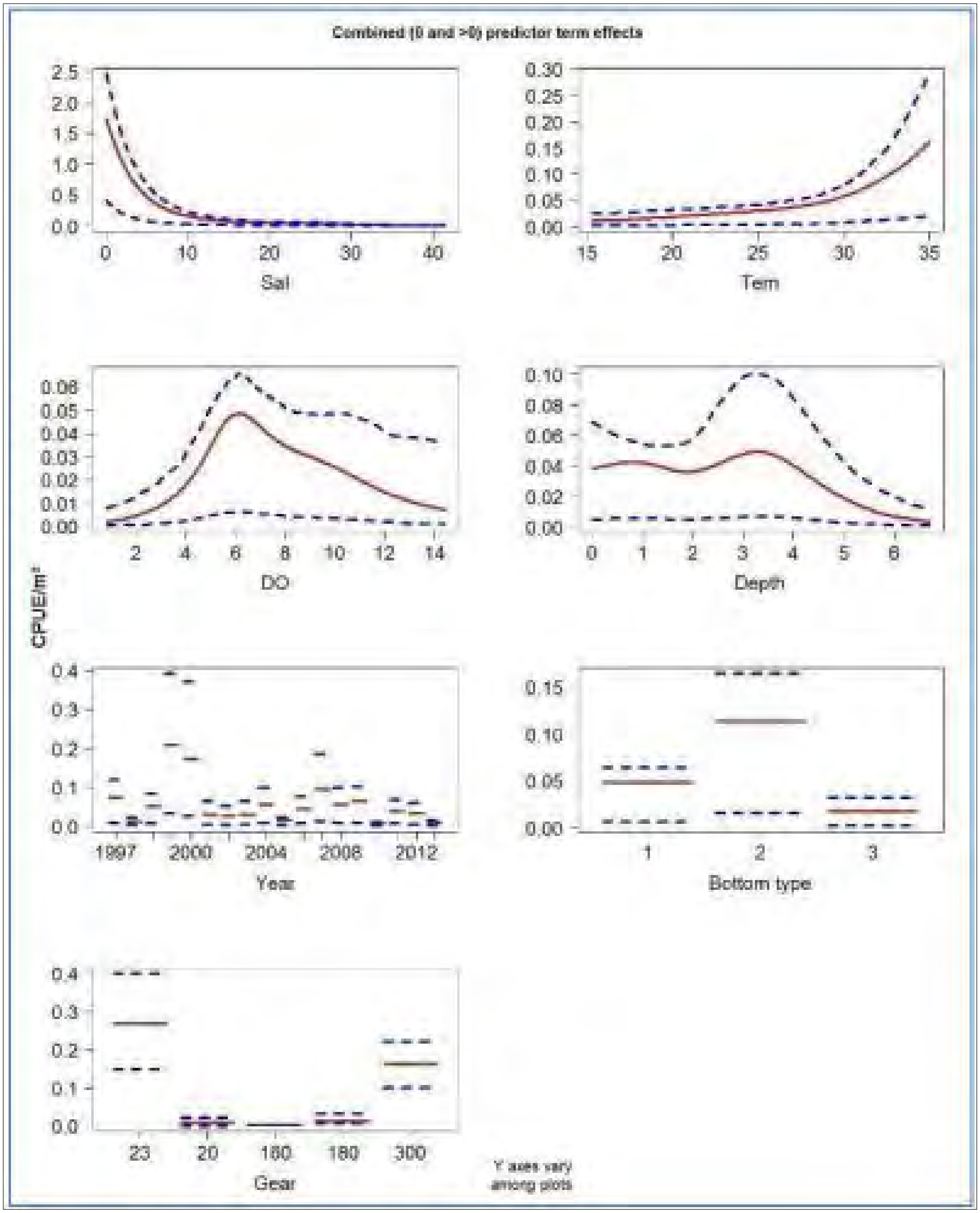

FIGURE 7. Back-transformed splines and histograms depicted for Juvenile+Adult Hogchoker in the spring. The dashed lines associated with the fitted splines and histograms are 95% confidence limits around mean GC-CPUEs. Bottom type 1=sand, 2=mud, 3=SAV.

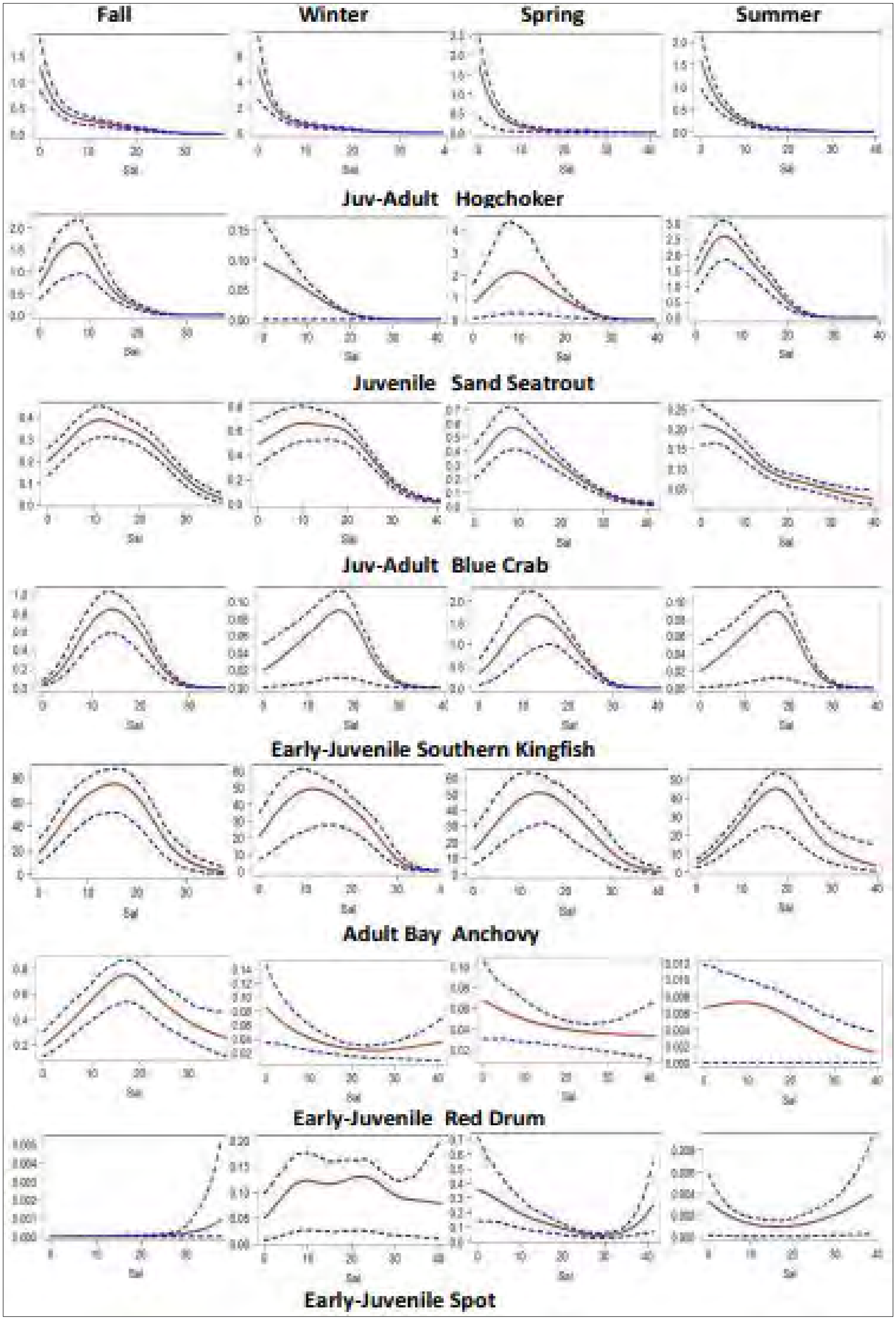

FIGURE 8. Seasonal fitted splines for back-transformed GC-CPUEs by salinity for species life stages. Dashed lines represent 95% confidence limits.

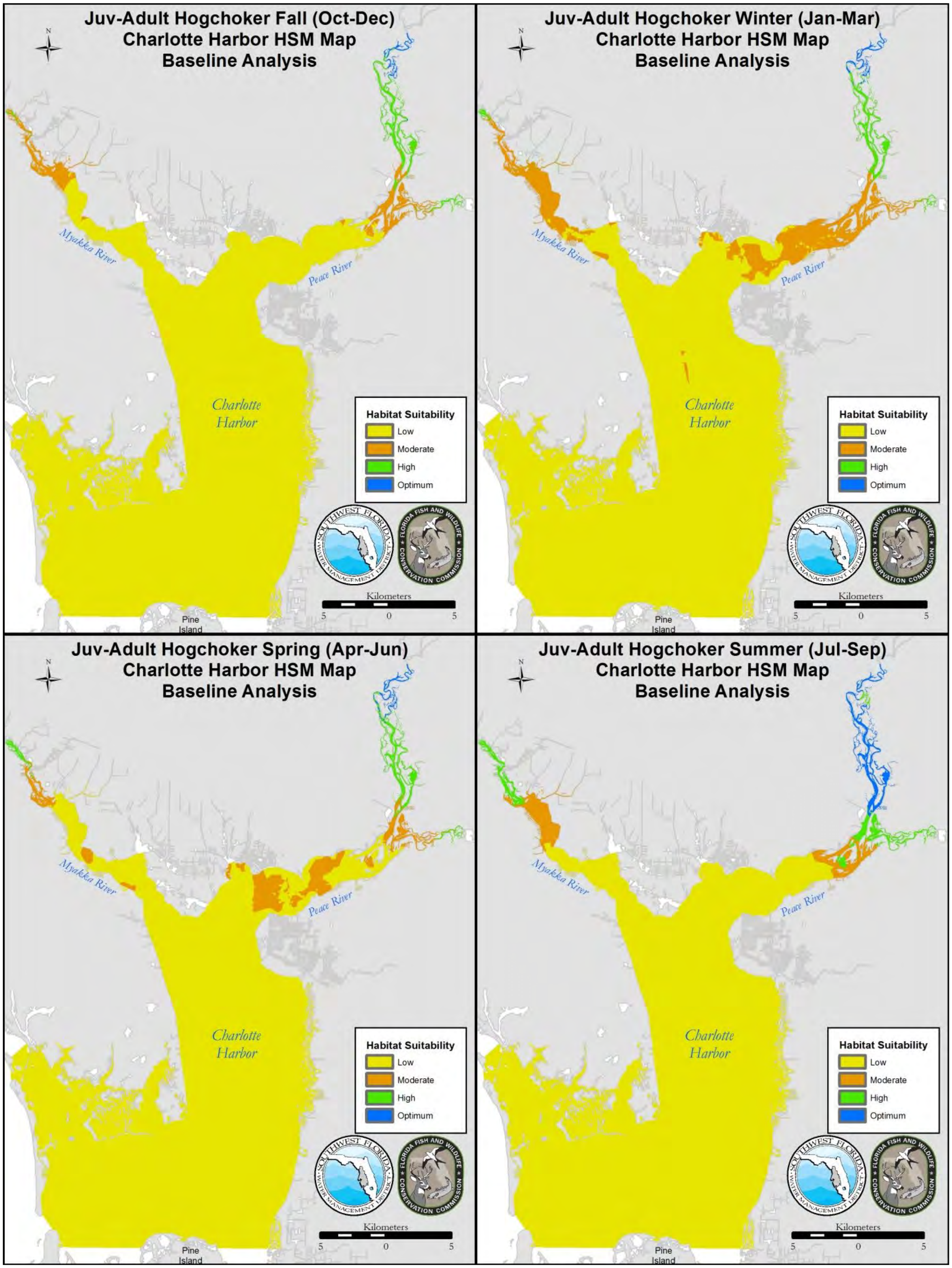

FIGURE 9. HSM maps for Juvenile+Adult Hogchoker depicting changes in HSM zones between seasons for Baseline scenario.

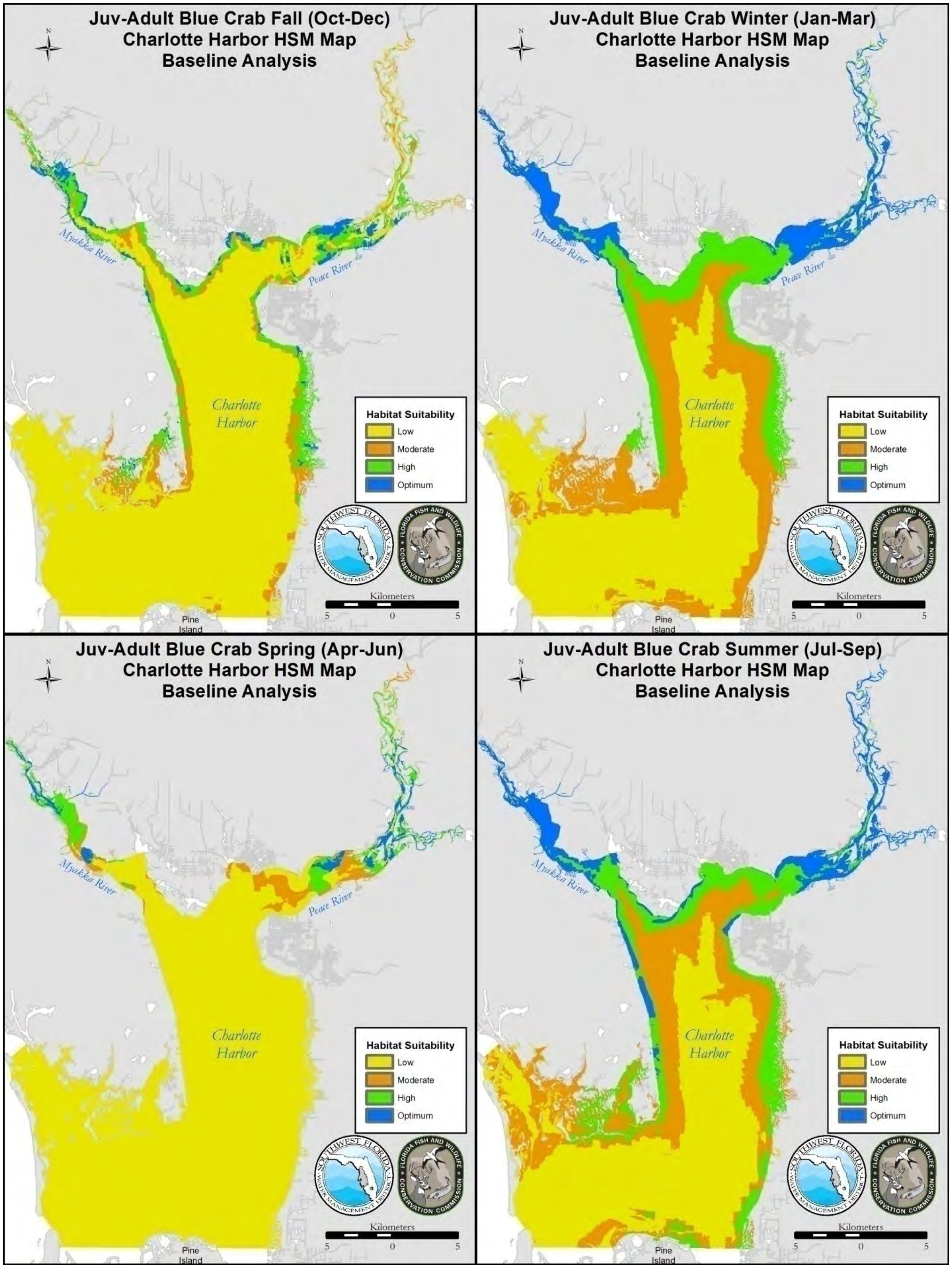

FIGURE 10. HSM maps for Juvenile+Adult blue crab depicting changes in HSM zones between seasons for Baseline scenario.

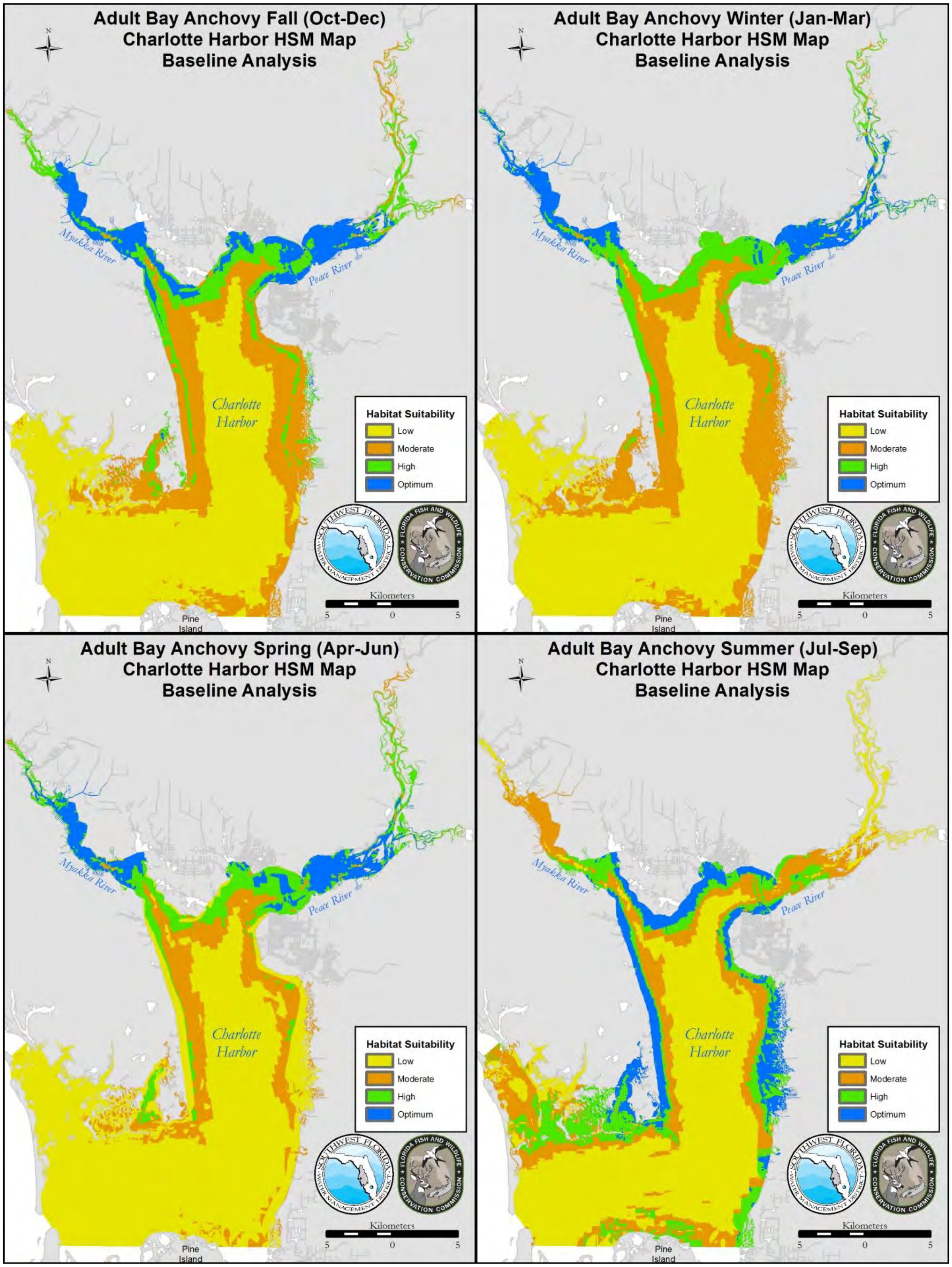

FIGURE 11. HSM maps for Adult Bay Anchovy depicting changes in HSM zones between seasons for Baseline scenario.

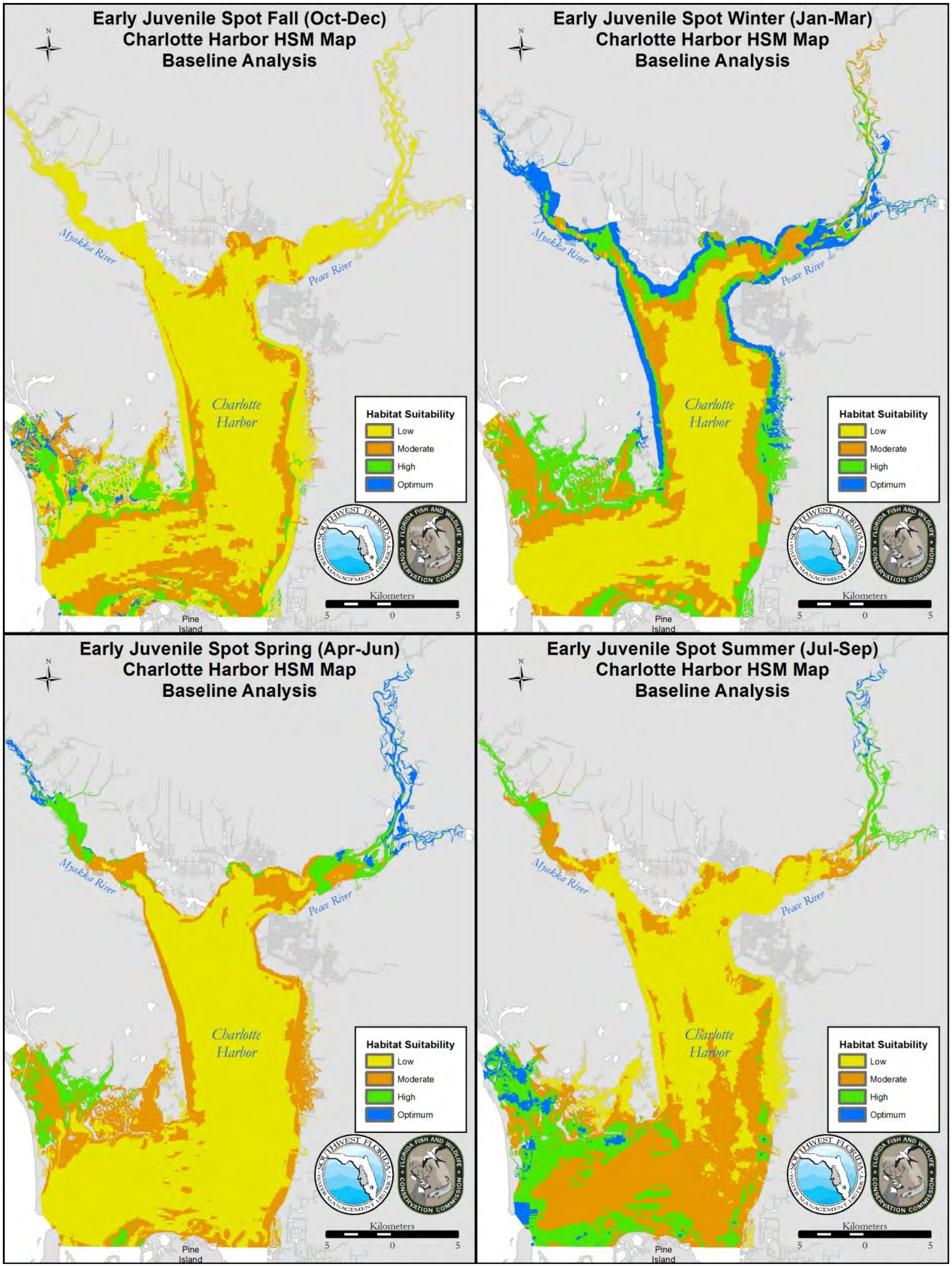

FIGURE 12. HSM maps for Early-Juvenile Spot depicting changes in HSM zones between seasons for Baseline scenario.

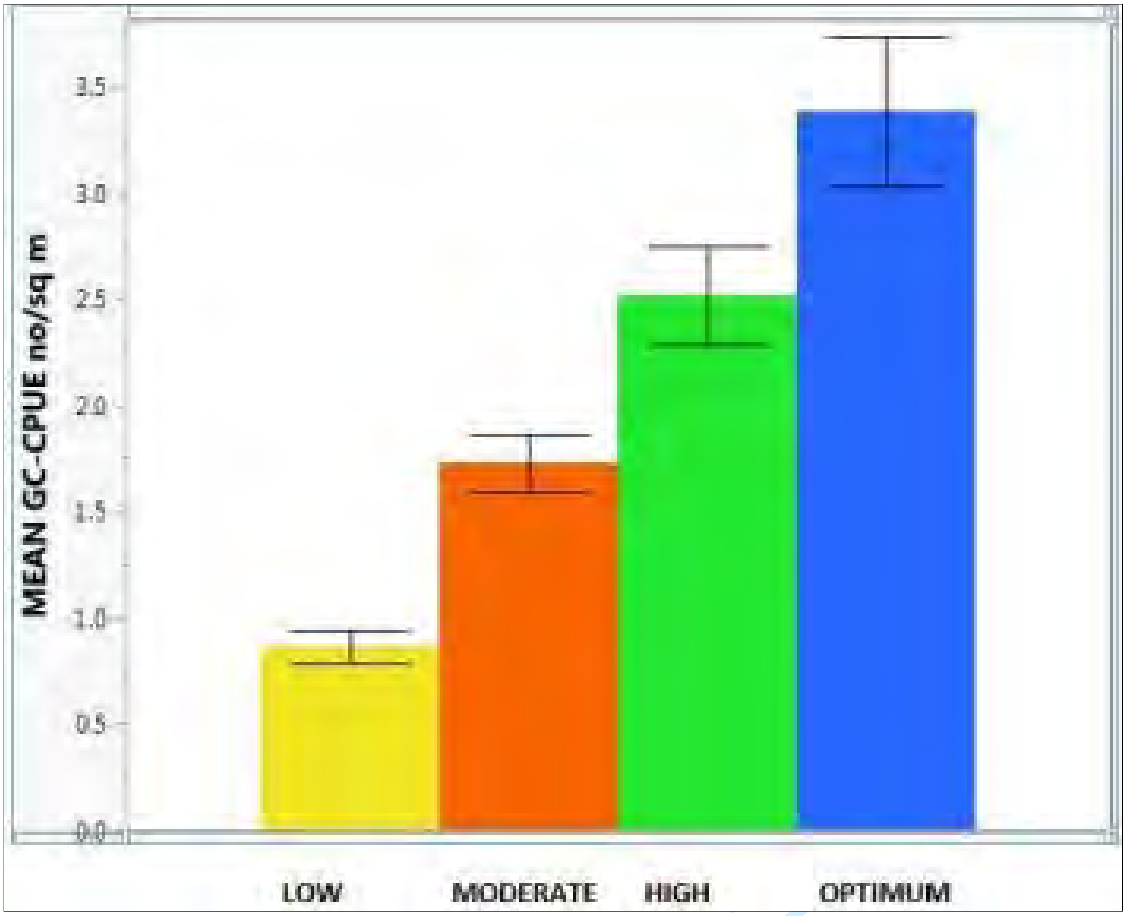

FIGURE 13. Validation graph for Adult Bay Anchovy in Charlotte Harbor during fall for Minimum Flows. Mean observed gear-corrected CPUEs are plotted versus predicted HSM zones. The upper and lower bars represent 95% confidence intervals.

K. Rose comments (as AE and Editor):

(1) The writing at the level of sentences is clear. It is at the paragraph and higher levels that the manuscript needs to be heavily edited and re-written. There are one sentence paragraphs, the methods are very long and difficult to follow as a series of steps in an analysis, the results about each species appear repetitively worded and should be condensed and integrated, etc. For example, Figure 2 has to identical vertical pathways, which means you only need one of them. The same flow of analyses applies to baseline and minimum flows.

REPLY-The Draft submitted 12-28-19 contained several places with one sentence paragraphs. The most notable are the goals listed at the end of the introduction. The goals were combined into one paragraph. In the discussion, separate paragraphs concerned with abundance by salinity splines and seasonal HSM maps were combined into single paragraphs stressing different concerns for each species life stage. Figure 2 was modified to remove the flow diagram for Minimum Flows, leaving the flow diagram for Baseline.

(2) The manuscript reads more like the text for an environmental impact statement (EIS) than a scientific paper. This means all of the information is presented but in a very complete and systematic way. A revision should make the manuscript more succinct and written in a way for the broad audience who are interested in developments in methods, and the generality of the results and how they relate to other systems. Addressing this is not difficult (that is the good aspect of it being complete like an EIS) but requires a major re-write to make a journal paper of general interest. You should consider more emphasis on the new methods and generality of results using lower Peace River and Charlotte Harbor as a case study and demonstration.

REPLY-The previous draft (47) was extensively revised with a major rewrite. The phrasing of sentences and paragraphs in Draft 56B are consistent with a journal article instead of the way it was presented in the 2018 report to SWFWMD. The opening paragraphs now cite a series of papers pertaining to studies in Florida and other states concerned with the impacts of reductions in freshwater inflows on fish and invertebrate species, including some of importance to commercial and recreational fisheries. It is now more succinctly written for a broad audience. As mentioned in the revised paper, most studies do not use habitat suitability modeling (HSM) and GIS to estimate population numbers in estuaries subjected to fisheries-independent monitoring (FIM). Hence, we did not compare our HSM-GIS approach with other studies in Florida or in other states. Because this is a new approach, it was necessary to describe the methods in some detail, while referring readers to the most pertinent reports and publications that describe the ecology and life histories of the subject species in the study area. I suggest that the Rubec et al. (2018) report should be posted online as supplemental material to the paper published online by Marine and Coastal Fisheries.

(3) There is no reason to include both the baseline and the minimum flows in the manuscript. Looking at Figures 6-9 would immediately say there is little difference in environmental variables between baseline and minimum flows. I suggest you use one or the other, and then discuss the one not presented in the Discussion as generating similar results.

REPLY-The main purpose of the study was to compare seasonal habitat maps for temperature and for salinity, and seasonal HSM maps between Baseline Flows (BL) and Minimum Flows (MF). Hence, it was necessary to state in the methods that seasonal maps were produced for both scenarios. But, due to the similarity of seasonal habitat maps and seasonal HSM maps, we have removed the seasonal MF maps for temperature and for salinity, and removed the MF maps (4 seasons in figure) for JA-Hoghoker from Draft 56B (current draft). Consequently, the number of tables has been reduced from 12 to 9, and number of figures reduced from 17 to 13. The revised paper stresses that the maps were similar and refers readers to the 2018 report, should they wish to see all of the maps for both BL and MF.

(4) I would like to see more justification for the use of seasonally-averaged environmental variables as input to the analyses. Figure 4 does show differences in daily flows between baseline and minimum flows that are apparently simply averaged away on the seasonal scale. If you want to include both baseline and minimum flows in the results, then add a few analyses that focus on these shorter-term differences (examples would be sufficient). This is challenging because fish relative abundances would not be expected to respond on fine time scales. That is why I think the other option of taking out detailed results for one of the flows is easier. You can then discuss this in the Discussion and caveat the results as being on a seasonal scale.

REPLY-While it is true that differences exist in daily flows between BL and MF (Figure 4), we did not add an analysis of these shorter-term differences in the revised Draft (56B). We could speculate that different species life stages shift upstream and downstream in the lower Peace River on a short-term basis in response to fluctuations in freshwater inflows. Another possibility is that they move vertically in the water column to maintain themselves in the preferred salinity ranges. We decided not to speculate about daily or short-term movements in the present paper. The revised paper (56B) refers to the MF maps in the Discussion. Because species to not respond to most short-term changes in flow, we believed that average conditions for four seasons that represent typical seasonal rates of freshwater inflow and water temperature and salinity values would be more meaningful and informative.

Greenwood et al. (2004) regressed the abundance of various species life stages versus flows in the lower Peace River and in Shell Creek averaged over different preceding time periods. They plotted mean CPUEs in relation to salinity zones ranging from oligohaline to polyhaline. The study provided plots of abundance for different size ranges for the more abundant species by size groups for different seasons of the year. The data tend to agree with our findings; although the methods were very different and no maps of species distributions were produced.The title of their report is: Assessment of Relationships Between Freshwater Inflow and Populations of Fish and Selected Macro-invertebrates in the Peace River and Shell Creek, Florida.

(5) You may want to include a summary of the skill of the hydrodynamics-water quality model for the environmental variables used in your analysis in this manuscript. Nothing extensive but a paragraph or so that shows the reader the model's predictions of environmental variables used in your analysis are realistic.

REPLY-Dr. Xinjian Chen has developed a series of different hydrodynamic models over the past 15 years. We removed citing the scientific papers describing the models from previous Drafts of this paper. This is part of our effort to shorten the paper and help the reader distinguish the forest from the trees. Since Dr. Chen's papers are peer reviewed, we don't see any reason to doubt that the 2D and 3D models included in UNLESS are realistic. If necessary, upon review of this draft, we could provide additional citations that describe the models including verification parameters and statistics or list citations for reviews of the model.

(6) Be clear how this analysis relates to your earlier paper(s) and also how gear selectivity was adjusted for.

REPLY-The previous Draft (47), which is the subject of the reviews received on 5-06-20, cited earlier papers associated with habitat suitability index modeling (Rubec et al. 2001) and HSMs reciprocally transferred between Tampa Bay and Charlotte Harbor and linked to habitat grids to produce within and transferred HSM maps (Rubec et al., 2009, 2016b). The methods used have been described in reports (Rubec et. al. 2018) and published papers (2016a, 2019). The present draft (56B) states that when the suitability splines were similar between the two estuaries, the transferred HSM maps produced were very similar to the within HSM maps. The gear-correction (GC) of catch-per-unit-effort to standardize CPUEs is a common practice used by fisheries scientists. The present author has used GC-CPUEs in these previous studies. All of this is clearly explained in the revised draft (56B).

(7) The Discussion has a lot of repeating of the results already stated, especially the species-by-species part. Here is where you can step back and relate what you did compared to other analyses of these same systems and to similar analyses of other systems with similar questions. There are many, so you can select a reasonable subset (maybe you pick some similar systems, maybe similar information available at these other systems, maybe these other systems illustrate how your methods may help, maybe compare metrics of minimum flows across systems, …).

REPLY-Draft 47 was not clearly written because it mixed results with discussion of the species life stages presented in the Results section. The Discussion section repeated some of the results while linking them to published papers pertaining to each species. In the Results section, the newly revised manuscript (Draft 56B) has separated results for splines of abundance across environmental gradients from results pertaining to the seasonal HSM maps for each species life stage. The Discussion has been extensively rewritten. Instead of discussing the splines of abundance separately from the HSMs in different paragraphs, we have been discussed them together in the same paragraph. Rather than repeating the fact that Optimum zones for each species life stage expanded with increased inflows during the summer, different issues are emphasized with each species life stage for 4 seasons. This allowed a more concise discussion of the influence of water withdrawals and a better discussion of life histories across seasons for each species life stage. Hence, the Discussion is tighter, more interesting, and less repetitive. There is no longer a Conclusions section. Conclusions are included in the Discussion that stresses the HSM-GIS study across the Charlotte Harbor-lower Peace River study area. One strength of the present study is it modeled and mapped the Charlotte Harbor study area, while earlier studies only considered the lower Peace River and lower Shell Creek. The computation of population numbers from GC-CPUEs applied to habitat grids is an original approach that can be used to help manage both water withdrawals and biological resources in estuaries.

Reviewer 4 (Joan Browder)

Joan Browder is the Ecosystems Investigations Unit Leader with the NOAA Southeast Fisheries Science Center based in Miami, Florida. She was a member of a multiyear group that reviewed water withdrawal plans by the Charlotte Harbor-Manasota County Water Authority. She is familiar with the water management practices of SWFWMD and other water management agencies in Florida.

(8) The paper is well written and clear in explanations. We made some minor edits and one important clarification suggestion to replace a previous sentence with one I offered. I used the "sticky note" feature to suggest the edits. This is an important paper in estuarine ecology and water management science. I commend you for it.

REPLY-We made the changes indicated in the sticky notes to Draft 47 and changes she suggested to various versions of Draft 56 developed from May 5th to the present.

Reviewer 1 (anonymous)

The paper presents valuable work. Florida has undergone an explosion of MFL evaluations and many of these plans have few fish data, or really any quantitative biological information above the level of producers. Several of the MFL plans rely on fish lists because the fish data just haven't been available. Therefore, I am happy to see work that includes detailed fish population assessment. However, in my opinion, the paper loses the forest for the trees.

(9) Abstract: I might be missing something, but if the fish data are used to build models, don't you need new fish data to evaluate whether the modeling approach "can be used to manage freshwater inflows without markedly impacting biological resources in the study area"? If you use the same data to build the model and to assess it, isn't that circular?

REPLY- The paper clearly explains that Tampa Bay and Charlotte Harbor have received a number of previous studies using within and reciprocally transferred HSMs to produce similar HSM maps that act as external validations. This required separate HSM analyses to produce seasonal within HSM maps and seasonal transferred HSM maps. External validations would double the amount of analyses required. In the present study, it would be too time-consuming to do external validations with 8 species life stages analyzed seasonally for both Baseline Flows (BL) and Minimum Flows (MF).The R-software computed 31 models for 1 to 5 factors before selecting the best HSM based on the lowest Akaike Information Criterion

(AIC) for each species life stage. Doing everything described in the paper was already very time-consuming. The internal validations, plotting mean Observed GC-CPUEs versus Predicted mean GC-CPUEs, were considered to be sufficient. The internal validations, plotting mean Observed GC-CPUEs versus Predicted mean GC-CPUEs, provided good results with the one exception for hogchoker, which can be explained by weaker input data.

(10) Introduction: In the first paragraph, the authors say that the inflow-based modeling approach has been used for Texas, Florida, and California. If the goal of the paper is to show the inflow-based modeling approach works well, perhaps some discussion of those projects would be helpful. Have those projects been assessed for how well they protect the resources? If so, how is the assessment in this paper different? If not, why not? Is that the research hole that this paper is filling?

REPLY-That depends on what is meant by "inflow-based modeling". In the introduction, it is defined by Alber (2002) as: "inflow-based (flow is kept within some prescribed bounds under the assumption that taking too much away is bad for the resources)." In other words, the models are based on assumptions. However, there are well documented papers that show that SWFWMD in Florida and the Water Development Board in Texas have conducted numerous studies that have examined impacts of water withdrawals on various biological resources (i.e., algae, benthic macro-invertebrates, SAV, fish etc). This is resource-based modeling, the 3rd modeling approach discussed by Alber (2002). Hence, the statement in Draft 47 that inflow-based modeling has been used in Texas, Florida, and California is incorrect. We removed this sentence from Draft 56B (draft recently submitted).

(11) The second paragraph is very specific and should either come later in the introduction or, reworked, in a "study site" paragraph in the methods. The third paragraph is important and should be expanded. How do these data on phytoplankton, inverts, and larval fish put the current research into context?

In 1972, the Florida Legislature directed the five Florida water management districts to establish minimum flows and levels (MFLs) for rivers and streams within their boundaries (Section 373.042, Florida Statutes). As currently defined by statute, "the minimum flow for a given watercourse shall be the limit at which further withdrawals would be significantly harmful to the water resources or the ecology of the area". The water management districts have taken different approaches to comply with the legislation (Alber 2002).

REPLY-The second paragraph above is meant to be specific. It states that the water management districts are required by the Florida Legislature to establish minimum flows and levels (MFLs) to protect water resources. We believe it does not need to be reworked. We retained the paragraph in Draft 56B, which was recently submitted for possible publication. We are willing to modify the paragraph, if the subject editor believes that it is necessary.

Changes were made to the third paragraph in Draft 56B of the proof recently submitted.

The paragraph in Draft47 states:

The Southwest Florida Water Management District (SWFWMD), due to its responsibility to permit the consumptive use of water and the legislative mandate to protect water resources from "significant harm" has established Minimum Flows (MF) for the free-flowing lower Peace River, which drains into Charlotte Harbor on the southwest coast of Florida (SWFWMD 2010). The District has been conducting a reevaluation ofthe MF and developing new ones for the lower portion of Shell Creek, a tributary to the lower Peace River. The Peace River and Shell Creek are both important sources of municipal water supplies. Water withdrawals from the lower Peace River are diverted approximately 30 km upstream of the river mouth. Withdrawals from Shell Creek are made from an impounded reach of the creek approximately10 km upstream of its confluence with the lower Peace River. A percent-of-flow approach was developed using MF to maintain 85% of the most sensitive salinity habitat (i.e., <2 psu salinity) in comparison to Baseline (BL) conditions in the uppermost part of the tidally-influenced lower Peace River. This assumes that when seasonal salinity and temperature predictions do not differ substantially between BL and MF; the associated water withdrawals should not be detrimental to biological resources in the lower Peace River.

The rewritten paragraph in Draft 56B states:

The Southwest Florida Water Management District (SWFWMD), due to its responsibility to permit the consumptive use of water and the legislative mandate to protect water resources from "significant harm", has established Minimum Flows (MF) for the free-flowing lower Peace River, which drains into Charlotte Harbor on the southwest coast of Florida (SWFWMD 2010). The District has been conducting a reevaluation of the MF and developing new ones for the lower portion of Shell Creek, a tributary to the lower Peace River that enters the river 12 kilometers upstream of the river mouth. The Peace River and Shell Creek are both used for municipal water supplies. To evaluate MF, historic freshwater withdrawals were added back into the flow records for each source and other hydrologic adjustments were made to create a Baseline (BL) flow record that reflects natural flow conditions. A variety of analytical approaches were then used to evaluate the effects of different daily flow reductions on salinity, water quality and various biological parameters in the tidal reaches of these tributaries and Charlotte Harbor to determine the total amount of water than can be available for withdrawal without causing significant harm to environmental resources (SWFWMD 2020). As part of this overall effort, our study was conducted to evaluate predicted changes in the habitat and abundance for a number of species life stages across the study area that would result from the MF.

(12) The third paragraph is very vague, but it could be very interesting in setting the context for the study. Yes, conditions change seasonally, that's to be expected. How do conditions change and how do they affect fish and invert species? Again, this paragraph is an opportunity to show what's known and what holes their analysis can fill.

REPLY-Since the 3rd paragraph does not state that conditions change seasonally, we believe the reviewer is referring to the 4th paragraph and possibly the 5th paragraph in Draft 47. Both Draft 47 and Draft 56B have a sentence pertaining to the use of regressions by Peters and Burghart (2013). While they did do regressions, the report by Greenwood et al.(2004) has more thorough analyses using regressions of the abundance of various species life stages versus inflows in cfs. If Draft 56B is accepted for publication, the sentence pertaining to regressions should cite both Greenwood et al. (2004) and Peebles and Burghart (2013). The report by Greenwood et al. (2004) explains how fluctuating inflows influenced short-term movements (upstream and downstream) of species life stages and their relative abundance (mean CPUEs) in salinity zones (based on the Venice system) in the lower Peace River.

The present study was focused on explaining longer-term responses to changes in salinity and temperature (predicted by Chen's hydrodynamic modeling from to 2007 to 2014) in both the lower Peace River and Charlotte Harbor. It differs from all of the short-term studies (mostly funded by SWFWMD) in assessing changes between BL and MF associated with water withdrawals by using the HSM-GIS approach. We created maps of seasonal temperature and seasonal salinity changes and seasonal HSM maps depicting changes in spatial distributions of species life stages, while also predicting changes in population numbers between the two scenarios. None of the short-term studies cited used maps to quantify the spatial impacts of water withdrawals. This is explained in the 6th paragraph of Draft 56B.

(13) Some of the 4th paragraph seems to be methods rather than context. Perhaps describing the shrimp approach would be more helpful.

REPLY-We believe the reviewer is referring to the HSM-GIS methods developed for analyses of 87 species life stages in Tampa Bay described in the 6th paragraph of Draft 47 (and the 7th paragraph of Draft 56B). The methods using delta-type GAMs for HSM analyses were described using pink shrimp as an example by Rubec et al. (2016b).

(14) The last four paragraphs should be one paragraph that outlines the questions addressed by the paper. Is there a hypothesis or are there hypotheses? Would it be that the approach could be used to assess the ability of inflow-based modeling to protect biological resources? Or is the hypothesis that it does protect biological resources?

REPLY-The four single sentence paragraphs were combined into one paragraph in Draft 56B. There is no hypothesis provided, and we don't believe that one is required. In a recent powerpoint, we stated that the main goal was to: "Assess the influence of environmental conditions on fish and invertebrate species to support setting minimum flows and levels (MFLs) for the lower Peace River and Charlotte Harbor." We will add this to the paper. The four sentences are the objectives of the study. We listed them in the last paragraph of the Introduction in Draft 56B because reviewers of previous drafts did not understand the approach taken to determine the long-term influence of water withdrawals on species life stages.

(15) In the first sentence (of methods in Draft 47), I'm assuming that by "this approach", you mean the inflow-based modeling?

REPLY-In Draft 47, this approach meant inflow-based modeling based on "assumed" percent-of-flows used for management of daily water withdrawals. However, Michael Flannery (formerly with SWFWMD) pointed out that the percent-of-flows being used were based on the short-term studies of impacts of different freshwater inflows on salinity, water quality and a variety of biological resources in the lower Peace River and lower Shell Creek (such as benthic invertebrate abundance, plankton studies, and fish/invertebrate community structure in the lower Peace River). This is the reason we cited the short-term studies in the Introduction. The answer to question 16 is that it was not based solely on inflow-based models. See the REPLY to question 11 in this document. Draft 56B explains that the percent-of-flows used were based on studies to assess impacts of water withdrawals on natural systems.

(16) P. 5, line 104 (in Draft 47): the semicolon does not belong there. A semicolon separates independent clauses and the part of the sentence after the semicolon is not independent.
P. 5, lines 108-109: there should be no comma after "since" and the semicolon should be a comma.

REPLY- These changes and others were made based on the editing of both Draft 47 and Draft 56B by Joan Browder.

(17) Methods: Typically, the methods section presents the methods rather than evaluates them. In the third paragraph (top of p. 6 in Draft 47), the text evaluates their data. That text could be moved to the discussion section that outlines the drawbacks to the approach.

REPLY-We assume that the paragraph at the top of page 6 in the Proof of Draft 47 pertains to methods to characterize bottom sediments. The sentences of concern to the reviewer are probably the following:

Bottom types should be characterized by sediment analysis of benthic grab samples. The only recent sediment data available for the study area was associated with fewer than 10 grab samples. A grab sampling survey to better characterize the spatial distribution of sediment types in the Charlotte Harbor study area is needed.

These sentences are in Draft 56B recently submitted for review. We will remove the sentences from the galley proof before the paper is published.

(18) There is also another issue that I think that I might be missing. How are the authors establishing the "baseline"? Water withdrawals have been occurring and increasing all over Florida for more than 100 years. Is the withdrawal from Shell Creek and the upper Peace River new? I have seen other MFL plans that use something like the 1980s and 1990s as baseline, but that period is hardly pre-impact. Otherwise, the two periods might be "low withdrawal" vs. "high withdrawal".

REPLY-Direct surface water withdrawals from the Peace River and Shell Creek are limited to the two utilities described in the 2018 report and those withdrawals were added back into the flow record for the baseline. There were also adjustments made to the flow record to correct for documented excess agricultural irrigation water that flows to Shell Creek, the infrequent use of water stored in that small impoundment, and the effects of groundwater withdrawals that affect portions of the Peace River along it length. The hydrologic corrections that were used to create the baseline flow record are described in the minimum flows report by SWFWMD (2020) which is referenced in that regard in the revised manuscript. In addition to adding back in the surface water withdrawals, the other corrections to the flow record are generally referenced, but would be too lengthy and not germane to describe those hydrologic corrections in this manuscript about HSM mapping and modeling.

With regard to the years selected for the baseline flows, this study was done by FWC staff in collaboration with staff from SWFWMD. The hydrological modeling done by Dr. Xinjian Chen (SWFWMD) from 2007 to

2014 provided the temperature and salinity data for Baseline (BF) and Minimum Flows (MF) in the Charlotte Harbor study area analyzed by Dr. Peter Rubec (FWRI). Hence, the time period for BL and MF was determined by Dr. Chen's hydrodynamic modeling, which was calibrated and verified for the 2007-2014 period.

(19) In the latter half of the paragraph on p. 9 (lines 218-223), saying that figures "are presented" uses up valuable paper real estate in a long paper. Something should be said about where the data in Fig. 4 and Table 3 came from or how they were used rather than "presenting" them. The last two sentences read like results rather than methods.

REPLY- Fig. 4 and Table 3 (Draft 47) were provided by SWFWMD. The two sentences using "are presented" are still in the current draft (56B). We will correct this. Efforts to remove redundant phases from Draft 56B have been made. We will review it again to ensure the paper does not use repetitive phases.

(20) In the "Estuarine Species…" section, how were the species analyzed?

REPLY-The two paragraphs under the heading **Estuarine Species Life Stages** listed the common and scientific species names and the abbreviations used for species life stages. We explained the analysis of species life stages in Draft 47, although we did not remove the phrases requested by the reviewer because they seemed to be needed for the reader.

(21) In the "Continuous CPUE Grids" paragraph, the address could be incorporated into another sentence in parentheses "(R code available from: GISLibrarian@MyFWC.com)".

REPLY-We agree that the sentence used below is too long.

Since the Florida Fish and WildlifeConservation Commission is a public agency, people can obtain the R code from FWRI using the email address: GISLibrarian@MyFWC.com.

We will append the phrase in parentheses suggested by the reviewer to the end of the previous sentence about continuous GC-CPUE grids.

(22) In the "Validation Graphs" paragraph, why are the internal validations sufficient? Again, I'm concerned that the analysis is a bit circular, although I may well have missed something. It says that the observed data are overlaid on the HSM zones, but weren't the observed data used to create the zones? If that's not correct, then some reworking of the layout of the purpose of the study to make the approach a little clearer would be helpful. How are the four zones defined? P. 14, line 335 is the first that I'm seeing the four zones. This definition seems critical to the question of whether the analysis is circular.

REPLY-Observed FIM data were used to build habitat suitability models (HSM). The models output fitted splines of GC-CPUEs by environmental variables. Abundance values (GC-CPUEs) from the fitted splines were applied to the habitat grids. However, the seasonal temperature grids and seasonal salinity grids (each with about 1.9 million 15 X 15 m cells) were independently derived from the hydrodynamic modeling data. After averaging the GC-CPUEs associated with the habitat grids continuous GC-CPUE grids were produced. The continuous GC-CPUEs were partitioned into 4 HSM zones using the Jenks classification method. The validation test overlaid mean Observed CPUEs onto the HSM zones to determine whether the mean Observed GC-CPUEs increase across the HSM zones consisting of mean Predicted GC-CPUEs. This is analogous to regressing Observed GC-CPUEs versus Predicted GC-CPUEs to test whether the HSM analyses correctly predicted the spatial distribution and abundance of the each species life stage. Considering the complexity of the analyses in selecting gear types, standardizing GC-CPUEs across gear types, and using temperature and salinity data from the hydrodynamic model, the mean Predicted GC-CPUEs may not agree with mean Observed GC-CPUEs, but both should increase across the HSM zones.

As Draft 56B explains the internal validate test was used because it would have been too time consuming to double the amount of analyses to produce seasonal transferred HSM maps for both BL and MF.

Previous research already demonstrated that HSMs created with Tampa Bay data transferred to Charlotte Harbor and linked to Charlotte Harbor habitat grids to produce transferred HSM maps agree with the within HSM maps.

(23) Results: Much of the results consist of data-are-presented-in-figures type sentences. They are peppered throughout the results section, so I am not going to mention each one. Again, these types of sentences are a waste of paper real estate. I would reword them to describe the trends in the figures instead. Many of the other sentences in the results could be streamlined as well. For example, the sentence on P. 15, line 368 could say instead, "Salinity differed little between MF and BL conditions; differences were primarily <1% for salinity up to 20 psu and <4% for salinity up to 35 psu." Or something like that.

REPLY-Efforts have been made in Draft 56B to reduce the use of "data-are-presented-in-figures" in sentences in the Results section.

We have retained a table that shows the % differences by zones between the BL and MF salinity maps. The analysis was summarized by the sentence "Differences were primarily <1% for salinity up to 20 psu and <4% for salinity up to 35 psu." The table with similar analyses between the BL and MF temperature maps was not presented in Draft 56B. We used the sentence "The percent changes within zones obtained by subtracting percent temperature for MF from percent temperature for BL were <0.5 % for temperature ranges up to 30^{o}C and <3 % for higher temperature ranges up to 34^{o}C (Rubec et al. 2018)."

(24) The first three paragraphs are just a sentence or two. When they are rewritten, they should be incorporated into one paragraph.

REPLY-The three sentences at the beginning of the Discussion in Draft 47 no longer exist in the Discussion with Draft 56B. They dealt with the % changes in salinity and % changes in temperature between BL and MF, which were presented in the Results section. There was no need to repeat them in the Discussion section.

(25) In the "Statistical Table Reduced HSM" section, I don't actually quite get that title. Also, the second sentence is more methods than results. Statistics are either significant or not; the authors should remove "highly" before significant in the second paragraph of this section.

REPLY-The GAMLSS program in R outputs statistical results for a Full model that is based on use of 5 environmental variables (S,T,O,D,B). It also computes 31 models consisting of 1 to 5 environmental factors before selecting the best Reducedmodel based on the lowest AIC. The statistical table presents the statistical significance of seasonal HSM analyses of 8 species life stages for the Reduced models. This is explained under Methods in Draft 56B. Description to these methods was removed from the Results section in Draft 56B. We removed "highly" in describing significance in Draft 56B.

(26) In the "Fitted Splines and Histograms from HSM" section, results should be past tense and some of the text seems like interpretation, which should be in the discussion instead. I can't read Fig. 11 because the panels are super small and blurry.

REPLY-We dealt with the present and past tense problem in Draft 56B. We removed the interpretation of results from the Results section. We moved them to the Discussion section.

Figure 11 becomes blurry when the MS-Word file containing the figures is saved repeatedly. We will provide a clearer image of the fitted splines by salinity for use with the publication.

(27) The individual species sections are very important, clearly, but they could be streamlined a lot for clarity. Again, I'm losing the forest for the trees.

REPLY- As explained earlier (Response 8) the description of individual species in the Results section of Draft 47 had problems because it mixed results for the splines with the results for the HSM analyses.

There also were interpretive comments that should be in the Discussion section. We dealt with these problems in Draft 56B.

(28) I don't quite know why there's a separate section with three sentences for "Zonal areas and population numbers". There's another section later that is called "Population numbers by HSM zones" and both refer to Fig. 9? And what does "Percent zonal areas between baseline and minimum flows" mean? I think that it means the percent of animals in the different HSM zones (which weren't defined other than to say that they were based on CPUE). The title for the section and of Table 10 aren't quite clear. This section also has some interpretation mixed in with the results. It should be streamlined for clarity. The next section also could be streamlined.

REPLY-

In Draft 47, **Figure 9** was cited associated with seasonal temperature maps for Minimum Flows (MF). It was only cited once in the Proof submitted on December 24, 2019. So, we are not sure what document you reviewed. As far as we can tell, there is no reference to **Figure 9** under the heading **Population Numbers by HSM zones. Table 9** is cited once and **Table 11** is cited twice.

In Draft 47, **Table 9** under the heading **Zonal Areas and Population Numbers** shows how population numbers were derived for Adult Bay Anchovy in spring for BL and MF by multiplying mean GC-CPUEs by zonal areas for each HSM zone to derive population number estimates for each HSM zone. It explains that this method was seasonally applied to each of the 8 species life stages.

In Draft 47, under the heading **Percent Zonal Areas Between Baseline and Minimum Flows,**changes in percent zonal areas for the HSM maps between BL and MF were computed in **Table 10**. Since, the analyses did not show large differences in percent zonal areas between BL and MF, this table was not presented in Draft 56B.

The first paragraph associated with the heading **Population Numbers by HSM zones** cites **Table 9** which shows an example of how population numbers were derived by multiplying mean GC-CPUEs by zonal areas to derive population numbers by HSM zones. The first and second paragraphs cite **Table 11** which presents seasonal population numbers estimated for 8 species life stages for both BL and MF.

(29) Discussion: There is a lot of detail to support the distributions of fish in the study. However, the goal was to show the efficacy of the modeling approach. Of course, being able to justify why fish were where they are important to showing that the model works (again, if there is no circularity), but it needs to be streamlined a lot and focused on the question. Does the model work to predict how changing flows affect fish population sizes and distributions? Again, watch the commas after "since" and inappropriate semicolon use.

REPLY-There were 3 goals presented at the end of the Introduction in Draft 47. The efficacy of the modeling approach was one goal. But, this was also dealt with in the pink shrimp paper in Tampa Bay (Rubec et al. 2016a). The Discussion section in Draft 56B has been extensively revised to reduce repetition concerning species life stages in the Results section and emphasizes the effects of water withdrawals on Population number estimates, which was the main goal of the present paper.

(30) In conclusion: This paper is very long and complicated with a lot of figures and tables. It might actually be the longest paper that I have ever reviewed. The work is complicated, of course, but the paper needs to be streamlined so that the reader can follow it better. I think that it should be accepted after this editorial work has been done.

REPLY- A lot of editing and rewriting of Draft 56B has been done to streamline the text to provide a more readable, concise and focused paper. The text is still quite long (24 pages with 1.5 line spacing). But, the paper is shorter due to the reduction of the number of tables and figures.

Reviewer 2 (anonymous)

(31) The paper provides a great quantitative assessment on comparing the suitability of estuarine habitat in the lower Peace River, lower Shell Creek, and Charlotte Harbor, FL under two freshwater inflow regimes. Species' habitat suitability models (HSMs) were developed to display the spatial distribution and abundance in GIS under baseline and minimum flow conditions. The primary conclusions of the paper were that fish and blue crab population numbers slightly decreased under minimum flow conditions when compared to baseline conditions. Therefore, the SWFWMD management approach that uses percent-of-flow to regulate freshwater inflows is an adequate tool to minimize impacts on biological resources. It is great to see a science-based paper directly linked to a management entity by addressing specific impacts of modifying freshwater inflow. Many of the "water wars" around the country and especially in the Gulf of Mexico usually end up in the courts, thus having peer reviewed publications on the impacts of freshwater inflow on estuarine habitats and species are key to regulation and decision making.

REPLY-Great! We are happy to see that Draft47 was so well understood and appreciated in that regard.

(32) The paper provides a robust statistical assessment to support its overall conclusions and I recommend acceptance of the paper, but it does need some significant modification in the presentation of the materials as the manuscript is very long (65 pages) and is difficult to read due the "choppy" nature of explaining the results from HSMs for 32 fish and invertebrate species' life stages under the baseline and minimum flow conditions.

REPLY- We agree that Draft47 is too long and difficult to read due to the choppy nature of explaining the results. As previously explained (4), the paper is shorter because the number of tables were reduced from 12 to 9 and the number of figures reduced from 17 to 13. The paper has been extensively edited and rewritten (31) to streamline the text in order to provide a more readable, concise and focused paper.

(33) Since, the vast majority of the HSM models for both flow regimes have been published in the Rubec et al. 2018 technical report, I recommend the manuscript focus on peer review of the approach with a few example HSMs maps and explanatory text. This approach will reduce text by relying on the figures and tables, such as Tables 11 and 12, to portray the individual species' life stage versus text on pages 18-21. If necessary, provide additional species' interpretation in the discussion section where the overall conclusions are presented. Carefully evaluate each table and figure and determine if they are necessary to your analysis. For example, Figure 11 is not very easy to read and much of the information on species CPUE by salinity is discussed in text and tables. All of these suggestions are to reduce the text, table, and figures that are easily found in Rubec et al. 2018 and for the peer reviewed publication not to read like the technical report.

REPLY- It is not correct to state that the vast majority of the results have been published in the Rubec et al. (2018) technical report. It is not easily available because it has not been published. The report could be posted online as supplementary material with the paper to make it more accessible.

We are reluctant to remove Figure 8 (formerly Figure 11) which shows the splines of abundance by salinity. A more legible copy of the figure is available.

Draft 56B has been extensively edited to ensure the publication does not read like the technical report.

(34) It may be better from a management perspective to manage flow to increase the percent area of high or optimum habitat suitability zones to conserve and enhance biological resources……..

In addition, please clarify that the HSM maps (Figures 12-16) depict changes in each of the 4 habitat suitability classes and not just the optimal zone as stated in the figure captions.

REPLY-The suggestion from a management perspective to manage flow to increase the percent area of High or Optimum habitat suitability zones is interesting. However, the management question addressed by this study was the effects the reduced freshwater inflow due to water withdrawals. The resulting changes in habitat and population numbers are then simulated, with decreases in population numbers being the most common. The Peace River is not an impounded river, and the impoundment on Shell Creek is very small, so releasing water to increase salinity habitat is not an option.

While the paper discusses the locations of Optimum zones in seasonal HSM maps for different species life stages, the figure captions for the HSM maps depict the spatial extent of all four HSM zones.

(35) With respect to the transferability of this approach and conclusions to other estuarine ecosystems, I recommend to be very careful on broad sweeping applicability statements (lines 730-736 in Draft 47) due to the fact of differences in habitat quantity and complexity and species composition and management issues. For example, in Apalachicola Bay, FL managing to minimum flows has been modeled and observed to have significant negative impacts on oyster populations due to high salinities associated with increasing oyster disease and predation. In addition, HSMs are a great screening approach, but does not account for species interactions including predation and behavior. Thus, using the HSM approach in isolation without other models, ecological considerations and habitat quality (e.g. contaminants) could result in erroneous conclusions and/or unintended consequences for particular species.

REPLY- These concerns were added to the Discussion in Draft 56B.

From: Doug Leeper
To: "Sid Flannery"
Subject: RE: Rubec"s paper submitted
Date: Tuesday, June 16, 2020 7:30:00 AM

Thanks, Sid.

Doug Leeper
MFLs Program Lead
Environmental Flows and Assessments Section
Natural Systems & Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street (U.S. Hwy. 41 South)
Brooksville, FL 34604-6899
352-796-7211, Ext. 4272
1-800-423-1476, Ext. 4272
Doug.leeper@watermatters.org

From: Sid Flannery <sidflannery22@gmail.com>
Sent: Monday, June 15, 2020 9:32 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: Rubec's paper submitted

Hello Doug,

Attached is the final version of the draft paper that Peter Rubec submitted to the journal Marine and Coastal Fisheries. I don't expect you need it or will read it, but also attached is his reply to the reviewers.

Both Joan Browder and I spent considerable time reviewing the paper and the response to reviewers and Peter accepted most of our suggested edits. Yonas also made the very helpful suggestion that percent reduction values in averaged seasonal flows be removed from Table 2.

Between you and me, Joan's and my comments were fairly time consuming and improved the paper considerably. After my 2002 paper with Peebles and Montgomery, this is the only the second time the percent-of-flow approach has been described in the journal literature. It was important that it not be misrepresented and Peter really needed some help on how to explain, or not try to explain, some of its elements.

Sid

From:	Doug Leeper
To:	Xinjian Chen; Yonas Ghile
Cc:	Chris Zajac; Kristina Deak
Subject:	SFlannery email RE PRubec et al paper
Date:	Tuesday, June 16, 2020 7:29:00 AM
Attachments:	Rubec Paper, UMCF-2019-0072.R1 Proof hi 6-08-20.pdf Rubec2 Reply to reviewers (6-12-20) submitted.pdf

FROM SID FLANNERY (6/15/2020):

"Attached is the final version of the draft paper that Peter Rubec submitted to the journal Marine and Coastal Fisheries. I don't expect you need it or will read it, but also attached is his reply to the reviewers.

Both Joan Browder and I spent considerable time reviewing the paper and the response to reviewers and Peter accepted most of our suggested edits. Yonas also made the very helpful suggestion that percent reduction values in averaged seasonal flows be removed from Table 2."

Doug Leeper
MFLs Program Lead
Environmental Flows and Assessments Section
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Southwest Florida Water Management District
2379 Broad Street (U.S. Hwy. 41 South)
Brooksville, FL 34604-6899
352-796-7211, Ext. 4272
1-800-423-1476, Ext. 4272
Doug.leeper@watermatters.org

From:	Steve Adams
To:	Eric DeHaven; Doug Leeper
Cc:	Charles Pavlos; "Laura Baumberger"; Steven Leonard; Brian Fuller
Subject:	Review comments of Proposed Recovery Strategy for the Lower Shell Creek Report
Date:	Wednesday, June 17, 2020 10:17:25 AM
Attachments:	M - comment memo.pdf Punta Gorda - 8 MGD Expansion.pdf

Eric:

Please review and consider the attached comment memo prior to final agency action for the Proposed Recovery Strategy for the Lower Shell Creek.

Steve Adams
Utilities Engineering Manager
Utilities

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CITY OF PUNTA GORDA
UTILITIES DEPARTMENT

326 West Marion Avenue
Punta Gorda, Florida 33950
941-575-3339

TO: Eric DeHaven, Doug Leeper
FROM: Steve Adams
DATE: June 17, 2020
SUBJECT SWFWMD MFL Shell Creek Recovery Plan

I am submitting comments for your consideration regarding the SWFWMD Report; Proposed Recovery Strategy For The Lower Shell Creek, Draft Report, February 19, 2019. This Report was issued to the City March 10, 2020.

I find the report to be deeply flawed. I recommend you cease using the term Peer Reviewed Science in association with this report. Peer Reviewed Science requires the data, the data analysis, and the findings and conclusions can be repeated by a third party and the third party will obtain the same result. The report appears to be unlikely to pass this test.

I recommend you consider the following comments:

1. Please include a rigorous proof of methodology to demonstrate temperature and salinity are reliable surrogates to quantify the biological resources of Lower Shell Creek.
2. Please quantify the biological resources of Lower Shell Creek used to establish the baseline condition of 1972. Quantify means; list every species of flora and fauna, and the populations of each species. The term flora is intended to mean plant species, the term fauna is intended to mean animal species.
3. Please establish the findings of the flora and fauna in each study year and provide comparisons to the baseline condition for use with evaluating the 85% condition assessment.
4. Data sets used in the study should be limited to data actually measured with proper instruments or data established by laboratory standard methods. Page 9 of the report states; The primary criterion for development of the proposed minimum flows for the Lower Shell Creek was maintenance of 85% of the 2 parts per thousand or less of salinity-based habitat for the combined lower creek. Page 7 of the report states; Salinity and temperature data were derived from the hydrodynamic model. These two statements infer that the methodology of establishing the block flow regimes and the 85% condition assessment is deeply flawed. The methodology appears to be based on data invented by the hydrodynamic model, rather than a data set established from actual measurements.
5. The report appears to rely on the substitution of complexity for correctness. Using a digital computer to perform millions of calculations is not a substitute for establishing a reliable data set from actual observations, and measured values.
6. The report appears to be deeply flawed from using data created by a hydrodynamic model. Please describe how this methodology can be repeated by a third party and obtain the same result.
7. Please include a section in the report to identify all groundwater inputs in the watershed during the study period. The District, via the water use permit process is likely to possess monthly flow reports from groundwater wells in use in the watershed. These groundwater inputs should be

taken into consideration with regards to estimating the salinity of Lower Shell Creek during the study period. Please provide a data set to show all groundwater wells, and all pumping volumes of each month during the study period.

8. Please use the data source from the City WUP to establish the water withdrawal volumes for each month of the study period and compare these flows to the groundwater pumping volumes of the study period. Please provide data analysis to demonstrate the net effect to salinity estimates with consideration of both groundwater inputs and surface water withdrawals.
9. Please include a section of the report to calculate the hydrograph of the Shell and Prairie Creek watershed, for the baseline year and the final year of the study. Please characterize the hydrologic conditions in the baseline year and the final year of the study period. Please describe the extensive land use changes occurring during the study period. Please describe the changes in the land surface and the drainage improvements. Please determine stage storage discharge conditions of the Shell Creek reservoir for the baseline year and the final year of the study period. Please provide a table of monthly discharge volumes for the baseline year and the final year of the study period. Please provide data analysis to estimate the changes to the watershed hydrology and the downstream flow volumes and rates and how these conditions effect estimating salinity of the Lower Shell Creek. The entire watershed has been changed by extensive drainage during the study period. The watershed has a herringbone system of ditches used to drain water from the land surface. The drainage system has reduced land storage, reduced time of concentration, and increased peak discharge rates of the watershed during the study period. Please provide analysis to compare the altered hydrograph, and monthly runoff flow volumes to the monthly withdrawals at the Shell Creek WTP during the study period. Please include a summary of how these two data sets effect salinity of the Lower Shell Creek during the baseline year and the final year of the study.
10. The report is silent with regards to the effect to salinity from groundwater inputs and changes in the watershed hydrology. These conditions should be presented in the report.
11. Real data exists for the study period of groundwater inputs, and Shell Creek monthly discharge rates, and Shell Creek WTP withdrawal rates. This data is more reliable than data invented by programing instructions into a digital computer. Analysis of real data from groundwater inputs, monthly watershed discharge rates, and Shell Creek WTP withdrawals can be expected to identify a picture of monthly salinity with better reliability than can be established from invented data.
12. Estimating monthly salinity in Lower Shell Creek from real data can be reviewed and repeated by a third party and obtain the same result. Estimating monthly salinity in Lower Shell Creek using the data invention methodology can produce any outcome the investigator chooses.
13. Page 17 of the Draft Recovery Strategy Report states; The District expects the City to initiate a feasibility study through application to the District for cooperative funding for the proposed Bypass Facility Project in 2022. We recommend District staff present the findings of the Shell Creek Recovery Strategy to City Council prior to the CFI 2022 application period. City staff will need City Council direction before we can initiate a Bypass Facility Project.
14. The Draft Recovery Strategy Report should consider expansion of the Shell Creek RO facility from 4 MGD to 8 MGD as an alternative recovery strategy. The preliminary cost estimate to expand the RO facility is $16,100,000.

CITY OF PUNTA GORDA SHELL CREEK WTP
RO WTP EXPANSION FROM 4 TO 8 MGD
CONCEPTUAL CONSTRUCTION COST

Item	Description	Quantity	Unit	Unit Cost	Total Cost
RAW WATER SYSTEM					
1	Raw Water Supply Well	3	EA	$ 420,000	$ 1,260,000
2	Raw Water Pump and Above Grade Piping	3	EA	$ 230,000	$ 690,000
3	Raw Water Pump for Existing ASR Wells & Above Grade Piping	2	EA	$ 210,000	$ 420,000
4	PVC Raw Water Main	1	LS	$ 650,000	$ 650,000
RO WATER TREATMENT PLANT					
1	RO Skids	2	EA	$ 590,000	$ 1,180,000
2	RO Feed Pumps	2	EA	$ 130,000	$ 260,000
3	Cartridge Filter	1	EA	$ 110,000	$ 110,000
4	Degasifiers and Blowers	1	LS	$ 530,000	$ 530,000
5	Chemical Day Tanks (Sulfuric Acid and Sodium Hydroxide)	1	LS	$ 20,000	$ 20,000
CONCENTRATE DISPOSAL					
1	Deep Injection Well and DZMW	1	LS	$ 5,300,000	$ 5,300,000
PERMEATE BLENDING FACILITIES					
1	RO Permeate Transfer Pump	1	EA	$ 90,000	$ 90,000
2	Blended Finished Water Transfer Pumps	1	EA	$ 80,000	$ 80,000
Electrical & Instrumentation					
1	Electrical and I&C (10%)	1	LS	$ 1,060,000	$ 1,060,000
1	1,250 kW Emergency Generator and Paralleling Gear	1	LS	$ 760,000	$ 760,000
				SUBTOTAL	$ 12,400,000
	Mobilization/Demobilization/General Conditions (10%)				$ 1,200,000
			Contingency (20%)		$ 2,500,000
				TOTAL	**$ 16,100,000**

From: Angel Martin
To: Doug Leeper
Subject: RE: Minimum Flows--Lower Peace River and Lower Shell Creek--June 22, 2020
Date: Monday, June 22, 2020 3:09:49 PM

Doug,

As per the discussion with the peer review panel concerning the subject proposed minimum flows, I offer the following comments following today's conference call.

The text that accompanies tables 6-10 and 6-11 concerning the sea-level rise information and discussion needs further clarification and expansion. The baseline sea-level conditions (two conditions for table 6-10 and six for table 6-11 as I understand) on which the MFLs are based must be clear. The plus and minus values shown on the tables bust be clearly defined. There should be some text added that as additional sea-level data and conditions become available, the MFLs may be adjusted by the District. As Doug Leeper mentioned, it must be made clear that the MFLs are determined based on the effects of withdrawals and not specifically on sea-level change. The sea-level conditions are considered part of the baseline conditions. The possible sea-level rise issues may add to the uncertainty in the determination of the MFLs.

Please contact me if you need any clarifications or additional information. Thank you for the opportunity to comment on the proposed MFLs for the Lower Peace River and Lower Shell Creek.

____
Angel Martin
813-767-6944

DL

Moderator
113 posts

Doug Leeper
a few seconds ago

Comments from Angel Martin provided via email to Doug Leeper, as a follow-up to oral comments provided during the June 8, 2022 peer review panel teleconference.

As per the discussion with the peer review panel concerning the subject proposed minimum flows, I offer the following comments following today's conference call.

The text that accompanies tables 6-10 and 6-11 concerning the sea-level rise information and discussion needs further clarification and expansion. The baseline sea-level conditions (two conditions for table 6-10 and six for table 6-11 as I understand) on which the MFLs are based must be clear. The plus and minus values shown on the tables bust be clearly defined. There should be some text added that as additional sea-level data and conditions become available, the MFLs may be adjusted by the District. As Doug Leeper mentioned, it must be made clear that the MFLs are determined based on the effects of withdrawals and not specifically on sea-level change. The sea-level conditions are considered part of the baseline conditions. The possible sea-level rise issues may add to the uncertainty in the determination of the MFLs.

Please contact me if you need any clarifications or additional information. Thank you for the opportunity to comment on the proposed MFLs for the Lower Peace River and Lower Shell Creek.

Angel Martin

From:	Laura Baumberger
To:	Victoria Steinnecker; Sarah Burns; Chris Zajac; Doug Leeper; Eric DeHaven; Randy Smith; Yonas Ghile; Xinjian Chen; Steve Adams; Steven Leonard; Brian Fuller; cpavlos@cityofpuntagordafl.com
Subject:	Shell Creek MFL - June 25, 2020 Status Meeting Minutes and Action Items
Date:	Saturday, June 27, 2020 8:23:26 AM
Attachments:	shell creek proposed mfl_meeting_3.pdf City-SWFWMD June2020 Meeting Minutes.pdf Punta Gorda Demand Analysis 2010-2019.xlsx

Good morning,

Attached please find:

- Presentation slides presented by Carollo at the subject meeting
- Draft minutes and action items from the meeting
- Historical data analysis for updated monthly peaking factors and 20-year water demand projection

Please let us know of any comments on the attached. We also would appreciate if SWFWMD could send its presentation from this meeting for our records.

Regards,
Laura

Laura Baumberger, PE
Project Manager | Vice President
301 North Cattlemen Road, Suite 302 | Sarasota, FL 34243
P 941-371-9832 | **M** 941-400-2320
carollo.com

Shell Creek Proposed MFL Review

City of Punta Gorda – MS Teams // June 16, 2020

MFL Background

Definitions

What are minimum flows and minimum water levels (MFLs)?

In short, an MFL sets a limit on how much water can be withdrawn from various water resources to prevent significant harm occurring to those resources or the ecology of the area.

What does "significant harm" mean?

The Florida legislature did not define the term 'significant harm.' However, the District has developed criteria for significant harm to various types of water resources. The criteria are based on environmental changes resulting from variances in water flows or levels. Their use for setting MFLs has been reviewed and accepted by numerous panels of independent scientists.

Why does the Southwest Florida Water Management District establish MFLs?

Florida law (Chapter 373.042, Florida Statutes) requires the state water management districts or the Florida Department of Environmental Protection to establish MFLs. Rivers, streams, estuaries and springs require minimum flows, while minimum levels are developed for lakes, wetlands and aquifers.

Shell Creek MFL: Background

“If, at the time a minimum flow or minimum water level is initially established for a water body pursuant to s. 373.042 or is revised, the existing flow or water level in the water body is below, or is projected to fall within 20 years below, the applicable minimum flow or minimum water level, the department or governing board, as part of the regional water supply plan described in s. 373.709, shall concurrently adopt or modify and implement a recovery or prevention strategy.”

– Chapter 373.042 FS

Shell Creek is being evaluated for an MFL in conjunction with the lower Peace River because of strong hydrologic relationships established by Charlotte Harbor. However, separate MFLs are proposed for each water body.

Shell Creek MFL: Timeline

- 2010 and earlier – SWFWMD proposes Shell Creek MFL to their Governing Board; MFL not adopted largely because the need for a recovery strategy. Carollo provided an engineering evaluation of the proposed MFL.
- March 24, 2020 – SWFWMD provided a draft MFL report and Shell Creek recovery strategy to their Board
- March 25, 2020 through June 26, 2020 – scientific peer review panel evaluates draft MFL and publishes a report of findings
- August 2020 – ongoing Shell Creek recovery strategy development and public workshop on proposed MFLs
- September 22, 2020 – Final MFL report and request for initiation of rulemaking to SWFWMD Governing Board

Shell Creek MFL: History

- Proposed Minimum Flows and Levels for the Lower Peace River and Shell Creek (SWFWMD, 2007)
- Scientific Peer Review of the Proposed Minimum Flows and Levels for the Lower Peace River and Shell Creek (Montagna et al, 2008)
- FINAL Proposed Minimum Flows and Levels for the Lower Peace River and Shell Creek (SWFWMD, 2010)
- DRAFT Proposed Recovery Strategy for the Lower Shell Creek (SWFWMD, 2020)
- DRAFT Proposed Minimum Flows for the Lower Peace River and Lower Shell Creek (SWFWMD, 2020)
- FINAL Scientific Peer Review Panel Review of “Proposed Minimum Flows for the Lower Peace River and Lower Shell Creek” – Final Initial Report (Bedinger et al, 2020)

Proposed MFL

Proposed MFL

Block	If Inflow to Reservoir on Previous Day is	Flow Release
Block 1	<56 cfs (<36 mgd)	87% of inflow
Block 2	56 - 137 cfs (36 - 88 mgd)	77% of inflow
Block 3	>137 cfs (>88 mgd)	60% of inflow

* cfs = cubic feet per second
** mgd = million gallons per day; included for reference

- Flows measured at USGS Shell Creek gage (No. 02298202)
- Flow-based blocks derived from baseline flows
- MFL developed to maintain 85% of the 2 parts per thousand (ppt) or less salinity-based habitat (combined Lower Peace River and Lower Shell Creek)

Proposed MFL: Baseline Flow Evaluation

Block	If Inflow to Reservoir on Previous Day is	Flow Release
Block 1	<56 cfs (<36 mgd)	87% of inflow
Block 2	56 - 137 cfs (36 - 88 mgd)	77% of inflow
Block 3	>137 cfs (>88 mgd)	60% of inflow

* cfs = cubic feet per second
** mgd = million gallons per day; included for reference

- Block flows established from baseline flows
- Baseline flows "are flows that have occurred or are expected in the absence of withdrawal impacts."
- Baseline flows were established using a water balance model.
- Block flows are annual 75% and 50% exceedance flows from baseline flows.

Proposed MFL: Minimum Flows

Block	If Inflow to Reservoir on Previous Day is	Flow Release
Block 1	<56 cfs (<36 mgd)	87% of inflow
Block 2	56 - 137 cfs (36 - 88 mgd)	77% of inflow
Block 3	>137 cfs (>88 mgd)	60% of inflow

* cfs = cubic feet per second
** mgd = million gallons per day; included for reference

- Minimum flows based on flow-related changes in salinity-based habitats.

Potential Changes to MFL

Filename.ppt/11

SWFWMD Updating Model: Operations

- Use of City water supplies: RO, reservoir, Peace River - in that order
- Constant use of RO
  - 4 mgd in Block 1
  - 2 mgd in Blocks 2 and 3

SWFWMD Updating Model: Reservoir Volume

- From 2010 proposed MFL

Table 7-1 Reported Dimensions and Capacities.

Source	Area (acres)	Stage (ft)	Volume (mg)	Safe Yield (mgd)
Russell & Axon 1962 (Design Report)	892	5.0	908	
Russell & Axon 1963 (possibly a subset of above)		4.36		10
Watson Engineering (1974)		5.0	860	8.75
Reynolds Smith & Hill (1975)	660		860	10.8
SWFWMD (1981)	660	~5	697	
PBSJ (2007)	800			

- From 2020 proposed MFL: “Shell Creek Reservoir has a usable volume of approximately 320 million gallons (Personal Communication with City of Punta Gorda).”

Inputs and Assumptions

- Average demands:
  - Current: 5.4 mgd
  - 2040: 6.3 mgd
- Seasonal variations:

Month	Peaking Factor
January	1.05
February	1.08
March	1.13
April	1.15
May	1.12
June	0.97
July	0.83
August	0.80
September	0.84
October	0.92
November	1.06
December	1. 06

Model Results

Filename.ppt/20

Scenario Summary

Scenario	Source Water	DEP TDS Limit (mg/L)	Reliability 100% Met Days	MFL Met Days
1	Reservoir	1,000 mg/L	99.71% 99.91%	80.00%
2	Reservoir	500 mg/L	62.21% 62.21%	80.00%
3	Reservoir & RO	500 mg/L	100.00% 100.00%	80.00%
4	Reservoir & RO	500 mg/L	97.44% 98.46%	100.00%
5	Reservoir, RO, & Interconnect	500 mg/L	100.00% 100.00%	100.00%

Scenario Summary

Projected demand: 6.3 mgd
Current demand: 5.4 mgd

Scenario	Source Water	DEP TDS Limit (mg/L)	Reliability 100% Met Days	MFL Met Days
1	Reservoir	1,000 mg/L	99.71% 99.91%	80.00%
2	Reservoir	500 mg/L	62.21% 62.21%	80.00%
3	Reservoir & RO	500 mg/L	100.00% 100.00%	80.00%
4	Reservoir & RO	500 mg/L	97.44% 98.46%	100.00%
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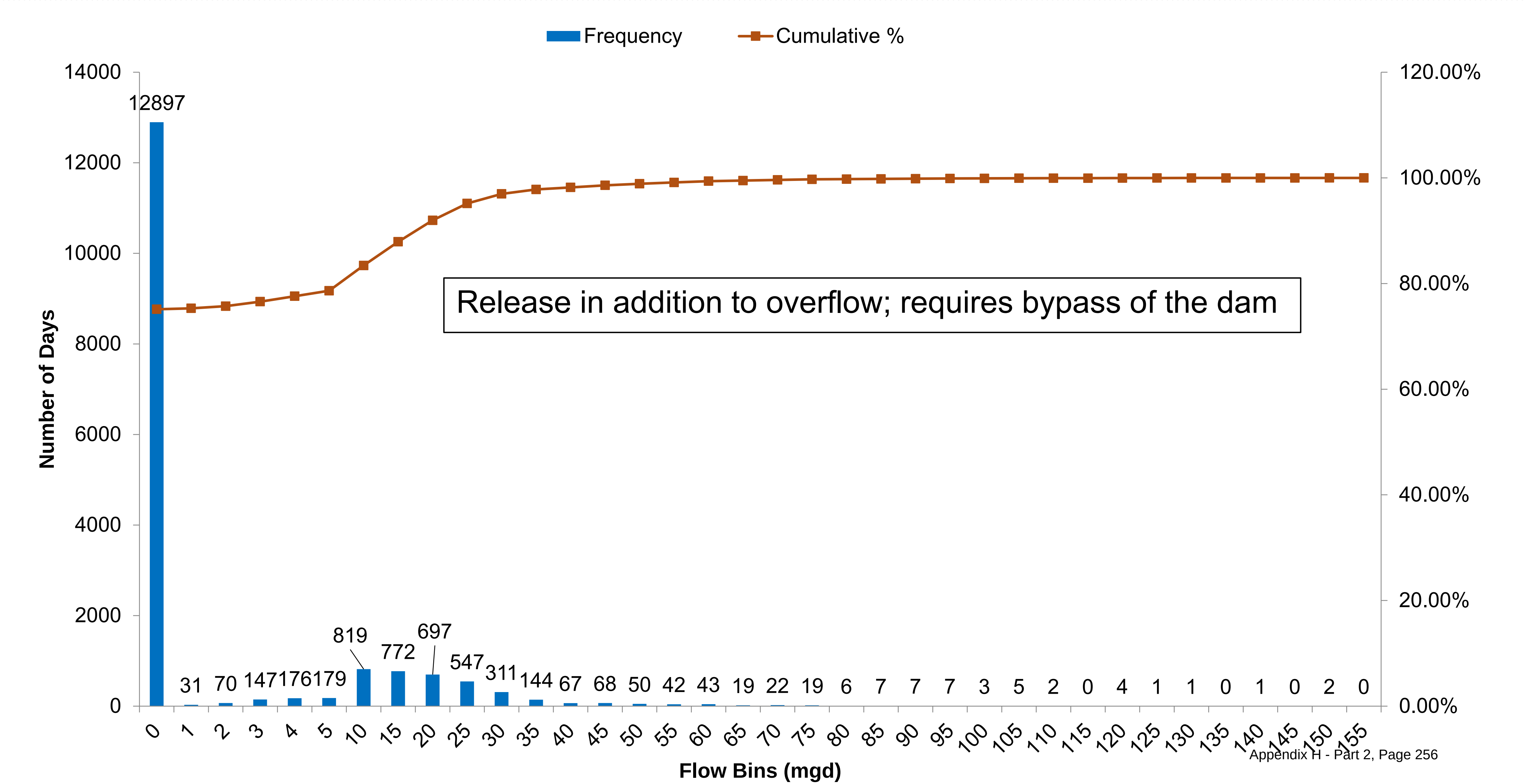
5	Reservoir, RO, & Interconnect	500 mg/L	100.00% 100.00%	100.00%

Results Summary

Scenario 5

Scenario 5: MFL Release (Around the Dam) Histogram



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Shell Creek MFL: Recovery Strategy Requirement

- A recovery strategy is needed for Shell Creek per Section 373.0421 F.S
  - Minimum flows for Lower Shell Creek not currently being met
  - The minimum flows are expected to continue to not be met through the 20-year planning horizon

Figure 2: Map of Lower Shell Creek and the Hendrickson Reservoir.

Recovery Strategy Goals

- Meet MFL
  - Under current conditions
  - Through 20-year planning horizon
- Meet TDS requirements
- Continue to meet demands (100% reliability)

Initial Recovery Strategy - Bypass Facility

- Bypass facility required for MFL release when reservoir level drops below the dam
  - Diversion past the Hendrickson Dam to the lower creek (Up to 148 CFS)
  - Feasibility study, design, permitting, and construction: 2022-2025
  - Potential options (included in SWFWMD report)
    - Spillway outlet
    - Low-level gated conduit
    - Pump station modification or construction

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Next Steps

- Continue review of SWFWMD's revised model
- Confirm 20-year demand projection to be used in model
- Confirm reservoir volume to be used in model
- Meet with SWFWMD in June to discuss new model results and potential recovery strategy

MEETING MINUTES

EVALUATION OF THE SHELL CREEK MFL

City of Punta Gorda

Issue Date: June 27, 2020

Project No.: 11775A.00

Purpose:	For the Southwest Florida Water Management District (SWFWMD) to address concerns about the recovery strategy for the proposed Shell Creek minimum flows and levels (MFL) and provide an update on additional work performed to date.
Meeting Date:	June 25, 2020
Meeting Location:	Virtual Meeting - MS Teams
Prepared By:	Victoria Steinnecker

Attendees/ Distribution:

Client:	**Carollo:**	**SWFWMD:**	
Steve Leonard	Laura Baumberger	Eric DeHaven	Chris Zajac
Steve Adams	Sarah Burns	Doug Leeper	Xinjian Chen
Brian Fuller	Victoria Steinnecker	Randy Smith	Jennette Seachrist
		Yonas Ghile	

The following is our understanding of the subject matter covered in this conference. If this differs from your understanding, please notify us.

Project Progress

1. SWFWMD updated their recovery strategy (flow/TDS balance) model to reflect City operations more accurately and to determine the impacts of a 20-mgd MFL release cap. New results show that a 20-mgd MFL release cap allows the City to maintain high reliability and does not greatly reduce the benefits of having the MFL.
2. SWFWMD maintains that a bypass facility is required to meet the MFL, and that they will help fund the bypass facility. SWFWMD recommended that the City have a cost estimate completed for different sized bypass facilities.
3. SWFWMD is working out legal considerations associated with the MFL. They are also preparing a response letter to Steve Adam's comments letter.
4. Carollo provided additional updates to SWFWMD's recovery strategy model (revised peaking factors, 3.5 mgd average RO supply under Block 1, and revised demand). SWFWMD is working to implement model updates.

Action Items

The following action items were discussed:

1. **Carollo** to schedule a meeting with SWFWMD to review technical comments on the model.
2. **Carollo** to provide SWFWMD with Carollo's slides and data/methodology for updated peaking factors and demand projections.
3. **City** to provide SWFWMD with their intake structure invert elevation on the Shell Creek Reservoir so SWFWMD can perform a desktop review of the reservoir volume based on the best available information.

4. **City** to consider hiring an engineer to perform a cost estimate for various recovery strategy structure sizes.
5. **SWFWMD** to perform a desktop review of the reservoir volume and consider surveying the reservoir volume during the next MFL reevaluation.
6. **SWFWMD** to update the recovery strategy model based on new best available information.
7. **SWFWMD** to provide Carollo with modeling results using a 10-mgd MFL release cap.
8. **SWFWMD** to update recovery strategy model with MFL cap and provide to Carollo.

From:	Yonas Ghile
To:	Laura Baumberger; Victoria Steinnecker; Sarah Burns; Chris Zajac; Doug Leeper; Eric DeHaven; Randy Smith; Xinjian Chen; Steve Adams; Steven Leonard; Brian Fuller; cpavlos@cityofpuntagordafl.com
Subject:	RE: Shell Creek MFL - June 25, 2020 Status Meeting Minutes and Action Items
Date:	Monday, June 29, 2020 8:01:52 AM
Attachments:	Shell Creek MFL_June 25_2020_updated.pdf

Thank you Laura. Attached is a draft of slides presented by the District. Please send me a copy of your slides that was presented on June 25, 2020.

From: Laura Baumberger <LBaumberger@carollo.com>
Sent: Saturday, June 27, 2020 8:21 AM
To: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>; Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Steve Adams <SAdams@cityofpuntagordafl.com>; Steven Leonard <SLeonard@cityofpuntagordafl.com>; Brian Fuller <BFuller@cityofpuntagordafl.com>; cpavlos@cityofpuntagordafl.com
Subject: Shell Creek MFL - June 25, 2020 Status Meeting Minutes and Action Items

Good morning,

Attached please find:

- Presentation slides presented by Carollo at the subject meeting
- Draft minutes and action items from the meeting
- Historical data analysis for updated monthly peaking factors and 20-year water demand projection

Please let us know of any comments on the attached. We also would appreciate if SWFWMD could send its presentation from this meeting for our records.

Regards,
Laura

Laura Baumberger, PE
Project Manager | Vice President
301 North Cattlemen Road, Suite 302 | Sarasota, FL 34243
P 941-371-9832 | **M** 941-400-2320
carollo.com

Proposed Minimum Flows and Recovery Strategy for Lower Shell Creek

Southwest Florida Water Management District

June 25, 2020

Meeting	Purpose
May 20, 2019	▪ Proposed MFLs for Lower Shell Creek ▪ Proposed recovery & prevention strategy ▪ RO project cost increase ($4,400,000) ▪ Visit the RO facility and the dam
June 25, 2019	▪ Governing Board approved RO cost increase

March 09, 2020	▪ Recovery & prevention strategy
	    ▪ Limitation
	    ▪ Potential solutions

June 25, 2020	▪ Evaluating potential solutions
	    ▪ Optimize RO/reservoir operation
	    ▪ A release with limit

Approach for Minimum Flows Development

- Identified three flow-based blocks using data from 1966 through 2018

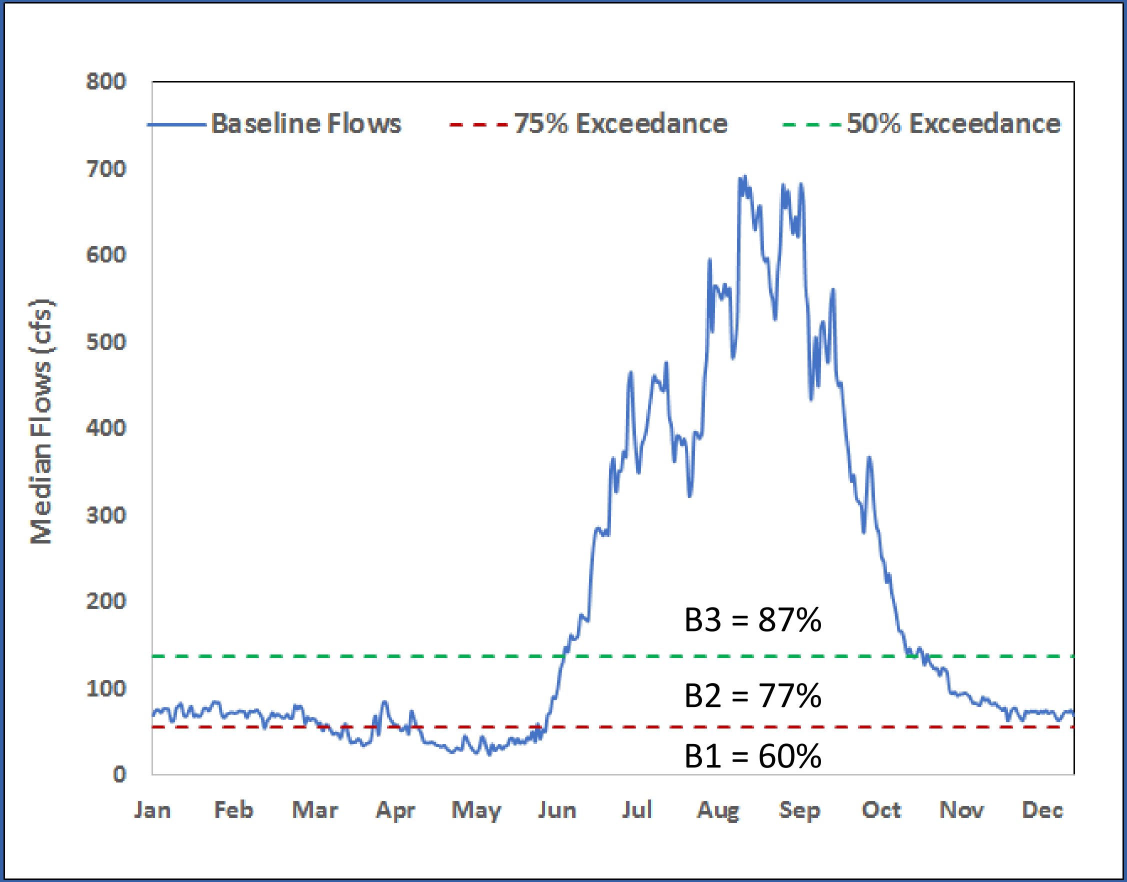
Low Flow (Block 1)	Medium Flow (Block 2)	High Flow (Block 3)
<56 cfs	56 - 137 cfs	>137 cfs

Ecological Criteria and Models used

Ecological Resources	Model	Metrics
1. Salinity-based habitats	Hydrodynamic model	Shoreline, river bottom area and water volume associated with <2, <5, <10, <15, <20 psu zones
2. Floodplain wetlands (Lower Peace River)	Hydrodynamic model & GeoRAS	Area of inundations, water levels
3. Habitats for 8 fish species and Blue Crab	Hydrodynamic model & non-linear regression models	Habitat suitability zones: low, moderate, high and optimum
4. Water quality	Non-linear regression models	Levels of dissolved oxygen, nutrients, chlorophyll, color

- **< 2 psu salinity volume** was the most sensitive metric to flow reduction scenarios
- Minimum flows developed based on preserving 85% of **< 2 psu salinity volume**

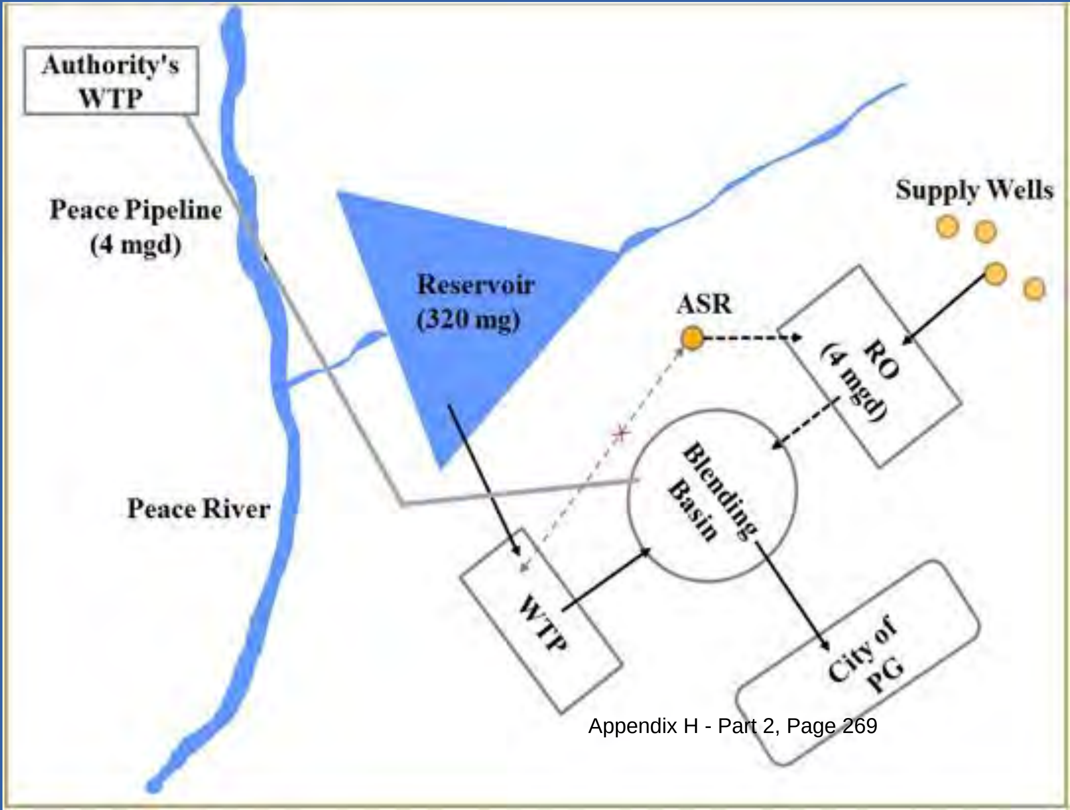
Proposed Minimum Flows for Lower Shell Creek



	Low Flow (B1)	Medium Flow (B2)	High Flow (B3)
Flow (cfs)	<=56	>56 - 137	> 137
Minimum Flow Release (%)	87%	77%	60%

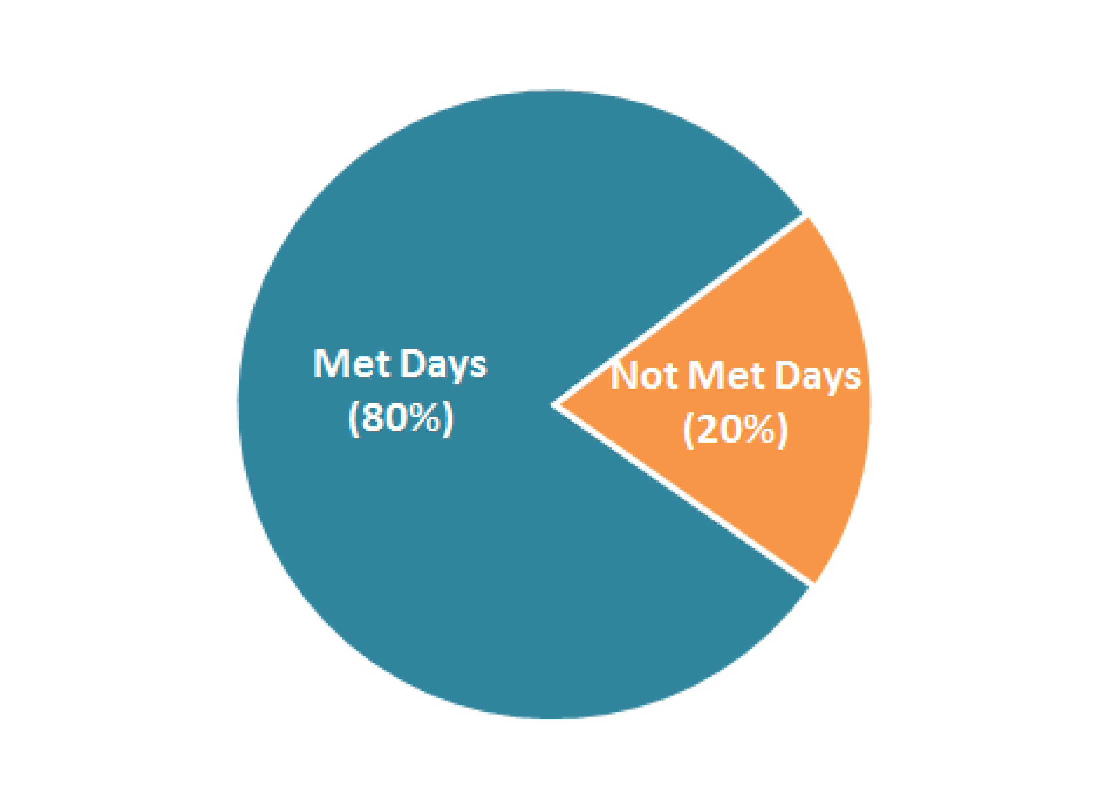
Impact Analyses Modeling (1972-2018)

- Source for minimum flows
  - Shell Creek
- Sources of water supply, in order:
  - Reservoir (~ 320 mg)
  - RO (4 mgd)
  - Peace Pipeline(4 mgd)
  - ASR (discontinued)
- Seepage through the dam
  - (0.4-0.6 mgd)
- City's demand projections
  - 2040 (6.3 mgd)
- TDS limit at the blending basin
  - Emergency rule ≤ 1000 mg/l
  - DEP rule ≤ 500 mg/l



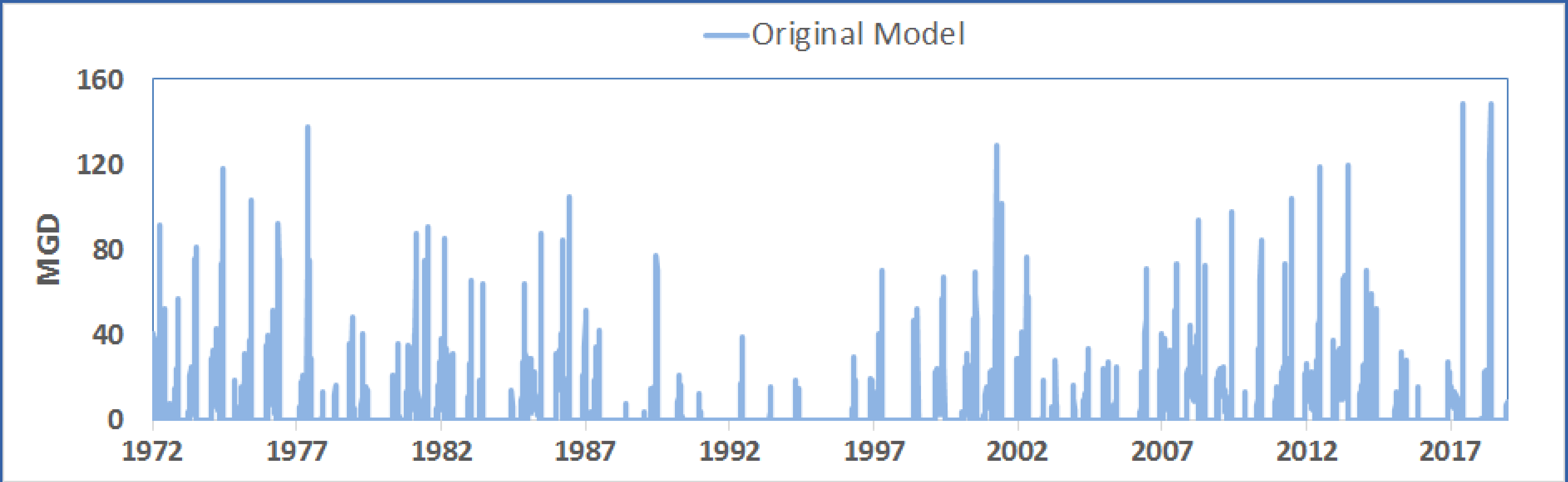
Minimum Flow Status - Lower Shell Creek

- Proposed minimum flows are not met
- A recovery strategy would need to be adopted along with adoption of the minimum flows



MFL Release using Original Model

- Some days would require high flow release to meet MFL when reservoir level is low and high storm event occurs.

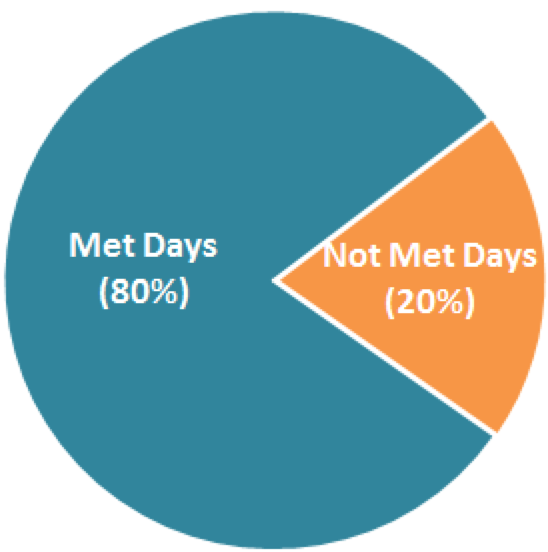


- Solution 1:
  - RO/reservoir optimization based on City's planned operation for water supply

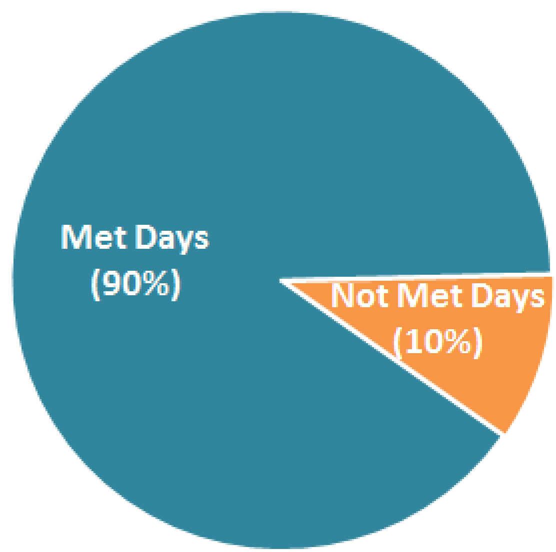
Change in RO/Reservoir Operation

1. Original Model	2. Updated Model
Reservoir (~ 320 mg)	RO (4mgd in B1, 2mgd in B2 and B3)
RO (4 mgd)	Reservoir (~ 320 mg)
Peace Pipeline (4 mgd)	Peace Pipeline (4 mgd)

MFL

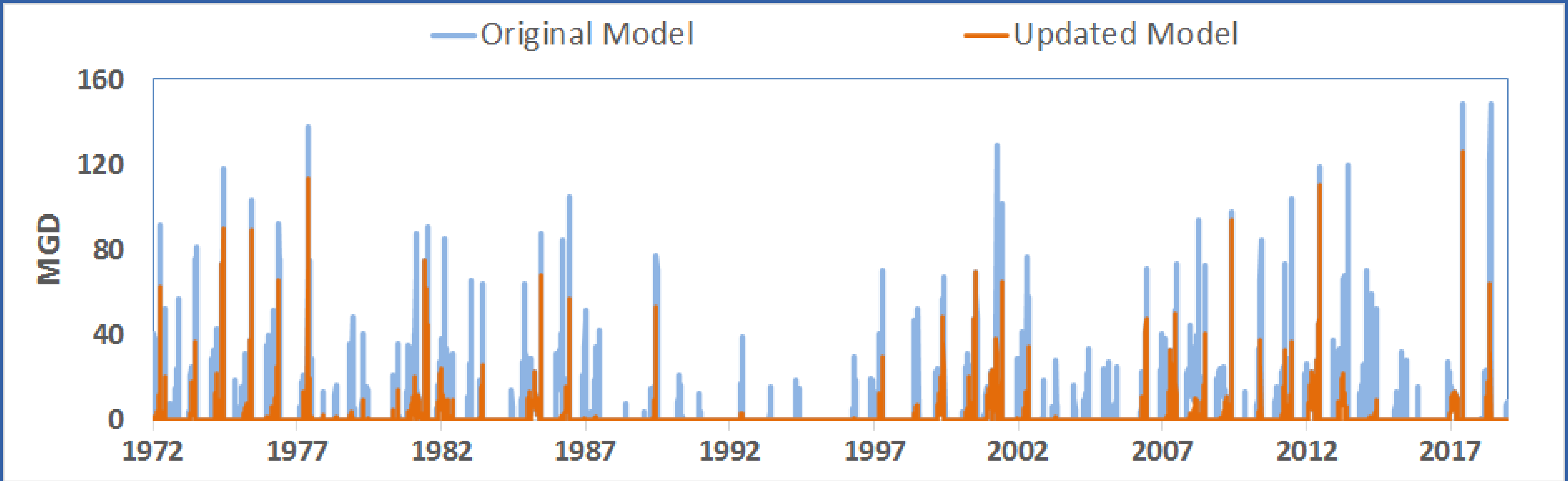


MFL



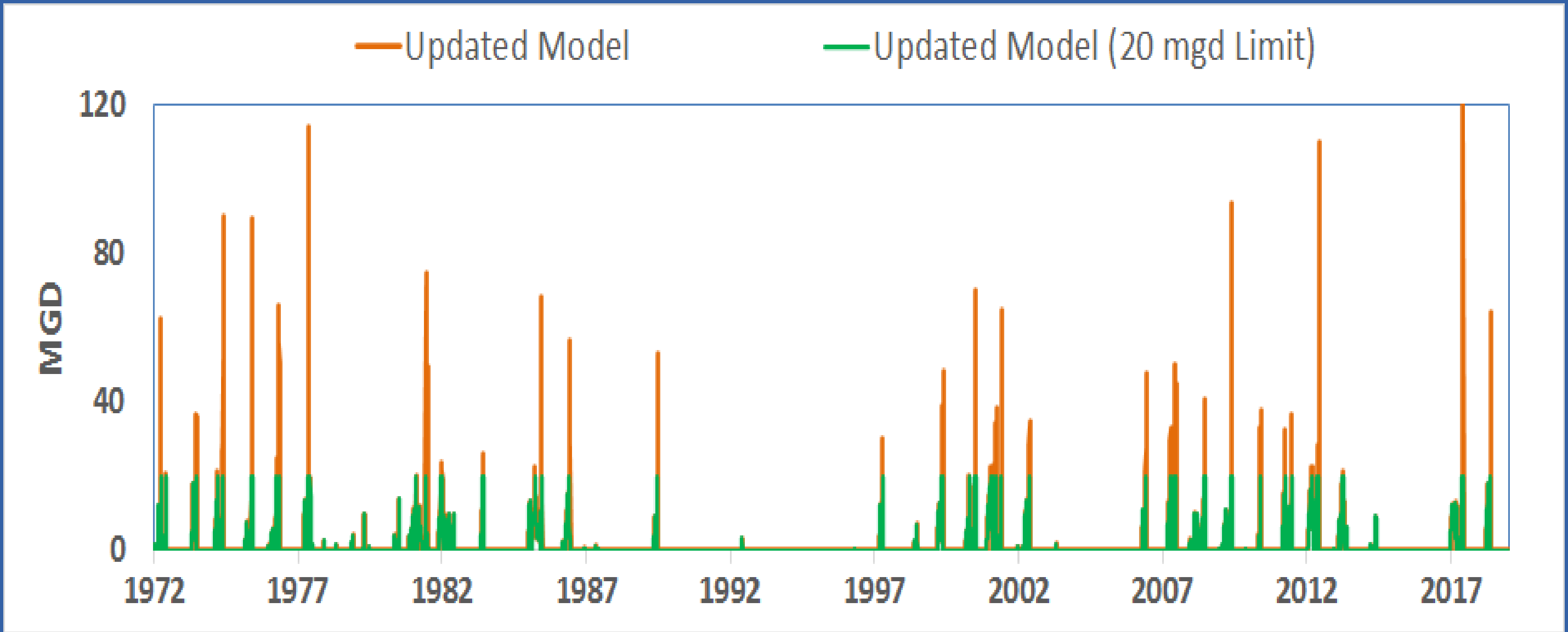
MFL Release using Original Model & Updated Model

- Improvement has made but still there are few days that would require high flow



- Solution 2
  - A release with limit scenario (20 mgd Limit)

Limitation of Recovery Strategy

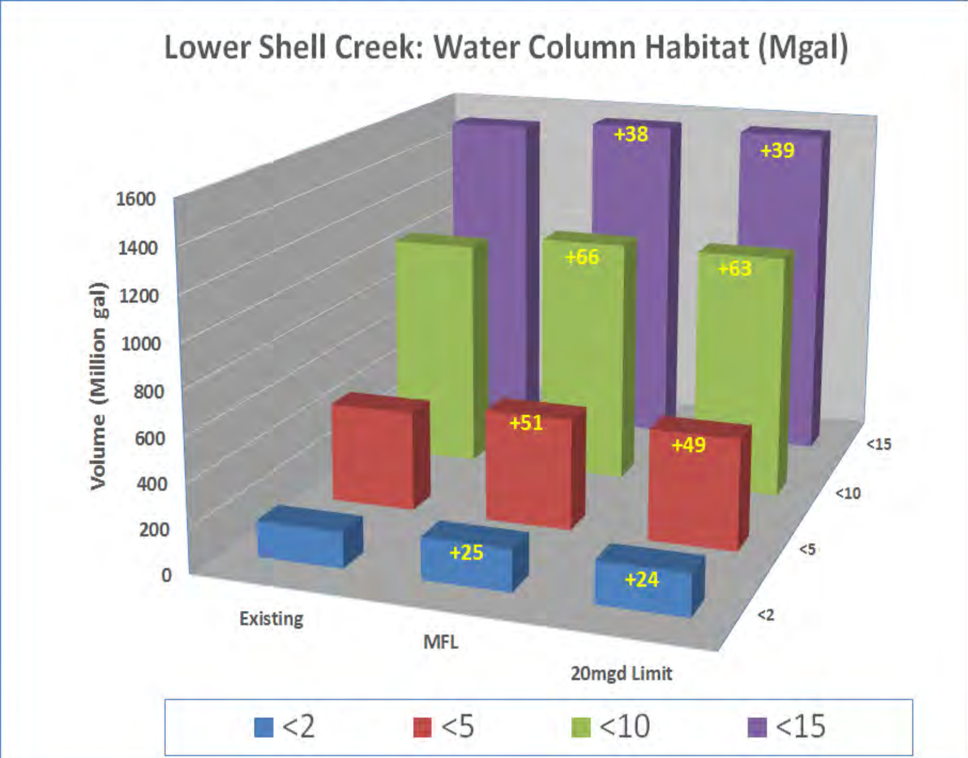


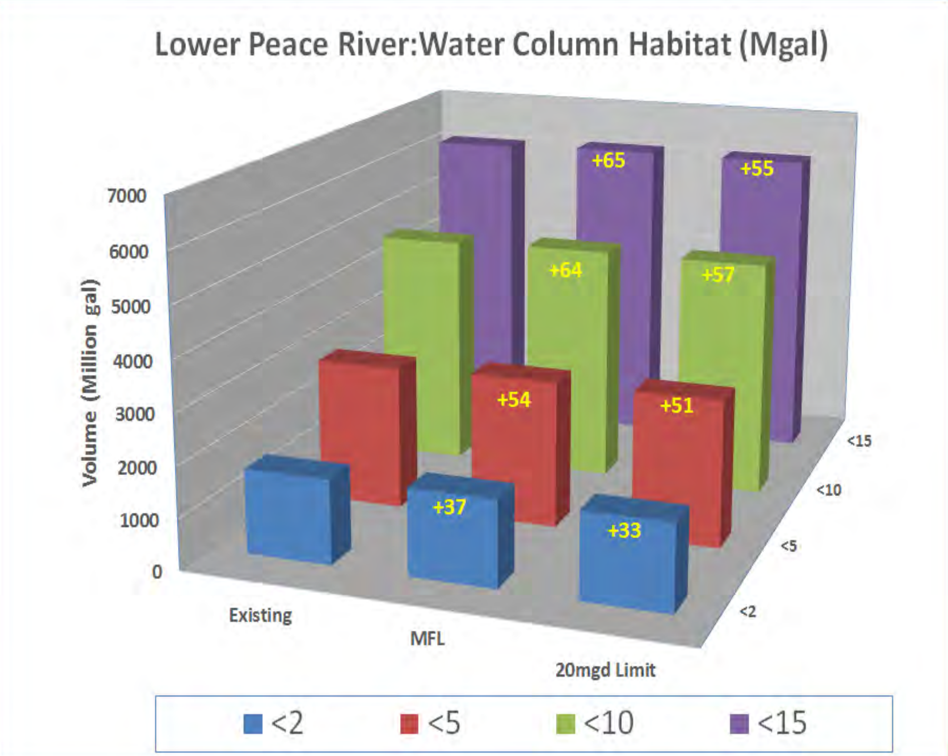
How does the MFL-20 mgd Limit impact the Lower Peace/Shell Creek estuarine system?

Scenario Results

Scenarios Limit	Source of Water	2040 Demand Projection	DEP TDS Limit	Water Supply 100% Met Days	MFL Met Days
Existing (no MFL)	Reservoir	6.3 mgd	1000 mg/l	99.71%	80.00%
Existing (no MFL)	Reservoir	6.3 mgd	500 mg/l	62.21%	80.00%
Existing (no MFL)	Res. & RO	6.3 mgd	500 mg/l	99.84%	89.91%
MFL	Res. & RO	6.3 mgd	500 mg/l	99.81%	100.00%
MFL-20 mgd Limit	Res. & RO	6.3 mgd	500 mg/l	99.81%	99.00%

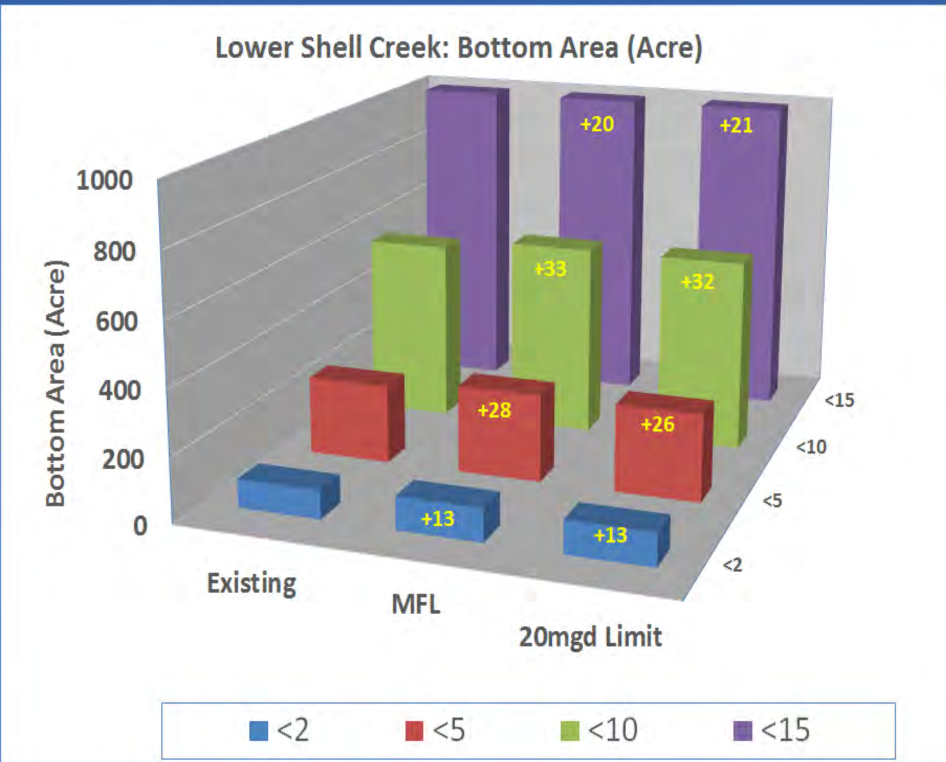
Water Column Habitat Improvement (Mgal) in B1

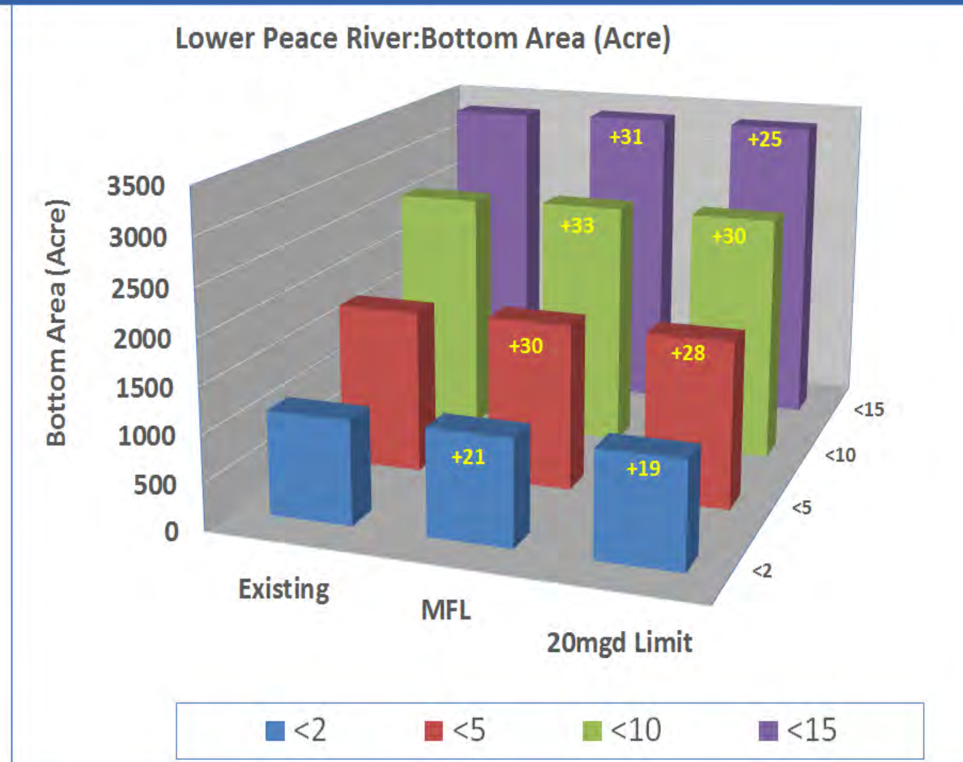




Total water column Improvement (Mgal)	<2 psu	<5 psu	<10 psu	<15 psu
MFL	62	105	130	104
MFL- 20 mgd Limit	57	100	121	94

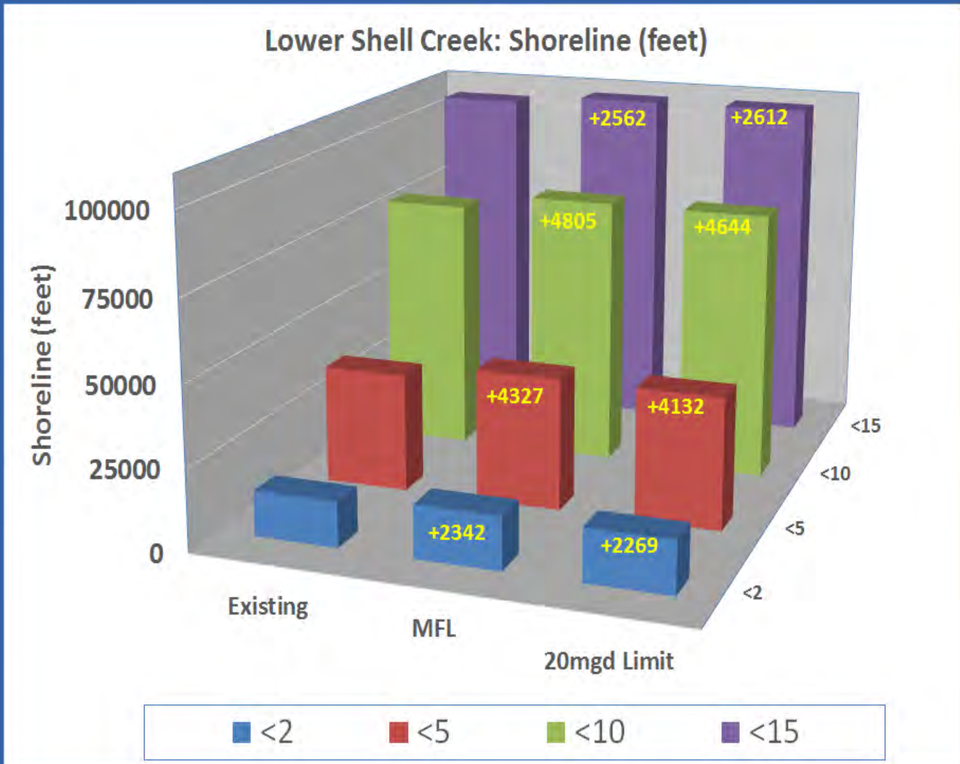
Bottom Area Habitat Improvement (acre) in B1

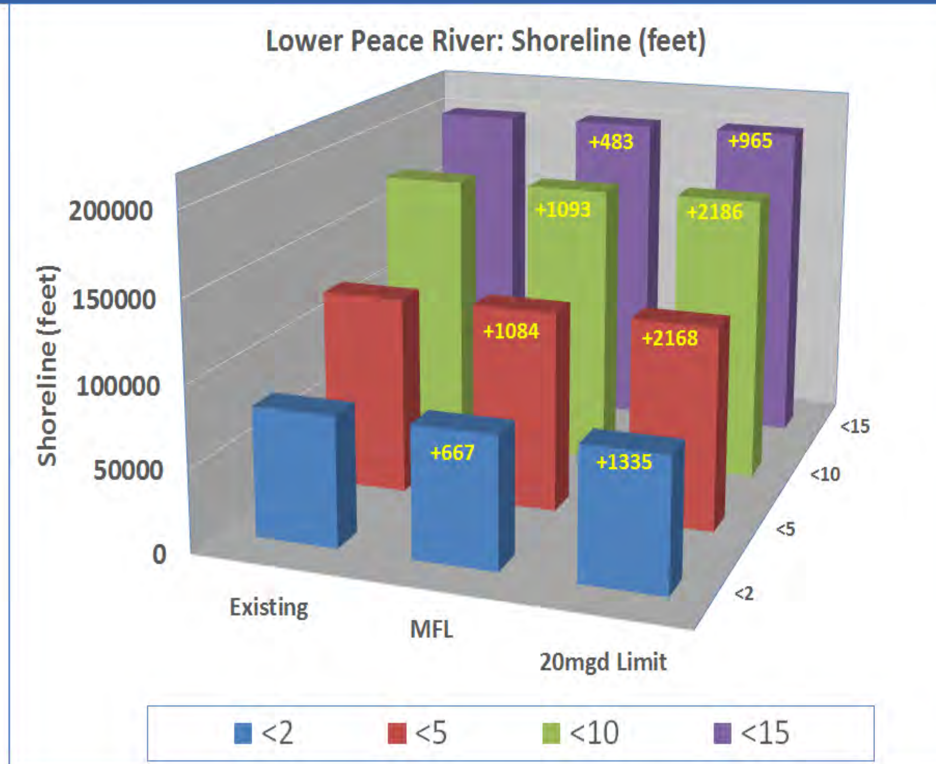




Total bottom area Improvement (acre)	<2 psu	<5 psu	<10 psu	<15 psu
MFL	34	57	66	51
MFL- 20 mgd Limit	32	54	62	46

Shoreline Habitat Improvement (feet) in B1





Total Shoreline Improvement (feet)	<2 psu	<5 psu	<10 psu	<15 psu
MFL	3408	5690	5984	2987
MFL- 20 mgd Limit	3587	5761	6080	3328

Evaluating Options

- Full implementation of MFLs
  - Recovery strategy is required to meet the full MFLs
- A release with limit
  - MFLs not fully met
  - Requires technical, economic and legal considerations

Thank you

From:	Laura Baumberger
To:	Yonas Ghile; Victoria Steinnecker; Sarah Burns; Chris Zajac; Doug Leeper; Eric DeHaven; Randy Smith; Xinjian Chen; Steve Adams; Steven Leonard; Brian Fuller; cpavlos@cityofpuntagordafl.com
Subject:	RE: Shell Creek MFL - June 25, 2020 Status Meeting Minutes and Action Items
Date:	Tuesday, June 30, 2020 9:11:39 AM
Attachments:	shell creek mfl_june_25_2020.pdf

Good morning,

Attached please find the slides presented on June 25th. I inadvertently attached the wrong presentation file in my email on Saturday.

Thanks,
Laura

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Monday, June 29, 2020 8:02 AM
To: Laura Baumberger <LBaumberger@carollo.com>; Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Steve Adams <SAdams@cityofpuntagordafl.com>; Steven Leonard <SLeonard@cityofpuntagordafl.com>; Brian Fuller <BFuller@cityofpuntagordafl.com>; cpavlos@cityofpuntagordafl.com
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P 941-371-9832 | **M** 941-400-2320
carollo.com

Shell Creek MFL

Model Review Meeting

June 25, 2020

Updates to Revised Model

- RO in Block 1: 3.5 mgd
- Updated PFs:

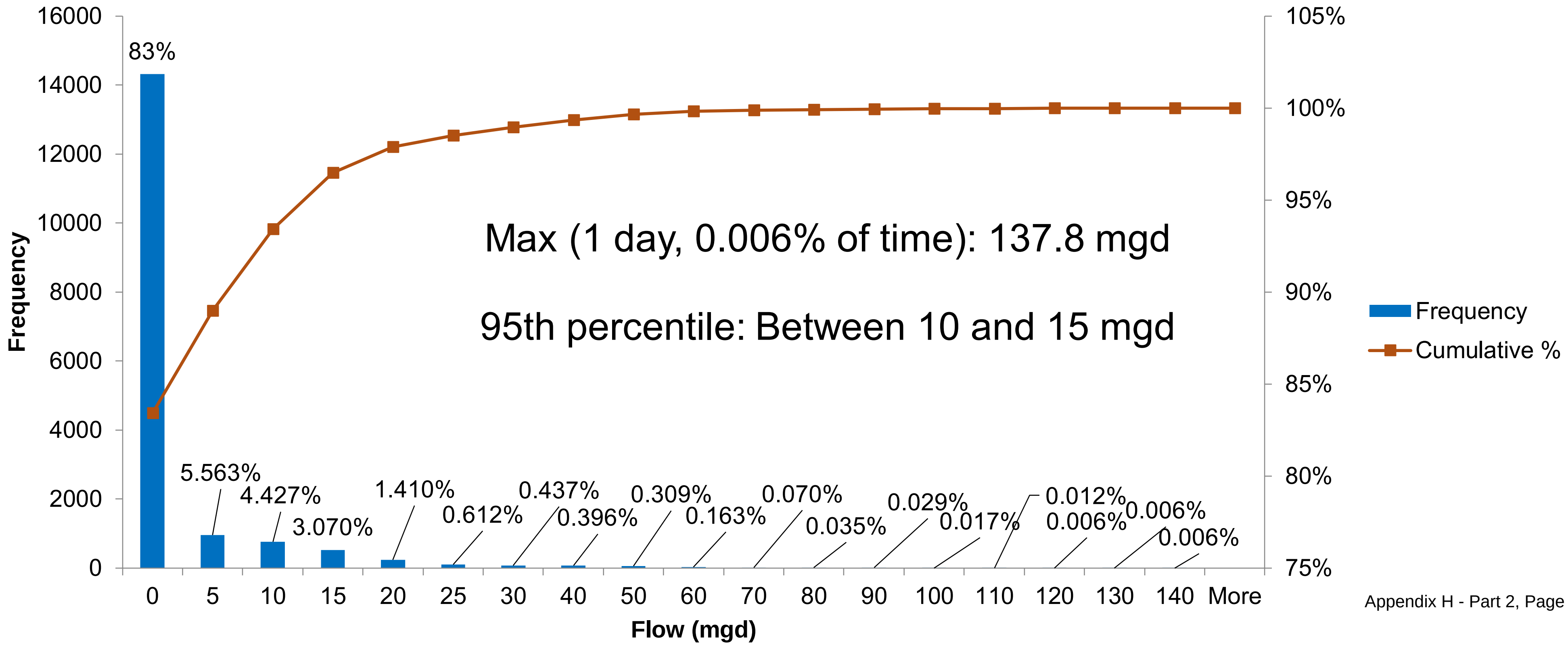
	Currently in SWFWMD Model	New: Calculated Based On 2014-2019 Data
JAN	1.05	1.04
FEB	1.08	1.05
MAR	1.13	1.13
APR	1.15	1.17
MAY	1.12	1.08
JUN	0.97	0.88
JUL	0.83	0.78
AUG	0.8	0.67
SEP	0.84	0.84
OCT	0.92	1.03
NOV	1.06	1.20
DEC	1.06	1.11

Revised Model Results: Reliability

	Reliability RO +Res (%)	Reliability RO + Res + Interconnect (%)
Original Model	97.38%	100%
Revised Model	99.73%	100%
Revised model includes new PFs and 3.5 mgd in Block 1 for RO		

Revised Model Results: MFL and Bypass

- Under baseline scenario (no bypass), MFL % increases from 80% to 86.8%
- Bypass scenario:



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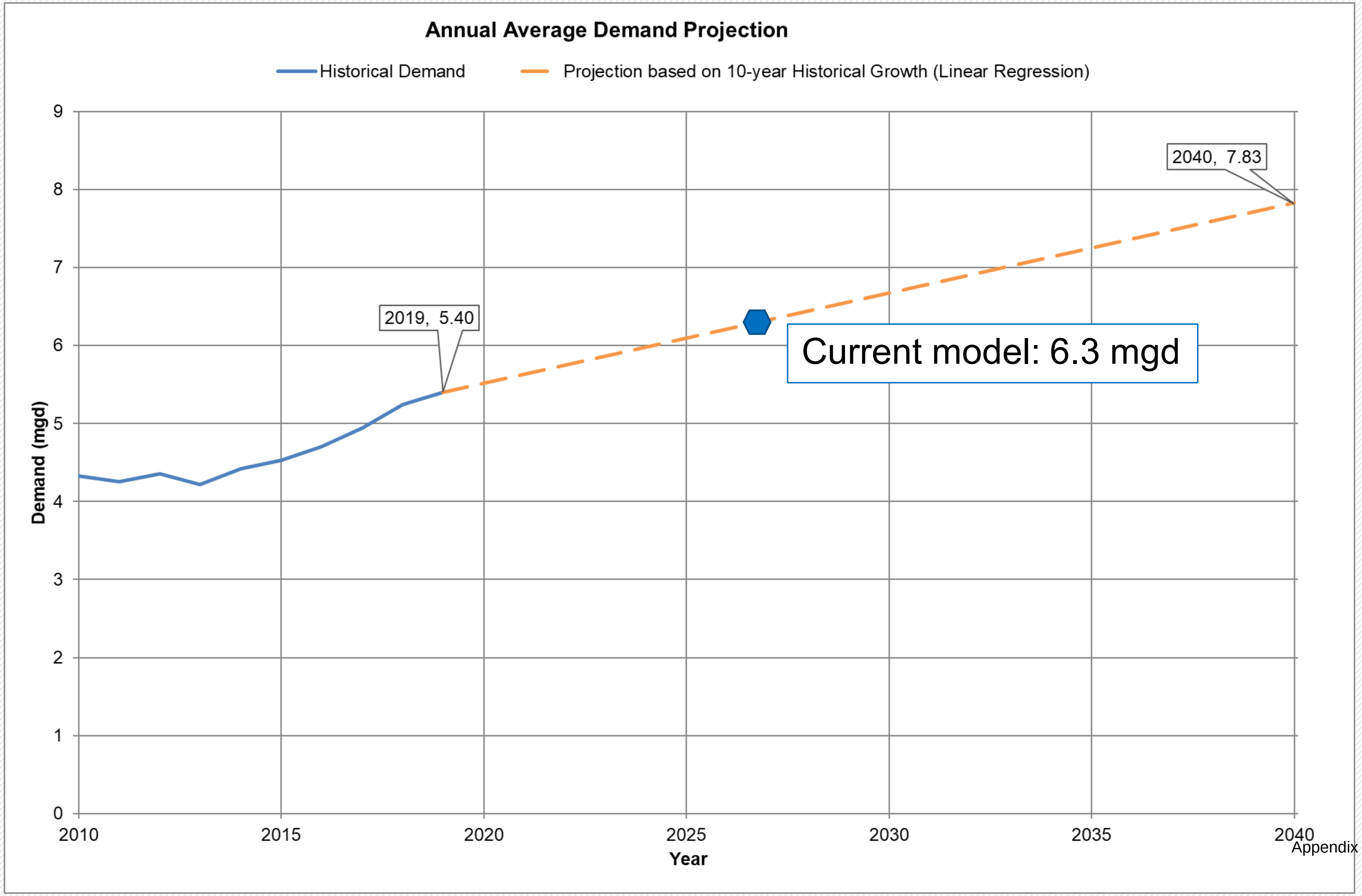
Further Updates to Revised Model: Demand Projection



Model Questions for SWFWMD

- Reservoir volume
  - Model allows to become negative
- Bypass volume
  - Increase with reservoir volume
  - Increase with demand

Final Storage Volume (mg)	Re St
320.00	
318.94	
-0.96	
-1.44	
-1.92	
-2.40	
-2.88	
-3.36	
-3.83	
-4.31	
-4.79	
-5.27	
-5.75	
-6.22	
-6.70	
-7.18	
-7.66	
-8.13	
-8.61	
-9.09	
-9.56	
-10.04	
-10.52	
-10.99	
-11.47	
-11.94	
-9.79	
3.63	

Bypass Volume Evaluation: Reservoir Volume Impact

Reservoir Volume (MG)	Bypass Volume (mgd)	
	Org Model	Revised Model
320	148.9	125.7
500	204.6	148.2
860	270.6	148.7
Original PFs		
4 mgd RO in Block 1		

Bypass Volume: Demand Comparison

	Meet MFL				No Release			
	Reliability RO +Res (%)	Reliability RO + Res + Interconnect (%)	Bypass Volume (mgd)	MFL Met (%)	Reliability RO +Res (%)	Reliability RO + Res + Interconnect (%)	Bypass Volume (mgd)	MFL Met (%)
Original Demand (6.3 mgd)	99.73%	100%	137.8	100%	99.91%	100%	NA	86.82%
Increased Demand (7.83 mgd)	97.35%	100%	143.7	100%	99.43%	100.00%	NA	80.93%
Updated PFs								
RO>Reservoir>Interconnect								
3.5 mgd RO in Block 1								

Other Topics

- Reservoir volume
- Recovery strategy (expand RO)
- Inflow methodology

Next Steps

- Address outstanding model questions and revise model accordingly
- Revise model to include limit on MFL bypass volume

From:	Yonas Ghile
To:	Laura Baumberger; Victoria Steinnecker; Sarah Burns; Chris Zajac; Doug Leeper; Eric DeHaven; Randy Smith; Xinjian Chen; Steve Adams; Steven Leonard; Brian Fuller; cpavlos@cityofpuntagordafl.com
Subject:	RE: Shell Creek MFL - June 25, 2020 Status Meeting Minutes and Action Items
Date:	Tuesday, June 30, 2020 9:45:56 AM
Attachments:	Projection_WUP_871_District.xlsx

Laura
Attached is the District's water supply demand projections for the City through 2040. District's approach is not based on linear increase of historical demands. It accounts for historical demands (including imports and exports), population projections, demand per capita (129 gpcd), treatment loss, and line flushing. Please review it and let's discuss at the technical meeting on Thursday.

Thank you

From: Laura Baumberger <LBaumberger@carollo.com>
Sent: Tuesday, June 30, 2020 9:11 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Steve Adams <SAdams@cityofpuntagordafl.com>; Steven Leonard <SLeonard@cityofpuntagordafl.com>; Brian Fuller <BFuller@cityofpuntagordafl.com>; cpavlos@cityofpuntagordafl.com
Subject: RE: Shell Creek MFL - June 25, 2020 Status Meeting Minutes and Action Items

Good morning,

Attached please find the slides presented on June 25th. I inadvertently attached the wrong presentation file in my email on Saturday.

Thanks,
Laura

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Monday, June 29, 2020 8:02 AM
To: Laura Baumberger <LBaumberger@carollo.com>; Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Steve Adams <SAdams@cityofpuntagordafl.com>; Steven Leonard <SLeonard@cityofpuntagordafl.com>; Brian Fuller <BFuller@cityofpuntagordafl.com>; cpavlos@cityofpuntagordafl.com
Subject: RE: Shell Creek MFL - June 25, 2020 Status Meeting Minutes and Action Items

Thank you Laura. Attached is a draft of slides presented by the District. Please send me a copy of your slides that was presented on June 25, 2020.

From: Laura Baumberger <LBaumberger@carollo.com>
Sent: Saturday, June 27, 2020 8:21 AM
To: Victoria Steinnecker <vsteinnecker@carollo.com>; Sarah Burns <sburns@carollo.com>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>; Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Steve Adams <SAdams@cityofpuntagordafl.com>; Steven Leonard <SLeonard@cityofpuntagordafl.com>; Brian Fuller <BFuller@cityofpuntagordafl.com>; cpavlos@cityofpuntagordafl.com
Subject: Shell Creek MFL - June 25, 2020 Status Meeting Minutes and Action Items

Good morning,

Attached please find:

- Presentation slides presented by Carollo at the subject meeting
- Draft minutes and action items from the meeting
- Historical data analysis for updated monthly peaking factors and 20-year water demand projection

Please let us know of any comments on the attached. We also would appreciate if SWFWMD could send its presentation from this meeting for our records.

Regards,
Laura

Laura Baumberger, PE
Project Manager | Vice President
301 North Cattlemen Road, Suite 302 | Sarasota, FL 34243
P 941-371-9832 | **M** 941-400-2320
carollo.com

From: Sid Flannery
To: AOL CUSTOMER SERVICE(Security tips)
Cc: joan.browder@noaa.gov; Xinjian Chen; Yonas Ghile; Doug Leeper
Subject: Re: revisions in progress
Date: Friday, July 10, 2020 12:12:55 PM

Hello Peter,

It has been a long haul but it looks like the paper is getting closer to being accepted. I will look over the editor's review comments and get back with you early next week.

Sid

On Fri, Jul 10, 2020 at 11:39 AM <peterrubec@cs.com> wrote:

> Everyone,
>
> I received a review of the last draft submitted 6-16-20 done by
> Dr. Kenneth Rose (the editor for Marine and Coastal Fisheries).
> He wants me to address the changes he has identified.
> I am presently working on them. But, I need your feedback
> on what you believe I should change in the text, tables, figures (attached)
> and what I should reply to his 24 points in Changes Required.
>
> This paper has already been submitted and reviewed 3 times. I am
> frustrated concerning the requirement for further changes. But, I am
> willing to do them, where the changes can improve the paper.
> Please send me you comments and suggested changes.
> The paper must be resubmitted by August 8th.
>
> Please call me if you want to discuss the paper,
>
> Peter Rubec
> Tel. 727-327-9226
> Email: peterrubec@cs.com

From:	Sid Flannery
To:	peterrubec@cs.com; Yonas Ghile; Xinjian Chen; Doug Leeper; Browder Joan; Joan Browder; christi.santi@myfwc.com <christi.santi@myfwc.com> <christi.santi@myfwc.com >
Subject:	Average flows during HSM study compared to long term
Date:	Monday, June 1, 2020 8:36:22 AM
Attachments:	Peace and Shell flows - long term and HSM study (2007-2014).xls

Hello Peter and others,

Good luck with the presentation today. I know it will be valuable and of interest to the audience.

I have finished my second review of the draft manuscript and will send everyone my comments tomorrow morning. They are brief - mostly grammatical stuff with a few other modest edits/revisions. The deadline for resubmitting the paper is June 5, so I think Peter is in very good shape to get it in on time.

In the mean time, which might be relevant to any questions today, attached is a spreadsheet in which average flows are listed for the Lower Peace River (Peace at Arcadia + Horse + Joshua), Shell Creek, and the sum of the four gages for long-term (1965-2017) and the period of the HSM study (2007-2014). I took these from simple gaged records with no baseline corrections, but the patterns will still hold.

You can see that in general the HSM results are for a very dry period with below average flows, most notable is how dry the winter (January-March) season was, averaging only 34% of the long-term mean. The fact that the winter was very dry is mentioned in the draft manuscript. It is worth keeping this and the other seasons in mind today when the seasonal maps are shown

I wish I could, but it doesn't look like I will be able to follow the Charlotte Harbor Summitt today. I expect it will be very good.

Cheers,

Sid

From:	Sid Flannery
To:	peterrubec@cs.com; Yonas Ghile; Xinjian Chen; Doug Leeper; Browder Joan; Joan Browder; christi.santi@myfwc.com <christi.santi@myfwc.com> <christi.santi@myfwc.com >
Subject:	Added annual values to average flows during HSM study compared to long term
Date:	Monday, June 1, 2020 9:03:25 AM
Attachments:	Peace and Shell flows - long term and HSM study (2007-2014) with annuals.xls

Hello again,

Attached is a spreadsheet in which I added rows for the annual mean flows for the two periods. You can see that the annual mean flow for the Lower Peace River for the HSM period was 67% of the long-term mean, Shell Creek was 86% of the long term mean, and the sum of the four gages was 73% of the long-term annual mean. The HSM analyses were conducted over what was generally a dry period, especially in the winter.

Sid

On Mon, Jun 1, 2020 at 8:34 AM Sid Flannery <sidflannery22@gmail.com> wrote:

> Hello Peter and others,
>
> Good luck with the presentation today. I know it will be valuable and of interest to the audience.
>
> I have finished my second review of the draft manuscript and will send everyone my comments tomorrow morning. They are brief - mostly grammatical stuff with a few other modest edits/revisions. The deadline for resubmitting the paper is June 5, so I think Peter is in very good shape to get it in on time.
>
> **In the mean time**, which might be relevant to any questions today, attached is a spreadsheet in which average flows are listed for the Lower Peace River (Peace at Arcadia + Horse + Joshua), Shell Creek, and the sum of the four gages for long-term (1965-2017) and the period of the HSM study (2007-2014). I took these from simple gaged records with no baseline corrections, but the patterns will still hold.
>
> You can see that in general the HSM results are for a very dry period with below average flows, most notable is how dry the winter (January-March) season was, averaging only 34% of the long-term mean. The fact that the winter was very dry is mentioned in the draft manuscript. It is worth keeping this and the other seasons in mind today when the seasonal maps are shown
>
> I wish I could, but it doesn't look like I will be able to follow the Charlotte Harbor Summitt today. I expect it will be very good.
>
> Cheers,

Sid

From:	Sid Flannery
To:	AOL CUSTOMER SERVICE(Security tips)
Cc:	Xinjian Chen; Yonas Ghile; Browder Joan; christi.santi@myfwc.com <christi.santi@myfwc.com> <christi.santi@myfwc.com >; Doug Leeper; Joan Browder
Subject:	Response to editor"s comments
Date:	Friday, July 17, 2020 12:35:34 PM

Hello Peter,

Here are my suggestions on how to address the editor's comments. I want to first commend you on all the excellent work you have done on this project and this paper. At this point, I suggest addressing the editor's comments to the greatest extent possible. It is not a done deal, but I get the impression he wants to publish the paper if his comments can be suitably addressed, which I also think will benefit the paper.

My comments primarily pertain to one element of the paper - the use of seasonal average values for the HSM mapping and assessment. It is clear the editor thinks that more information on this is critical to the success of the paper. In that regard, I think it is important to justify the approach, but also important to describe its limitations, or caveats as the editor refers to it in his comment #22.

Along with a revised manuscript, will you also send to the editor a second document that discusses how you handle some of his suggestions? Below I have offered some draft language for the paper, and also some discussion of the subject of each change. Possibly you can use some of these thoughts if you submit a second document that addresses the editor's comments.

Lets first enjoy the fact that he had no comments on the abstract.

Comment #6, Line 136. The editor says that analyzing the data on a seasonal basis is a major assumption and needs more justification. He also mentions that the large differences in baseline (BL) and minimum flow (MF) scenarios were during peak flows, which he says "*which are averaged out seasonally so the result that BL and MF are similar habitat and therefore minimal biological impacts can be questioned.*" I think his issues need to be addressed in sequence at different locations in the paper. First the seasonal approach, which I think is very defensible, then the averaging, which is trickier.

With regard to the seasonal approach, I suggest the following text to start the paragraph at Line 136. Please ignore of modiify as you see appropriate.

"A seasonal approach was taken for the HSM modeling because the life-stages of the species of interest show peak abundances in the estuary during different times of year (Greenwood et al. 2004, Peebles et al.

2006). In addition, salinity and water temperature exhibit typical seasonal variations in response to regional climatic patterns including seasonal variations of rainfall and freshwater inflow. By applying the percent of flow approach, proportionately more freshwater inflow was simulated during seasons of the year when high flows are most common, suggesting that the wet seasons should be separately examined. On the other hand, the area and volume of salinity based habitats are generally more susceptible to impacts from a given percent flow reduction during the dry times of year (SWFWMD, 2010), indicating that dry periods should be evaluated separately as well. Considering these factors, four three-month seasons were chosen by the District ....(return to text)"

My comment - Is there an FWRI report or citation of the FWRI program that can be used to further reference the point that the life stages of the species of interest show peak abundances in the estuary during different times of year. In the same sentence it could be simply added to the references for Greenwood et al. (2004) and Peebles et al. (2006).

Comment #7, Line 178. You can tell the editor you prefer to address the averaging of values at the end of this section, 42 lines later. Something like below could be added either to the last paragraph (Line 207) or added as a short paragraph (preferred). I think there are hydrologic reasons and also practical reasons for the averaging approach, as the generation of each HSM requires considerable effort so decisions had to be made on what conditions to simulate, which is inferred below. Consider language such as below and ignore or modify at will.

"Given that the project allowed for a generation of a limited number of HSM maps, average salinity and temperature conditions for each season were applied to the HSM mapping to represent typical changes in habitats between BL and MF for four periods of the year. In all the seasons the largest reductions in freshwater inflow were during peak flows, but due to the nonlinear response of the area and volume of salinity zones to freshwater inflow, significant impacts to habitats during lower flows could occur as well. The effects of reductions in low flows or peak flow events in each season or anytime within the year could be pursued with further research and include the 400 cfs limit to maximum withdrawals that the District later applied."

Comment 23, Line 603 (601 in current draft). In keeping with the Editor's comment, clearly mention the caveats of the study. Using different language, you could reiterate in the discussion the point above for Comment #7. As he suggests, mention other studies where applicable and in the final paragraph emphasize the further research could be done to look at changes in habitats in seasons or events in different years, with this project providing an initial application of the HSM approach to evaluate changes in salinity and temperature conditions that would result from the maximum potential freshwater withdrawals that would be allowed from these systems.

In this same comment from the editor, I concur that some discussion needs to be inserted in the text that a second caveat is that you go from changes in habitat to changes in abundance, which would be less certain. I think the text does that somewhat now, but it could be enhanced to be more explicit in that regard possibly at the top of paragraph at line 588.

In closing, I want to again say good work. Good luck in addressing the editor's comments and getting this valuable paper published. Please let me know if I can be of any further assistance.

Sid

On Tue, Jul 14, 2020 at 1:45 PM <peterrubec@cs.com> wrote:

> Sid, I am attaching the draft of the paper dated (6-16-20) that the editor reviewed.
> Peter
>
> -----Original Message-----
> From: Sid Flannery <sidflannery22@gmail.com>
> To: AOL CUSTOMER SERVICE(Security tips) <peterrubec@cs.com>
> Sent: Tue, Jul 14, 2020 1:38 pm
> Subject: Re: line numbers in current draft
>
> Peter,
> Could you send me the text only of the paper that was dated 6-16-20. I realize it is outdated, but might help me understand the editor's comments.
> Sid
>
> On Tue, Jul 14, 2020 at 11:28 AM <peterrubec@cs.com> wrote:
>
>> The line numbers cited by the Editor refer to an earlier draft of the paper dated 6-16-20. So, they don't correspond exactly to the line numbers in the current draft (7-14-20)
>> sent to everyone today.
>>
>> Peter
>>
>> -----Original Message-----
>> To: sidflannery22@gmail.com <sidflannery22@gmail.com>; jjoan.browder@NOAA.gov <jjoan.browder@NOAA.gov>; Xinjian.Chen@swfwmd.state.fl.us <Xinjian.Chen@swfwmd.state.fl.us>; Yonas.Ghile@swfwmd.state.fl.us <Yonas.Ghile@swfwmd.state.fl.us>; Christi.Santi@myfwc.com <Christi.Santi@myfwc.com>
>> Sent: Tue, Jul 14, 2020 10:45 am
>> Subject: Re: revisions in progress
>>
>> Sid, I have made further changes to the Reply to Reviewers and to the Draft paper. Please use the attached files instead of the ones sent to you on July 10th.
>>
>> On July 10th, I was making changes to the text of the paper based on Reviewer Comments. But, I did not explain the changes under reviewer comments. I just had the word DONE.

Presently, I have added my replies to most (but not all) of the reviewer comments (see the attachments).

Peter

-----Original Message-----
From: Sid Flannery <sidflannery22@gmail.com>
To: AOL CUSTOMER SERVICE(Security tips) <peterrubec@cs.com>
Sent: Tue, Jul 14, 2020 9:21 am
Subject: Re: revisions in progress

Peter,

I can start working on the editor review comments a little today, but it will likely take me until Wednesday or Thursday to get my comments to you. I made pdfs out of two of the WORD documents you sent on Jul 10th - they are attached for reference.

Two questions I have refers to the document titled Editor changes required. Are the words in all caps after each comment his or yours. For example, his comment #2 for Line 63 about needing better citations is followed by the word DONE. Did the editor write DONE or did you insert that?

Similarly, for comment 11 for Line 303. Did he write (SENTENCES REMOVED) or did you?

Also, in some or most cases the line numbers he refers to don't quite match the line numbers in the draft manuscript, which is also attached. For example, the comment 17 for Line 427 looks like it refers to Line 424 in the attached draft. Is that because he was looking at a different lined version of the draft and some sentences have been removed. Whatever the reason, I don't see this as a big problem for me as I think I can tell what passage the editor is referring to.

Overall, I think his comments are pretty good and can be addressed. The paper is definitely getting closer and I am optimistic about it getting published.

Sid

On Fri, Jul 10, 2020 at 12:12 PM Sid Flannery <sidflannery22@gmail.com> wrote:

Hello Peter,

It has been a long haul but it looks like the paper is getting closer to being accepted. I will look over the editor's review comments and get back with you early next week.

Sid

On Fri, Jul 10, 2020 at 11:39 AM <peterrubec@cs.com> wrote:

Everyone,

I received a review of the last draft submitted 6-16-20 done by
Dr. Kenneth Rose (the editor for Marine and Coastal Fisheries).
He wants me to address the changes he has identified.
I am presently working on them. But, I need your feedback
on what you believe I should change in the text, tables, figures (attached)
and what I should reply to his 24 points in Changes Required.

This paper has already been submitted and reviewed 3 times. I am

frustrated concerning the requirement for further changes. But, I am willing to do them, where the changes can improve the paper. Please send me you comments and suggested changes.
The paper must be resubmitted by August 8th.

Please call me if you want to discuss the paper,

Peter Rubec
Tel. 727-327-9226
Email: peterrubec@cs.com

From:	Sid Flannery
To:	AOL CUSTOMER SERVICE(Security tips)
Cc:	christi.santi@myfwc.com <christi.santi@myfwc.com> <christi.santi@myfwc.com >; Browder Joan; Xinjian Chen; Joan Browder; Doug Leeper; Yonas Ghile
Subject:	Comments on 7_20 draft and reply to Editor
Date:	Monday, July 20, 2020 2:18:27 PM
Attachments:	Rubec Draft57 BL MF TEXT (7-20-20) Sid edits.docx Editor Changes Required (7-20-20) Sid Edits.docx

Peter,

Attached are two WORD files that are my edits to the most recent 7_20 version of the paper and edits to 7_20 version of the reply to the Editor.

It has been a long haul, but I suggest keeping a patient approach for just a little bit longer as a few other edits are needed to address the Editor's comments. I think he wants to publish the paper, but the paper needs a few more small revisions to address his concerns. The attached file of the revised paper has just a few additional edits, and I also made corresponding edits to the reply to the editor as well.

A short discussion of some of my edits is below. The line numbers below pertain to the attached versions which include my edits in track changes.

Line 126. This is a short straightforward clarification of some text I suggested in which I mistakenly left out a couple of key words. The new edits states it is freshwater withdrawals that proportionately increase with flows. Also, percent-of-flow needs to be hyphenated.

Line 63 - This sentence refers to riverine and freshwater systems, but the citations are only for estuarine systems. I suggest one or two suitable options: District staff could provide Peter with two good references on the importance of environmental flows for freshwater rivers, **OR,** you could simply drop mention of riverine systems in the sentence and just use references to estuaries.

Line 130. I think moving this sentence up from later in the paper fits much better here.

Line 530. Using just one sentence, the important work of Whaley et al. (2016) regarding Red Drum juveniles could follow the sentences that discuss the older paper by Peters and McMichael (1986). Using words of Peter's choice, I suggest that the finding of Whaley et al (2016) that in a study of Tampa Bay, juveniles of red drum were concentrated within the tidal reaches of three tributaries to the bay. I saw reference to this paper in the Literature Cited, but it is cited only on line 63 as a reference regarding the general role of freshwater inflow with no mention of Red Drum. Relationships of Red Drum with freshwater inflow are important to the District's overall minimum flows program, as it played a critical role in the determination of minimum flows for the Lower Alafia River. The relevance of the Whaley et al. (2016) paper to Red Drum needs to be mentioned in at least one location in this paper, with line 530 a good spot.

Paragraph that starts on page 595. I agree with the Editor that compared to mapping the changes of habitats, the predictions of changes in population numbers are less certain. It is good that the paper examined and predicted changes in population numbers, but in some sentences in the discussion it needs to be qualified a bit more than the changes in habitats. I made a few small edits to this paragraph that I think does that. In the last sentence, I think you misinterpreted the Editor's comment, and inserting population numbers in this sentence was not what he was looking for and it would backfire. I think it is better to emphasize that management decisions will look first at spatial changes in habitat areas. Again, it is good that changes in population numbers were examined and reported in the paper, but I think the changes in habitat need the primary emphasis, especially for supporting the percent-of-flow approach as stated in Lines 603-604. I think that is what the Editor would like to see and I agree.

Lines 623 - 629. Along with earlier discussions that justify the average conditions approach, the sentence I added addresses the Editor's concerns about averaging and clarifies that specific peak flow events or low flow periods of a selected duration in a year can be examined. The sentence that Peter added implies that changes can be assessed for entire years, which is even a greater degree of averaging, which does not address the Editor's concern.

Lines 628-629 . I think it helps to clarify that changes in habitat areas near and far from the location of freshwater withdrawals can be assessed, then overall changes in population abundance evaluated. I think that separating these two evaluations in the sentence helps.

<u>My edits to the replies to the Editor's comments</u>

I made edits to the replies to the Editor to reinforce some of the points in the paper and the edits I made. Keep in mind the Editor wanted a separate paragraph about caveats, but I think the necessary qualifiers about the averaging approach and the greater uncertainty for population estimates are now adequately covered in a few spots in the paper, so a new paragraph is not needed. In that regard, I think it is especially important to explain the rationale and caveats for the averaging approach and describe the revisions to the paper in that regard. I think my sentence in the text about being able to evaluate specific peak flow events within a year for any time of interest addresses the Editor's concerns. Also, the reply reinforces that the text now has an entire paragraph about how other factors can affect abundance, and optimally, the HSM modeling approach could be combined with other types of analyses including trophic based modeling.

If you think any of these edits to the text or replies are warranted, please send out a revised version of the documents to check for any glitches or typos.

Again, good work. I think it will be a valuable addition to the literature when it gets published.

Sid

From:	Sid Flannery
To:	AOL CUSTOMER SERVICE(Security tips)
Cc:	Yonas Ghile; Xinjian Chen; Joan Browder; christi.santi@myfwc.com <christi.santi@myfwc.com> <christi.santi@myfwc.com >; Doug Leeper; Browder Joan
Subject:	A few more edits
Date:	Wednesday, July 22, 2020 7:39:07 AM
Attachments:	Rubec Draft57 BL MF TEXT (7-22-20) CHANGES ACCEPTED with a few more edits 2.docx

Hello Peter and others,

I have made a few very helpful edits to the paper. I think they are important as I caught a few things that needed some slight wording revisions to be more correct. AND, I added a sentence that discusses the terms environmental flows vs minimum flows, which is needed to be consistent with current terminology, plus this project was an excellent case of assessing environmental flows.

The edits were not made in track changes, but are highlighted in yellow. Strikethroughs are used for words or phrases that should be deleted.

A summary of my edits are below. The line numbers correspond to the line numbers in the attached draft.

Line 17 - add the word "simulated" to denote these were not actual freshwater withdrawals.

Line 43 - need to say reductions or alterations of freshwater inflow, as regulating freshwater inflow implies releasing water from an impoundment. Regulated rivers is term to mean rivers in which waters are controlled, and we need to include freshwater inflows from free-flowing rivers.

Lines 62 - 63 - As my note in the margin says, a bit more review is needed, but I think you can use three freshwater references and three estuarine references to mention flow regimes. I have put in some placeholders,which are probably pretty good, but a bit more review should be done. I have not added these to the literature cited, which should be done after the final citations are selected.

Line 63 - The sentence that starts on line 63 that is highlighted in green can be deleted, or kept if you really want to. The previous paragraph talks about creating a corrected flow regime. That is all that is needed to be said about impacts to the Peace River.

Line 67 - This new sentence is important, as minimum flows is kind of an archaic misleading term, and what SWFWMD did was environmental flows, which is the term that is now more commonly used in the literature.

Line 177 - it was the 2020 SWFWMD report that used these percentages

Line 72 - need to say in the estuary as the paper is switching to that area. Also, say add that conditions vary in response to freshwater inflow

LIne 76 - inflow should be singular in this usage

Line 583 - need to add <10 psu as SWFWMD looked at it in the 2020 report.

Sid

Habitat Suitability Modeling and Mapping to Assess the Influence of Freshwater Withdrawals on Spatial Distributions and Population Numbers of Estuarine Species in the Lower Peace River and Charlotte Harbor, Florida

Peter J. Rubec[1*], Christi Santi[2], Xinjian Chen[3], Yonas Ghile[4]

1, 2-Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, 100 Eighth Ave. SE, St. Petersburg, Florida 33701, USA. peterrubec@cs.com, Christi.Santi@myfwc.com

3, 4-Southwest Florida Water Management District, 2379 Broad Street, Brooksville, Florida 34604, USA. Xinjian.Chen@swfwmd.state.fl.us,Yonas.Ghile@swfwmd.state.fl.us

Abstract-The Southwest Florida Water Management District is reevaluating adopted Minimum Flow regulations for the lower Peace River and its largest tributary lower Shell Creek, which flow to the Charlotte Harbor estuary. Habitat suitability modeling (HSM) and mapping of fish and invertebrate species life stages were used to seasonally predict changes in spatial distributions and population numbers associated with simulated freshwater withdrawals. Seasonal salinity grids and temperature grids from 2007-2014 derived from values predicted by hydrodynamic modeling were similar between Baseline (i.e., flows not affected by water withdrawals) and Minimum Flows (flows associated with water withdrawals). Depth grids, bottom type grids, and seasonal dissolved oxygen grids were held constant between the two scenarios. Seasonal HSMs were applied to 28 fish and invertebrate species life stages with affinities for low or moderate salinity. Salinity was the most significant factor in seasonal models for species life stages. The seasonal HSM maps produced were similar between Baseline and Minimum Flows for each species life stage. Most seasonal estimates of population numbers under Minimum Flows were less than the estimates for the Baseline condition, indicating some impact on population numbers associated with flow reductions. Reductions in population numbers under Minimum Flows ranged from 0.3 to 21% with 3 out of 28 seasonal comparisons exceeding 15% and 12 others between 5% and 15% loss. While other factors can also influence species abundance, these results demonstrate how output from hydrodynamic modeling can be applied to HSM analyses and mapping to estimate spatial changes in habitat areas and population numbers for the life stages of fish and invertebrate species in relation to changes in salinity distributions in an estuarine system.

Commented [S1]: Need to point out these are not actual freshwater withdrawlas that have occurred

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The assessment and management of freshwater inflow to estuaries has received increased emphasis in recent decades to account for the important ways that freshwater inflow affects physical, chemical, and biological processes and the resources of estuaries, including relationships with the productivity of sport and commercial fisheries (Drinkwater and Frank 1994, Longley 1994, Estevez 2002, Montagna et al. 2002, Powell et al. 2002, Gillson 2011, Adams 2014). Alber (2002) proposed a conceptual model to support management of freshwater inflows by establishing inflow standards that help protect resources and functions of estuaries. The management approach can be inflow-based (flow is kept within some prescribed bounds under the assumption that taking too much away is bad for biological resources), condition-based (inflow standards are set in order to maintain specified conditions in the estuary), or resource-based (inflow standards are set based on the requirements of specific resources). Each approach is carried out by regulating reductions or alterations of freshwater inflow.

In 1972, the Florida Legislature directed the five Florida water management districts to establish minimum flows and levels (MFLs) for rivers and streams within their boundaries (Section 373.042, Florida Statutes). As currently defined by statute, “the minimum flow for a given watercourse shall be the limit at which further withdrawals would be significantly harmful to the water resources or the ecology of the area”. The water management districts have taken different approaches to comply with the legislation (Alber 2002).

The Southwest Florida Water Management District (SWFWMD), due to its responsibility to permit the consumptive use of water and the legislative mandate to protect water resources from “significant harm”, has established Minimum Flows (MF) for the free-flowing lower Peace River, which drains into Charlotte Harbor on the southwest coast of Florida (SWFWMD 2010). The District has been conducting a reevaluation of the MF and developing new ones for the lower portion of Shell Creek, a tributary to the lower Peace River that enters the river 12 kilometers upstream of the river mouth. The Peace River and Shell Creek are both used for municipal water supplies. To evaluate MF, historic freshwater withdrawals were added back into the flow records for each source and other hydrologic adjustments were made to create a Baseline (BL) flow record that reflects natural flow conditions. A variety of analytical approaches were then used to evaluate the effects of different daily flow reductions on salinity, water quality and various biological parameters in the tidal reaches of the lower Peace River/Shell Creek to determine the total amount of water available for withdrawal without causing significant harm to environmental resources (SWFWMD 2020).

Fundamental to the approach used for development of MFLs is the realization that a freshwater flow regime is necessary to protect the ecology of both riverine and estuarine systems (Livingston 1997, Poff et al. 1997, Alber 2002, Flannery et al. 2002, Mattson 2002, Richter et al. 2003, Gillson 2011). ~~The initial step in this process requires an understanding of historic and current flow conditions to assess the extent to which water withdrawals or other anthropogenic factors have affected flows. It has been demonstrated that flow declines in the Peace River can be ascribed to both climatic variation and anthropogenic effects (PBS&J 2007, SWFWMD 2010).~~ By simulating the daily removal of allowable amounts of water from a free-flowing river, the determination of minimum flows for the Peace River could considered be a determination of environmental flows, the term that is now frequently used to describe the establishment of flows needed to support natural

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Studies found that conditions in the estuary change seasonally and in response to freshwater inflow, ~~and~~ as the locations of early life stages of fish and invertebrate species vary along the salinity gradient in the lower Peace River (Greenwood et al. 2004; Idelberger and Greenwood 2005; Greenwood 2007; Peebles et al. 2007; Call et al. 2011, 2013; Stevens et al. 2013). Greenwood et al. (2004) found that early life stages of 14 fish and invertebrate species had differing responses to freshwater inflow~~s~~ in the lower Peace River. None of these studies used geographic information systems (GIS) to map seasonal changes in spatial distributions of species life stages in the lower Peace River. While numerous agencies have FIM programs, most do not use the data collected to estimate population numbers for the species found in the estuaries they monitor.

A new approach for estimating population numbers in estuaries was developed for juvenile pink shrimp (*Farfantepenaeus duorarum*) in Tampa Bay (Rubec et al. 2016a). Habitat Suitability Modeling (HSM) used delta-type generalized additive models (GAMs) associated with GAMLSS software in R to create seasonal maps of species distributions and population abundance. Using GIS, environmental data points collected by FIM were interpolated to create habitat grids. Gear-corrected (GC) catch-per-unit-effort (CPUEs) from fitted splines and graphs derived from the HSMs were assigned to corresponding cells in the habitat grids to create seasonal grids containing predicted GC-CPUEs for 87 species life stages. The GC-CPUE grids were then averaged to create HSM maps, which provided a means to visualize the spatial distribution of mean GC-CPUEs by zones. Population number estimates were derived from the mean GC-CPUEs associated with the HSM zones. The approach was applied to the Charlotte Harbor system during phase 1 (Rubec et al. 2019).

The main goal of the present study was to assess the influence of environmental conditions on fish and invertebrate species to support setting minimum flows and levels (MFLs) for the lower Peace River and Charlotte Harbor. The primary concern was how to tie this HSM-GIS approach to assessment of impacts of freshwater withdrawals on biological resources in the study area. The first step was to map seasonally temperature and salinity conditions in the lower Peace River and Charlotte Harbor associated with BL (phase 2-no water withdrawals) and with MF (phase 3-water withdrawals). A second step was to estimate relative population numbers from seasonal HSM maps to determine the impacts of water withdrawals on early life stages of fish and invertebrate species (biological resources). The third step was to use the HSM maps to spatially elucidate species life history patterns and compare these findings with published literature. Since the abundance of species life stages change between seasons and across years, modeling and mapping methods were required to separate climatic effects from the effects associated with water withdrawals.

METHODS

Fisheries-Independent Monitoring

The main source of data for early life stages of fish species and blue crab has been FIM data collected in the Charlotte Harbor study area (**Figure 1**). FIM sampling has been conducted north of Pine Island, in geographic segments A, B and C in Charlotte Harbor, M in the lower Myakka River and the Lower P segment of the lower Peace River and lower Shell Creek. Seasonal data extracted from the FIM database for 1996 to 2013 included catch numbers, effort, environmental data for temperature (T), salinity (S), dissolved oxygen (O) and depth (D), date, latitude/longitude, and associated gear types. The Upper P segment in the lower Peace River, north of its confluence with Shell Creek, was not part of long-term FIM. For this segment, we used FIM data collected during two special studies conducted by Greenwood et al. (2004) from April 1997 to March 1998 and by Call et al. (2011) from July 2007 to June 2010. The T, S, O, D, B data at FIM sampling locations were used with HSM to relate CPUEs to environmental conditions. The HSM analyses and mapping methods using FIM data have been described in more detail in a report (Rubec et al. 2018) and recent paper (Rubec et al. 2019).

Bottom types (B) at FIM sampling locations were extracted from a National Oceanic and Atmospheric Administration (NOAA) fishing chart created in 1989. The NOAA map is based on mud/sand distributions determined using a plumb line dropped onto the bottom to assess the firmness of bottom sediments at stations across the estuary. When we initiated the present study in 2015, the NOAA sediment map was the best information available.

Sampling gears used in the study area from 1996 to 2013 included a 21.3-m circular bag seine, a 21.3-m boat bag seine, a 183-m haul seine, and a 6.1-m otter trawl. A 61-m haul seine for sampling in the lower Peace River was added in 2007. **Table 1** lists the gear types used for the HSM analyses with mean CPUEs ordered from high to low, the total number of FIM samples by season, and the percent of zeros present in seasonal datasets for each species life stage. The high percentage zeroes necessitated the use of delta-gamma GAMs to deal with zero inflation. Sample sizes were adequate for all species life stage combinations.

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A seasonal approach was taken for the HSM modeling because the life stages of the species of interest show peak abundances in the Charlotte Harbor system during different times of year (Greenwood et al. 2004, Peebles et al. 2006, Rubec et al. 2018). In addition, salinity and water temperature exhibit typical seasonal variations in response to regional climatic patterns including seasonal variations of rainfall and freshwater inflow. By applying the percent-of-flow approach, the withdrawal of proportionately more freshwater inflow was simulated during seasons of the year when high flows are most common, suggesting that the wet seasons should be separately examined. On the other hand, the area and volume of salinity based habitats are generally more susceptible to impacts from a given percent flow reduction during the dry times of year (SWFWMD 2010), indicating that dry periods should be evaluated separately as well. Given that the project allowed for the generation of a limited number of HSM maps, it was determined that average salinity and temperature conditions for each season would be applied to the HSM mapping to represent typical changes in habitats between BL and MF for four periods of the year.

Considering these factors, four three-month seasons were chosen by the District to reflect seasonal changes in water temperature, salinity and rainfall conditions in the region (SWFWMD 2010). Water temperatures and freshwater inflows are greatest in the summer (July–September), which typically has the highest rainfall. The fall (October–December) has declining water temperatures and declining freshwater inflow, often followed by a minor increase in inflow during the winter (January–March) due to rains associated with cold fronts. However from 2007 to 2014, the winters were unusually dry and had the lowest average inflow of the four seasons. The spring (April–June) has rising water temperatures and typically includes the lowest inflows, although inflows usually increase in mid-June as the rainy season begins.

Habitat Mapping

A bottom type grid/map was created with polygons coded for mud, sand and submerged aquatic vegetation (SAV). Bottom types for mud and sand were digitized as polygons from the NOAA fishing chart for Charlotte Harbor (Rubec et al. 2019). Seagrass coverages in Charlotte Harbor were derived from images obtained using aerial photography conducted every two years since 2002 (Photo Science and Kaufman 2013). Most of the imagery was collected during the winter. The imagery for SAV showed little or no change in the spatial extent of SAV from 2002 to 2013. Based on good water clarity, we chose the 2012 coverage as being most representative of the spatial extent of SAV. A bottom type grid was created using ArcGIS (Esri 2014).

Bathymetry data derived from a sonar survey in 2012 by Wang (2013) were obtained from the District for the Charlotte Harbor study area. Additional data for Gasparilla Sound were obtained from NOAA for areas where data were not present in the SWFWMD dataset (Rubec et al. 2018). This included data obtained from hydrographic surveys conducted by NOAA in 1955 and 1956. The NOAA and SWFWMD data were merged into a single point feature class. Large backwaters and canals with no bathymetry data were removed. Some smaller backwaters were included. The bathymetry data points were interpolated in ArcGIS using empirical Bayesian kriging (Krivoruchka 2012). The output raster grid for bathymetry was clipped to the water extent within the study area.

We extracted averaged surface and bottom dissolved oxygen data from the FIM database using SAS. Point data collected from 1996 to 2013 at FIM sampling stations were interpolated in ArcGIS using empirical Bayesian kriging associated with the Geostatistical Analyst 10.3 extension to create seasonal dissolved oxygen grids (Esri 2014). The seasonal dissolved oxygen grids were clipped to the same spatial extent as the bathymetry grid and bottom type grid, with each grid containing about 1.9 million total 15 x 15 m cells. Since the methods are fairly complicated a diagram is included outlining the methods (**Figure 2**).

Hydrodynamic Modeling Using Two Flow Scenarios

The effects of changes in freshwater inflow to the estuary were evaluated for the years 2007 to 2014 using the percent-of-flow approach in which various percentage flow reductions were applied to daily flows in the baseline flow record (Flannery el al. 2002, SWFWMD 2010, 2020). Based on other analyses that assessed changes in the volume, area and shoreline length of various salinity zones, a minimum flow scenario was created by SWFWMD in which daily flow reduction percentages were applied within three flow ranges for both the lower Peace River and lower Shell Creek, ranging from 13% of low flows to 40% of high flows (SWFWMD ~~2010~~ 2020). On the lower Peace River, a low flow cutoff was also employed that prohibits any withdrawals, which was in effect 26% of the days during the study period, while the 40% limit for high flows was applied to 22% of the days.

A hydrograph depicts daily flows for BL and MF in the lower Peace River across years (2007 to 2014) (**Figure 3)**. Average flows in cubic feet per second (cfs) by season across years are presented for these flow scenarios in the lower Peace River and lower Shell Creek (**Table 2**). The reductions in average flows for each of the four seasons were influenced by large differences in daily flows between the BL and MF scenarios during periods of high flow within each season. Smaller flow reductions, both in terms of differences in daily flows and percent daily flow reductions, occurred during most of the year. The largest reductions in freshwater inflow by season were during peak flows, but due to the nonlinear response of the area and volume of salinity zones to freshwater inflow, significant impacts to habitats during lower flows could occur as well. SWFWMD later added a maximum flow reduction rate of 400 cfs between BL and MF in the lower Peace River, which was not included nor simulated in our study.

To simulate the effects of these flow reductions on salinity distributions in tributary rivers, a dynamically coupled 3D-2DV model similar to that used in previous MFL evaluations (Chen 2007), was developed (Chen 2018). The UnLESS model, which dynamically couples LAMFE and UnLESS3D, was applied to greater Charlotte Harbor (**Figure 4**) using 4790 grids in the horizontal plane and 17 layers in the vertical direction to discretize the 3D simulation domain and 311 grids and 17 layers to discretize the 2DV simulation domain. The simulation domain for greater Charlotte Harbor included tidally influenced sections of the lower Peace River, lower Myakka River and lower Shell Creek, Gasparilla Sound, Pine Island Sound, Matlacha Pass, a downstream portion of the Caloosahatchee River, and an offshore area extending about 20-30 km into the Gulf of Mexico. The tidally influenced sections included a 34.2 km section of the lower Peace River, a 38.6 km section of lower Myakka River, and a 10 km section of lower Shell Creek.

While the greatest changes in salinity and temperature distributions were mostly within the tidal rivers, the area modeled using UnLESS included greater Charlotte Harbor to eliminate the effect of barriers from predictions for salinity and temperature patterns in the tidal portion of the rivers. Salinity and temperature fields were simulated in greater Charlotte Harbor and its major tributaries from 2007 to 2014 for both the BL and MF scenarios. Twenty-four simulations were run with different percent flow reductions for the lower Peace River and Shell Creek to determine the proposed minimum flows.

Seasonal values for predicted salinity and temperature derived from UnLESS were averaged across years (2007-2014) for both BL and MF in the Charlotte Harbor study area north of Pine Island. Then, the point data were interpolated using kriging to create seasonal temperature grids and seasonal salinity grids with the same cell size and spatial extent as the bathymetry grid, bottom type grid and seasonal dissolved oxygen grids. For the spatial analyses, we held the bathymetry, bottom type, and seasonal dissolved oxygen grids constant between BL and MF. The seasonal temperature grids and seasonal salinity grids changed between BL and MF.

Estuarine Species Life Stages

Eight species life stages were selected based on the criterion that they exhibit preferences for low or moderate salinity and have been found to be abundant in the Charlotte Harbor study area (Rubec et al. 2018). Six species life stages exhibited affinities for low salinity in a previous HSM study in Tampa Bay and Charlotte Harbor (Rubec et al. 2016b). These species were seasonally analyzed by early-juvenile (EJ), juvenile (J) and adult (A) life stages (**Table 3**). Hogchoker and blue crab were added based on studies by Peebles (2002a) and Greenwood et al. (2004). For these two species, juvenile and adult life stages were combined (JA) and analyzed together.

Peebles (2002a) and Greenwood et al. (2004) recognized estuarine residents, which reproduce in the estuary and remain there during all life stages. For the present study, estuarine residents refer to species life stages for Hogchoker (*Trinectes maculatus*), Sand Seatrout (*Cynoscion arenarius*), blue crab (*Callinectes sapidus*), Southern Kingfish (*Menticirrhus americanus*), and Bay Anchovy (*Anchoa mitchilli*) which are abundant in the Charlotte Harbor study area during most seasons of the year (**Table 3**). Estuarine transients, such as Red Drum (*Sciaenops ocellatus*) and Spot (*Leiostomus xanthurus*) leave the estuary to spawn in the Gulf of Mexico (Stevens et al. 2013). Since early life stages of the species mentioned are abundant in Florida estuaries during most seasons; they are considered to be estuarine dependent (Peebles 2005).

Habitat Suitability Modeling

The gear-correction (GC) of CPUEs for different gear types was originally used in 2001 associated with habitat suitability index models for Tampa Bay and Charlotte Harbor (Rubec et al. 2001). The CPUEs were standardized by the ratio of each gear's mean CPUE to the gear with the highest mean CPUE to create GC-CPUEs. This approach has been used with previous HSM studies in Tampa Bay and Charlotte Harbor (Rubec et al. 2016a, 2016b, 2019). Gear corrections were computed within the R-based HSM software used in the present study.

Seasonal delta-gamma GAMs were developed that relate GC-CPUEs to environmental data collected in Charlotte Harbor. We used the online R-based program *gamlss* (Rigby and Stasinopoulos 2005, Stasinopoulos and Rigby 2007) designed for datasets with a surplus of zero catch values (i.e., zero-inflated data) that was previously applied to FIM data from Tampa Bay (Rubec al. 2016a). Log-transformed cubic smoothing splines were fit to non-zero (+CPUE) data (MU) and logit transformed splines fit to probability of zero occurrence (P=0) data (NU) across environmental gradients for both Full and Reduced models. Then, the spline data were back-transformed and the two components multiplied (MU x NU) to derive seasonal GC-CPUE splines across gradients for water temperature, salinity, dissolved oxygen and depth. Histograms were created for categorical variables with mean GC-CPUEs by bottom type, gear type, and year. Predictions based on the combined MU and NU models account for uncertainty in predicted GC-CPUEs. Further details about the modeling methods are presented elsewhere (Rubec et al. 2016a, 2016b, 2018, 2019).

First, a Full model (i.e., all predictor variables included) was fit using the penalized B-spline. Next, 31 Reduced models were developed comprised of various combinations of 1 to 5 environmental factors, each with a different Akaike information criterion (AIC). The model with the lowest AIC was chosen as the final Reduced model. Depending on selectivity for the size of the species life stage being analyzed, not all gear types were used for each HSM analysis (i.e., if a gear type did not catch any individuals of the species life stage being analyzed, that gear type was not included in the final analysis).

The delta-gamma GAMs developed using Reduced models are not spatial. A second part of the R program (GAMLSS) used GC-CPUEs derived from fitted cubic smoothing splines to assign GC-CPUEs to a data set representing the centers of the cells associated with the habitat grids, according to latitude and longitude. Unique combinations of values for T, S, O, D, and the three categorical variables were available for each grid cell. The GC-CPUEs associated with the cell coordinates were then averaged to create a dataset with mean GC-CPUEs. Seasonal mean GC-CPUE datasets for each species life stage were then imported into ArcGIS and continuous GC-GPUE grids created across the estuary (R code available from: GISLibrarian @MyFWC.com).

Zonal Grids Used to Create HSM Maps

Using the ArcGIS Spatial Analyst Slice tool, the continuous GC-CPUE grids were assigned to four habitat suitability zones by the Jenks natural breaks classification method (Jenks 1967). The natural breaks method associated with the Slice tool specifies “that the classes will be based on natural groupings inherent in the data”. Break points are identified by choosing the class breaks that best group similar values and that maximize the differences between classes. This provided an objective means of partitioning continuous GC-CPUE grids into four zones for each species life stage for the BL scenario. HSM zones for MF were created using the same natural breaks that were calculated for BL. Seasonal HSM maps were created from the zonal grids for each species life stage associated with BL and with MF (Rubec et al. 2018). Each HSM map has four habitat suitability zones: Low, Moderate, High, and Optimum, representing predicted mean GC-CPUEs increasing across the HSM zones.

Validation Graphs

Gear standardized FIM data (observed GC-CPUEs), for species life stages within each season, were spatially joined to the zonal grid data using ArcGIS to create validation datasets. Each FIM data point was joined to the closest habitat point within 50 meters. We validated each model by overlaying the observed data onto predicted HSM zones to create validation graphs for each season (Rubec et al. 2018). Increasing trends in mean observed GC-CPUE across HSM zones indicated spatial agreement between mean observed GC-CPUEs and mean predicted GC-CPUEs within HSM zones.

Validation graphs with increasing mean observed GC-CPUEs across four zones, Low to Optimum, were scored as 1.0. When the mean observed GC-CPUEs exhibited increasing trends across three zones (Low to High) instead of across all four HSM zones, they were scored as 0.5.

Computation of Zonal Areas and Population Numbers

Tables were created for each species life stage respectively for BL and MF that present mean GC-CPUEs (no/m^2) and zonal areas (m^2) for each seasonal HSM zone. The study area is comprised of 1,906,683 total 15 x 15 m cells with a total area of 429,003,675 m^2. Changes in percent zonal area (A) were calculated as relative difference between percent areas for Baseline and Minimum Flows: $(\%A_{baseline} - \%A_{minimum}) / \%A_{baseline}$.

Zonal population number estimates by season for each species life stage were derived by multiplying mean GC-CPUEs (no/m^2) by the areas (m^2) associated with the HSM zones. Total population numbers in the study area were then estimated for each season by summing the zonal population estimates.

Confidence Intervals

The R program (GAMLSS) computed confidence intervals around Owens Plots, around fitted splines and associated with validation datasets allowing assessment of uncertainty in the GC-CPUE data. The population number estimates were not computed by the delta-gamma GAMs used with the HSM. They were derived from the GC-CPUEs from fitted splines applied to datasets containing the central coordinates of cells in the habitat grids. After the GC-CPUEs associated with the cell coordinate were averaged, the datasets were imported into ArcGIS in order to produce continuous GC-CPUE grids. Then, the continuous GC-CPUE grids for each species life stage were partitioned to produce seasonal HSM maps. Due to the averaging, the estimated population numbers derived from the GC-CPUE grids do not have confidence intervals.

RESULTS

Habitat Maps

Seasonal salinity maps (**Figure 5**) and seasonal temperature maps (**Figure 6**) for BL were produced (Rubec et al. 2018). Salinity and temperature maps also were created for MF; but are not shown here because they appear similar to the BL maps. The percent changes within zones obtained by subtracting percent salinity for MF from percent salinity for BL were mostly <1% for salinity ranges up to 20 psu and <4 % for higher salinity ranges up to 35 psu (**Table 4**). The percent changes within zones obtained by subtracting percent temperature for MF from percent temperature for BL were <0.5 % for temperature ranges up to 30ºC and <3 % for higher temperature ranges up to 34ºC (Rubec et al. 2018**)**.

Statistical Table of Reduced HSM

Final Reduced models have the lowest AICs and contain the best combinations of environmental variables (**Table 5**). Salinity (S) is significant, based on high abundance (GC-CPUEs) at low salinity ranges, for species life stages during most seasons on both the MU and NU sides of the models. Temperature (T) is significant for some seasonal species life stages. However, there is no seasonal preference for temperature with most species life stages. Depth (D), dissolved oxygen (O), Mud, and SAV are less significant for most species life stages. But, these environmental variables are included in many of the final seasonal HSMs.

Fitted Splines and Histograms From HSM

Fitted splines and histograms of abundance by salinity for JA-Hogchoker in the spring are based on output from the Full delta-gamma GAM (**Figure 7**). The graphs illustrate relationships between abundance and the environmental variables included in the Full model. There is a marked preference for salinities 0.5-5 psu and temperatures >30ºC. The broader fitted splines for dissolved oxygen and depth suggest these environmental factors may not be as significant. This was confirmed with the statistical output during spring for the Reduced model (**Table 5**). Seasonal splines and histograms also were produced from Full delta-gamma GAMs for the other species life stages.

Because salinity was significant for most resident species life stages (**Table 5**) and was the variable of greatest interest in comparing MF to BL, we plotted seasonal abundance by salinity splines together to facilitate comparisons of abundance within and between species (**Figure 8**). JA-Hogchoker exhibited highest abundance at oligohaline salinity (0.5-5 psu) in the Upper P segment for all four seasons. J-Sand Seatrout and JA-blue crab were most abundant in the Upper P and Lower P segments. The abundance for J-Sand Seatrout peaked near 7 psu during four seasons. The abundance for JA-blue crab peaked at 10 psu in fall and winter, at 8 psu in spring and <5 psu in summer. EJ-Southern Kingfish and A-Bay Anchovy were abundant in the Lower P segment of the river. The abundance for EJ-Southern Kingfish peaked at 15 psu in fall, and near 18 psu during winter, spring and summer. The abundance by salinity relationships for A-Bay Anchovy were similar during all four seasons with peaks for the fitted GC-CPUEs near 18 psu.

The Optimum zones derived from HSM analyses indicate that each species was most abundant at different salinity ranges proceeding downstream. The species order from low to higher salinities is JA-Hogchoker, J-Sand Seatrout, JA-blue crab, EJ-Kingfish, A-Bay Anchovy, EJ-Red Drum, EJ-Spot. The Optimum salinity ranges selected by estuarine resident species were similar between seasons (Rubec et al. 2019). With estuarine transient species, the salinity ranges associated with Optimum zones changed between seasons.

EJ-Red Drum abundance peaked near 18 psu in fall and <10 psu during winter and spring (**Figure 8**). But, there were also increasing relationships associated with the GC-CPUE by salinity splines during winter and spring at salinities >30 psu. The fitted GC-CPUE spline for EJ-Red Drum in summer indicates they were most abundant over a broad range of salinities <20 psu.

During winter, the GC-CPUE by salinity spline for EJ-Spot indicates they were most abundant at salinities ranging from 5 to 25 psu (**Figure 8**). In spring, the abundance by salinity spline decreases at salinities ranging from 0.5 to 20 psu, then increases at salinities >30 psu. In summer, the abundance by salinity spline for EJ-Spot declines at salinities ranging from 0.1 to 10 psu, then increases at salinities >20 psu. During fall, the abundance spline increases at salinities >30 psu.

HSM Maps

Seasonal BL and MF HSM maps for eight species life stages were created (Rubec et al. 2018) but only the BL maps are shown here because the MF maps are so similar. In most cases for resident species, predicted Optimum zones occurred in low or moderate salinity segments of the lower Peace River, lower Shell Creek and lower Myakka River, rather than in Charlotte Harbor. The report (Rubec et al. 2018) submitted to SWFWMD containing all of the seasonal HSM maps is available as a supplemental online.

JA-Hogchoker

Seasonal HSM maps for JA-Hogchoker associated with BL show Optimum zones of abundance in the Upper P segment during all seasons **(Figure 9).** During fall, winter and spring dry seasons, the Optimum zones contract within the upper part of the Upper P segment, then expand throughout the Upper P segment during the summer rainy season. For both BL and MF, the spatial extent of Optimum zones expanded during the summer (Rubec et al. 2018). Close examination reveals that the Optimum zone for MF contracts slightly associated with water withdrawals during the summer.

J-Sand Seatrout

Seasonal HSM maps for J-Sand Seatrout (Rubec et al. 2018) are so similar between BL and MF that it is difficult to visually discern whether there is any effect of water withdrawals. The HSM maps show J-Sand Seatrout occurring in both the Upper P and Lower P segments during fall. Small blue polygons representing the Optimum zone are present in Upper P during the winter. In spring, the Optimum zones expand indicating J-Sand Seatrout become very abundant throughout the Upper P and Lower P segments. During summer, the Optimum zone shrinks, while the northern part of Charlotte Harbor has High abundance (green polygon). However, there is also a small Optimum zone near the mouth of Charlotte Harbor during the summer.

JA-blue crab

The Optimum zone in the BL HSM map for JA-blue crab during winter is situated in the Upper P and Lower P segments of the lower Peace River and in the lower Myakka River (**Figure 10**). In spring, JA-blue crab are abundant in the rivers, but the Optimum zones diminish in area. In summer, the Optimum zone expands in the two rivers and into northern Charlotte Harbor. The Optimum zone contracts in the fall and is present in the Lower P segment.

EJ Southern Kingfish

The Optimum zones in BL and MF HSM maps for EJ-Southern Kingfish indicate they were most abundant in the Lower P segment of the lower Peace River during all seasons (Rubec et al. 2018). The Optimum zones expand in the river during winter with High abundance in the northern part of Charlotte Harbor. There is a contraction of the spatial extents of High and Optimum zones in the maps during spring for both scenarios. During summer, the Optimum and High zones expand, possibly in relation to higher freshwater inflows. In summer, the Optimum zone in the river for MF is visibly smaller than the Optimum zone associated with BL.

A-Bay Anchovy

The seasonal BL HSM maps for A-Bay Anchovy (**Figure 11**) are very similar to the seasonal HSM maps associated with MF (Rubec et al. 2018)**.** The Optimum zones for both scenarios expand during summer from the rivers into Charlotte Harbor in shallow water areas (<2 m) associated with increases in freshwater inflow.

EJ-Red Drum

Based on Optimum zones in BL and MF HSM maps, EJ-Red Drum during the fall were most abundant over SAV in segments A and B in Charlotte Harbor and in the Lower P segment of the lower Peace River (Rubec et al. 2018). In winter, the Optimum zones shift upriver into the Upper P segment. But, EJ-Red Drum were also abundant in segment B near the mouth of the estuary. During spring, the Optimum zones shift downstream into Lower P and into the northern and central parts (segments A and B) of Charlotte Harbor in shallow water over SAV. In summer, the Optimum zones for BL and MF indicate they were most abundant in Lower P. But, High zones (shown in green) in the HSM maps indicate they also were prevalent in deeper water of segment A in northern Charlotte Harbor. During summer, there no longer is an Optimum zone in segment B near the mouth of the estuary.

EJ-Spot

The Optimum zone in the BL HSM map for EJ-Spot in winter (**Figure 12**) indicates they were abundant in the lower Peace River and in shallow areas in the northern part of Charlotte Harbor. During spring, the Optimum zone situated in the Upper P segment may be due to an affinity by EJ-Spot for low salinity. Optimum zones for summer indicate some EJ-Spot still were present in Upper P at low salinities, with the rest of the population present in segment B near the mouth of the estuary where high salinities were found. In fall, small Optimum zones are located in segment B near the mouth of the estuary.

Validation

We validated the delineation of HSM zones for each species life stage by confirming that seasonal mean observed GC-CPUEs increased across four zones (**Table 6**). An example validation graph is presented for A-Bay Anchovy in the fall for MF (**Figure 13**). Consequently, most species life stages received a validation score of 1.0.

For JA-Hogchoker, three out of four seasons have validation scores of 0.5 during spring, summer and fall for both BL and MF (**Table 6**). Lower mean observed GC-CPUEs were associated with the Optimum zone in comparison to the High zone in the validation graphs.

Zonal Areas and Population Numbers

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The example provided shows how spring zonal areas and population number estimates were derived for A-Bay Anchovy with both BL and MF from seasonal HSM maps (**Table 7**). Total spring population numbers estimated for A-Bay Anchovy for BL is 2,098,463,644 and for MF is 1,995,985,434. Similar computations were done to seasonally derive zonal areas and population number estimates for other species life stages.

Population Numbers by HSM Zones

Seasonal population number estimates for each species life stage are presented for BL and MF respectively (**Table 8**). Percentage changes in population numbers between BL and MF indicate that total population numbers declined between 0.3% and 21%. Although percentage declines are <15% for most species, reductions in estimated total population numbers exceed 15% for JA-Hogchoker in spring (19.0%), J-Sand Seatrout in spring (21.0%) and EJ-Southern Kingfish in summer (17.5%). Total population numbers for A-Bay Anchovy in summer increased by 1.1% and decreased during the other seasons. Total population numbers between BL and MF for EJ-Spot decreased during winter (1.5%) and spring (1.7%) and increased by 4.8% in summer and by 7.8% in fall. Summer and fall were the seasons when EJ-Spot left the estuary and estimated population numbers were low.

In most cases, there are higher seasonal percent population numbers of fish/crabs in the Moderate and High zones than in the Optimum zones (**Table 9**). This is because the Moderate and High zones have larger zonal areas than the Optimum zones. Since population numbers were derived by multiplying mean GC-CPUEs (no/m^2) by zonal areas (m^2), it was possible to obtain higher estimates for percent population numbers for the Moderate and High zones, despite these zones having lower mean GC-CPUEs than those estimated for the Optimum zones.

DISCUSSION

Short-term studies in the lower Peace River of benthic macroinvertebrates, fish and nektonic invertebrate communities in relation to physical habitat, salinity and freshwater inflow were summarized by SWFWMD (2010). SWFWMD has also sponsored surveys to relate distributions and relative abundance of phytoplankton, zooplankton, larval fish and larval macro-invertebrate communities to salinity and water temperature changes associated with freshwater inflow and other habitat variables in the lower Peace River and lower Shell Creek (Peebles 2002a, Vargo et al. 2004, Atkins North America 2014, Janicki Environmental 2015). Regression analyses indicated that larval stages of 20 fish and invertebrate species displayed different responses to changes in freshwater inflow in the lower Peace River (Greenwood et al. 2004, Peebles and Burghart 2013). Estuarine studies have been done in other regions of Florida (Livingston 1997, Browder and Moore 1981, Doering and Wan 2017), in other states such as Texas (Longley 1994, Montagna et al. 2002, Powell et al. 2002), California (Kimmerer et al. 2009, Weber-Stover et al. 2016), Georgia (Alber and Flory 2002), and in other countries (Drinkwater and Frank 1994, Estevez 2002). The studies cited used a variety of methods for different purposes, which negate comparisons between them. What seperates the present study from them is the population number estimates derived from seasonal temperature and salinity grids predicted from hydrodynamic modeling of freshwater inflows.

Commented [S7]: No hyphen in macroinvertebrates

The Peace River is not impounded and is free-flowing along its length, while Shell Creek is impounded by a low head structure located 10 kilometers upstream of its confluence with the Peace. However, water is infrequently taken from storage in this small impoundment, so freshwater flows to lower Shell Creek largely follow the normal seasonal pattern for southwest Florida. Also, corrections to the flow records for both systems were made for existing withdrawals and other anthropogenic impacts to flow, so the BL flow record examined in this study and the corresponding salinity distributions predicted from the hydrodynamic model reflect natural seasonal variations in the region. This allowed for the assessment of changes in fish habitat and species population abundance due to freshwater withdrawals that are representative of four seasons in southwest Florida, with the caveat that flows during the winter were unusually low due to climatic conditions during the study period.

The abundance by salinity relationships for resident species were similar across seasons for JA-Hogchoker, J-Sand Seatrout, JA-blue crab, EJ-Southern Kingfish and A-Bay Anchovy indicating that each species life stage has a preferred salinity range, which does not change much between seasons (**Figure 8**). This was previously verified by overlaying Optimum zones from HSM grids onto the salinity grids and extracting the salinity ranges by season (Rubec et al. 2019).

Most of the seasonal HSM maps for species life stages show an expansion of their spatial distributions in the lower Peace River during summer that is associated with higher freshwater inflows. In most cases, Optimum zones of abundance expanded to match the expansion of low and moderate salinity zones during the high-flow summer months (**Figure 5**).

While the seasonal validation scores for most species life stages were 1.0, the scores for JA-Hogchoker during spring, summer and fall were 0.5 for both BL and MF (**Table 6**). Reduced freshwater inflows due to water withdrawals appear to be detrimental for JA-Hogchoker due to the reduced areas of low salinity habitats (0.5-5 psu). This may be because the predicted Optimum zones in HSM maps for BL and MF have smaller areas than the Optimum zones predicted from the phase 1 analyses of FIM data (Rubec et al. 2019). In that study, the validation scores for JA-Hogchoker were 1.0 for all four seasons.

Peebles and Greenwood (2009) used spatial abundance quantiles to demonstrate impingement of Hogchoker <31 mm SL on Shell Creek's estuarine dam associated with a reduction of 3-day mean freshwater inflow and the loss of low salinity habitat. JA-Hogchoker caught in seines also showed evidence of crowding below the dam. The loss of low salinity habitat (0.5-5 psu) was detrimental for JA-Hogchoker.

J-Sand Seatrout were abundant in the lower Peace and lower Myakka Rivers during spring and less abundant in Charlotte Harbor during summer, fall and winter (Rubec et al. 2018). The summer HSM maps have a small Optimum zone near the mouth of the estuary, which might indicate that they move out of Charlotte Harbor in summer and later spawn in the Gulf of Mexico (Cowan and Shaw 1988). Another possibility is that juvenile Sand Seatrout grow to adult size in Charlotte Harbor during the summer and fall, and adults spawn in the lower part of the estuary in the following spring (Knapp and Purtlebaugh 2008). Sand Seatrout sought a reduced salinity range when they reached a length of 30–70 mm SL and then moved to higher salinities as they grew toward 100 mm SL (Purtlebaugh and Rogers 2007). Peebles (2002a) found post-flexion larvae and juvenile Sand Seatrout in the lower Peace River and Shell Creek during spring. Some spawning evidently took place there; but most post larvae and juveniles were believed to originate from higher salinity areas within Charlotte Harbor.

Optimum zones for JA-blue crab during all seasons were in the tidal portions of the Peace and Myakka Rivers (**Figure 10**). Literature reviewed by Gandy et al. (2011) indicates that immature females seek low salinity areas in estuaries (<15 psu) where they subsequently mate with mature males. When mating occurs in the spring and summer, the interval between mating and egg extrusion is about two months. When mating occurs in the fall and winter, spawning occurs during the following spring. Freshwater inflows are highest in the summer and lowest in the winter; so it is interesting that JA-blue crab in our study were most abundant in expanded Optimum zones during those seasons. The expansion of the Optimum and High zones in the lower Peace River during winter and summer appears to be partly related to peaks in recruitment of juvenile blue crab during winter and summer.

In their analysis of inter-annual trends in abundance of blue crab, Flaherty and Guenther (2011) found that immature and adult blue crab indices of abundance and commercial landings were high in Tampa Bay in 1998 in association with increased rainfall during the 1997-1998 El Niño. This was followed by a reduction in the abundance of immature blue crabs in 2002 corresponding to lower-than-average river inflows from late 1998 through to the beginning of 2002. They noted that reduced rainfall and freshwater diversions had the potential to adversely affect recruitment and survival of young crabs in the estuary. From 2003 to 2004, there was a dramatic increase in blue crab recruitment and a steady rise in adult abundance and commercial landings in Tampa Bay that appears to be linked to increases in freshwater inflows above historic means.

The distribution of EJ-Southern Kingfish in the lower Peace and Myakka Rivers during all seasons (Rubec et al. 2018) and in the northern part of Charlotte Harbor during winter and summer suggests expanded geographic ranges in Optimum and High zones during winter and summer that may be related to spawning during fall and spring in the estuary. A marked contraction of the Optimum zone is apparent for MF in comparison with the Optimum zone for BL, associated with water withdrawals during the summer.

Peters and McMichael (1987) found two size groups of early life stages of Red Drum were present Tampa Bay, probably based on recruitment to the estuary during different years. They remained in the estuary for about three years before moving into the Gulf of Mexico. In another study of Tampa Bay, Whaley et al. (2016) found that juveniles of Red Drum in two size classes (15 – 50 Standard Length and 51-100 SL) were concentrated in the tidal reaches of three rivers that flow to the bay. In Charlotte Harbor, fitted splines indicate EJ-Red Drum were most abundant at salinities ranging from 10-20 psu in the fall and at salinities <10 psu during winter and spring (**Figure 8**). Based on Optimum zones in HSM maps for BL and MF, EJ-Red Drum recruited during the fall were most abundant over SAV in northern Charlotte Harbor and in the Lower P segment of the lower Peace River (Rubec et al. 2018). In winter, they moved upstream to the Upper P segment. During spring, they moved downstream into the Lower P segment and into segment A in northern Charlotte Harbor. In summer, the

Commented [S8]: Whaley and others have another paper from 2007 that contains data from Charlotte Harbor. It should probably be cited as well.

Optimum zones show they were most abundant in the Lower P segment. But, the High zones for summer indicate they also were prevalent in deeper water within segment A. The Optimum zones indicate that larger Red Drum, probably recruited two years earlier, were present in segment B near the mouth of the estuary during fall, winter, and spring. Their absence in segment B during the summer suggests they moved out of Charlotte Harbor into the Gulf of Mexico.

Seasonal HSM maps show that EJ-Spot were abundant in the lower Peace River during winter and spring (**Figure 12)**. The fitted abundance splines by salinity and Optimum zones in the HSM maps indicate that most EJ-Spot left Charlotte Harbor in summer and fall starting at an age of about 6 months. The movement out of Charlotte Harbor starting in summer was unexpected; since peaks in larval abundance in the Gulf of Mexico suggest that Spot leave Louisiana estuaries to spawn in the Gulf of Mexico during fall and winter (Cowan and Shaw 1988).

The Optimum zones in seasonal HSM maps for the resident species life stages indicate they had high abundances within salinity ranges found in the lower Peace River. This could be due to habitat affinities for low or moderate salinities. However, it does not explain why the estuarine transients (EJ-Red Drum, EJ-Spot) were most abundant in the Upper P section of the river during winter and spring, respectively. It seems likely that freshwater inflows to the river introduce nutrients that enhance production of phytoplankton, zooplankton and larval fish that are exploited by early life stages of estuarine fish and invertebrates (Peebles 2002a, 2002b, 2005; Flannery et al. 2002). The relationships between species abundance and low or moderate salinities may be indicative of food availability created by nutrients and organic materials entering the lower Peace River associated with freshwater inflows from upstream (Rubec et al. 2019).

Optimum zones for A-Bay Anchovy show their prevalence in the lower Peace River during all seasons (**Figure 11**). Their Optimum zones expanded into northern Charlotte Harbor in summer for both BL and MF and were apparently related to the expansion of low to moderate salinity zones associated with increased freshwater inflows (**Figure 5**). A-Bay Anchovy was the most populous species life stage with their population numbers estimated to be five to six orders of magnitude greater than those of the other species life stages represented in the study (**Table 8**). Similar seasonal HSM maps and population number estimates for J-Bay Anchovy were produced for the BL and MF scenarios (Rubec et al. 2018) that are not presented in this paper.

These estimates look reasonable for a species known to aggregate in great numbers. Bay Anchovy filter plankton from the water through their gills. Hence, one can assume that their population numbers in the lower Peace River are related more to the flow-related abundance of plankton in the river tied to the influx of nutrients, than directly to salinity. Studies by Peebles et al. (1996, 2007) and Peebles (2002b) have demonstrated relationships between spatial distributions and abundance of A-Bay Anchovy and larval prey, such as copepod larval abundance, tied to salinities behind frontal zones of river-plumes in Tampa Bay.

The population number estimates for species life stages averaged across years (2007-2013) in the present study are lower than those estimated across years (1996-2013) during the first phase of this study (Rubec et al. 2019). Since the same FIM data were used to create seasonal HSMs for species life stages in both studies, the differences in population number estimates appear to be related to the habitat grids. The depth, bottom type and dissolved oxygen grids used were the same in both studies. Hence, the lower population estimates in the present study must be related to the seasonal temperature grids and seasonal salinity grids derived from data produced by the hydrodynamic model and used for the BL and MF analyses. The most likely explanation is that the higher population estimates are related to higher rainfalls prior to 2007, which influenced the seasonal salinity grids created for the previous study (Rubec et al. 2019). There were higher than average rainfalls in 1998, 2003 and 2004 (Flaherty and Guenther 2011).

Water managers have focused on ~~the~~ volume, area, and shoreline length of low salinity zones (< 2, < 5, <10 and <15 psu) ~~oligohaline segment (0.5-5 psu) of~~ in the lower Peace River as their MFL management target as the low salinity zones there are most sensitive to change (SWFWMD 2010, 2020). The present study found that seasonal salinity maps for BL in the Charlotte Harbor study area are very similar to those for MF (Rubec et al. 2018). Seasonal temperature maps are also very similar for the two scenarios. Despite seasonal water withdrawals associated with MF, the predicted seasonal salinity grids and seasonal temperature grids do not differ substantially between BL and MF. Since other environmental variables (depth, bottom type, dissolved oxygen) were kept constant, the similarities of salinity and temperature grids within each season largely explain why seasonal HSM maps associated with BL and MF are so similar within the Charlotte Harbor study area.

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In the present study, there is an effect of seasonal water withdrawals on total population numbers associated with MF in comparison to BL (**Table 8**). The differences in percent population numbers between BL and MF range between an increase of 7.8 % for EJ-Spot in fall to a decline of 21.0% for J-Sand Seatrout in summer. Declines in percent population numbers for JA-Hogchoker varied between 11.5% in fall and 19.0% in spring. J-Sand Seatrout and EJ-Kingfish losses were of similar magnitude to JA-Hogchoker—over 10% in three of four seasons. By percent, A-Bay Anchovy population number losses associated with MF appear low, although by sheer numbers, their losses were huge.

We have illustrated a spatial HSM approach to predict and compare changes in habitat areas and population numbers of selected species life stages of fish and crabs in the lower Peace River-Charlotte Harbor system under two water management scenarios, BL and the accepted MF. The approach was successful in quantifying small differences in habitats and and predicting resulting differences in seasonal population numbers for some species life stages that would not have been detectable otherwise. Habitat suitability models linked to GIS provide meaningful quantitative comparisons to assist water managers with their decisions and help to explain the impacts of water withdrawals on biological resources to policy makers and the interested public. Our study found there were small reductions in habitat areas and population numbers associated with MF in comparison to

BL across the study area, indicating the percent-of-flow approach for regulating daily freshwater withdrawals was effective at preventing unacceptable impacts to habitat areas for the life stages of key species that would result from spatial shifts of salinity distributions in the estuary.

The HSM-GIS approach, while providing population estimates and their change with changes in salinity patterns, does not account for species interactions including predation and other factors. For example in Apalachicola Bay, the impacts of minimum flows have been analyzed using ecosystem-based models and observed to have significant negative impacts on oyster populations due to high salinities associated with increasing oyster disease and predation (Livingston 1997). The HSM approach also does not evaluate the effects of changes in freshwater inflow on nutrient inputs and trophic interactions that can affect food webs and overall ecosystem productivity. Thus, using the HSM approach in isolation without other models, ecological considerations and habitat quality (e.g. contaminants) could result in erroneous conclusions and/or unintended consequences for particular species. Optimally, this HSM-GIS approach should be accompanied by trophic-based analyses and ecosystem modeling conducted in the Charlotte Harbor study area, with data derived from the cited short-term studies and possibly additional research. However, various constraints do not currently allow ecosystem modeling to be used to support the management of daily water withdrawals by SWFWMD, which require immediate attention.

Salinity and temperature are major factors affecting the distribution of fish species and communities in estuaries and the availability of FIM data in the study area allowed for the determination of HSM zones, ranging from Low to Optimum, for the life stages of various important species. When combined with salinity and temperature predictions output from a hydrodynamic model, the HSM-GIS approach allowed the assessment of spatial changes of species life stages and population numbers for the Charlotte Harbor estuarine system for different seasons across years (2007-2014). The effects of reductions of freshwater inflow for specific peak flow events or prolonged low flows can be also evaluated for any period within a year or across years for a selected duration of interest. Using these tools, potential impacts to fish habitats near and far from the location of the freshwater flow reductions and associated changes in populations numbers of species life stages can be evaluated, allowing resource managers to focus their attention on zones of the estuary that are most vulnerable to change, providing sensitive indicators so that adverse impacts to the resources of the estuary can be avoided.

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From:	Sid Flannery
To:	AOL CUSTOMER SERVICE(Security Tips)
Cc:	Yonas Ghile; Xinjian Chen; christi.santi@myfwc.com; joan.browder@noaa.gov; Philip.Stevens@MYFWC.com; Doug Leeper
Subject:	Re: FINAL DRAFT
Date:	Thursday, August 6, 2020 1:23:42 PM
Attachments:	Rubec Draft60 BL MF TEXT (8-06-20) Sid Edits.docx

[EXTERNAL SENDER] Use caution before opening.

Peter,

Attached are my suggested edits to the paper. They are relatively few. A couple of them are substantive, but the changes I am suggesting do not involve extensive wording changes and should be quick to implement if you choose. Whatever you do is fine with me.

The attached file is not in track changes, but instead the additions and strike-throughs are highlighted in yellow. Some background on the edits is below with the lines numbers listed being those in the attached draft. Please review these comments as they pertain to the rationale of my edits. Some minor edits highlighted in the paper are not described below, but would also be helpful

I copied Joan, Phil, Doug Leeper and the co-authors on this email.

<u>Comments on my edits</u>

Line 15 - The new first sentence in the abstract is inadequate and almost misleading as described in the paragraph below. The first sentence that was in the version submitted to the journal, which has been in subsequent drafts until early this week, is better because: (1) The agency name includes the word Florida, which is not used elsewhere in the abstract: (2) SWFWMD is mentioned repeatedly in the paper, but it doesn't hurt to give the agency a plug in the abstract as that the only part that some will read, but most importantly, (3) this paper is about inflows to an estuary - the original first sentence names the river and creek for which minimum flows are being established and also the Charlotte Harbor estuary. I realize these water bodies and Florida are still mentioned in the second sentence in the new version, but it is more effective in the first sentence as before.

The new first sentence mentions rivers and refers to state law. The legal aspects are not critical in the abstract, as this is not a legal paper and the relationship of minimum flows to Florida Statutes is described in the paper. Also, the term rivers is misleading as this paper primarily involves freshwater inflow to an estuary, of which the tidal rivers are a critical component. A few days ago, I suggested the new first sentence could be okay if it also included a phrase about "environmental flows," but that is covered in the paper and might be cluttered in the abstract. As described above, I think the original first sentence that names the river, creek, and the Charlotte Harbor estuary is a much better opening sentence and my edits have it reinserted.

Line 35 - The two sentence approach to closing the abstract in your most recent version is fine, but the word "output" is used in the previous sentence with regard to the hydrodynamic model. Possibly another term could be used to refer to the HSM modeling and mapping without being redundant. The two sentence version could be good if a replacement for output is used.

Alternately, the one sentence solution that was in the drafts until a few days ago works well, and my edits include that. As the comment in the margins says, if the one sentence approach is used, you could just say "inflow reductions" at the end of the sentence as the term "freshwater inflow" is used previously in the sentence.

Lines 116 to 127. In his comment #5, the Editor was clear that the sentence that says "Table 1 lists ......" was not appropriate style for the journal. I think honoring his suggestion could go a long way in getting this paper accepted. That could be accomplished by combining and consolidating the two paragraphs from Lines 116 to 127 into one paragraph, that somewhere refers to Table 1 in parentheses.

Line 131 - see comment in margin of paper. Kelly and Gore (2018) pertains to a much broader geographic scale, and references to seasonal rainfall patterns in the region of this study are listed in the next paragraph. Also, the sentence starring on Line 130 is a general statement about the response of salinity and temperature to freshwater inflow, it does not need a citation.

Lines 490- 494. Seems like this short paragraph about hogchokers in Shell Creek could simply be added to the paragraph below, and makes sense as Shell Creek is a sub-unit of the lower Peace River. It seems to flow better to describe hog chokers in the unimpounded river, then describe the findings in the impounded creek.

Line 659 - as described in the margin, use "a" instead of "any" as any is used several words prior referring to any period within a year, so a second use of any is redundant.

Good work Peter and good luck with submittal of the revised manuscript.

Sid

On Thu, Aug 6, 2020 at 5:46 AM AOL CUSTOMER SERVICE(Security Tips)

<peterrubec@cs.com> wrote:

Attached is the FINAL draft (60) that I plan to submit to the journal Marine and Coastal Fisheries. Please read it. If
you find anything that needs correction, please let me know today or tomorrow (at the latest). I plan to submit
the paper tomorrow.

Peter Rubec
Tel. 727-327-9226
Email: peterrubec@cs.com

From:	Sid Flannery
To:	Doug Leeper
Subject:	Fwd: PDF paper submitted
Date:	Sunday, August 9, 2020 10:12:05 AM
Attachments:	UMCF-2019-0072.R2_Proof_8-07-20.pdf

[EXTERNAL SENDER] Use caution before opening.

Doug,

See email below and attachment of paper that Peter Rubec submitted to the journal. I also helped him quite a bit on the reply to the editor, which is not attached.

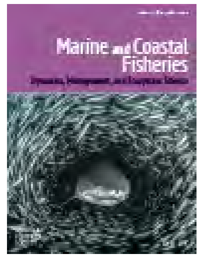
And yes, if it is not a bureaucratic/legal hassle, at some point (next year or two) extend the Middle Peace minimum flows down to the Horse Creek confluence - no further research would be needed. Possibly put in on a priority list for 2021 or 2022.

Sid

---------- Forwarded message ---------
From: **AOL CUSTOMER SERVICE(Security Tips)** <peterrubec@cs.com>
Date: Sun, Aug 9, 2020 at 9:28 AM
Subject: PDF paper submitted
To: yonas.ghile@swfwmd.state.fl.us <yonas.ghile@swfwmd.state.fl.us>, xinjian.chen@swfwmd.state.fl.us <xinjian.chen@swfwmd.state.fl.us>, Chrisiti.Santi@myfwc.com <Chrisiti.Santi@myfwc.com>, sidflannery22@gmail.com <sidflannery22@gmail.com>, Joan.Browder@myfwc.com <Joan.Browder@myfwc.com>, richard.flamm@mfywc.com <richard.flamm@mfywc.com>, Philip.Stevens@MYFWC.com <Philip.Stevens@myfwc.com>, robin.grunwald@myfwc.com <robin.grunwald@myfwc.com>, rene.baumstark@myfwc.com <rene.baumstark@myfwc.com>

I am attaching the proof of the paper submitted to Marine and Coastal Fisheries this Thursday.

Peter Rubec
Tel. 727-327-9226



Habitat Suitability Modeling and Mapping to Assess the Influence of Freshwater Withdrawals on Spatial Distributions and Population Numbers of Estuarine Species in the Lower Peace River and Charlotte Harbor, Florida

Journal:	*Marine and Coastal Fisheries*
Manuscript ID	UMCF-2019-0072.R2
Manuscript Type:	Article
Keywords:	spatial modeling, habitat suitability, mapping, water management, population estimation, hydrodynamic modeling, environmental flows

Habitat Suitability Modeling and Mapping to Assess the Influence of Freshwater Withdrawals on Spatial Distributions and Population Numbers of Estuarine Species in the Lower Peace River and Charlotte Harbor, Florida

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Abstract

The effects of potential reductions of freshwater inflow were evaluated for the lower Peace River and its largest tributary lower Shell Creek, which flow to the Charlotte Harbor estuary in southwest Florida. Habitat suitability modeling (HSM) and mapping of fish and invertebrate species life stages were used to seasonally predict changes in spatial distributions and population numbers associated with simulated freshwater withdrawals. Seasonal salinity grids and temperature grids derived from values predicted by hydrodynamic modeling (2007-2014) were similar between Baseline (i.e., flows not affected by water withdrawals) and Minimum Flows (flows associated with water withdrawals). Depth grids, bottom type grids, and seasonal dissolved oxygen grids were held constant between the two scenarios. Seasonal HSMs were applied to 28 fish and invertebrate species life stages with affinities for low or moderate salinity. Salinity was the most significant factor in seasonal models for species life stages. The seasonal HSM maps produced showed that spatial distributions were similar between Baseline and Minimum Flows for each species life stage. Most seasonal estimates of population numbers under Minimum Flows were less than the estimates for the Baseline condition, indicating some effect on population numbers associated with flow reductions. Reductions in population numbers under minimum flows ranged from 0.3% to 21% with 3 out of 28 seasonal comparisons exceeding 15% and 12 others between 5% and 15% loss. While other factors related to freshwater inflow can also influence species abundance and distribution, these results demonstrate how output from hydrodynamic modeling can be applied to HSM analyses and mapping to estimate spatial changes in habitat areas and population numbers for the life stages of selected fish and invertebrate species in relation to changes in salinity distributions, which can be used to identify areas of an estuary that are particularly susceptible to the effects of inflow reductions.

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The assessment and management of freshwater inflow to estuaries has received increased emphasis in recent decades to account for the important ways that freshwater inflow affects physical, chemical, and biological processes and the resources of estuaries, including relationships with the productivity of sport and commercial fisheries (Drinkwater and Frank 1994, Estevez 2002, Powell et al. 2002, Olsen et al. 2006, Gillson 2011, Adams 2014). Alber (2002) proposed a conceptual model to support management of freshwater inflows by establishing inflow standards that help protect resources and functions of estuaries. The management approach can be inflow-based (flow is kept within some prescribed bounds under the assumption that taking too much away is bad for biological resources), condition-based (inflow standards are set in order to maintain specified conditions in the estuary), or resource-based (inflow standards are set based on the requirements of specific resources). Each approach is carried out by regulating reductions or other alterations of freshwater inflow.

In 1972, the Florida Legislature directed the five Florida water management districts to establish minimum flows and levels (MFLs) for rivers and streams within their boundaries (Section 373.042, Florida Statutes). As currently defined by statute, "the minimum flow for a given watercourse shall be the limit at which further withdrawals would be significantly harmful to the water resources or the ecology of the area." The water management districts have taken different approaches to comply with the legislation (Alber 2002).

The Southwest Florida Water Management District (SWFWMD), due to its responsibility to permit the consumptive use of water and the legislative mandate to protect water resources from "significant harm," has established Minimum Flows for the free-flowing lower Peace River, which drains into Charlotte Harbor on the southwest coast of Florida (SWFWMD 2010). The District has been conducting a reevaluation of the Minimum Flows and developing new ones for the lower portion of Shell Creek, a tributary to the lower Peace River that enters the river 12 kilometers upstream of the river mouth. The Peace River and Shell Creek are both used for municipal water supplies. To evaluate Minimum Flows, historic freshwater withdrawals were added back into the flow records for each source and other hydrologic adjustments were made to create a Baseline flow record that reflects natural flow conditions. A variety of analytical approaches were then used to evaluate the effects of different daily flow reductions on salinity, water quality, and various biological parameters in the tidal reaches of the lower Peace River/Shell Creek to determine the total amount of water available for withdrawal without causing significant harm to environmental resources (SWFWMD 2020).

Fundamental to the approach for developing MFLs is the understanding that freshwater flow regimes which have largely natural patterns of variation are important for maintaining the ecological characteristics and productivity of riverine and estuarine systems (Browder 1991, Livingston 1997, Poff et al. 1997, Richter et al. 1997, Mattson 2002, Flannery et al. 2002, Gillson 2011). By simulating maximum allowable percentage daily withdrawals from the Baseline flow record of an unimpounded river, the evaluation of Minimum Flows for the Peace River could be considered a determination of environmental flows, the term that is now used to describe the timing, quality, and quantity of flows needed to sustain freshwater and estuarine ecosystems (Arthington 2012, Poff et al. 2017). However, the term minimum flows is used herein because it is established in Florida statutes and is the term given to the corresponding regulatory rules.

The locations of early life stages of fish and invertebrate species vary along the salinity gradient in the lower Peace River (Greenwood et al. 2004, Idelberger and Greenwood 2005, Greenwood 2007, Peebles et al. 2007, Call et al. 2013, Stevens et al. 2013). Greenwood et al. (2004) found that early life stages of 14 fish and invertebrate species had differing responses to freshwater inflow in the lower Peace River. None of these studies used geographic information systems (GIS) to map seasonal changes in spatial distributions of species life stages in the lower Peace River. While numerous agencies have Fisheries-Independent Monitoring (FIM) programs, most do not use the data collected to estimate population numbers for the species found in the estuaries they monitor.

A new approach for estimating population numbers in estuaries was developed for juvenile pink shrimp (*Farfantepenaeus duorarum*) in Tampa Bay (Rubec et al. 2016a). Habitat Suitability Modeling (HSM) used delta-type generalized additive models (GAMs) associated with *GAMLSS* software in R to create seasonal maps of species distributions and population abundance. Environmental data points were interpolated to create habitat grids. Gear-corrected (GC) catch-per-unit-effort (CPUEs) from fitted splines and graphs derived from the HSMs were assigned to corresponding cells in the habitat grids to create seasonal grids containing predicted GC-CPUEs for 87 species life stages. The seasonal grid cells were then averaged to create continuous GC-CPUE grids, which were partitioned into zones to create seasonal HSM maps for each species life stage. This provided a means to visualize the spatial distribution of mean GC-CPUEs by zones. Population number estimates were derived from the mean GC-CPUEs associated with the HSM zones. The approach was applied to the Charlotte Harbor system (Rubec et al. 2019).

The main goal of the present study was to assess the influence of changes in freshwater inflows on spatial distributions and population abundance of fish and invertebrate species in the lower Peace River and Charlotte Harbor. We used HSM with GIS to assess the effects of freshwater withdrawals on fish and invertebrate species life stages in the study area. The first step was to map seasonal temperature and salinity conditions associated with Baseline conditions (no water withdrawals) and with Minimum Flows (with water withdrawals). A second step was to estimate relative population numbers from seasonal HSM maps to determine the impacts of water withdrawals on early life stages of fish and invertebrate species (biological resources). The third step was to use the HSM maps to spatially elucidate species life history patterns and compare these findings with published literature. Since the abundance of species life stages change between seasons and across years, modeling and mapping methods were required to separate climatic effects from the effects associated with water withdrawals.

METHODS

Fisheries-Independent Monitoring

The main source of data for early life stages of fish species and blue crab has been FIM data collected in the Charlotte Harbor study area (**Figure 1**). FIM sampling has been conducted north of Pine Island within Charlotte Harbor, the lower Myakka River, and the Lower P segment of the lower Peace River and lower Shell Creek. Seasonal data extracted from the FIM database for 1996 to 2013 included catch numbers, effort, physicochemical data (for temperature, salinity, dissolved oxygen, and depth) along with the date, latitude/longitude and associated gear types. The Upper P segment in the lower Peace River, north of its confluence with Shell Creek, was not part of long-term FIM. For this segment, we used FIM data collected during two studies conducted from April 1997 to March 1998 and from July 2007 to June 2010 (Stevens et al. 2013).

Sampling gears used in the study area from 1996 to 2013 included a 21.3-m circular bag seine, a 21.3-m boat bag seine, a 183-m haul seine, and a 6.1-m otter trawl. A 61-m haul seine for sampling in the lower Peace River was added in 2007. As typical of FIM data, catches have a high percentage of zeros (no fish collected in samples**).** Gear corrections (GC) were used to standardize the CPUEs for different gear types (Robson 1966). This approach has been used with previous HSM studies in Florida estuaries (Rubec et al. 2001, 2006, 2016a, 2016b, 2019). Gears with lower mean CPUEs were standardized within the R program (*GAMLSS*) by the ratio of each gear's mean CPUE to the gear with the highest mean CPUE to create GC-CPUEs. Gear corrections were applied to seasonal datasets for all species life stages. Gear codes were used to illustrate what gear types were used in final HSMs (**Table 1**). The ordering of gear codes from high to low indicate the gear types (first one for each species life stage) used for gear type standardization. The high percentage zeroes necessitated the use of delta-gamma GAMs to deal with zero inflation. Sample numbers indicate that sample sizes were adequate for all gear type combinations.

A seasonal approach was taken because the life stages of the species of interest show peak abundances in the Charlotte Harbor system during different times of year (Greenwood et al. 2004, Idelberger and Greenwood 2005, Peebles et al. 2006). In addition, salinity and water temperature exhibit typical seasonal variations in response to regional climatic patterns including seasonal variations of rainfall and freshwater inflow. By applying the percent-of-flow approach (Flannery et al. 2002), the withdrawal of proportionately more freshwater inflow was simulated during seasons of the year when high flows were most common, suggesting that the wet seasons should be separately examined. On the other hand, the area and volume of salinity-based habitats are generally more susceptible to impacts from a given percent flow reduction during the dry times of the year (SWFWMD 2010, SWFWMD 2020). Major episodic flow events such as floods and droughts can greatly influence the distribution and abundance of fish and invertebrate species and community composition in estuaries (Livingston 1997, Whitfield 2005, Gillson 2011, Stevens et al. 2013). Given that this project allowed for the generation of a limited number of HSM maps, it was determined that average salinity and temperature conditions for each season would best be applied to represent typical changes in habitats between Baseline and Minimum Flows, with the evaluation of specific high or low flow events possible for future assessment.

Considering these factors, four three-month seasons were chosen to reflect seasonal changes in water temperature, salinity and rainfall conditions in the region (PBS&J 1999, Flannery et al. 2002). Water temperatures and freshwater inflows are greatest in the summer (July–September), which typically has the highest rainfall. The fall (October–December) has declining water temperatures and declining freshwater inflow, often followed by a minor increase in inflow during the winter (January–March) due to rains associated with cold fronts. However, from 2007 to 2014, the winters were unusually dry and had the lowest average inflow of the four seasons. The spring (April–June) has rising water temperatures and typically includes the lowest inflows, although inflows usually increase in mid-June as the rainy season begins.

Habitat Mapping

Bottom sediment types at FIM sampling locations were extracted from a National Oceanic and Atmospheric Administration (NOAA) fishing chart created in 1989. The NOAA map is based on mud/sand distributions determined using a plumb line dropped onto the bottom to assess the firmness of bottom sediments at stations across the estuary. When we initiated the present study in 2015, the NOAA sediment map was the best information available.

A bottom type grid/map was created with polygons coded for mud, sand and submerged aquatic vegetation (SAV). Bottom types for mud and sand were digitized as polygons from the NOAA fishing chart for Charlotte Harbor (Rubec et al. 2019). Seagrass coverages in Charlotte Harbor were derived from images obtained using aerial photography conducted every two years since 2002 (Photo Science and Kaufman 2013). Most of the imagery was collected during winter. The imagery for SAV showed little or no change in the spatial extent of SAV from 2002 to 2013. Based on good water clarity, we chose the 2012 coverage as being most representative of the spatial extent of SAV. A bottom type grid was created using ArcGIS (Esri 2014).

Bathymetry data derived from a sonar survey in 2012 by Wang (2013) were obtained from the District for the Charlotte Harbor study area. Additional data for Gasparilla Sound were obtained from NOAA for areas where data were not present in the SWFWMD dataset (Rubec et al. 2018). This included data obtained from hydrographic surveys conducted by NOAA in 1955 and 1956. The bathymetry data were merged into a single point feature class. Large backwaters and canals with no bathymetry data were removed. Some smaller backwaters were included. The bathymetry data points were interpolated in ArcGIS using Empirical Bayesian kriging (Krivoruchka 2012). The output raster grid for bathymetry was clipped to the water extent within the study area.

We extracted averaged surface and bottom dissolved oxygen data from the FIM database using the Statistical Analysis System (SAS Institute Inc). Point data collected from 1996 to 2013 at FIM sampling stations were interpolated in ArcGIS using Empirical Bayesian kriging associated with the Geostatistical Analyst 10.3 extension to create seasonal dissolved oxygen grids (Esri 2014). The seasonal dissolved oxygen grids were clipped to the same spatial extent as the bathymetry grid and bottom type grid, with each grid containing about 1.9 million total 15 x 15 m cells. Since the methods are fairly complicated a diagram is included outlining the methods (**Figure 2**).

Hydrodynamic Modeling Using Two Flow Scenarios

The effects of reductions in freshwater inflow to the estuary were evaluated for the years 2007 to 2014 using the percent-of-flow approach in which various percentage flow reductions were applied to daily flows in the baseline flow record (SWFWMD 2020). Based on other analyses that assessed changes in the volume, area and shoreline length of various salinity zones, a Minimum Flows scenario was created by SWFWMD in which daily flow reduction percentages were applied within three flow ranges for both the lower Peace River and lower Shell Creek, ranging from 13% of low flows to 40% of high flows. On the lower Peace River, a low flow cutoff was also employed that prohibits any withdrawals, which was in effect 26% of the days during the study period, while the 40% limit for high flows was applied to 22% of the days. Using this withdrawal schedule, the greatest differences in daily flows between the Baseline and Minimum Flows scenarios were during periodic high flow events that were most common in the summer wet season (**Figure 3**). Much smaller flow reductions, both in terms of differences in daily flows and percent daily flow reductions, occurred during most of the year. The District later added a total maximum withdrawal limit of 400 cfs between Baseline and Minimum Flows in the lower Peace River, which was not included nor simulated in our study.

To simulate the effects of these flow reductions on salinity distributions in tributary rivers, a dynamically coupled 3D-2DV model was developed by SWFWMD (Chen 2018). The UnLESS hydrodynamic model, which dynamically couples LAMFE and UnLESS3D, was applied to greater Charlotte Harbor (**Figure 4**) using 4790 grids in the horizontal plane and 17 layers in the vertical direction to discretize the 3D simulation domain, and 311 grids and 17 layers to discretize the 2DV simulation domain. The simulation domain for greater Charlotte Harbor included tidally influenced sections of the lower Peace River, lower Myakka River and lower Shell Creek, and the estuary extending southward past the mouth of the Caloosahatchee River and offshore about 20-30 km into the Gulf of Mexico. The tidally influenced sections included a 34.2 km section of the lower Peace River, a 38.6 km section of lower Myakka River, and a10 km section of lower Shell Creek.

While the greatest changes in salinity and temperature distributions were mostly within the tidal rivers, the area modeled using UnLESS included greater Charlotte Harbor to eliminate the effect of barriers from predictions for salinity and temperature patterns in the tidal portion of the rivers (Chen 2018). Salinity and temperature fields were simulated in greater Charlotte Harbor and its major tributaries from 2007 to 2014 for both the Baseline and Minimum Flows scenarios. UNLESS was used to predict temperature and salinity for each hour in a day (24) for 90 days within each season.

For the present study, seasonal files with 2160 predictions for temperature and salinity within the Charlotte Harbor study area (**Figure 1**) were obtained for each year from 2007 to 2014 for both Baseline and Minimum Flows (Rubec et al. 2018). Seasonal values for predicted salinity and temperature were averaged across years (2007-2014) for both scenarios. Then, the point data were interpolated using Empirical Bayesian kriging to create seasonal temperature grids and seasonal salinity grids with the same cell size and spatial extent as the bathymetry grid, bottom type grid and seasonal dissolved oxygen grids. For the spatial analyses, we held the bathymetry, bottom type, and seasonal dissolved oxygen grids constant between Baseline and Minimum Flows. Only the seasonal temperature grids and seasonal salinity grids changed between the two scenarios.

Estuarine Species Life Stages

Eight species life stages were selected based on the criterion that they exhibit preferences for low or moderate salinity and have been found to be abundant in the Charlotte Harbor study area. Six species life stages exhibited affinities for low salinity in a previous HSM study in Tampa Bay and Charlotte Harbor (Rubec et al. 2016b). These species were seasonally analyzed by early-juvenile (EJ), juvenile (J) and adult (A) life stages (**Table 2**). Hogchoker and blue crab were added because they have been found to exhibit affinities for low salinity (Flaherty and Guenther 2011, Stevens et al. 2013, Doering and Wan 2018). For these two species, juvenile and adult life stages were combined (JA) and analyzed together.

For the present study, estuarine residents refer to species life stages for Hogchoker (*Trinectes maculatus*), Sand Seatrout (*Cynoscion arenarius*), blue crab (*Callinectes sapidus*), Southern Kingfish (*Menticirrhus americanus*), and Bay Anchovy (*Anchoa mitchilli*) which are abundant in the Charlotte Harbor study area during most seasons of the year (Idelberger and Greenwood 2005; Stevens et al. 2013). Estuarine transients, such as Red Drum (*Sciaenops ocellatus*) and Spot (*Leiostomus xanthurus*) occupy nearshore waters of the Gulf of Mexico as adults, but are abundant in the lower portions of rivers as juveniles during discrete time periods corresponding with the species spawning cycles (Stevens et al. 2013).

Habitat Suitability Modeling

The physicochemical data at FIM sampling locations were used with HSM to relate CPUEs to environmental conditions. Seasonal delta-gamma GAMs were developed that relate GC-CPUEs to environmental data collected in Charlotte Harbor. We used the online R-based program *gamlss* (Rigby and Stasinopoulos 2005, Stasinopoulos and Rigby 2007) designed for datasets with a surplus of zero catch values (i.e., zero-inflated data) that was previously applied to FIM data from Tampa Bay (Rubec al. 2016a). Log-transformed cubic smoothing splines were fit to non-zero (+CPUE) data (MU) and logit transformed splines fit to probability of zero occurrence (P=0) data (NU) across environmental gradients for both Full and Reduced models. Then, the spline data were back-transformed and the two components multiplied (MU x NU) to derive seasonal GC-CPUE splines across gradients for water temperature, salinity, dissolved oxygen and depth. Histograms were created for categorical variables with mean GC-CPUEs by bottom type, gear type, and year. Predictions based on the combined MU and NU models account for uncertainty in predicted GC-CPUEs. The HSM analyses and mapping methods using FIM data have been described in more detail by Rubec et al. (2016a, 2016b, 2019).

First, a Full model (i.e., all predictor variables included) was fit using the penalized B-spline. Next, 31 Reduced models were developed comprised of various combinations of 1 to 5 environmental factors, each with a different Akaike information criterion (AIC). The model with the lowest AIC was chosen as the final Reduced model. Depending on selectivity for the size of the species life stage being analyzed, not all gear types were used for each HSM analysis (i.e., if a gear type did not catch any individuals of the species life stage being analyzed, that gear type was not included in the final analysis).

The delta-gamma GAMs developed using Reduced models are not spatial. A second part of the R program (*GAMLSS*) used GC-CPUEs derived from fitted cubic smoothing splines to assign GC-CPUEs to a dataset representing the centers of the cells associated with the habitat grids, according to latitude and longitude. Unique combinations of values for temperature, salinity, oxygen, depth and the three categorical variables were available for each grid cell. The GC-CPUEs associated with the cell coordinates were then averaged to create a dataset with mean GC-CPUEs. Seasonal mean GC-CPUE datasets for each species life stage were then imported into ArcGIS and continuous GC-GPUE grids created across the estuary (R code available from: GISLibrarian @MyFWC.com).

Zonal Grids Used to Create HSM Maps

Using the ArcGIS Spatial Analyst Slice tool, the continuous GC-CPUE grids were assigned to four habitat suitability zones by the Jenks natural breaks classification method (Jenks 1967). The natural breaks method associated with the Slice tool specifies "that the classes will be based on natural groupings inherent in the data". Break points are identified by choosing the class breaks that best group similar values and that maximize the differences between classes. This provided an objective means of partitioning continuous GC-CPUE grids into four zones for each species life stage for the Baseline scenario. HSM zones for Minimum Flows were created using the same natural breaks that were calculated for Baseline. Seasonal HSM maps were created from the zonal grids for each species life stage associated with Baseline and with Minimum Flows (Rubec et al. 2018). Each HSM map has four habitat suitability zones: Low, Moderate, High, and Optimum, representing predicted mean GC-CPUEs increasing across the HSM zones.

Validation Graphs

Gear standardized FIM data (observed GC-CPUEs), for species life stages within each season, were spatially joined to the zonal grid data using ArcGIS to create validation datasets. Each FIM data point was joined to the closest habitat point within 50 meters. We validated each model by overlaying mean observed data onto predicted HSM zones to create validation graphs for each season (Rubec et al. 2018). Increasing trends in mean observed GC-CPUE across HSM zones indicated spatial agreement between mean observed GC-CPUEs and mean predicted GC-CPUEs within HSM zones. Validation graphs with increasing mean observed GC-CPUEs across four zones, Low to Optimum, were scored as 1.0. When the mean observed GC-CPUEs exhibited increasing trends across three zones (Low to High), instead of across all four HSM zones, they were scored as 0.5.

Computation of Zonal Areas and Population Numbers

Tables were created for each species life stage respectively for Baseline and Minimum Flows that present mean GC-CPUEs (no/m^2) and zonal areas (m^2) for each seasonal HSM zone. The study area is comprised of 1,906,683 total 15 x 15 m cells with a total area of 429,003,675 m^2. Changes in percent zonal area (A) were calculated as relative difference between percent areas for Baseline and Minimum Flows: $(\%A_{baseline} - \%A_{minimum})/\%A_{baseline}$.

Zonal population number estimates by season for each species life stage were derived by multiplying mean GC-CPUEs (no/m^2) by the areas (m^2) associated with the HSM zones. Total population numbers in the study area were then estimated for each season by summing the zonal population estimates.

Confidence Intervals

The R program (*GAMLSS*) computed confidence intervals around Owens Plots, around fitted splines and associated with validation datasets allowing assessment of uncertainty in the GC-CPUE data. The population number estimates were not computed by the delta-gamma GAMs used with the HSM. They were derived from the GC-CPUEs from fitted splines applied to datasets containing the central coordinates of cells in the habitat grids. The averaged GC-CPUEs associated with the cell coordinates were imported into ArcGIS in order to produce continuous GC-CPUE grids. Then, the continuous GC-CPUE grids for each species life stage were partitioned to produce seasonal HSM maps. Due to the averaging, the estimated population numbers derived from continuous GC-CPUE grids do not have confidence intervals.

RESULTS

Habitat Maps

Seasonal maps illustrate spatial patterns in salinity and temperature in the Charlotte Harbor estuary (Figures 5 and 6). The maps were similar for both Baseline and Minimum Flows conditions. The percent changes within zones obtained by subtracting percent salinity for Minimum Flows from percent salinity for Baseline were mostly <1% for salinity ranges up to 20 psu and <4 % for higher salinity ranges up to 35 psu (**Table 3**). The percent changes within zones obtained by subtracting percent temperature for Minimum Flows from percent temperature for Baseline were <0.5 % for temperature ranges up to 30°C and <3 % for higher temperature ranges up to 34°C (Rubec et al. 2018**)**. While the salinity maps and the temperature maps respectively change between seasons; they appear almost identical between the two scenarios within each season.

Statistical Table of Reduced HSM

Final Reduced habitat suitability models have the lowest AICs and contain the best combinations of environmental variables (**Table 4**). Salinity is significant, based on high abundance (GC-CPUEs) at low salinity ranges, for species life stages during most seasons on both the MU and NU sides of the models. Temperature is significant for some seasonal species life stages. However, there is no seasonal preference for temperature with most species life stages. Depth, dissolved oxygen, mud, and SAV are less significant for most species life stages. But, these environmental variables are included in many of the final seasonal HSMs.

Fitted Splines and Histograms From HSM

Seasonal abundance from fitted splines (for continuous variables) and histograms (for categorical variables) illustrate marked preferences for salinity based on outputs from Full delta-gamma GAMs for all species life stages. In the Reduced models, salinity was significant for most resident species life stages (**Table 4**). For example, JA-Hogchoker during spring showed marked preferences for low salinities (0.5-5 psu) and temperatures >30°C (**Figure 7**). The broader fitted splines for dissolved oxygen and depth suggest these environmental factors may not be as significant for Hogchoker. This was confirmed with the statistical output during spring for the Reduced model. Plots of seasonal abundances showed that each of the species life history stages of interest exhibited strong affinities for salinity, the variable of greatest interest in comparing Minimum Flows to Baseline conditions (**Figure 8**).

JA-Hogchoker exhibited highest abundance at oligohaline salinity (0.5-5 psu) in the Upper P segment for all four seasons. J-Sand Seatrout and JA-blue crab were most abundant in the Upper P and Lower P segments. The abundance for J-Sand Seatrout peaked near 7 psu during four seasons. The abundance for JA-blue crab peaked at 10 psu in fall and winter, at 8 psu in spring and <5 psu in summer. The abundance for EJ-Southern Kingfish peaked at 15 psu in fall, and near 18 psu during winter, spring and summer. The abundance by salinity relationships for A-Bay Anchovy were similar during all four seasons with peaks for the fitted GC-CPUEs near 18 psu.

The Optimum zones derived from HSM analyses indicate that each species was most abundant at different salinity ranges proceeding downstream. The species order from low to higher salinities is JA-Hogchoker, J-Sand Seatrout, JA-blue crab, EJ-Kingfish, A-Bay Anchovy, EJ-Red Drum, EJ-Spot. The Optimum salinity ranges for each species life history stage when compared by season were similar for estuarine resident species, but as expected they differed for estuarine transient species as they progressed through their life history.

The estuarine transient species exhibit affinities for a broad range of moderate salinity as they first settle in the estuary, then they exhibit affinities for a narrow range of low salinity as early-juveniles, followed later by affinities for moderate salinity. For example, EJ-Red Drum abundance peaked near 18 psu in fall when they were first settling, and then <10 psu during winter and spring (**Figure 8**). There also were increasing relationships associated with the GC-CPUE by salinity splines during winter and spring at salinities >30 psu. The fitted GC-CPUE spline for EJ-Red Drum in summer indicates they were most abundant over a broad range of salinities <20 psu.

For EJ-Spot during winter, the GC-CPUE by salinity spline indicates they were most abundant at salinities ranging from 5 to 25 psu (**Figure 8**). In spring, the abundance by salinity spline decreases at salinities ranging from 0.5 to 20 psu, then increases at salinities >30 psu. In summer, the abundance by salinity spline for EJ-Spot declines at salinities ranging from 0.1 to 10 psu, then increases at salinities >20 psu. During fall, the abundance spline increases at salinities >30 psu.

HSM Maps

Seasonal HSM maps illustrate spatial use by species life stages. In most cases for resident species, predicted Optimum zones occurred in low or moderate salinity segments of the lower Peace River, lower Shell Creek and lower Myakka River, rather than in Charlotte Harbor. Seasonal Baseline and Minimum Flows HSM maps were created but only the Baseline maps are shown here because the Minimum Flows maps are so similar. The report submitted to SWFWMD containing all of the seasonal HSM maps is available as a supplement online (Rubec et al. 2018).

Most of the seasonal HSM maps for species life stages show an expansion of their spatial distributions in the lower Peace River during summer that is associated with higher freshwater inflows. In most cases, Optimum zones of abundance expanded to match the expansion of low and moderate salinity zones during the high-inflow summer months (**Figure 5**).

JA-Hogchoker

Seasonal HSM maps for JA-Hogchoker associated with Baseline show Optimum zones of abundance in the Upper P segment during all seasons **(Figure 9).** During fall, winter and spring dry seasons, the Optimum zones contract within the upper part of the Upper P segment. For both Baseline and Minimum Flows, the spatial extent of Optimum zones expanded within the Upper P segment during the summer (Rubec et al. 2018). Close examination reveals that the Optimum zone for Minimum Flows contracts slightly associated with water withdrawals during the summer.

J-Sand Seatrout

Seasonal HSM maps for J-Sand Seatrout are so similar between Baseline and Minimum Flows that it is difficult to visually discern whether there is any effect of water withdrawals. The HSM maps show J-Sand Seatrout occurring in both the Upper P and Lower P segments during fall. Small blue polygons representing the Optimum zone are present in Upper P during the winter. In spring, the Optimum zones expand indicating J-Sand Seatrout become very abundant throughout the Upper P and Lower P segments. During summer, the Optimum zone shrinks, while the northern part of Charlotte Harbor has High abundance (green polygon). However, there is also a small Optimum zone near the mouth of Charlotte Harbor during the summer.

JA-blue crab

The Optimum zone in the Baseline HSM map for JA-blue crab during winter is situated in the Upper P and Lower P segments of the lower Peace River and in the lower Myakka River (**Figure 10**). In spring, JA-blue crab are abundant in the rivers, but the Optimum zones diminish in area. In summer, the Optimum zone expands in the two rivers and into northern Charlotte Harbor. The Optimum zone contracts in the fall and is present in the Lower P segment.

EJ Southern Kingfish

The Optimum zones in Baseline and Minimum Flows HSM maps for EJ-Southern Kingfish indicate they were most abundant in the Lower P segment of the lower Peace River during all seasons. The Optimum zones expand in the river during winter with High abundance in the northern part of Charlotte Harbor. There is a contraction of the spatial extents of High and Optimum zones in the maps during spring for both scenarios. During summer, the Optimum and High zones expand, possibly in relation to higher freshwater inflows. In summer, the Optimum zone in the river for Minimum Flows is visibly smaller than the Optimum zone associated with Baseline.

A-Bay Anchovy

The seasonal Baseline HSM maps for A-Bay Anchovy (**Figure 11**) are very similar to the seasonal HSM maps associated with Minimum Flows (Rubec et al. 2018)**.** The Optimum zones for both scenarios expand during summer from the rivers into Charlotte Harbor in shallow water areas (<2 m) associated with increases in freshwater inflow.

EJ-Red Drum

Based on Optimum zones in Baseline and Minimum Flows HSM maps, EJ-Red Drum during the fall were most abundant over SAV in segments A and B **(Figure 1)** in Charlotte Harbor and in the Lower P segment of the lower Peace River (**Figure 12**). In winter, the Optimum zones shift upriver into the Upper P segment. But, EJ-Red Drum also were abundant in segment B near the mouth of the estuary. During spring, the Optimum zones shift downstream into Lower P and into the northern and central parts (segments A and B) of Charlotte Harbor in shallow water over SAV. In summer, the Optimum zones for Baseline and Minimum Flows indicate they were most abundant in Lower P. But, High zones (shown in green) in the HSM maps indicate they also were prevalent in deeper water of segment A in northern Charlotte Harbor. During summer, there no longer is an Optimum zone for EJ-Red Drum in segment B near the mouth of the estuary.

EJ-Spot

The Optimum zone in the Baseline HSM map for EJ-Spot in winter (**Figure 13**) indicates they were abundant in the lower Peace River and in shallow areas in the northern part of Charlotte Harbor. During spring, the Optimum zone situated in the Upper P segment may be due to an affinity by EJ-Spot for low salinity. Optimum zones for summer indicate some EJ-Spot still were present in Upper P at low salinities, with the rest of the population present in segment B near the mouth of the estuary where high salinities were found. In fall, small Optimum zones are located in segment B near the mouth of the estuary.

Validation

We validated the delineation of HSM zones for each species life stage by confirming that seasonal mean observed GC-CPUEs increased across four zones (**Table 5**). An example validation graph is presented for A-Bay Anchovy in summer for Minimum Flows (**Figure 14**). Consequently, most species life stages received a validation score of 1.0. For JA-Hogchoker, three out of four seasons have validation scores of 0.5 during spring, summer and fall for both Baseline and Minimum Flows. Lower mean observed GC-CPUEs for these seasons were associated with the Optimum zone in comparison to the High zone in the JA-Hogchoker validation graphs.

Zonal Areas and Population Numbers

Zonal areas and population number estimates were derived from seasonal HSM maps for A-Bay Anchovy during spring with both Baseline and Minimum Flows (**Table 6**). Total spring population numbers estimated for A-Bay Anchovy for Baseline is 2,098,463,644 and for Minimum Flows is 1,995,985,434. Similar computations were done to seasonally to derive zonal areas and population number estimates for other species life stages.

Seasonal population number estimates for species life stages are presented for each scenario (**Table 7**). Percentage changes between BL and MF indicate total population numbers declined between 0.3% and 21%. Although declines in total population numbers are <15% for most species, there are higher percent reductions for JA-Hogchoker in spring (19.0%), J-Sand Seatrout in spring (21.0%) and EJ-Southern Kingfish in summer (17.5%) (**Table 7**). Total population numbers for A-Bay Anchovy increased by 1.1% in summer and decreased during the other seasons. Total population numbers between Baseline and Minimum Flows for EJ-Spot decreased during winter (1.5%) and spring (1.7%) and increased by 4.8% in summer and by 7.8% in fall. Summer and fall were the seasons when EJ-Spot left the estuary and estimated population numbers were low.

In most cases, there are higher seasonal percent population numbers of fish/crabs in the Moderate and High zones than in the Optimum zones (**Table 8**). This is because the Moderate and High zones have larger zonal areas than the Optimum zones. Since population numbers were derived by multiplying mean GC-CPUEs (no/m^2) by zonal areas (m^2), it was possible to obtain higher estimates for percent population numbers for the Moderate and High zones, despite these zones having lower mean GC-CPUEs than those estimated for the Optimum zones.

DISCUSSION

This study, based on HSM analyses of FIM data, showed that the abundance by salinity relationships for resident species were similar across seasons for JA-Hogchoker, J-Sand Seatrout, JA-blue crab, EJ-Southern Kingfish and A-Bay Anchovy indicating that each species life stage has a preferred salinity range, which does not change much between seasons (**Figure 8**). This was previously verified by overlaying Optimum zones from HSM grids onto salinity grids and extracting the salinity ranges by season (Rubec et al. 2019).

Short-term studies in the lower Peace River of benthic macroinvertebrates, fish and nektonic invertebrate communities in relation to physical habitat, salinity and freshwater inflow were summarized by SWFWMD (2010). SWFWMD has also sponsored surveys to relate distributions and relative abundance of phytoplankton, zooplankton, larval fish and larval macroinvertebrate communities to salinity and water temperature changes associated with freshwater inflow and other habitat variables in the lower Peace River and lower Shell Creek (Peebles 2002a, Vargo et al. 2004, Atkins North America 2014, Janicki Environmental 2015). Regression analyses indicated that larval stages of 20 fish and invertebrate species displayed different responses to changes in freshwater inflow in the lower Peace River (Greenwood et al. 2004, Peebles and Burghart 2013). Estuarine studies of responses to changes in freshwater inflows have been done in other regions of Florida (Livingston 1997, Browder and Moore 1981, Sklar and Browder 1998, Doering and Wan 2018), in other states such as Texas (Longley 1994, Powell et al. 2002), California (Kimmerer et al. 2009, Weber-Stover et al. 2016), Georgia (Alber and Flory 2002), and in other countries (Drinkwater and Frank 1994, Estevez 2002, Gillson 2011, Adams 2014). The studies cited used a variety of methods for different purposes, which prevent comparisons between them. What separates the present study is the population number estimates derived from seasonal temperature and salinity grids predicted from hydrodynamic modeling of freshwater inflows by the District (Chen 2018).

The Peace River is not impounded and is free-flowing along its length, while Shell Creek is impounded by a low head structure located 10 kilometers upstream of its confluence with the Peace. However, water is infrequently taken from storage in this small impoundment, so freshwater flows to lower Shell Creek largely follow the normal seasonal pattern for southwest Florida. Also, corrections to the flow records for both systems were made for existing withdrawals and other anthropogenic impacts to flow, so the Baseline flow record examined in this study and the corresponding salinity distributions predicted from the hydrodynamic model reflect natural seasonal variations in the region. This allowed for the HSM-GIS assessment of changes in fish habitat and species population abundance due to freshwater withdrawals that are representative of four seasons in southwest Florida, with the caveat that freshwater inflows during the winter were unusually low due to dry climatic conditions during the study period.

Peebles and Greenwood (2009) used spatial abundance quantiles to demonstrate impingement of EJ-Hogchoker <31 mm SL on Shell Creek's estuarine dam associated with a reduction of 3-day mean freshwater inflow and the loss of low salinity habitat. JA-Hogchoker caught in seines also showed evidence of crowding below the dam. The loss of low salinity habitat (0.5-5 psu) was detrimental for EJ-Hogchoker and JA-Hogchoker.

Stevens et al. (2013) compared the abundance of Hogchoker (and other species not discussed here) within an oligohaline stretch in the lower Peace River during periods of varying freshwater inflow (wet and dry periods). The study used FIM data collected with a 21.3-m circular seine during a wet period (April 1997-May 1999) and a dry period (July 2007-April 2010). Mean salinity in the oligohaline zone (<5 psu) during the wet period (1.7 psu) was less than that of the dry period (4.6 psu). Hogchoker had a significantly higher mean CPUE (37/100 m^2) during the wet period than during the dry period (10/100 m^2) in the oligohaline zone. But, the spatial extent of the oligohaline zone was not determined from measurements of salinity. Its location was inferred based on shoreline vegetation usually associated with low salinity. The authors speculate that the drop in the mean CPUE of Hogchoker during the dry period could have occurred because: a) Hogchoker moved upstream to remain within the oligohaline zone as the isohaline shifted upstream (outside of the zone being monitored by FIM), or b) Production of Hogchoker decreased as a result of higher salinities in what was believed to be the oligohaline zone.

In the present study, reduced freshwater inflows due to water withdrawals from the lower Peace River and Shell Creek appear to be detrimental for JA-Hogchoker due to reduced areas of low salinity habitats (0.5-5 psu). While the seasonal validation scores for most species life stages were 1.0, the scores for JA-Hogchoker during spring, summer and fall were 0.5 for both Baseline and Minimum Flows (**Table 5**). Insufficient FIM samples in the Upper P segment, associated with the special studies, may account for mean observed GC-CPUEs within Optimum zones being lower than in the High zones. It may also be because the predicted Optimum zones in HSM maps for Baseline and Minimum Flows in the Charlotte Harbor study area have smaller areas than the Optimum zones predicted from the analyses of FIM data (Rubec et al. 2019). In that study, the validation scores for JA-Hogchoker were 1.0 for all four seasons.

J-Sand Seatrout were abundant in the lower Peace and lower Myakka Rivers during spring and less abundant in Charlotte Harbor during summer, fall and winter (Rubec et al. 2018). The summer HSM maps have a small Optimum zone near the mouth of the estuary, which might indicate that they move out of Charlotte Harbor in summer and later spawn in the Gulf of Mexico (Cowan and Shaw 1988). Another possibility is that J-Sand Seatrout grow to adult size in Charlotte Harbor during the summer and fall, and adults spawn in the lower part of the estuary in the following spring (Knapp and Purtlebaugh 2008). Sand Seatrout sought a reduced salinity range when they reached a length of 30–70 mm SL and then moved to higher salinities as they grew toward 100 mm SL (Purtlebaugh and Rogers 2007). Peebles (2002a) found post-flexion larvae and J-Sand Seatrout in the lower Peace River and Shell Creek during spring. Some spawning evidently took place there; but most post larvae and juveniles were believed to originate from higher salinity areas within Charlotte Harbor.

Optimum zones for JA-blue crab during all seasons were in the tidal portions of the Peace and Myakka Rivers (**Figure 10**). Literature reviewed by Gandy et al. (2011) indicates that immature females seek low salinity areas in estuaries (<15 psu) where they subsequently mate with mature males. When mating occurs in the spring and summer, the interval between mating and egg extrusion is about two months. When mating occurs in the fall and winter, spawning occurs during the following spring. Freshwater inflows were highest in the summer and lowest in the winter; so it is interesting that JA-blue crab in our study were most abundant in expanded Optimum zones during those seasons. The expansion of the Optimum and High zones in the lower Peace River during winter and summer appears to be partly related to peaks in recruitment of juvenile blue crab during winter and summer.

In their analysis of inter-annual trends in abundance of blue crab, Flaherty and Guenther (2011) found that immature and adult blue crab indices of abundance and commercial landings were high in Tampa Bay in 1998 in association with increased rainfall during the 1997-1998 El Niño. This was followed by a reduction in the abundance of immature blue crabs in 2002 corresponding to lower-than-average river inflows from late 1998 through to the beginning of 2002. They noted that reduced rainfall and freshwater diversions had the potential to adversely affect recruitment and survival of young crabs in the estuary. From 2003 to 2004, there was a dramatic increase in blue crab recruitment and a steady rise in adult abundance and commercial landings in Tampa Bay that appears to be linked to increases in freshwater inflows above historic means.

The distribution of EJ-Southern Kingfish in the lower Peace and Myakka Rivers during all seasons (Rubec et al. 2018) and in the northern part of Charlotte Harbor during winter and summer suggests expanded geographic ranges in Optimum and High zones during winter and summer that may be related to spawning during fall and spring in the estuary. A marked contraction of the Optimum zone is apparent for Minimum Flows in comparison with the Optimum zone for Baseline, associated with water withdrawals during the summer.

Optimum zones for A-Bay Anchovy show their prevalence in the lower Peace River during all seasons (**Figure 11**). Their Optimum zones expanded into northern Charlotte Harbor in summer for both Baseline and Minimum Flows and were apparently related to the expansion of low to moderate salinity zones associated with increased freshwater inflows (**Figure 5**). A-Bay Anchovy was the most populous species life stage with their population numbers estimated to be five to six orders of magnitude greater than those of the other species life stages represented in the study (**Table 7**). Similar seasonal HSM maps and population number estimates for J-Bay Anchovy were produced for both flow scenarios (Rubec et al. 2018) that are not presented in this paper.

These estimates look reasonable for a species known to aggregate in great numbers. Bay Anchovy filter plankton from the water through their gills. Hence, one can assume that their population numbers in the lower Peace River are related more to the flow-related abundance of plankton in the river tied to the influx of nutrients, than directly to salinity. Studies by Peebles et al. (1996, 2007) and Peebles (2002b) have demonstrated relationships between spatial distributions and abundance of A-Bay Anchovy and larval prey, such as copepod larval abundance, tied to salinities behind frontal zones of river plumes in Tampa Bay.

In a community-based study of the Charlotte Harbor system, the frequency of occurrence of age 0 Red Drum (15-100 mm SL) was highest during the fall in the lower Peace River and lower Myakka River, when this size range recruits to the estuary (Whaley et al. 2007). In Tampa Bay, two size classes of age 0 Red Drum (15-50 mm SL and 51-100 mm SL) were most abundant in the fall and winter respectively within the lower portions of three rivers adjacent to the bay, which collectively comprised only 2% of the study area but contained between 40 and 96 % of the annual populations (Whaley et al. 2016). Freshwater inflows were positively related to spatial distributions and population abundance in the rivers, suggesting that reductions in inflow can reduce both habitat areas and population numbers. Due to their spatial distributions in the rivers, age 0 Red Drum appear to be particularly vulnerable to modification of the riverine environment.

Peters and McMichael (1987) tracked the monthly growth of EJ-Red Drum present in backwater areas and rivers adjoining Tampa Bay. Length frequencies indicate they were <100 mm SL in September 1982 and they grew to lengths ranging from 200 to 300 mm SL by September 1983. With the present study in Charlotte Harbor, fitted splines indicate EJ-Red Drum (10-100 mm SL) were most abundant at salinities ranging from 10-20 psu in the fall and at salinities <10 psu during winter and spring (**Figure 8**). Based on Optimum zones in HSM maps for Baseline and Minimum Flows, EJ-Red Drum recruited during the fall were most abundant over SAV in northern Charlotte Harbor and in the Lower P segment of the lower Peace River (**Figure 12**). In winter, they moved upstream to the Upper P segment. During spring, they moved downstream into the Lower P segment and into segment A in northern Charlotte Harbor. In summer, the Optimum zones show they were most abundant in the Lower P segment. But, the High zones for summer indicate they also were prevalent in deeper water within segment A. The Optimum zones indicate that larger EJ-Red Drum (101-299 mm SL), probably recruited a year earlier, were present near the mouth of the estuary during fall, winter, and spring. Their absence near the mouth of Charlotte Harbor during the summer may be because they grew beyond this size range to become J-Red Drum

Seasonal HSM maps in our study in Charlotte Harbor show that EJ-Spot were abundant in the lower Peace River during winter and spring (**Figure 13)**.The fitted abundance splines by salinity and Optimum zones in the HSM maps indicate that most EJ-Spot left Charlotte Harbor in summer and fall starting at an age of about 6 months. The movement out of Charlotte Harbor starting in summer was unexpected; since peaks in larval abundance in the Gulf of Mexico suggest that Spot leave Louisiana estuaries to spawn in the Gulf of Mexico during fall and winter (Cowan and Shaw 1988).

The Optimum zones in seasonal HSM maps for the resident species life stages indicate they had high abundances within salinity ranges found in the lower Peace River. This could be due to habitat affinities for low or moderate salinities. However, it does not explain why the estuarine transients (EJ-Red Drum, EJ-Spot) were most abundant in the Upper P segment of the river during winter and spring respectively. It seems likely that freshwater inflows to the river introduce nutrients that enhance production of phytoplankton, zooplankton and larval fish that are exploited by early life stages of estuarine fish and invertebrates (Flannery et al. 2002, Peebles 2002a, 2002b, 2005). The relationships between species abundance and low or moderate salinities may be indicative of food availability created by nutrients and organic materials entering the lower Peace River associated with freshwater inflows from upstream (Rubec et al. 2019).

The population number estimates for species life stages averaged across years (2007-2014) in the present study are lower than those estimated across years (1996-2013) during the first phase of this study (Rubec et al. 2019). Since the same FIM data were used to create seasonal HSMs for species life stages in both studies, the differences in population number estimates appear to be related to the habitat grids. The depth, bottom type and dissolved oxygen grids used were the same in both studies. Hence, the lower population estimates in the present study must be related to the seasonal temperature grids and seasonal salinity grids derived from data produced by the hydrodynamic model and used for the Baseline and Minimum Flows analyses. The most likely explanation is that the higher population estimates are related to generally higher rainfalls prior to 2007, which influenced the seasonal salinity grids created for the previous study (Rubec et al. 2019). Data derived from the SWFWMD database indicate yearly rainfall totals in the Peace River watershed were higher than average during 1997, 1998, 2002, 2004 and 2005, while there were no years with above average rainfall between 2007 and 2014. The combined average flow for the Peace River and Shell Creek for 1996 –2013 was 1,576 cfs, while the average flow for 2007-2014 was considerably less at 1,106 cfs.

Water managers have focused on volume, area, and shoreline length of low salinity zones (< 2, < 5, <10 and <15 psu) in the lower Peace River as their MFL management target as the low salinity zones there are most sensitive to change (SWFWMD 2020). The present study found that seasonal salinity maps for Baseline in the Charlotte Harbor study area are very similar to those for Minimum Flows (Rubec et al. 2018). Seasonal temperature maps are also very similar for the two scenarios. Despite seasonal water withdrawals associated with Minimum Flows, the predicted seasonal salinity grids and seasonal temperature grids do not differ substantially between the flow scenarios. Since other environmental variables (depth, bottom type, dissolved oxygen) were kept constant, the similarities of salinity and temperature grids within each season largely explain why seasonal HSM maps associated with Baseline and Minimum Flows are so similar within the Charlotte Harbor study area.

In the present study, there is an effect of seasonal water withdrawals on total population numbers associated with Minimum Flows in comparison to Baseline (**Table 7**). The differences in percent population numbers for the two flow scenarios range between an increase of 7.8 % for EJ-Spot in fall to a decline of 21.0% for J-Sand Seatrout in summer. Declines in percent population numbers for JA-Hogchoker varied between 11.5% in fall and 19.0% in spring. J-Sand Seatrout and EJ-Kingfish losses were of similar magnitude to JA-Hogchoker—over 10% in three of four seasons. By percent, A-Bay Anchovy population number losses associated with Minimum Flows appear low, although by sheer numbers, their losses were huge.

Habitat suitability models linked to GIS provide meaningful quantitative comparisons to assist water managers with their decisions and help to explain the impacts of water withdrawals to policy makers and the interested public. We have illustrated a spatial HSM approach to predict and compare habitats and population numbers of selected species life stages of fish and crabs in the lower Peace River-Charlotte Harbor system under two water management scenarios, Baseline and Minimum Flows. The approach was successful in quantifying small differences in seasonal salinity and temperature patterns (habitat areas) used to predict seasonal population numbers (biological resources) for species life stages that would not have been detectable otherwise. There were small reductions in habitat areas and population numbers associated with Minimum Flows in comparison to Baseline across the study area, indicating the percent-of-flow approach for regulating daily freshwater withdrawals was effective at preventing unacceptable impacts on habitat areas for the life stages of key species that would result from spatial shifts of salinity distributions in the estuary.

The HSM-GIS approach, while providing estimates of habitat areas and population numbers associated with changes in water temperature and salinity distributions, does not account for other important mechanisms by which freshwater inflow can influence the abundance and distribution of fish and invertebrate populations in estuaries. Freshwater inflow delivers terrestrially derived organic matter and nutrients and variations in the timing and volume of inflow can have pronounced effects on water quality, light penetration, primary production, trophic organization and food webs in estuarine and coastal systems (Livingston et al. 1997, Darnaude 2005, Wissel and Fry 2005, Gillson 2011, Kim et al. 2014). Thus, using the HSM-GIS approach in isolation without other analyses or modeling could result in erroneous conclusions and/or unintended consequences for particular species. Optimally, the HSM-GIS approach should be accompanied by other assessments or modeling of the effects of freshwater inflow reductions on the physicochemical characteristics, trophic dynamics, and species interactions in an estuarine system.

Within a broader research and management strategy, the HSM-GIS approach allows for the evaluation of how changes in salinity and temperature can affect the distribution and abundance of life stages of key species in an estuary. The availability of FIM data for Charlotte Harbor and its primary tributaries allowed for the determination of HSM zones, ranging from Low to Optimum, for the life stages of species known to be responsive to changes in freshwater inflow. When combined with salinity and temperature predictions output from a hydrodynamic model, the HSM-GIS approach allowed the seasonal assessment of spatial changes of species life stages and population numbers for the Charlotte Harbor estuarine system across years (2007-2014). Using predictions from hydrodynamic modeling, the effects of reductions in freshwater inflow for specific peak flow events or prolonged low flows can be evaluated for any period within a year or across years for a selected duration of interest. Using these tools, potential impacts to fish habitats near and far from the location of the freshwater flow reductions and associated changes in population numbers of species life stages can be evaluated, allowing resource managers to focus their attention on zones of the estuary that are most vulnerable to change, providing sensitive indicators so that adverse impacts to the resources of the estuary can be avoided.

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TABLE 1.Summary of FIM samples used with final HSM analyses listing species life stages by season, gear types included, total number of samples and percent zero CPUEs included in each seasonal dataset. Gears: 20=21.3-m circular bag seine, 23=21.3-m boat bag seine, 160=183-m haul seine, 180=61-m haul seine, 300=6.1-m otter trawl.

Life Stage by Species	Season	Gears Ordered High to Low mean CPUEs	Number of Samples	Percent Zeros
Juvenile + Adult	Fall	23,300,180,20,160	3008	75.3
Hogchoker	Summer	23,300,180,20,160	3105	71.7
	Spring	23,300,180,20,160	3116	79.5
	Winter	23,300,180	1746	71.9
Juvenile	Fall	23,300,20	2370	82.8
Sand Seatrout	Summer	300,23,20	2446	74.9
	Spring	300,23,20	1754	87.5
	Winter	300,23,20,160	2751	96.1
Juvenile + Adult	Fall	23,20,300,180,160	3008	67.1
blue crab	Summer	23,300,20,160	3020	75.5
	Spring	23,300,20,180,160	3116	72.8
	Winter	23,20,300,180,160	2832	63.3
Early-Juvenile	Fall	23,300,20	2370	83.5
Southern Kingfish	Summer	23,300,20,160	3020	88.2
	Spring	23,20,300	2505	83.2
	Winter	300,23,20	2271	92.6
Adult	Fall	23,20,300	2370	63.8
Bay Anchovy	Summer	20,23,300	2446	70.1
	Spring	23,20,300	2505	62.7
	Winter	23,20,300	2271	67.5
Early-Juvenile	Fall	23,20,180,160	2021	72.4
Red Drum	Summer	23,20,180,160,300	3105	94.3
	Spring	180,23,160	1500	87.4
	Winter	23,180,160,300	2226	84.1
Early-Juvenile	Fall	160,300,23	2368	98.6
Spot	Summer	23,300,160	2414	93.7
	Spring	23,180,300,20,160	3116	88.3
	Winter	23,20,180,300,160	2832	84.6

TABLE 2. Size ranges for species life stages: A= adult, J=juvenile, EJ= early juvenile, JA=juvenile+adult. Size ranges are by standard length (mm) for fish species and by carapace width (mm) for blue crab.

Species Life Stage	Size Range
JA-Hogchoker	30-100
J-Sand Seatrout	10-149
JA-blue crab	10-150
EJ-Southern Kingfish	10-119
A-Bay Anchovy	30-60
EJ-Red Drum	10-299
EJ-Spot	10-149

TABLE 3. Seasonal changes in percent of total area by salinity ranges between grids for Baseline (BL) and Minimum Flows (MF). Percent change decreasing (black font), increasing (red font).

Season	Fall			Winter		
Salinity Range (psu)	Percent BL	Percent MF	Percent Change	Percent BL	Percent MF	Percent Change
0.01-5	2.7	2.5	0.2	1.1	0.9	0.2
5.01-10	1.9	1.8	0.1	1.4	1.6	0.2
10.01-15	2.4	2.3	0.1	1.6	1.5	0.1
15.01-20	5.2	4.1	1.1	2.6	2.4	0.2
20.01-25	20.7	17.4	3.3	7.2	6.2	1.0
25.01-30	44.5	47.0	2.5	40.2	38.5	1.7
30.01-35	22.6	25.1	2.5	45.9	48.9	3.0

Season	Spring			Summer		
Salinity Range (psu)	Percent BL	Percent MF	Percent Change	Percent BL	Percent MF	Percent Change
0.01-5	0.7	0.6	0.1	5.2	4.6	0.6
5.01-10	2.0	1.9	0.1	2.6	2.1	0.5
10.01-15	1.7	1.7	0.0	3.8	3.2	0.6
15.01-20	2.6	2.4	0.2	10.6	7.8	2.8
20.01-25	7.0	5.8	1.2	31.6	28.9	2.7
25.01-30	38.9	37.3	1.6	34.5	38.0	3.5
30.01-35	47.1	50.4	3.3	11.7	15.4	3.7

TABLE 4. Statistical significance of factors determined from delta-gamma GAMs for species life stages in the lower Peace River and Charlotte Harbor. P≤0.0001=***, P≤0.001=**, P≤0.05=*, P>0.05 and P≤0.10=ns (non-significant), blank spaces=factors not in models. Environmental factors: S=salinity, T=temperature, O=dissolved oxygen, D=depth, Mud=mud, SAV=submerged aquatic vegetation, Season: FL=fall, SM=summer, SP=spring, WN=winter. MU=part of model with + GC-CPUEs, NU=part of model with zero frequency of occurrence.

	J-Bay Anchovy				A-Bay Anchovy				JA-blue crab				JA-Hoghoker			
	FL	SM	SP	WN	FL	SM	SP	WN	FL	SM	SP	WN	FL	SM	SP	WN
MU																
S	**	***	**		**	***	**		*	***	***	***	***	***	***	***
T									***	**	**			***	**	*
O	***				***			ns		ns		**	***	***	*	*
D		*	*			*	*		**				ns			
Mud		*				*			***			**		***	*	
SAV	*		***		*		***				*			ns		
NU																
S	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
T	***	*			***	*		***	***						***	
O		***		**		***										**
D			***				***		***	*	*	***				
Mud	*		ns		*		ns				***	**	ns		***	***
SAV													***	***		

	EJ-Red Drum				EJ-Kingfish				EJ-Spot				J-Sand Seatrout			
	FL	SM	SP	WN	FL	SM	SP	WN	FL	SM	SP	WN	FL	SM	SP	WN
MU																
S	*				*	***	***	**	***	*	**		***	***		***
T	*		*								***		**			
O		ns			ns				***	*						
D	*							**	***			**	***	***		***
Mud		*										**				**
SAV	ns	***	ns						***	**	*					
NU																
S		**		***	***		***	***	*	*			***	***	***	***
T							***		**	ns	***	***	**	*	***	*
O			ns	ns							*					
D	***		***	ns									ns			**
Mud		ns			**	*	*	***			ns		***		***	*
SAV	*	ns		ns		ns	**	*		ns				ns		

TABLE 5. Seasonal validation scores for mean GC-CPUEs versus HSM zones associated with Baseline (BL) and Minimum Flows (MF). Increasing across four zones=1, increasing across three zones=0.05.

Season	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer
Flow Condition	BL	BL	BL	BL	MF	MF	MF	MF
Species Life Stage								
JA-Hogchoker	0.5	1	0.5	0.5	0.5	1	0.5	0.5
J-Sand Seatrout	1	0.5	1	1	1	0.5	1	1
JA-blue crab	1	1	1	1	1	1	1	1
EJ-Southern Kingfish	1	1	1	1	1	1	1	1
A-Bay Anchovy	1	1	1	1	1	1	1	1
EJ-Red Drum	1	1	1	1	1	1	1	1
EJ-Spot	1	1	1	1	1	1	1	1

TABLE 6. Example for Adult Bay Anchovy in spring showing how zonal areas and population numbers were estimated for each HSM zone for Baseline and for Minimum Flows respectively.

Baseline HSM Zone	Mean GC-CPUE no/sq m	Number of Cells	Zonal Area sq m	Percent Of Total Area	Population Number
Low	0.20858391	1290759	290420775	67.70	60577100
Moderate	8.78987151	306395	68938875	16.07	605963854
High	16.70502530	182731	41114475	9.58	686818345
Optimum	26.11693299	126798	28529550	6.65	745104346
TOTAL		1906683	429003675	100.00	2098463644
Minimum Flows HSM Zone	**Mean GC-CPUE no/sq m**	**Number of Cells**	**Zonal Area sq m**	**Percent Of Total Area**	**Population Number**
Low	0.19516414	1316360	296181000	69.04	57803911
Moderate	8.77852331	295483	66483675	15.50	583628491
High	16.70134253	173896	39126600	9.12	653466749
Optimum	25.76348587	120944	27212400	6.34	701086283
TOTAL		1906683	429003675	100.00	1995985434

TABLE 7. Changes in total population numbers estimated between Baseline and Minimum Flows in lower Peace River/Shell Creek and Charlotte Harbor. Percent changes in population numbers between Baseline and Minimum Flows: decreasing (black font), increasing (red font).

Species Life Stage	Season	Population Number Baseline	Population Number Minimum Flows	Percent Change Population Number
JA-Hogchoker	Fall	701,377	620,900	11.5
	Winter	553,351	482,250	12.9
	Spring	126,269	102,233	19.0
	Summer	124,983	109,281	12.6
J-Sand Seatrout	Fall	983,889	863,283	12.3
	Winter	16,827	14,446	14.2
	Spring	2,999,378	2,369,853	21.0
	Summer	4,257,044	4,388,843	3.1
JA-blue crab	Fall	337,046	315,665	6.3
	Winter	5,577,933	5,338,615	4.3
	Spring	204,920	189,248	7.7
	Summer	93,881	89,385	4.8
EJ-Southern Kingfish	Fall	480,831	414,399	13.8
	Winter	289,190	267,599	7.5
	Spring	289,894	255,701	11.8
	Summer	177,108	146,191	17.5
A-Bay Anchovy	Fall	409,669,579	386,497,346	5.7
	Winter	1,114,145,755	1,069,235,403	4.0
	Spring	2,098,463,644	1,995,985,434	4.9
	Summer	275,313,382	278,372,737	1.1
EJ-Red Drum	Fall	12,599,998	12,357,379	1.9
	Winter	2,771,344	2,762,907	0.3
	Spring	363,119	363,129	0.0
	Summer	265,019	250,736	5.4
EJ-Spot	Fall	6,153	6,635	7.8
	Winter	107,931	106,339	1.5
	Spring	783,736	770,237	1.7
	Summer	58,781	61,605	4.8

TABLE 8. Seasonal percent of population numbers by HSM zones for species life stages in the lower Peace River/Shell Creek and Charlotte Harbor for Baseline (BL) and for Minimum Flows (MF).

	Season	Fall	Fall	Winter	Winter	Spring	Spring	Summer	Summer
Species Life Stage	HSM Zone	%BL	%MF	%BL	%MF	%BL	%MF	%BL	%,MF
JA-Hogchoker	Low	0.3	0.3	9.2	11.0	0.0	0.0	0.0	0.0
	Moderate	37.4	39.9	48.4	51.1	43.4	45.6	30.4	29.2
	High	44.9	41.4	27.3	25.1	36.5	36.3	30.6	29.1
	Optimum	17.4	18.3	15.1	12.9	20.1	18.0	39.0	41.7
J-Sand Seatrout	Low	2.8	3.4	7.0	7.6	0.2	0.2	10.5	14.5
	Moderate	57.6	53.7	51.5	48.1	25.7	27.3	37.9	41.7
	High	26.9	28.8	28.3	30.4	35.8	32.3	43.8	35.8
	Optimum	12.8	14.1	13.2	13.9	38.4	40.3	7.8	8.0
JA-blue crab	Low	0.0	0.0	16.4	17.3	0.0	0.0	27.5	30.0
	Moderate	30.9	33.3	26.7	27.2	28.2	26.6	26.7	27.1
	High	48.8	46.6	26.8	25.9	42.8	45.4	24.7	24.1
	Optimum	20.4	20.1	30.3	29.6	29.0	28.0	21.1	18.8
EJ-Southern	Low	0.00	0.00	3.2	3.6	0.0	0.0	19.0	23.8
Kingfish	Moderate	28.9	29.7	33.1	35.6	37.7	39.3	28.5	29.8
	High	52.2	52.3	40.0	39.9	51.1	52.2	33.4	29.9
	Optimum	18.9	18.0	23.7	20.9	11.3	8.6	19.0	16.5
A-Bay	Low	6.9	7.4	11.9	12.2	2.9	2.9	8.2	6.7
Anchovy	Moderate	27.6	27.3	29.8	29.9	28.9	29.2	25.7	23.9
	High	26.5	26.0	26.5	25.8	32.7	32.7	27.4	36.4
	Optimum	39.0	39.3	31.8	32.2	35.5	35.1	38.7	33.0
EJ-Red	Low	0.3	0.3	0.0	0.0	0.0	0.0	21.0	23.0
Drum	Moderate	21.0	21.6	29.6	29.4	31.9	31.9	22.4	24.2
	High	40.4	42.3	38.7	38.6	34.1	34.1	44.5	42.7
	Optimum	38.3	35.7	31.8	32.0	34.0	34.0	12.1	10.1
EJ-Spot	Low	33.2	29.9	12.7	13.0	34.7	35.4	28.0	23.6
	Moderate	35.2	36.6	23.9	24.2	32.2	33.0	41.9	39.7
	High	22.1	22.4	33.7	34.5	19.3	19.3	24.1	29.5
	Optimum	9.5	11.1	29.8	28.3	13.8	12.3	6.1	7.2

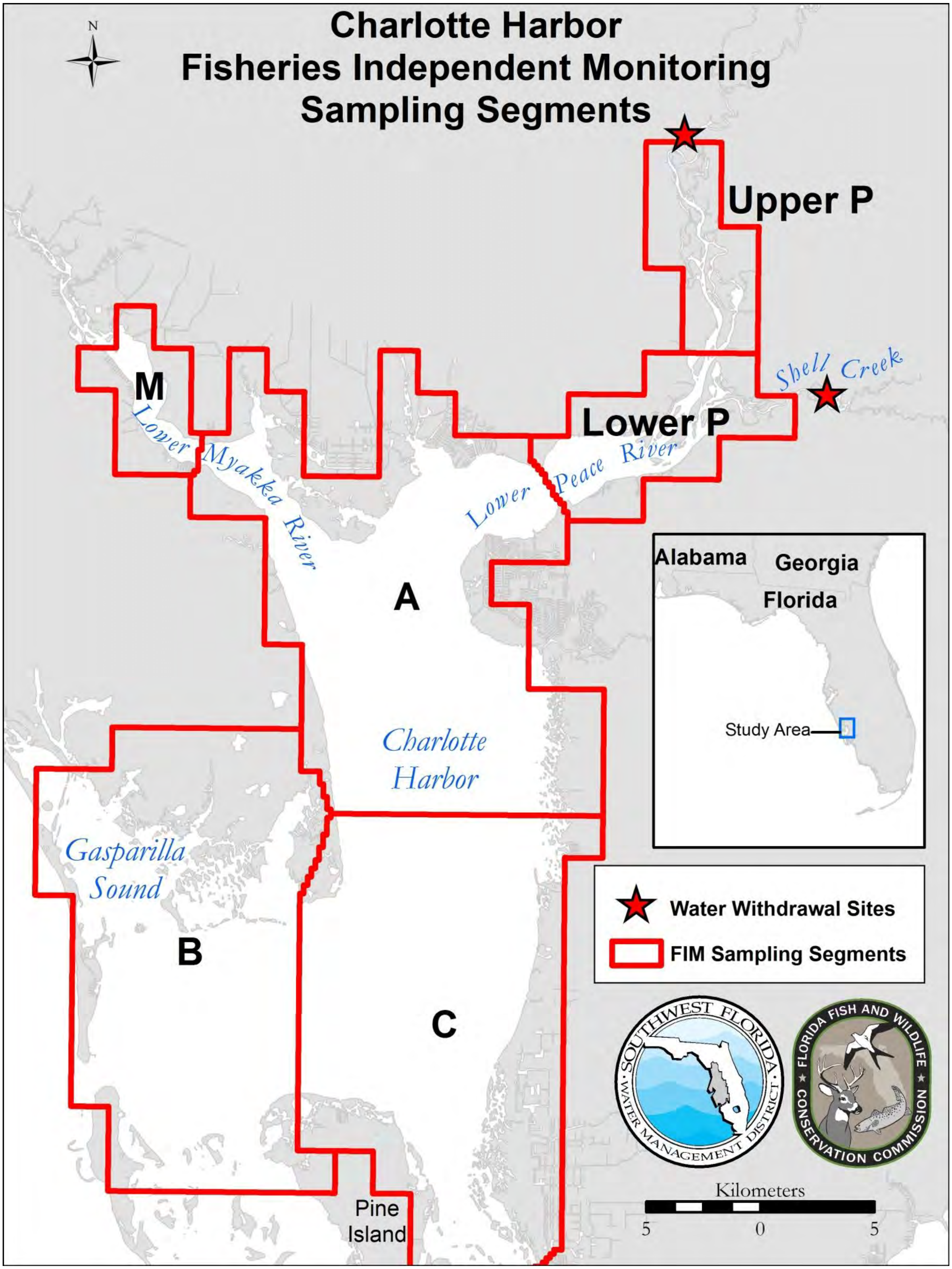

FIGURE 1. Sampling segments associated with Fisheries-Independent Monitoring within the lower Peace River and Charlotte Harbor. Sampling within the Upper P segment was associated with two special studies.

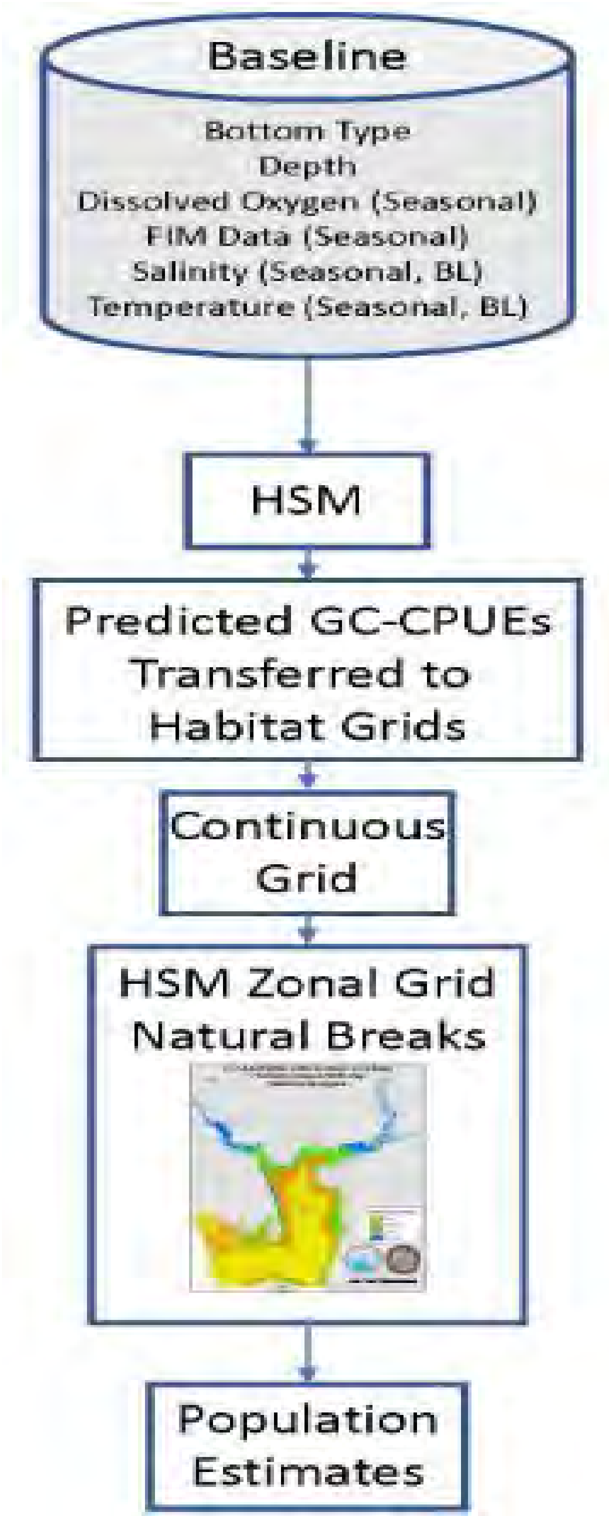

FIGURE 2. Flow diagram outlining the process by which habitat suitability modeling (HSM) was conducted to relate gear-corrected (GC) catch-per-unit-effort (CPUEs) to environmental variables. The GC-CPUEs from fitted splines were transferred to the habitat grids. By averaging t GC-CPUEs associated with the habitat grids, continuous GC-CPUE grids were created for each species life stage. Using natural breaks, seasonal HSM grids were created. Mean GC-CPUEs associated with HSM zones were multiplied by zonal areas to obtain zonal population numbers and summed to derive total population number estimates for baseline flows. The process was repeated to derive population number estimates for minimum flows.

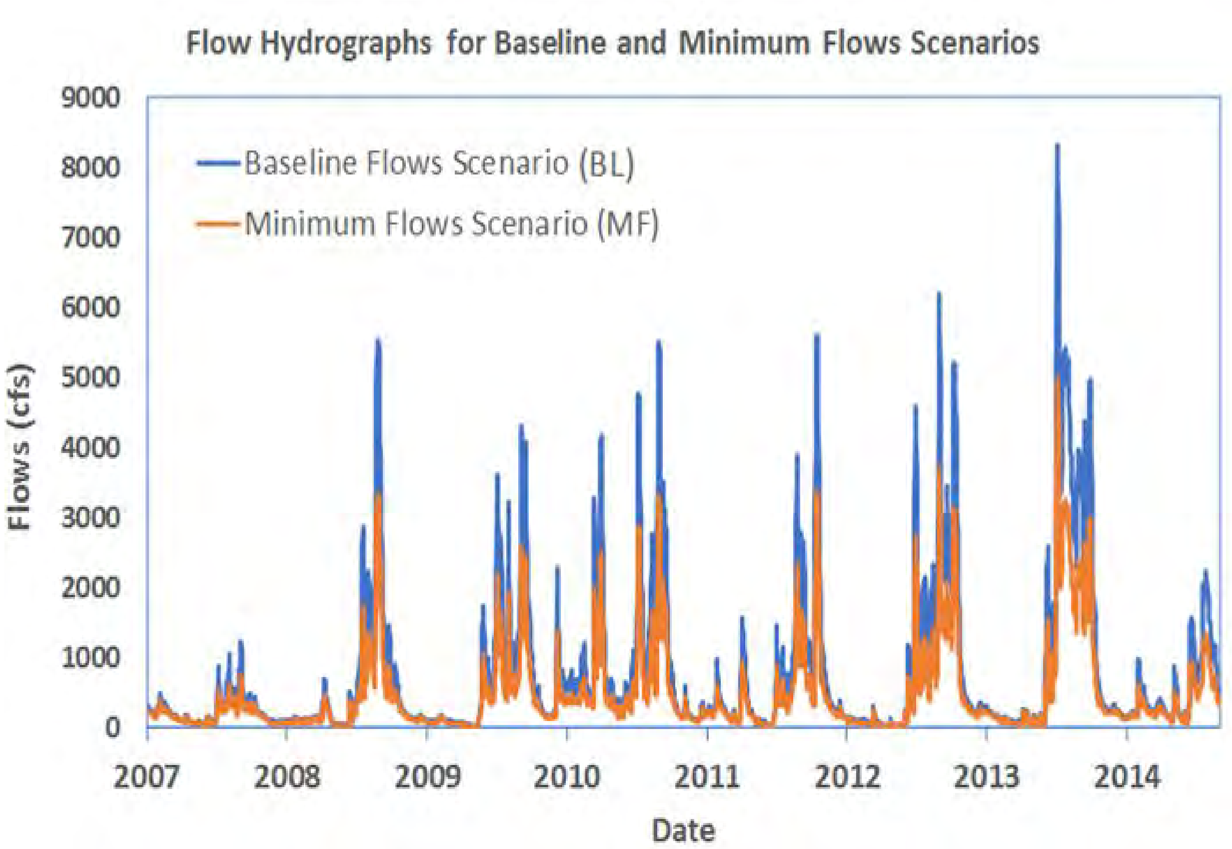

FIGURE 3. Daily flow hydrograph by year for Baseline (blue) and Minimum Flows (red) conditions in the lower Peace River system. The difference between Baseline and Minimum Flows represent the proportion of the flows available for human use.

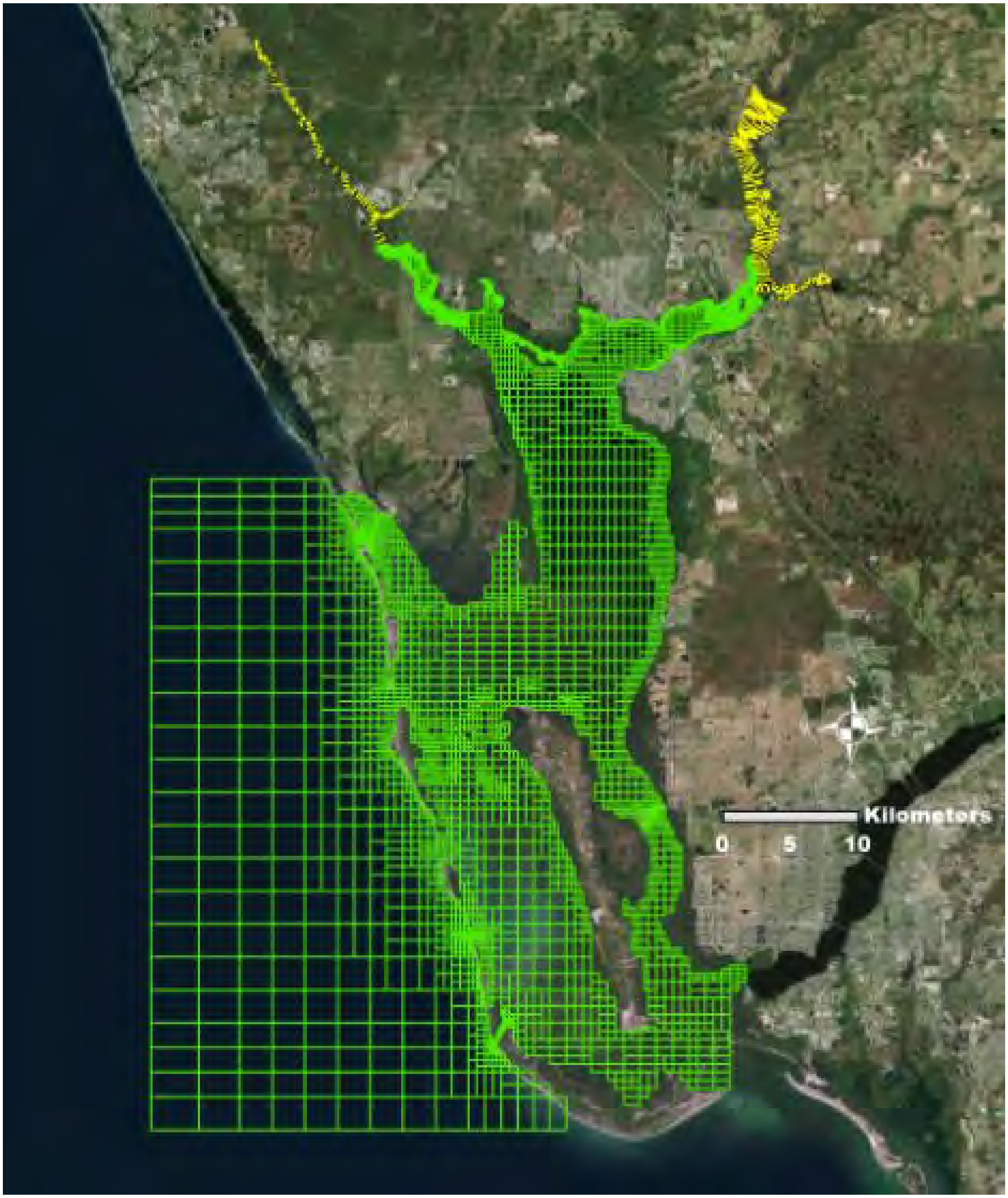

FIGURE 4. UnLESS grid used for hydrodynamic modeling of greater Charlotte Harbor. Green rectangular tiles are model grids for the 3D simulation domain, while 2DV grids are bounded by cross sections drawn with yellow lines.

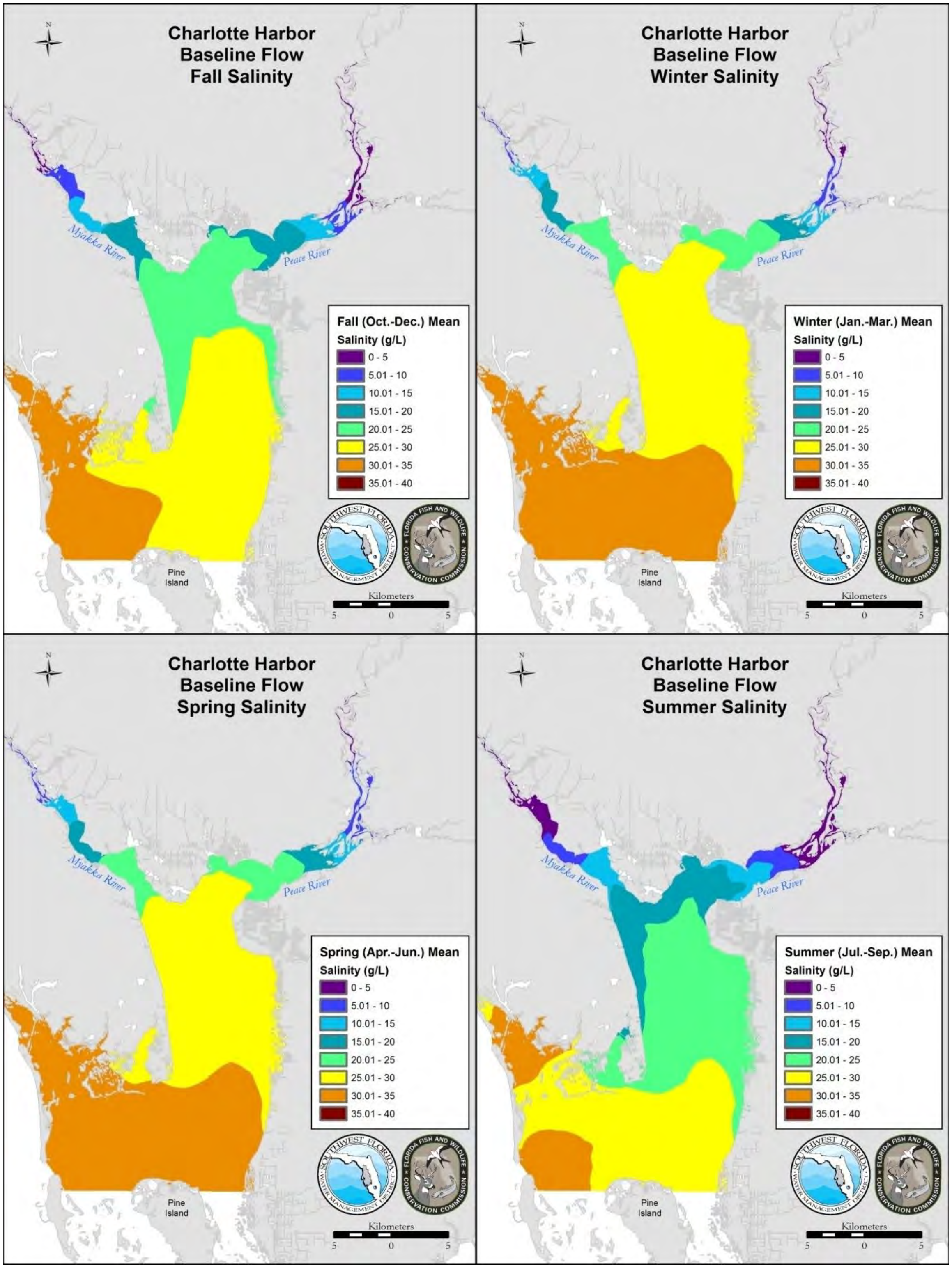

FIGURE 5. Seasonal maps for salinity created from Baseline data derived using hydrodynamic modeling.

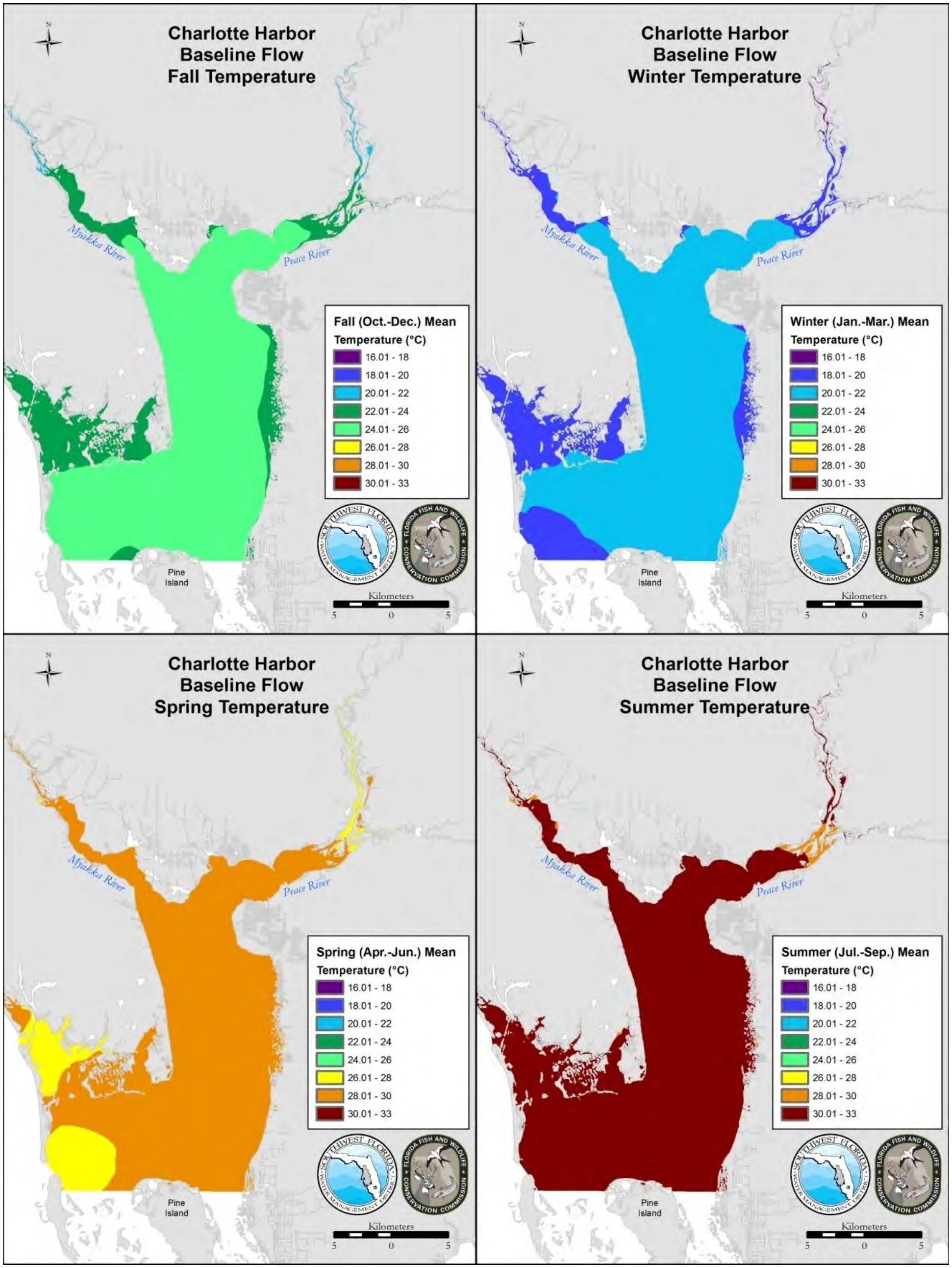

FIGURE 6. Seasonal maps for temperature created from Baseline data derived using hydrodynamic modeling.

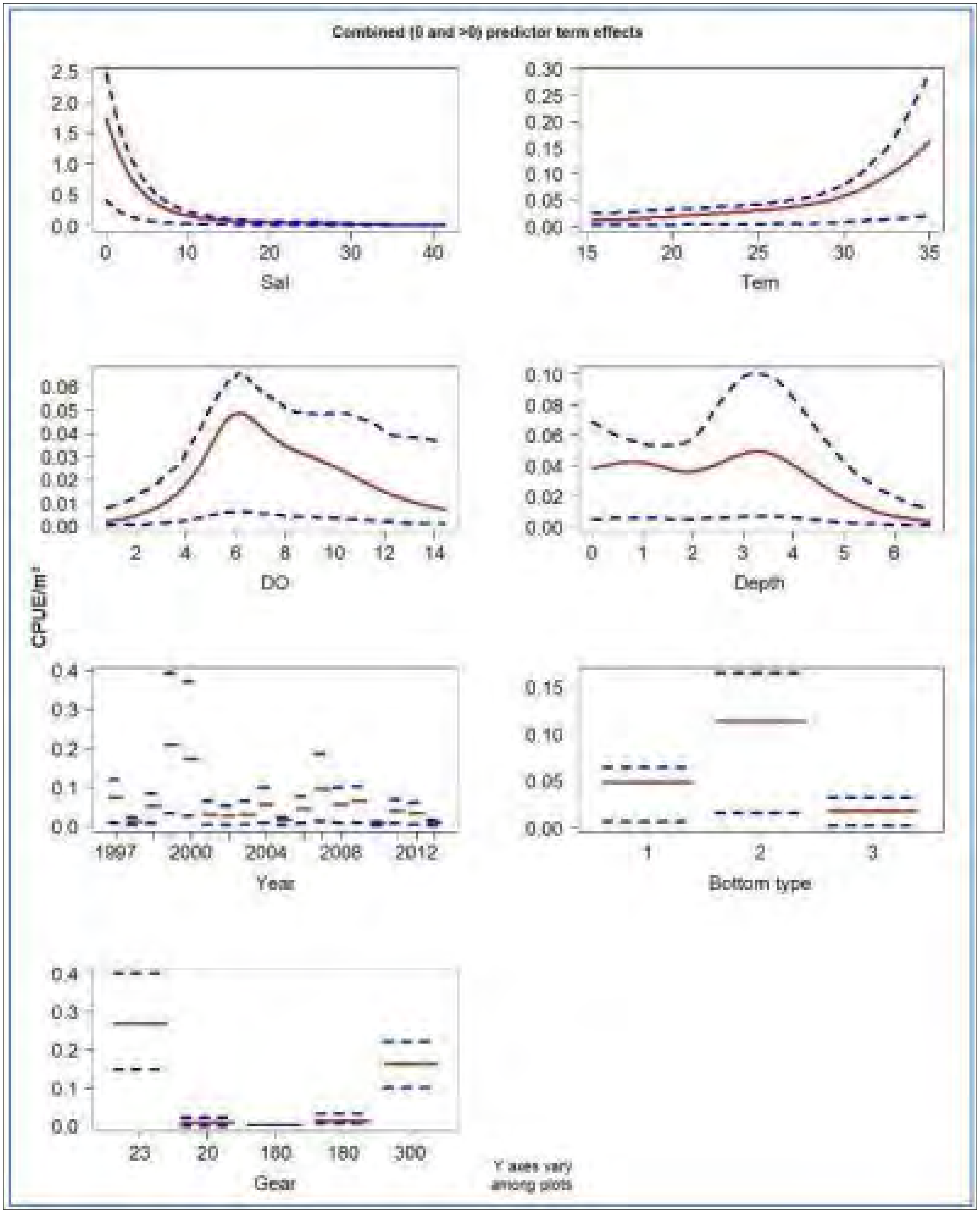

FIGURE 7. Back-transformed splines and histograms depicted for Juvenile+Adult Hogchoker in the spring. The dashed lines associated with the fitted splines and histograms are 95% confidence limits around mean GC-CPUEs. Bottom type 1=sand, 2=mud, 3=SAV.

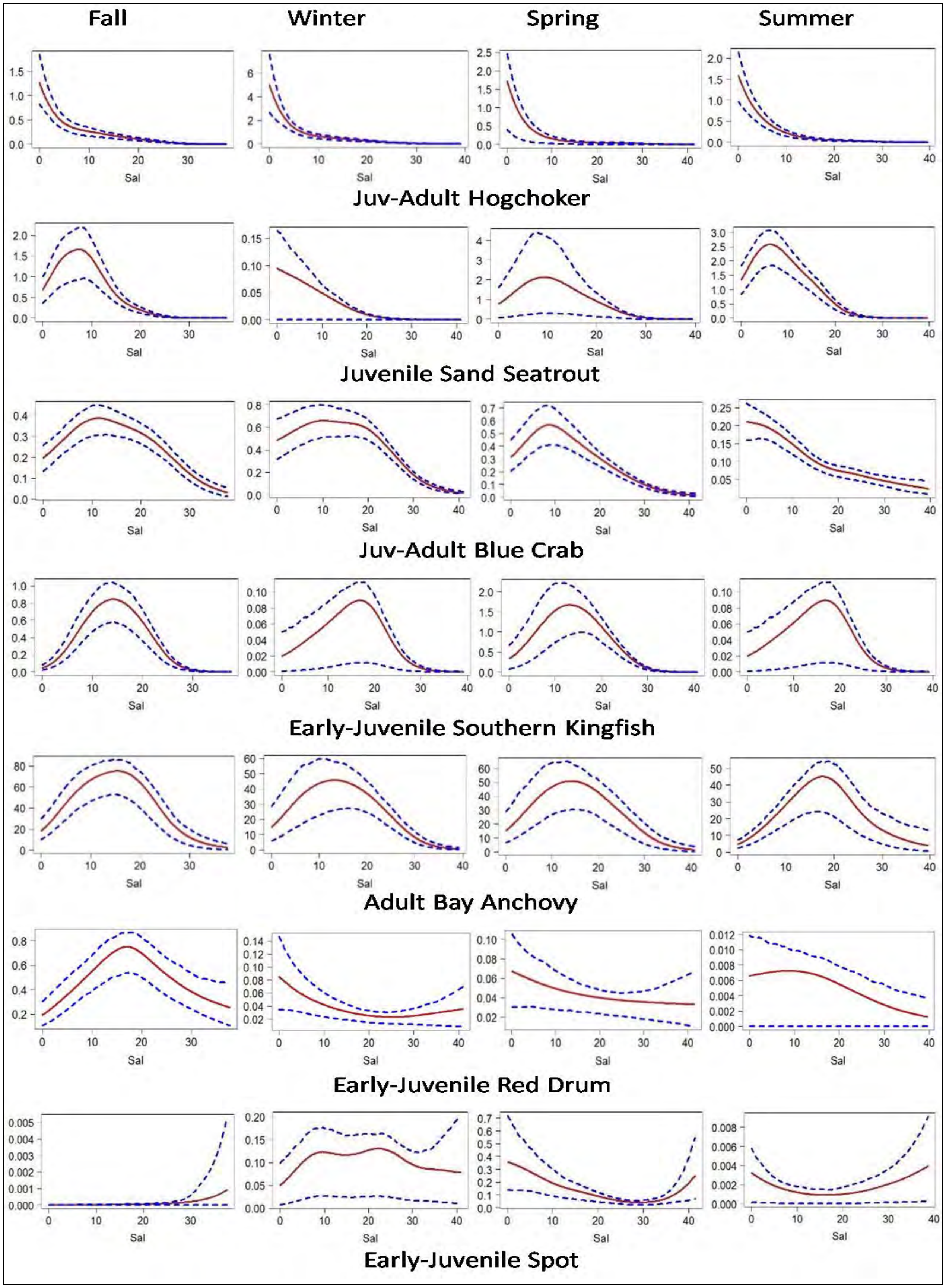

FIGURE 8. Seasonal fitted splines for back-transformed GC-CPUEs by salinity for species life stages. Dashed lines represent 95% confidence limits.

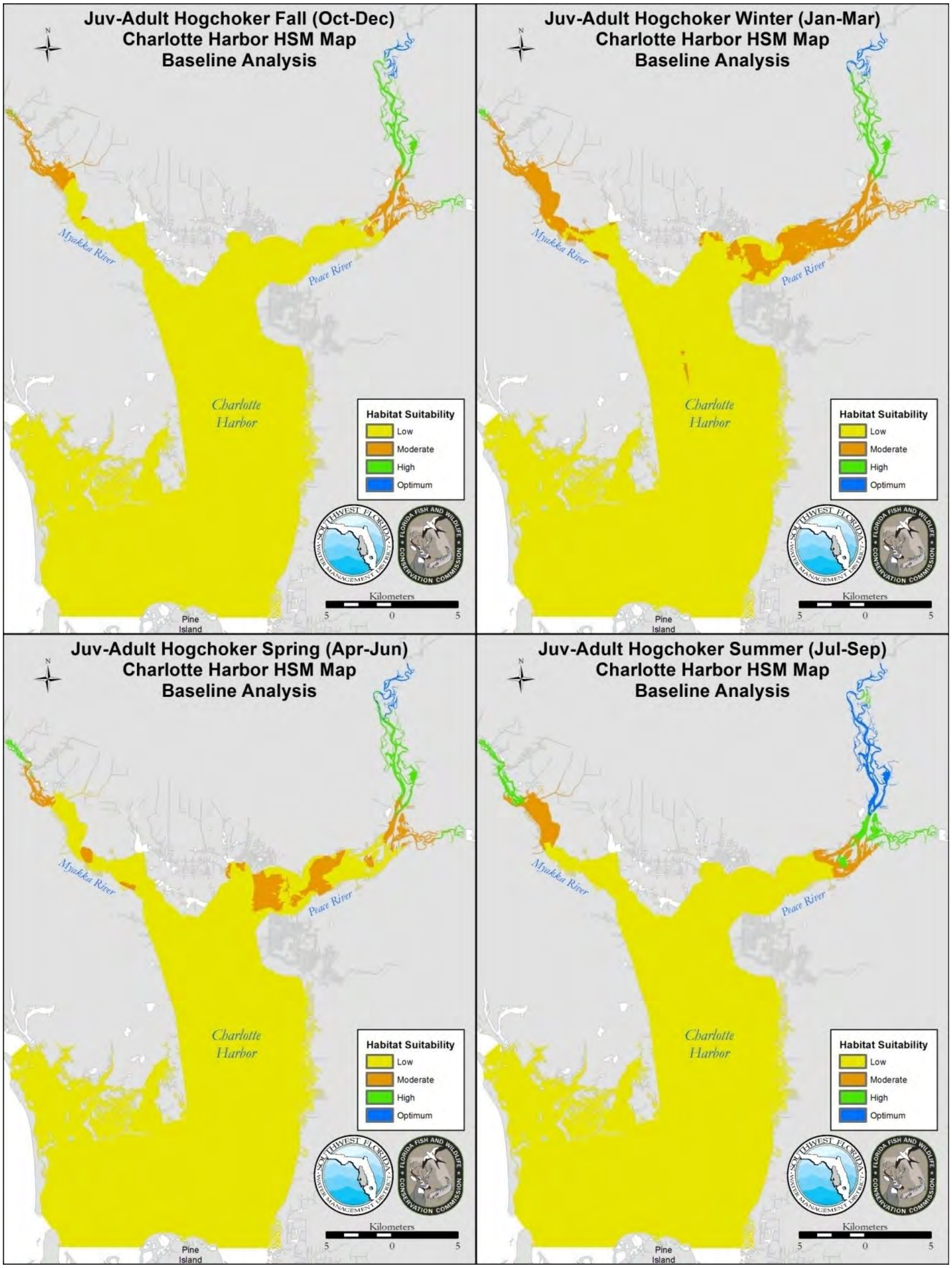

FIGURE 9. HSM maps for Juvenile+Adult Hogchoker depicting changes in HSM zones between seasons for the Baseline scenario.

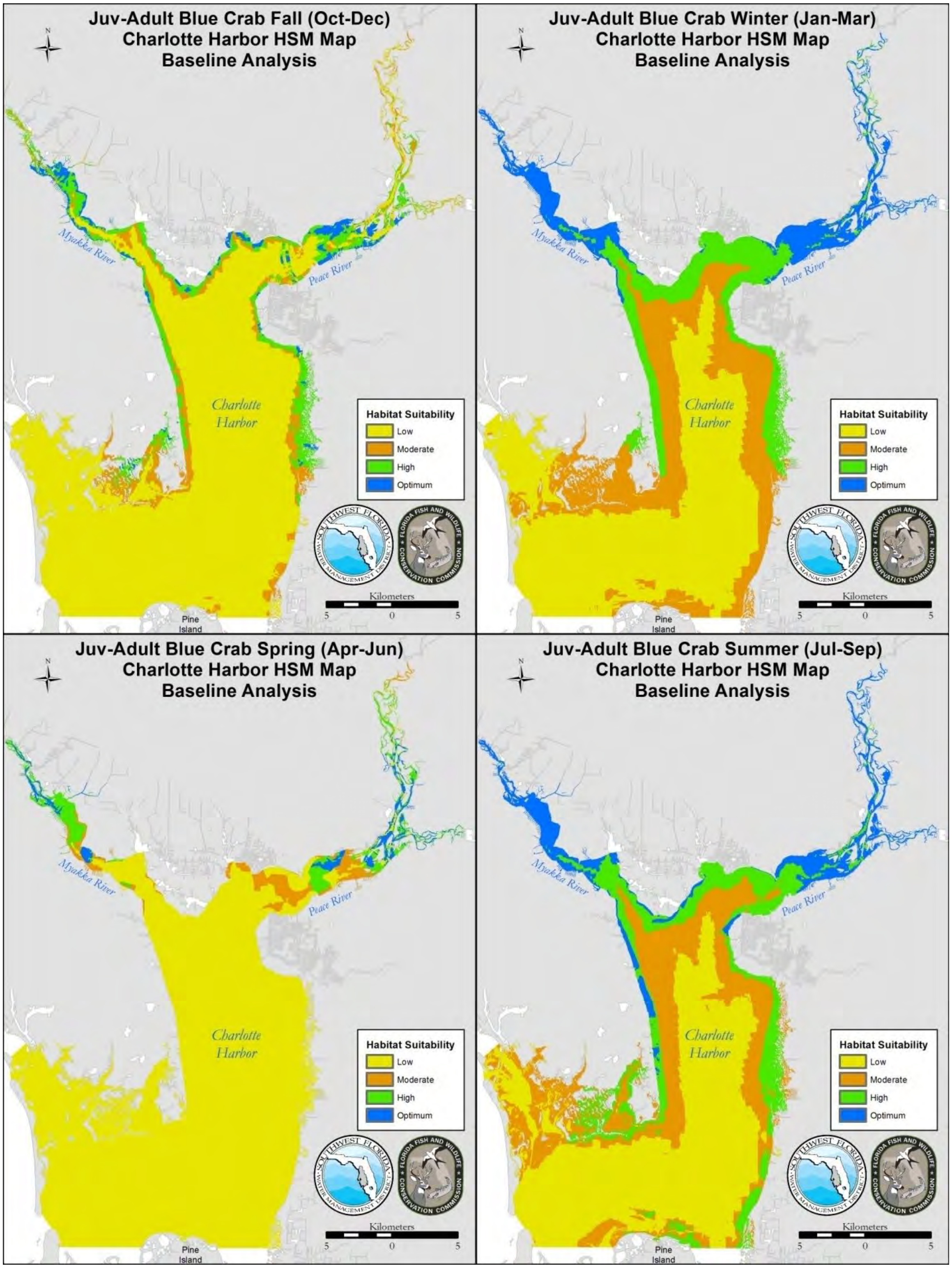

FIGURE 10. HSM maps for Juvenile+Adult blue crab depicting changes in HSM zones between seasons for the Baseline scenario.

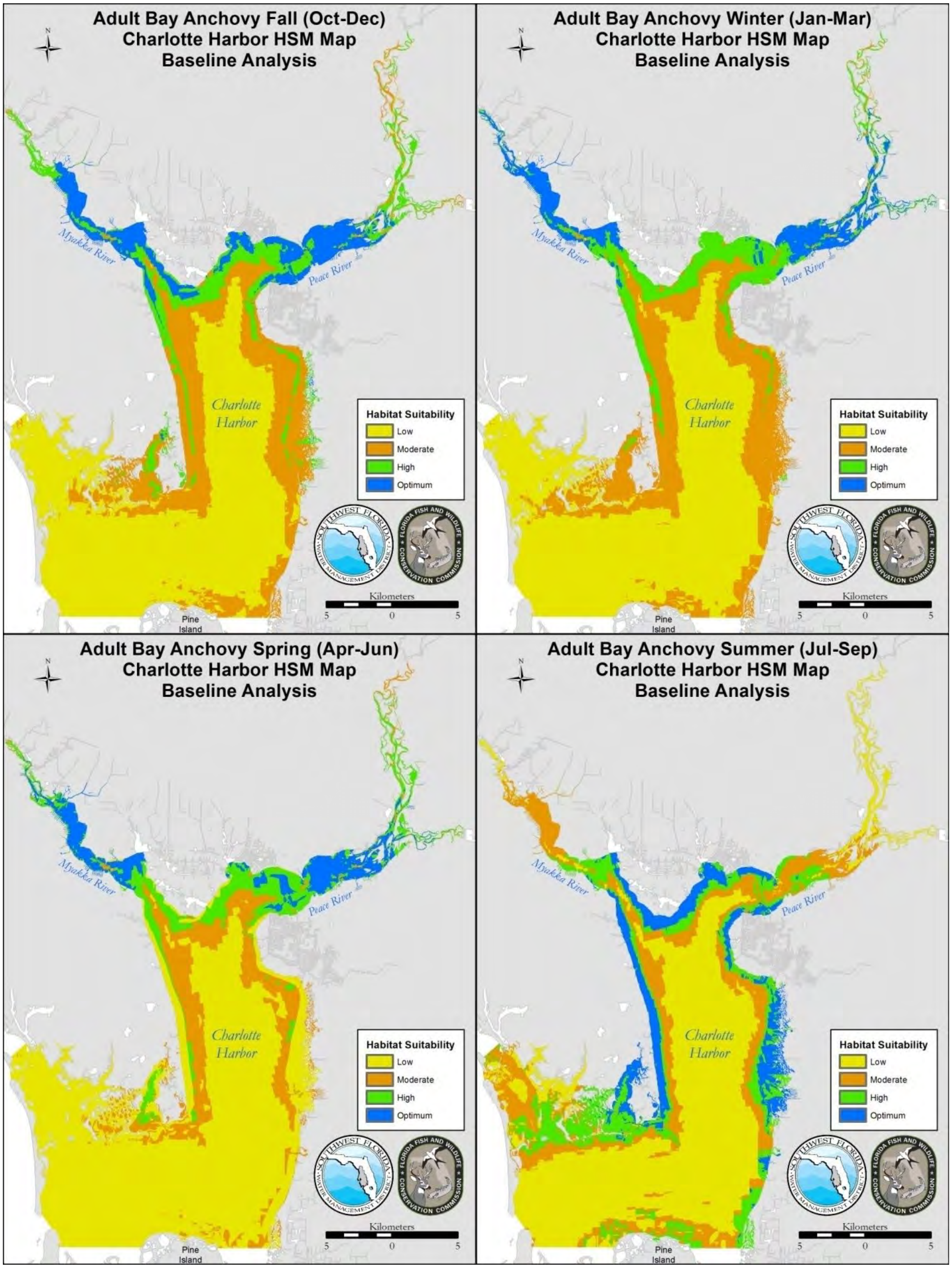

FIGURE 11. HSM maps for Adult Bay Anchovy depicting changes in HSM zones between seasons for the Baseline scenario.

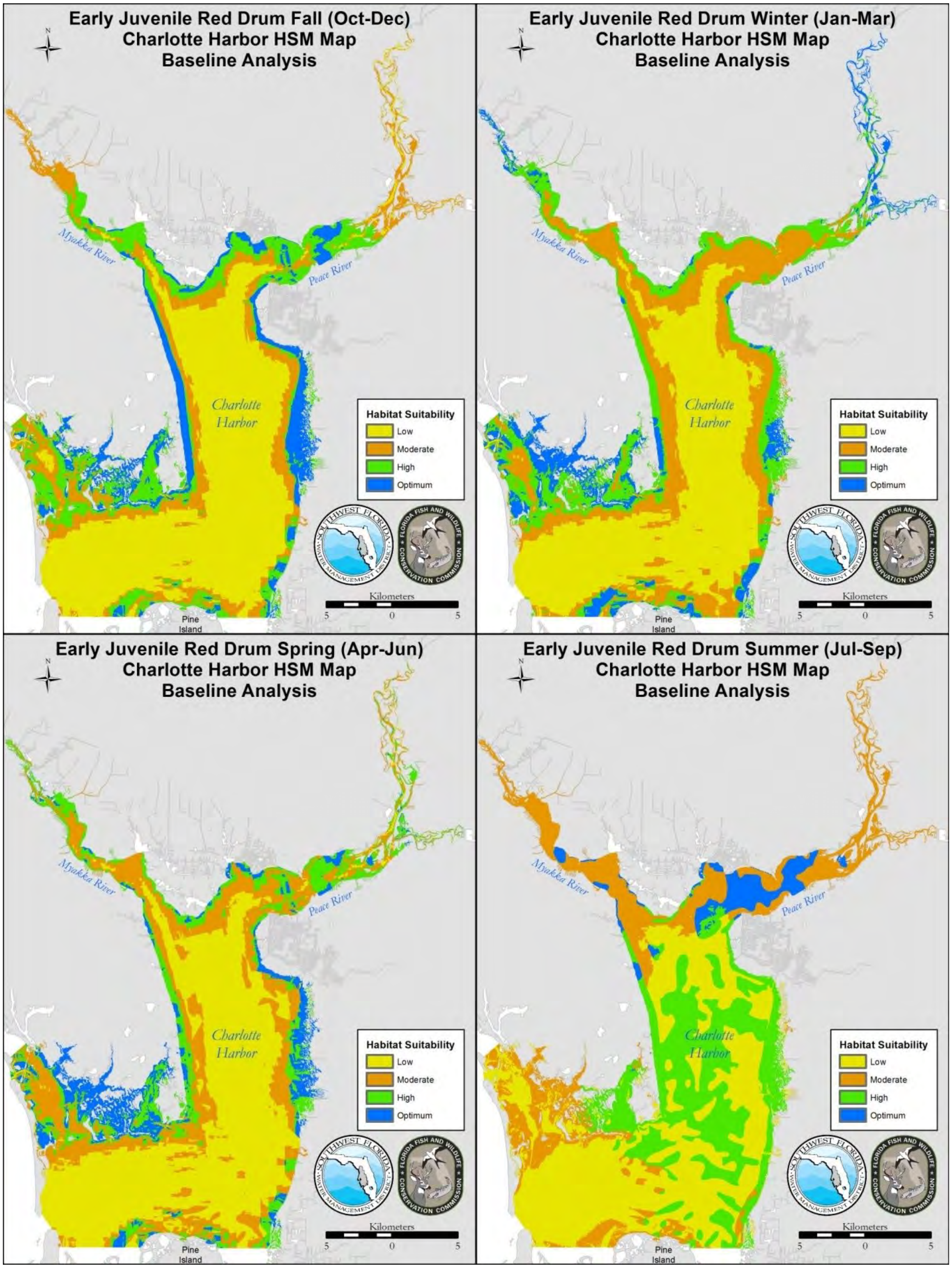

FIGURE 12. HSM maps for Early-Juvenile Red Drum depicting changes in HSM zones between seasons for the Baseline scenario.

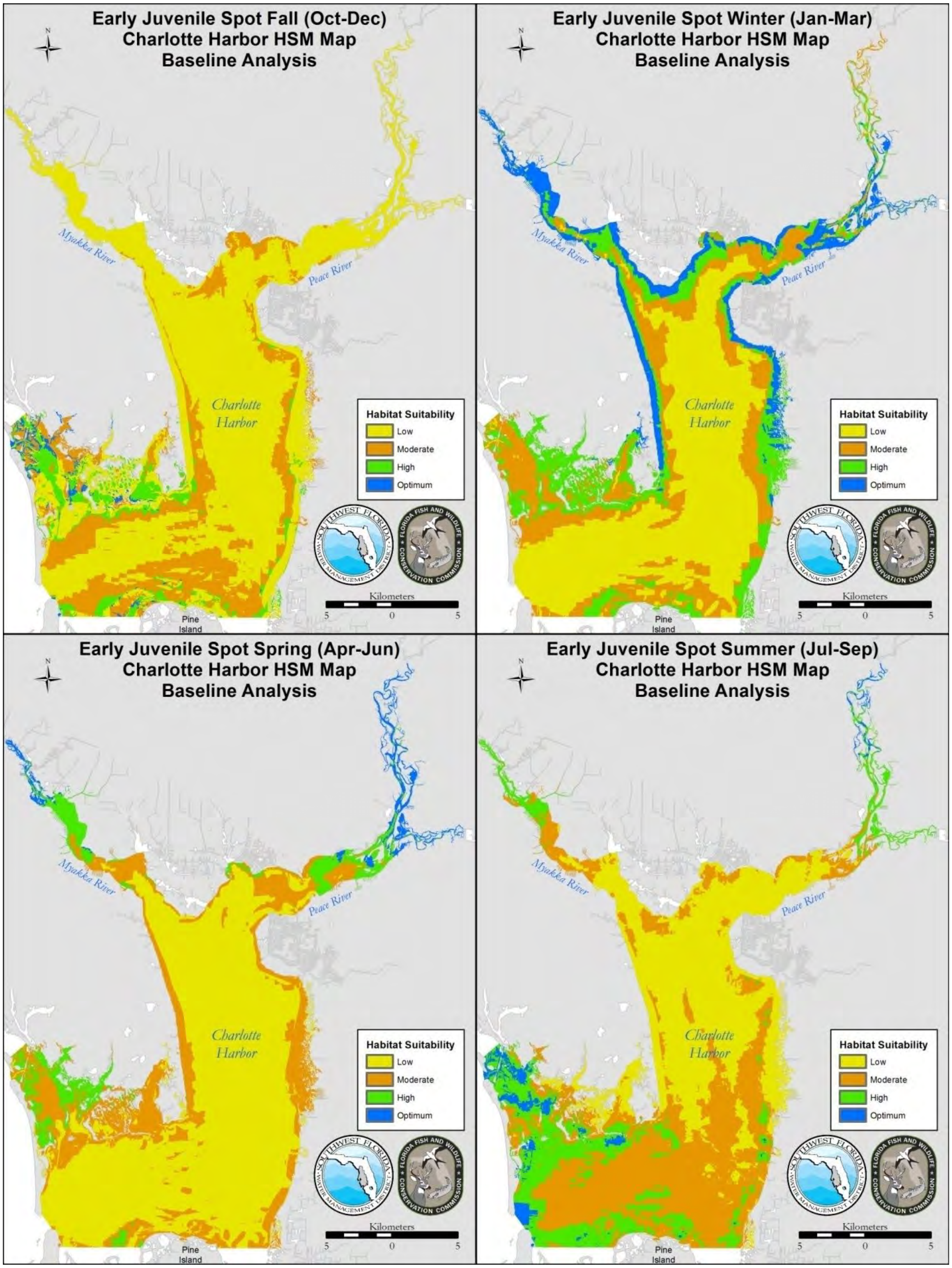

FIGURE 13. HSM maps for Early-Juvenile Spot depicting changes in HSM zones between seasons for the Baseline scenario.

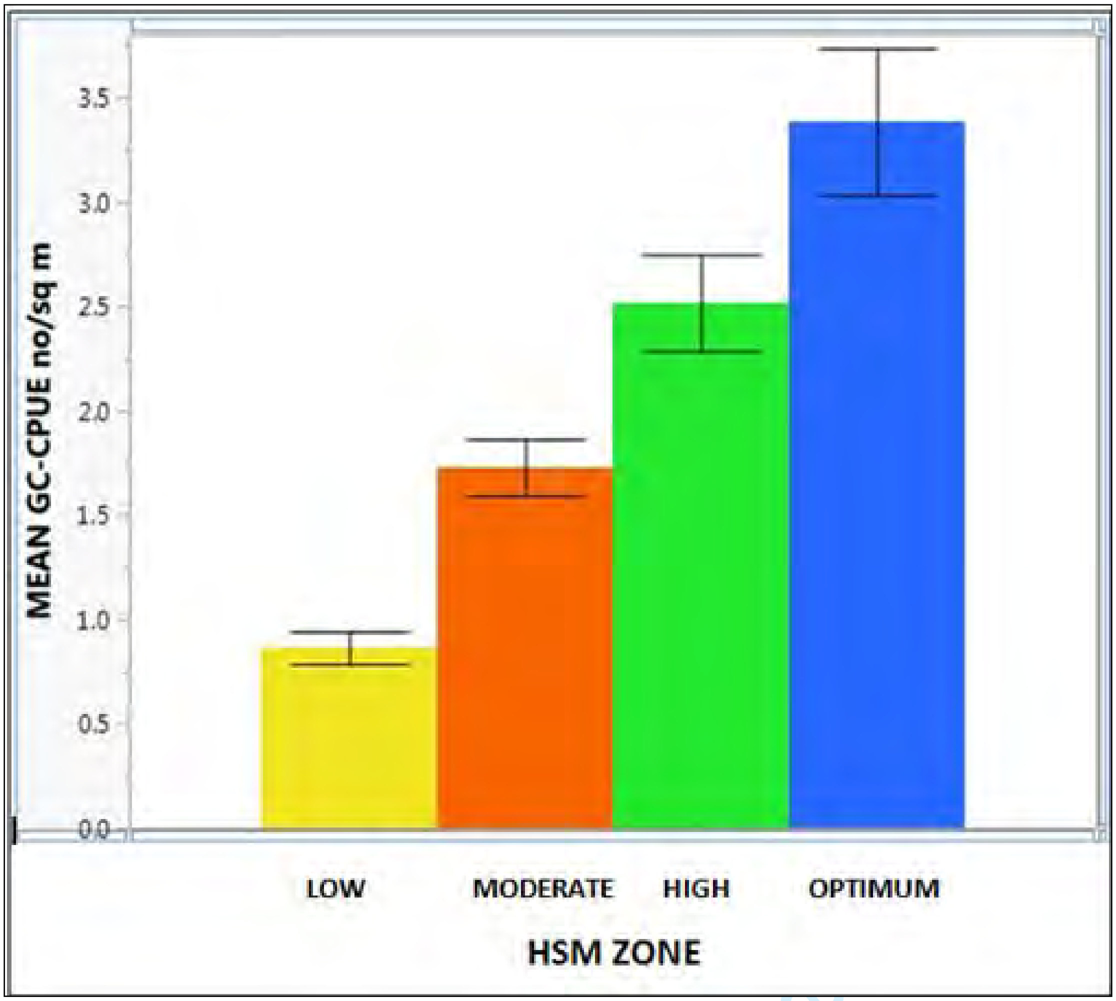

FIGURE 14. Validation graph for Adult Bay Anchovy in Charlotte Harbor during summer for minimum flows. The upper and lower bars represent 95% confidence intervals. With increases in mean Observed GC-CPUEs across four HSM zones, scores for validation graphs for most seasons were set to 1.0. When mean GC-CPUEs were lower in the Optimum zones than in the High zones the validation graphs were scored as 0.5.

From:	Sid Flannery
To:	Doug Leeper
Subject:	when to extend minimum flows for the Middle Peace River
Date:	Monday, August 10, 2020 6:20:41 AM
Attachments:	UMCF-2019-0072.R2_Proof_8-07-20.pdf

[EXTERNAL SENDER] Use caution before opening.

Doug,

As a follow-up to the email below from yesterday, if Legal would approve, one alternative would be that when the minimum flows for the Lower Peace River are taken to the Governing Board for adoption in 2020, as part of that process extend the minimum flows for the Middle Peace River down to the Horse Creek confluence.

Sid

---------- Forwarded message ---------
From: **Sid Flannery** <sidflannery22@gmail.com>
Date: Sun, Aug 9, 2020 at 10:11 AM
Subject: Fwd: PDF paper submitted
To: Leeper Doug <doug.leeper@swfwmd.state.fl.us>

Doug,

See email below and attachment of paper that Peter Rubec submitted to the journal. I also helped him quite a bit on the reply to the editor, which is not attached.

And yes, if it is not a bureaucratic/legal hassle, at some point (next year or two) extend the Middle Peace minimum flows down to the Horse Creek confluence - no further research would be needed. Possibly put in on a priority list for 2021 or 2022.

Sid

---------- Forwarded message ---------
From: **AOL CUSTOMER SERVICE(Security Tips)** <peterrubec@cs.com>
Date: Sun, Aug 9, 2020 at 9:28 AM
Subject: PDF paper submitted
To: yonas.ghile@swfwmd.state.fl.us <yonas.ghile@swfwmd.state.fl.us>, xinjian.chen@swfwmd.state.fl.us <xinjian.chen@swfwmd.state.fl.us>, Chrisiti.Santi@myfwc.com <Chrisiti.Santi@myfwc.com>, sidflannery22@gmail.com <sidflannery22@gmail.com>, Joan.Browder@myfwc.com <Joan.Browder@myfwc.com>, richard.flamm@mfywc.com <richard.flamm@mfywc.com>, Philip.Stevens@MYFWC.com

<Philip.Stevens@myfwc.com>, robin.grunwald@myfwc.com
<robin.grunwald@myfwc.com>, rene.baumstark@myfwc.com
<rene.baumstark@myfwc.com>

I am attaching the proof of the paper submitted to Marine and Coastal Fisheries this Thursday.

Peter Rubec
Tel. 727-327-9226

From:	Doug Leeper
To:	Sid Flannery
Subject:	RE: when to extend minimum flows for the Middle Peace River
Date:	Monday, August 10, 2020 7:49:00 AM

Got it. Thanks.

Doug Leeper
MFLs Program Lead
Environmental Flows and Assessments Section
Natural Systems & Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street (U.S. Hwy. 41 South)
Brooksville, FL 34604-6899
352-796-7211, Ext. 4272
1-800-423-1476, Ext. 4272
Doug.leeper@watermatters.org

From: Sid Flannery <sidflannery22@gmail.com>
Sent: Monday, August 10, 2020 6:20 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: when to extend minimum flows for the Middle Peace River

[EXTERNAL SENDER] Use caution before opening.

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I am attaching the proof of the paper submitted to Marine and Coastal Fisheries this Thursday.

Peter Rubec
Tel. 727-327-9226

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Proposed Minimum Flows for the Lower Peace River

Public Supply Advisory Committee

Yonas Ghile, PhD, PH
Lead Hydrologist
Natural Systems & Restoration Bureau
August 11, 2020

1

1

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Planned Schedule

Major Activities	Schedule
Draft MFLs report developed	March 20, 2020
Presentation to Governing Board – Draft MFLs report	March 24, 2020
Stakeholder outreach	Feb 15 – July 30, 2020
Peer review of MFLs report	Mar 25 - Jun 26, 2020
Presentation to Public Supply Advisory Committee	August 11, 2020
Public workshop	September 15 - 30, 2020
Presentation to Environmental Advisory Committee	October 13, 2020
Presentation to Governing Board – Final MFLs report, SERC and MFLs rule	November ?, 2020

2

2

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Lower Peace River

- River segment downstream of Arcadia
- Based on combined flows:
  - Peace River at Arcadia
  - Joshua Creek at Nocatee
  - Horse Creek near Arcadia
- Minimum flows
  - Adopted in 2010
  - Initial reevaluation in 2015
  - Comprehensive reevaluation and adoption scheduled for 2020

3

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

LPR Minimum Flows & Permit Conditions

Combined Flows from gages @ Arcadia, Horse and Joshua	Lower Peace MFL		
	Block 1 (Apr 20 - Jun 25)	Block 2 (Oct 27 – Apr 19)	Block 3 (Jun 26 - Oct 26)
<130 cfs	0% (0%)		
130 - 625 cfs	16% (16%)		
≥ 625 cfs	16% *(16%*)	29%* (28%*)	38%* (28%*)
* Maximum daily withdrawal also limited to 400 cfs			

- PRMRWSA permit condition in yellow

4

4

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Developed Baseline flows

- Developed baseline flows (flows with no withdrawals effect) for the period from 1950 through 2014

5

5

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Developed Flow-Based Blocks

Currently Used Flow-Based Blocks

Previously Used Calendar-Based Blocks

- Flow-based blocks better represent low, medium and high flow conditions for minimum flows development and implementation

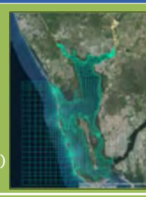
6

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Enhanced Hydrodynamic Modeling

Current model (Chen 2020)

- Unstructured 3D hydrodynamic model
- Includes entire Charlotte Harbor
- New LiDAR and bathymetry data
- 21-month calibration/validation period
- 7.7-year simulation period (Jan 2007 – Aug 2014)



Previously used model (Chen 2010)

- Structured 3D hydrodynamic model
- Limited to Upper Charlotte Harbor
- 13-month calibration/validation period
- 3-year simulation period (2000 - 2002)

7

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Enhanced Ecological Criteria and Considerations

Current Ecological Criteria and Considerations	Previous (2010 Evaluation) Ecological Criteria and Considerations
▪ Salinity-based habitats (<2, <5, <10, <15, <20 psu) ▪ Floodplain inundation ▪ Habitats for 7 fish species and Blue Crab ▪ Water quality (dissolved oxygen, nutrients, chlorophyll, color)	▪ Salinity-based habitats (<2, <5, <10, <15, <20 psu)

- **< 2 psu salinity volume** was the metric most sensitive to modeled flow reductions
- Minimum flows developed based on preserving 85% of **< 2 psu salinity volume**

8

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Proposed Minimum Flows for the Lower Peace River

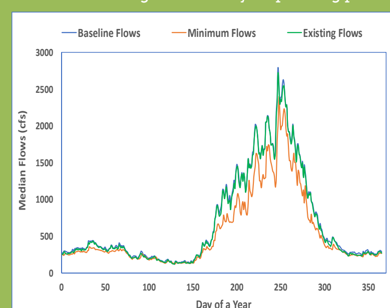
Flow-based Block	If flow on previous day is:	Potentially allowable flow reduction is:
1	≤130 cfs	0 cfs
	131 cfs to 149 cfs	flow minus 130 cfs
	150 cfs to 297 cfs	13% of flow
2	298 cfs to 335 cfs	Flow minus 258 cfs
	336 cfs to 622 cfs	23% of flow
3	623 cfs to 798 cfs	Flow minus 479 cfs
	799 cfs to 1,000 cfs	40% of flow
	>1,000 cfs	400 cfs

9

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Minimum flow Status - Lower Peace River

- Proposed Lower Peace River minimum flows are currently met, and are projected to be met during the next 20-year planning period

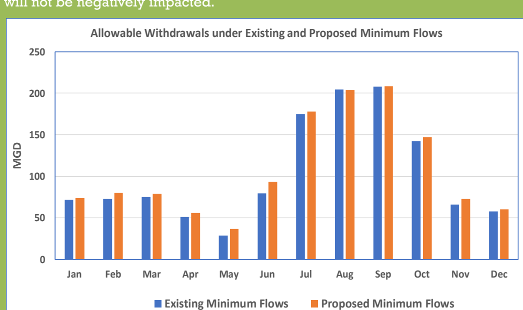


10

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Impacts of Proposed Minimum Flows to PRMRWSA

- The proposed minimum flows will allow slightly more withdrawals and PRMRWSA will not be negatively impacted.



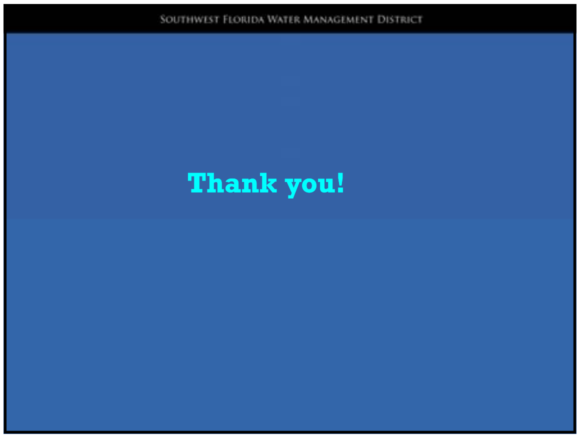
11

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Proposed Minimum Flows Summary

- Proposed minimum flows for the Lower Peace River and Lower Shell Creek are based on maintaining 85% of the 2 psu salinity volume.
- Proposed minimum flows are protective of all environmental values identified for consideration when establishing minimum flows
- Proposed Lower Peace River minimum flow is currently met, and projected to be met during the next 20-year planning period

12



13

Southwest Florida Water Management District

2379 Broad Street, Brooksville, Florida 34604-6899
(352) 796-7211 or 1-800-423-1476 (FL only)
WaterMatters.org

MEETING NOTICE

AGENDA

PUBLIC SUPPLY ADVISORY COMMITTEE

TUESDAY, August 11, 2020

1:00 P.M.

Join Teams Meeting

All meetings are open to the public.

1. Call to Order and Introductions – Jennifer Desrosiers, City of North Port Utilities, Committee Chair
2. Additions and Deletions to the Agenda – Virginia Singer, Board and Executive Services Manager
3. Approval of the February 11, 2020 Meeting Minutes
4. Public Comments
5. Cooperative Funding Initiative Updates – Scott Letasi, Project Management Office Chief
6. Lower Peace River Proposed MFL – Yonas Ghile, Lead Hydrologist
7. MFL Priority List and Schedule – Chris Zajac, Environmental Flows and Assessment Manager
8. Regional Water Supply Plan Update – Joseph Quinn, Water Supply Project Manager
9. ePermitting Replacement Project – Eryn Worthington, Project Manager, and Wendy Tipton, Business Analyst
10. Governing Board Liaison Comments
11. Development of agenda topics for the next Public Supply Advisory Committee at the District's Tampa Office tentatively to be held on Tuesday, November 10, 2020.
12. Announcements and Other Business
13. Adjournment

Bartow Office
170 Century Boulevard
Bartow, FL 33830-7700
863-534-1448 or 1-800-492-7862

Sarasota Office
6750 Fruitville Road
Sarasota, FL 34240-9711
941-377-3722 or 1-800-320-3503

Tampa Office
7601 US Highway 301 North
Tampa, FL 33637-6759
813-985-7481 or 1-800-836-0797

From:	Dale Helms
To:	Doug Leeper
Cc:	Eric DeHaven; Gene Heath
Subject:	RE: Peace River Meeting - Discuss Water Availability - Comment on Latest Draft Lower Peace River MFL Implementation Table
Date:	Thursday, August 13, 2020 11:41:01 AM
Attachments:	image002.png Slide3 from Peace Riv Mtg 2020-07-13_v4.pptx Comment on draft LPR MFL.xlsx

[EXTERNAL SENDER] Use caution before opening.

Hi Doug,

We appreciate the ongoing collaboration with the District regarding the proposed re-evaluated Lower Peace River Minimum Flows and their influence on potential water availability from the Peace River system. In reviewing your presentation from our July 13 meeting, on behalf of the PRWC, I have a comment for your consideration on the latest proposed LPR Minimum Flow implementation approach table (attached).

In both the current rule and the March 2020 draft re-evaluation report, the 400-cfs maximum daily withdrawal limit has always been shown separate from the MFL table as a supplemental constraint. District staff has confirmed in recent months that the 400-cfs daily limit only applies to withdrawals from the Lower Peace River. For example, page 112 of the March 2020 draft report states "It is important to note that the 400 cfs withdrawal limit is only for withdrawals from the Lower Peace River."

However, in the latest proposed MFL table, the 400-cfs withdrawal limit has instead been explicitly integrated into the table. I am concerned that presenting it this way may unintentionally prevent the District from being able to clarify that it applies to LPR withdrawals only, and instead it may be interpreted as applying universally to the entire Peace River system.

For your consideration, I would recommend that the draft MFL implementation approach table be modified as follows to avoid this potential confusion:

Flow-Based Block	If Combined Flow in cubic feet per second (cfs) on the Previous Day is:	Minimum Flow is:	Potentially Allowable Flow Reduction is:	Formula for Calculation of Potentially Allowable Flow Reduction (Q_{Red}) baed on Combined Flow on Previous Day (Q_{Prev})
1	≤ 130 cfs	Combined flow on the previous day	0 cfs	QRed = 0 cfs
	> 130 cfs and ≤ 149 cfs	130 cfs	Combined flow on the previous day minus 130 cfs	QRed = QPrev - 130 cfs
	> 149 cfs and ≤ 297 cfs	87% of combined flow on the previous day	13% of combined flow on the previous day	QRed = QPrev * 13%
2	> 297 cfs and ≤ 335 cfs	258 cfs	Combined flow on the previous day minus 258 cfs	QRed = QPrev - 258 cfs
	> 335 cfs and ≤ 622 cfs	77% of combined flow on the previous day	23% of combined flow on the previous day	QRed = QPrev * 23%
3	> 622 cfs and ≤ 798 cfs	479 cfs	Combined flow on the previous day minus 479 cfs	QRed = QPrev - 479 cfs
	> 798 cfs ~~and ≤ 1,000 cfs~~	60% of combined flow on the previous day	40% of combined flow on the previous day	QRed = QPrev * 40%
	~~> 1,000 cfs~~	~~Combined flow on the previous day minus 400 cfs~~	~~400 cfs~~	~~QRed = 400 cfs~~
The total permitted maximum withdrawals on any day shall not exceed 400 cfs.				

From page 112 of the March 2020 draft Lower Peace River Minimum Flow re-evaulation report:
"It is important to note that the 400 cfs withdrawal limit is only for withdrawals from the Lower Peace River."

Best,
Dale

A. Dale Helms, PE
Senior Client Services Manager | Vice President
200 East Robinson Street, Suite 1400 | Orlando, FL 32801
P 407.377.2656 | **M** 407.247.2455
carollo.com

From: Doug Leeper [mailto:Doug.Leeper@swfwmd.state.fl.us]
Sent: Monday, July 13, 2020 11:31 AM
To: George A. Schlutermann <George.Schlutermann@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; MCoates@regionalwater.org; Mary Thomas <mthomas@carollo.com>; Dale Helms <dhelms@carollo.com>; Elizabeth Perez <lperez@collectivewater.com>; Jay Hoecker <Jay.Hoecker@swfwmd.state.fl.us>; Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Lei Yang <Lei.Yang@swfwmd.state.fl.us>; John F. Ferguson <John.Ferguson@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>; Chris Zajac

<Chris.Zajac@swfwmd.state.fl.us>
Cc: Lisann Morris <Lisann.Morris@swfwmd.state.fl.us>; Patrick Tara <ptara@intera.com>; Kevin Morris <kmorris@regionalwater.org>; James Guida <jguida@prowatersource.com>; Owen Thornberry <Owen.Thornberry@swfwmd.state.fl.us>; April D. Breton <April.Breton@swfwmd.state.fl.us>; Gary Hubbard <ghubbard@mywinterhaven.com>; Mike Britt <mbritt@mywinterhaven.com>; Gene Heath <geneheath@prwcwater.org>
Subject: RE: Peace River Meeting - Discuss Water Availability

Draft slides used during today's meeting are included in the attached file.

Doug Leeper
MFLs Program Lead
Environmental Flows and Assessments Section
Natural Systems & Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street (U.S. Hwy. 41 South)
Brooksville, FL 34604-6899
352-796-7211, Ext. 4272
1-800-423-1476, Ext. 4272
Doug.leeper@watermatters.org

-----Original Appointment-----
From: George A. Schlutermann <George.Schlutermann@swfwmd.state.fl.us>
Sent: Tuesday, June 23, 2020 5:24 PM
To: George A. Schlutermann; Eric DeHaven; MCoates@regionalwater.org; Mary Thomas; Dale Helms; Elizabeth Perez; Jay Hoecker; Yonas Ghile; Lei Yang; John F. Ferguson; Doug Leeper; Randy Smith; Chris Zajac
Cc: Lisann Morris; Patrick Tara; Kevin Morris; James Guida; Owen Thornberry; April D. Breton; Gary Hubbard; Mike Britt; Gene Heath
Subject: Peace River Meeting - Discuss Water Availability
When: Monday, July 13, 2020 10:00 AM-11:30 AM (UTC-05:00) Eastern Time (US & Canada).
Where: Microsoft Teams Meeting

The intent of the meeting will be to discuss the comments provided by PRWC on May 5, 2020 (attached).
Any folks calling in can use the number provided below.

I believe the intended meeting duration is approximately 1 hour.

Join Microsoft Teams Meeting

+1 786-749-6127 United States, Miami (Toll)

Conference ID: 579 081 29#

Local numbers | Reset PIN | Learn more about Teams | Meeting options

INTERNAL USERS: Please use headset and microphone to join meeting audio. EXTERNAL USERS: Please dial toll # or use headset and microphone to join meeting audio.

Suggested edits to 7/13/20 draft Lower Peace River Minimum Flows implementation table:

Flow-Based Block	If Combined Flow in cubic feet per second (cfs) on the Previous Day is:	Minimum Flow is:	Potentially Allowable Flow Reduction is:	Formula for Calculation of Potentially Allowable Flow Reduction (Q_{Red}) baed on Combined Flow on Previous Day (Q_{Prev})
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	> 149 cfs and ≤ 297 cfs	87% of combined flow on the previous day	13% of combined flow on the previous day	QRed = QPrev * 13%
2	> 297 cfs and ≤ 335 cfs	258 cfs	Combined flow on the previous day minus 258 cfs	QRed = QPrev - 258 cfs
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3	> 622 cfs and ≤ 798 cfs	479 cfs	Combined flow on the previous day minus 479 cfs	QRed = QPrev - 479 cfs
	> 798 cfs ~~and ≤ 1,000 cfs~~	60% of combined flow on the previous day	40% of combined flow on the previous day	QRed = QPrev * 40%
	~~> 1,000 cfs~~	~~Combined flow on the previous day minus 400 cfs~~	~~400 cfs~~	~~QRed = 400 cfs~~

The total permitted maximum withdrawals on any day shall not exceed 400 cfs.

From page 112 of the March 2020 draft Lower Peace River Minimum Flow re-evaulation report:
"It is important to note that the 400 cfs withdrawal limit is only for withdrawals from the Lower Peace River."

MFLs Expression and Implementation: "Updated" Approach

Table 6-7. Summary of minimum flows and potentially allowable percent-of-flow reduction for the Lower Peace River for flow-based blocks determined from combined flows for the previous day at the USGS Horse Creek near Arcadia, Joshua Creek near Nocatee and the Peace River at Arcadia gages. Formulas that could be used to calculate potentially allowable flow reductions are also provided.

Flow-Based Block	If Combined Flow in cubic feet per second (cfs) on the Previous Day is:	Minimum Flow is:	Potentially Allowable Flow Reduction is:	Formula for Calculation of Potentially Allowable Flow Reduction (Q_{Red}) based on Combined Flow on Previous Day (Q_{Prev})
1	≤130 cfs	Combined flow on the previous day	0 cfs	Q_{Red} = 0 cfs
	>130 cfs and ≤149 cfs	130 cfs	Combined flow on the previous day minus 130 cfs	QRed = QPrev - 130 cfs
	>149 cfs and ≤ 297 cfs	87% of combined flow on the previous day	13% of combined flow on the previous day	QRed = QPrev * 13%
2	>297 cfs and ≤335 cfs	258 cfs	Combined flow on the previous day minus 258 cfs	QRed = QPrev - 258 cfs
	>335 cfs and ≤622 cfs	77% of combined flow on the previous day	23% of combined flow on the previous day	QRed = QPrev * 23%
3	>622 cfs and ≤798 cfs	479 cfs	Combined flow on the previous day minus 479 cfs	QRed = QPrev – 479 cfs
	>798 cfs and ≤1,000 cfs	60% of combined flow on the previous day	40% of combined flow on the previous day	QRed = QPrev * 40%
	>1,000 cfs	Combined flow on the previous day minus 400 cfs	400 cfs[a]	QRed = 400 cfs

[a] 400 cfs maximum daily withdrawal

From: Sid Flannery
To: Doug Leeper
Subject: Fwd: FYI: Marine and Coastal Fisheries - Decision on Manuscript ID UMCF-2019-0072.R2
Date: Tuesday, August 25, 2020 4:58:27 PM

[EXTERNAL SENDER] Use caution before opening.

Doug,

See below. Peter Rubec's paper got accepted in its current form (the final revision he submitted a few weeks ago). I've told you before, but this took a lot of patient work on my part to get the paper into a better form. Phil Stevens of FWC also made some good edits in the late going.

Although some researchers have published results that came from District sponsored work, I think this may be only the second time the percent-of-flow approach has been directly applied or discussed in the primary literature. I'm not crazy about the average approach that was taken, but that is now qualified in the paper, and the paper is a valuable contribution regarding the percent-of-flow approach and this particular habitat assessment technique.

Sid

On Tue, Aug 25, 2020 at 11:09 AM AOL CUSTOMER SERVICE(Security Tips) <peterrubec@cs.com> wrote:

> -----Original Message-----
> From: AOL CUSTOMER SERVICE(Security Tips) <peterrubec@cs.com>
> To: rene.baumstark@myfwc.com <rene.baumstark@myfwc.com>; robin.grunwald@myfwc.com <robin.grunwald@myfwc.com>; yonas.ghile@swfwmd.state.fl.us <yonas.ghile@swfwmd.state.fl.us>; xinjian.chen@swfwmd.state.fl.us <xinjian.chen@swfwmd.state.fl.us>; christi.santi@myfwc.com <christi.santi@myfwc.com>
> Sent: Tue, Aug 25, 2020 11:03 am
> Subject: Fwd: Marine and Coastal Fisheries - Decision on Manuscript ID UMCF-2019-0072.R2
>
> To everyone. The draft paper has been accepted for publication. After it is typeset, I will
> receive an email with the publication cost. In my case, being a member of the American Fisheries Society
> the cost is about 50%. I will forward the bill to Robin Grunwald who can arrange payment. on behalf of FWC.
>
> Thanks,
> Peter Rubec
> Tel. 727-327-9226
> Email: peterrubec@cs.com
>
> -----Original Message-----

From: Kenneth Rose <onbehalfof@manuscriptcentral.com>
To: peterrubec@cs.com
Sent: Tue, Aug 25, 2020 10:09 am
Subject: Marine and Coastal Fisheries - Decision on Manuscript ID UMCF-2019-0072.R2

25-Aug-2020

Dear Dr. RUBEC:

Ref: Habitat Suitability Modeling and Mapping to Assess the Influence of Freshwater Withdrawals on Spatial Distributions and Population Numbers of Estuarine Species in the Lower Peace River and Charlotte Harbor, Florida

I have evaluated your third version of the manuscript and have recommended publication in Marine and Coastal Fisheries. We are pleased to accept your paper in its current form which will now be forwarded to the publisher for copy editing and typesetting.

First Look NEW: Please note although the manuscript is accepted the files will now be checked to ensure that everything is ready for publication, and you may be contacted if final versions of files for publication are required.

You will receive proofs for checking in due course.

The publisher also requests that proofs are checked through the publisher's tracking system and returned within 48 hours of receipt.

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Before we can publish your article, your payment must be completed. The corresponding author for this manuscript will have already received a quote email shortly after original submission with the estimated Article Publication Charge; please let us know if this has not been received. Once your accepted paper is in production, the corresponding author will receive an e-mail inviting them to register with or log in to Wiley Author Services (www.wileyauthors.com) where the publication fee can be paid by credit card, or an invoice or proforma can be requested. The option to pay via credit card and claim reimbursement from your institution may help to avoid delays with payment processing.

Thank you for your contribution to Marine and Coastal Fisheries and we look forward to receiving further submissions from you.

Sincerely,
Kenneth Rose
Editor, Marine and Coastal Fisheries
krose@umces.edu

P.S. – You can help your research get the attention it deserves! Check out Wiley's free Promotion Guide for best-practice recommendations for promoting your work at www.wileyauthors.com/eeo/guide. And learn more about Wiley Editing Services which offers professional video, design, and writing services to create shareable video abstracts, infographics, conference posters, lay summaries, and research news stories for your research at www.wileyauthors.com/eeo/promotion.

Reviewer(s)' Comments to Author:
NONE

Editor's Comments to Author:
NONE

Associate Editor:
(There are no comments.)

From:	Doug Leeper
To:	"Dale Helms"
Cc:	Eric DeHaven; Gene Heath; Yonas Ghile; Xinjian Chen; Kristina Deak; Chris Zajac; Randy Smith; Adrienne E. Vining; Mike R. Bray
Subject:	RE: Peace River Meeting - Discuss Water Availability - Comment on Latest Draft Lower Peace River MFL Implementation Table
Date:	Friday, August 28, 2020 2:10:00 PM
Attachments:	image005.png

Dale:

- Thanks for your comments regarding the 400 cfs maximum daily withdrawal limit associated with the proposed minimum flows for the Lower Peace River.
- District staff currently agree that exclusion of the 400 cfs limit from any table that may be included in the proposed minimum flows rule for the Lower Peace River is appropriate.
- We are considering inclusion of the withdrawal limit in the proposed rule in the manner similar to that used for the existing rule, i.e., in the narrative portion of the rule.
- We also anticipate revising the tabular presentation of the proposed minimum flow in our draft minimum flows report.

Thanks, again.

Doug Leeper
MFLs Program Lead
Environmental Flows and Assessments Section
Natural Systems & Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street (U.S. Hwy. 41 South)
Brooksville, FL 34604-6899
352-796-7211, Ext. 4272
1-800-423-1476, Ext. 4272
Doug.leeper@watermatters.org

From: Dale Helms <dhelms@carollo.com>
Sent: Thursday, August 13, 2020 11:29 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Gene Heath <geneheath@prwcwater.org>
Subject: RE: Peace River Meeting - Discuss Water Availability - Comment on Latest Draft Lower Peace River MFL Implementation Table

[EXTERNAL SENDER] Use caution before opening.

Hi Doug,

We appreciate the ongoing collaboration with the District regarding the proposed re-evaluated Lower Peace River Minimum Flows and their influence on potential water availability from the Peace River system. In reviewing your presentation from our July 13 meeting, on behalf of the PRWC, I have a comment for your consideration on the latest proposed LPR Minimum Flow implementation approach table (attached).

In both the current rule and the March 2020 draft re-evaluation report, the 400-cfs maximum daily withdrawal limit has always been shown separate from the MFL table as a supplemental constraint. District staff has confirmed in recent months that the 400-cfs daily limit only applies to withdrawals from the Lower Peace River. For example, page 112 of the March 2020 draft report states "It is important to note that the 400 cfs withdrawal limit is only for withdrawals from the Lower Peace River."

However, in the latest proposed MFL table, the 400-cfs withdrawal limit has instead been explicitly integrated into the table. I am concerned that presenting it this way may unintentionally prevent the District from being able to clarify that it applies to LPR withdrawals only, and instead it may be interpreted as applying universally to the entire Peace River system.

For your consideration, I would recommend that the draft MFL implementation approach table be modified as follows to avoid this potential confusion:

Flow-Based Block	If Combined Flow in cubic feet per second (cfs) on the Previous Day is:	Minimum Flow is:	Potentially Allowable Flow Reduction is:	Formula for Calculation of Potentially Allowable Flow Reduction (Q_{Red}) baed on Combined Flow on Previous Day (Q_{Prev})
1	≤ 130 cfs	Combined flow on the previous day	0 cfs	QRed = 0 cfs
	> 130 cfs and ≤ 149 cfs	130 cfs	Combined flow on the previous day minus 130 cfs	QRed = QPrev - 130 cfs
	> 149 cfs and ≤ 297 cfs	87% of combined flow on the previous day	13% of combined flow on the previous day	QRed = QPrev * 13%
2	> 297 cfs and ≤ 335 cfs	258 cfs	Combined flow on the previous day minus 258 cfs	QRed = QPrev - 258 cfs
	> 335 cfs and ≤ 622 cfs	77% of combined flow on the previous day	23% of combined flow on the previous day	QRed = QPrev * 23%
3	> 622 cfs and ≤ 798 cfs	479 cfs	Combined flow on the previous day minus 479 cfs	QRed = QPrev - 479 cfs
	> 798 cfs ~~and ≤ 1,000 cfs~~	60% of combined flow on the previous day	40% of combined flow on the previous day	QRed = QPrev * 40%
	~~> 1,000 cfs~~	~~Combined flow on the previous day minus 400 cfs~~	~~400 cfs~~	~~QRed = 400 cfs~~
The total permitted maximum withdrawals on any day shall not exceed 400 cfs.				

From page 112 of the March 2020 draft Lower Peace River Minimum Flow re-evaulation report:

"It is important to note that the 400 cfs withdrawal limit is only for withdrawals from the Lower Peace River."

Best,
Dale

A. Dale Helms, PE
Senior Client Services Manager | Vice President
200 East Robinson Street, Suite 1400 | Orlando, FL 32801
P 407.377.2656 | M 407.247.2455
carollo.com

From: Doug Leeper [mailto:Doug.Leeper@swfwmd.state.fl.us]
Sent: Monday, July 13, 2020 11:31 AM
To: George A. Schlutermann <George.Schlutermann@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; MCoates@regionalwater.org; Mary Thomas <mthomas@carollo.com>; Dale Helms <dhelms@carollo.com>; Elizabeth Perez <lperez@collectivewater.com>; Jay Hoecker <Jay.Hoecker@swfwmd.state.fl.us>;

Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Lei Yang <Lei.Yang@swfwmd.state.fl.us>; John F. Ferguson <John.Ferguson@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>
Cc: Lisann Morris <Lisann.Morris@swfwmd.state.fl.us>; Patrick Tara <ptara@intera.com>; Kevin Morris <kmorris@regionalwater.org>; James Guida <jguida@prowatersource.com>; Owen Thornberry <Owen.Thornberry@swfwmd.state.fl.us>; April D. Breton <April.Breton@swfwmd.state.fl.us>; Gary Hubbard <ghubbard@mywinterhaven.com>; Mike Britt <mbritt@mywinterhaven.com>; Gene Heath <geneheath@prwcwater.org>
Subject: RE: Peace River Meeting - Discuss Water Availability

Draft slides used during today's meeting are included in the attached file.

Doug Leeper
MFLs Program Lead
Environmental Flows and Assessments Section
Natural Systems & Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street (U.S. Hwy. 41 South)
Brooksville, FL 34604-6899
352-796-7211, Ext. 4272
1-800-423-1476, Ext. 4272
Doug.leeper@watermatters.org

-----Original Appointment-----
From: George A. Schlutermann <George.Schlutermann@swfwmd.state.fl.us>
Sent: Tuesday, June 23, 2020 5:24 PM
To: George A. Schlutermann; Eric DeHaven; MCoates@regionalwater.org; Mary Thomas; Dale Helms; Elizabeth Perez; Jay Hoecker; Yonas Ghile; Lei Yang; John F. Ferguson; Doug Leeper; Randy Smith; Chris Zajac
Cc: Lisann Morris; Patrick Tara; Kevin Morris; James Guida; Owen Thornberry; April D. Breton; Gary Hubbard; Mike Britt; Gene Heath
Subject: Peace River Meeting - Discuss Water Availability
When: Monday, July 13, 2020 10:00 AM-11:30 AM (UTC-05:00) Eastern Time (US & Canada).
Where: Microsoft Teams Meeting

The intent of the meeting will be to discuss the comments provided by PRWC on May 5, 2020 (attached).
Any folks calling in can use the number provided below.

I believe the intended meeting duration is approximately 1 hour.

Join Microsoft Teams Meeting

+1 786-749-6127 United States, Miami (Toll)

Conference ID: 579 081 29#

Local numbers | Reset PIN | Learn more about Teams | Meeting options

From:	Eric DeHaven
To:	Yonas Ghile; Xinjian Chen; Doug Leeper; Chris Zajac; Randy Smith
Cc:	Cindy C. Rodriguez; Jay Hoecker; George A. Schlutermann; John F. Ferguson
Subject:	FW: Proposed Lower Peace River MFL"s
Date:	Tuesday, September 1, 2020 5:34:25 PM

Eric DeHaven, P.G.
Southwest Florida Water Management District
Assistant Director, Resource Management Division
7601 HWY 301N Tampa FL 33637
(813) 985-7481 X2118

From: Mike Coates <mcoates@regionalwater.org>
Sent: Tuesday, September 1, 2020 4:59 PM
To: Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>
Cc: Terri Holcomb <tholcomb@regionalwater.org>; Kevin Morris <kmorris@regionalwater.org>; Jim Guida <jguida@prowatersource.com>; Patrick Tara <ptara@intera.com>; Patrick Lehman <plehman@regionalwater.org>
Subject: Proposed Lower Peace River MFL's

[EXTERNAL SENDER] Use caution before opening.
Eric:

The Authority and our consultants have reviewed the March 20, 2020 Draft Lower Peace River MFL document. From an environmental standpoint we believe the District's re-evaluation of the MFL's was well done. We note that the 400 CFS maximum withdrawal from the lower river doesn't appear to be associated with environmental conditions and as such at high river flows it would seem a withdrawal rate above 400 CFS should be considered either during the current MFL re-evaluation or the next. Also - because the proposed MFL schedule will affect our permitted withdrawal schedule and necessitate modification of our WUP, the Authority continues to assess the percentage withdrawals (within the proposed new MFL limits) that we'll need to insure optimal reliability for the regional facility expansion project that is underway in meet future water demand. We expect to have this evaluation completed and ready for discussion in approximately three weeks. At that time a staff meeting between the Authority, the District, and Polk Regional Water Cooperative would be beneficial for all parties.

Thanks,

Mike

Mike Coates, P.G.
Deputy Director
PRMRWSA

Office: 941-316-1776
Cell: 941-915-3728

From:	Xinjian Chen
To:	Yonas Ghile; Eric DeHaven; Doug Leeper
Subject:	RE: Flow velocity in Peace River
Date:	Friday, September 4, 2020 11:03:48 AM

Eric,

Yes, we can provide velocities in the lower Peace River. I will need the locations where Mike Coates is looking for.

XinJian

From: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>
Sent: Friday, September 4, 2020 10:56 AM
To: Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>
Subject: RE: Flow velocity in Peace River

Eric
Simulated flow velocity may be generated from the hydrodynamic model outputs. XinJian, please see the email below and respond to Eric.
Thanks

From: Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>
Sent: Friday, September 4, 2020 10:45 AM
To: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: FW: Flow velocity in Peace River

Yonas, see email below and let me know.

Eric DeHaven, P.G.
Southwest Florida Water Management District
Assistant Director, Resource Management Division
7601 HWY 301N Tampa FL 33637
(813) 985-7481 X2118

From: Mike Coates <mcoates@regionalwater.org>
Sent: Friday, September 4, 2020 9:56 AM
To: Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>
Subject: Flow velocity in Peace River

[EXTERNAL SENDER] Use caution before opening.
Eric:

Does the District have information on flow velocity in the Peace River (ft/sec…) at various locations – or even just an average upstream of our intake? If so can you point me to it.

Thanks,

Mike

Mike Coates, P.G.
Deputy Director
PRMRWSA

Office: 941-316-1776
Cell: 941-915-3728

Peace River Manasota
Regional Water Supply Authority

From:	Doug Leeper
To:	ConservationPlanningServices@myFWC.com
Cc:	Kat.Amoah@MyFWC.com; Fury, Jon; Jason.Hight@MyFWC.com; jennifer.goff@MyFWC.comr; eric.johnson@myFWC.com; Michelle.Sempsrott@MyFWC.com; Eric Nagid; Stasey.Whichel@MyFWC.com; Ryan Hamm (Ryan.Hamm@MyFWC.com); Eric.Sutton@myFWC.com; Phillip Stevens; Dave Blewett; Yonas Ghile; Xinjian Chen; Kristina Deak; Chris Anastasiou; Chris Zajac; Randy Smith; Eric DeHaven; Adrienne E. Vining; Mike R. Bray; carla.Lambert@MyFWC.com; Ryan Ellis
Subject:	SWFWMD memo - John Fury FWC letter on Lower Peace/Shell MFLs
Date:	Thursday, October 8, 2020 7:26:00 AM
Attachments:	SWFWMD 2020-Response to FWC LPR_Shell 2020-10-08.pdf

Greetings:

On behalf of the Southwest Florida Water Management District, I would like to thank Mr. John Fury for his May 4, 2020 letter in which he summarized comments from Florida Fish and Wildlife Conservation Commission (FWC) staff on the District's draft report concerning minimum flows under development for the Lower Peace River and Lower Shell Creek. We appreciate the careful review and comments provided by the FWC and look forward to continued coordination between our organizations during the remainder of the minimum flows development process, as well as for future efforts associated with our mutual goals concerning protection of the Lower Peace River, Lower Shell Creek and other water resources.

Please find attached a memorandum that outlines District staff's consideration of and response to the comments provided in Mr. Fury's letter.

Note that the District facilitated an independent, scientific peer review of the Lower Peace River/Lower Shell Creek minimum flows work and will be facilitating a public workshop (webinar) on recommended minimum flows for the Lower Peace River on October 29, 2020. Information on the public workshop is available from the District's Boards, Meetings and Events webpage at: https://www.swfwmd.state.fl.us/about/calendar/public-meeting-recommended-minimum-flows-the-lower-peace-river.

Also note that we are continuing to update the draft minimum flows report for the Lower Peace/Shell System and anticipate posting an updated version of the document to the District website prior to the scheduled public workshop. The updated report appendices will include information associated with the peer review and stakeholder input, such as that provided by the FWC.

Please contact me if FWC staff have any additional comments or questions concerning the minimum flows or the upcoming public workshop.

Doug Leeper
MFLs Program Lead
Environmental Flows and Assessments Section
Natural Systems & Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street (U.S. Hwy. 41 South)
Brooksville, FL 34604-6899

352-796-7211, Ext. 4272
1-800-423-1476, Ext. 4272
Doug.leeper@watermatters.org

October 8, 2020

MEMORANDUM

TO: File

FROM: Kristina Deak, Staff Environmental Scientist, Environmental Flows and Assessments Section, Southwest Florida Water Management District

Doug Leeper, MFLs Program Lead, Environmental Flows and Assessments Section, Southwest Florida Water Management District

SUBJECT: Staff response to comments submitted by the Florida Fish and Wildlife Conservation Commission on May 4, 2020 concerning the District's draft report on proposed minimum flows for the Lower Peace River and Lower Shell Creek

---

Overview

On May 4, 2020, John Fury, Director of the Division of Freshwater Fisheries Management for the Florida Fish and Wildlife Conservation Commission (FWC) submitted a letter to the Southwest Florida Water Management District that included comments and recommendations from FWC staff on the District's draft report on proposed minimum flows for the Lower Peace River and Lower Shell Creek.

Comments and recommendations from the FWC are reproduced below, along with District responses. Note that many FWC comments and recommendations include the acronym "MFL", which corresponds with "minimum flows and levels" and can synonymously be equated with "minimum flows." As noted in several of the responses, the questions provided by the FWC will support preparation of an updated version of the draft report that will be used by the District to further development of minimum flows for the Lower Peace River and Lower Shell Creek.

John Fury's letter and this summary response memorandum prepared by District staff will be included in a stakeholder review appendix to the updated version of the draft minimum flows report.

<u>FWC Comments/Recommendations (1):</u>
"Overall, FWC staff appreciates the job the District has done in using the best information available to reevaluate the recommended minimum flows and levels for the Lower Peace River and Lower Shell Creek Systems. The majority of the analyses used to determine MFL targets are scientifically sound and should be protective of fish and wildlife and their habitats. The District's collection and use of additional data from the systems are appreciated, and FWC staff support the District's change to a new flow-

based block regime for determining MFLs in both systems and evaluating the potential effects of sea level rise. Staff acknowledge this document focuses on the zone of low salinity (oligohaline) as the target for MFL development and believe this river stretch is very important to fish and wildlife. Environmental conditions upstream often affect the dynamics of the ecosystem downstream, and a healthy estuary represents a continuum from freshwater to marine. Staff also endorses the percent-of-flow method for regulating consumptive use because it maintains all aspects of the natural flow regime (i.e., timing, duration, magnitude, and seasonality of flow events), which are important for the maintenance of ecological function."

District Staff Response(s) to FWC Comments/Recommendations (1):
We thank FWC staff for these comments and their support.

FWC Comments/Recommendations (2):
"The zone of low salinity and the lowermost non-tidal freshwater stretches could be better characterized by drawing from work the District funded on fish assemblages in the Peace River during the past decade. This work investigated the oligohaline stretch of the Peace River, characterized fish assemblages in each of three river sections used in previous MFLs (lower, middle and upper river) and defined habitat and diet of large predatory fishes (common snook, largemouth bass, and Florida gar) in three river sections (lower, middle and upper river). Additionally, a long period of record (eight years) was used to relate mean annual river flows to the abundance and condition of a representative large-bodied fish, common snook. This is among the most comprehensive fish work conducted for a river system in Florida, which is important since the Peace River MFL tends to serve as a model for other MFLs in Florida. Unfortunately, this work is not well summarized in the document."

District Staff Response(s) to FWC Comments/Recommendations (2):
Staff acknowledges that the important work done by the FWC and others in this system could be better summarized in our minimum flows report and has rewritten portions of section 4.1.1 to incorporate the findings from Blewett et al. (2013) and (2017), Call et al. (2013), and Stevens et al. (2013). The updated portions of the text in the current draft of the report are as follows:

> "Salinity is an important physical factor affecting biota of tidal rivers that is influenced by both freshwater inflow and tidal effects. Osmotic limitations impose restrictions on the range of freshwater and marine species and fish communities in the Lower Peace River can be separated based upon their primary salinity habitat (Call et al. 2013, Stevens 2017). Estuaries also support euryhaline communities, which are organisms that can tolerate a wide range of salinities and have adapted to seasonal fluctuations in flow regimes (Banks et al. 1991). Many species, including estuarine-dependent fish, rely on different salinity zones, during different life stages (Wang and Raney 1971; Peebles 2002; Greenwood et al. 2004; Rubec et al. 2018). Based upon catch data, the oligohaline zone (<5 psu) in the Lower Peace River may serve as an extension of juvenile habitat for estuarine residents and transients, species that can tolerate a wide range of salinities (Banks et al. 1991, Stevens et al. 2013).

Flow can shift salinity regimes to expand either the freshwater habitat during wet periods or the saline conditions in dry periods, with subsequent impacts on the structure of biological communities (Alber 2002). Several researchers have evaluated the effects of flow on fish assemblages and on individual fish species in the Lower Peace River (Stevens et al. 2013, Blewett et al. 2013, Call et al 2013). In a study comparing fish populations in the lower and oligohaline portions of the river in years of comparatively high and low flow, communities in the oligohaline zone were distinct from those in the lower river during wet years, but became more similar in dry years, when Sand Seatrout (*Cynoscion arenarius*), Tidewater Mojarra (*Eucinostomus harengulus*), and Red Drum (*Sciaenops ocellatus*) became more abundant in the oligohaline stretch (Stevens et al. 2013). The three dominant predators of the Peace River, Common Snook (*Centropomus undecimalis*), Largemouth Bass (*Micropterus salmoides*), and Florida Gar (*Lepisosteus platyrhincus*) also abide by salinity constraints, with Common Snook being most abundant within the Lower Peace River (Blewett et al. 2013).

Flow has additional effects on the growth and abundance of fish species by altering the amount and duration of floodplain inundation and subsequently the availability of habitat and prey derived therein (Wharton et al. 1982, Ainsle et al. 1999, Hill and Cichra 2002). Tropical floodplains are highly productive habitats for invertebrates and small fish, important prey items for large-bodied predators that become available in the main river channel as water levels fall (Blewett et al. 2017). In the subtropical Lower Peace River, Common Snook abundance and body condition was positively correlated with flow over an eight-year record. This was likely due to increased consumption of prey items whose life cycles are associated with inundated floodplains during periods of high flow, particularly Crayfishes (*Procambarus* spp.) and Brown Hoplo (*Hoplosternum littorale*) (Blewett et al. 2017).

Changes in water level with flow exposes different amounts of critical habitat for fish and their prey, such as snags or woody debris. Snags provide cover for ambush predators, refuge from high velocity currents, and habitat for prey items like invertebrates (Blewett et al. 2013). The period of inundation of woody habitat is important for prey production, as sustained submersion is necessary for microbial conditioning and periphyton development prior to invertebrate colonization. Highlighting the importance of structure to fish assemblages, the presence of woody debris in the Lower Peace River was associated with changes in fish community structure between sampling events over a three-year period (Call et al. 2013)."

FWC Comments/Recommendations (3):

"The FWC's fish community data in the Lower Peace River and Charlotte Harbor areas (Appendix E) was well summarized in the report; however, fish assemblages should also be characterized throughout the freshwater portions of the river in order to provide for a more thorough background that may be relevant to future MFL documents. A dedicated section on the importance of floodplain inundation would be ideal (see below). Also, it would be useful to outline habitat parameters that are important to protect in the freshwater portions of the river (e.g., snags and overhanging vegetation). Although hydrologic modeling found the oligohaline zone to be more sensitive to inflow-related changes, it is still important to summarize fisheries data related to the freshwater portions of rivers, especially since maintenance of floodplain connectivity is a resource of concern."

District Staff Response(s) to FWC Comments/Recommendations (3):
Staff recognize the utility of better characterizing the entirety of the fish community within the extent of the river associated with the proposed minimum flows, while acknowledging the most sensitive habitat was sufficiently examined. We have requested any additional available freshwater fisheries data from Lower Peace River study region from the Division of Freshwater Fisheries Management of the FWC, and time-permitting, will incorporate all relevant information into future updates of our minimum flows report. Currently, additional text has been added to section 4.1.1 summarizing the importance of floodplain inundation and woody habitat.

FWC Comments/Recommendations (4):
"In Section 5.4 Resources of Concern for Determining Minimum Flows, the importance of floodplain inundation and connectivity to the mainstem of the Peace River is acknowledged as one of three resources of concern for the MFL – "Maintenance of seasonal hydrologic connections between the river channel and floodplain to ensure the persistence of floodplain structure and function." However, background text supporting this concern and later describing the results of modeling related to floodplain inundation in the document is lacking and should be emphasized more. It could be said that floodplain inundation has a profound effect on the distribution and condition of large piscivores.

Since the first MFL was adopted, District staff have been proactive in obtaining information related to the effects of high inflow events. The FWC's work was focused on helping to fill this data gap. The District followed up with detailed vegetation surveys to determine what was being flooded during high inflow periods. However, the area of river selected for study appears to be more influenced by tides than by seasonal floodwaters. The FWC's studies of large sportfish show that common snook are heavily using the mainstem areas just downstream of SR 760 (Nocatee Road) around Johnson and Bee Gum lakes and several other unnamed floodplain waterbodies. These areas connect seasonally to the river and provide habitat for prey production; much of this prey eventually ends up in the main stem of the river for large predators to consume during the fall. New information regarding the importance of floodplain inundation has recently come to light from our region and in other countries where researchers are seeing that timing, as well as duration, of flood events, are important ecological factors. The identification of threshold levels of floodplain inundation (i.e., targets) would be very useful in the Peace River."

District Staff Response(s) to FWC Comments/Recommendations (4):
The text of section 4.1.1 has been updated to highlight the importance of floodplain inundation within the ecological resources section of the report. We think this description and the background information provided in Section 5.4.3 are sufficient to substantiate our evaluation of floodplain inundation in support of the proposed minimum flows. Total inundated floodplain area was calculated for flow reduction scenarios relevant to minimum flows development (e.g., baseline to 40% flow reductions) modeled from 2007 to 2014, rather than obtaining a critical threshold level. The 10% decrease in inundated floodplain wetland habitat observed with a 40% reduction in flow was deemed unlikely to alter the structure and function of the floodplain wetland community in the Lower Peace River. We thank the FWC for their inclusion of recent literature that highlights the importance of evaluating the timing and duration of flooding in relation to prey production for important fisheries, including Common Snook. District Minimum Flows and Levels are established with a priority for maintaining the natural flow regime of each river, including flooding events. Therefore, we believe our current body of work on the Lower Peace River adequately studies the effects of flow reduction on area of floodplain inundation for the purpose of MFL establishment. However, in review of the recent literature, we acknowledge the importance on including timing and duration effects in future floodplain inundation modeling of this system.

FWC Comments/Recommendations (5):
"Staff supports the protection of salinity-based habitats as an effective method for protecting a diverse array of species and preventing significant harm to environmental values in the Lower Peace River and Lower Shell Creek Systems. However, since it was determined that the water volume associated with the < 2 psu habitat zone was the most sensitive salinity-habitat criterion, it would be helpful to include a table or graphic, subsequent to table 6-4, showing the percent decrease in water volume associated with the 1-40% flow reductions from just this salinity zone (< 2 psu) to highlight the 13, 23 and 40% flow reduction thresholds from Blocks 1-3. It is not currently clear, based only on Table 6-4, if the water volume relationship in habitats < 2 psu are affected linearly or non-linearly with percent flow reductions."

District Staff Response(s) to FWC Comments/Recommendations (5):
Details regarding relationship between flow reductions and the water volume of the ≤ 2 psu habitat may be found in Figure 43 and Tables 8 through 10 of Appendix C. There is a linear relationship between water volume and percentage flow reduction with an R^2 value greater than 0.99 for Blocks 1-3.

The text in Section 6.3 of the minimum flows document has been modified to reflect the linear relationship between percent flow reduction and decline in available water volume as follows:

> "The water volume associated with salinity less than 2 psu habitat was the most sensitive salinity-habitat criterion and a linear relationship ($R^2 = 0.99$) was observed between percent-of-flow reductions and decline in water volume for Blocks 1-3."

FWC Comments/Recommendations (6):
"While the benthic macroinvertebrate summaries in this document are important, recent benthic community data in this document is lacking. Benthic communities have proven to be valuable as indicators of environmental health, primarily because they are relatively immobile and can be abundant. Benthic macroinvertebrates are very important ecologically because they serve as prey for many fishes, motile crustaceans, and even birds. Furthermore, benthic macroinvertebrates have been shown to be sensitive indicators of salinity."

District Staff Response(s) to FWC Comments/Recommendations (6):
Staff acknowledge that the benthic macroinvertebrate community is ecologically important. The most recent available data, to our knowledge, has been summarized in the draft minimum flows report and we included Blue Crab (*Callinectes sapidus*) in the modeling efforts completed in support of the minimum flows (Appendix E). We think the biological information collected to date and summarized in our report is sufficient for the development of recommended minimum flows for the Lower Peace River. However, to further our adaptive management approach to minimum flows development and implementation, we continue to support ongoing data collection efforts and will consider additional sampling and analysis of biological data as needed, for future evaluations.

We note that much of the available benthic macroinvertebrate information has been collected in support of the required Charlotte Harbor Hydrobiological Monitoring Program (HBMP) and monitoring by the Peace River/Manasota Regional Water Supply Authority (PRMRWSA). In 1996, the HBMP Scientific Review Panel recommended that monitoring primarily focus on assessing long-term trends in key physical, chemical, and biological characteristics that could be directly linked to potential effects from withdrawals at PRMRWSA, rather than indirect biological indicators, like benthic macroinvertebrates, after their baseline was established. District Regulation Division staff will be provided with the peer review panel's concerns regarding current HBMP data-collection parameters.

FWC Comments/Recommendations (7):
"In Section 4.1.1 Shoreline Vegetation, description of shoreline vegetation communities is made using information collected in 1988 and 1989, which is over 30 years ago. Additionally, the map shown in Figure 4-1 is also 30 years old. While this historical information has value, it would be helpful to include more recent vegetation community data and maps for comparative purposes."

District Staff Response(s) to FWC Comments/Recommendations (7):
The District acknowledges that vegetation studies utilized in Section 4.1.1 were from 1998 and 1999 and updated surveys should be considered for future evaluations, however the descriptions provided therein were sufficient for the needs of this report. Figure 4.1 was replaced with a map using the Land Use Land Cover 2017 layer

maintained by the District's Mapping and GIS section to reflect the most recent available data.

FWC Comments/Recommendations (8):
"In Appendix E, the modeling only includes data collected from 1996 to 2013, but the FWC FIM program collected fish data during 2016, according to Section 4.2.1. This report does not address changes from 2013 to 2016. It would be helpful to include the latest data available in this report and during modeling in order to improve MFL development."

District Staff Response(s) to FWC Comments/Recommendations (8):
At the time of model development, the best available data were used. As noted in Section 4.2.1 of the draft minimum flows report, Call et al., (2013) performed a survey on fish communities within the Lower Peace River from 2007 to 2010 and found no temporal variation across years, suggesting a generally stable system within the river. This hypothesis was tested by comparing the abundance of the taxa and size classes of fish examined in the Rubec et al. (2016) model from 2009-2013 with more recent data (2014-2018). There was no statistically significant difference in the abundance of any size class of the examined taxa between modeled and more recent years, with the exception of early juvenile Spot (*Leiostomus xanthurus*) caught by 21.3 m seine, whose abundance was higher ($p = 0.002$) during modeled years. The abundance of early juvenile Spot caught by 6.1 m otter trawl was not significantly different ($p = 0.815$) between modeled and unmodeled years. Therefore, staff did not consider remodeling the newer data to be necessary for the generation of scientifically sound minimum flows.

To augment presentation of information on the fish assemblage in the Lower Peace River, the descriptive FWC Fisheries-Independent Monitoring data from 2016 in Section 4.2.1 of our original draft minimum flows report has been replaced with the most recent available data (2018) in the revised report.

FWC Comments/Recommendations (9):
"Finally, at the end of this letter, FWC staff provided references for your review and consideration, which support the importance of freshwater flows for fish communities and fish population dynamics in oligohaline environments, several of which were conducted on the Peace River."

Suggested literature

Blewett, D.A., P.W. Stevens, and M.E. Call. 2013. Comparative ecology of euryhaline and freshwater predators in a subtropical river. Florida Scientist 76:166-190.

> "Both euryhaline and freshwater predators had affinities for structure (e.g., snags) and ate similar prey (predominantly crayfish *Procambarus* spp. and brown hoplo *Hoplosternum littorale*)."

Blewett, D.A., P.W. Stevens, J. Carter. 2017. Ecological effects of river flooding on abundance and body condition of a large, euryhaline fish. Marine Ecology Progress Series 563: 211-218.

> "Over the 8-year record, mean annual abundance and body condition of snook were positively related to mean annual river flow (R^2 = 0.88) and the number of days that river level exceeded a specific threshold (R^2 = 0.70), respectively."

Call, M.E., D.R. Sechler, P.W. Stevens, D.A. Blewett, S. Canter, and T.R. Champeau. 2013. Freshwater fish communities and habitat use in the Peace River, Florida. Florida Scientist 76:150- 164.

> "The habitat affinities of fishes identified in this study should be useful to resource managers for modeling biotic responses to changes in river water levels and habitat availability."

Stevens, P.W., M.F.D. Greenwood, and D.A. Blewett. 2013. Fish assemblages in the oligohaline stretch of a southwest Florida river during periods of extreme freshwater inflow variation. Transactions of the American Fisheries Society 142:1644-1658.

> "During a dry period, the oligohaline fish assemblage became more similar to the assemblage of the lower river mouth. Reductions in the abundance of species characteristic of the oligohaline stretch were offset by increases in the abundance of Bay Anchovy *Anchoa mitchilli*. This study provides information to managers that can be used in the restoration of oligohaline waters by identifying characteristic fishes in the oligohaline stretch of a large river, providing insight into how this river section functions as fish habitat, and determining the changes in fish assemblages that occur during low freshwater inflow conditions."

Baustian, J.J., and B.P. Piazza. 2019. Hydrologic connectivity and backswamp water quality during a flood in the Atchafalaya Basin, USA. River Research and Applications 2019:1-6. DOI: 10.1002/rra.3417.

Kozak, J.P., M.G. Bennett, B.P. Piazza, and J.W.F. Remo. 2016. Towards dynamic flow regime management for floodplain restoration in the Atchafalaya River Basin, Louisiana. Environmental Science and Policy 64:118-128.

Rabuffetti, A.P., L.A. Espinola, E. Abrial, M.L. Amsler, M.C.M. Blettler, M.F. Eurich, and E.G. Eberle. 2019. Commercial fisheries in a mega unregulated floodplain river: Assessment of the most favourable hydrological conditions for its preservation. Journal of Fish Biology 2019:1-15. DOI: 10.1111/jfb.14184.

> "Analysing more than eight decades (1935–2016) of information on the most frequent and abundant commercial species in conjunction with hydrological levels and temperature, our results show that spring–summer floods of a certain magnitude (c. 6 m) and durations (> 80 days) are crucial for sustaining commercial fisheries."

District Staff Response(s) to FWC Comments/Recommendations (9)
We thank FWC staff for bringing these papers to our attention. We have reviewed the papers and incorporated several studies into the newest draft of the minimum flows report.

FCC Comments/Recommendations (10):
In closing, FWC staff appreciates the opportunity to review the proposed MFL documents and looks forward to working with the District throughout the final approval process. If you have specific technical questions regarding the content of this letter, please contact Eric Johnson at (863) 648-3809 or by email at eric.johnson@MyFWC.com. For all other inquiries may be directed to ConservationPlanningServices@MyFWC.com.

District Staff Response(s) to FWC Comments/Recommendations (10):
We thank FWC staff for their careful review of our proposed minimum flows for the Lower Peace River and Lower Shell Creek. We also look forward to continued coordination with the FWC during the remainder of the minimum flows development process, as well as for future efforts associated with our mutual goals concerning protection of these and other valuable water resources.

We plan to provide this response memorandum to Eric Johnson via email and will copy the email provided for the FWC Office of Conservation Planning Services.

From:	Doug Leeper
To:	Christina Coger (Christina.G.Coger@floridadep.gov); Pam Flores (Pamela.Flores@dep.state.fl.us); Jennifer Adams (Jennifer.G.Adams@dep.state.fl.us); Stefani.Weeks@FloridaDEP.gov; Edward.C.Smith@FloridaDEP.gov; Medellin, Donald; Sutherland, Andrew (asutherl@sjrwmd.com); Good, John; Coates, Kathleen (Kathleen.Coates@nwfwmd.state.fl.us); Kathleen Greenwood (Kathleen.greenwood@fdacs.gov); Stempien, Jessica Lea; Michelle.Sempsrott@MyFWC.com; Eric Nagid (eric.nagid@MyFWC.com); Wiche, Stasey (Stasey.Whichel@MyFWC.com); PLehman@regionalwater.org; Genegeneheath@prwcwater. org Heath (geneheath@prwcwater.org); MCoates@regionalwater.org; ryantaylor@polk-county.net; Angela.Chelette@fdacs.gov
Cc:	Yonas Ghile; Xinjian Chen; Kristina Deak; Chris Anastasiou; Chris Zajac; Randy Smith; Eric DeHaven; Cindy C. Rodriguez; Dennis Ragosta
Subject:	SWFWMD Recommended Minimum Flows - Lower Peace River
Date:	Thursday, October 8, 2020 8:06:00 AM

Greetings:

I'm providing an update on the status of the Southwest Florida Water Management District's development of minimum flows for the Lower Peace River in DeSoto and Charlotte counties.

The District has scheduled a public meeting (webinar) to solicit stakeholder input on the recommended minimum flows for the river. Information on the public workshop is available from the District's Boards, Meetings and Events webpage at: https://www.swfwmd.state.fl.us/about/calendar/public-meeting-recommended-minimum-flows-the-lower-peace-river.

Minimum flows are limits beyond which further water withdrawals would be significantly harmful to the water resources or ecology of the area. Minimum flows are established as rules by the District Governing Board and used in regulatory and planning programs. Recommended minimum flows for the Lower Peace River were summarized in a draft report that was presented to the District Governing Board and made available on the District website in March 2020. Independent, scientific peer review of the report was conducted from March through June 2020. A revised version of the draft minimum flows report will be posted on the District's website prior to the public workshop. All public comment received prior to, during and subsequent to the workshop will be summarized for consideration by the Governing Board. District staff anticipate seeking Board approval for initiation of rulemaking for recommended minimum flows for the Lower Peace River at the Governing Board meeting scheduled for 12/15/2020.

A Lower Peace River /Lower Shell Creek web page that includes links to the draft minimum flows report, a web forum used for the independent, scientific peer review, and other relevant information is available at the District we site at: https://www.swfwmd.state.fl.us/projects/mfls/lower-peace-river/lower-shell-creek.

Written comments on the recommended minimum flows for the Lower Peace River are welcome and should be submitted no later than November 30, 2020 to me (Doug Leeper) via email (doug.leeper@watermaters.org) or by U.S. Mail (2379 Broad Street, Brooksville, Florida, 34604-6899). I can also be reached by phone at 1-800-423-1476 or 352-796,7211, extension 4272.

Let me know if you have any questions regarding the upcoming workshop or other matters related to the recommended minimum flows for the Lower Peace River.

Doug Leeper
MFLs Program Lead
Environmental Flows and Assessments Section
Natural Systems & Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street (U.S. Hwy. 41 South)
Brooksville, FL 34604-6899
352-796-7211, Ext. 4272
1-800-423-1476, Ext. 4272
Doug.leeper@watermatters.org

From:	Medellin, Donald
To:	Doug Leeper
Subject:	RE: SWFWMD Recommended Minimum Flows - Lower Peace River
Date:	Friday, October 9, 2020 9:29:29 AM

[EXTERNAL SENDER] Use caution before opening.
Thank you Doug! Have a great weekend

Don

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Thursday, October 8, 2020 8:06 AM
To: Coger, Christina G <Christina.G.Coger@floridadep.gov>; pamela.flores@dep.state.fl.us; Jennifer Adams (Jennifer.G.Adams@dep.state.fl.us) <Jennifer.G.Adams@dep.state.fl.us>; Weeks, Stefani <stefani.weeks@floridaDEP.gov>; Edward.C.Smith@FloridaDEP.gov; Medellin, Donald <dmedelli@sfwmd.gov>; Andrew Sutherland <asutherl@sjrwmd.com>; Good, John <John.Good@srwmd.org>; Kathleen Coates <Kathleen.Coates@nwfwmd.state.fl.us>; Kathleen Greenwood (Kathleen.greenwood@fdacs.gov) <Kathleen.greenwood@fdacs.gov>; Stempien, Jessica Lea <JessicaLea.Stempien@fdacs.gov>; Michelle.Sempsrott@MyFWC.com; Nagid, Eric <eric.nagid@myfwc.com>; Wiche, Stasey (Stasey.Whichel@MyFWC.com) <Stasey.Whichel@MyFWC.com>; PLehman@regionalwater.org; Genegeneheath@prwcwater. org Heath (geneheath@prwcwater.org) <geneheath@prwcwater.org>; MCoates@regionalwater.org; ryantaylor@polk-county.net; Angela.Chelette@fdacs.gov
Cc: Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Kristina Deak <Kristina.Deak@swfwmd.state.fl.us>; Chris Anastasiou <Chris.Anastasiou@swfwmd.state.fl.us>; Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Cindy.Rodriguez <Cindy.Rodriguez@swfwmd.state.fl.us>; Dennis Ragosta <Dennis.Ragosta@swfwmd.state.fl.us>
Subject: SWFWMD Recommended Minimum Flows - Lower Peace River

[Please remember, this is an external email]

Greetings:

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Let me know if you have any questions regarding the upcoming workshop or other matters related to the recommended minimum flows for the Lower Peace River.

Doug Leeper
MFLs Program Lead
Environmental Flows and Assessments Section
Natural Systems & Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street (U.S. Hwy. 41 South)
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Doug.leeper@watermatters.org

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WaterMatters.org

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941-377-3722 or 1-800-320-3503

Tampa Office
7601 US Highway 301 North
Tampa, FL 33637-6759
813-985-7481 or 1-800-836-0797

MEETING NOTICE

AGENDA
Environmental Advisory Committee Meeting

TUESDAY, OCTOBER 13, 2020

10:00 AM

Teams Meeting
2379 BROAD STREET, BROOKSVILLE, FL 34608
(352) 796-7211

All meetings are open to the public.

1. Call to Order and Introductions – Committee Chair Jennifer Hecker, Coastal and Heartland National Estuary Partnership
2. Additions and Deletions to the Agenda – Virginia Singer, Board and Executive Services Manager
3. Approval of the July 13, 2020 Meeting Minutes
4. Public Comments
5. Lower Peace River Proposed MFL – Yonas Ghile, Lead Hydrologist
6. Charlotte Harbor SWIM Plan Update – Lizanne Garcia, Lead Project Manager
7. District Seagrass Mapping Update – Chris Anastasiou, Chief Water Quality Scientist
8. The Occurrence of Filamentous Macroalgal Blooms in Southwest Florida Estuaries – Chris Anastasiou, Chief Water Quality Scientist
9. Hydrologic Conditions Update – Granville Kinsman, Hydrologic Data Manager
10. Governing Board Liaison Comments
11. Development of agenda topics for the next Environmental Advisory Committee meeting at 10:00 a.m. on Tuesday, January 12, 2021 at the District's Tampa Office.
12. Announcements and Other Business
13. Adjournment

If you have any questions concerning this meeting, please call 1-800-423-1476 or (352) 796-7211, extension 4605.

The Southwest Florida Water Management District (District) does not discriminate on the basis of disability. This nondiscrimination policy involves every aspect of the District's functions, including access to and participation in the District's programs, services and activities. Anyone requiring reasonable accommodation, or would like information as to the existence and location of accessible services, activities, and facilities, as provided for in the Americans with Disabilities Act, should contact Donna Eisenbeis, Sr. Performance Management Professional, at 2379 Broad St., Brooksville, FL 34604-6899; telephone (352) 796-7211 or 1-800-423-1476 (FL only), ext. 4706; or email ADACoordinator@WaterMatters.org. If you are hearing or speech impaired, please contact the agency using the Florida Relay Service, 1-800-955-8771 (TDD) or 1-800-955-8770 (Voice). If requested, appropriate auxiliary aids and services will be provided at any public meeting, forum, or event of the District. In the event of a complaint, please follow the grievance procedure located at WaterMatters.org/ADA.

Recommended Minimum Flows for the Lower Peace River

Environmental Advisory Committee

Yonas Ghile, XinJian Chen, Douglas Leeper, Chris Anastasiou and Kristina Deak
Natural Systems & Restoration Bureau
October 13, 2020

1

Minimum Flows

- The **minimum flow** for a given watercourse is the limit at which further withdrawals would be significantly harmful to the water resources of the area.

  – Section 373.042, Florida Statutes

2

Planned Schedule

Major Activities	Schedule
Presentation to Governing Board – Draft MFLs report	March 24, 2020
Peer review of MFLs report	March 25 – June 26, 2020
Stakeholder outreach	March 25 - Oct 30, 2020
Presentation to PRMRWSA & PRWC	April 08, 2020
Presentation at CHNEP TAC meeting	April 17, 2020
Presentation at CHNEP Watershed Summit by P. Rubec	June 01, 2020
Presentation to Public Supply Advisory Committee	August 11, 2020
Presentation to Environmental Advisory Committee	October 13, 2020
Public workshop	October 29, 2020
Presentation to Governing Board – Final MFLs report and MFLs rule	December 15, 2020

3

3

Lower Peace River

- River segment downstream of Arcadia
- Based on combined flows:
  - Peace River at Arcadia
  - Joshua Creek at Nocatee
  - Horse Creek near Arcadia
- Minimum flows
  - Adopted in 2010
  - Initial reevaluation in 2015
  - Comprehensive reevaluation and adoption scheduled for 2020

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Existing Minimum Flows & Permit Conditions for PRMRWSA

Combined Flows from Gages @ Arcadia, Horse and Joshua	Lower Peace MFL		
	Block 1 (Apr 20 - Jun 25)	Block 2 (Oct 27 – Apr 19)	Block 3 (Jun 26 - Oct 26)
<130 cfs	0% (0%)		
130 - 625 cfs	16% (16%)		
≥ 625 cfs	16% *(16%*)	29%* (28%*)	38%* (28%*)
* Maximum daily withdrawal also limited to 400 cfs			

- PRMRWSA permit conditions in yellow

5

5

Developed Baseline flows

- Developed baseline flows (flows with no withdrawal effects) for the period from 1950 through 2014

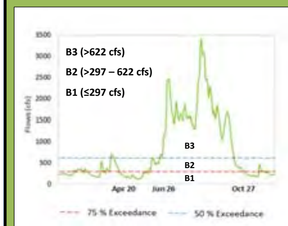
6

6

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Developed Flow-Based Blocks

Currently Used Flow-Based Blocks	Previously Used Calendar-Based Blocks



- Flow-based blocks better represent low, medium and high flow conditions for minimum flows development and implementation

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Enhanced Hydrodynamic Modeling

Current model (Chen 2020)

- Unstructured 3D hydrodynamic model
- Includes entire Charlotte Harbor
- New LiDAR and bathymetry data
- 21-month calibration/validation period
- 7.7-year simulation period (Jan 2007 – Aug 2014)

Previously used model (Chen 2010)

- Structured 3D hydrodynamic model
- Limited to Upper Charlotte Harbor
- 13-month calibration/validation period
- 3-year simulation period (2000 - 2002)

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Enhanced Ecological Criteria and Considerations

Current Ecological Criteria and Considerations	Previous (2010 Evaluation) Ecological Criteria and Considerations
▪ Salinity-based habitats (≤2, ≤5, ≤10, ≤15, ≤20 psu) ▪ Floodplain inundation ▪ Habitats for 7 fish species and Blue Crab ▪ Water quality (dissolved oxygen, nutrients, chlorophyll, color)	▪ Salinity-based habitats (≤2, ≤5, ≤10, ≤15, ≤20 psu)

- **≤ 2 psu salinity volume** was the metric most sensitive to flow reductions
- Minimum flows developed based on preserving 85% of **≤2 psu salinity volume**

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Recommended Minimum Flows for the Lower Peace River

Flow-based Block	If Flow on Previous Day is:	Minimum Flow is:	Maximum Flow Reduction is:
1	≤130 cfs	100% of flow	0 cfs
	130 cfs to 149 cfs	130 cfs	flow minus 130 cfs
	150 cfs to 297 cfs	87% of flow	13% of flow
2	298 cfs to 335 cfs	258 cfs	flow minus 258 cfs
	336 cfs to 622 cfs	77% of flow	23% of flow
3	623 cfs to 798 cfs	479 cfs	flow minus 479 cfs
	>798 cfs	60% of flow*	40% of flow*

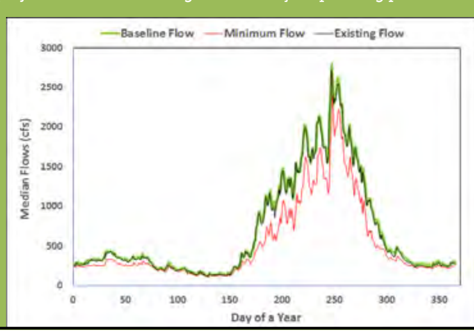
* Daily maximum withdrawal is 400 cfs

10

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Minimum Flows Status - Lower Peace River

- Proposed Lower Peace River minimum flows are currently met and are projected to be met during the next 20-year planning period



11

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Recommended Minimum Flows Summary

- Recommended minimum flows for the Lower Peace River and Lower Shell Creek are based on maintaining 85% of the 2 psu or less salinity volume
- Recommended minimum flows are protective of all environmental values identified for consideration when establishing minimum flows
- Recommended Lower Peace River minimum flows are currently met and projected to be met during the next 20-year planning period

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Southwest Florida Water Management District

Peer Review Panel

- MFLs report well written and comprehensive
- Use of flow-based blocks supported
- Use of 15% threshold for "significant harm" supported
- Enhanced hydrodynamic model supported
- Enhanced ecological criteria supported
- Continued coordination with SFWMD
- Sea level rise analysis supported

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Southwest Florida Water Management District

Next Steps and Contact Information

- Public workshop - October 29, 2020
- Presentation to Governing Board – Dec 15, 2020
- Minimum flows report and appendices:
  https://www.swfwmd.state.fl.us/projects/mfl/documents-and-reports
- Contact information:

Yonas Ghile
2379 Broad Street
Brooksville, FL 34604
(352) 796-7211, Ext. 4488
Yonas.ghile@swfwmd.state.fl.us

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Southwest Florida Water Management District

Thank you!

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Southwest Florida Water Management District

Habitat Suitability Modeling

- Habitat Suitability Modeling
  - Salinity
  - Temperature
  - Dissolved oxygen
  - Water depth
  - Bottom type
- Modeled low, moderate, high and optimum habitat suitability for:
  - J-Bay Anchovy
  - A-Bay Anchovy
  - EJ-Southern Kingfish
  - EJ-Red
  - EJ-Spot
  - J-Sand Seatrout
  - JA-Hogchoker

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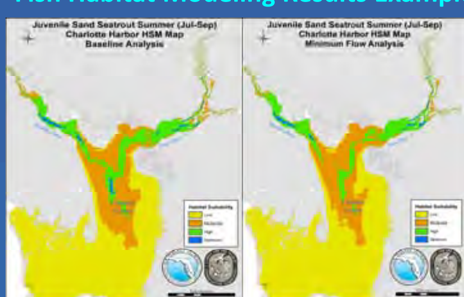
Southwest Florida Water Management District

Fish Habitat Modeling Results Example



Habitat Zones	Low	Moderate	High	Optimum
Habitat Gained/Lost	+ 7.0%	- 2.4%	- 4.3%	- 0.3%

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From:	matt warren
To:	Doug Leeper
Subject:	Peace River Minimum Flow Levels
Date:	Tuesday, October 20, 2020 10:58:15 AM

[EXTERNAL SENDER] Use caution before opening.

This is for public comment on the Minimal Flow Levels for the Peace River.
Having grown up in Zolfo Springs I spent many days on the river. I have noticed the change very noticeable. Especially during the dry times of spring when the water does not flow much and it has a dirty black look and smells. One thing that never gets mentioned is the Phosphate mines that dig on both sides of the river. These mines break up the underground river and springs which allows fresh water to flow into the river by creeks or even under the river by small holes. I know they are not 1st magnitude springs but regardless they bring in fresh clean water, or did in the past. Why can nothing be done about this issue. This would help the minimal flow down stream if mining could be slowed down. Just my thoughts
Thanks
Matt Warren
Hardee County

--

Love is what Jesus did at the Cross
Remember why he did it

Southwest Florida Water Management District

2379 Broad Street, Brooksville, Florida 34604-6899
(352) 796-7211 or 1-800-423-1476 (FL only)
WaterMatters.org

An Equal Opportunity Employer

MEETING NOTICE

AGENDA
Public Meeting
Recommended Minimum Flows for the Lower Peace River

THURSDAY, OCTOBER 29, 2020
5:30 PM TO 7:00 PM

WEBINAR (TEAMS MEETING)

Teams meeting (Conference ID 838 375 52#) link: Join Microsoft Teams Meeting

Alternative Teams meeting link: https://bit.ly/2GjUvvv

Telephone-only participation: 1-786-749-6127; Conference ID: 838 375 52#

All meetings are open to the public.

1. Recommended minimum flows for the Lower Peace River by Doug Leeper, District MFLs Program Lead

2. Public comment facilitated by Doug Leeper

Participants will be asked to save their comments until the public comment portion of the meeting. If you wish to speak during the public comment period, please identify yourself to the Moderator (Doug Leeper), who will then facilitate your input. Comments will be limited to three minutes per speaker. In appropriate circumstances, the Moderator may grant exceptions to the three-minute limit.

For questions or to submit additional public comment on the Minimum Flows and Levels Priority List and Schedule, please contact Doug Leeper by email at doug.leeper@watermatters.org, by telephone at 1-800-423-1476 or 352-796-7211, extension 4272, or by mail at the address listed at the top of this agenda. Written comments should be submitted no later than November 30, 2020.

Bartow Office
170 Century Boulevard
Bartow, FL 33830-7700
863-534-1448 or 1-800-492-7862

Sarasota Office
78 Sarasota Center Boulevard
Sarasota, FL 34240-9711
941-377-3722 or 1-800-320-3503

Tampa Office
7601 US Highway 301 North
Tampa, FL 33637-6759
813-985-7481 or 1-800-836-0797

From:	Yonas Ghile
To:	Laura Baumberger; Sarah Burns; Victoria Steinnecker; Steve Adams; Chuck Pavlos
Cc:	Doug Leeper; Chris Zajac; Xinjian Chen; Kristina Deak; Randy Smith; Eric DeHaven
Subject:	LSC presentation
Date:	Thursday, October 22, 2020 11:22:01 AM
Attachments:	shell_creek scenario analyses_city of PG_oct 22.pptx

Hi Laura

Attached, the slides presented today. I will send the updated spreadsheet model via ftp.

Thank you

Yonas Ghile, PhD, PH
Lead Hydrologist
Natural Systems & Restoration Bureau
Southwest Florida Water Management District
(352) 796-7211 Ext. 4488
Email: Yonas.Ghile@swfwmd.state.fl.us

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Minimum Flows Assessment for Lower Shell Creek

Southwest Florida Water Management District

October 22, 2020

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Review and Presentation Preview

1. MFLs development for Lower Shell Creek (LSC) and Lower Peace River (LPR) scheduled for 2020
2. Peer review completed in spring 2020; draft MFLs supported
3. Initial status assessment – recovery strategy (reverse osmosis (RO) facility, bypass structure) needed for LSC; not needed for LPR
4. MFLs development – LPR proceeding; LSC rescheduled for 2021

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Review and Presentation Preview (continued)

5. Additional LSC assessments
   - Daily flow status method – binary met/not met vs. partial credit
   - Agricultural runoff correction for inflows – identifies MFLs requirement
   - Recovery project simulations – RO facility and bypass structures with differing conveyance capacity
   - Salinity habitat responses
6. Results
   - Bypass structure may not be needed for LSC recovery strategy
   - Prevention strategy needs for LSC being assessed
   - LPR MFLs continue to be met
7. Next steps

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Approach for Minimum Flows Development

- Baseline flows developed for the period 1966 through 2018
  (Gaged flow + surface withdrawals - agricultural runoff)
- Identified three flow-based blocks using baseline flows
- Minimum flows developed based on combined ≤ 2psu salinity volume in the LPR/LSC

Flow-based Blocks	Low Flow (Block 1)	Medium Flow (Block 2)	High Flow (Block 3)
	<56 cfs	56 - 137 cfs	>137 cfs
Minimum Flows	87%	77%	60%

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Initial Minimum Flow Assessment

Scenarios Limit	Source of Water	2040 Demand Projection	DEP TDS Limit	Water Supply 100% Met Days	MFL Met Days
Existing (no MFL)	Reservoir	6.3 mgd	1000 mg/l	99.71%	80.00%
Existing (no MFL)	Reservoir	6.3 mgd	500 mg/l	62.21%	80.00%
Existing (no MFL)	Res. & RO	6.3 mgd	500 mg/l	99.84%	89.91%
MFL	Res. & RO	6.3 mgd	500 mg/l	99.81%	100.00%
MFL-20 mgd Limit	Res. & RO	6.3 mgd	500 mg/l	99.81%	99.00%

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Methods for MFLs Status Assessment

1. MFLs met days method

Full met days (previously used)	Credit for partially met days (recommended)
MFLs Credit = 1, if released flow >= MFLs MFLs Credit = 0, if released flow < MFLs	MFLs Credit = MIN (1, released flow/ MFLs)
MFLs Met (%) = average of MFLs credit in the evaluation period	

- Evaluation period from 1972 through 2018

2. Habitat response method (based on ≤2 psu volume)

$$\text{MFLs Met (\%)} = \frac{\text{Scenario}_{\text{habitat}}}{\text{MFLs}_{\text{habitat}}} \times 100$$

- MFLs Met is calculated for each flow-based block
- Evaluation period from 2007 through 08/2014

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Example 1: MFLs Met Days

Date	Inflows (cfs)	Block	MFLs (cfs)	Flow Released (cfs)	Fully Met Days	Credit for Paritally Met Days
04/17/1972	63					
04/18/1972	63	2	48.2	53.77	1	1.00
04/19/1972	51	2	48.2	53.75	1	1.00
04/20/1972	45	1	39.1	41.93	1	1.00
04/21/1972	45	1	39.0	38.33	0	0.98
04/22/1972	27	1	38.9	38.22	0	0.98
04/23/1972	21	1	23.4	20.32	0	0.87
04/24/1972	27	1	18.2	14.33	0	0.79
04/25/1972	33	1	23.4	20.31	0	0.87
MFLs met in the evaluation period (%)					37.5% (days)	93.7% (flows)

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Example 2: Inflows Correction for Agricultural Runoff

Date	Inflows (cfs)	Corrected Inflows (cfs)*	Block	MFLs (cfs)	Flow Released (cfs)	Fully Met Days	Credit for Paritally Met Days
04/17/1972	63	49					
04/18/1972	63	49	1	42.7	53.77	1	1.0
04/19/1972	51	37	1	42.7	53.75	1	1.0
04/20/1972	45	31	1	32.4	41.93	1	1.0
04/21/1972	45	31	1	27.3	38.33	1	1.0
04/22/1972	27	13	1	27.2	38.22	1	1.0
04/23/1972	21	7	1	11.6	20.32	1	1.0
04/24/1972	27	13	1	6.4	14.33	1	1.0
04/25/1972	33	19	1	11.6	20.31	1	1.0
MFLs met in the evaluation period (%)						100% (days)	100% (flows)

* Corrected inflows = inflows minus agricultural runoff

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Selected Scenarios for MFLs Assessment

Sc. Num	Scenario	Agricultural Runoff
1	MFLs	Not included
2	No RO & No Bypass	Included
3	RO & No Bypass	
4	RO & 5 mgd Bypass	
5	RO & 20 mgd Bypass	
6	RO & Maximum Bypass ▪ 96 mgd for 2020 (5.4 mgd) ▪ 144 mgd for 2040 (6.6 mgd)	

- Scenarios were run using 2020 (5.4 mgd) and projected 2040 (6.6 mgd) water use demand

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

MFLs Status Assessment Results

MFLs (inflows corrected for agricultrual runoff)		
2020 Water Demand (5.4 mgd)	Fully Met MFLs Days	Credit for Paritally MFLs Met Days
No RO & No Bypass	98.8%	99.4%
RO & No Bypass	99.8%	99.8%
RO & 5 mgd Bypass	99.8%	99.9%
RO & 20 mgd Bypass	99.9%	100.0%
RO & 96 mgd Bypass	100.0%	100.0%
2040 Water Demand (6.6 mgd)	Fully Met MFLs Days	Credit for Paritally MFLs Met Days
No RO & No Bypass	97.7%	99.1%
RO & No Bypass	99.5%	99.7%
RO & 5 mgd Bypass	99.7%	99.8%
RO & 20 mgd Bypass	99.7%	99.9%
RO & 144 mgd Bypass	100.0%	100.0%

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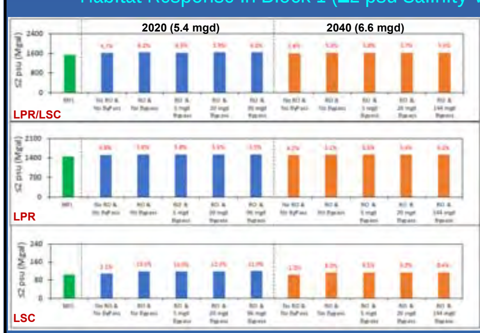
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Habitat Response in Block 1 (≤2 psu Salinity Volume)



- MFLs developed based o combined LPR/LSC ≤2 psu volume habitat
- LPR MFLs met, no recovery/prevention strategy needed
- LSC MFLs expected to be met with the use of RO and agricultural runoff, no recovery strategy is required

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Summary

- No recovery strategy needed for LSC MFLs
- Prevention strategy needed
  - Needs assurance for continued use of RO
    - 3.5 mgd in Block 1 (dry flow condition)
    - 2 mgd in Blocks 2 (medium flow condition) and 3 (high flow condition)

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Southwest Florida Water Management District

Next Steps

- Prevention strategy development
- Develop amendment (addendum) to MFLs report to address new LSC MFLs assessment
- Presentation LSC MFLs to Public Supply Advisory Committee
- Presentation LSC MFLs to Environmental Advisory Committee
- Coordination with other stakeholders
- Public workshop
- Draft MFLs Rule for LSC
- Presentation to Governing Board

13

District to Hold Virtual Workshop on Minimum Flow for the Lower Peace River in Charlotte and DeSoto Counties

October 20, 2020 by Post

https://www.tampabaynewswire.com/2020/10/20/district-to-hold-virtual-workshop-on-minimum-flow-for-the-lower-peace-river-in-charlotte-and-desoto-counties-91362

The Southwest Florida Water Management District (District) invites the public to a virtual workshop Thursday, Oct. 29, from 5:30 to 7 p.m. The purpose of the virtual workshop is to allow for public comment on recommended minimum flows for the Lower Peace River in Charlotte and DeSoto counties.

In accordance with the directive in the Florida Department of Environmental Protection's Emergency Order to conduct all public meetings electronically, members of the public may join the meeting via Microsoft Teams through this link: https://bit.ly/2GjUvvv. The Google Chrome browser is recommended for best compatibility with Microsoft Teams. For telephone-only participation, dial 1-786-749-6127 and when prompted enter the conference ID: 838 375 52#.

Minimum flows are limits established by the District's Governing Board, and required by state law, to protect flowing water bodies from significant harm caused by ground and surface water withdrawals.

The District's experienced scientists use numerous tools to collect, develop and analyze data before recommending a minimum flow. Their work is then evaluated by an independent peer review panel. During the workshop, District staff will review the technical basis for the recommended minimum flows for the Lower Peace River. A draft 2020 report summarizing the recommended minimum flows is available for review and is posted at*WaterMatters.org/documents-and-reports.*

District staff anticipates presenting the recommended minimum flow for the Lower Peace River at the December Governing Board meeting, where the Governing Board may choose to initiate rulemaking for adoption of the minimum flow into District rules. Governing Board meetings are open to the public, and brief oral comments are permitted on meeting agenda items.

For more information regarding the recommended minimum flow, please contact Doug Leeper, MFLs Program Lead with the District's Environmental Flows and Assessments Section at 1-800-423-1476, ext. 4272.

Written comments regarding the minimum flows are also welcome. They can be submitted via mail or email no later than Nov. 30, 2020, to Doug Leeper, at 2379 Broad Street, Brooksville, FL 34604-6899 or doug.leeper@watermatters.org.

From:	Laura Baumberger
To:	Chris Zajac; Eric DeHaven; Randy Smith; Doug Leeper; Yonas Ghile; Kristina Deak; Xinjian Chen; Steve Adams; Chuck Pavlos; Sarah Burns; Victoria Steinnecker; Dennis Ragosta
Cc:	Steven Leonard; Brian Fuller
Subject:	Lower Shell Creek MFL
Date:	Tuesday, October 27, 2020 1:54:51 PM
Attachments:	Lower Shell Creek MFL - October 2020 Meeting Minutes.pdf

[EXTERNAL SENDER] Use caution before opening.

Good afternoon,

Attached please find draft minutes to document discussions at the meeting held last Thursday. A number of next steps/action items are also included.

Please let us know of any additions or corrections.

Thanks,
Laura

Laura Baumberger, PE
Project Manager | Vice President
301 North Cattlemen Road, Suite 302 | Sarasota, FL 34243
P 941-371-9832 | **M** 941-400-2320
carollo.com

-----Original Appointment-----
From: Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>
Sent: Saturday, October 3, 2020 10:09 AM
To: Chris Zajac; Eric DeHaven; Randy Smith; Doug Leeper; Yonas Ghile; Kristina Deak; Xinjian Chen; Laura Baumberger; Steve Adams; Chuck Pavlos; Sarah Burns; Victoria Steinnecker; Dennis Ragosta
Subject: Discuss Lower Shell Creek MFL
When: Thursday, October 22, 2020 10:00 AM-11:30 AM (UTC-05:00) Eastern Time (US & Canada).
Where: Microsoft Teams Meeting

The purpose of this meeting will be to discuss the District's most recent model results for Lower Shell Creek. Please feel free to invite others as deemed appropriate.

Join Microsoft Teams Meeting

+1 786-749-6127 United States, Miami (Toll)

Conference ID: 605 789 808#

Local numbers | Reset PIN | Learn more about Teams | Meeting options

INTERNAL USERS: Please use headset and microphone to join meeting audio. EXTERNAL USERS: Please dial toll # or use headset and microphone to join meeting audio.

MEETING MINUTES

LOWER SHELL CREEK MFL

City of Punta Gorda

Issue Date: October 27, 2020

Project No.: 11775A.00

Purpose:	To discuss the Southwest Florida Water Management District's (SWFWMD) most recent model results for the Lower Shell Creek minimum flows and levels (MFL).			
Meeting Date:	October 22, 2020			
Meeting Location:	Virtual Meeting - MS Teams			
Prepared By:	Victoria Steinnecker			
Attendees/ Distribution:	**Client:**	**Carollo:**	**SWFWMD:**	
	Chuck Pavlos	Laura Baumberger	Eric DeHaven	Chris Zajac
	Steve Adams	Sarah Burns	Kristina Deak	Xinjian Chen
		Victoria Steinnecker	Randy Smith	Jordan Miller
			Yonas Ghile	

The following is our understanding of the subject matter covered in this meeting. If it differs from your understanding, please notify us.

SWFWMD kicked off the meeting by recapping the status of the Lower Shell Creek MFL when we last met in July 2020. At that time, a combined MFL was being developed for the Lower Shell Creek and the Lower Peace River. The initial assessment showed that the Lower Shell Creek MFL was not going to be met over the next 20 years and, thus, required a recovery strategy (reverse osmosis (RO) facility, bypass structure).

Below are the discussion points on the MFL progress, current status, and next steps.

Project Progress

1. The Lower Peace River MFL is proceeding since the need for a recovery strategy was not identified. The Lower Shell Creek MFL has been rescheduled for 2021.
2. SWFWMD performed additional assessments on the Lower Shell Creek including the following:
   a. Evaluated the previous met/not met days criteria vs. partial credit for days meeting a portion of the required downstream flow.
   b. Corrected flows for agricultural runoff.
   c. Modeled recovery project simulations with the RO facility and bypass structure for differing conveyance capacities.
   d. Modeled salinity habitat responses.
3. The results of these additional assessments are summarized as follows:
   a. A recovery strategy (such as a bypass structure) is not needed for the Lower Shell Creek MFL.
   b. A prevention strategy is needed to ensure that the Lower Shell Creek MFL will be met. This prevention strategy may include the following components:
      i. The RO facility will operate at an average of 3.5 mgd during dry flow conditions (Block 1).
      ii. The RO facility will operate at an average of 2.0 mgd during medium and high flow conditions (Blocks 2 and 3).
      iii. It is preferred that these conditions be documented in the City's water use permit (WUP).

Action Items

The following action items were discussed:

1. SWFWMD will provide the presentation given at this meeting and the new MFL model to the City and Carollo.
2. SWFWMD will develop an addendum to the original MFL report to include the new assessments.
3. SWFWMD will draft language for the prevention strategy for the City's review.
4. SWFWMD will present the MFL findings to the City of Punta Gorda's Utility Advisory Board (UAB) and City Council.
5. SWFWMD will hold a public workshop, coordinate with other stakeholders, and draft the MFL rule for the Lower Shell Creek to be submitted in 2021.

From:	Chris Zajac
To:	Laura Baumberger; Eric DeHaven; Randy Smith; Doug Leeper; Yonas Ghile; Kristina Deak; Xinjian Chen; Steve Adams; Chuck Pavlos; Sarah Burns; Victoria Steinnecker; Dennis Ragosta
Cc:	Steven Leonard; Brian Fuller
Subject:	RE: Lower Shell Creek MFL
Date:	Wednesday, October 28, 2020 2:42:24 PM

Laura,

Thank you for sending us the meeting summary. The summary looks great.

My only suggesting would be to change 3.b.iii to the following "The District is reviewing if documenting these conditions in the City's water use permit (WUP) is the appropriate approach."

We are working closely with our Regulation and Office of General Counsel Divisions to determine the appropriate measures. I'll set up another meeting as soon as we develop some options for consideration. I should be in touch soon.

Chris Zajac
Environmental Flows and Assessments Manager
Natural Systems and Restoration Bureau
2379 Broad Street
Brooksville, FL 34604
(352) 796-7211, Ext. 4413
(352) 586-3776
Chris.Zajac@WaterMatters.org

From: Laura Baumberger <LBaumberger@carollo.com>
Sent: Tuesday, October 27, 2020 1:54 PM
To: Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Randy Smith <Randy.Smith@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Yonas Ghile <Yonas.Ghile@swfwmd.state.fl.us>; Kristina Deak <Kristina.Deak@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Steve Adams <SAdams@cityofpuntagordafl.com>; Chuck Pavlos <CPavlos@cityofpuntagordafl.com>; Sarah Burns <sburns@carollo.com>; Victoria Steinnecker <vsteinnecker@carollo.com>; Dennis Ragosta <Dennis.Ragosta@swfwmd.state.fl.us>
Cc: Steven Leonard <SLeonard@cityofpuntagordafl.com>; Brian Fuller <BFuller@cityofpuntagordafl.com>
Subject: Lower Shell Creek MFL

[EXTERNAL SENDER] Use caution before opening.
Good afternoon,

Attached please find draft minutes to document discussions at the meeting held last Thursday. A number of next steps/action items are also included.

Please let us know of any additions or corrections.

Thanks,
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To:	Chris Zajac; Eric DeHaven; Randy Smith; Doug Leeper; Yonas Ghile; Kristina Deak; Xinjian Chen; Steve Adams; Chuck Pavlos; Sarah Burns; Victoria Steinnecker; Dennis Ragosta
Cc:	Steven Leonard; Brian Fuller
Subject:	RE: Lower Shell Creek MFL
Date:	Wednesday, October 28, 2020 3:01:04 PM
Attachments:	October2020 Meeting Minutes_v2.pdf

[EXTERNAL SENDER] Use caution before opening.

Thank you, Chris.

Attached are the revised minutes.

Regards,
Laura

Laura Baumberger, PE
Project Manager | Vice President
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Cc: Steven Leonard <SLeonard@cityofpuntagordafl.com>; Brian Fuller <BFuller@cityofpuntagordafl.com>
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Project Manager | Vice President
301 North Cattlemen Road, Suite 302 | Sarasota, FL 34243
P 941-371-9832 | **M** 941-400-2320
carollo.com

-----Original Appointment-----
From: Chris Zajac <Chris.Zajac@swfwmd.state.fl.us>
Sent: Saturday, October 3, 2020 10:09 AM
To: Chris Zajac; Eric DeHaven; Randy Smith; Doug Leeper; Yonas Ghile; Kristina Deak; Xinjian Chen; Laura Baumberger; Steve Adams; Chuck Pavlos; Sarah Burns; Victoria Steinnecker; Dennis Ragosta
Subject: Discuss Lower Shell Creek MFL
When: Thursday, October 22, 2020 10:00 AM-11:30 AM (UTC-05:00) Eastern Time (US & Canada).
Where: Microsoft Teams Meeting

The purpose of this meeting will be to discuss the District's most recent model results for Lower Shell Creek. Please feel free to invite others as deemed appropriate.

Join Microsoft Teams Meeting

+1 786-749-6127 United States, Miami (Toll)

Conference ID: 605 789 808#

Local numbers | Reset PIN | Learn more about Teams | Meeting options

INTERNAL USERS: Please use headset and microphone to join meeting audio. EXTERNAL USERS: Please dial toll # or use headset and microphone to join meeting audio.

MEETING MINUTES - REVISED

LOWER SHELL CREEK MFL

City of Punta Gorda

Issue Date: October 28, 2020

Project No.: 11775A.00

Purpose:	To discuss the Southwest Florida Water Management District's (SWFWMD) most recent model results for the Lower Shell Creek minimum flows and levels (MFL).
Meeting Date:	October 22, 2020
Meeting Location:	Virtual Meeting - MS Teams
Prepared By:	Victoria Steinnecker

Attendees/ Distribution:

Client:	Carollo:	SWFWMD:	
Chuck Pavlos	Laura Baumberger	Eric DeHaven	Chris Zajac
Steve Adams	Sarah Burns	Kristina Deak	Xinjian Chen
	Victoria Steinnecker	Randy Smith	Jordan Miller
		Yonas Ghile	

The following is our understanding of the subject matter covered in this meeting. If it differs from your understanding, please notify us.

SWFWMD kicked off the meeting by recapping the status of the Lower Shell Creek MFL when we last met in July 2020. At that time, a combined MFL was being developed for the Lower Shell Creek and the Lower Peace River. The initial assessment showed that the Lower Shell Creek MFL was not going to be met over the next 20 years and, thus, required a recovery strategy (reverse osmosis (RO) facility, bypass structure).

Below are the discussion points on the MFL progress, current status, and next steps.

Project Progress

1. The Lower Peace River MFL is proceeding since the need for a recovery strategy was not identified. The Lower Shell Creek MFL has been rescheduled for 2021.
2. SWFWMD performed additional assessments on the Lower Shell Creek including the following:
   a. Evaluated the previous met/not met days criteria vs. partial credit for days meeting a portion of the required downstream flow.
   b. Corrected flows for agricultural runoff.
   c. Modeled recovery project simulations with the RO facility and bypass structure for differing conveyance capacities.
   d. Modeled salinity habitat responses.
3. The results of these additional assessments are summarized as follows:
   a. A recovery strategy (such as a bypass structure) is not needed for the Lower Shell Creek MFL.
   b. A prevention strategy is needed to ensure that the Lower Shell Creek MFL will be met. This prevention strategy may include the following components:
      i. The RO facility will operate at an average of 3.5 mgd during dry flow conditions (Block 1).
      ii. The RO facility will operate at an average of 2.0 mgd during medium and high flow conditions (Blocks 2 and 3).

iii. The District is reviewing if documenting these conditions in the City's water use permit (WUP) is the appropriate approach.

Action Items

The following action items were discussed:

1. SWFWMD will provide the presentation given at this meeting and the new MFL model to the City and Carollo.
2. SWFWMD will develop an addendum to the original MFL report to include the new assessments.
3. SWFWMD will draft language for the prevention strategy for the City's review.
4. SWFWMD will present the MFL findings to the City of Punta Gorda's Utility Advisory Board (UAB) and City Council.
5. SWFWMD will hold a public workshop, coordinate with other stakeholders, and draft the MFL rule for the Lower Shell Creek to be submitted in 2021.

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Recommended Minimum Flows for the Lower Peace River

October 29, 2020

Southwest Florida Water Management District

Doug Leeper
Minimum Flows and Levels Program Lead
Natural Systems and Restoration Bureau

1

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Teams Meeting Protocol

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Southwest Florida Water Management District

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Agenda

1. Recommended minimum flows for the Lower Peace River
2. Public comment

Telephone-only participation: 1-786-749-6127; Conference ID: 838 375 52#

Southwest Florida Water Management District

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Florida's Water Management Districts

4

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Southwest Florida Water Management District

- All or part of 16 counties
- 10,000 square miles

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Areas of Responsibility and Mission Statement

Water Supply

Water Quality

Natural Systems

Flood Protection

Our mission is to protect water resources, minimize flood risks, and ensure the public's water needs are met.

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Minimum Flows

- The **minimum flow** for a given watercourse is the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area. - Section 373.042, Florida Statutes
- Minimum flow rules are used in District permitting and planning programs

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Lower Peace River

- River segment downstream of Arcadia
- Based on combined flows:
  - Peace River at Arcadia
  - Joshua Creek at Nocatee
  - Horse Creek near Arcadia
- Minimum flows
  - Adopted in 2010
  - Initial reevaluation in 2015
  - Comprehensive reevaluation and adoption scheduled for 2020

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Lower Peace River Minimum Flows Development

- Draft minimum flows report to District Governing Board (March 24, 2020)
- Independent scientific peer review (March 25 – June 26, 2020)
- Stakeholder outreach (ongoing)
- Presentations to Coastal & Heartland National Estuary Partnership Technical Advisory Committee (April 17, 2020), District Public Supply Advisory Committee (August 11, 2020), District Environmental Advisory Committee (October 13, 2020)
- Public workshop (today)
- Final minimum flows report and request for initiation of rulemaking to District Governing Board (December 15, 2020)

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Baseline Flows

- Baseline (adjusted for withdrawal effects) and gaged flows for the period from 1950 through 2014

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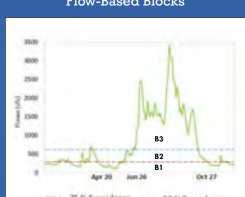
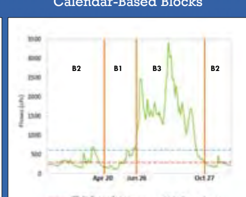
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Flow-Based Blocks

Currently Used Flow-Based Blocks



Previously Used Calendar-Based Blocks



- Flow-based blocks better represent low, medium and high flow conditions for minimum flows development and implementation

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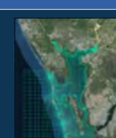
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Enhanced Hydrodynamic Modeling

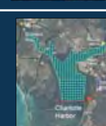
Current model (Chen 2020)

- Unstructured 3D hydrodynamic model
- Includes entire Charlotte Harbor
- New LiDAR and bathymetry data
- 21-month calibration/validation period
- 7.7-year simulation period (Jan 2007 – Aug 2014)



Previously used model (Chen 2010)

- Structured 3D hydrodynamic model
- Limited to Upper Charlotte Harbor
- 13-month calibration/validation period
- 3-year simulation period (2000 - 2002)



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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Enhanced Ecological Criteria and Considerations

Current Evaluation	Previous (2010 Evaluation)
▪ Salinity-based habitats (≤2, ≤5, ≤10, ≤15, ≤20 psu) ▪ Floodplain inundation ▪ Habitats for 8 estuarine-dependent taxa (fish and Blue Crab) ▪ Water quality (dissolved oxygen, nutrients, chlorophyll, color)	▪ Salinity-based habitats (≤2, ≤5, ≤10, ≤15, ≤20 psu)

- ≤ 2 psu salinity volume was the metric most sensitive to flow reductions
- Minimum flows developed based on preserving 85% of ≤2 psu salinity volume

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Lower Peace River Recommended Minimum Flows

Flow-based Block	If Flow on Previous Day is:	Minimum Flow is:	Maximum Flow Reduction is:
1	≤130 cfs	100% of flow	0 cfs
	130 cfs to 149 cfs	130 cfs	flow minus 130 cfs
	150 cfs to 297 cfs	87% of flow	13% of flow
2	298 cfs to 335 cfs	258 cfs	flow minus 258 cfs
	336 cfs to 622 cfs	77% of flow	23% of flow
3	623 cfs to 798 cfs	479 cfs	flow minus 479 cfs
	>798 cfs	60% of flow*	40% of flow*

* Daily maximum withdrawal is 400 cfs

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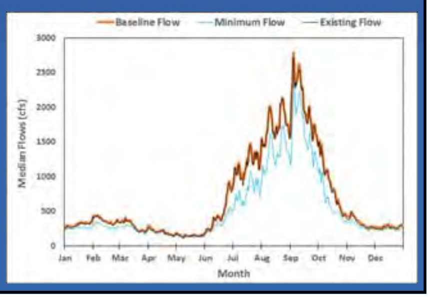
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Lower Peace River Recommended Minimum Flows

- Baseline (adjusted for withdrawal effects), gaged and minimum flows for the period from 1975 through 2018



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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Minimum Flows Summary

- Recommended minimum flows for the Lower Peace River (and Lower Shell Creek) are based on maintaining 85% of the 2 psu or less salinity volume
- Recommended minimum flows are protective of all environmental values identified for consideration when establishing minimum flows
- Recommended minimum flows for the Lower Peace River are currently met and projected to be met during the next 20-year planning period

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

More Information on the District Website

- Minimum flows page for the Lower Peace River and Lower Shell Creek: https://www.swfwmd.state.fl.us/projects/mfls/lower-peace-river/lower-shell-creek
- Minimum flows and level documents and reports: https://www.swfwmd.state.fl.us/projects/mfl/documents-and-reports
- Meeting/teleconference announcements posted on the Boards, Meetings & Events calendar: https://www.swfwmd.state.fl.us/about/calendar/month

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Public Input

- Comment orally today
- Comment orally by telephone, in person at the District, and/or in writing (preferred) via email or letter by November 30, 2020
- Contact: **Doug Leeper**
  2379 Broad Street
  Brooksville, FL 34604
  (352) 796-7211, Ext. 4272
  Doug.leeper@swfwmd.state.fl.us
- Comment during the Governing Board meeting on December 15, 2020

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

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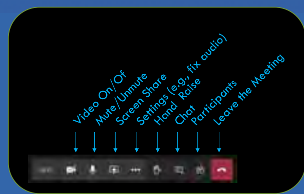

Southwest Florida Water Management District

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From:	Angel Martin
To:	Doug Leeper
Subject:	Recommended Minimum Flows for the Lower Peace River--Public Meeting-Comments
Date:	Thursday, October 29, 2020 6:36:54 PM

[EXTERNAL SENDER] Use caution before opening.

Concerning the subject public meeting, I had the following questions/comments.

1. Unsure on how the salinity value of less than 2 psu was determined for the harbor area and whether the salinity value was an average over a particular time period? It was explained by Dr. Chen how salinity values were calculated and used in model simulation.
2. Martin asked about the 15% threshold for habitat significant harmed was determined and if uncertainty in this percentage was considered. This was considered and discussed by the peer review panel and included in the report.
3. Martin asked about changes in salinity in the study/model domain will be considered with respect to possible sea-level rise. Mr. Leeper stated that this was an issue that will be considered by the District but there is no fixed schedule on possibly studying this issue.

Please contact me if you have any questions or need any additional information concerning these comments. Thank you for the opportunity to participate in this process.

____

Angel Martin
813-767-6944

From:	Doug Leeper
To:	Angel Martin
Cc:	Yonas Ghile; Xinjian Chen; Kristina Deak; Chris Anastasiou; Chris Zajac; Randy Smith; Eric DeHaven; Ryan J. Pearson; Adrienne E. Vining; Mike R. Bray
Subject:	RE: Lower Peace River min flows comments
Date:	Friday, October 30, 2020 10:02:00 AM

Angel:

- Thanks again for participating in the meeting yesterday and for sending your comment in writing.
- Your questions and comments on this process continue to be helpful and useful.

Doug Leeper
MFLs Program Lead
Environmental Flows and Assessments Section
Natural Systems & Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street (U.S. Hwy. 41 South)
Brooksville, FL 34604-6899
352-796-7211, Ext. 4272
1-800-423-1476, Ext. 4272
Doug.leeper@watermatters.org

From: Angel Martin <amartin217@tampabay.rr.com>
Sent: Thursday, October 29, 2020 6:37 PM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: Recommended Minimum Flows for the Lower Peace River--Public Meeting-Comments

[EXTERNAL SENDER] Use caution before opening.
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Please contact me if you have any questions or need any additional information concerning these comments. Thank you for the opportunity to participate in this process.

____

Angel Martin
813-767-6944

From:	Eric DeHaven
To:	Yonas Ghile; Doug Leeper; Kristina Deak; Randy Smith; Chris Zajac; Cindy C. Rodriguez; Jay Hoecker; John F. Ferguson; George A. Schlutermann
Subject:	FW: Presentation from Meeting Today
Date:	Tuesday, November 3, 2020 3:13:43 PM
Attachments:	SUMDAT Modifications and Scenarios Final 11 03 2020.pdf

Please pass on to anyone I missed.

Eric DeHaven, P.G.
Southwest Florida Water Management District
Assistant Director, Resource Management Division
7601 HWY 301N Tampa FL 33637
(813) 985-7481 X2118

From: Mike Coates <mcoates@regionalwater.org>
Sent: Tuesday, November 3, 2020 1:27 PM
To: Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Stephen James <stephenjames@prwcwater.org>
Cc: Patrick Tara <ptara@intera.com>
Subject: Presentation from Meeting Today

[EXTERNAL SENDER] Use caution before opening.
Gents:

Attached is the Authority presentation from the meeting this morning. Any questions - let me know.

Thanks,

Mike

Mike Coates, P.G.
Deputy Director
PRMRWSA

Office: 941-316-1776
Cell: 941-915-3728

Peace River Manasota Regional Water Supply Authority

SUMDAT

Modifications
And
Scenario Results

11/3/2020

Peace River Manasota Regional Water Supply Authority

Progressive Water Resources
Integrated Water Resource Consultants

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

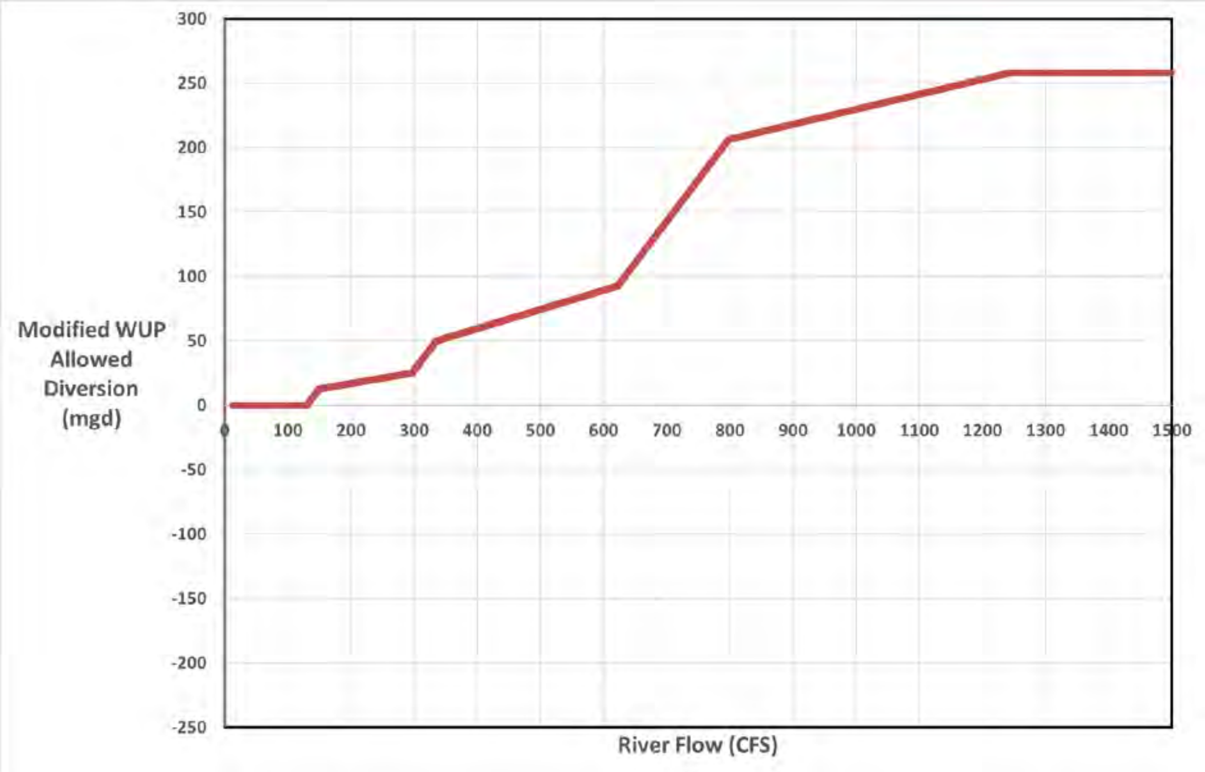
Outline

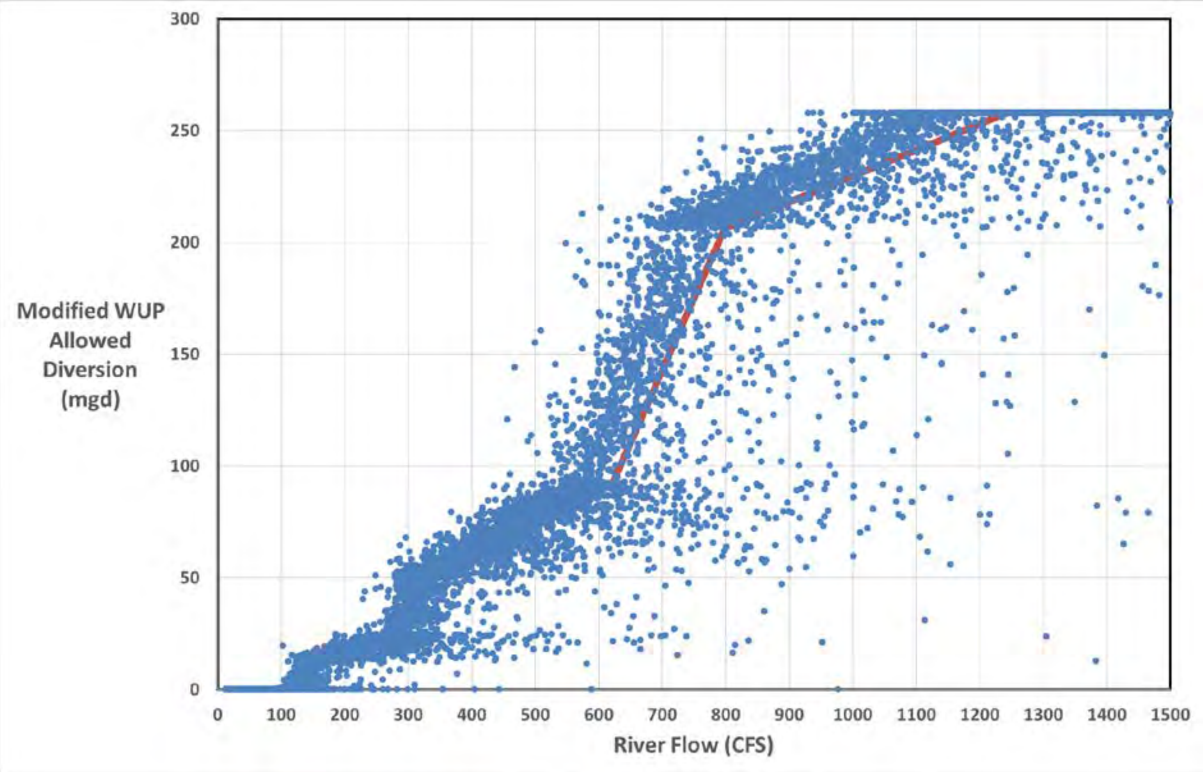
- SUMDAT Modifications
- SUMDAT Scenarios
- Questions/Discussion

SUMDAT Modifications

- New MFL Implementation (implemented by Kevin Morris)
- Time Series Extensions
  - Extended model from 12/31/2015 to 6/30/2020 (over 45 years)
  - USGS Flows
  - Rainfall
  - Evaporation
- SUMDAT Macro

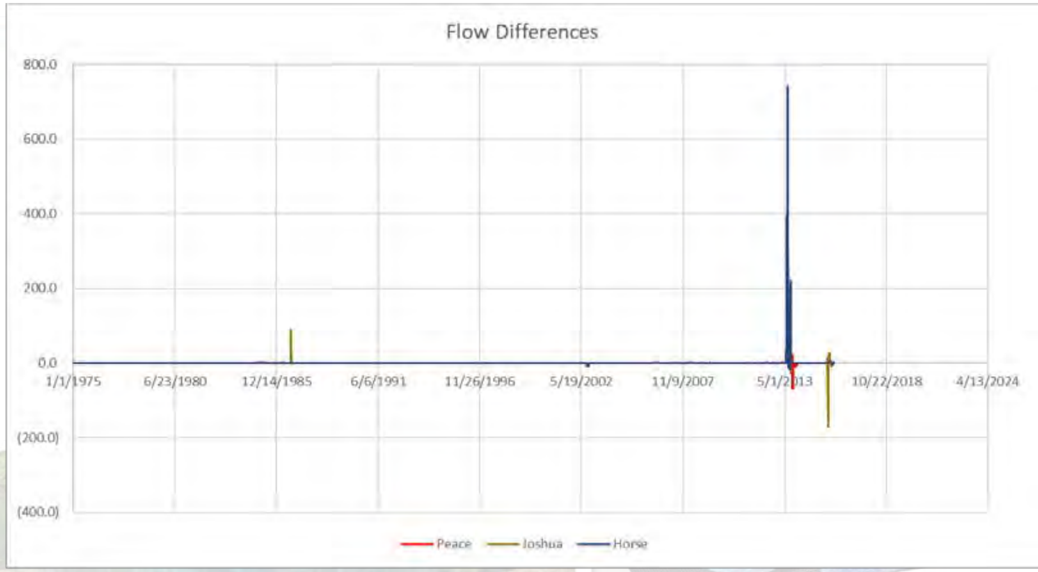
MFL Implementation – Same Day / Previous Day

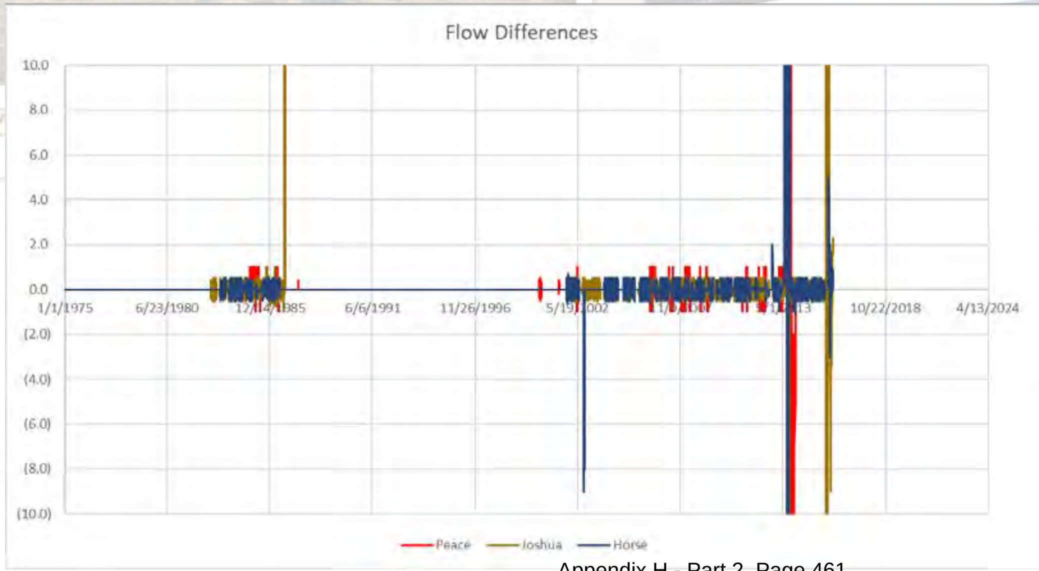




Time Series Extensions – USGS Flow

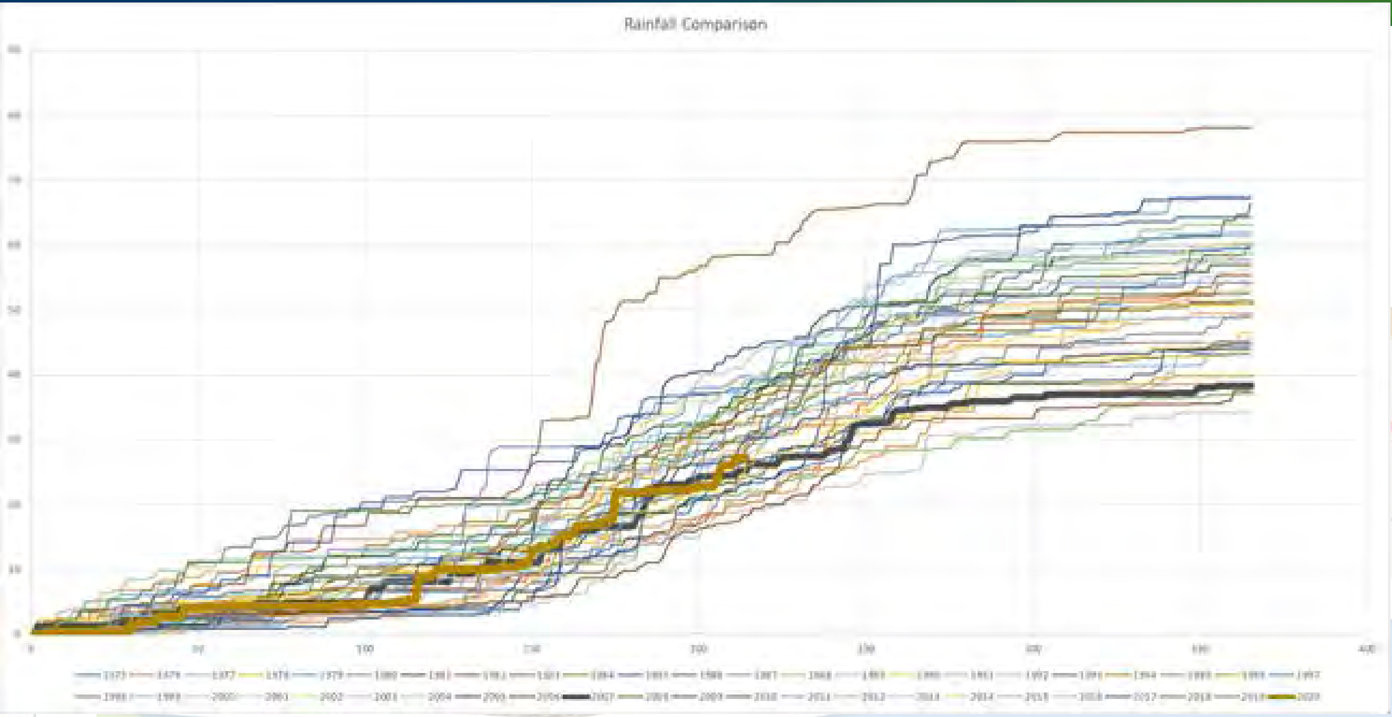
- Through the multiple time extensions of the SUMDAT model, it is possible provisional data remained in the flow data
- All flow data has been updated with current USGS database
- Note: data in the current year is still provisional 1/1/2020 to 6/30/2020, future updates will have to replace this data when it is finalized

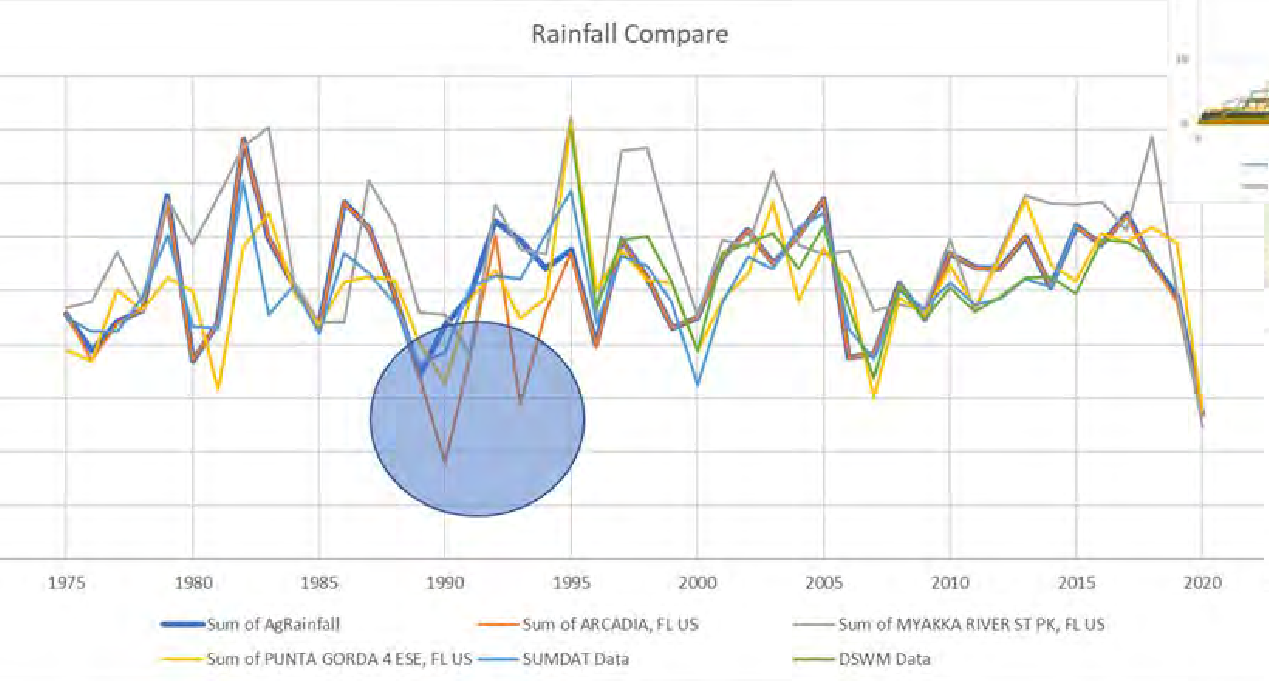




Time Series Extensions – Rainfall

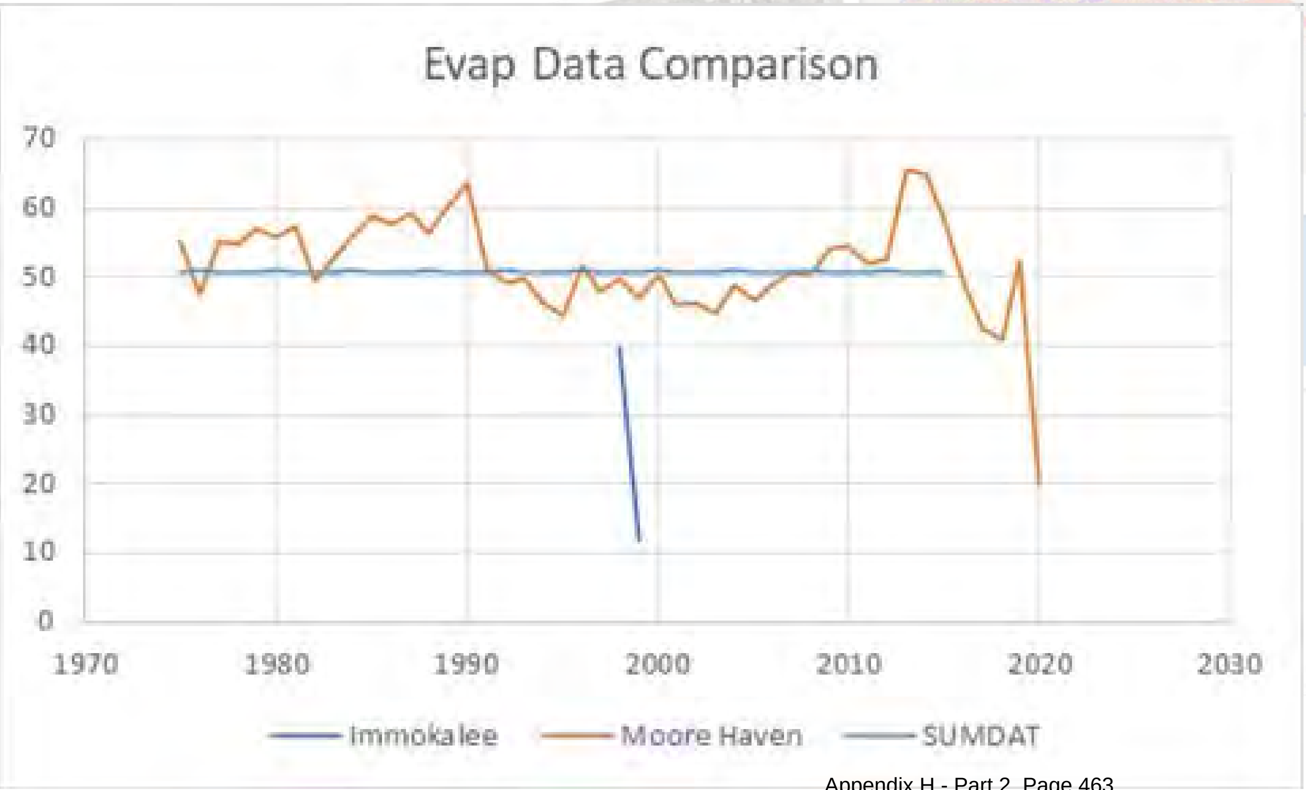
- NOAA daily rainfall data used
- In order of precedence Arcadia, Myakka, Punta Gorda





Time Series Extensions – Evaporation

- NOAA Data collected for Moore Haven station
- NOAA Data represents Pan ET
- Utilized a Pan ET coefficient of .67



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

SUMDAT Scenarios

1. River Pump Maximum Capacity
   a. 12 BG Reservoir
   b. 15 BG Reservoir
2. Customer Demand Scenarios
   a. 12 BG Reservoir
   b. 15 BG Reservoir
3. Seasonal Flow Reductions
   a. 12 BG Reservoir
   b. 15 BG Reservoir
4. Adjusting the 3rd Tier percent of flow
   a. 12 BG Reservoir
   b. 15 BG Reservoir
5. Sea Level Rise Simulations
   a. Sea Level Rise and 12 BG Reservoir
   b. Sea Level Rise and 15 BG Reservoir
   c. Sea Level Rise and Wet Season Flow Changes and 12 BG Reservoir
   d. Sea Level Rise and Wet Season Flow Changes and 12 BG Reservoir

MFLs Expression and Implementation: "Updated" Approach

Table 6-7. Summary of minimum flows and potentially allowable percent-of-flow reduction for the Lower Peace River for flow-based blocks determined from combined flows for the previous day at the USGS Horse Creek near Arcadia, Joshua Creek near Nocatee and the Peace River at Arcadia gages. Formulas that could be used to calculate potentially allowable flow reductions are also provided.

Flow-Based Block	If Combined Flow in cubic feet per second (cfs) on the Previous Day is:	Minimum Flow is:	Potentially Allowable Flow Reduction is:	Formula for Calculation of Potentially Allowable Flow Reduction (Q_{Red}) based on Combined Flow on Previous Day (Q_{Prev})
1	≤130 cfs	Combined flow on the previous day	0 cfs	Q_{Red} = 0 cfs
	>130 cfs and ≤149 cfs	130 cfs	Combined flow on the previous day minus 130 cfs	QRed = QPrev - 130 cfs
	>149 cfs and ≤ 297 cfs	87% of combined flow on the previous day	13% of combined flow on the previous day	QRed = QPrev * 13%
2	>297 cfs and ≤335 cfs	258 cfs	Combined flow on the previous day minus 258 cfs	QRed = QPrev - 258 cfs
	>335 cfs and ≤622 cfs	77% of combined flow on the previous day	23% of combined flow on the previous day	QRed = QPrev * 23%
3	>622 cfs and ≤798 cfs	479 cfs	Combined flow on the previous day minus 479 cfs	QRed = QPrev – 479 cfs
	>798 cfs and ≤1,000 cfs	60% of combined flow on the previous day	40% of combined flow on the previous day	QRed = QPrev * 40%
	>1,000 cfs	Combined flow on the previous day minus 400 cfs	400 cfs[a]	QRed = 400 cfs

[a] 400 cfs maximum daily withdrawal

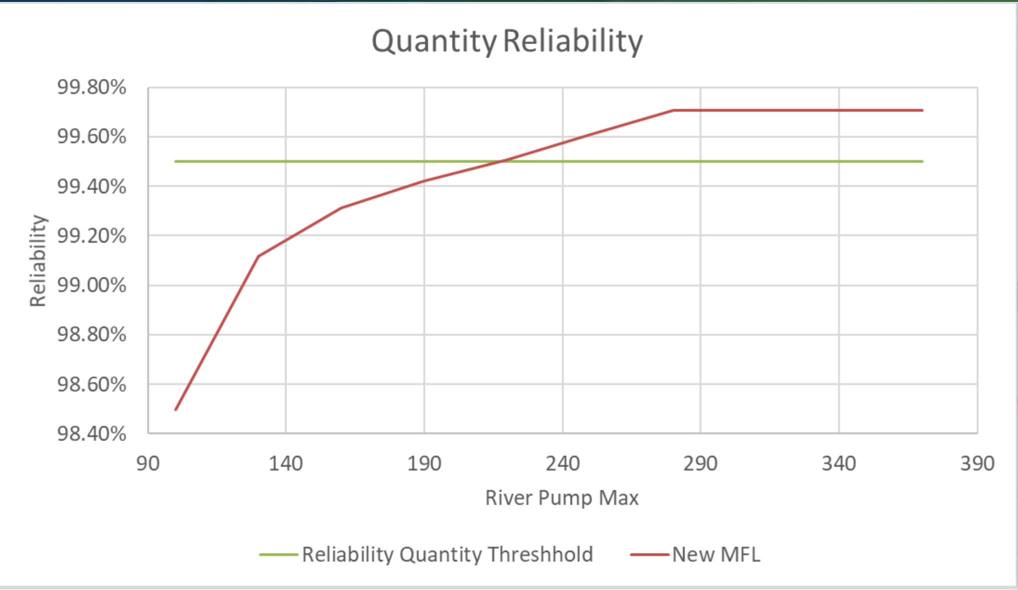
Baseline

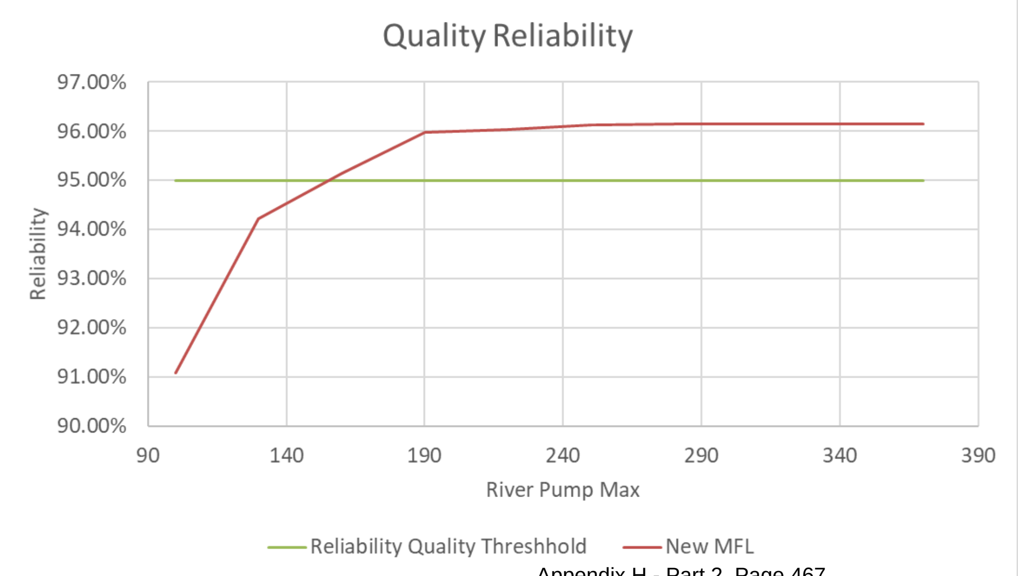
- Current withdrawal schedule
- 258 MGD WUP
- 50MGD Demand
- 80MGD WTP
- 12.5 BG reservoir storage (total storage $.5_{existing} + 6_{existing} + 6_{proposed}$)
- No sea level rise
- Historic rainfall, evaporation, and river flow

Baseline Scenario 1a – River Pump Capacity, 12BG

- Strong sensitivity to pump capacity
- New MFL consistently performs better than Old MFL
- 258 MGD is enough to guarantee adequate reliability for both quantity and quality

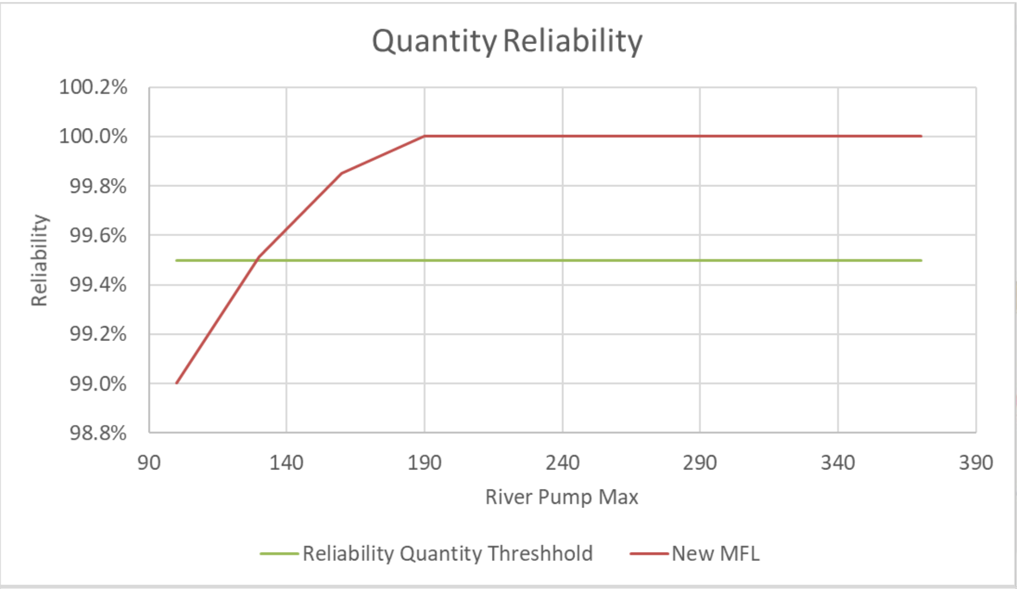
- Scenario: 50MGD Demand, 80MGD WTP, 12BG Reservoir

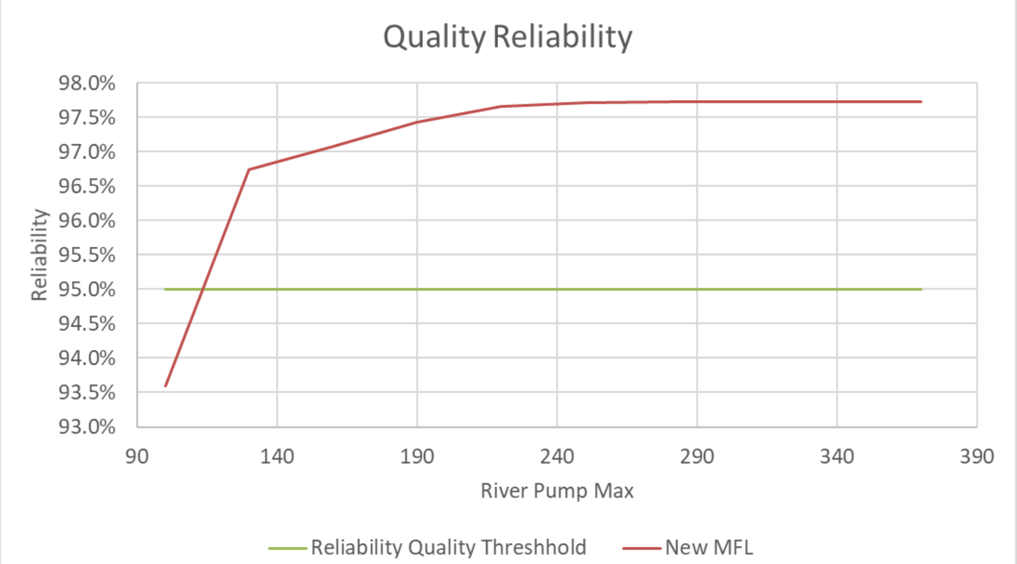




Baseline Scenario 1b – River Pump Capacity, 15BG

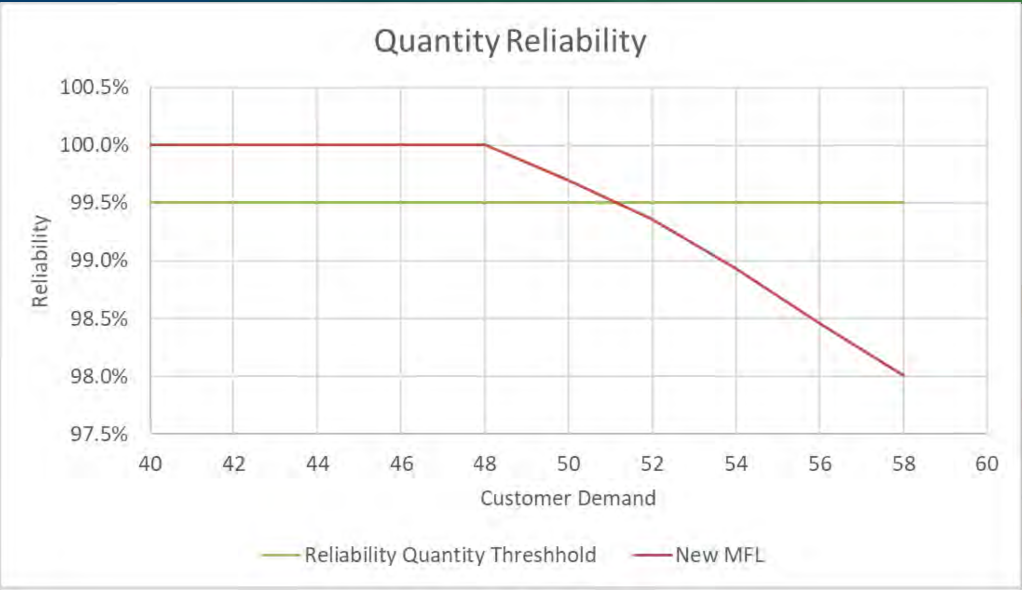
- Strong sensitivity to pump capacity
- 258 MGD is enough to guarantee adequate reliability for both quantity and quality
- Increased storage provide greater reliability
- Scenario: 50MGD Demand, 80MGD WTP, 15BG Reservoir

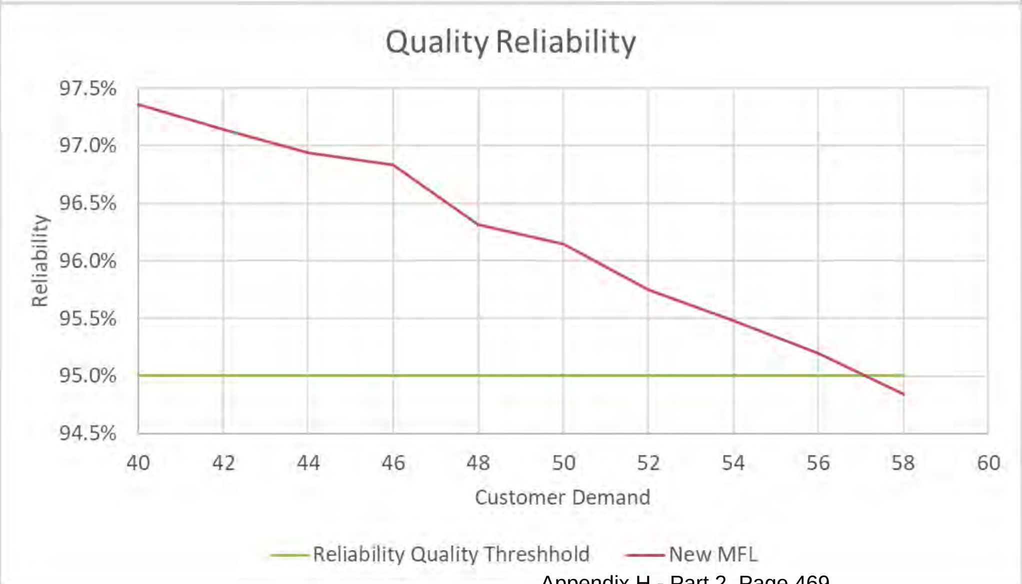




Scenario 2a – Customer Demands, 12 BG

- Increasing the Customer Demands dramatically impacts the reliability of the system
- The 12 BG system does not have the capacity to serve beyond 50MGD as both the quantity and quality reliability metric degrades
- Scenario: 258MGD WUP, 80MGD WTP, 12BG Reservoir

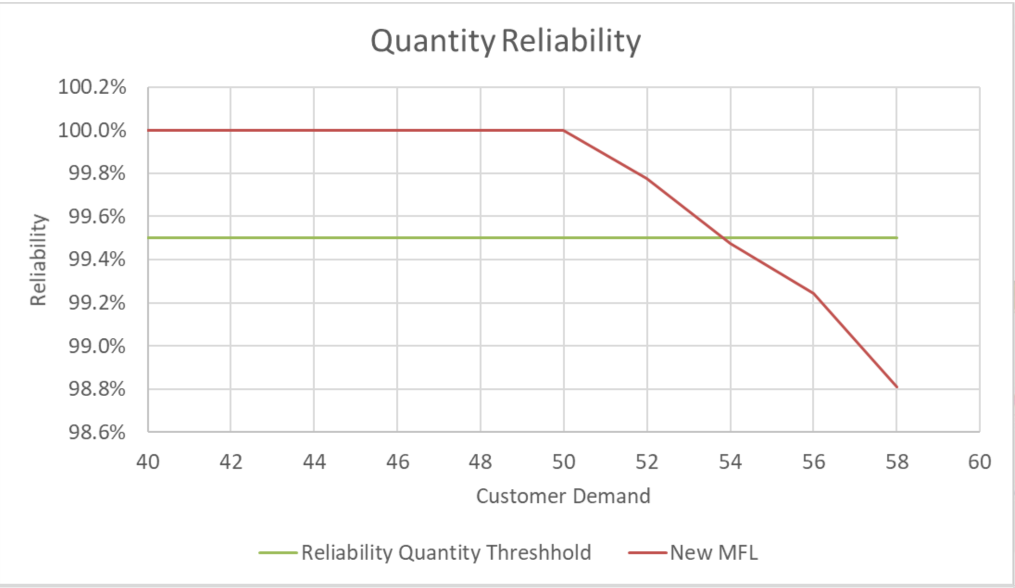


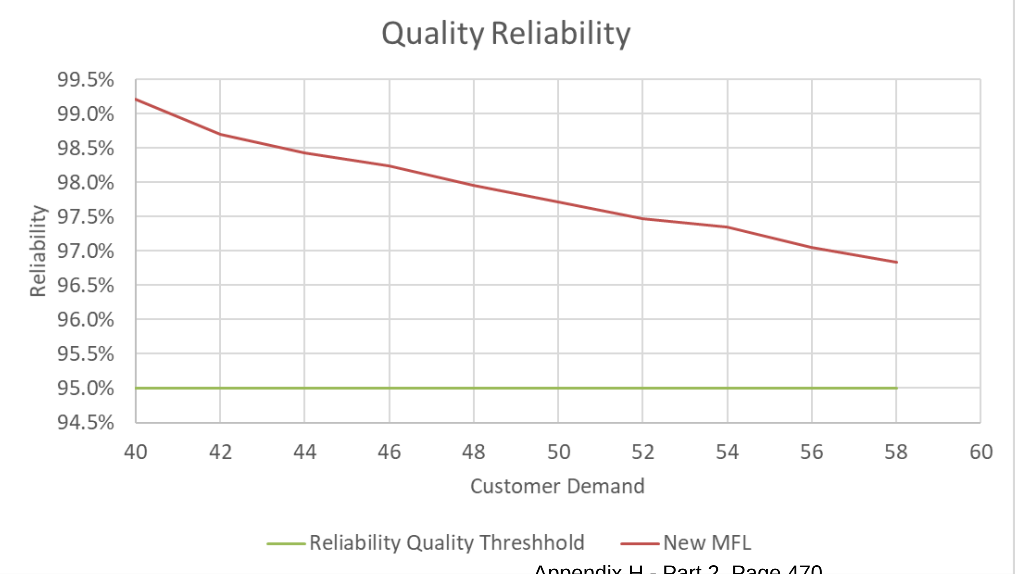


Scenario 2b – Customer Demands, 15BG Reservoir

- Increasing the Customer Demands dramatically impacts the reliability of the system
- The larger reservoir capacity can handle customer demands in excess of 53 MGD with the new MFL

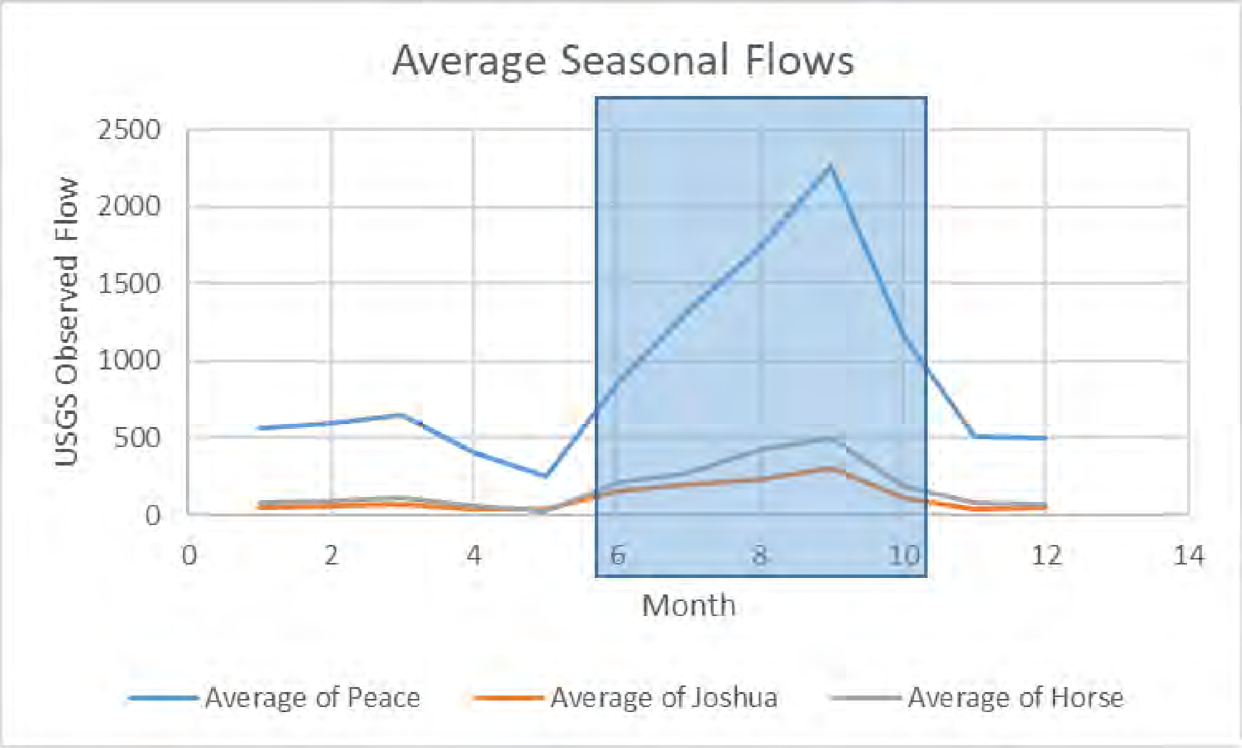
- Scenario: 258MGD WUP, 80MGD WTP, 15BG Reservoir





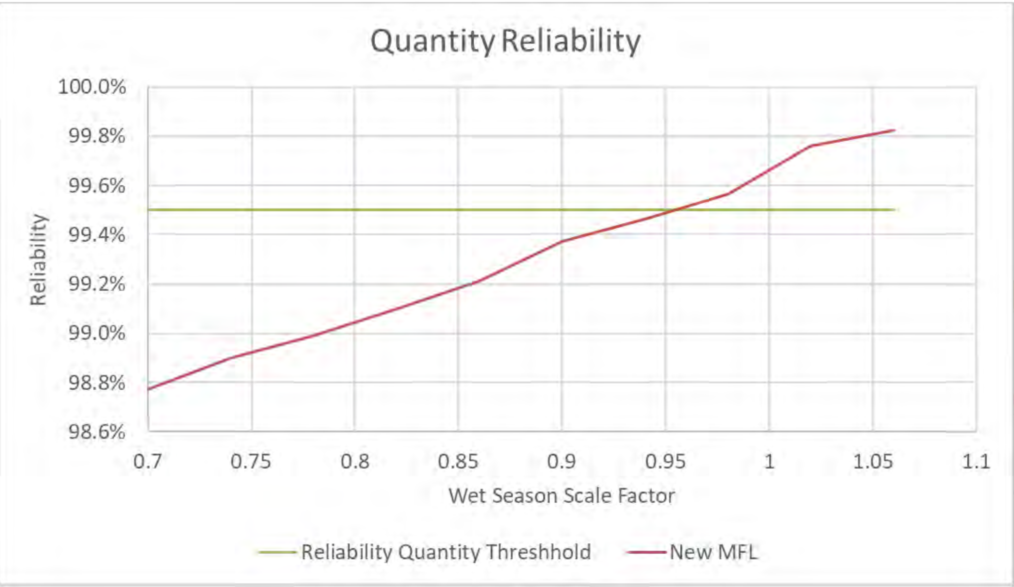
Scenario 3 – Climate Change, Flow Reduction

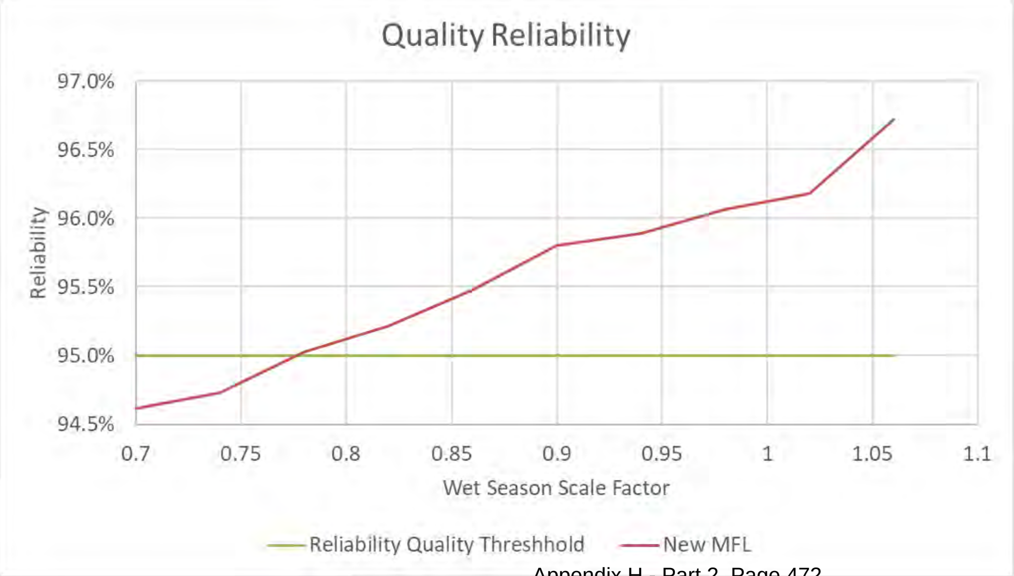
- Impact climate seasonally
- Wet season is defined as June to Oct
- Dry Season is Nov – May
- Scaled all river flows: Peace, Joshua, and Horse



Scenario 3a – Wet Season Scale Factor

- Scaled Flows from June to Oct
- System is very sensitive to changes to river flows
- System reliability is impacted at only a 4% reduction in river flows
- Scenario: 258MGD WUP, 80MGD WTP, 12BG Reservoir, 50MGD Demand

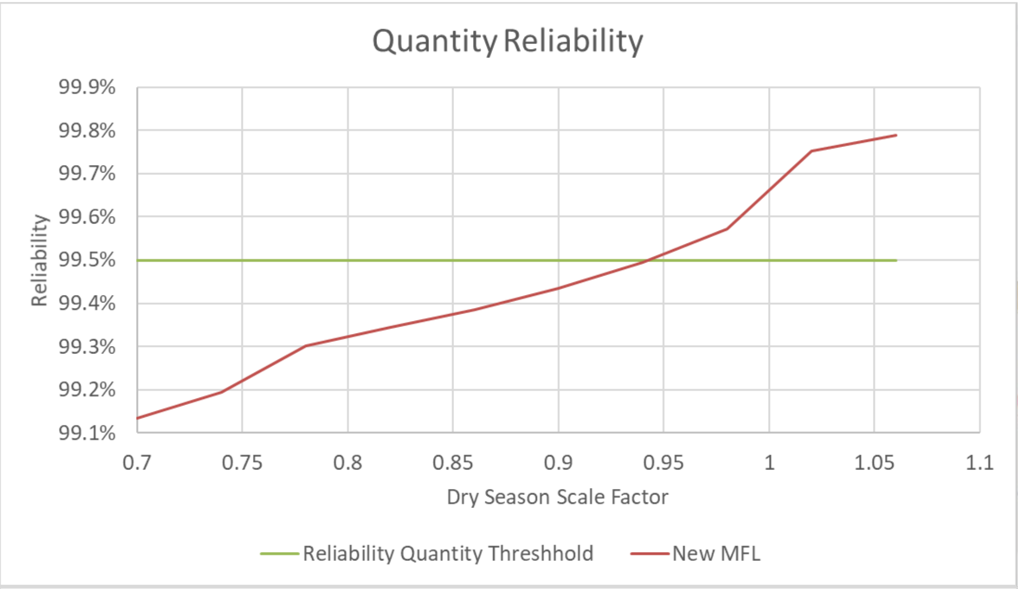


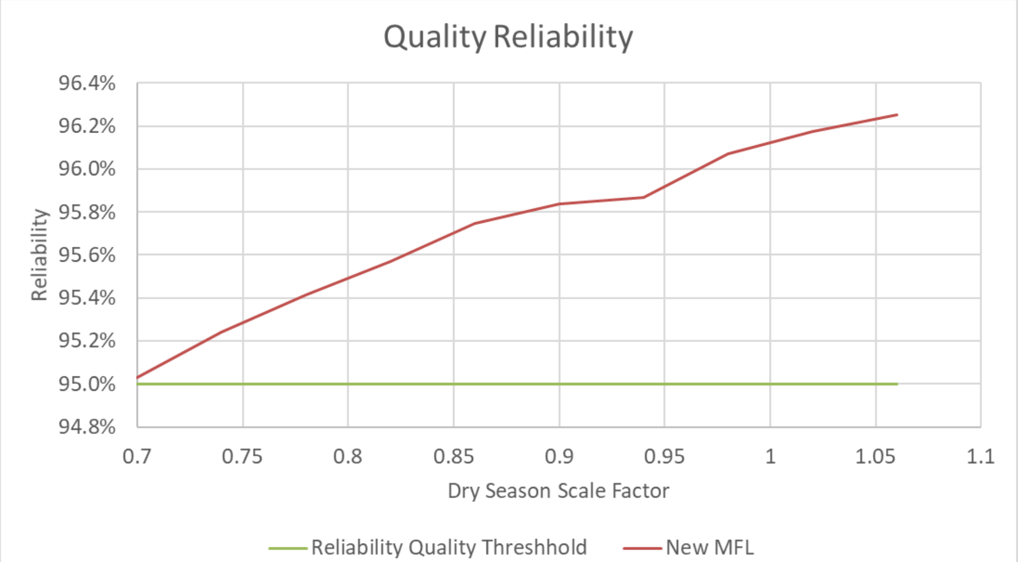


Scenario 3b – Dry Season Scale Factor

- Scaled Flows from Nov to May dry season
- System is very sensitive to reductions in river flows
- System reliability is impacted at only a 6% reduction in river flows

- Scenario: 258MGD WUP, 80MGD WTP, 12BG Reservoir, 50MGD Demand

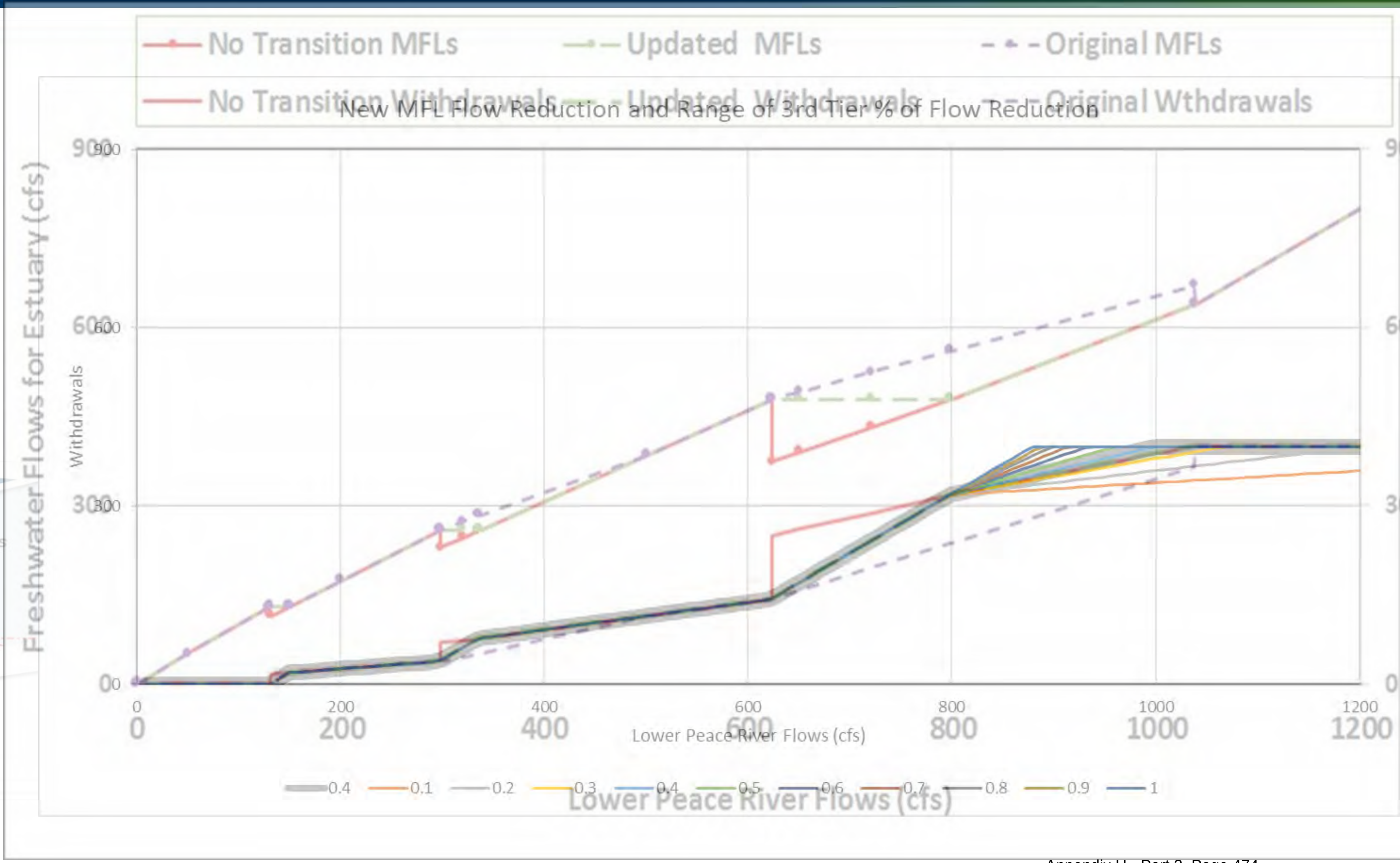




INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

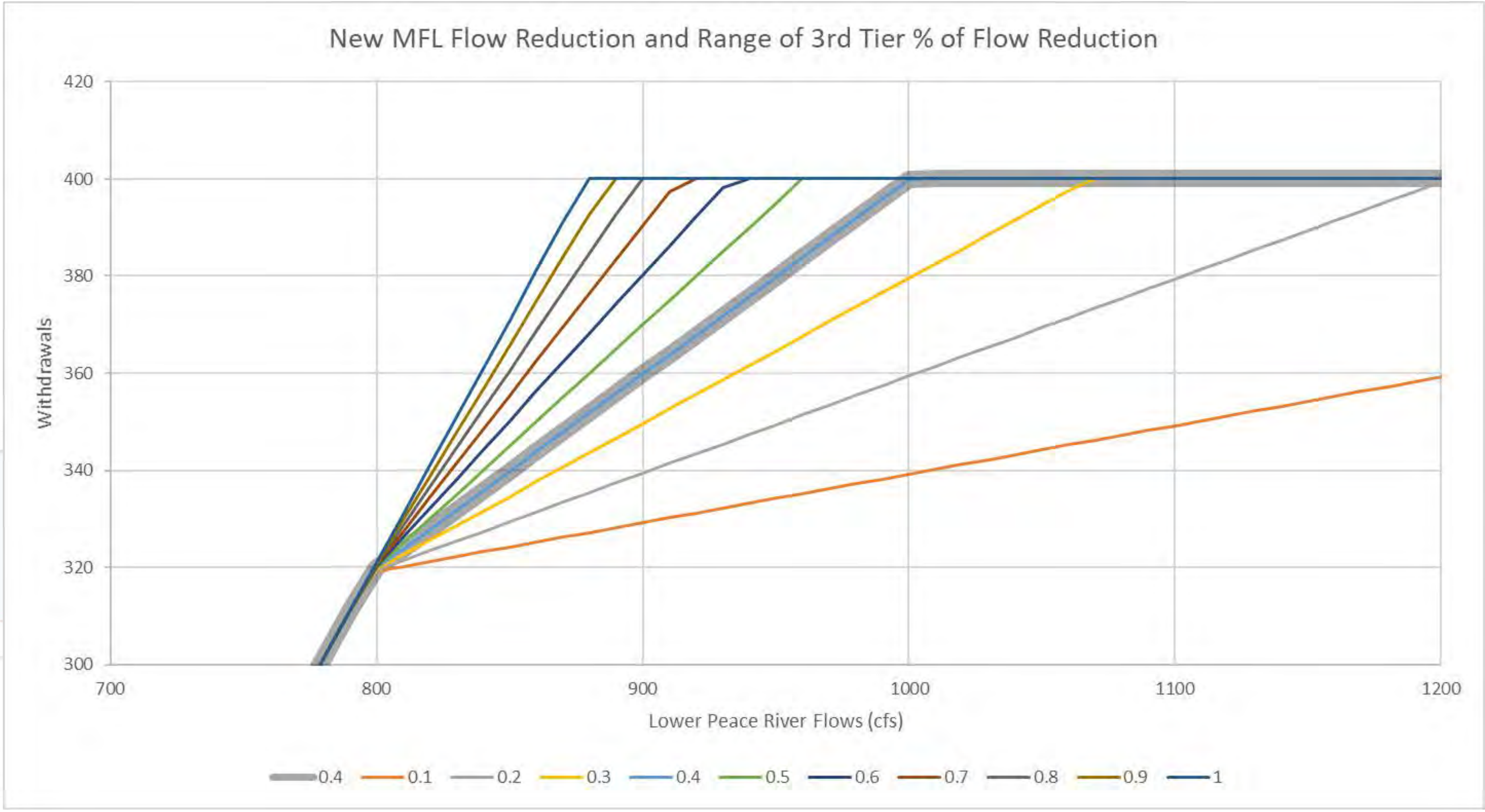
Scenario 4 – Allowable Percent of Flow Reduction

- New MFL uses 3 tiers
  - Tier 1 is 13%
  - Tier 2 is 23%
  - Tier 3 is 40%
- Tier 3 ranges between 798 and 1000 cfs if 40% is used
- After the upper threshold the allowable flow reduction is fixed at 400cfs



Scenario 4 – Allowable Percent of Flow Reduction

- The District is proposing 3rd tier water available as 40 percent of flow
- Percent available is adjusted from .1 to 1.0
- Given the change in slope the max flow changes in response

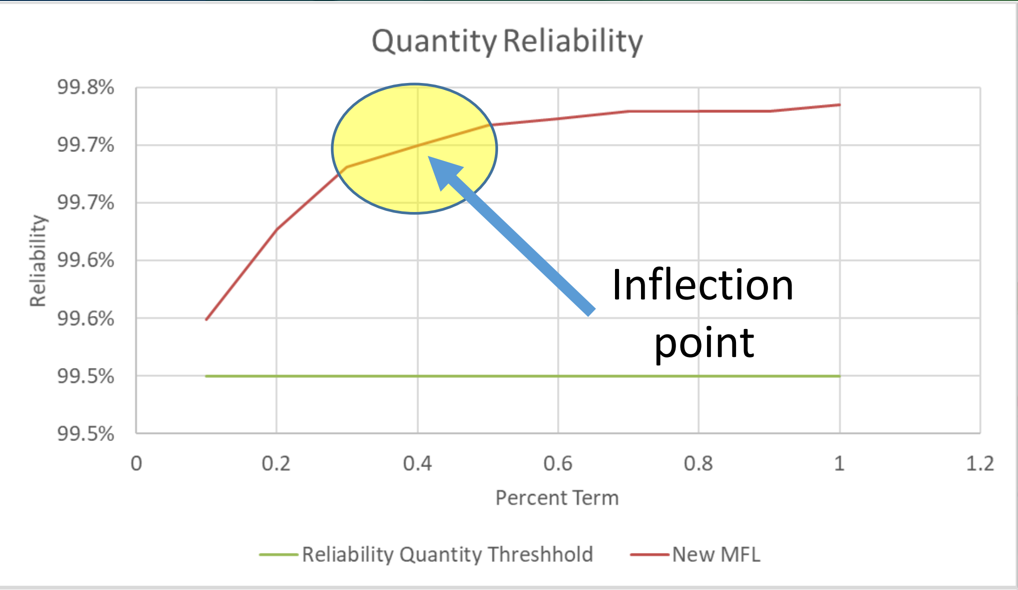


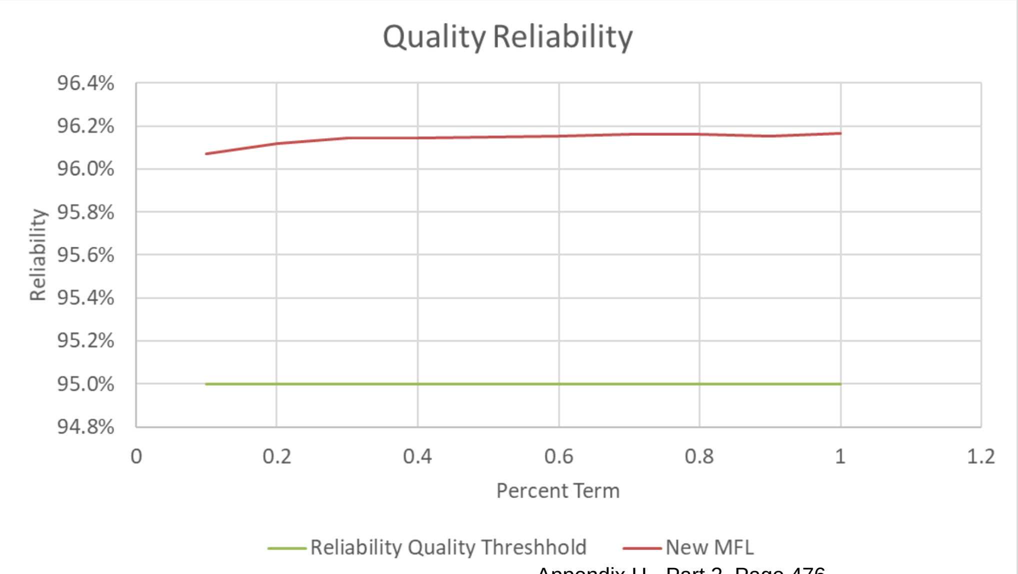
INTERA GEOSCIENCE & ENGINEERING SOLUTIONS

Scenario 4a – Allowable Percent of Flow Reduction

- 40% provides best quantity and quality reliability while keeping with the District's original MFL
- Lower percent of flow reductions decrease quantity reliability (nearing the threshold) but has minimal impact on the quality reliability

- Scenario: 258MGD WUP, 80MGD WTP, 12BG Reservoir, 50MGD Demand



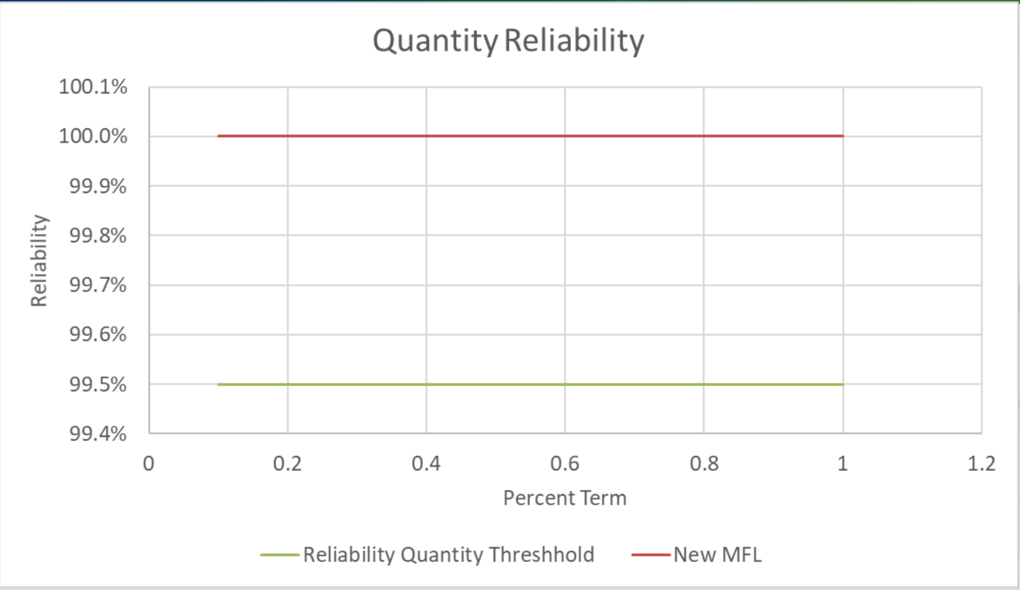


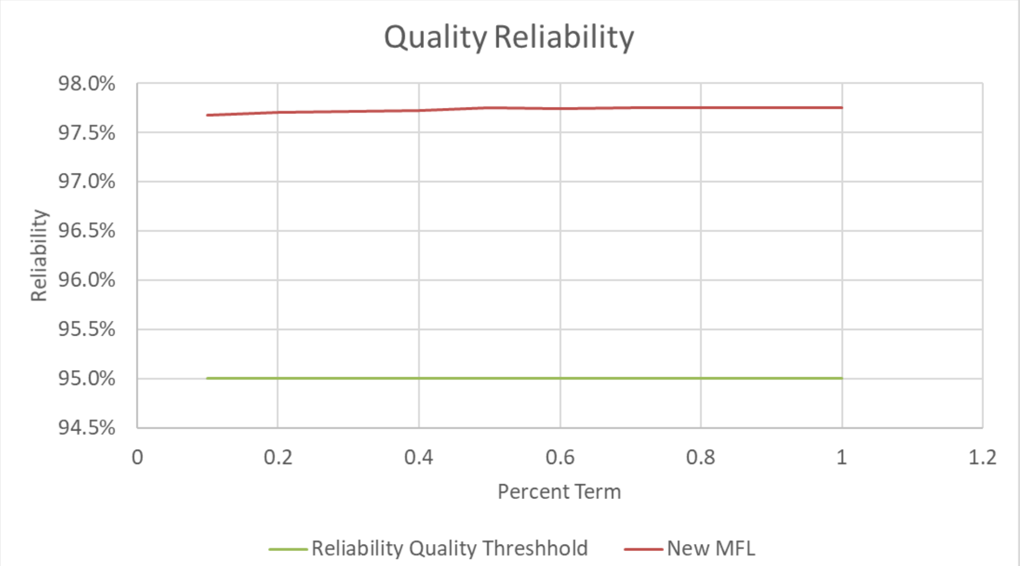
INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Scenario 4b – Flow Reduction w/ Larger Reservoir

- The larger reservoir does increase the reliability of the system
- The additional reliability will be necessary to address future trends in climate change and sea level rise

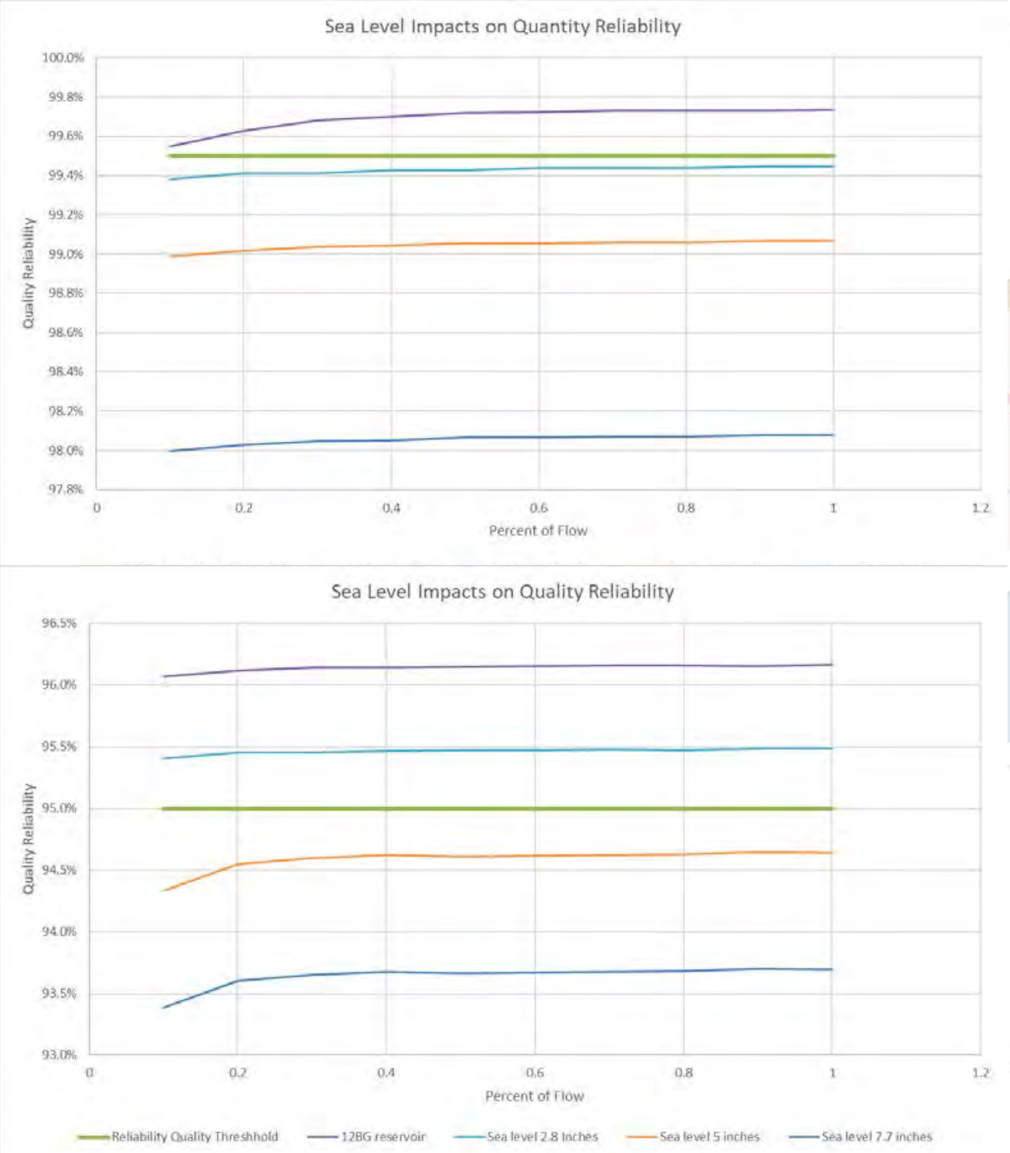
- Scenario: 258MGD WUP, 80MGD WTP, 15BG Reservoir, 50MGD Demand





Scenario 5a – Sea Level Rise , 12BG Reservoir

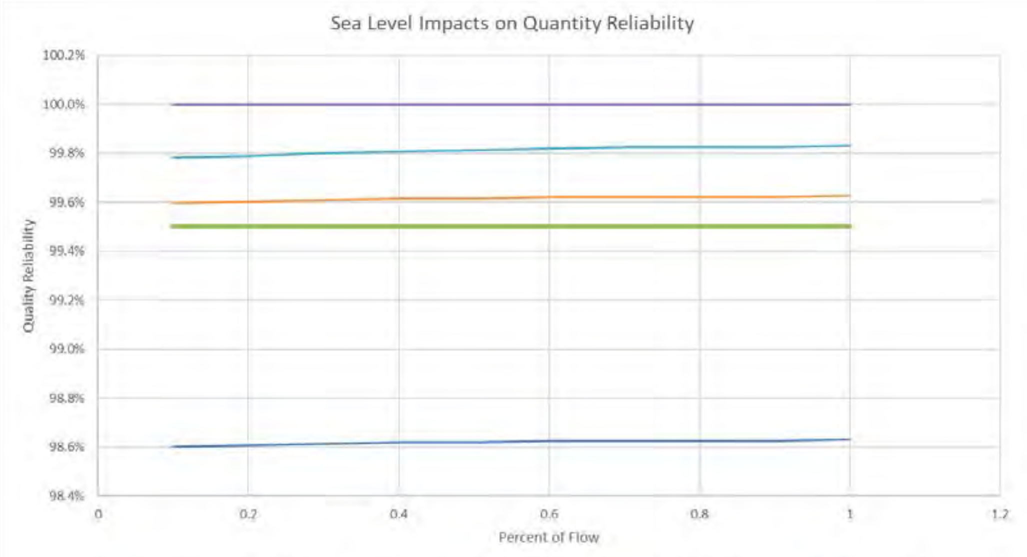
- Reliability is sensitive to sea level rise scenario
- Only baseline is above threshold
- All the sea level rise scenarios fail reliability metric for quantity
- Quality metric shows 5-inch and 7.7-inch sea level rise scenarios fail
- Scenario: 258MGD WUP, 80MGD WTP, 12BG Reservoir, 50MGD Demand

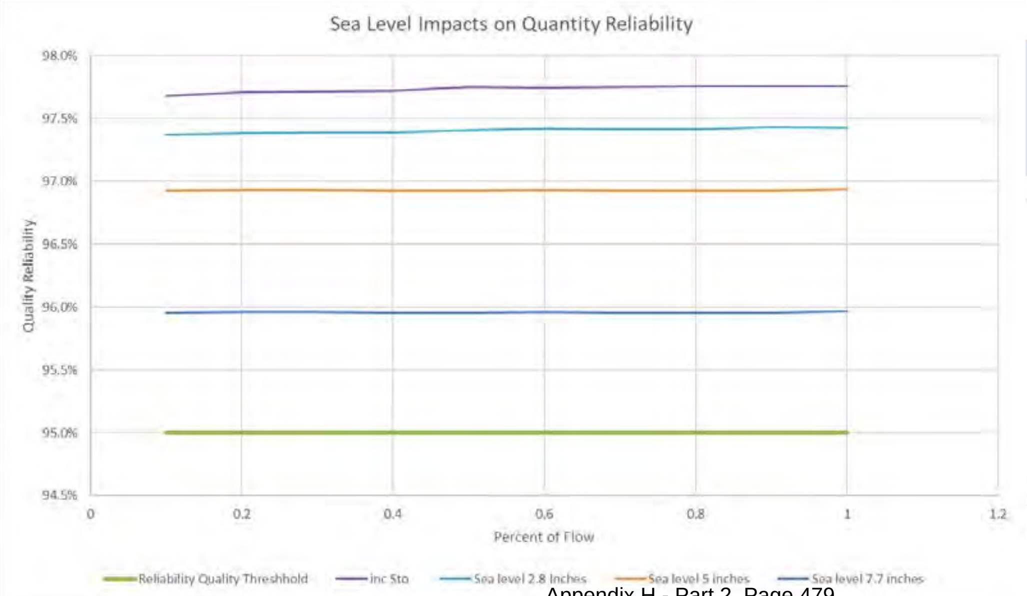


Scenario 5b – Sea Level Rise, 15BG Reservoir

- Same sea level rise data as before
- As shown in the graphs the larger reservoir capacity protects reliability in both quantity and quality, only 7.7-inch SLR fails quantity metric

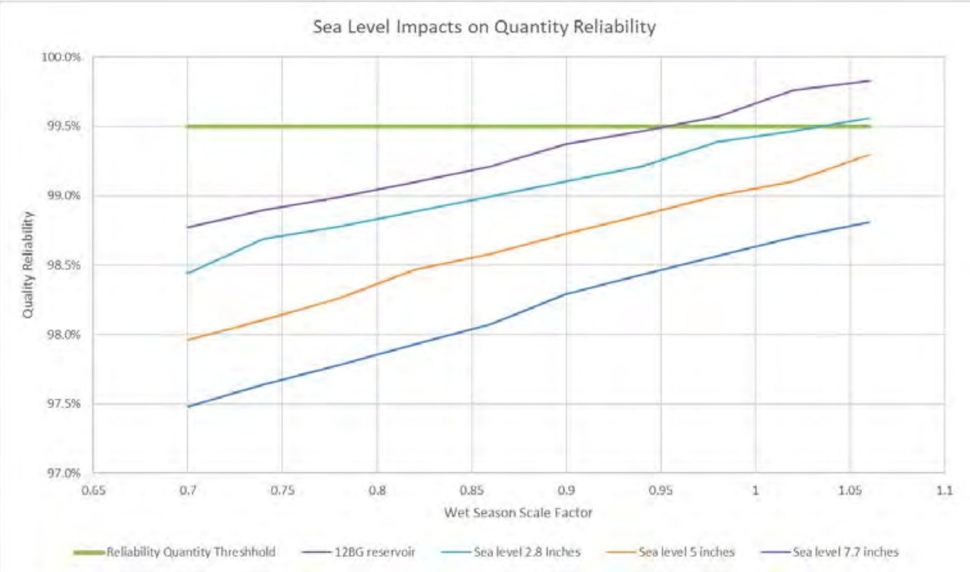
- Scenario: 258MGD WUP, 80MGD WTP, 15BG Reservoir, 50MGD Demand

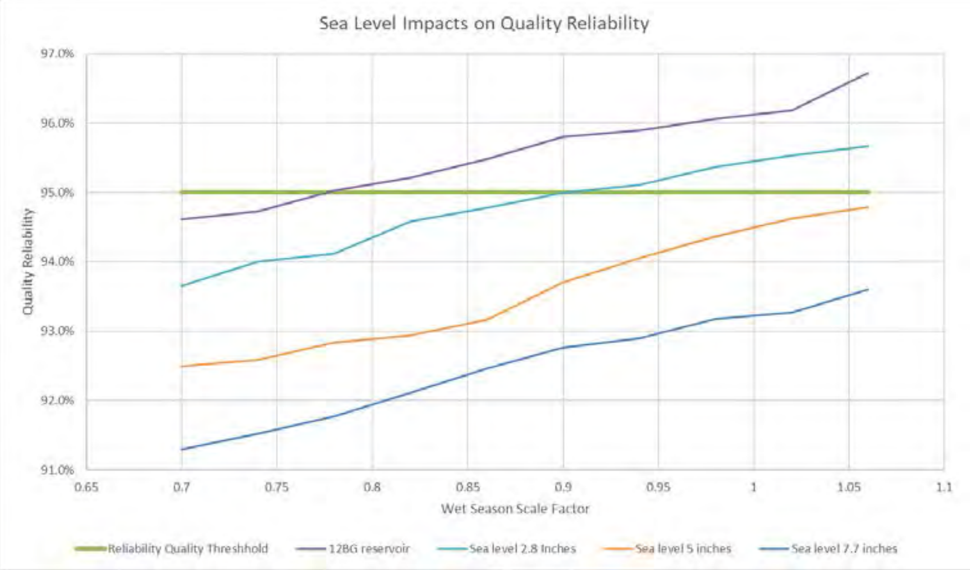




Scenario 5c – Sea Level Rise, 12BG Res , Flow Change

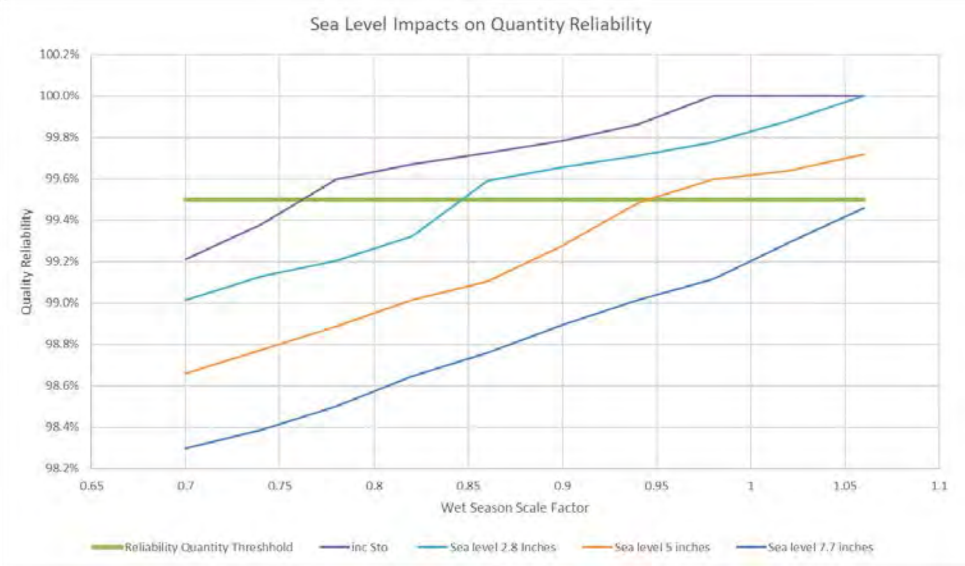
- Wet Season Flow Changes
  - June to Oct
  - Factored from Observed
- 4 sea level rise scenarios
  - Baseline
  - 2.8 inches SLR
  - 5 inches SLR
  - 7.7 inches SLR
- Scenario: 258MGD WUP, 80MGD WTP, 12BG Reservoir, 50MGD Demand

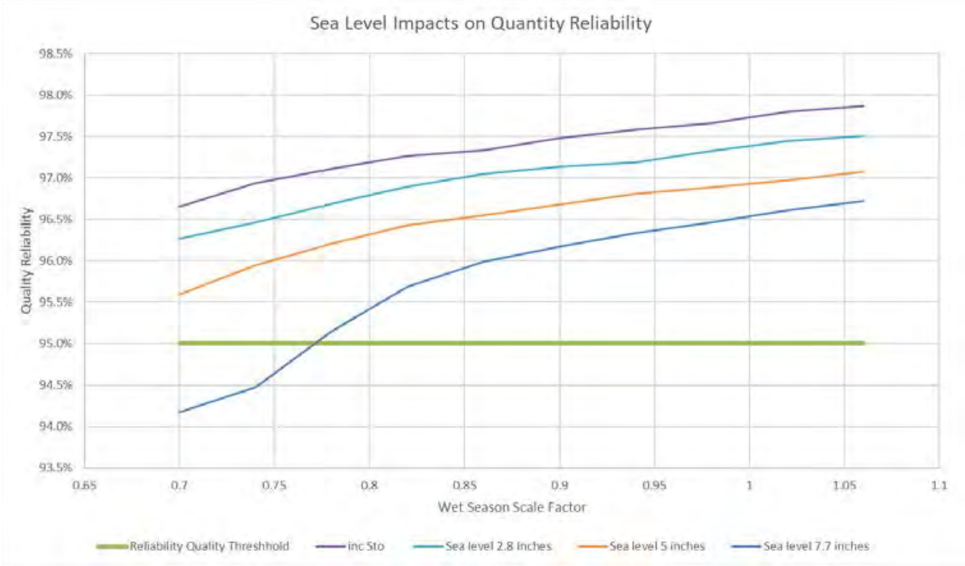




Scenario 5d – Sea Level Rise, 15BG Res, Flow Change

- Wet Season Flow Changes
  - June to Oct
  - Factored from Observed
- 4 sea level rise scenarios
  - Baseline
  - 2.8 inches SLR
  - 5 inches SLR
  - 7.7 inches SLR
- Scenario: 258MGD WUP, 80MGD WTP, 15BG Reservoir, 50MGD Demand





Discussion

MEETING SUMMARY

Southwest Florida Water Management District
Public Workshop
Recommended Minimum Flows for the Lower Peace River

October 29, 2020

(Summary prepared November 5, 2020)

The Southwest Florida Water Management District (District) hosted a public workshop from 5:30 p.m. to 7:00 p.m. on October 29, 2020 for discussion of recommended minimum flows for the Lower Peace River. The meeting was facilitated to disseminate relevant information and provide an opportunity for stakeholders to provide input on the recommended minimum flows.

The workshop was advertised in the Florida Administrative Register, local newspapers, and on the District's web site. In addition, numerous interested parties and local government staff and officials were notified of the meeting and a press release was made available to the regional media.

Following the directive in the Florida Department of Environmental Protection's Emergency Order to conduct all public meetings electronically to reduce the spread of COVID-19, the public meeting was held virtually via Microsoft Teams.

Nine stakeholders participated in the workshop, including: Krystal Azzarella, Mike Britt, Brian Fuller, Dale Helms, Angel Martin, Ruta Vardys and 3 others. Fifteen District staff members participated in the workshop: Chris Anastasiou, Chief Water Quality Scientist; Mike Bray, Assistant General Counsel; Kristina Deak, Staff Environmental Scientist; Randy Emberg, Video Production Engineer; Yonas Ghile, Lead Hydrologist; Doug Leeper, MFLs Program Lead; Jordan Miller, Environmental Scientist; Ryan Pearson, Economist; Cindy Rodriguez, Senior Governmental Affairs Regional Manager; Randy Smith, Natural Systems & Restoration Bureau Chief; Adrienne Vining, Assistant General Counsel; XinJian Chen, Chief Professional Engineer; Lei Yang, Chief Professional Engineer; Quanghee Yi, Senior Professional Engineer; and Chris Zajac, Environmental Flows and Assessments Manager.

Mr. Leeper began the workshop at 5:30 p.m. by providing information concerning use of the Teams software or telephone for meeting participation. He then identified the primary District staff who worked on development of the recommended minimum flows for the Lower Peace River, including Dr. Yonas Ghile, Dr. XinJian Chen, Dr. Kristina Deak and Dr. Chris Anastasiou. Mr. Leeper subsequently provided a brief presentation addressing general information on the District and the District's recommended minimum flows.

The presentation was followed by a public comment period, during which workshop participants were made aware of the various opportunities available for public comment on the proposed minimum flows, including providing oral comment during the workshop or providing oral or written comments following the workshop. Participants were informed that they may also provide comment on the proposed minimum flows at District Governing Board meetings, including the December 15, 2020 meeting at which District staff will recommend initiation of rulemaking for the proposed minimum flows. Mr. Leeper requested that stakeholder comments be provided as soon as practical, preferably by November 30, 2020 to allow time for staff to consider all input.

One workshop participant, Mr. Angel Martin, asked several questions during the public comment period, and indicated he would follow-up with submission of written input. His questions and District staff responses were as follows.

1. Was the 2 psu (practical salinity units) salinity habitat value used to develop the recommended minimum flows based on salinity throughout the harbor area and was it based on an average value for a specific time period?

   District response: Dr. Chen noted that salinity is measured at multiple sites in the Lower Peace/Lower Shell Creek/Charlotte Harbor area and this information was used for development and verification of the hydrodynamic model used for the minimum flow analyses. In addition, Dr. Chen described some aspects of the hydrodynamic model and noted that based on a 7.7-year model simulation period, average salinity values for low, medium and high flow conditions were used to develop the recommended minimum flows.

2. How was the 15%-change threshold for identifying significant harm determined and was uncertainty in this percentage considered?

   District response: Mr. Leeper indicated that as noted in the draft minimum flows report for the Lower Peace River, the 15% habitat change criterion for use in flowing systems within the District originated from a recommendation included in an early peer review of proposed minimum flows for a District river. Since that time, the criterion has been used extensively for development of minimum flows and has been repeatedly reviewed and considered by staff and by more than 20 independent review panels convened to assess minimum flows proposed by the District. Mr. Leeper noted this was the case for the panel that recently reviewed the recommended minimum flows for the Lower Peace River, adding that during that recent review the panel determined that the staff had investigated other criteria and determined that the percent-change in habitat criteria were the most sensitive of all assessed criteria and were appropriate for minimum flows establishment.

3. Will changes in salinity in the study/model domain be considered with respect to possible sea-level rise?

   District response: Mr. Leeper stated that potential effects of sea level rise on salinity in the Lower Peace River/Lower Shell Creek System were investigated and described in the District's draft minimum flows report. He noted that as described in the report, future evaluations of sea level change will help inform decisions regarding the need for reevaluation of minimum flows established for the Lower Peace River but indicated that a fixed-schedule for the analyses has not currently been identified. He added that sea level rise is discussed in the District regional water supply plan, which is updated on a five-year basis, and that this cyclical update process could provide an opportunity for consideration and discussion of potential environmental and water-supply impacts associated with rising seas in the Lower Peace River and other coastal river segments within the District.

No specific suggestions concerning support for or opposition to the recommended minimum flows for the Lower Peace River were provided by stakeholders during the workshop.

The public input period ended at approximately 6:30 pm., and based on Mr. Leeper's suggestion, most stakeholders exited from the virtual meeting space. Mr. Leeper continued to facilitate the workshop until the advertised end-time of 7:00 p.m., at which time the meeting was adjourned.

The workshop agenda and a printed version of the slides presented during the meeting are provided below.

Workshop Agenda

Southwest Florida
Water Management District

2379 Broad Street, Brooksville, Florida 34604-6899
(352) 796-7211 or 1-800-423-1476 (FL only)
WaterMatters.org

An Equal Opportunity Employer

The Southwest Florida Water Management District (District) does not discriminate on the basis of disability. This nondiscrimination policy involves every aspect of the District's functions, including access to and participation in the District's programs, services and activities. Anyone requiring reasonable accommodation, or would like information as to the existence and location of accessible services, activities, and facilities, as provided for in the Americans with Disabilities Act, should contact Donna Kaspari, Sr. Performance Management Professional, at 2379 Broad St., Brooksville, FL 34604-6899; telephone (352) 796-7211 or 1-800-423-1476 (FL only), ext. 4706; or email ADACoordinator@WaterMatters.org. If you are hearing or speech impaired, please contact the agency using the Florida Relay Service, 1-800-955-8771 (TDD) or 1-800-955-8770 (Voice). If requested, appropriate auxiliary aids and services will be provided at any public meeting, forum, or event of the District. In the event of a complaint, please follow the grievance procedure located at WaterMatters.org/ADA.

MEETING NOTICE

AGENDA
Public Meeting
Recommended Minimum Flows for the Lower Peace River

THURSDAY, OCTOBER 29, 2020
5:30 PM TO 7:00 PM

WEBINAR (TEAMS MEETING)

Teams meeting (Conference ID 838 375 52#) link: Join Microsoft Teams Meeting

Alternative Teams meeting link: https://bit.ly/2GjUvvv

Telephone-only participation: 1-786-749-6127; Conference ID: 838 375 52#

All meetings are open to the public.

1. Recommended minimum flows for the Lower Peace River by Doug Leeper, District MFLs Program Lead
2. Public comment facilitated by Doug Leeper

Participants will be asked to save their comments until the public comment portion of the meeting. If you wish to speak during the public comment period, please identify yourself to the Moderator (Doug Leeper), who will then facilitate your input. Comments will be limited to three minutes per speaker. In appropriate circumstances, the Moderator may grant exceptions to the three-minute limit.

For questions or to submit additional public comment on the Minimum Flows and Levels Priority List and Schedule, please contact Doug Leeper by email at doug.leeper@watermatters.org, by telephone at 1-800-423-1476 or 352-796-7211, extension 4272, or by mail at the address listed at the top of this agenda. Written comments should be submitted no later than November 30, 2020.

Bartow Office
170 Century Boulevard
Bartow, FL 33830-7700
863-534-1448 or 1-800-492-7862

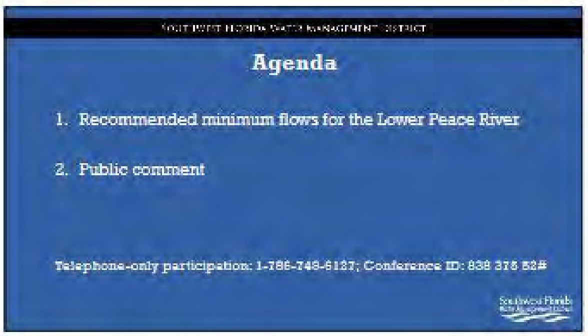
Sarasota Office
78 Sarasota Center Boulevard
Sarasota, FL 34240-9711
941-377-3722 or 1-800-320-3503

Tampa Office
7601 US Highway 301 North
Tampa, FL 33637-6759
813-985-7481 or 1-800-836-0797

Workshop Presentation Slides

1

2



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6


SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
Minimum Flows
The minimum flow for a given watercourse is the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area.
Minimum flow rules are used in District permitting and planning programs

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
Lower Peace River
River segment downstream of Arcadia
Based on combined flows:
Peace River at Arcadia
Joshua Creek at Nocatee
Horse Creek near Arcadia
Minimum flows
Adopted in 2010
Initial reevaluation in 2018
Comprehensive reevaluation and adoption scheduled for 2020

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SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
Lower Peace River
Minimum Flows Development
Draft minimum flows report to District Governing Board (March 24, 2020)
Independent scientific peer review (March 25 – June 26, 2020)
Stakeholder outreach (ongoing)
Presentations to Coastal & Heartland National Estuary Partnership Technical Advisory Committee (April 17, 2020), District Public Supply Advisory Committee (August 11, 2020), District Environmental Advisory Committee (October 13, 2020)
Public workshop (today)
Final minimum flows report and request for initiation of rulemaking to District Governing Board (December 15, 2020)

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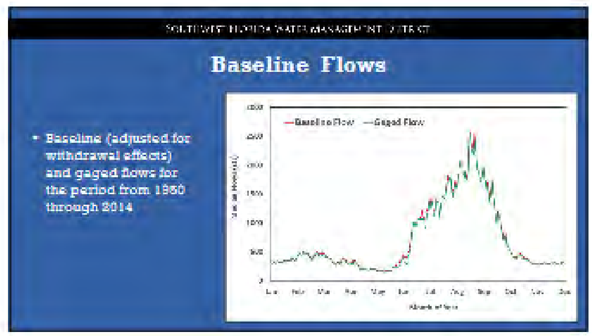
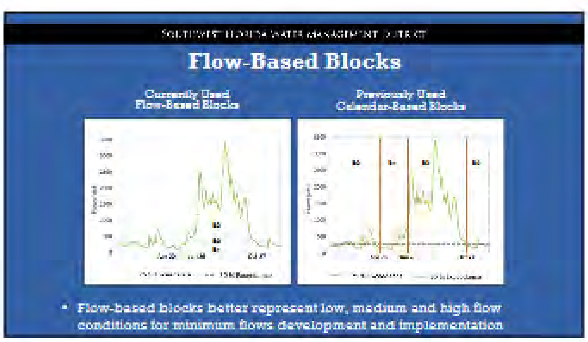
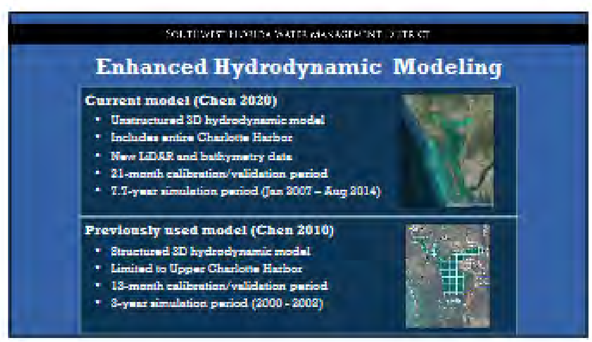

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
Baseline Flows
Baseline (adjusted for withdrawal effects) and gaged flows for the period from 1950 through 2014
Baseline Flow
Gaged Flow

10


SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
Flow-Based Blocks
Currently Used Flow-Based Blocks
Previously Used Calendar-Based Blocks
Flow-based blocks better represent low, medium and high flow conditions for minimum flows development and implementation

11


SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
Enhanced Hydrodynamic Modeling
Current model (Chen 2020)
Unstructured 3D hydrodynamic model
Includes entire Charlotte Harbor
New LiDAR and bathymetry data
21-month calibration/validation period
7.7-year simulation period (Jan 2007 – Aug 2014)
Previously used model (Chen 2010)
Structured 3D hydrodynamic model
Limited to Upper Charlotte Harbor
13-month calibration/validation period
3-year simulation period (2000 - 2002)

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Southwest Florida Water Management District

Enhanced Ecological Criteria and Considerations

Current Evaluation	Previous (2010 Evaluation)
• Salinity-based habitats (≤2, ≤5, ≤10, ≤15, ≤20 psu) • Floodplain inundation • Habitats for 3 estuarine-dependent taxa (fish and Blue Crab) • Water quality (dissolved oxygen, nutrients, chlorophyll, color)	• Salinity-based habitats (≤2, ≤5, ≤10, ≤15, ≤20 psu)

- ≤ 2 psu salinity volume was the metric most sensitive to flow reductions
- Minimum flows developed based on preserving 85% of ≤2 psu salinity volume

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Southwest Florida Water Management District

Lower Peace River Recommended Minimum Flows

Flow-based Block	If Flow on Previous Day is:	Minimum Flow is:	Maximum Flow Reduction is:
1	≤130 cfs	100% of flow	0 cfs
	130 cfs to 149 cfs	130 cfs	flow minus 130 cfs
	150 cfs to 297 cfs	87% of flow	13% of flow
2	298 cfs to 335 cfs	258 cfs	flow minus 258 cfs
	336 cfs to 622 cfs	77% of flow	23% of flow
3	623 cfs to 798 cfs	478 cfs	flow minus 478 cfs
	>798 cfs	60% of flow*	40% of flow*

* Daily maximum withdrawal is 400 cfs

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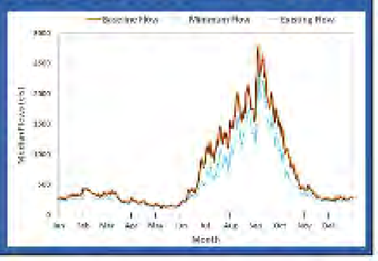
Southwest Florida Water Management District

Lower Peace River Recommended Minimum Flows

- Baseline (adjusted for withdrawal effects), gaged and minimum flows for the period from 1975 through 2018



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Southwest Florida Water Management District

Minimum Flows Summary

- Recommended minimum flows for the Lower Peace River (and Lower Shell Creek) are based on maintaining 85% of the 2 psu or less salinity volume
- Recommended minimum flows are protective of all environmental values identified for consideration when establishing minimum flows
- Recommended minimum flows for the Lower Peace River are currently met and projected to be met during the next 20-year planning period

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Southwest Florida Water Management District

More Information on the District Website

- Minimum flows page for the Lower Peace River and Lower Shell Creek: https://www.swfwmd.state.fl.us/projects/mfls/lower-peace-river/lower-shell-creek
- Minimum flows and level documents and reports: https://www.swfwmd.state.fl.us/projects/mfl/documents-and-reports
- Meeting/teleconference announcements posted on the Boards, Meetings & Events calendar: https://www.swfwmd.state.fl.us/about/calendar/month

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Southwest Florida Water Management District

Public Input

- Comment orally today
- Comment orally by telephone, in person at the District, and/or in writing (preferred) via email or letter by November 30, 2020
- Contact: Doug Leeper
  2379 Broad Street
  Brooksville, FL 34604
  (352) 796-7211, Ext. 4272
  Doug.leeper@swfwmd.state.fl.us
- Comment during the Governing Board meeting on December 15, 2020

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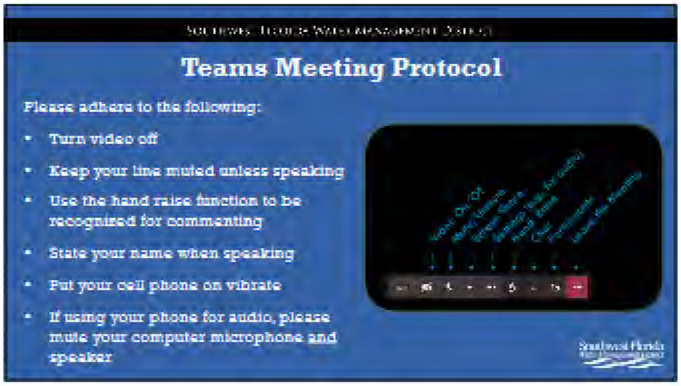
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
Teams Meeting Protocol
Please adhere to the following:
• Turn video off
• Keep your line muted unless speaking
• Use the hand raise function to be recognized for commenting
• State your name when speaking
• Put your cell phone on vibrate
• If using your phone for audio, please mute your computer microphone and speaker

19

From:	Doug Leeper
To:	"matt warren"
Cc:	Yonas Ghile; Xinjian Chen; Kristina Deak; Chris Anastasiou; Chris Zajac; Randy Smith; Eric DeHaven; Adrienne E. Vining; Mike R. Bray
Subject:	RE: Peace River Minimum Flow Levels
Date:	Monday, November 16, 2020 3:54:00 PM

Mr. Warren:

Thank you for your comments regarding the Peace River. I've shared your email with District staff working on the development of recommended minimum flows for the Lower Peace River and included the email in a stakeholder outreach appendix to the District's draft minimum flows report for the river and lower Shell Creek.

You may be interested in learning that mining activities and effects on the river are discussed in the Section 5.3 and Appendix A of the District's draft report on recommended minimum flows for the lower Peace River and Lower Shell Creek. Additional information on mining effects on the river is provided in the Peace River Cumulative Impact Study that was prepared for the Florida Department of Environmental Protection and Southwest Florida Water Management District in 2007. This 2007 study is referenced and cited in the District's draft minimum flows report.

For additional information regarding mining activities mentioned in your email, I've provided links to relevant information below for the Florida Department of Environmental Protection, which is the primary permitting authority for mining activities within the state.

- Florida Department of Environmental Protection Mining and Mitigation Program page: https://floridadep.gov/water/mining-mitigation
- A "Phosphate" page linked to the Florida Department of Environmental Protection Mining and Mitigation Program page: https://floridadep.gov/water/mining-mitigation/content/phosphate
- A "Mining and Mitigation Program Contacts" page linked to the Florida Department of Environmental Protection Mining and Mitigation Program page: https://floridadep.gov/water/mining-mitigation/content/mining-and-mitigation-program-contacts

Finally, please feel free to contact me if you have additional comment on the District's recommended minimum flows for the Lower Peace River or other water management issues.

Doug Leeper
MFLs Program Lead
Environmental Flows and Assessments Section
Natural Systems & Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street (U.S. Hwy. 41 South)
Brooksville, FL 34604-6899
352-796-7211, Ext. 4272
1-800-423-1476, Ext. 4272
Doug.leeper@watermatters.org

Doug Leeper
MFLs Program Lead
Environmental Flows and Assessments Section
Natural Systems & Restoration Bureau
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Brooksville, FL 34604-6899
352-796-7211, Ext. 4272
1-800-423-1476, Ext. 4272
Doug.leeper@watermatters.org

From: matt warren <flatwoodscattle@gmail.com>
Sent: Tuesday, October 20, 2020 10:58 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: Peace River Minimum Flow Levels

[EXTERNAL SENDER] Use caution before opening.
This is for public comment on the Minimal Flow Levels for the Peace River.
Having grown up in Zolfo Springs I spent many days on the river. I have noticed the change very noticeable. Especially during the dry times of spring when the water does not flow much and it has a dirty black look and smells. One thing that never gets mentioned is the Phosphate mines that dig on both sides of the river. These mines break up the underground river and springs which allows fresh water to flow into the river by creeks or even under the river by small holes. I know they are not 1st magnitude springs but regardless they bring in fresh clean water, or did in the past. Why can nothing be done about this issue. This would help the minimal flow down stream if mining could be slowed down. Just my thoughts
Thanks
Matt Warren
Hardee County

--

Love is what Jesus did at the Cross
Remember why he did it

From:	matt warren
To:	Doug Leeper
Cc:	Yonas Ghile; Xinjian Chen; Kristina Deak; Chris Anastasiou; Chris Zajac; Randy Smith; Eric DeHaven; Adrienne E. Vining; Mike R. Bray
Subject:	Re: Peace River Minimum Flow Levels
Date:	Monday, November 16, 2020 4:06:27 PM

[EXTERNAL SENDER] Use caution before opening.

Thank you for the information.

On Mon, Nov 16, 2020, 3:54 PM Doug Leeper <Doug.Leeper@swfwmd.state.fl.us> wrote:

> Mr. Warren:
>
> Thank you for your comments regarding the Peace River. I've shared your email with District staff working on the development of recommended minimum flows for the Lower Peace River and included the email in a stakeholder outreach appendix to the District's draft minimum flows report for the river and lower Shell Creek.
>
> You may be interested in learning that mining activities and effects on the river are discussed in the Section 5.3 and Appendix A of the District's draft report on recommended minimum flows for the lower Peace River and Lower Shell Creek. Additional information on mining effects on the river is provided in the Peace River Cumulative Impact Study that was prepared for the Florida Department of Environmental Protection and Southwest Florida Water Management District in 2007. This 2007 study is referenced and cited in the District's draft minimum flows report.
>
> For additional information regarding mining activities mentioned in your email, I've provided links to relevant information below for the Florida Department of Environmental Protection, which is the primary permitting authority for mining activities within the state.
>
> - Florida Department of Environmental Protection Mining and Mitigation Program page:
>
> https://floridadep.gov/water/mining-mitigation
>
> - A "Phosphate" page linked to the Florida Department of Environmental Protection Mining and Mitigation Program page:
>
> https://floridadep.gov/water/mining-mitigation/content/phosphate
>
> - A "Mining and Mitigation Program Contacts" page linked to the Florida Department of Environmental Protection Mining and Mitigation Program page:
>
> https://floridadep.gov/water/mining-mitigation/content/mining-and-mitigation-program-

contacts

Finally, please feel free to contact me if you have additional comment on the District's recommended minimum flows for the Lower Peace River or other water management issues.

Doug Leeper

MFLs Program Lead

Environmental Flows and Assessments Section

Natural Systems & Restoration Bureau

Southwest Florida Water Management District

2379 Broad Street (U.S. Hwy. 41 South)

Brooksville, FL 34604-6899

352-796-7211, Ext. 4272

1-800-423-1476, Ext. 4272

Doug.leeper@watermatters.org

Doug Leeper

MFLs Program Lead

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1-800-423-1476, Ext. 4272

Doug.leeper@watermatters.org

From: matt warren <flatwoodscattle@gmail.com>
Sent: Tuesday, October 20, 2020 10:58 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: Peace River Minimum Flow Levels

[EXTERNAL SENDER] Use caution before opening.

This is for public comment on the Minimal Flow Levels for the Peace River.

Having grown up in Zolfo Springs I spent many days on the river. I have noticed the change very noticeable. Especially during the dry times of spring when the water does not flow much and it has a dirty black look and smells. One thing that never gets mentioned is the Phosphate mines that dig on both sides of the river. These mines break up the underground river and springs which allows fresh water to flow into the river by creeks or even under the river by small holes. I know they are not 1st magnitude springs but regardless they bring in fresh clean water, or did in the past. Why can nothing be done about this issue. This would help the minimal flow down stream if mining could be slowed down. Just my thoughts

Thanks

Matt Warren

Hardee County

--

Love is what Jesus did at the Cross

Remember why he did it

From:	Vardys, Ruta
To:	Doug Leeper
Cc:	Rudy, Craig; Bullert, Bruce; Stecher, Kenneth
Subject:	RE: Recommended Minimum Flows for the Lower Peace River - Comment
Date:	Monday, November 30, 2020 1:35:43 PM

[EXTERNAL SENDER] Use caution before opening.

Hello Doug,

I used the below e-mail address (see below forwarded e-mail) to send our comment into you. I found the below e-mail address on the powerpoint presentation at the October 29th public meeting. Additionally, I noticed that on this website there is a typo on your e-mail address under the section "Public Meeting - Recommended Minimum Flows for the Lower Peace River" on the SWFWMD website. It looks like a 't' was missing in 'watermatters.org'.

I thought you would like to know. Thank you, in advance, for accepting our comment below.

Ruta

Ruta Vardys, PE
Engineer III
Charlotte County Utilities
Dir. 941.764.4302
CharlotteCountyFL.gov
Delivering Exceptional Service

From: Vardys, Ruta
Sent: Monday, November 30, 2020 10:36 AM
To: doug.leeper@swfwmd.st.fl.us
Cc: Rudy, Craig <Craig.Rudy@charlottecountyfl.gov>; Bullert, Bruce <Bruce.Bullert@charlottecountyfl.gov>; Stecher, Kenneth <Kenneth.Stecher@charlottecountyfl.gov>
Subject: Recommended Minimum Flows for the Lower Peace River - Comment

Doug,

Thank you for the presentation on October 29, 2020 at the public meeting held regarding the above subject.

Charlotte County Utilities would like to offer the following comment in relation to the recommended minimum flows:

Charlotte County Utilities interests are to ensure that the recommended minimum flows will allow for the Peace River Manasota Regional Water Supply Authority to provide an adequate water supply to meet the demands for our service area.

Thank you for your time and consideration.

Ruta

Ruta Vardys, P.E.
Engineer III
Charlotte County Utilities
25550 Harborview Rd. Suite 1
Port Charlotte, FL 33980
Dir. 941-764-4302

From:	Doug Leeper
To:	"Vardys, Ruta"
Cc:	Rudy, Craig; Bullert, Bruce; Stecher, Kenneth; Chris Zajac; Randy Smith; Eric DeHaven; Yonas Ghile; Xinjian Chen; Kristina Deak; Chris Anastasiou; Adrienne E. Vining; Mike R. Bray; Dennis Ragosta
Subject:	RE: Recommended Minimum Flows for the Lower Peace River - Comment
Date:	Monday, November 30, 2020 2:23:00 PM

Ruta:

- Thanks for the input from Charlotte Harbor Utilities on the District's proposed minimum flows for the Lower Peace River.
  - I will ensure your email is provided to others at the District for consideration and will include it in an updated version of Appendix H (Stakeholder outreach and comment information) to the draft minimum flows report for the river.
- Thanks also for noting the typo in my email address on the District's calendar entry for the October 29, 2020 public workshop on the proposed minimum flows.
  - We will correct that typo.
  - Note that both email addresses. doug.leeper@watermatters.org and doug.leeper@swfwmd.state.fl.us can be used to contact me.

Doug Leeper
MFLs Program Lead
Environmental Flows and Assessments Section
Natural Systems & Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street (U.S. Hwy. 41 South)
Brooksville, FL 34604-6899
352-796-7211, Ext. 4272
1-800-423-1476, Ext. 4272
Doug.leeper@watermatters.org

From: Vardys, Ruta <Ruta.Vardys@charlottecountyfl.gov>
Sent: Monday, November 30, 2020 1:36 PM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Rudy, Craig <Craig.Rudy@charlottecountyfl.gov>; Bullert, Bruce <Bruce.Bullert@charlottecountyfl.gov>; Stecher, Kenneth <Kenneth.Stecher@charlottecountyfl.gov>
Subject: RE: Recommended Minimum Flows for the Lower Peace River - Comment

[EXTERNAL SENDER] Use caution before opening.
Hello Doug,

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Ruta

Ruta Vardys, PE
Engineer III
Charlotte County Utilities
Dir. 941.764.4302
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Delivering Exceptional Service

From: Vardys, Ruta
Sent: Monday, November 30, 2020 10:36 AM
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Subject: Recommended Minimum Flows for the Lower Peace River - Comment

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Thank you for your time and consideration.

Ruta

Ruta Vardys, P.E.
Engineer III
Charlotte County Utilities
25550 Harborview Rd. Suite 1
Port Charlotte, FL 33980
Dir. 941-764-4302