

Wetland Assessment A Presentation to the

Northern Tampa Bay Phase I Peer Review Group

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Outline

- Impetus for Study
- Background
- Objectives
- Methods and Results
- Electronic Products
- Recommendations

Impetus for Study

A network of 400 additional wetlands will be established to be rated at a longer interval, such as every 5 years. It is proposed that this network consist of a larger spatial coverage than the more routinely rated wetlands network.

> Northern Tampa Bay Phase II Investigations Scope of Work (SWFWMD 1999)

Background

- In 1997-1998, the District performed an assessment of regional wetland conditions by determining and mapping wetland health in an extensive network of wetlands distributed across the Northern Tampa Bay Region.
- In 2004, the District contracted with the Berryman & Henigar – Bureau Veritas Project Team to update that original assessment.

ATTACHMENT 1

The Effects of Water Table Level Changes on Fresh-Water Marsh & Cypress Wetlands in the Northern Tampa Bay Region

A review by Theodore F. Rochow, Ph. D.



Environmental Section Technical Report 1998-1

DECEMBER 1998 Southwest Florida Water Management District



Objectives

- Convert hardcopy 1997/1998 Wetland Health Assessment (WHA) data to GIS
- Develop Field/Office Evaluation database
- Perform Wetland Health Assessments in expanded network of 400 Wetlands following methods used in 1997/1998
- Map and report 2004/2005 WHAs and change from 1997/1998 field effort

Methods and Results

- Creation of WHA GIS Database
- Site Selection
- Creation of Field Evaluation Database
- Team Field Calibration
- Preliminary Wetland Review (Office)
- Field Assessments
- Database Management
- Surrogate WHA from WAP Data
- Data Analysis and Mapping

Creation of WHA GIS Database



Hard Copy Wetland Health and Engineering Ratings from Rochow (1998) 1999 FLUCFCS GIS Database with Transferred Ratings

Understanding WHA and Engineering Rating Scales

Wetland Environmental Ratings

Rating	, Scale	Colors used on	Ecological Change	Wetland Health
3 Point	5 Point	District Maps	Ecological change	wettanu neatti
1	1-2	orange	severely changed	severely stressed
2	3	yellow	significantly changed	moderately stressed
3	4-5	green	not significantly changed	low or no stress

Wetland Engineering Ratings					
Colors used on District Maps	Meaning				
no color	no apparent man-made hydrologic alterations, or not evaluated				
brown	apparent man-made alterations that may significantly affect hydrology				
black	obvious man-made alterations to the system, that severely negatively affect hydrology				

Site Selection – Study Area



Site Selection - Identification of Existing Monitoring Sites

- District-monitored WHA sites obtained as spreadsheet and linked to District shapefile (100 polygons in study area)
- Tampa Bay Water ecologic sites obtained as shapefile and refined based on list of known WAP sites with Fall 2003 data (328 polygons in study area)
- 57 crossover sites monitored by both

Site Selection – Process

- 1343 sites evaluated in 1997/1998
- 123 of them already monitored
- Excluded wetlands with 1997/1998 surface drainage alterations (brown and black)
- Reduced sampling of green wetlands to 40
- 245 randomly selected yellow and orange
- Remaining 165 randomly selected from 4880 unmonitored and not previously assessed (i.e., 50 extra selected)

Creation of Field Evaluation Database (Pre-field Forms)

Wetland ID:	PRE-FIELD WETLAND REVIEW FORM	1997site	Wetland ID: PRE-FIELD W Candidate Site	/ETLAND REVIEW FORM s Evaluation Data, BHI 2000
Environmental Scientist Pre-Field Evaluation	1997 Rating Scientist Firm	Date		Historic Recent
Access Notes			Date of historical aerial photography:	Ditching:
			Historical wetland type:	
			Augmentation Status:	
			AKAs:	
Ditch Notes			Site candidacy status:	
			Change from historic to current:	
			Year stress first noted:	
			Stress intensity:	
Wetland Health Notes			Apparent causitive factors of stress:	
			% Change in wetland area over time:	
			Apparent or inferred cause:	
			Notes:	
Engineer Pre-Field Evaluation	1997 Rating Engineer Firm	Date		
Ditch Notes				Historic Recent
			Obvious or apparent stres	ss indicators:
				Ditching:
			Generic detectable canopy str	ess (forests):
			Cover stressed ca	nopy foliage:
D 1 N 4			Leaning/fallen trees as percent of st	ent (forests):
Drainage Notes			Gap area from tree fall area or natural	nan (forests):
			UPL or non-OBL shrubs, understory, or ground co	ver (forests):
			Shrubs, woody, or non-OBL vegetation invasio	n (marshes):
Other Notes			Sandy rim or dry rim exten	ts (marshes):
			Predicted NP Offset at historic, 121mgd and 90 mg	d production:
			Long term median water level predictions rela	ative to HNP:
Check if man-made alterations of	evident Engineer rating if evident:			
Check if engineer field visit requ	uired			

Creation of Field Evaluation Database (Field Forms)

Wetland ID: WETLAND	EVALUATION FIELD FORM STR(s):
Acreage: County(s):	
Date: Time:	Project Scientist: Firm:
Vegetation Type	Project Engineer Firm:
Present Hydrologic Condition	Present Wetland Condition
Water % Wetland Soil Hydration	Fire Scars <u>Fuel Accumulation</u> <u>Soil Subsidence</u>
Depth Flooded moist/saturated	normal moderate 1 - 3"
dry	abnormal excessive 3 - 6 "
Historic Water Level Indicators	Understory Horizontal Zonation Rating and Comments
Cypress Buttress	normal
Lyonia Root Crowns Mosses	adnormal
Other: Stain Line:	Woody Successional Trend and Comments
	normal
Wetland Wildlife and Abundance	autoritian
	Foliage Thinning
	Leaning Trees
	Fallen Trees
	Root Rot
	Other:
Aquatic Plants and Abundance	Terrestrial Plants and Abundance
Aquatic Flants and Abundance	Abundance
	Scoring
	< 1% tr
	1 - 5% 1
	5 - 25% 2
	25 - 50% 3
	50 - 75% 4
Land Use Influences Developme	13 - 100 70 3
Agriculture Ditching Commercial R	esidential Timbering Other (identify)
Ditching Etc. Significantly Influencing Wetland	Hydrology:
bad	nments on Evaluation
2	
3	
good 5	

Vetland ID:	SCORING CHART				
	Points	s Quality			
Canopy Foliage	1 2	 > 50% standing dead / thin canopy 10 - 50 % standing dead / thin canopy < 10% standing dead / thin canopy 			
Leaning Trees	1 2 3	> 25% leaning 5 - 25 % leaning < 5% leaning			
Fallen Trees	1 2 3	> 25% fallen 5 - 25 % fallen < 5% fallen			
Dominant Plant Species	1 2 3	< 50% OBL or FACW 50 - 75 % OBL or FACW > 75% OBL or FACW			
Exotic / Weedy Plants	1 2 3	abundant uncommon absent			
Soil	1 2 3	fissured, oxidized unseasonal dry absent			
Tree/Shrub Successional Trends	12	trees / shrubs indicate rapid change trees / shrubs dominance appears stable			
Understory Zonation	12	understory zonation abnormal understory zonation normal			
Wetland Hydration	1 2 3	severely depressed vs. reference controls moderately depressed vs. reference controls appropriate vs. reference controls			
Water Level Indicators vs. (Le., mosses, lichens, stain lines)	1 2 3	none or at tree base present, indistinct or abnormally low distinct at appropriate level			
Fotal Quality Points:					
Engineer Rating	D MT ND	obvious man-made alterations; severe negative effect on wetland hydrology apparent man-made alterations; may significantly effect wetland hydrology no apparent man-made alterations to system or not evaluated			
Additional Comments					
Disturbance	1 2 3	highly disturbed moderately disturbed undisturbed			

Key Data for Analysis

Relative Estimation of Wetland Health and Comments on Evaluation

2	
3	
good 5	

Engineer Rating	D MT ND	obvious man-made alterations; severe negative effect on wetland hydrology apparent man-made alterations; may significantly effect wetland hydrology no apparent man-made alterations to system or not evaluated

Creation of Field Evaluation Database (GPS and Photos)

Wetland ID:	WET	FLAND EVALUAT GPS and Photo I	TION FI	IELD FORM ntation
<u>Date /</u> <u>Time</u>	GPS Location	<u>Latitude /</u> <u>Longitude</u>	<u>Photo</u> <u>Frame</u>	Photo Description (enter n/a if none taken)

Team Field Calibration (scientists)



Team Field Calibration (engineers)



Preliminary Wetland Review

- Field packages provided to scientists and engineers who completed Pre-Field Wetland Review Form in the office:
 - Wetland polygons on 1999 and historical aerials
 - 1":200' one-foot aerial topographic maps
 - Preliminary Wetland Review Form with Candidate Sites Evaluation Study (CSES) data, if applicable

Field Assessments

- Environmental Scientists visited every site (409) between June 1, 2004 and March 11, 2005--78% between Oct 15 and Dec 30
 - Completed field forms
 - Recorded GPS location information
 - Took Photos
- Engineers visited selected sites where drainage alterations were unknown or uncertain

Site Access Protocols

- Telephone coordination with landowners of larger land holdings
- Use of drainage easements and roadside access
- "Knocking on doors" to request permission from single-family residents

Database Management

- GIS data transfer quality control check
- Field database quality control

WHA Score	General Criteria
1	No hydrology Severe non-wetland plant invasion into interior Severe treefall and/or most cypress stressed Severe soil subsidence
2	Reduced hydrology Severe non-wetland plant invasion into interior Some treefall and/or stressed cypress Substantial soil subsidence
3	Depressed hydrology or was depressed but now recovering Non-wetland plant invasion of edge (may be in interior if inappropriate plants stressed) Dominated by wetland plants Cypress healthy or some stressed Minor soil subsidence
4	Good hydrology or was depressed and now normal Few weedy plants (there may be some near the edge) Dominated by wetland plants (or most non-wetland plants dead) Most trees healthy Minor soil subsidence
5	Good hydrology Few non-wetland plants Most trees healthy No soil subsidence

Existing Wetland Health Data form Other Sources to "Fill in the Map"

- Fall 2003 Wetland Health Assessment Data collected by District staff and consultants (no conversion required for analysis and map display)
- Fall 2003 Tampa Bay Water Environmental Management Plan WAP Data (conversion required)

Surrogate WHA from WAP Data (Similar Categories)

WHA Category	WAP Category
Canopy Foliage	% Tree Canopy Stress
Leaning Trees	% Tree Leaning
Fallen Trees	% Trees Dead
Dominant Plant Species	Groundcover Deep Zone Composition
Exotic/Weedy Plants	Weedy Groundcover Composition
Soil	Soils – Forested Wetlands D x 1/2
Tree/Shrub Successional Trends	Shrub and Small Tree Species Zonation
Understory Zonation	Groundcover Species Zonation
Water Level Indicators vs. Historic	Current Water Level Indicators

Surrogate WHA from WAP Data (Linear Regression)



Surrogate WHA from WAP Data (Performance Assessment)

		WHA	(3 Point S	cale)	
		1	2	3	Total
Surrogate	1	7	1		8
WHA (3 Point	2	7	27	17	51
Scale)	3	2	23	60	85
	Total	16	51	77	144

WHA = (WAPAVG * 2.40306983392418) - 2.87061248427285

Data Analysis and Mapping Results

- Overall Maps
- Tabular Summaries
- Wellfield Area Determinations
- Statistical Analysis

Map 1. All Monitored/Assessed Sites



All Monitored/Assessed Sites (zoom)



Map 2. 1997/1998 WHA Ratings



1997/1998 WHA Ratings (zoom)



Environmental Scientist Rating



Wetland not significantly changed Wetland significantly changed Wetland severely changed

Wetland believed not significantly changed
 Environmental rating data unavailable

1997/1998 WHA Ratings

			Engineerin	g Ratings		
Environmental Ratings	Black	Brown	None	Unknown	Grand Total	% Total
Green				512	<u> </u>	38%
Yellow			211	2	213	16%
Orange			142		142	11%
Pattern			22	1	23	2%
Unknown	21	432			453	34%
Grand Total	21	432	375	515	1,343	100%
			Engineerin	g Ratings		
Environmental	Plaak	Drown	Engineerin	g Ratings	Grand	0/ Total
Environmental Ratings	Black	Brown	Engineerin None	g Ratings Unknown	Grand Total	% Total
Environmental Ratings Green	Black	Brown	Engineerin None	g Ratings Unknown 14,667.88	Grand Total 14,667.88	% Total 34%
Environmental Ratings Green Yellow	Black	Brown	Engineerin None 5,996.95	g Ratings Unknown 14,667.88 147.03	Grand <u>Total</u> 14,667.88 6,143.98	% Total 34% 14%
Environmental Ratings Green Yellow Orange	Black	Brown	Engineerin None 5,996.95 4,457.87	g Ratings Unknown 14,667.88 147.03	Grand <u>Total</u> 14,667.88 6,143.98 4,457.87	% Total 34% 14% 10%
Environmental Ratings Green Yellow Orange Pattern	Black	Brown	Engineerin None 5,996.95 4,457.87 10,694.20	g Ratings Unknown 14,667.88 147.03 20.64	Grand <u>Total</u> 14,667.88 6,143.98 4,457.87 10,714.84	% Total 34% 14% 10% 25%
Environmental Ratings Green Yellow Orange Pattern Unknown	Black 410.22	Brown 6,773.00	Engineerin None 5,996.95 4,457.87 10,694.20	g Ratings Unknown 14,667.88 147.03 20.64	Grand <u>Total</u> 14,667.88 6,143.98 4,457.87 10,714.84 7,183.22	% Total 34% 14% 10% 25% 17%

Map 3. 2004/2005 WHA Ratings



2004/2005 WHA Ratings (zoom)



Environmental Scientist Rating





Wetland not significantly changed Wetland significantly changed Wetland severely changed

2004/2005 WHA Ratings

	Engineering Ratings								
Environmental	Rlack	B rown	Nono	Unknown	Grand	0/ Total			
Ratings	Diack	DIOWI	None	UIIKIIUWII	Total	70 10tal			
Green	1	40	49	41	131	45%			
Yellow	3	77	78	35	193	38%			
Orange	4	. 69	87	15	175	16%			
Grand Total	8	186	214	91	499	100%			
	Engineering Ratings								
Environmental	Blook	Brown	Nono	Unknown	Grand	% Total			
Ratings	DIACK	DIUWII	none		Total	70 10tal			

932.78

781.95

1,062.70

2,777.43

3,591.03

664.00

209.69

4,464.72

5,062.70

2,869.33

2,204.08

10,136.11

50%

28%

22%

100%

538.30

911.56

1,378.56

2,828.42

0.59

44.81

20.13

65.53

Green

Yellow

Orange

Grand Total

Surrogate WHA from WAP Results

Wetland Health Surrogate		Sit	es	Acreage		
Color	Score	Count	% Total	Total	% Total	
Green	4	161	59.4%	3,023.69	50.4%	
Yellow	3	87	32.1%	2,707.00	45.1%	
Orange	2	19	7.0%	257.39	4.3%	
	1	4	1.5%	9.81	0.2%	
Grand Total		271	100%	5,997.89	100%	

Map 4. Change Between 1997/1998 and 2004/2005



Change Between 1997/1998 and 2004/2005 (zoom)



Change Between 1997/1998 and 2004/2005

		2004 Environmental Rating						
1998 Environmental Ratin	g Green	Yellow	Orange	Grand Total				
Green	,	78	38	8 124				
Yellow		38	80 5	4 172				
Orange		18	29 6	4 111				
Pattern		12	2	14				
Unknown		19	20	3 47				
Grand Total	1	65 1	69 13	4 468				
		2004 Environmental Rating						
1998 Environmental Rating	Green	Yellow	Orange	Grand Total				
Green	2,890.40	1,110.67	104.35	4,105.42				
Yellow	775.58	1,313.56	873.55	2,962.68				
Orange	215.61	1,301.66	883.82	2,401.09				
Pattern	1,880.16	66.54		1,946.70				
Unknown	715.31	642.56	155.21	1,513.08				
Grand Total	6,477.06	4,434.99	2,016.93	12,928.97				

Wellfield Area Determinations



XX7 110° 1 1	1998 Environmental	Environmental 2004 Environmental Rating		Crond Total Wellfield	1998 Environmental	2004 En	vironmenta	l Rating			
wenneid	Rating	Green	Yellow	Orange	Grand lotal weilfield	Rating	Green	Yellow	Orange	Grand Iotal	
	Green	4	1	oninge	5		Green	173 449	4 385	orange	177.834
	Vallow	4	12	0	26	\sim	Vallow	02.25	127.026	77.021	208 217
Cosme-Odessa	Tellow	0	12	0	20	Cosme-Odessa	Tellow	93.33	15,022	77.031	102.957
	Urange	-	4	11	15		Orange	22.246	15.022	87.835	102.857
	Unknown	2	4	1	7		Unknown	33.346	246.01	6.215	285.571
	Total	12	21	20	53		Total	300.145	403.353	171.081	874.579
	Green	2	1		3		Green	20.98	12.932		33.912
Cross Bar Banch	Yellow	2	20	5	27	Cross Bar Banch	Yellow	52.491	256.726	103.708	412.925
Closs Dai Kanen	Orange	2	10	3	15	Closs Dai Kanen	Orange	58.859	1078.575	78.812	1216.246
	Unknown	7	3	1	11		Unknown	246.874	130.041	7.176	384.091
	Total	13	34	9	56		Total	379.204	1478.274	189.696	2047.174
	Green	5			5		Green	48.018			48.018
	Vellow	2	3		5		Vellow	54 131	35 263		89 394
Cypross Bridge	Orongo	2	1	1	2	Cypross Bridge	Orongo	54.151	0.682	2.020	2 621
Cypress Bluge	Datte	7	1	1	2	Cypress Blidge	Datte	254 265	0.082	2.939	3.021
	Pattern	/			/		Pattern	254.305			254.505
	Unknown		1		1		Unknown		4.179		4.179
	Total	14	5	1	20		Total	356.514	40.124	2.939	399.577
	Green	10			10		Green	1753.103			1753.103
Cypress Creek	Yellow	14	12	6	32	Cynress Creek	Yellow	171.492	221.627	16.412	409.531
Cypiess Cleek	Orange	8	6	12	26	Cypress Creek	Orange	73.078	124.795	67.389	265.262
	Unknown	3			3		Unknown	18.53			18.53
	Total	35	18	18	71		Total	2016.203	346.422	83.801	2446.426
	Green	2	3		5		Green	6.173	66.411		72 584
	Vellow	3	4	4	11		Vellow	85.036	46 907	50 343	183 186
Eldridge-Wilde		5	4	4	0	Eldridge-Wilde	Output and	85.950	40.907	111.0(1	112 555
-	Unange	1	1	8	9		Orange	152 200	1.594	111.961	113.333
	Unknown	1	2	2	5		Unknown	153.208	18.95	15.989	188.147
	Total	6	10	14	30		Total	245.317	133.862	178.293	557.472
	Green	3	1	1	5	Inter wellfield Area	Green	8.806	3.886	5.567	18.259
Inter wellfield Area	Yellow		2		2		Yellow		41.291		41.291
inter-weinfeld Area	Orange			1	1	Inter-weinteru Area	Orange			9.406	9.406
	Unknown	1	1		2		Unknown	38.944	5.61		44.554
Total		4	4	2	10		Total	47.75	50.787	14.973	113.51
	Green	26	10	1	37		Green	455 547	124 346	40 356	620 249
	Yellow	4	13	18	35		Yellow	277 878	409 553	537.002	1224 433
J.B. Starkey	Orango	1	15	10	11	J.B. Starkey	Orango	10 287	107.555	107.027	207.214
	Unknown	1	1	10	2		Unknown	10.287	15 772	99 211	124.084
	UIIKIIOWII	21	1	2	3		UIKIIOWII	742 710	43.773	86.511	134.084
Total		31	24	31	86		lotal	/43./12	579.672	862.696	2186.08
	Green	9	5		14	Morris Bridge	Green	43.109	35.732		/8.841
Morris Bridge	Yellow	5	5	6	16		Yellow	23.666	19.022	53.734	96.422
ino ino Dinugo	Pattern	5	2		7	inoms bringe	Pattern	1625.795	66.538		1692.333
	Unknown	1	1		2		Unknown	6.638	90.701		97.339
	Total	20	13	6	39		Total	1699.208	211.993	53.734	1964.935
North Dasga Dagional	Green	7	3	1	11	North Dagas Dagion-1	Green	149.082	147.443	13.265	309.79
North Pasco Regional	Yellow		3	4	7	North Pasco Regional	Yellow		45.5	16.329	61.829
	Total	7	6	5	18		Total	149.082	192.943	29.594	371.619
	Green	4	11	3	18		Green	22.31	276 637	41 203	340.15
	Yellow	•	1		1		Yellow	22.01	5 025		5.025
Northwest Hillsborough	Orango	1	1	2	2	Northwest Hillsborough	Orango	2.061	5.025	28 662	21 722
	Ul	1	2	2	3		Ulange	5.001	45.041	28.002	31.723
	Unknown	_	5		3		Unknown	05 051	45.841	(0.075	45.841
	Total	5	15	5	25		Total	25.371	327.503	69.865	422.739
	Green	4	1		5		Green	137.082	392.832		529.914
Section 21	Yellow		1	1	2	Section 21	Yellow		4.425	0.932	5.357
5001011 21	Orange	5	4	10	19	5001011 21	Orange	57.24	24.096	82.251	163.587
	Unknown	3	3	1	7		Unknown	202.135	38.667	23.857	264.659
	Total	12	9	12	33		Total	396.457	460.02	107.04	963.517
	Green	2	2	2	6		Green	72,741	46.068	3.961	122.77
	Yellow	2	<u></u> <u>A</u>	2	8		Yellow	16 634	90.286	18 054	124.974
South Pasco	Orongo		2	6	10	South Pasco	Orango	12 080	56 801	217 524	297 516
	Ualige	1	3	1	10		Unla	15.009	16 701	12 (50	46.005
	Unknown	1	1	1	3		Unknown	15.636	16./91	13.658	46.085
	Total	6	10		21		Total		210.036	253 209	581 345

Statistical Analysis

Regional area	Valid N	Т	Z	p-level	Average_1998	Average_2004	Change	Conditions
Overall	297	3104.0000	2.6804	0.0074	1.9562	1.8249	-0.1313	Declined
CBR	39	48.0000	1.0342	0.3011	1.7692	1.8974	0.1282	Improved
COS	41	48.0000	0.6816	0.4955	1.7561	1.6829	-0.0732	Declined
СҮВ	9	0.0000			2.2222	2.4444	0.2222	Improved
CYC	36	42.0000	0.2446	0.8068	1.6667	1.6944	0.0278	Improved
ELW	23	10.0000	1.4809	0.1386	1.8261	1.6087	-0.2174	Declined
IWF	8	0.0000			2.5000	2.1250	-0.3750	Declined
MBR	28	32.0000	1.5903	0.1118	2.5000	2.2500	-0.2500	Declined
NOP	3	0.0000			2.3333	2.0000	-0.3333	Declined
NWH	13	0.0000	2.5205	0.0117	2.6154	1.7692	-0.8462	Declined
S21	18	2.0000	2.0284	0.0425	1.2222	1.7222	0.5000	Improved
SOP	22	28.0000	0.4446	0.6566	1.7727	1.6818	-0.0909	Declined
STK	55	45.0000	3.8566	0.0001	2.2182	1.7636	-0.4545	Declined

Statistical Analysis Conclusions (excluding Surrogate WHA Ratings)

- Overall slight degradation from 1.9562 to 1.8249.
 (6.6% of range average wetland still yellow)
- Significant wellfield area degradations:
 - NWH (0.8462 WHA points, 42% of range, green-yellow)
 - STK (0.4545 WHA points or 23% of range, yellow)
- Nonsignificant degradations occurred at COS, ELW, MBR, NPR, SOP, and IWA
- Significant improvement at S21 (1.222, orange, to 1.7222, yellow, or 25% of range)
- Nonsignificant improvement at CBR, CYB, CYC

Electronic Products

- Access Database (.mdb)
- Field Forms (.pdf) 1854 pages
- GIS
 - Rectified Rochow (1998) figures (.tif)
 - Wetlands and GPS shapefiles (.shp)
 - Metadata (.xml)
- Photos (.jpg) 1006 photos
- Report and Maps (.doc, .pdf, and .jpg)

Recommendations

- Use unique hardcopy map numbers
- Deploy GIS data and database forms "live" on handheld computers
- Exclude inappropriate randomly selected wetlands through office review (e.g., DRAs)
- Consider benefits of geodatabase format over shapefiles
- Schedule field calibration nearer to fieldwork
- Team leader should perform more frequent quality control of field data
- Scientists should exclusively use scientific names
- Investigate alternative model-fitting procedures and weighting for future WAP to Surrogate WHA indices

