Appendix D2

Subject TWA 20TW0002949 P274 Little Manatee River System MFLs Development Support Task 4.5 Modified Deliverable

Attention Kym Holzwart, Southwest Florida Water Management District

From Mike Wessel, Janicki Environmental, Inc.

Date March 9, 2021

Through James Greco, Jacobs Engineering Group

Dear Kym – On behalf of Janicki Environmental, Inc. (JEI) and Jacobs Engineering Group, we present this modified technical memorandum (TM) in fulfillment of Task 4.5 of Task Work Order Number 20TW0002949 describing application of additional hydrodynamic model runs. The deliverables for this task include modification of the TM delivered in September 2020 to include Southwest Florida Water Management District (District) comments, assessment of potential effects of flow reductions using the District's new flow-based block method, and the inclusion of an additional 15% reduction scenario with a low flow threshold. The deliverables include this TM, appendices and any requested data from the model runs. The source code and output is available but will need to be delivered using an external hard drive as the model output files are quite large. We hope that this will serve the District well in its efforts to develop minimum flows for the Little Manatee River. Please feel free to contact us for any reason.

1. Background:

Huang and Liu (2007) constructed a mechanistic Environmental Fluid Dynamics Code (EFDC) model (Hamrick 1996) in support of the establishment of minimum flows for the tidal reach of the Little Manatee River (i.e., below US Highway 301). The model was used to investigate the relationship between freshwater inflows and salinity distributions, simulate salinity transport processes, and estimate residence times in the Little Manatee River estuary as a function of freshwater inflow.

The estuarine portion of the Little Manatee River is a complex meandering system, and an orthogonal curvilinear grid system was developed to discretize the model domain (Huang and Liu 2007: Figure 1). Three vertical layers were constructed to simulate vertical variations in the shallow system. The District conducted a field data collection program to support model calibration and verification, which included the placement of three continuous recorders at three stations in the tidal reach measuring water levels, salinity, and temperature. Gaged freshwater inflows were obtained from the USGS gaging station: Little Manatee River at US 301 near Wimauma, FL (No. 02300500) located at the upstream end of the model domain. This gage is heretofore referred to in this document as the “Wimauma gage”. Ungaged flows from the watershed downstream of this gage were simulated by Intera (2006) using the Hydrological Simulation Program – Fortran (HSPF). Inputs to the runoff model included rainfall, land use, evapotranspiration, infiltration, and tidal elevations.

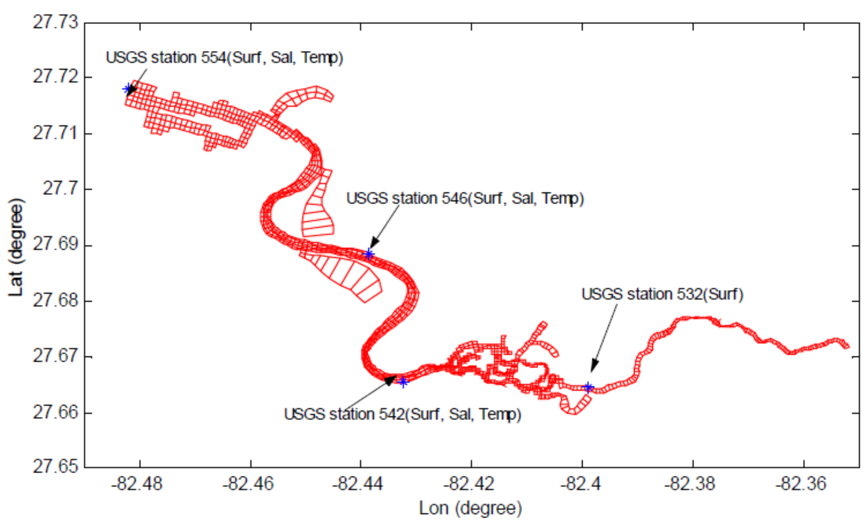


Figure 1. Model grid used by the EFDC model for the tidal reach of the Little Manatee River (from Huang and Liu 2007).

Continuous salinity recorder data from January and February 2005 were used for model calibration and from March through June 2005 for model verification. Results of the model calibration using continuous hourly data indicated model predictions were in good agreement with observed data. Similarly, model verification yielded model predictions of water levels, salinity, and temperature that matched well with observations. Huang and Lui (2007) concluded that model fit for the verification time period adequately characterized hydrodynamic characteristics in the estuarine portion of the Little Manatee River. An example output of the model for February 9, 2005 for a low and high tide condition is provided in Figure 2. Flow at the Wimauma gage on that date was 52 cubic feet per second (cfs), and the figure illustrates the dramatic difference in salinity that can occur at any point in the lower river as a function of tidal stage.

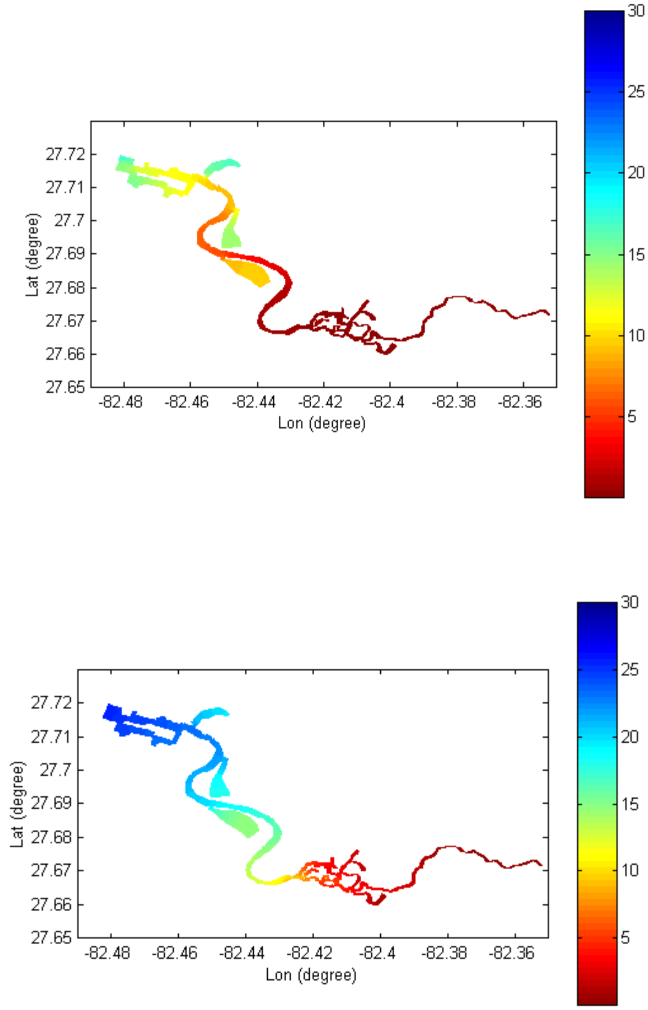


Figure 2. Salinity field at low tide (top) and high tide (bottom) on 2/9/2005 under river flow of 52 cfs (from Huang and Liu 2007).

The EFDC model for the Little Manatee River was subsequently used to simulate water ages (Huang et al. 2010) and evaluate the potential effects of surface water withdrawals on estuarine residence times (Huang et al. 2011).

1.1 EFDC Model Application 2018

Janicki Environmental Inc. (JEI 2018) used the Little Manatee River EFDC model to evaluate changes in the bottom area and volume of all salinity isohalines between 1 practical salinity units (psu) and 30 psu as a function of potential flow reduction scenarios ranging from 10% to 40% in 10% increments. The EFDC model was coded to output the files "SALVOLOUM.OUT" and "SALAREA.OUT", containing the estimated daily average volumes and bottom areas over the entire model domain for salinity levels less than specific values (e.g., area less than the 1 psu isohaline). Specifically, the EFDC subroutine SALVOLAREA (file efdc8.f) calculates the average daily salinity using the hourly salinity at each cell and averaging the 24 hourly values at the end of each day. This average daily salinity is then used to assign cells less than a specific isohaline for area and volume calculations. All analysis reported in JEI (2018) for evaluating the potential effects of potential flow reduction scenarios used the SALVOLOUM.OUT and SALAREA.OUT files as the basis for those calculations.

While the original source code used to generate model predictions was retained, JEI included some minor modifications to generate additional model salinity outputs for analysis. Specifically, the EFDC source code file efdc5.f was modified to create output files (Called “TX” files in this report) that contain salinity, water column depth, and water surface elevation estimates at hourly intervals for each cell in the model. These output files are quite large (3.5 – 7 gigabytes) but allow for calculation of salinity bottom area and volume at any point in the model domain or for specific subareas of interest from the model domain. In JEI 2018, this output was used mainly for descriptive purposes such as describing the salinity distribution for specific low-flow days as portrayed in Figure 3 below.

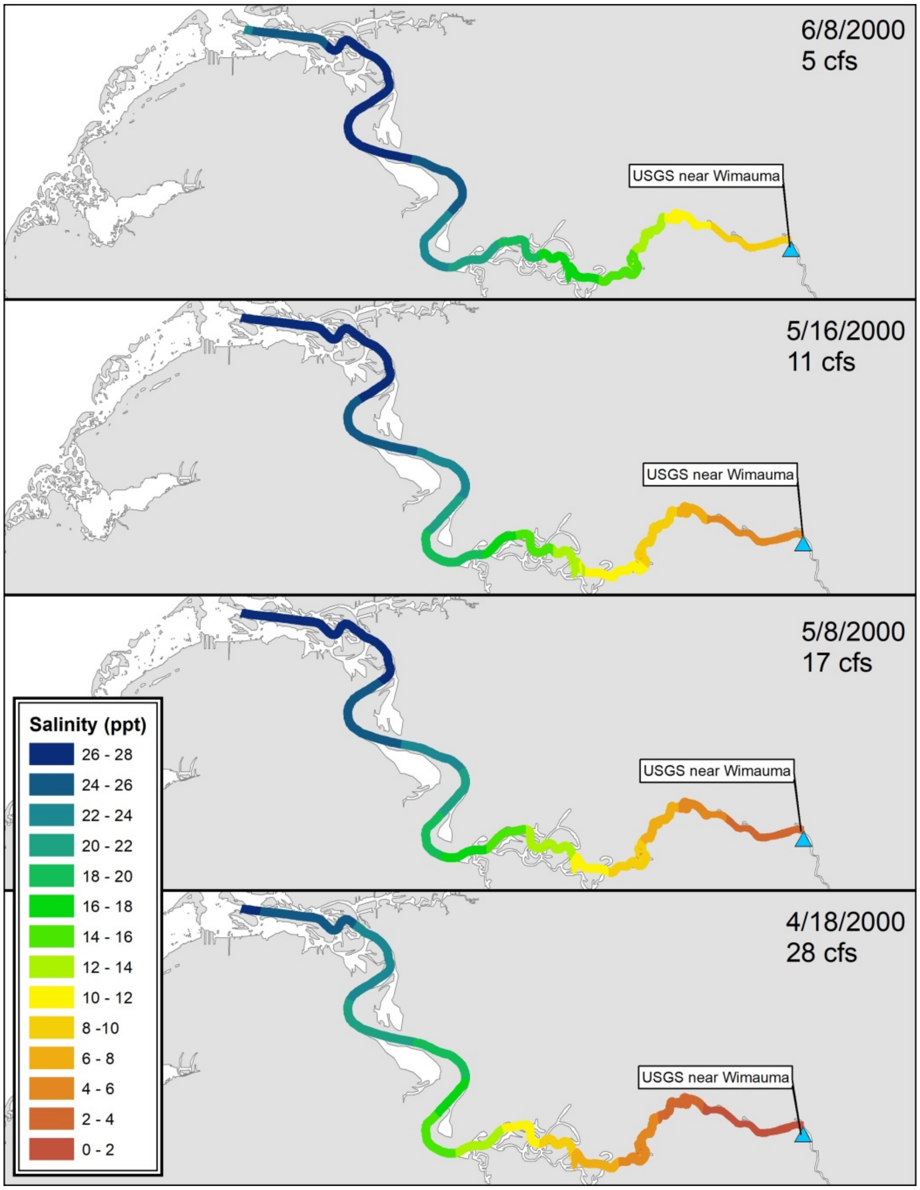


Figure 3. Daily water-column average salinity contours as a function of flow for a series of low flow events in 2000 (reproduced from Figure 5-7 of JEI 2018).

1.2 Objectives of this Effort

As part of the work effort associated with this TM, the District was interested in supplementing the analysis performed in 2018 by incorporating additional model runs for flow reduction scenarios between 5% and 35% in 10% increments to complement the existing runs of 10% to 40% flow-reductions in 10% increments. These additional runs would refine the interpolation of potential effects of flow reductions within this range. In addition, the District was interested in comparing output from the original hard-coded daily estimates (referred to as “FSU” in this document), and those using the cell-specific (“TX”) output described in Section 1.1 above. Finally, after review of the initial results, the District requested a final model run with a 15% flow reduction and a low flow threshold (i.e., a flow below which no surface water withdrawals would occur) of 35 cfs as an additional potential flow reduction scenario for evaluation.

2. Methods:

The additional flow reduction scenarios were generated using the “Reduction from Baseline” approach described in JEI (2018). Consistent with the original work, the EFDC model runs were conducted for the period from January 2000 through June 2005. December 1999 was used as a spin-up period for model development but was eliminated from all calculations associated with the flow reduction scenarios. Only full years (i.e., 2000-2004) were used to assess the effects of flow reductions on salinity bottom area and volume isohalines.

The District revised its “block” definition in 2020, switching from a calendar-based block definition to a flow-based block definition. The seasonal “blocks” used in Hood et al. (2011) and JEI (2018) were defined as follows:

- Block 1 – April 18th through June 22nd
- Block 2 – October 22nd through April 17th
- Block 3 – June 23rd through October 21st

The new flow-based block definitions used for all analysis associated with this TM are:

- Block 1 – Flows at Wimauma less than or equal to 35 cfs
- Block 2 – Flows at Wimauma between 36cfs and 72 cfs
- Block 3 – Flows greater than 72 cfs

The new flow reductions scenarios were generated, model runs conducted, and the results post processed using both the TX and FSU estimates. Comparisons of the predicted salinity bottom area and volumes were conducted to ensure agreement between the two methods and then the output was summarized to evaluate the effects of flow reductions on percent change in bottom area and volume of isohalines between 1 and 30 psu for each scenario by “year” across the new flow based blocks, by block across year, and by year and block. In the following sections any use of the term “block” is in reference to the flow-based blocks defined above.

3. Results:

All flow reduction scenarios between 5% and 35% were successfully completed and model output post-processed. A comparison of the FSU and TX outputs revealed some differences in the salinity volume estimates between the methods, particularly at the higher salinity isohaline volumes. The FSU output appears to have a lunar signal in the timeseries, which led us to investigate the hard-coded calculations in the efdc8.f subroutine of the model. The investigation (detailed in Appendix A) found that while the salinity was generated as a daily average, the volume assigned to the cell was determined by using the volume of each cell at the end of the day. Since tidal amplitude plays a significant role in the volume of the surface layer in the model, and the area has mixed semi-diurnal tides, this artifact of the calculation imparts a tidal signal bias into the volume estimates. Since the differences due to the flow reduction scenarios are summarized over fairly long temporal windows, the effect of this artifact is thought to be averaged-out over time; however, after review with the District following a presentation of this comparison, it was agreed that the results of the flow reduction scenarios would be summarized using the TX output for final evaluation. All subsequent summarizations are therefore based on the TX output.

Salinity Isohaline Bottom Areas:

The predicted percent change in bottom area from the Baseline condition, summarized over the entire simulation period, suggested that the average change in bottom area would be less than 15% for all salinity isohalines when flow reductions were 30% or less (Figure 4). Only the lowest isohalines (i.e., < 3 psu isohalines) exceeded 15% for any scenario evaluated.

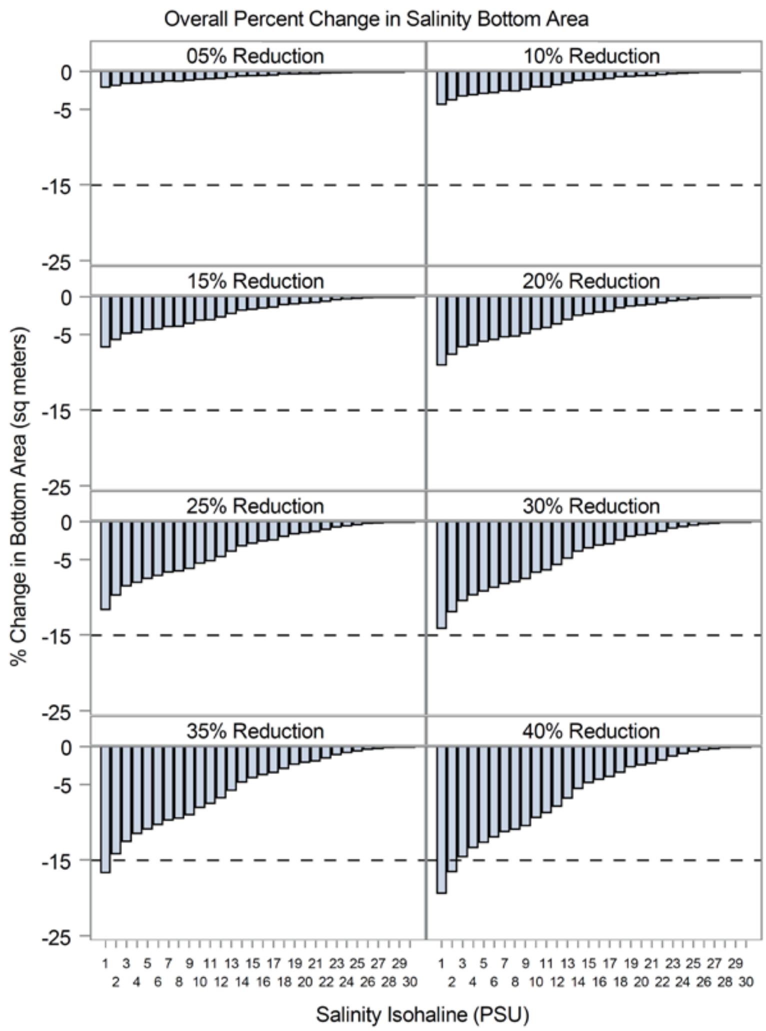


Figure 4. Percent change in salinity isohaline bottom area for each isohaline and flow reduction scenario evaluated using the TX output averaged over the entire simulation period.

However, some individual years were more sensitive than others to potential flow reductions. For example, salinity isohalines in the year 2003 were less sensitive to flow reductions than the year 2000 (Figure 5).

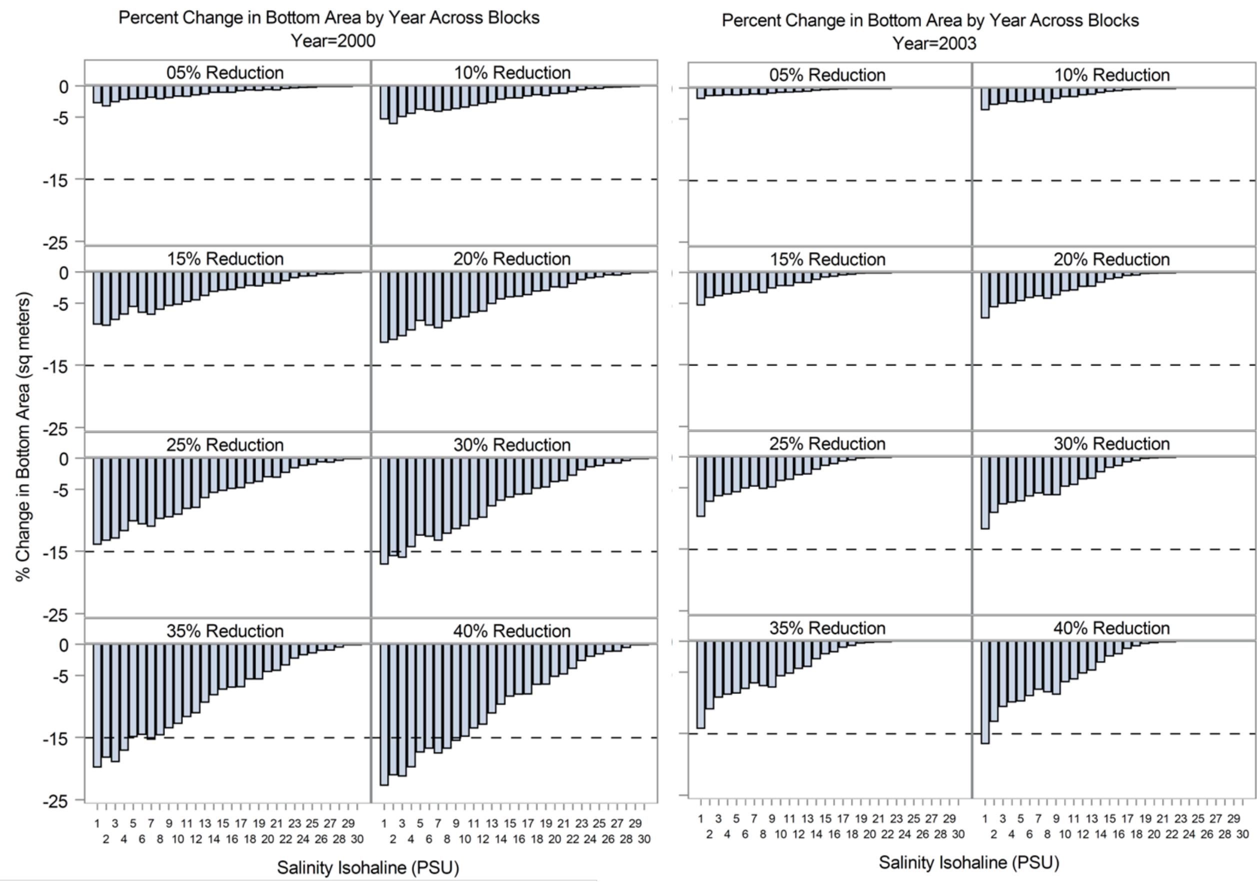


Figure 5. Percent change in salinity isohaline bottom area for each isohaline and flow reduction scenario evaluated using the TX output averaged by year across block for the years 2000 (left) and 2003 (right).

Evaluations by block across years suggested that the low flow “Block 1” (left panel plot in Figure 6) was considerably more sensitive to flow reductions than the other higher flow blocks, particularly for isohalines less than 10 psu (Figure 6).

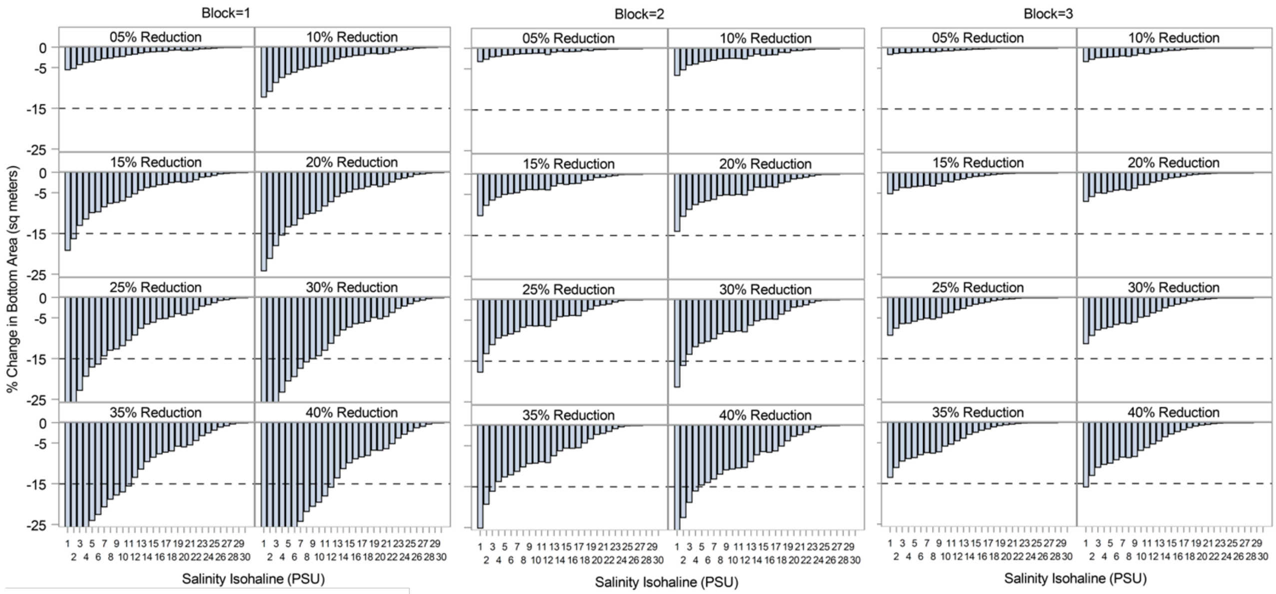


Figure 6. Percent change in salinity isohaline bottom area for each isohaline and flow reduction scenario evaluated using the TX output averaged by block across years using the flow-based block definitions described in section 2. Block 1 (left) flows <=35 cfs; Block 2 (middle) flows between 36 and 72 cfs; Block 3 (right) flows greater than 72 cfs.

Detailed plots summarizing the percent reductions by isohaline by year, block and all year/block combinations for salinity bottom area are provided in Appendix B.

Salinity Isohaline Volumes:

The percent change in volume from the Baseline condition summarized over the entire simulation period suggested that the average change in volume would be less than 15% for all salinity isohalines when flow reductions were 30% or less (Figure 7).

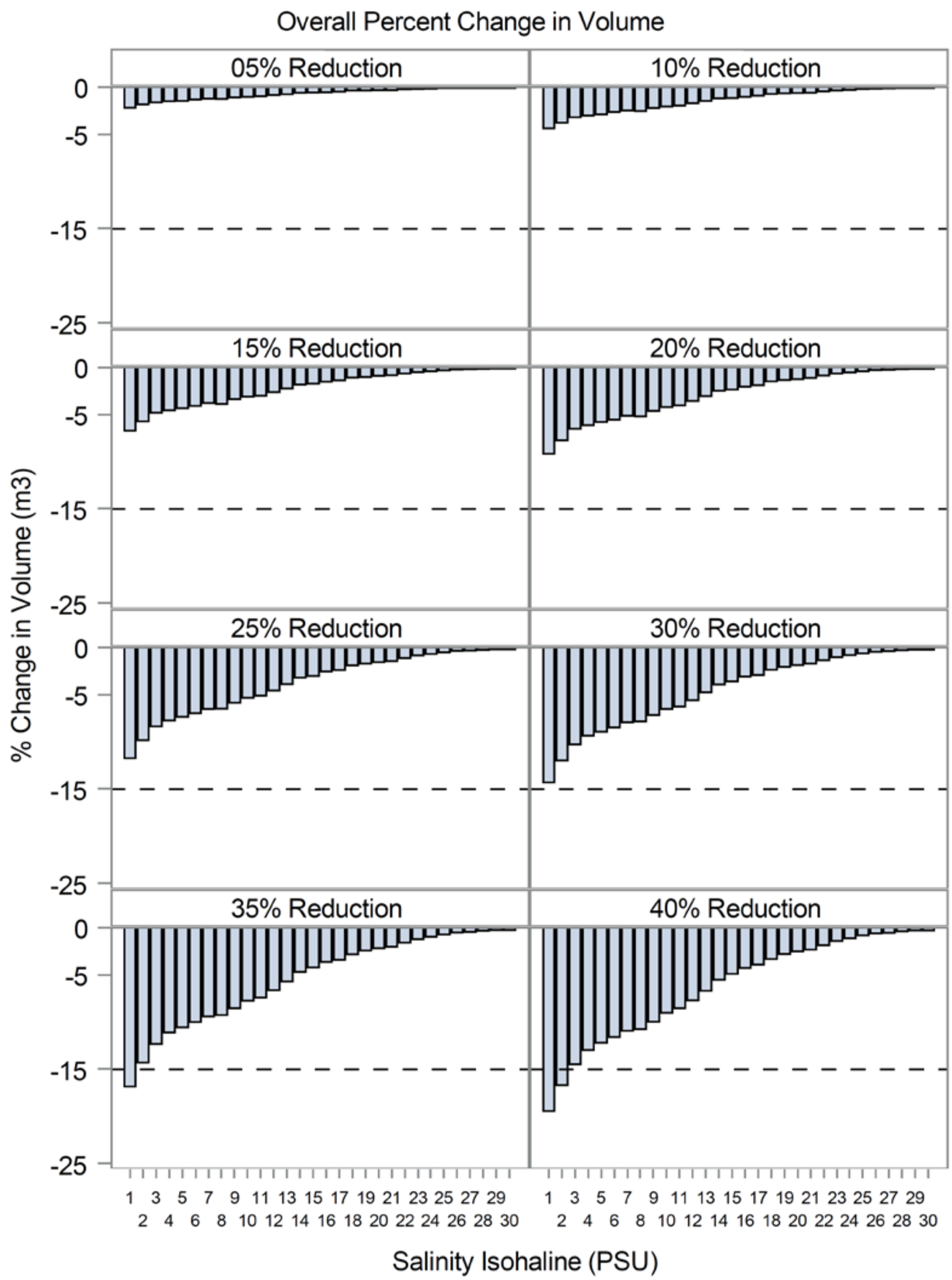


Figure 7. Percent change in salinity isohaline volume for each isohaline and flow reduction scenario evaluated using the TX output averaged over the entire simulation period.

However, some individual years were more sensitive than others to potential flow reductions. For example, salinity isohalines in 2003 were less sensitive to flow reductions than the year 2000 when the 30% flow reduction scenario predicted a greater than 15% in the lower salinity isohaline volume at the 30% flow reduction (Figure 8).

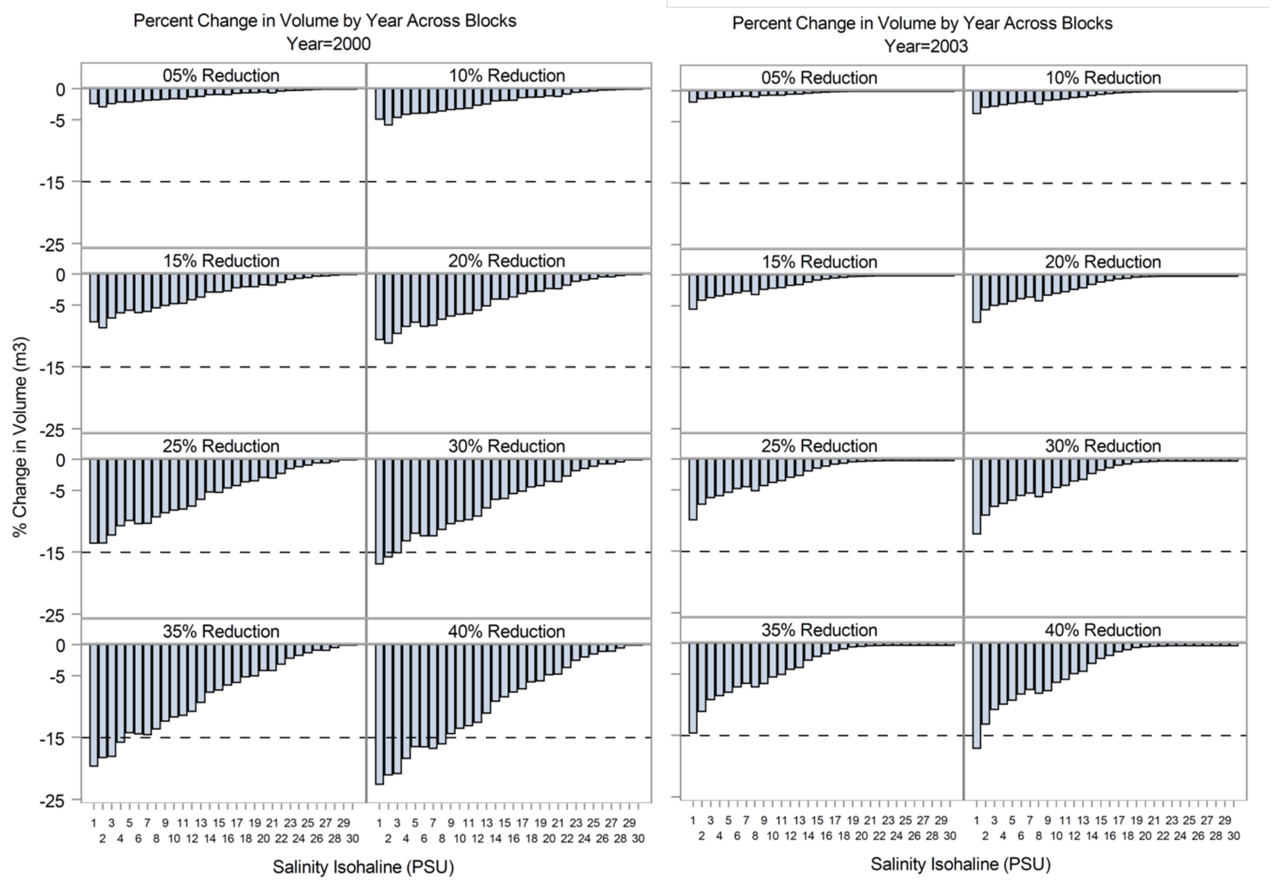


Figure 8. Percent change in salinity isohaline volume for each isohaline and flow reduction scenario evaluated using the TX output averaged by year across block for the years 2000 (left) and 2003 (right).

Evaluations of the LFT effects by block across years suggested that the low flow "Block 1" was considerably more sensitive to flow reductions than the other higher flow blocks, particularly for isohalines less than 10 psu (Figure 9).

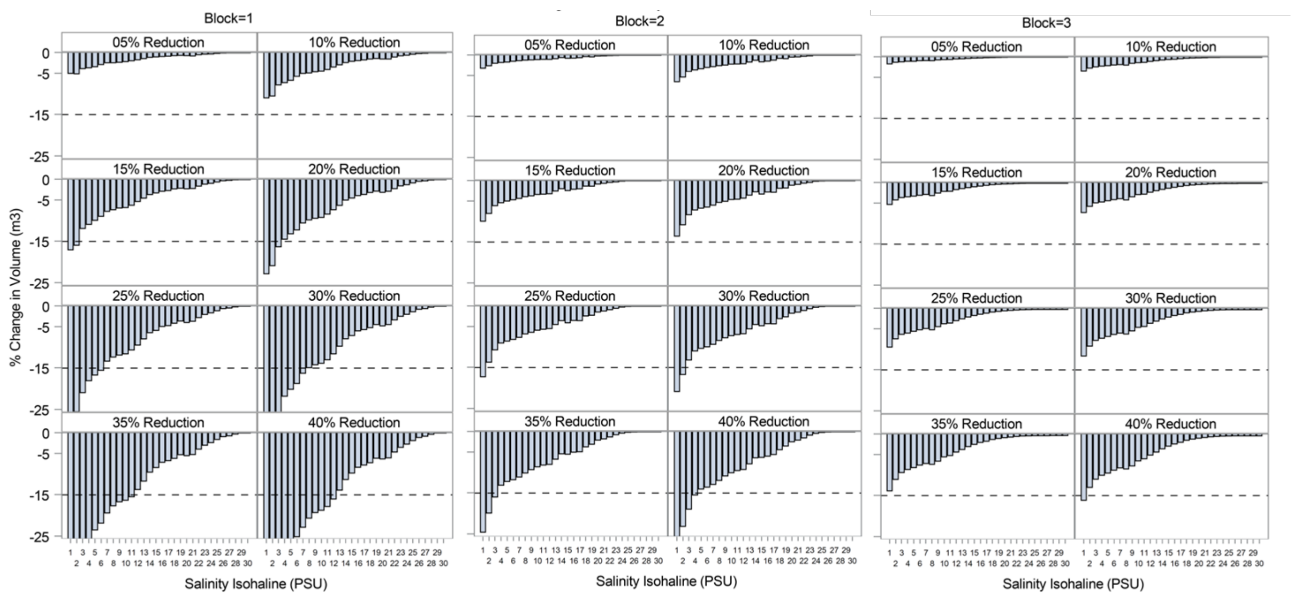


Figure 9. Percent change in salinity isohaline volume for each isohaline and flow reduction scenario evaluated using the TX output averaged by block across years using the flow-based block definitions described in section 2. Block 1 (left) flows <=35 cfs; Block 2 (middle) flows between 36 and 72 cfs; Block 3 (right flows greater than 72 cfs.

Detailed plots summarizing the percent reductions in salinity isohaline volume by year, block and all year/block combinations are provided in Appendix C.

Applying a Low Flow Threshold:

After the District reviewed the above results, the District proposed an additional flow reduction scenario be evaluated that included a 15% flow reduction with a “low flow threshold” (LFT), defined as a flow below which no reductions occur. This flow scenario was identical to the 15% flow reduction scenario described above except that when flows were 35 cfs or less under the Baseline condition, no flow reductions occurred. This scenario is defined as “Reduce15L” for this evaluation.

The results suggest that implementing the LFT is protective for both low salinity bottom area and volume habitats relative to the standard 15% flow reduction, particularly in Block 1 (Figure 10). Smaller percent decreases were observed associated with the LFT scenario in both bottom area and volume, particularly at the lower salinity isohalines. The percent reductions were generally similar for bottom area and volume comparisons (Figure 10). Plots for all blocks are provided in Appendix D.

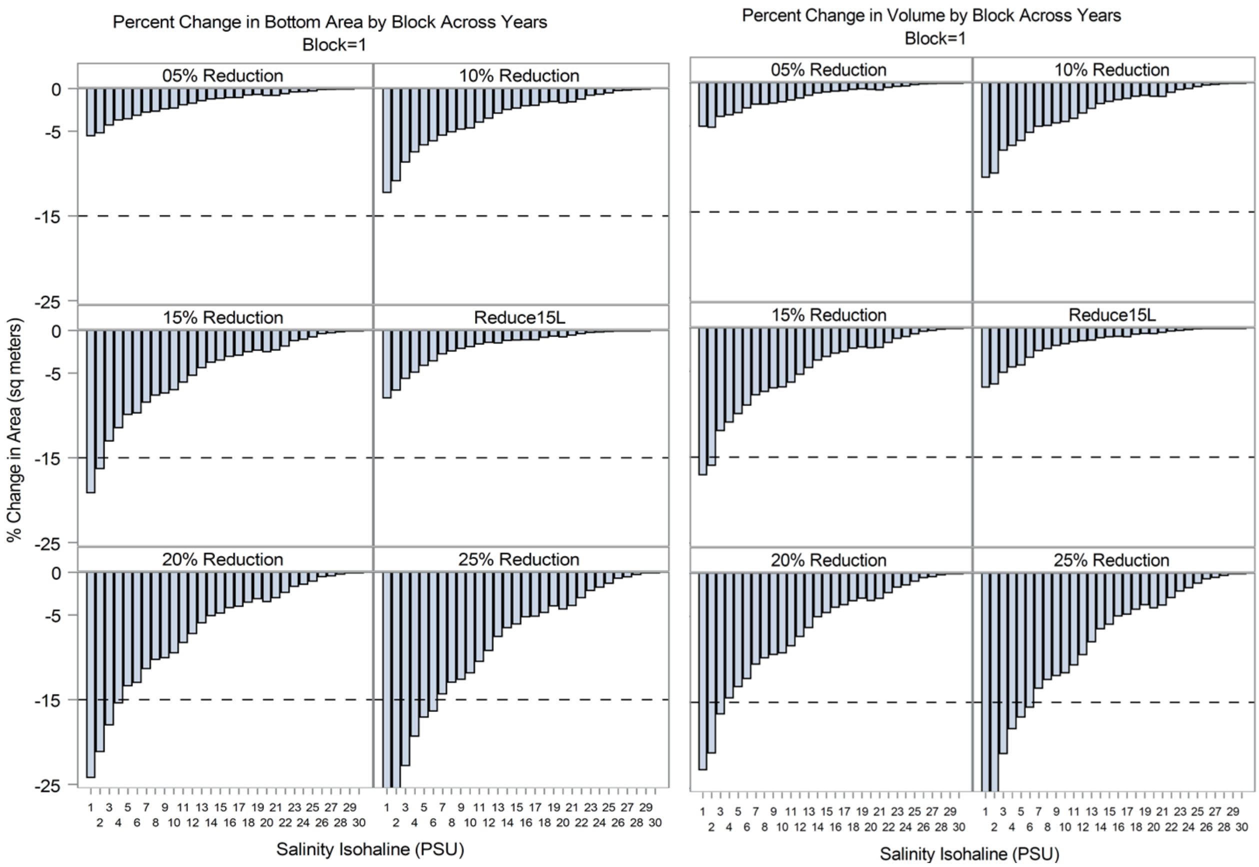


Figure 10. Evaluating effects of the low flow threshold applied to the 15% flow reduction scenario in Block 1 relative to other neighboring flow reduction scenarios averaged over the entire simulation period for salinity isohaline bottom area (left) and volume (right).

The effects of the LFT on percent change in bottom area during Block 1 for individual years (2001 – 2003) are summarized in Figure 11 relative to the 10 and 15% scenarios. In 2001 (top plot), the effect of the LFT is pronounced and results in a percent change in bottom area less than even the 10% flow reduction scenario for all isohalines. In 2002 (middle plot), the LFT results in similar reductions in bottom area to the 10% flow reduction while in 2003 (bottom plot), the LFT scenario is similar to the 15% reduction scenario.

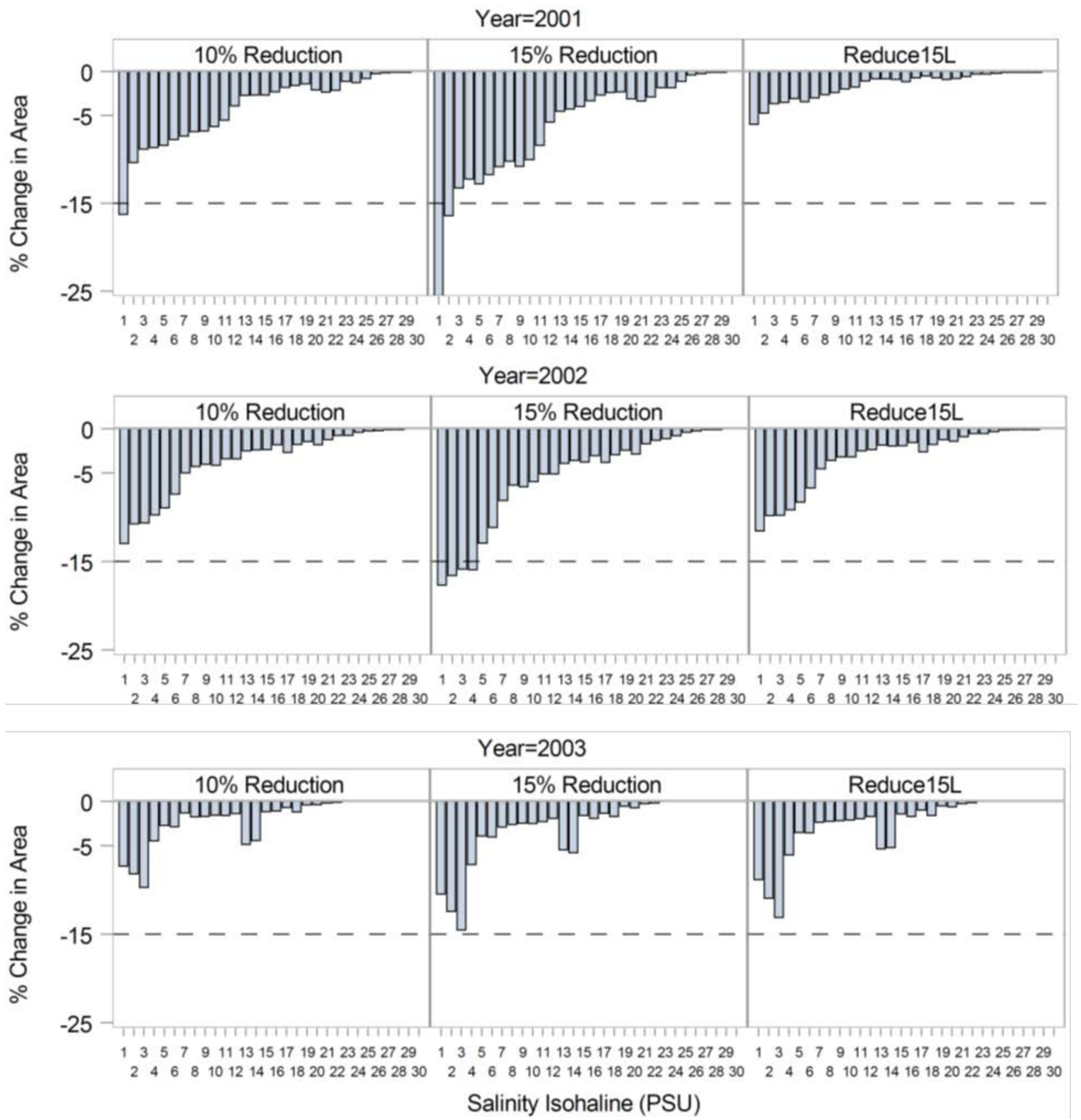


Figure 11. Results of flow reduction scenarios during Block 1 for the 10% (left), 15% (middle) and 15% with low flow threshold at 35 cfs (right) for three years of simulation including 2001 (top), 2002 (middle) and 2003 (bottom).

4. Summary

Despite the discovery of a bias in the calculation of daily average salinity isohaline volume in the original (FSU) EFDC model daily output, the inference of the flow reduction evaluations described in JEI (2018) were confirmed using the TX output reported in this TM. In addition, the additional flow reduction scenarios evaluated provided a finer resolution of interpolation of the effects of flow reductions on bottom area and volume salinity isohalines. The percent change in salinity bottom area and volumes do not generally exceed the 15% change threshold until the

30% flow reduction scenario when averaged over long temporal or flow-based windows within the simulation period. However, individual year and block results varied dramatically and the drier years (2000-2002) were more sensitive to flow reductions than the wetter years in the simulation. The lowest salinity isohalines were most sensitive to flow which may in part be due to the fact that when the starting extent (i.e., the extent of bottom area or volume under the Baseline condition) is small, changes in these extents due to the flow reductions can be a substantial percentage of the Baseline extent. Reductions in salinity area and volume greater than 15% only occurred in the lower salinity isohalines and in the lower flow Blocks 1 and 2.

As requested by the District, the percent change in flow required to detect a 15% change in the salinity bottom area and volume for each isohaline that exceeded a 15% change over the range of scenarios evaluated by block across years are presented in Table 1. These values are based on linear interpolation between the flow reduction scenario results using linear regression and represent the percent change in flow above which would exceed the 15% change in area or volume threshold. This evaluation did not include the LFT scenario. Only isohalines with greater than a 15% change are shown, other isohalines resulted in less than a 15% change under all scenarios evaluated.

Table 1. Percent change in flow above which would result in greater than a 15% change in salinity isohaline bottom area and volume by block across years. Note: only isohalines with greater than a 15% change are shown, other isohaline evaluations resulted in less than a 15% change under all scenarios evaluated.

Isohaline (psu)	% Change in flow above which results in at least a 15% change in Salinity Isohaline Bottom Area			% Change in flow above which results in at least a 15% change in Salinity Isohaline Volume		
	Block 1	Block 2	Block 3	Block 1	Block 2	Block 3
1	12%	21%	38%	13%	21%	37%
2	14%	27%		14%	26%	
3	16%	32%		17%	33%	
4	19%	38%		20%	39%	
5	21%			22%		
6	23%			24%		
7	25%			27%		
8	28%			29%		
9	29%			31%		
10	31%			32%		
11	34%			34%		
12	38%			38%		

The inclusion of the LFT resulted in significant protection, especially for lower isohalines and during drier years. While one might think that since no reductions occur during Block 1 in the LFT scenario there should be no percent change from the Baseline condition, this is not the case. The EFDC model simulates a date ordered timeseries and relies on antecedent conditions to determine salinity changes. Because the flows vary daily, the salinity evaluation during Block

1 essentially evaluates a residual effect of antecedent flow reductions of 15% from Block 2 as flows transition to below 35 cfs. Block 2 percent reductions for the LFT scenario were similar to the Block 2 reduction results without the LFT but there were some subtle differences. Detailed plots for the LFT scenario for all blocks years, and year/block combinations are provided in Appendix D.

5. References:

Hamrick, J. M. (1996). "User's Manual for the Environmental Fluid Dynamics Computer Code." Virginia Institute of Marine Sciences, Gloucester Point, Virginia.

Hood, J., M. Kelly, J. Morales, and T. Hinkle. 2011. Proposed Minimum Flows and Levels for the Little Manatee River – peer review draft. Ecologic Evaluation Section. Brooksville, FL: Southwest Florida Water Management District

Huang, W. and X. Liu. 2007. Hydrodynamic modeling of the Little Manatee River. Report submitted to the Southwest Florida Water Management District. Brooksville Florida.

Huang, W., X. Liu, X. Chen, and Michael S. Flannery. 2010. Estimating river flow effects on water ages by hydrodynamic modeling in Little Manatee River estuary, Florida, USA. Environmental Fluid Mechanics 10:1-2, 197-211.

Huang, W., X. Liu, X. Chen, and Michael S. Flannery. 2011. Critical flow for water management in a shallow tidal river based on estuarine residence time. Water Resources Management 25:10, 2367-2385.

Intera 2006. Estimating ungagged flows in the Little Manatee River Basin, Florida. Prepared for the Southwest Florida Water Management District. Brooksville FL.

Janicki Environmental, Inc. 2018. Reevaluation of the proposed minimum flows for the upper segment of the Little Manatee River. Prepared for the Southwest Florida Water Management District, Brooksville, Florida.

Links to Appendices

Appendix A: Investigation into the Original Hard-Coded EFDC Salinity Isohaline Bottom Area and Volume Output

Appendix B: Plots of Percent Reductions in Salinity Isohaline Bottom Area by Block, Year, and Year/Block Combinations

Appendix C: Plots of Percent Reductions in Salinity Isohaline Volume by Block, Year, and Year/Block Combinations

Appendix D: Evaluation of the Effects of the 15% Reduction with a Low Flow Threshold (LFT) on Salinity Isohaline Bottom Area and Volume by Block, Year, and Year/Block Combinations

Appendix A

Investigation into the Original Hard-Coded EFDC Salinity Isohaline Bottom Area and Volume Output

This appendix was part of an initial draft memorandum delivered to the District for review comparing the hard coded EFDC model output constructed by FSU ("FSU)" relative to the output generated by outputting the hourly salinity area and volumes for each cell ("TX") and summing across cells within a day.

A comparison plot of the 5 ppt isohaline is provided in Figure 1 where the bottom area prediction timeseries for the full model simulation period overlay one another with some extremely minor differences in predicted areas over the entire period. The 15 ppt isohaline (Figure 2) was also similar with some minor differences presumably due to differences in how the area calculations were performed (original FSU EFDC code used dx*dy while the TX code uses area estimates assigned using Geographic Information Systems (GIS) since the cells may not be exactly rectangular.

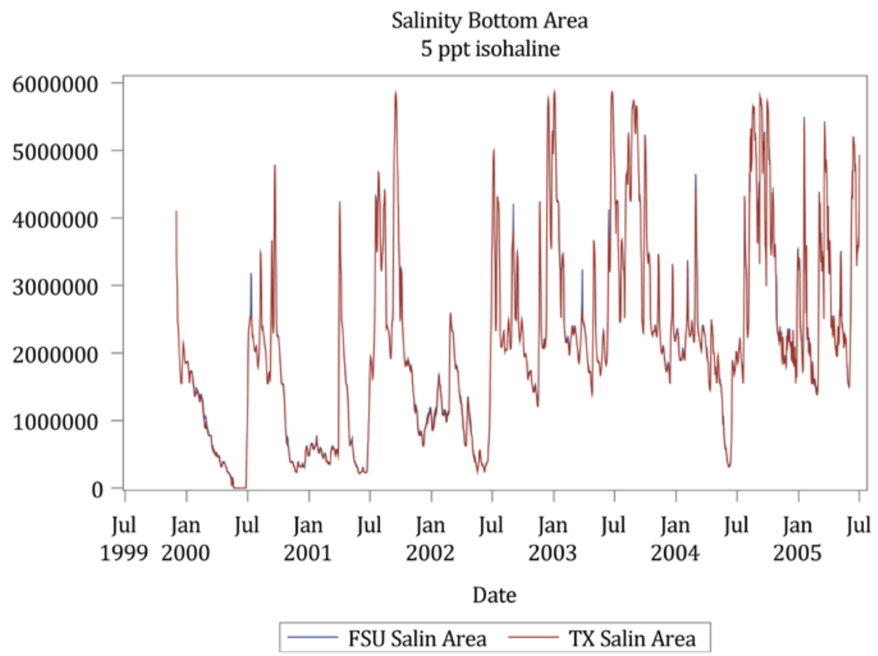


Figure 1. Comparison of salinity bottom area for the 5 ppt isohaline using the original FSU output format (blue line) and the modified TX format (red line).

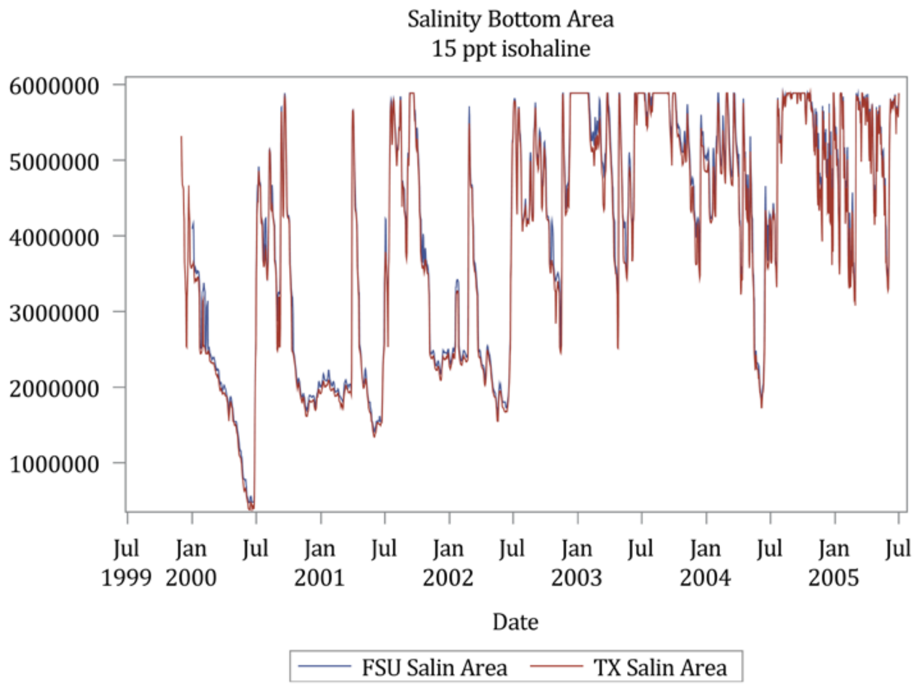


Figure 2. Comparison of salinity bottom area for the 5 ppt isohaline using the original FSU output format (blue line) and the TX format (red line).

However, the volume estimates comparison suggested larger discrepancies between the FSU and TX output, especially at the higher volume isohalines (Figure 3). The FSU output appears to have a lunar signal in the timeseries which led us to investigate the hard-coded calculations in the efdc8.f subroutine of the model.

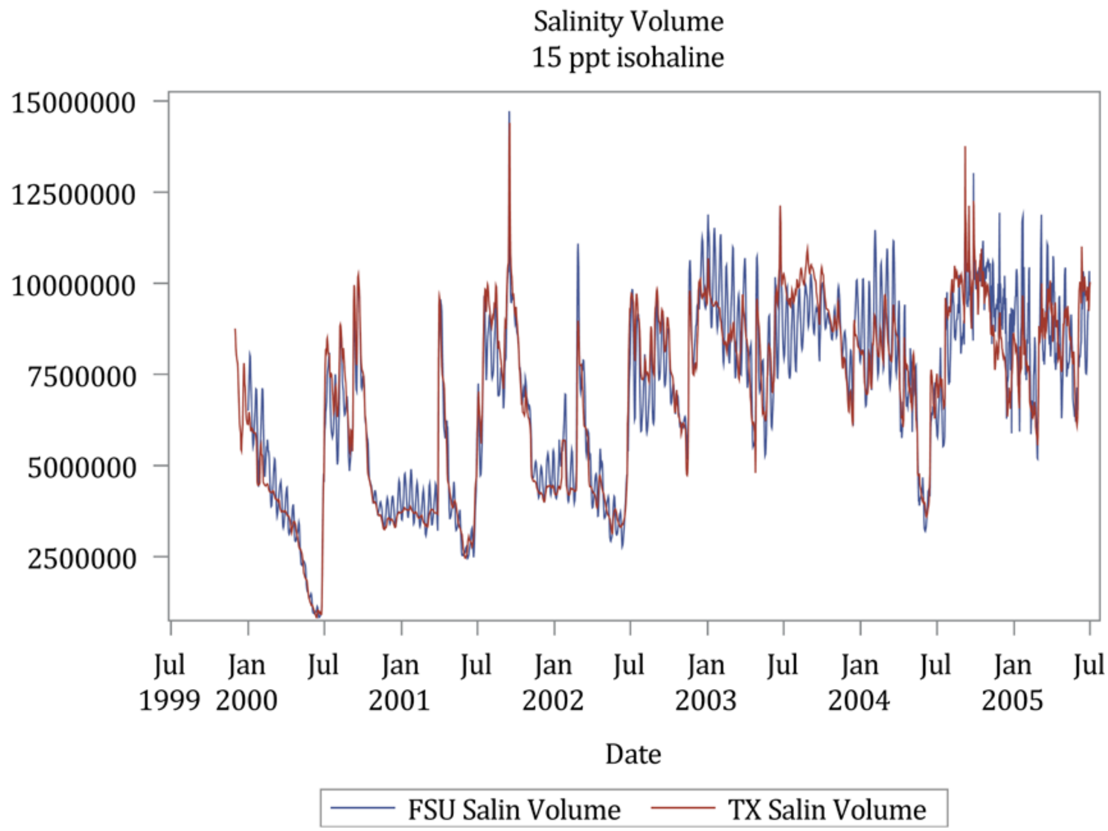


Figure 3. Comparison of salinity volumes for the 15 ppt isohaline using the original FSU output format (blue line) and the TX format (red line).

Investigation of the original FORTRAN source code for the EFDC model, specifically in the file efdc8.f subroutine SALVOLAREA, found that while the salinity was generated as a daily average, the volume assigned to the cell was determined by using the volume of each cell at the end of the day. Since tidal amplitude plays a significant role in the volume of the surface layer in the model this artifact of the calculation imparts a sine wave signal into the volume estimates.

Figure 4 illustrates this artifact, using tides at the NOAA gage at St. Petersburg (Station ID: 8726520**)** for January and June of 2013. In this example, the hourly water surface elevation (WSEL) timeseries is provided in the blue line, the red dot is the WSEL at hour 23, and the green broken line is the daily average. The red dots illustrate how sampling at a particular time of each day results in sampling at a different part of the tidal cycle. Since tides in west Florida are mixed diurnal and semi-diurnal, the pattern is not completely consistent over time. In fact, higher high tides tend to occur during the day in June 2013 at the NOAA site, resulting in the tendency for samples at hour 23 to be taken at below average tides. This artifact affected the volume estimates in the SALVOLUUM.OUT files, i.e., in the original FSU model output.

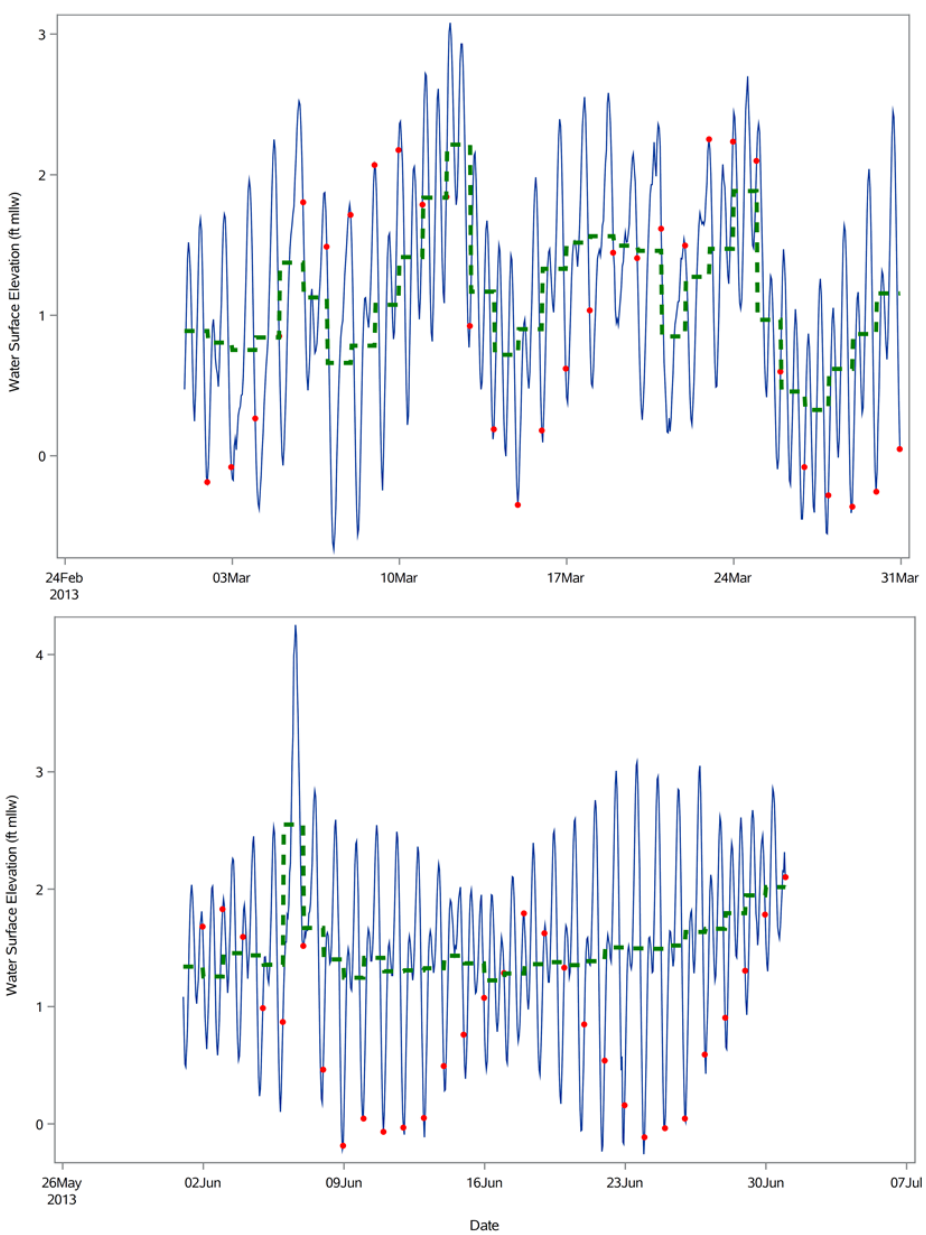


Figure 4. Two examples showing effects of selecting a specific time of day to characterize water surface elevations for March (top) and June of 2013 at the NOAA gage site Station ID: 8726520 at St. Petersburg, FL.

Despite this artifact, since the differences due to the flow reduction scenarios are summarized over fairly long temporal windows, the effect of this artifact is thought to be averaged-out over time. To investigate this hypothesis, comparisons of model output from the two methods, i.e., using the FSU and TX output, were generated for flow reduction scenarios ranging from 5 to 40%, in 5% increments. Example results for the year 2000 are provided in Figure 5 and indicate that on annual-basis, change in bottom area associated with the most sensitive isohalines (typically isohalines of 3 or less) does not exceed 15% until the flows are reduced by 30%. Similar results were observed for salinity isohaline volumes based on the FSU and TX output (Figure 6), and both sets of results were consistent with findings reported in Janicki

Environmental (2018). Therefore, despite this discrepancy, the averaging period tends to ameliorate any bias in the salinity volume calculations reported in the original model results. For accuracy, all results reported in the parent technical memo to this appendix use the TX output.

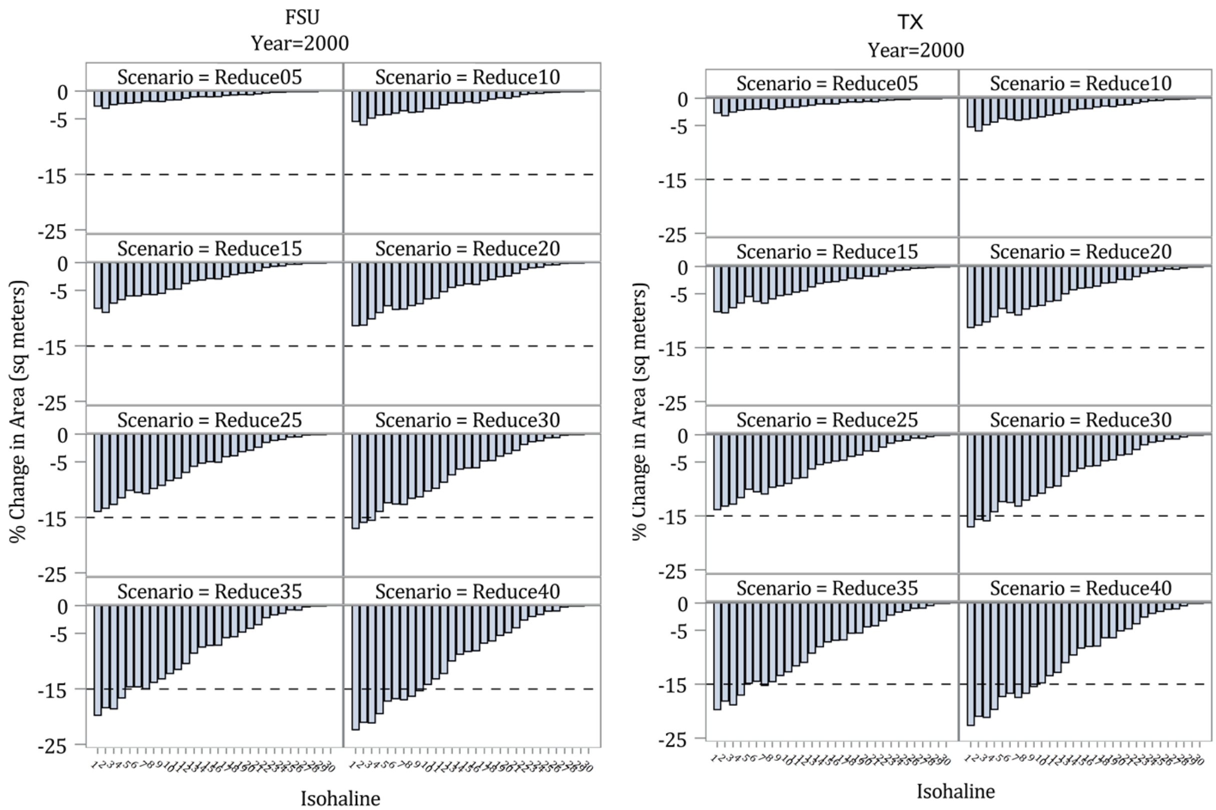


Figure 5. Comparison of predicted effects of flow reduction scenarios on salinity isohaline bottom area changes based on the original EFDC model output (FSU, left) and the cell-specific output (TX, right) for the year 2000.

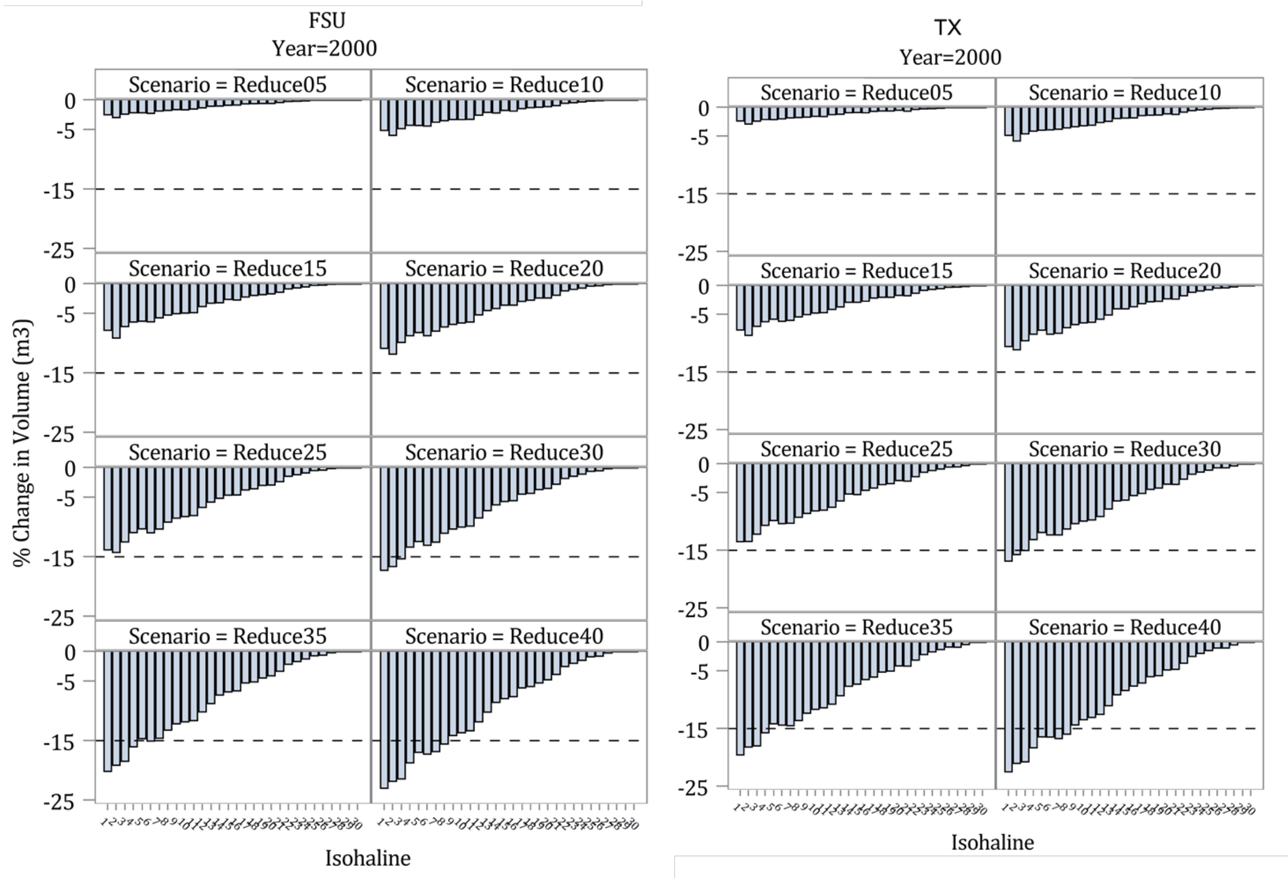
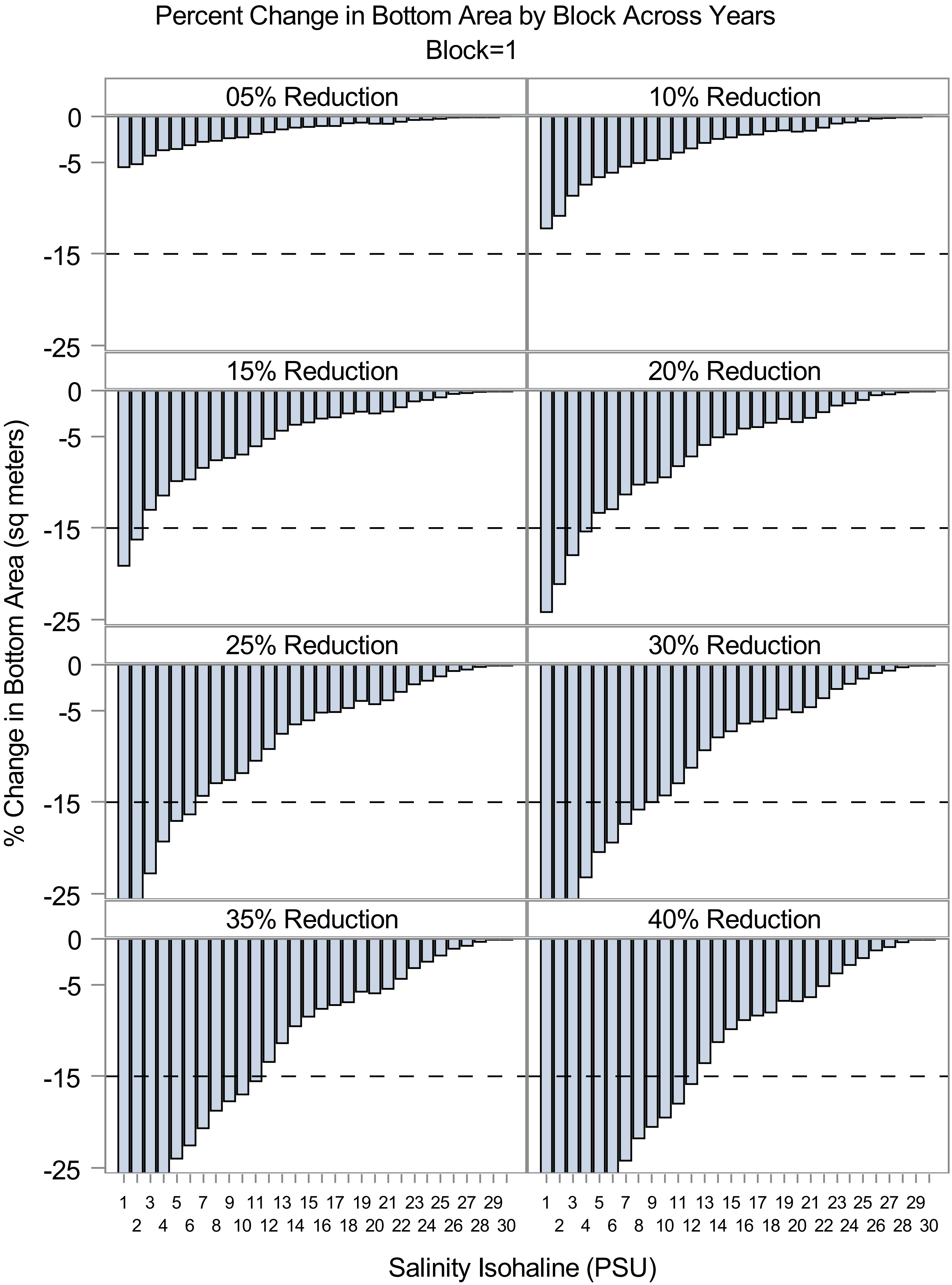


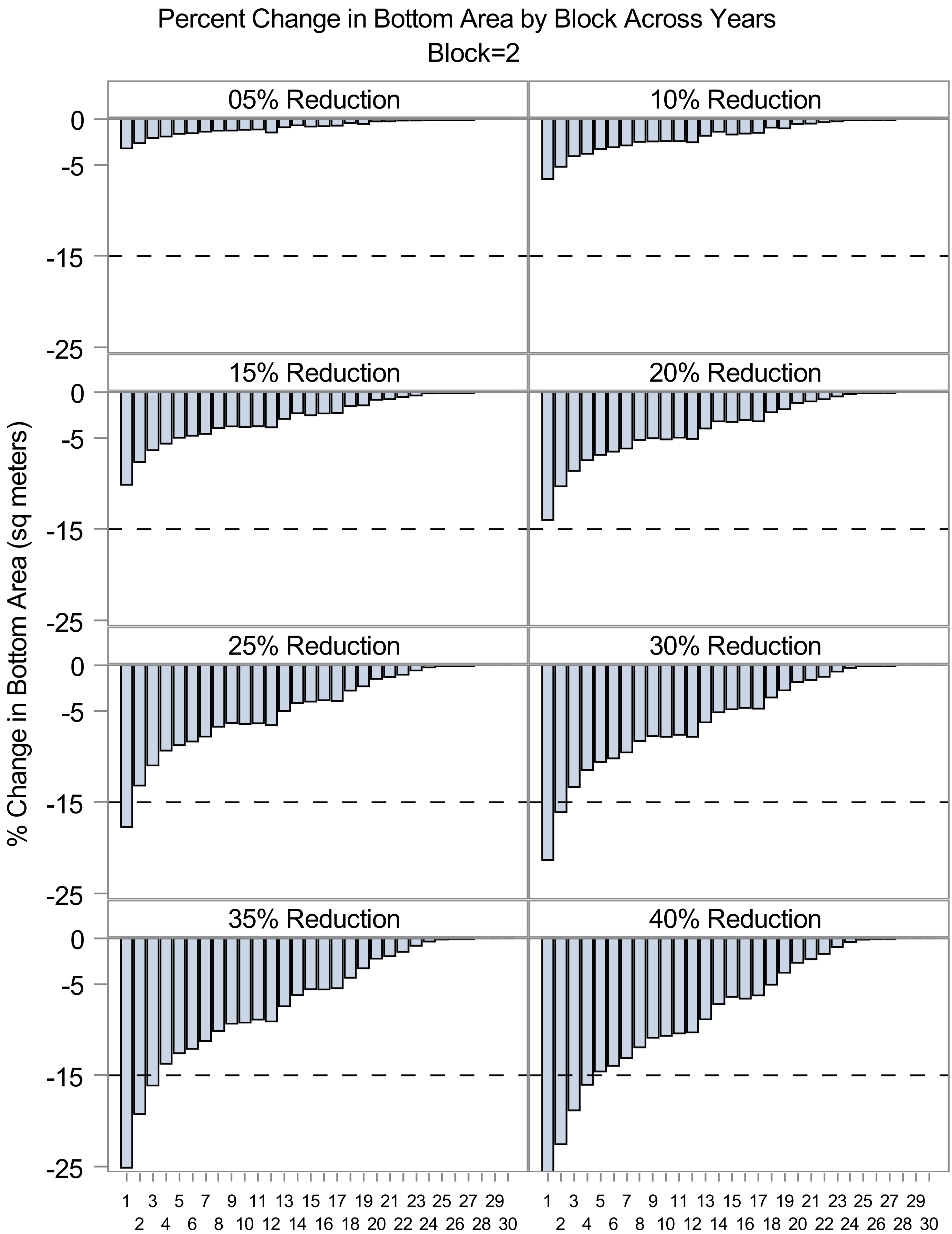
Figure 6. Comparison of predicted effects of flow reduction scenarios on salinity isohaline volume changes based on the original EFDC model output (FSU, left) and the cell-specific output (TX, right) for the year 2000.

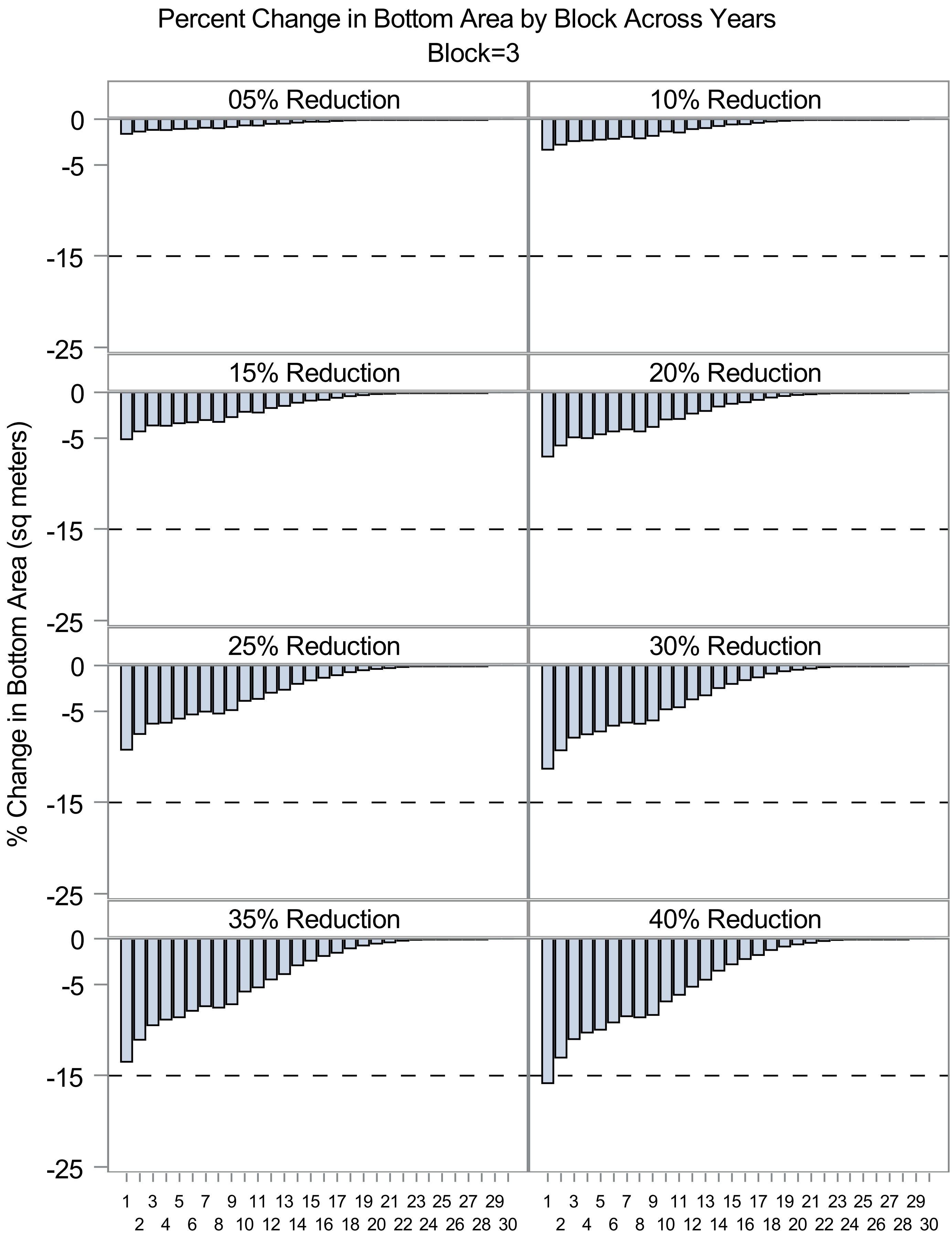
Appendix B

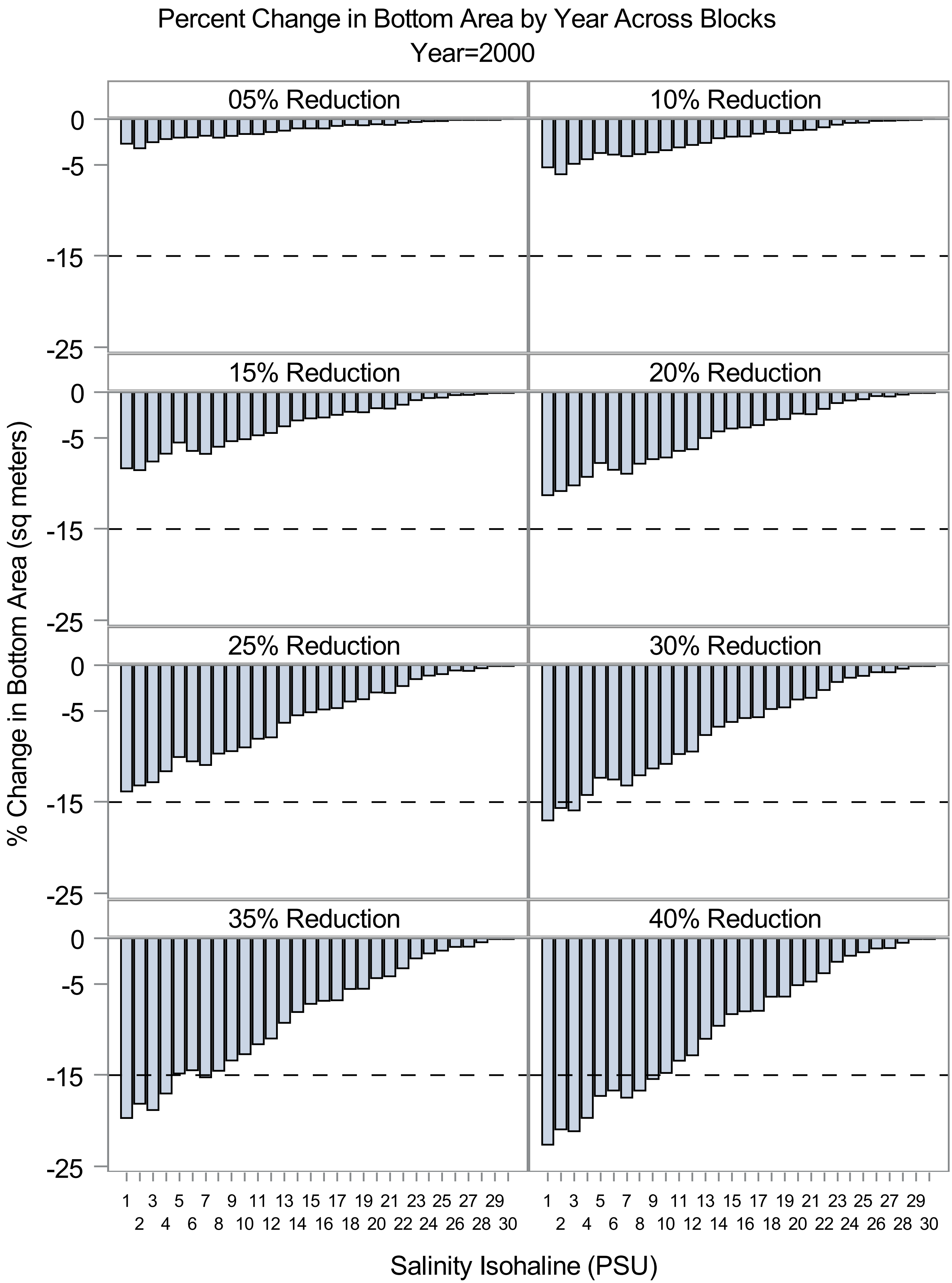
Plots of Percent Reductions in Salinity Isohaline Bottom Area by Block, Year, and Year/Block Combinations



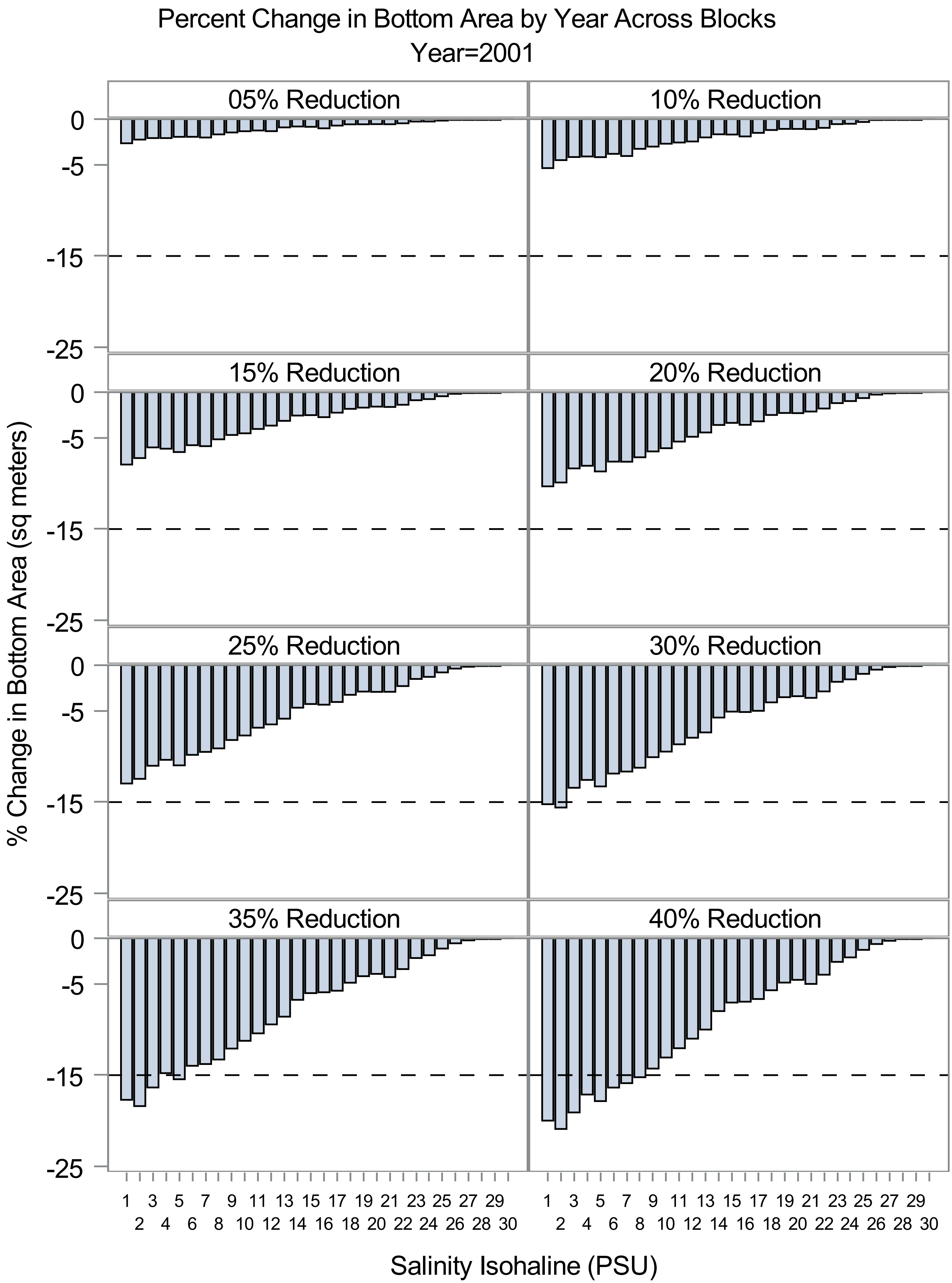
Percent Change in Bottom Area by Block Across Years
Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)


Percent Change in Bottom Area by Block Across Years
Block=2
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
Salinity Isohaline (PSU)

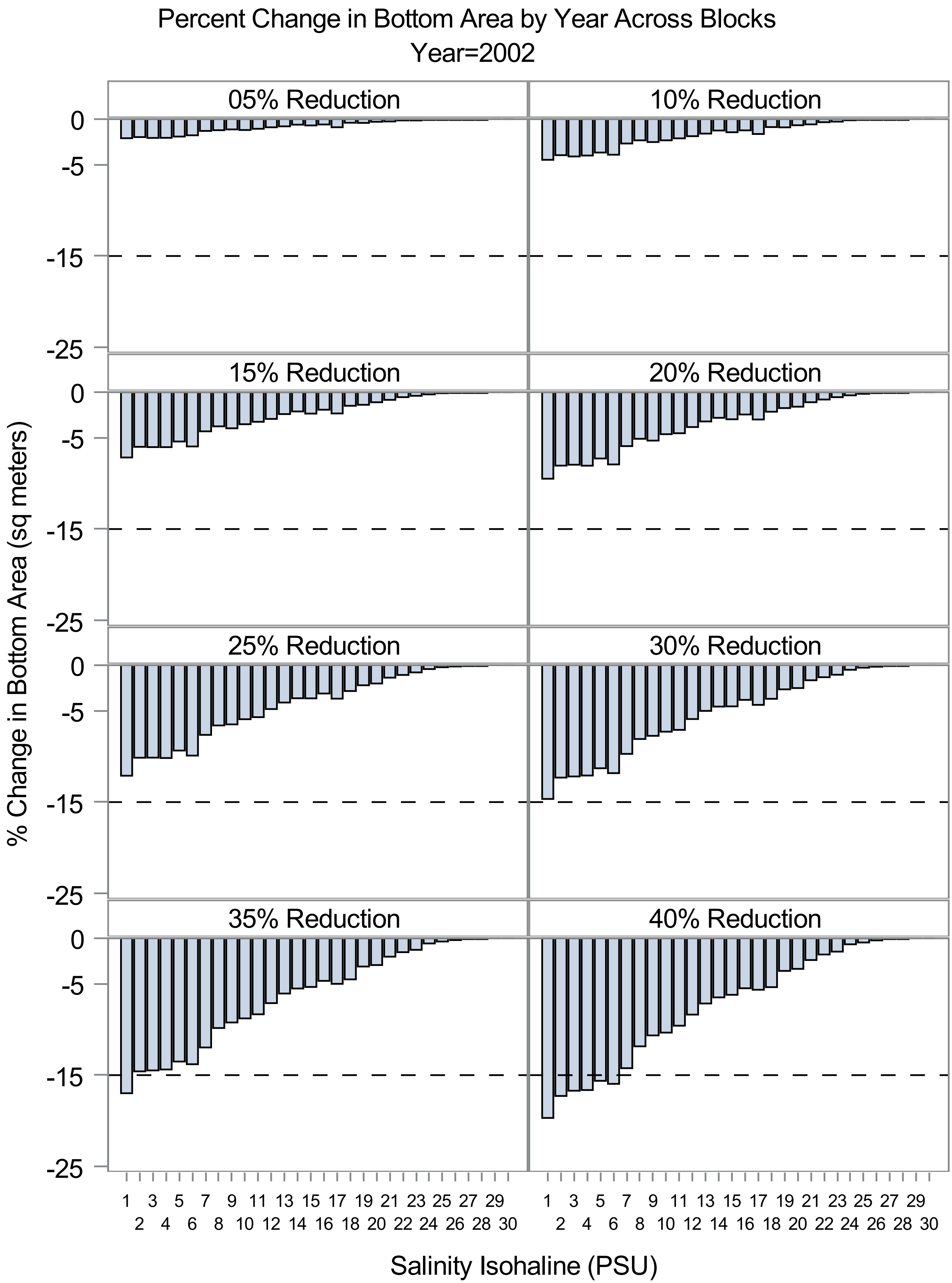

Percent Change in Bottom Area by Block Across Years
Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
% Change in Bottom Area (sq meters)
0
-5
-15
-25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



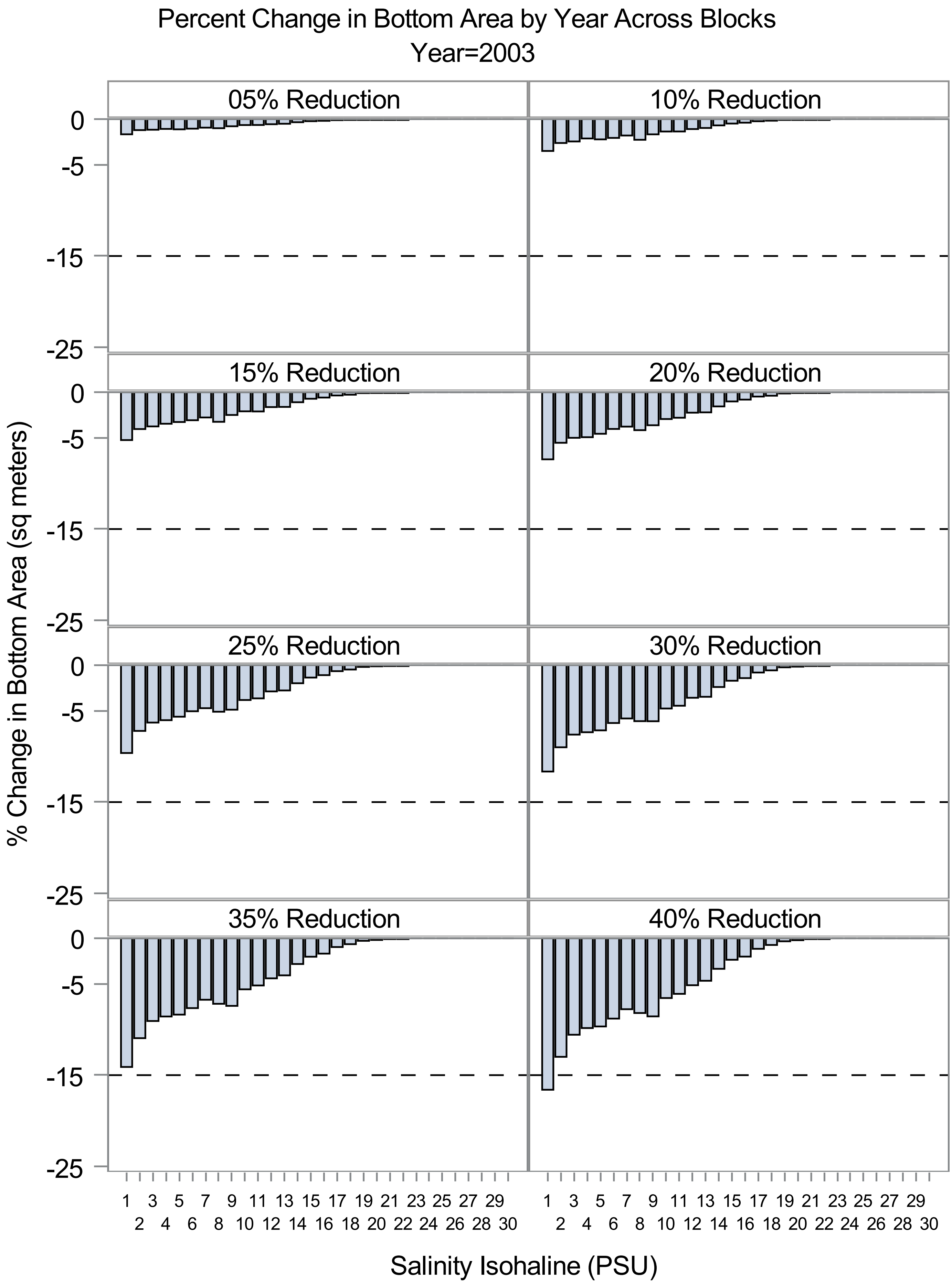
Percent Change in Bottom Area by Year Across Blocks
Year=2000
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

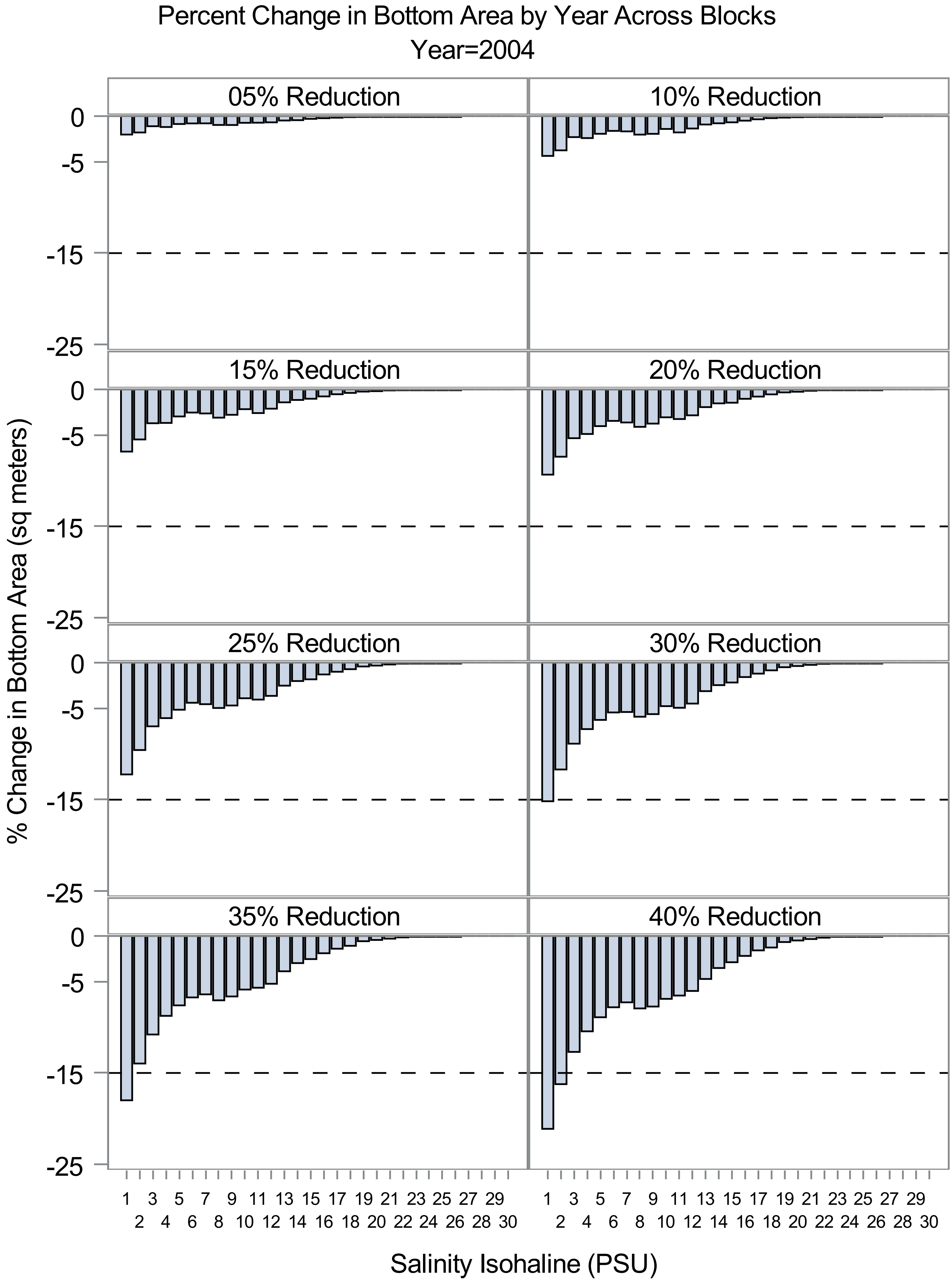


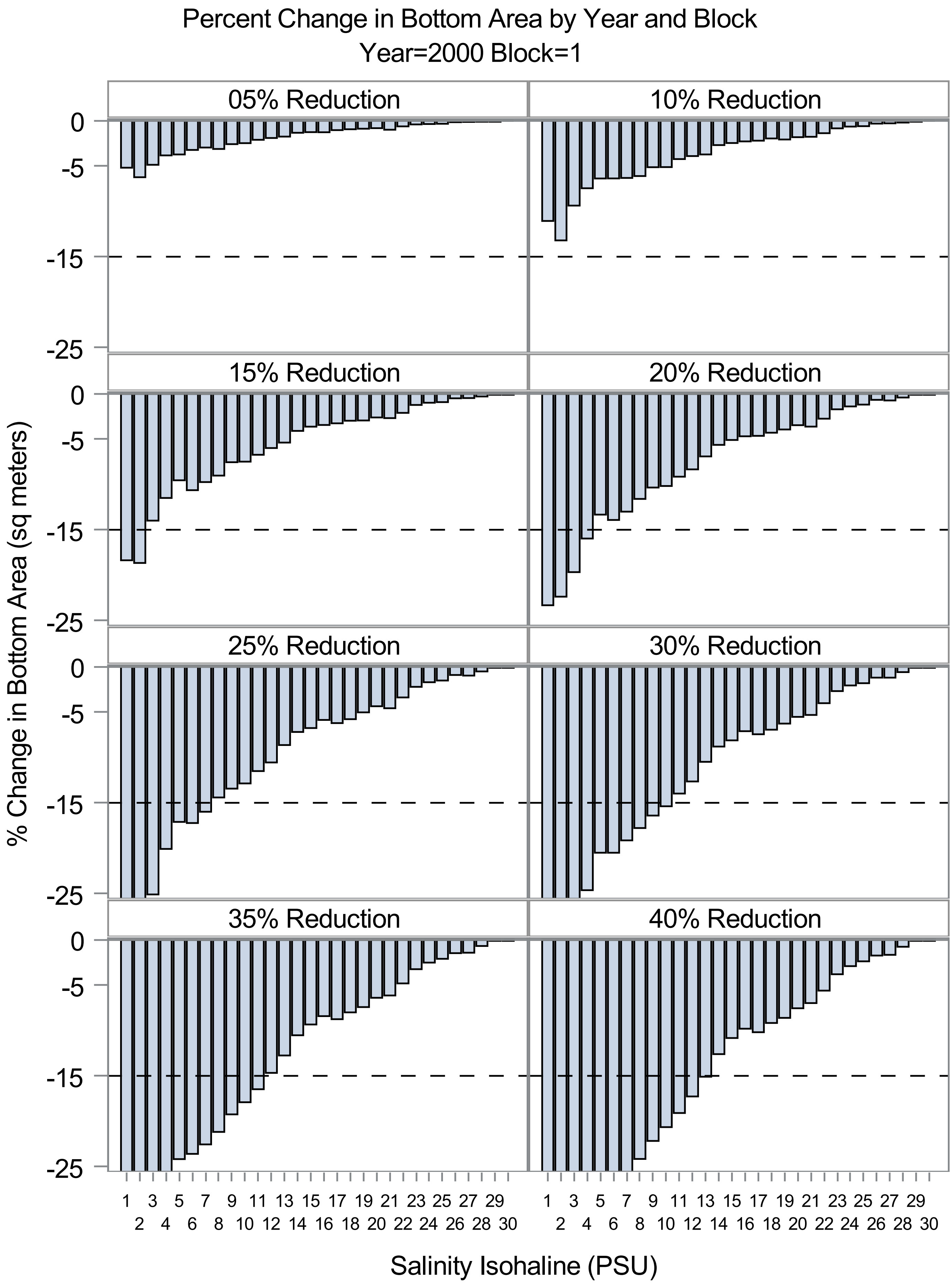
Percent Change in Bottom Area by Year Across Blocks
Year=2001
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)



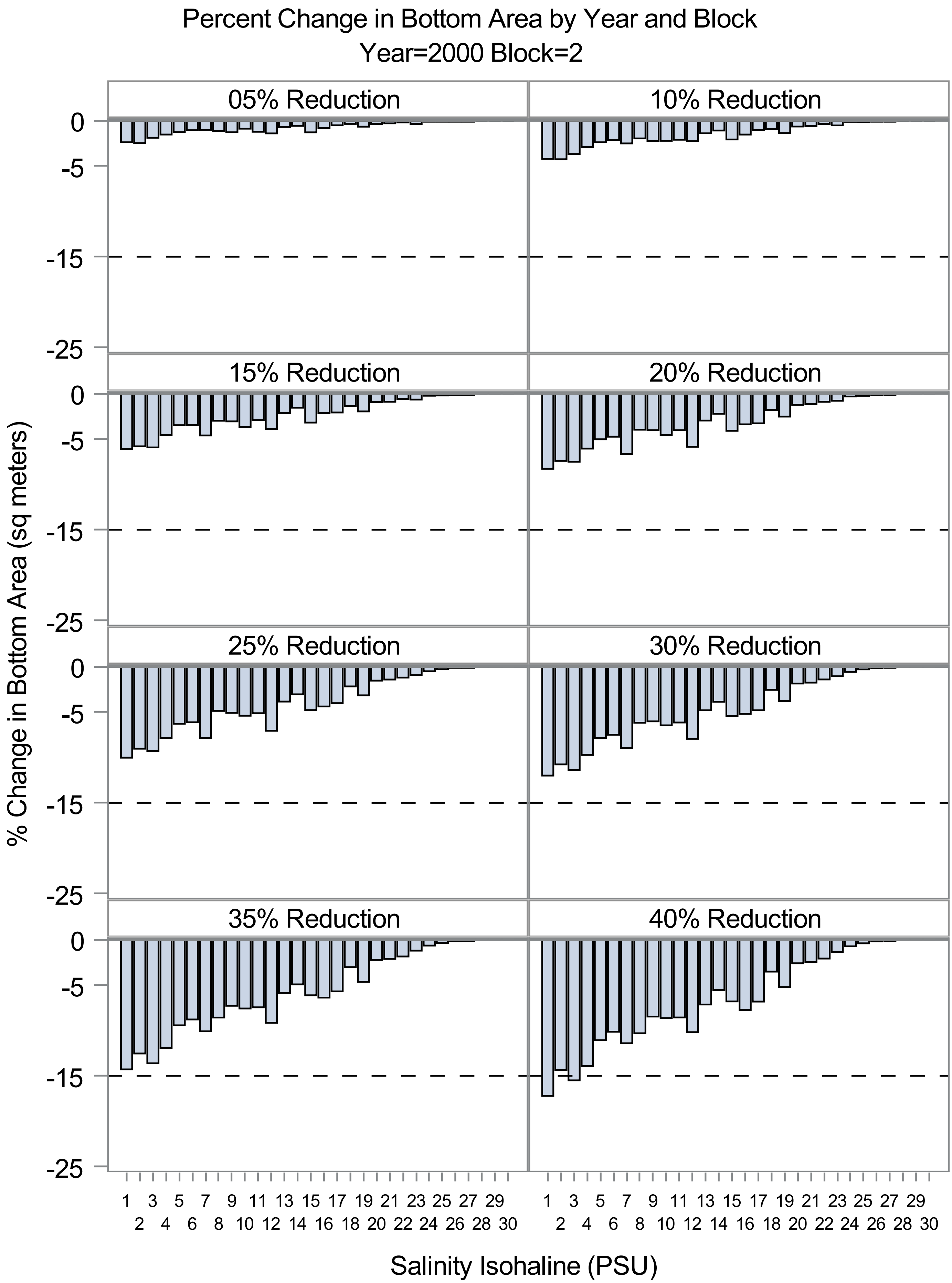
Percent Change in Bottom Area by Year Across Blocks
Year=2002
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)


Percent Change in Bottom Area by Year Across Blocks
Year=2003
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
Salinity Isohaline (PSU)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

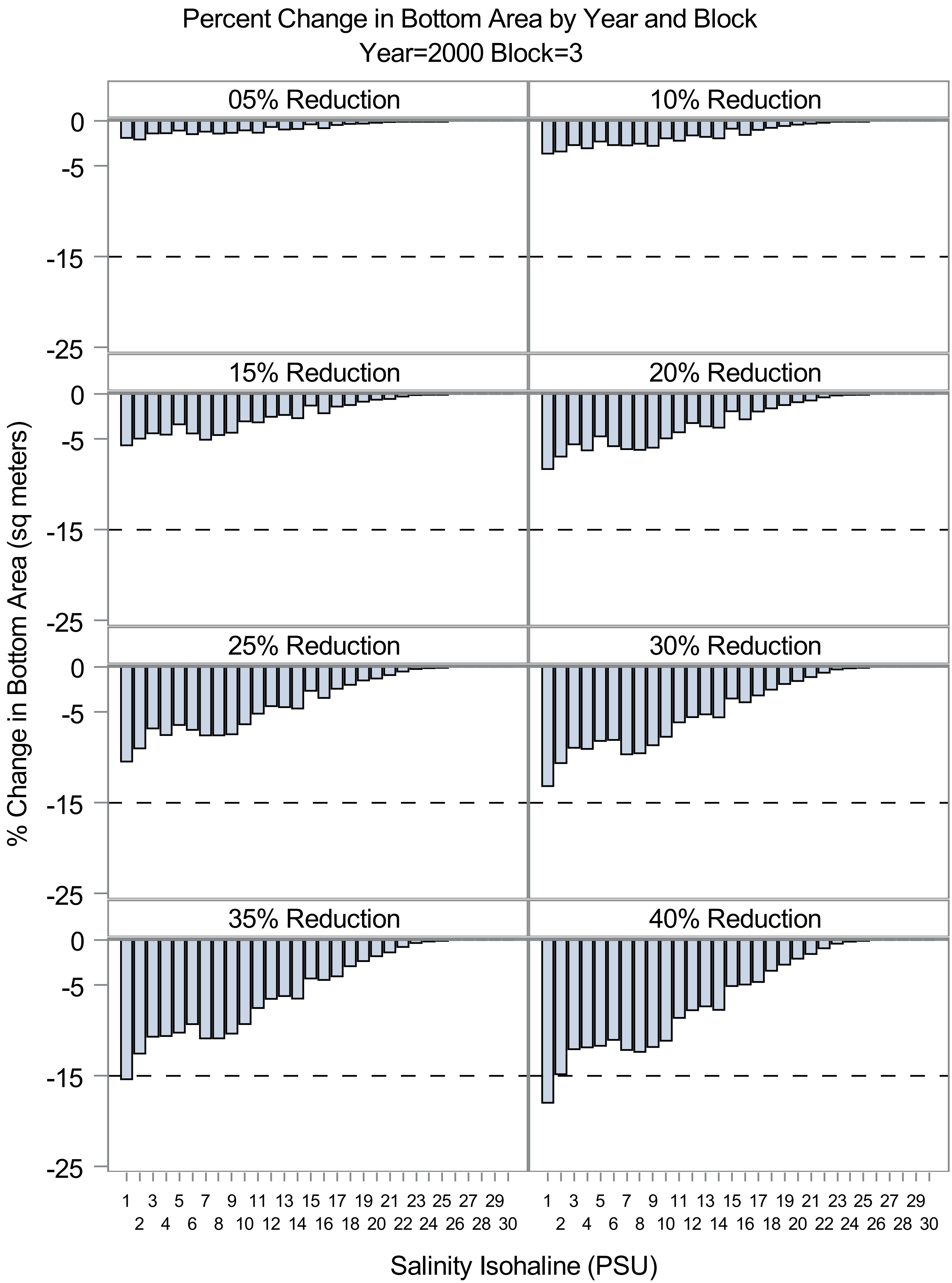

Percent Change in Bottom Area by Year Across Blocks
Year=2004
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
Salinity Isohaline (PSU)

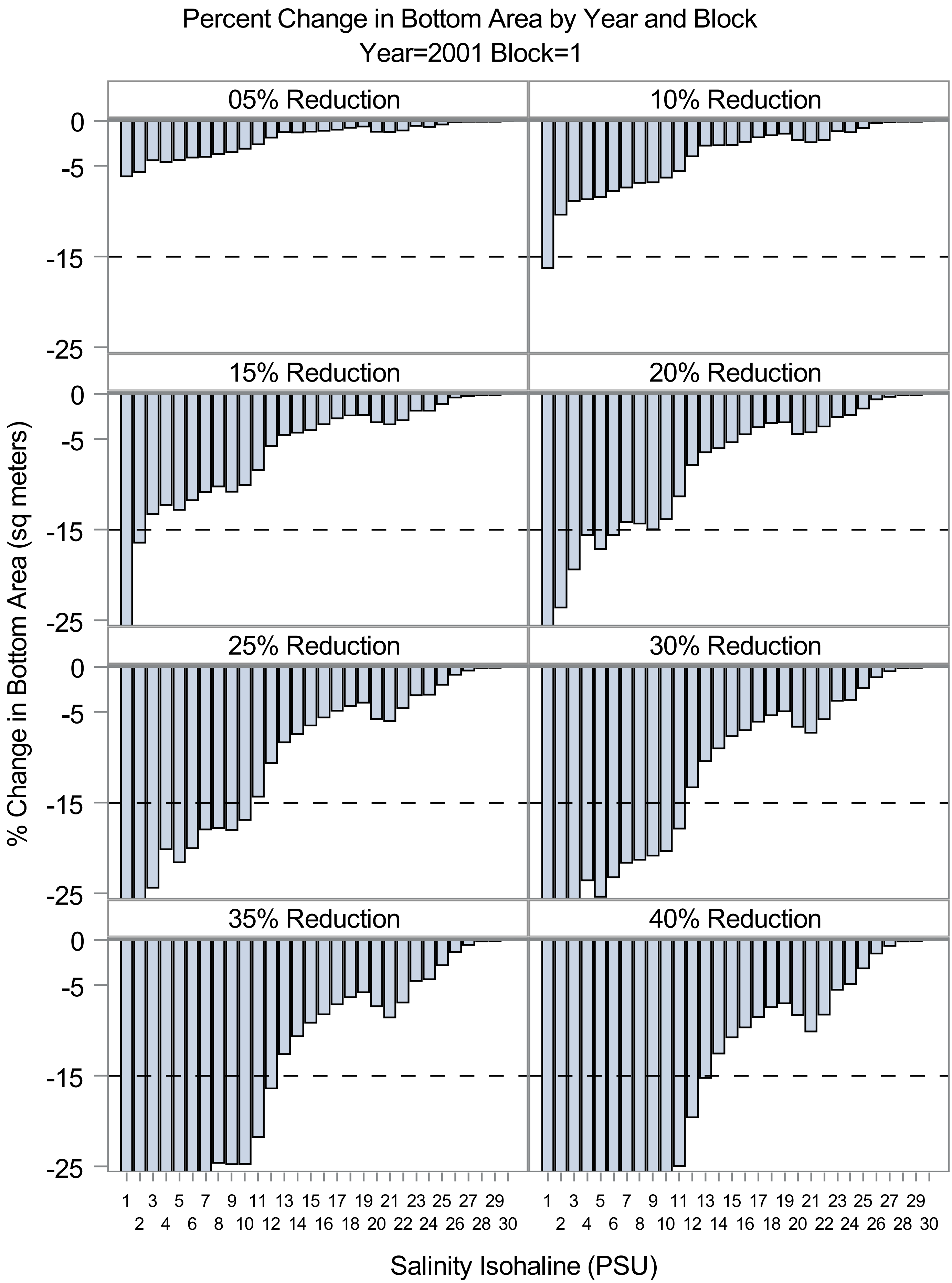


Percent Change in Bottom Area by Year and Block
Year=2000 Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)

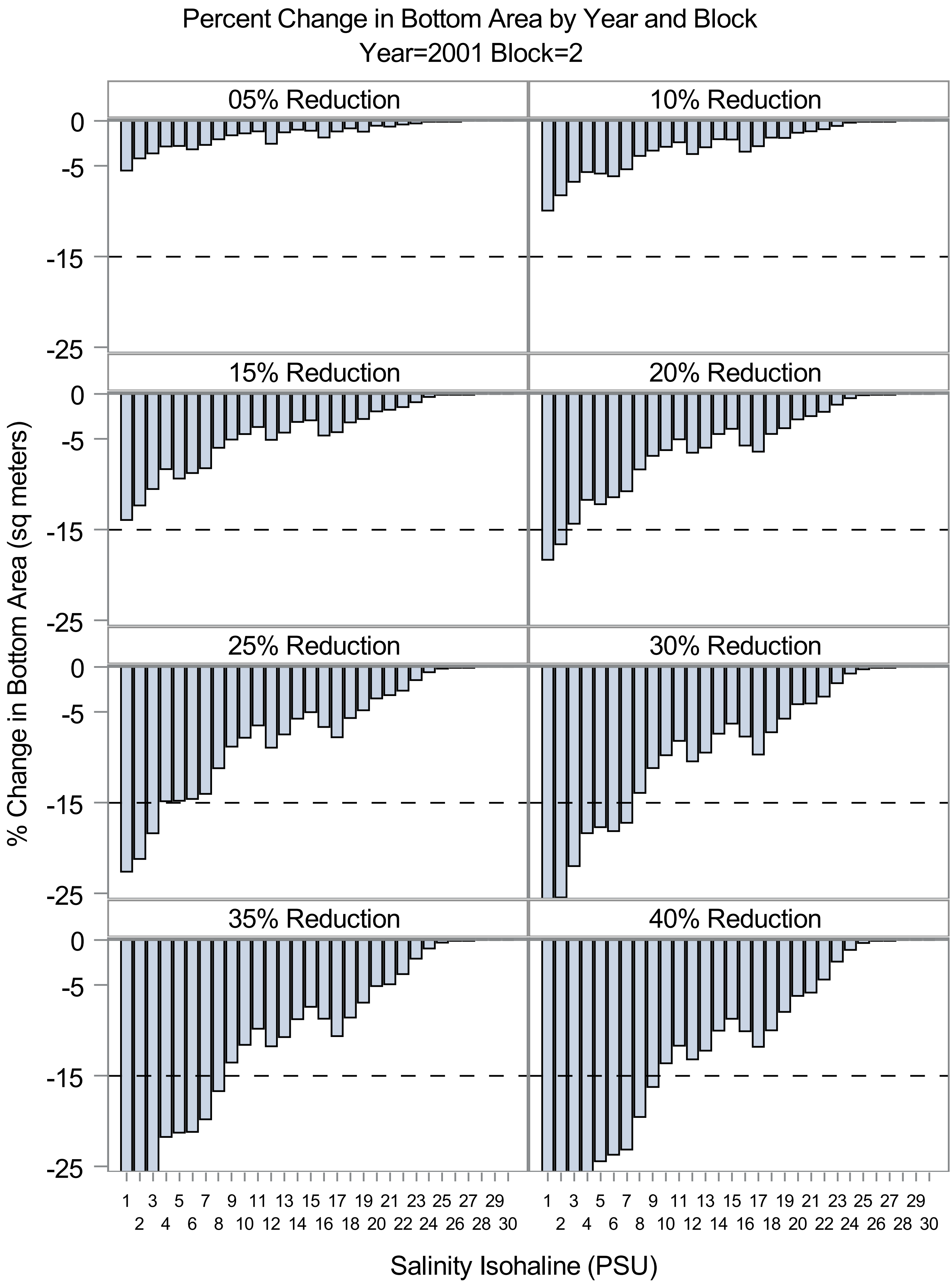


Percent Change in Bottom Area by Year and Block
Year=2000 Block=2
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
% Change in Bottom Area (sq meters)
0
-5
-15
-25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

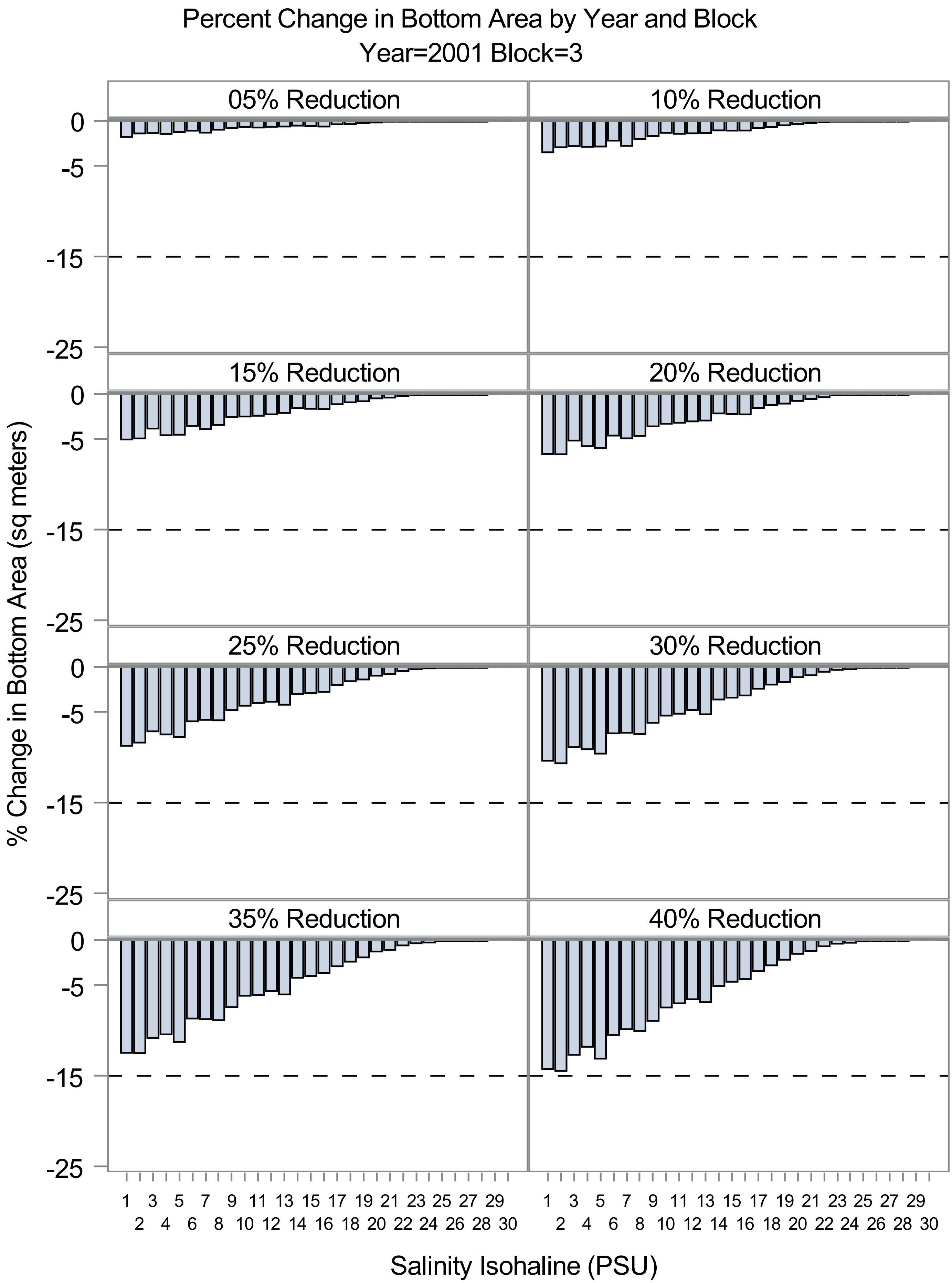

Percent Change in Bottom Area by Year and Block
Year=2000 Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
% Change in Bottom Area (sq meters)
Salinity Isohaline (PSU)



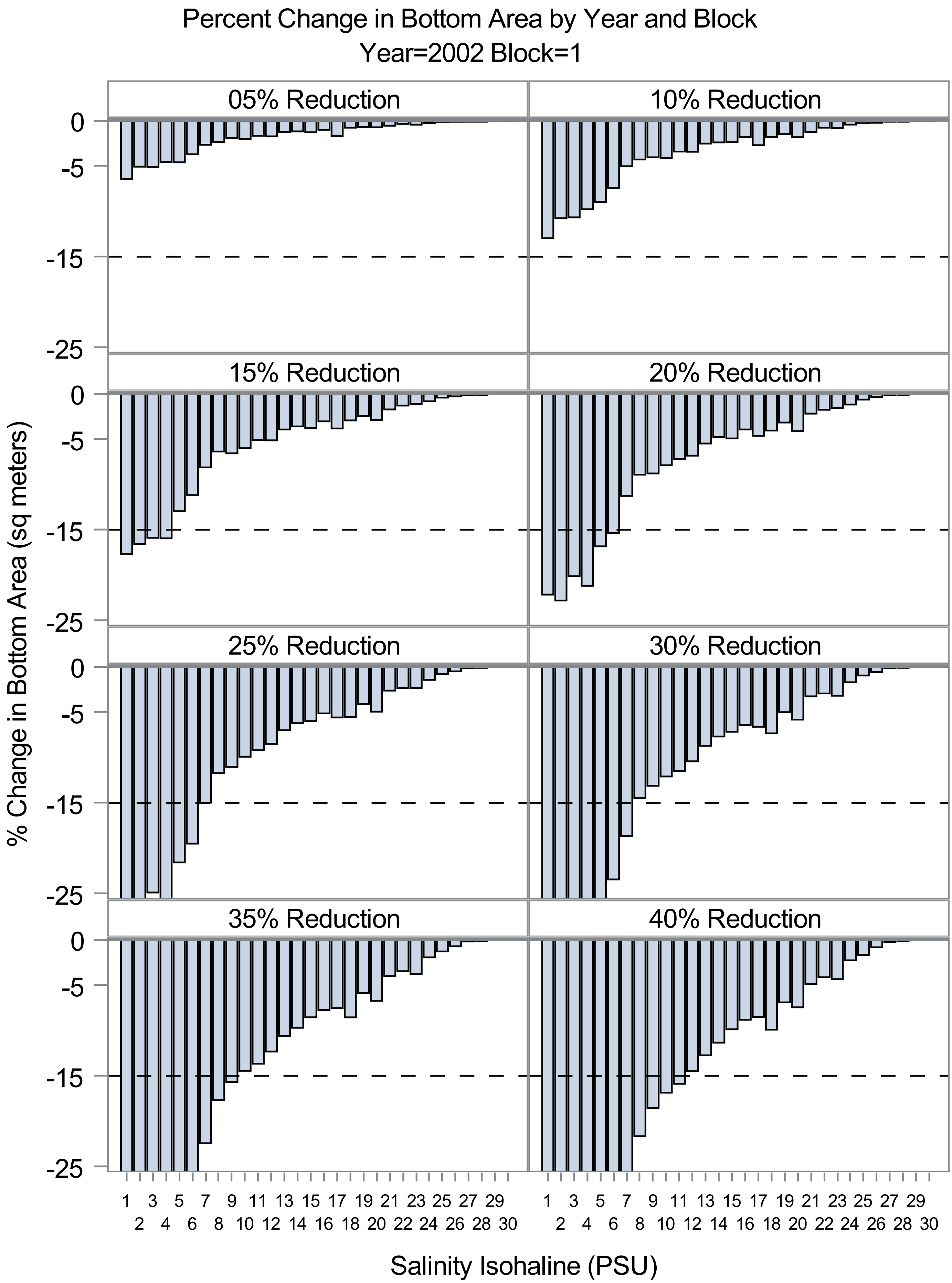
Percent Change in Bottom Area by Year and Block
Year=2001 Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
% Change in Bottom Area (sq meters)
Salinity Isohaline (PSU)

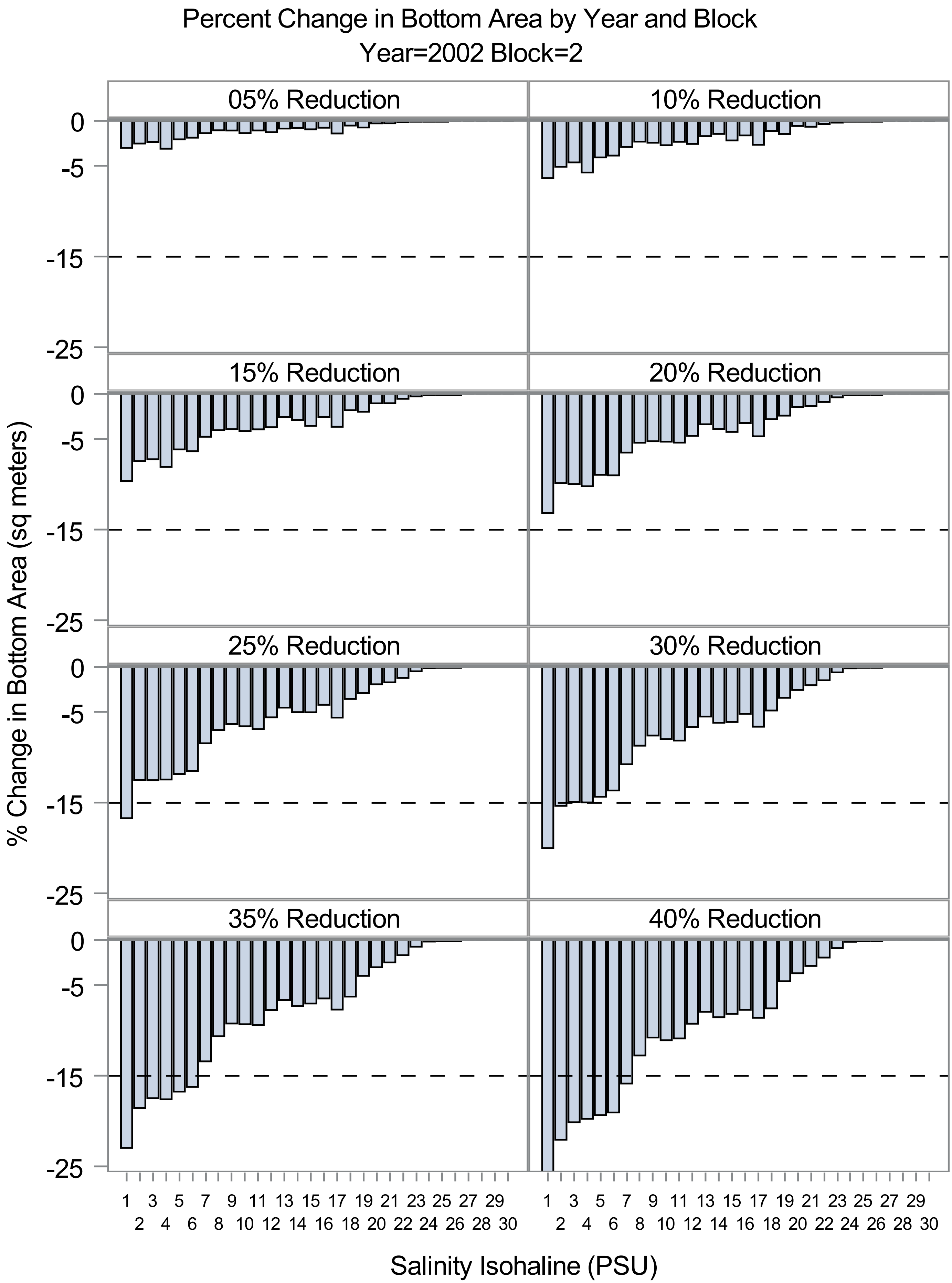


Percent Change in Bottom Area by Year and Block
Year=2001 Block=2
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

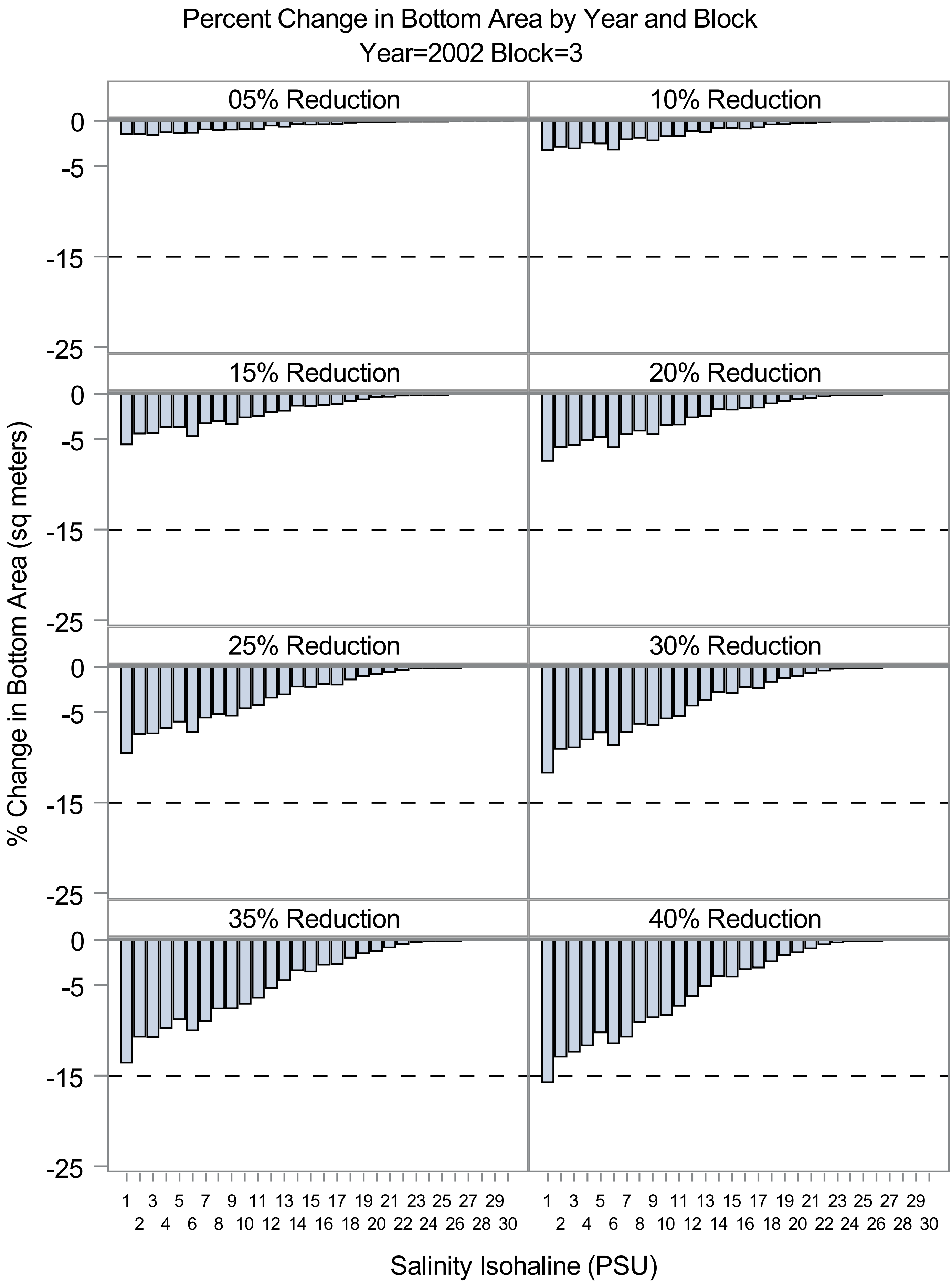


Percent Change in Bottom Area by Year and Block
Year=2001 Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

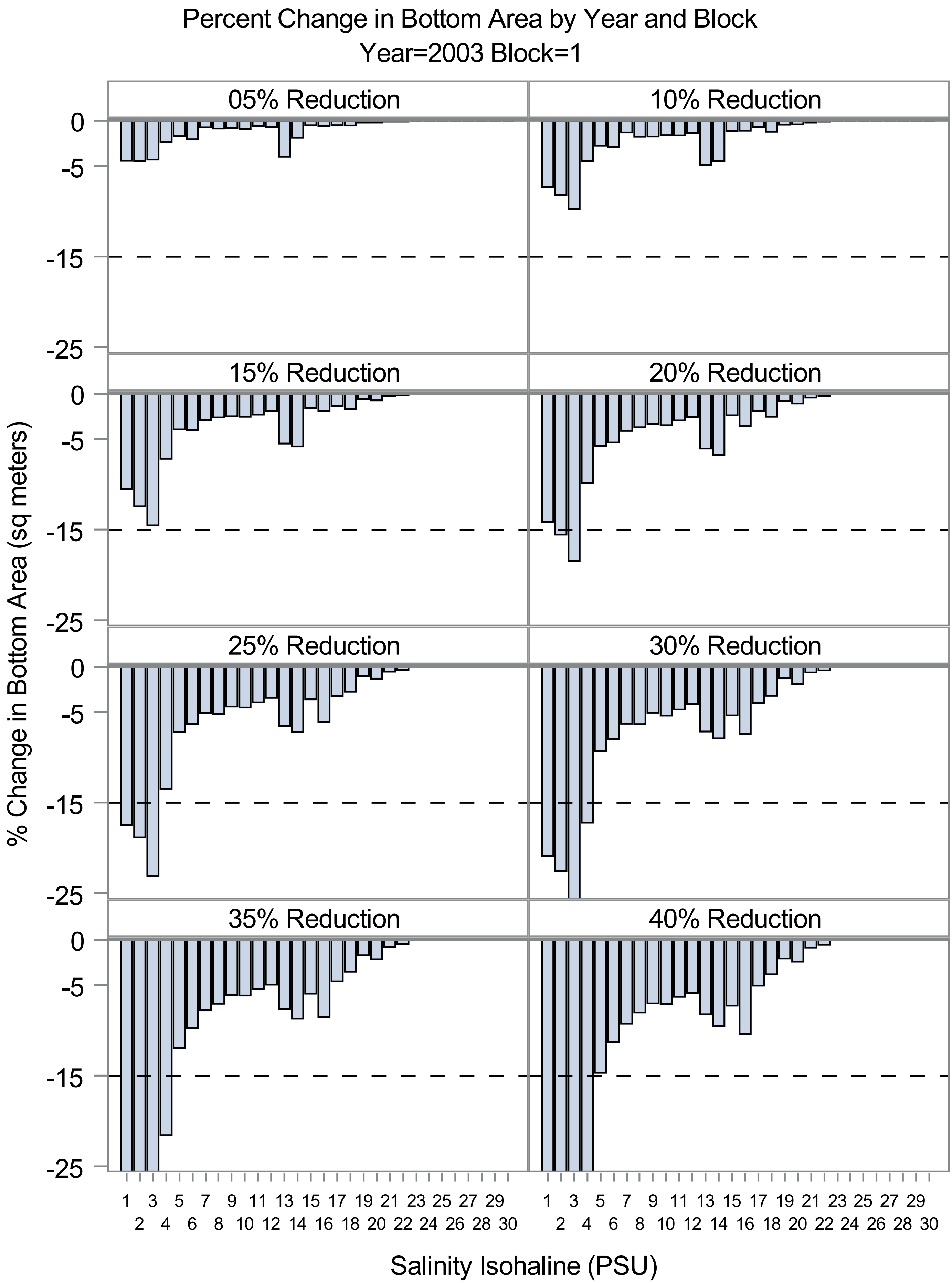

Percent Change in Bottom Area by Year and Block
Year=2002 Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
% Change in Bottom Area (sq meters)
0
-5
-15
-25
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)



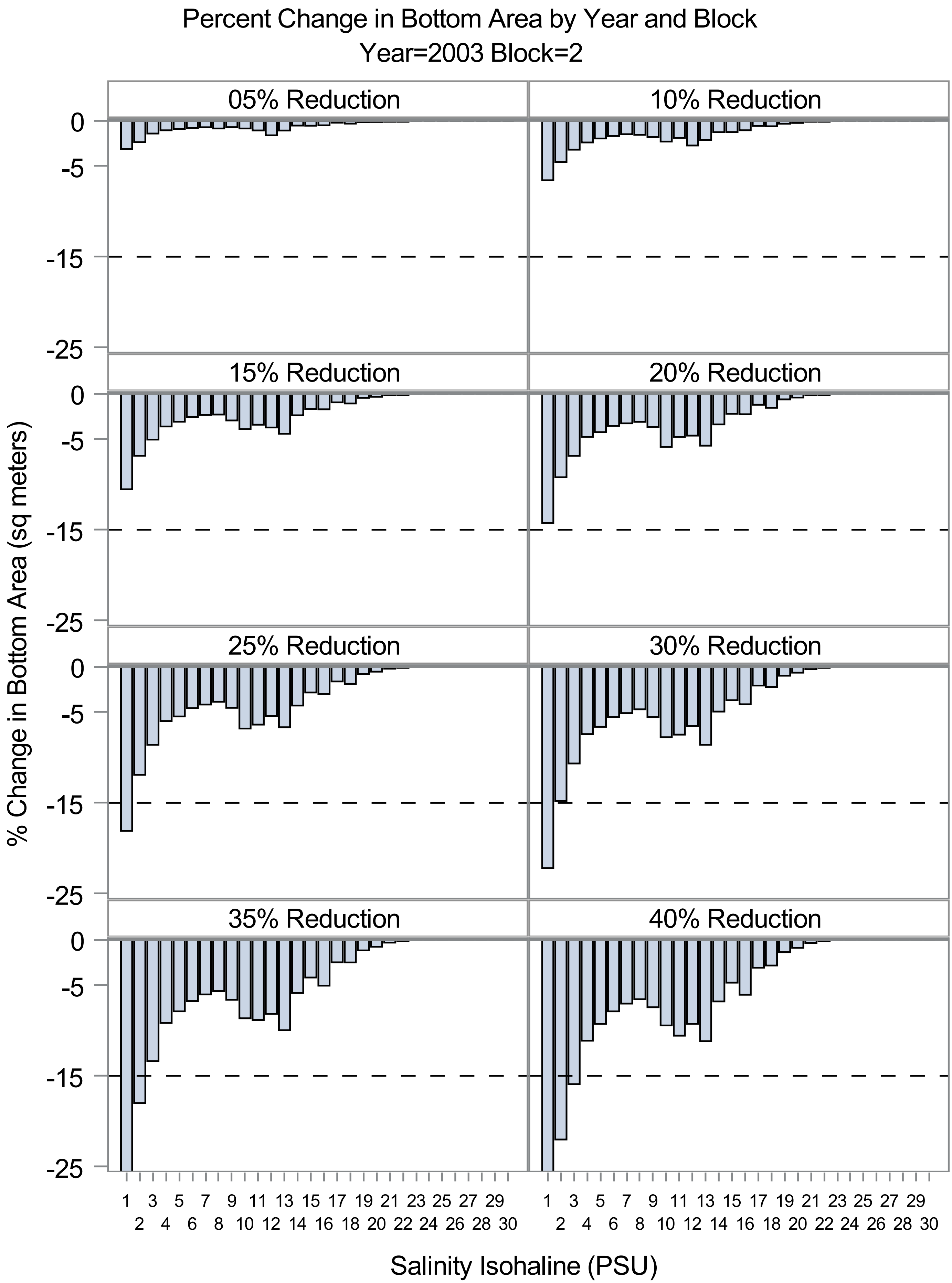
Percent Change in Bottom Area by Year and Block
Year=2002 Block=2
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



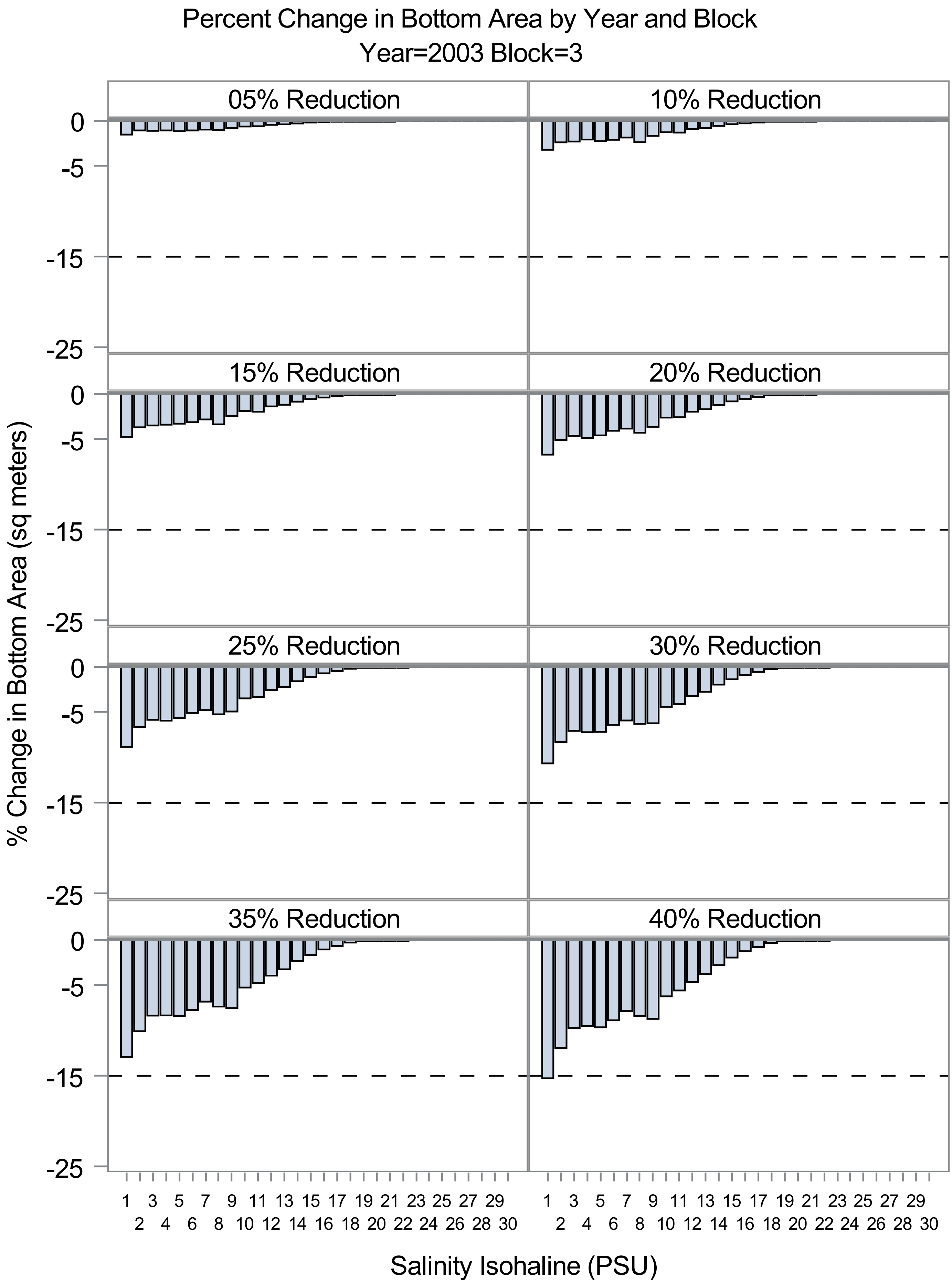
Percent Change in Bottom Area by Year and Block
Year=2002 Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



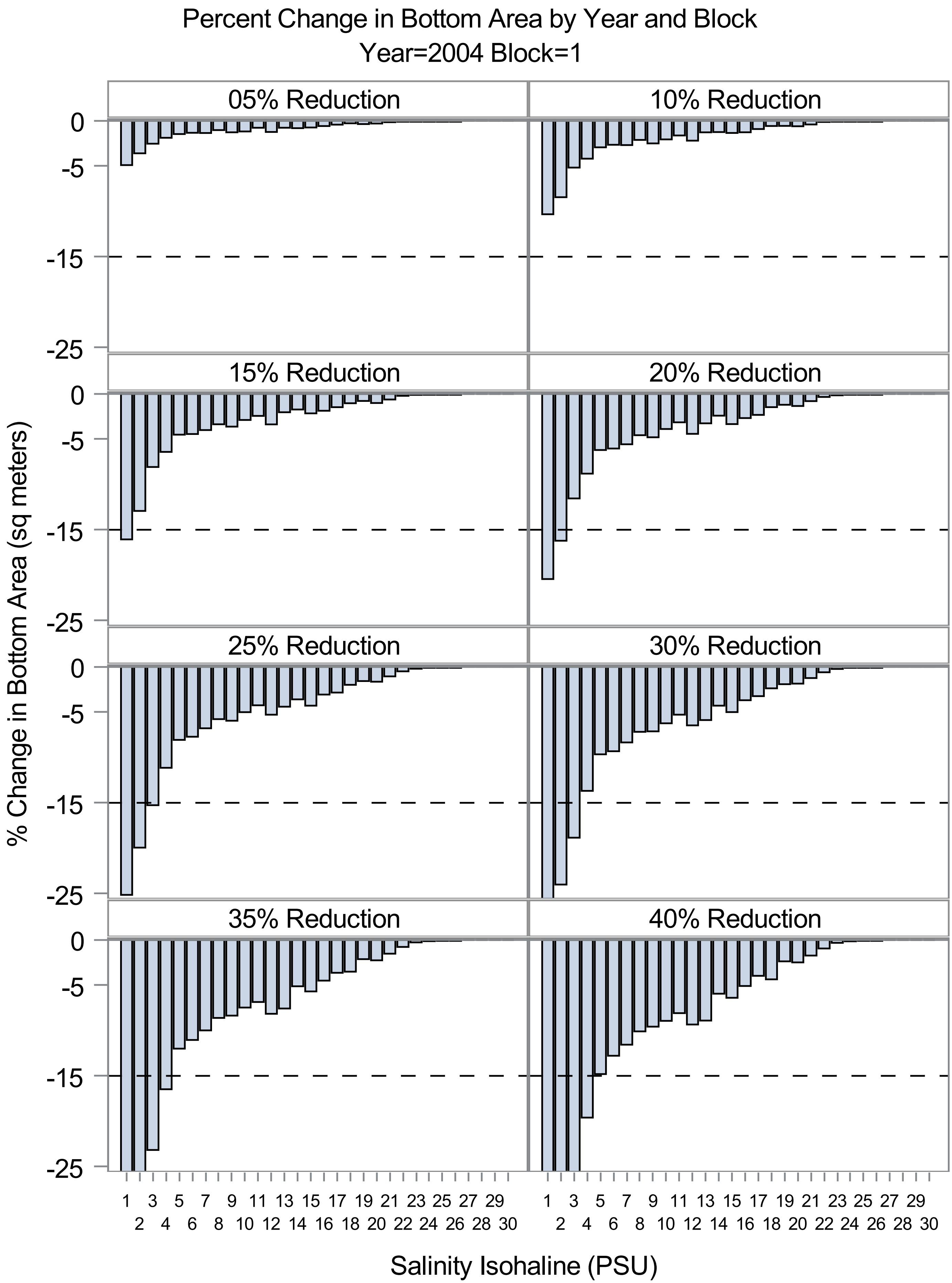
Percent Change in Bottom Area by Year and Block
Year=2003 Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)



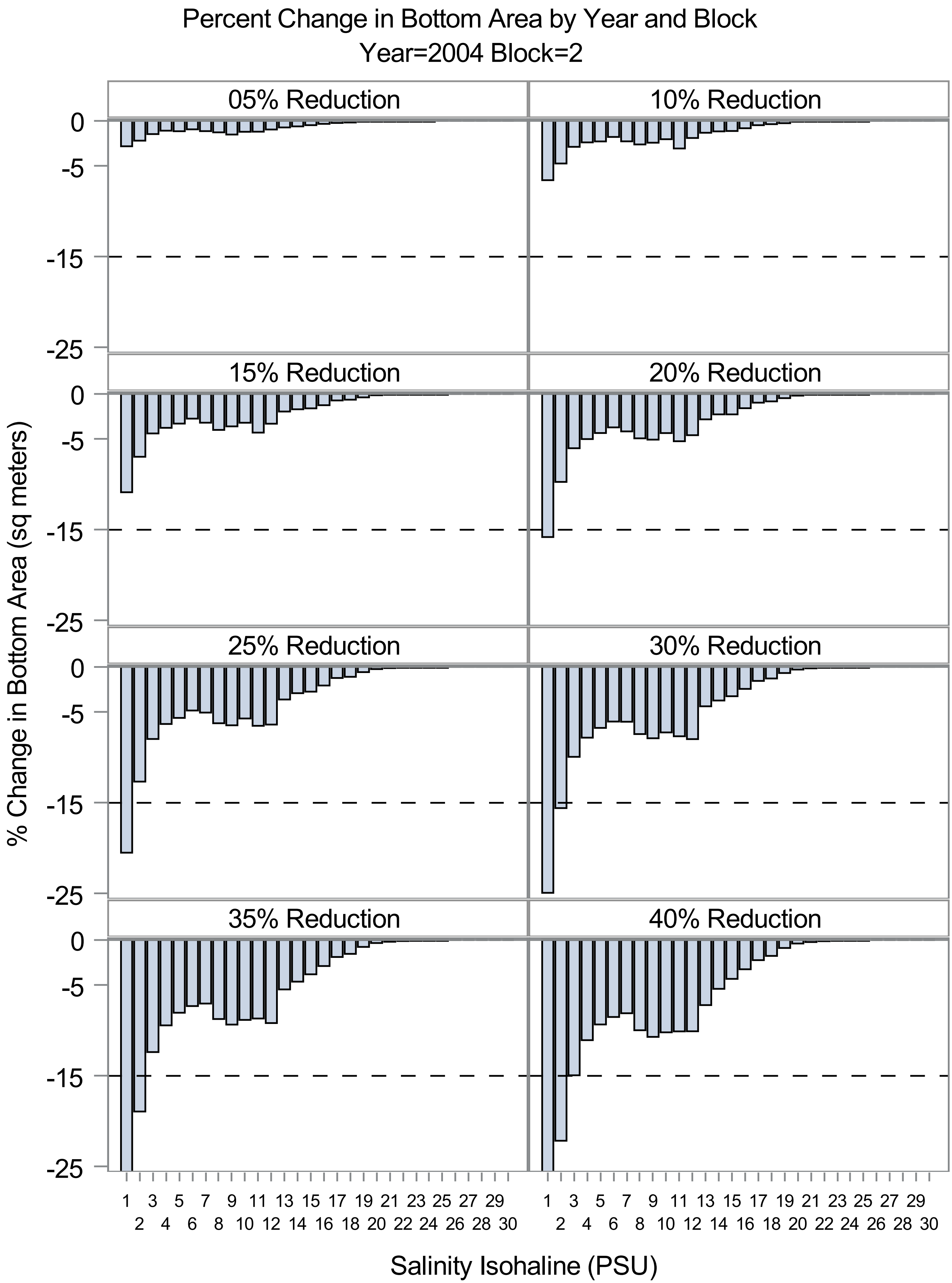
Percent Change in Bottom Area by Year and Block
Year=2003 Block=2
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



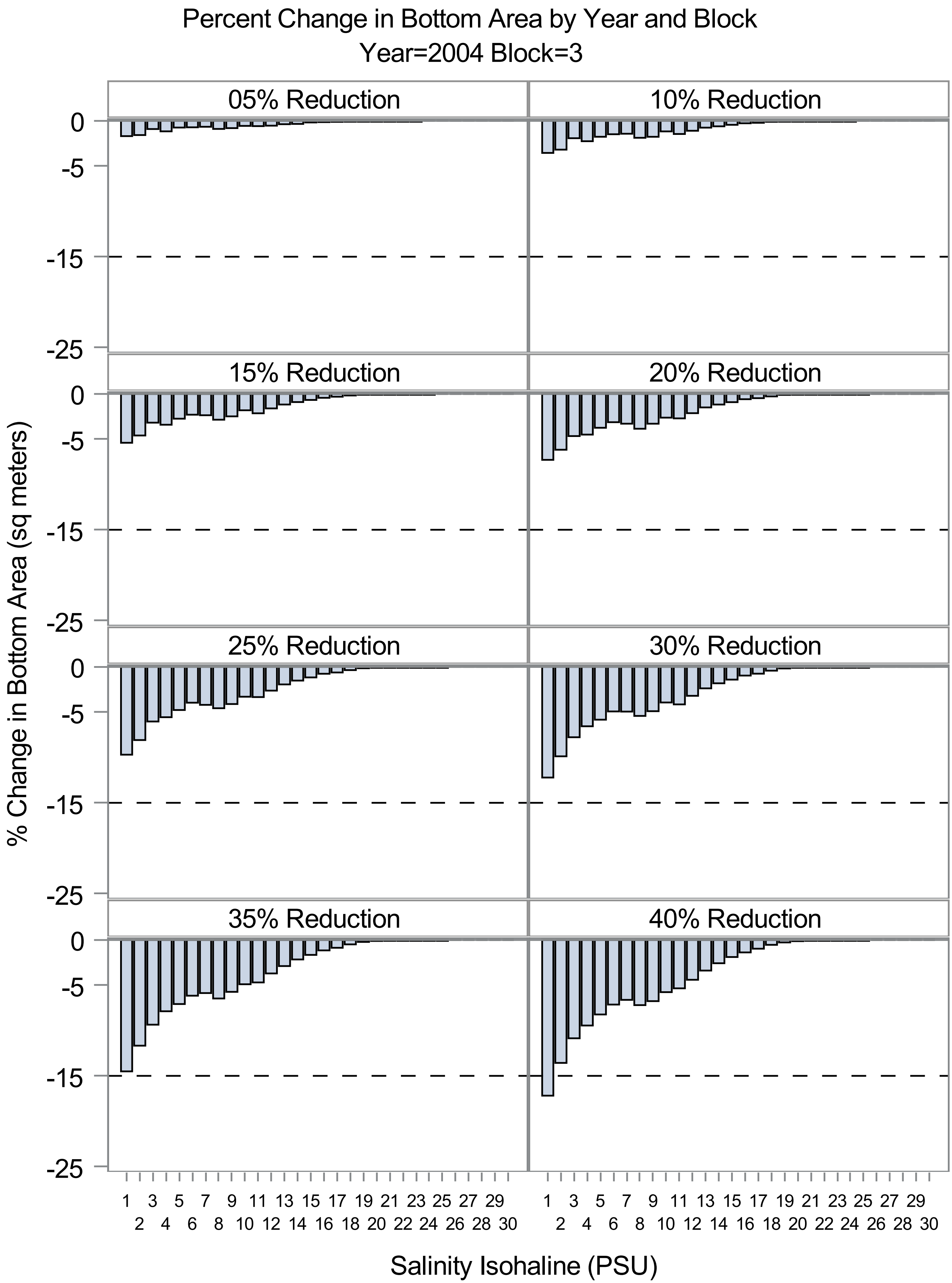
Percent Change in Bottom Area by Year and Block
Year=2003 Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)



Percent Change in Bottom Area by Year and Block
Year=2004 Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
% Change in Bottom Area (sq meters)
0
-5
-15
-25
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)



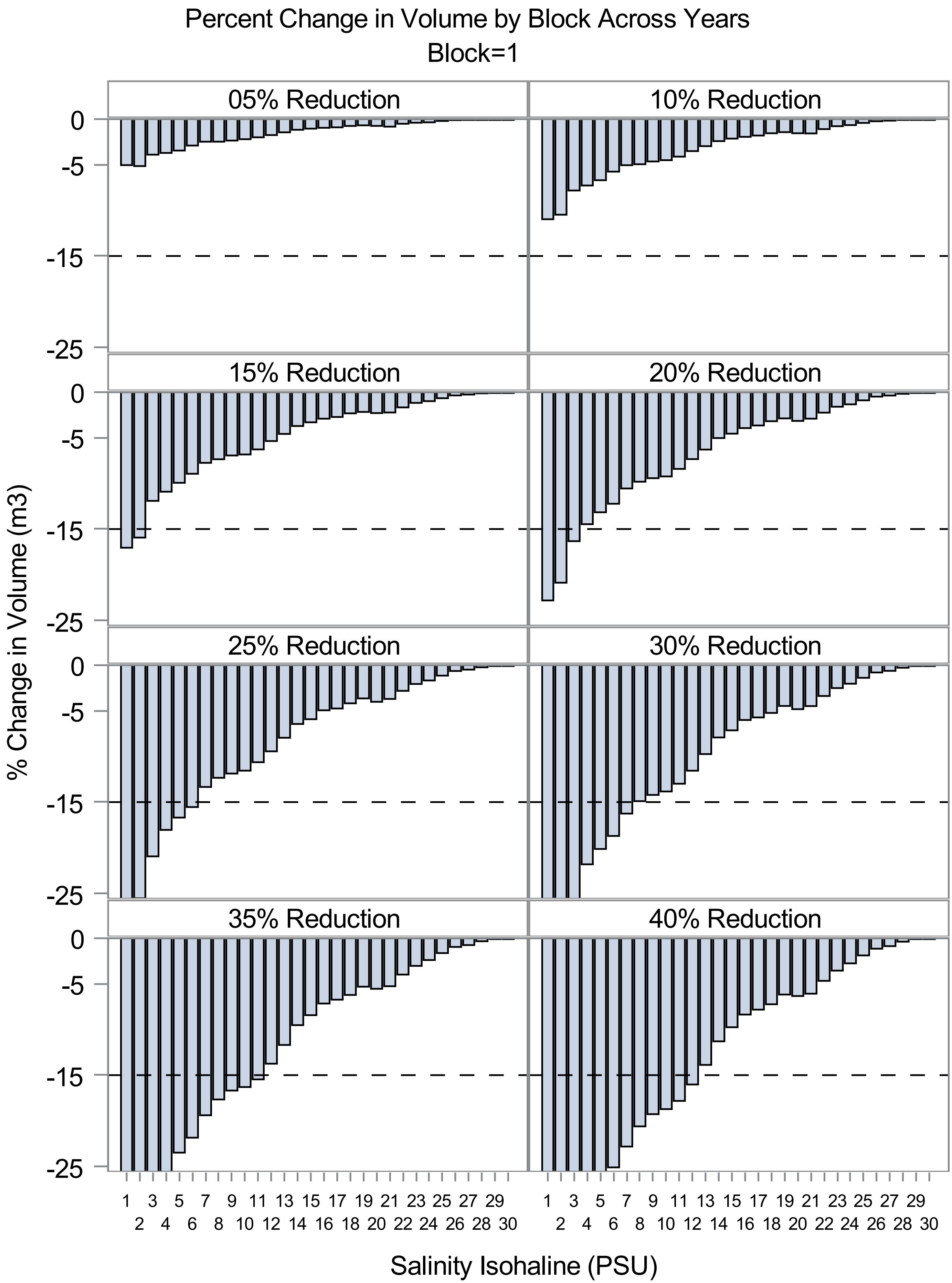
Percent Change in Bottom Area by Year and Block
Year=2004 Block=2
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



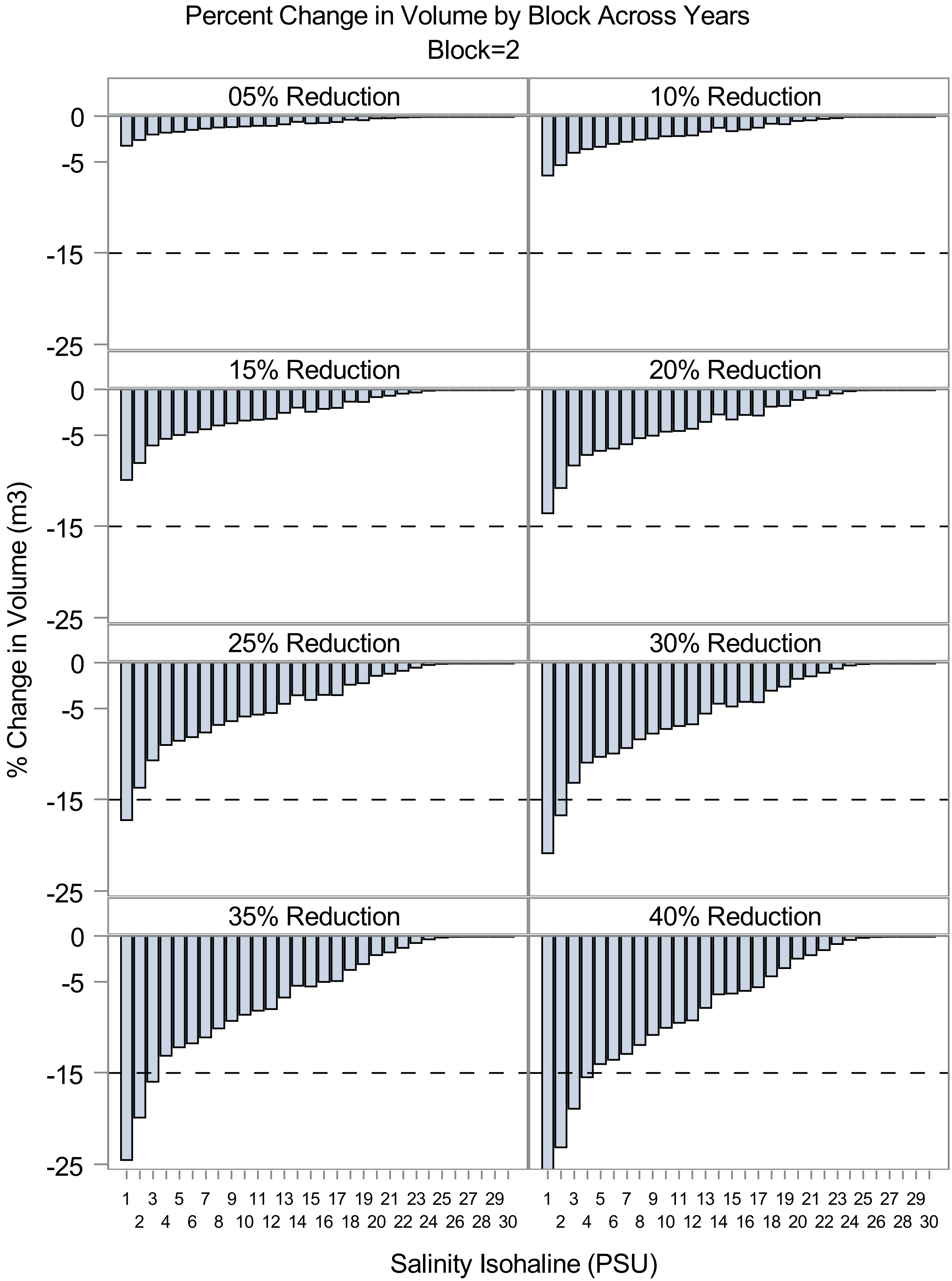
Percent Change in Bottom Area by Year and Block
Year=2004 Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

Appendix C

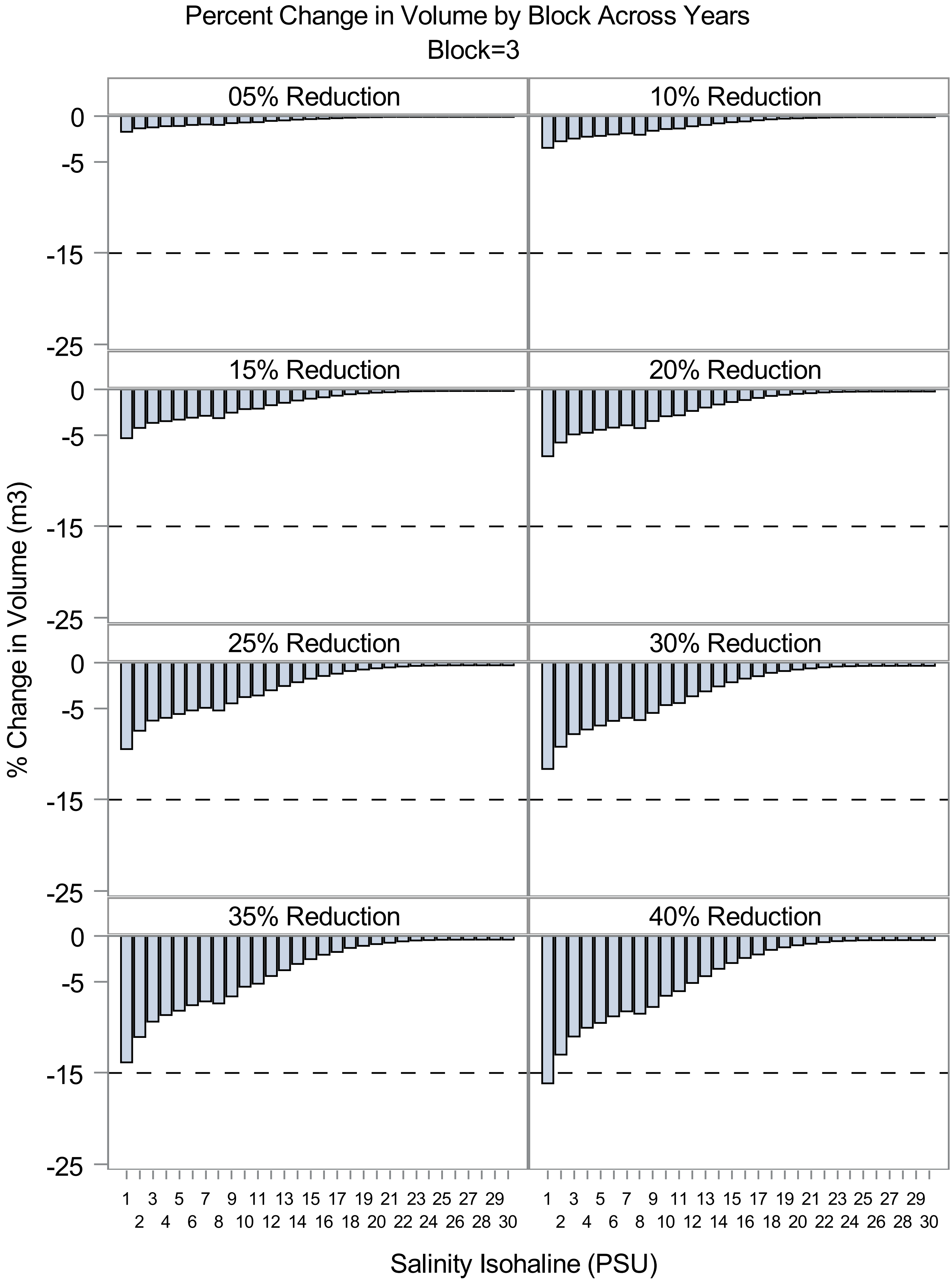
Plots of Percent Reductions in Salinity Isohaline Volume by Block, Year, and Year/Block Combinations



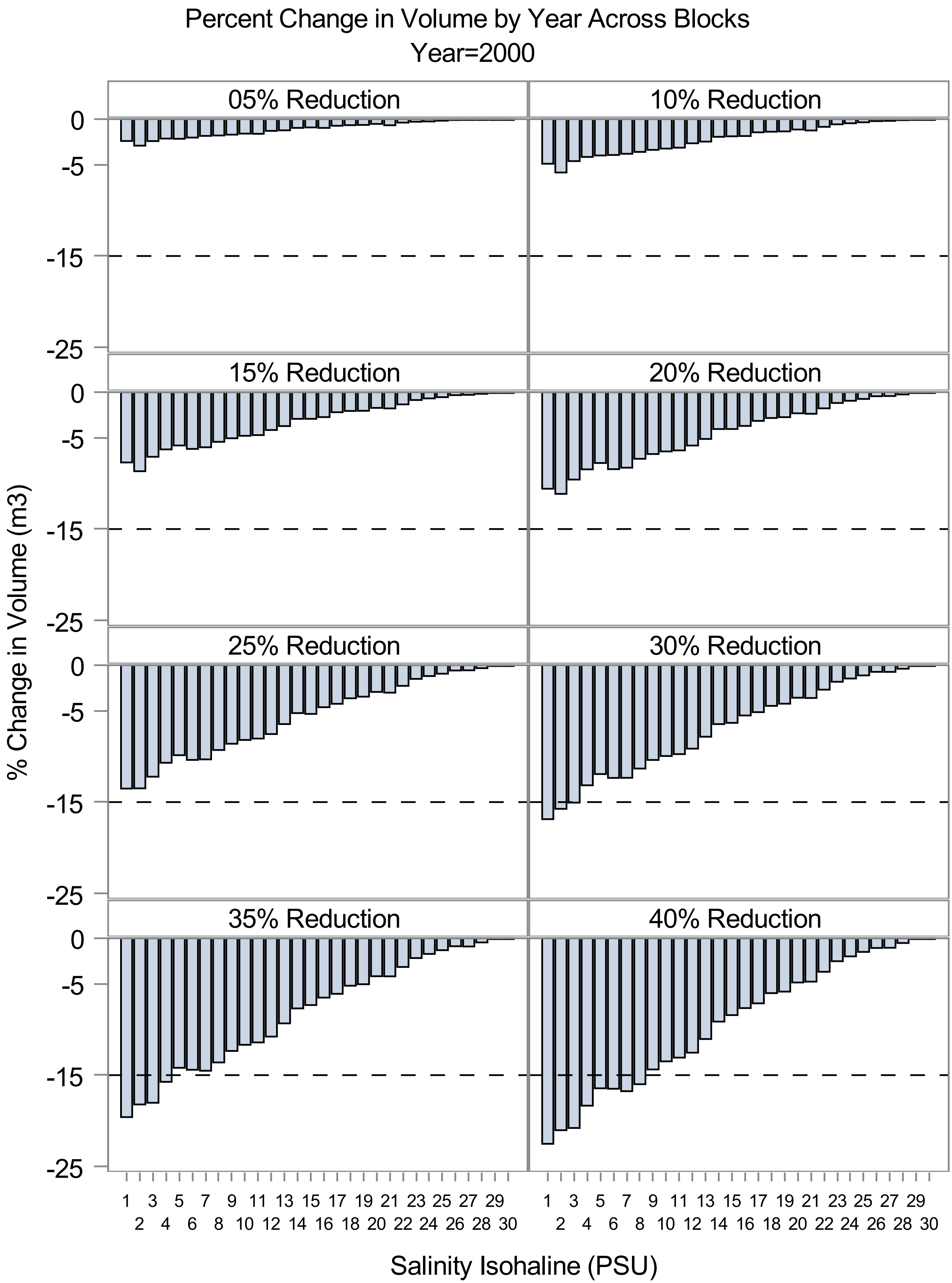
Percent Change in Volume by Block Across Years
Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



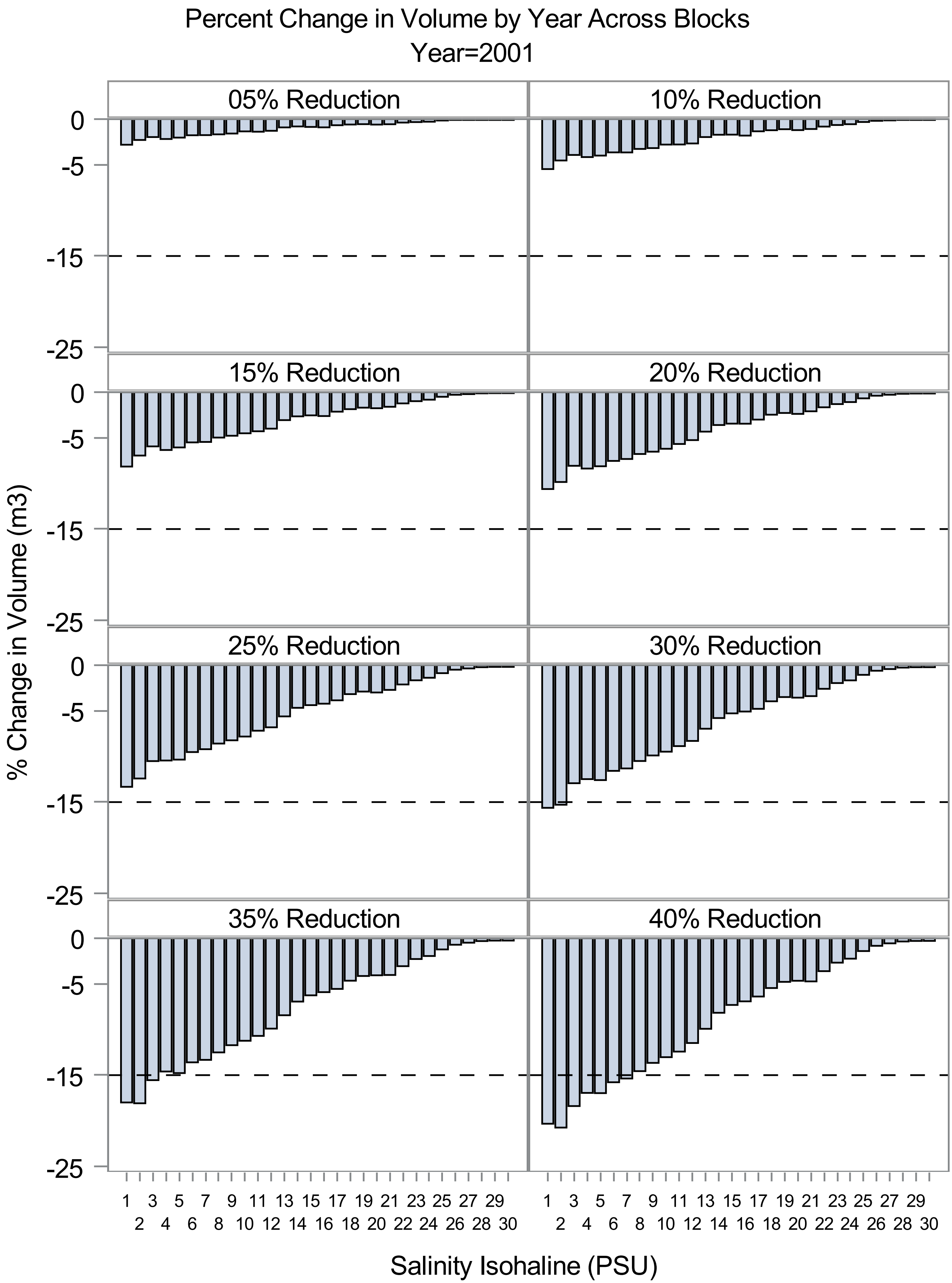
Percent Change in Volume by Block Across Years
Block=2
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



Percent Change in Volume by Block Across Years
Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
Salinity Isohaline (PSU)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

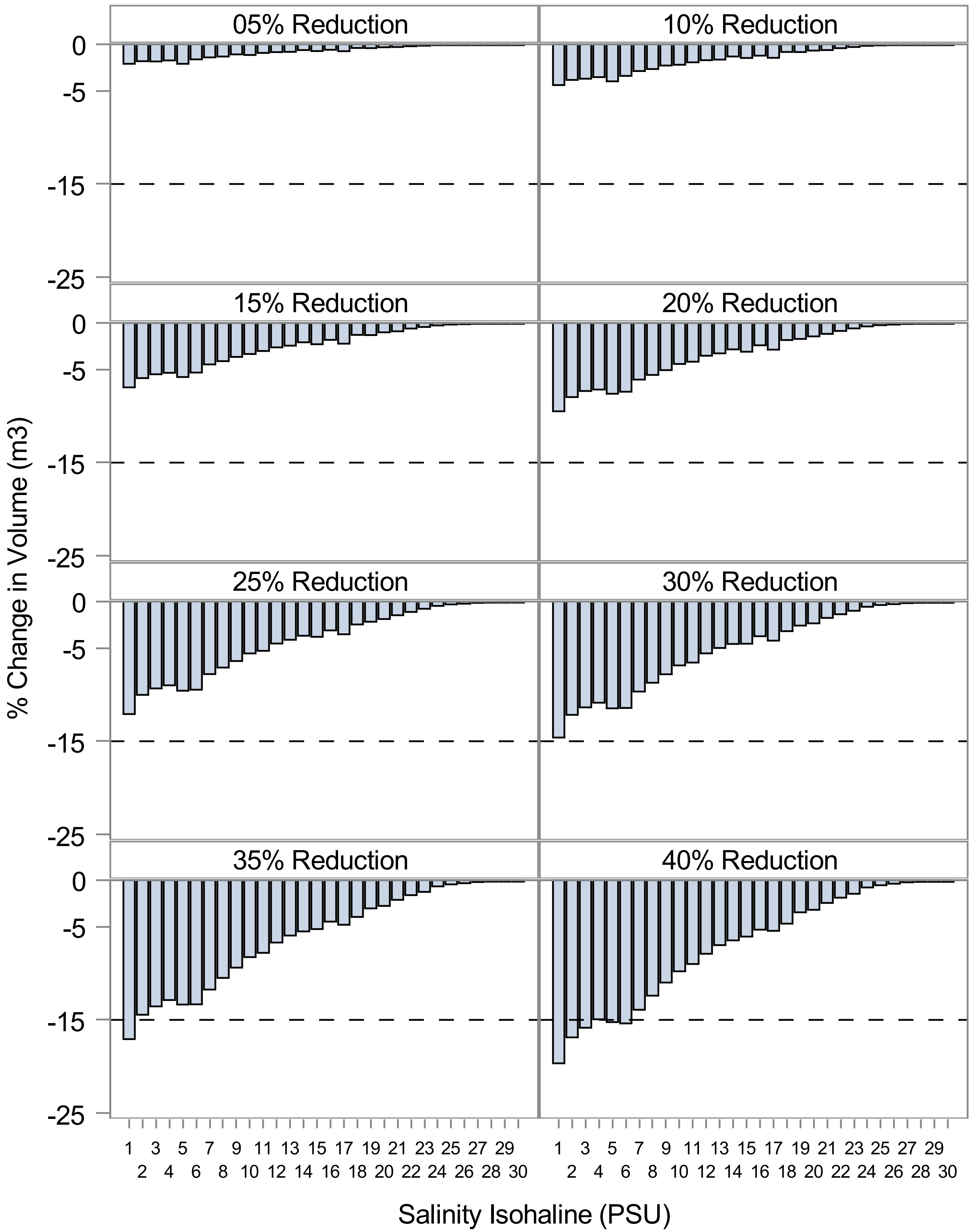


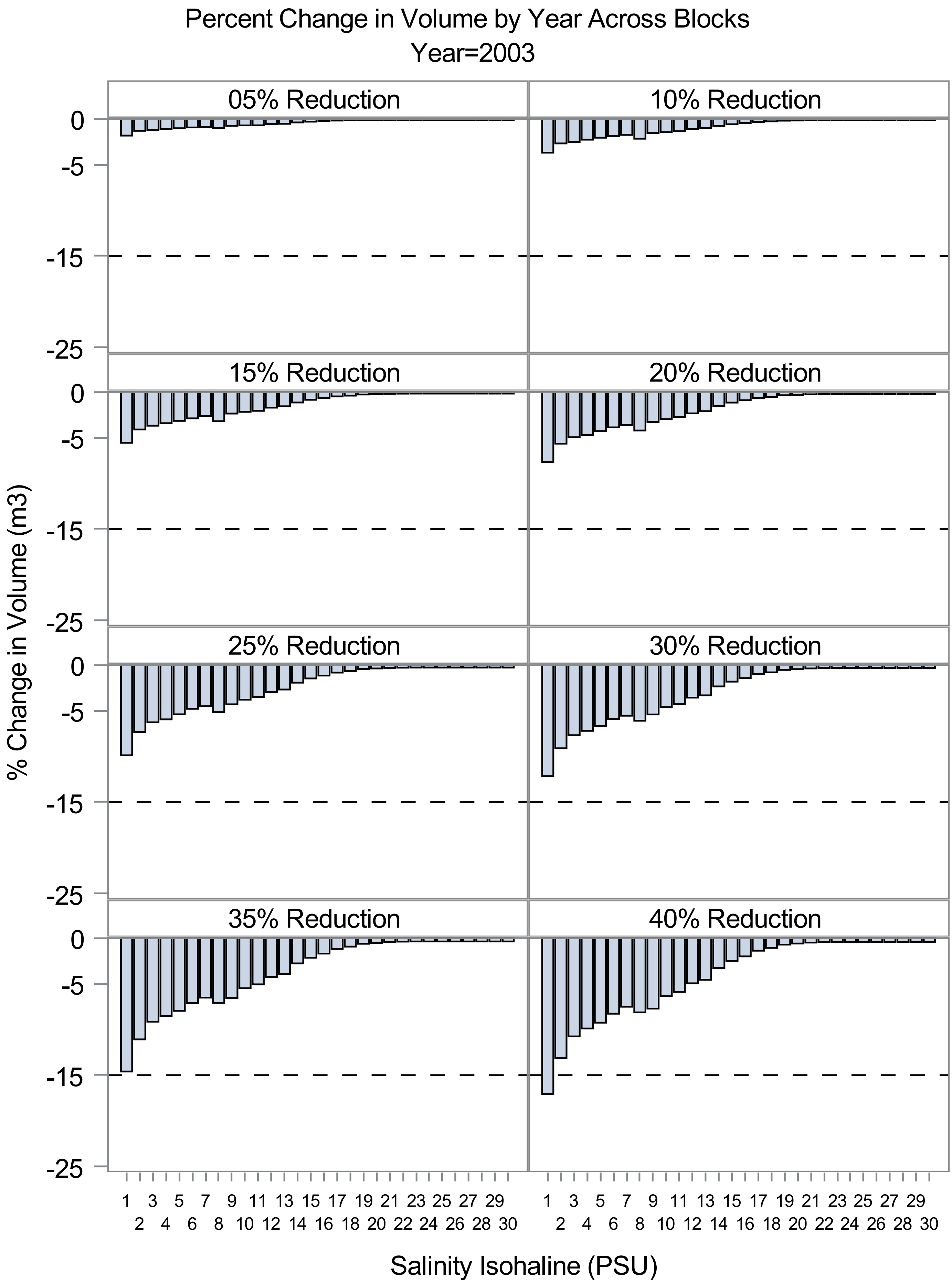
Percent Change in Volume by Year Across Blocks
Year=2000
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

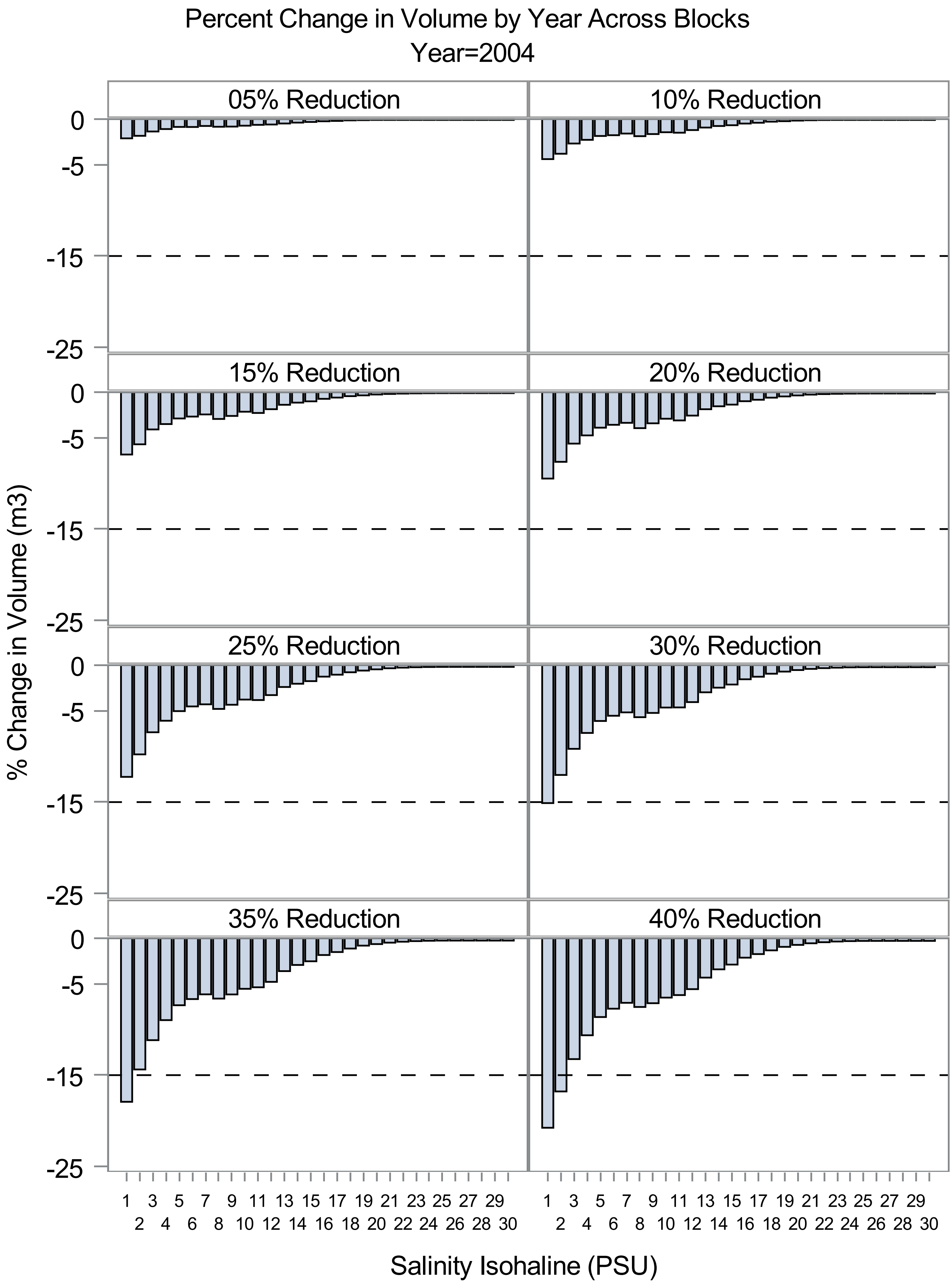


Percent Change in Volume by Year Across Blocks
Year=2001
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

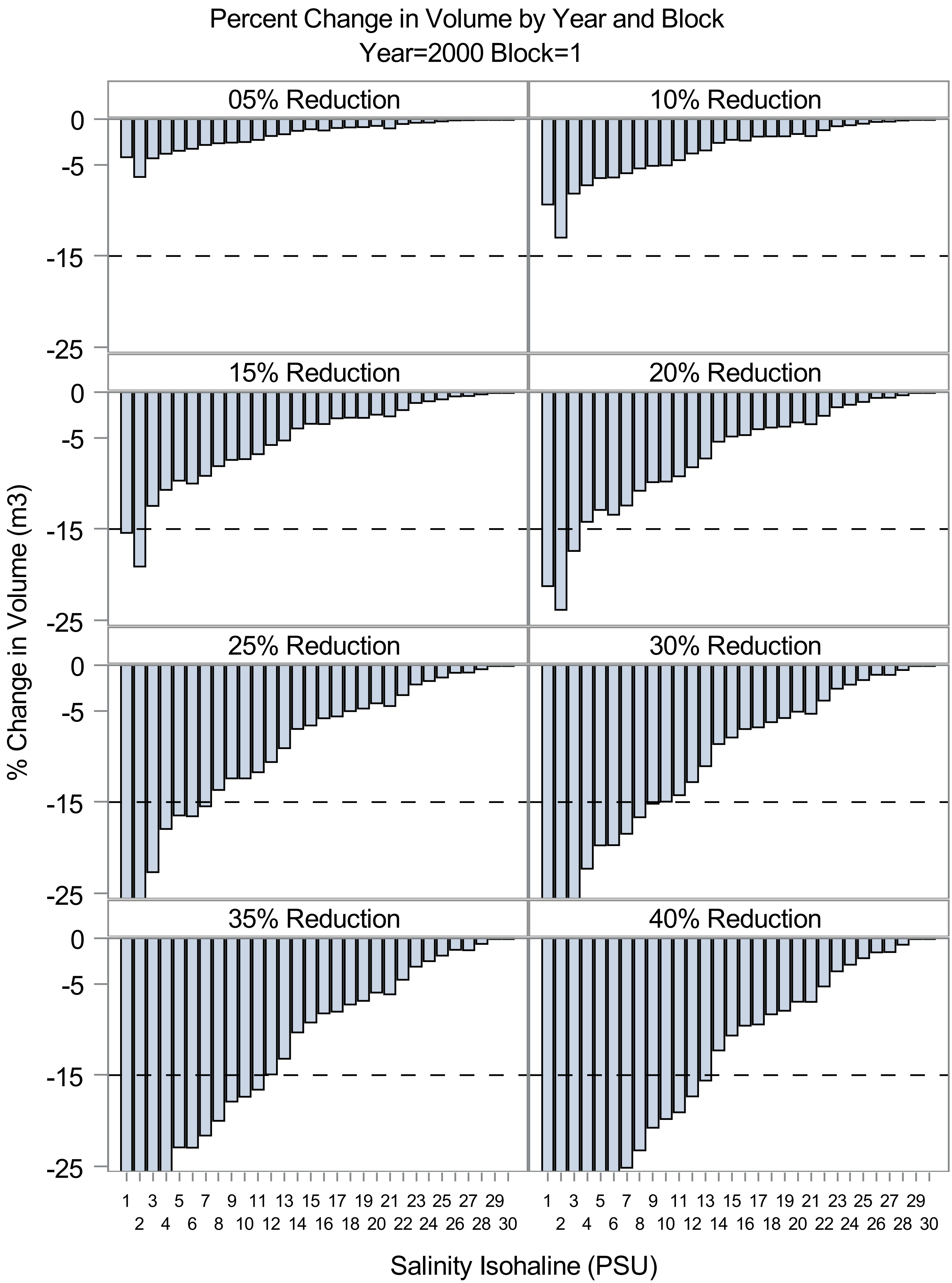
Percent Change in Volume by Year Across Blocks
Year=2002

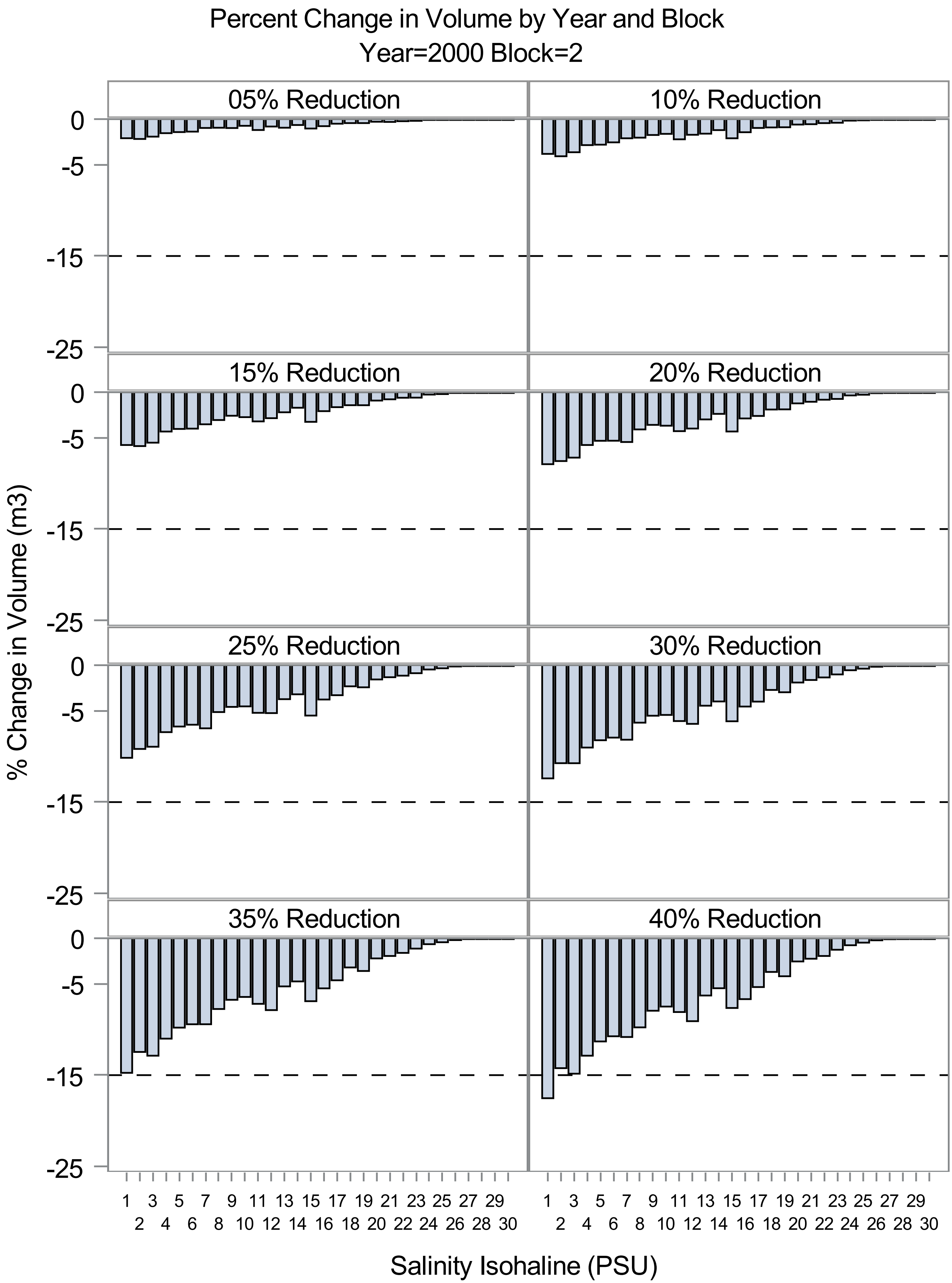



Percent Change in Volume by Year Across Blocks
Year=2003
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

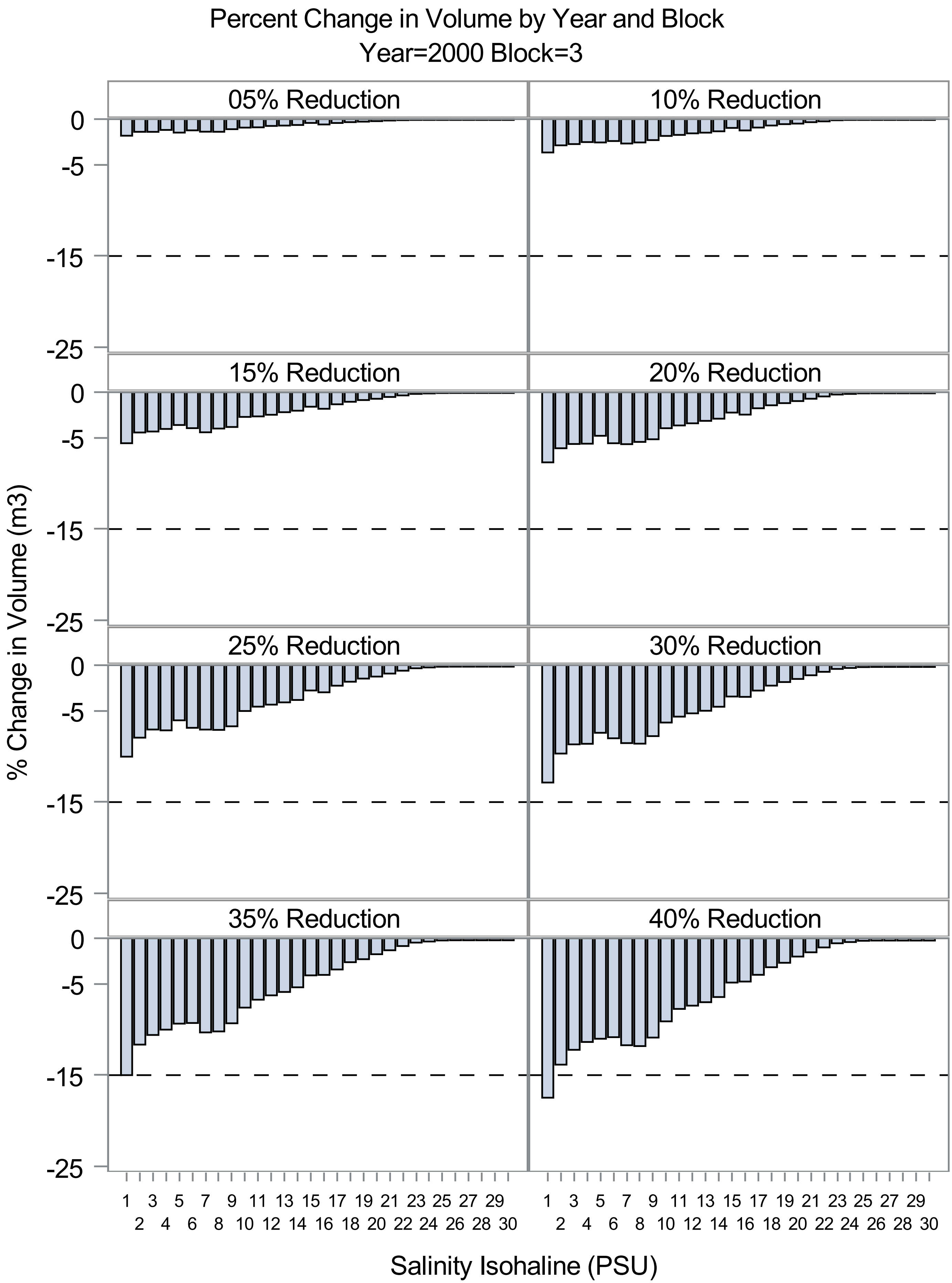


Percent Change in Volume by Year Across Blocks
Year=2004
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

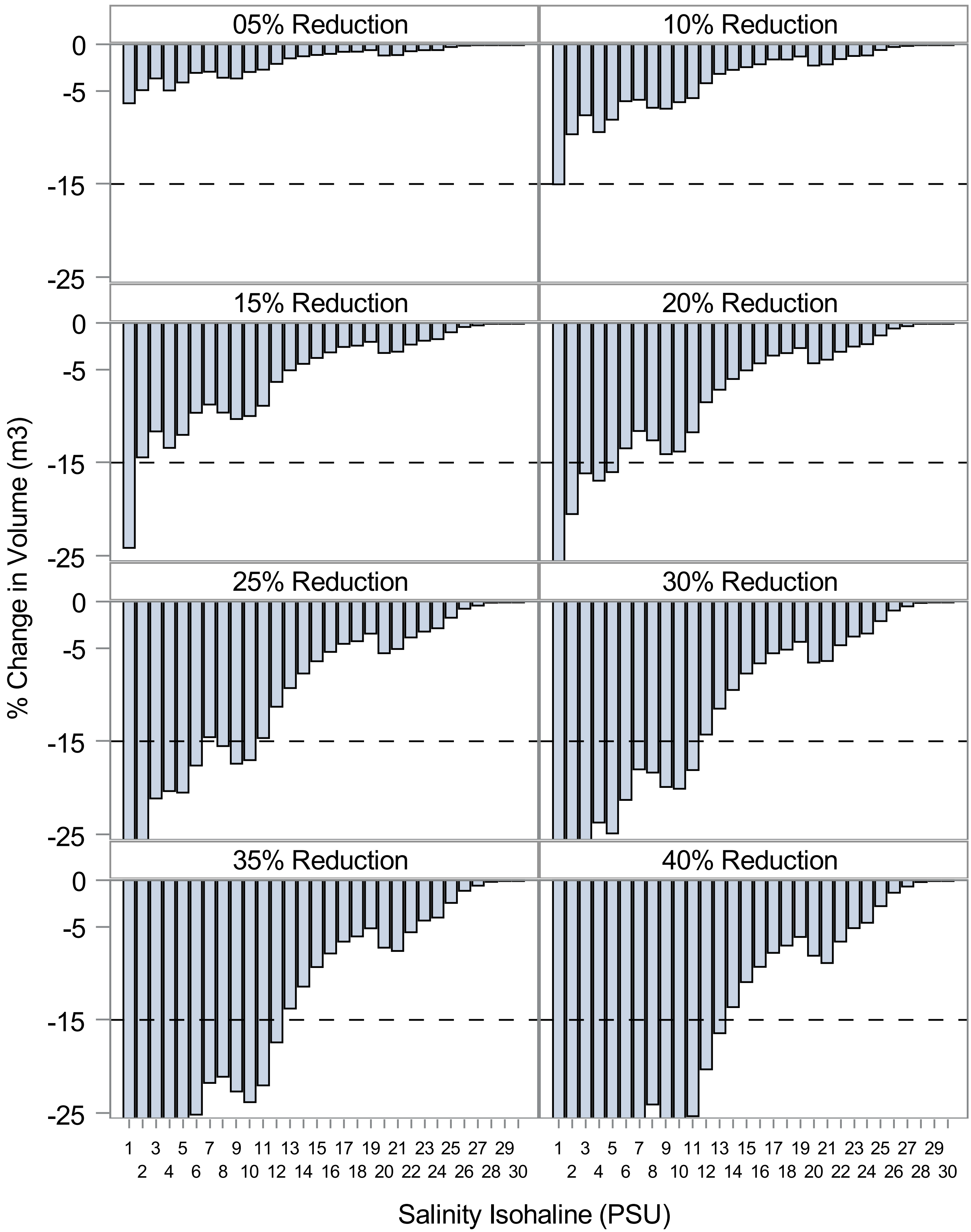

Percent Change in Volume by Year and Block
Year=2000 Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



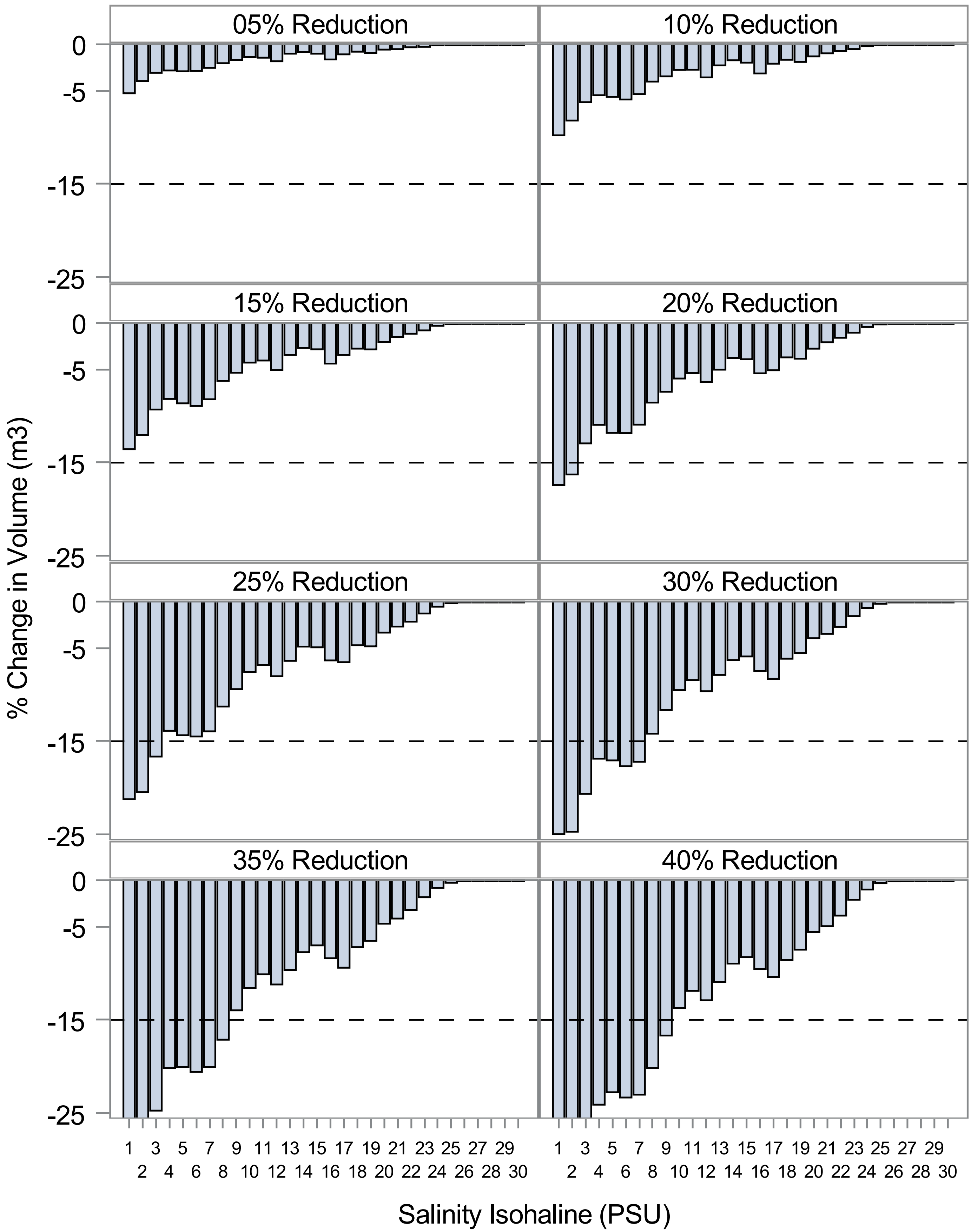
Percent Change in Volume by Year and Block
Year=2000 Block=2
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

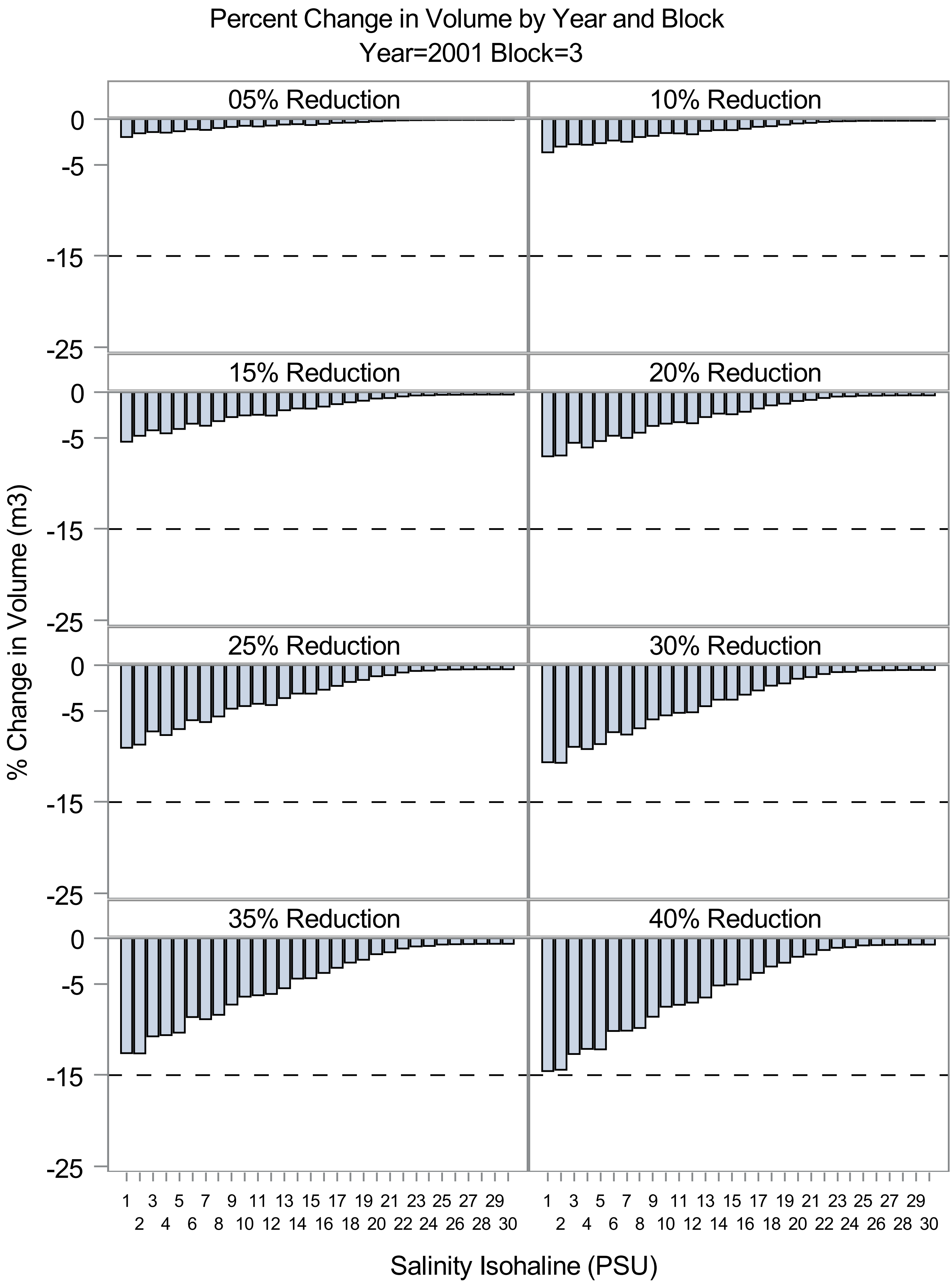

Percent Change in Volume by Year and Block
Year=2000 Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

Percent Change in Volume by Year and Block
Year=2001 Block=1

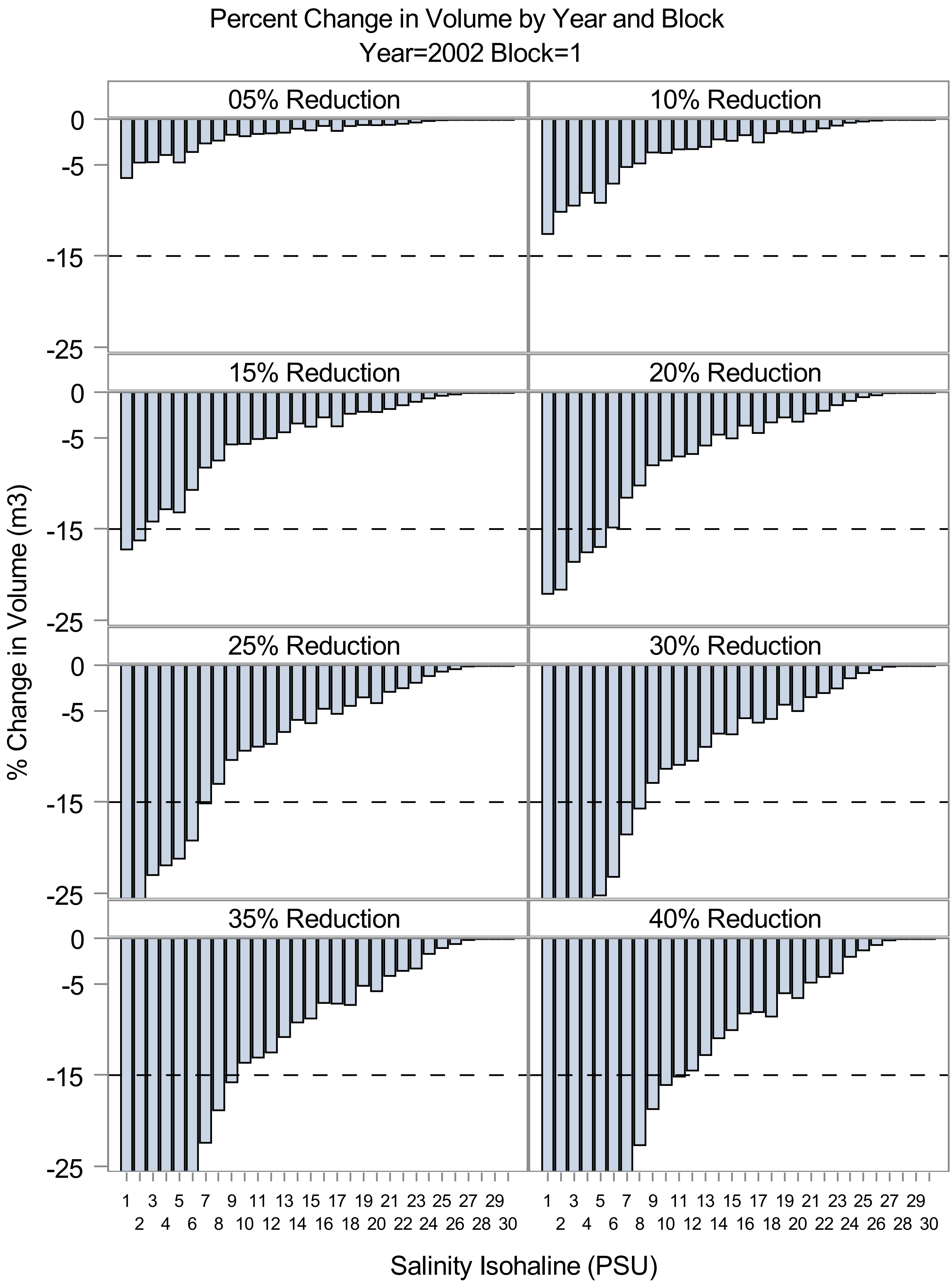


Percent Change in Volume by Year and Block
Year=2001 Block=2





Percent Change in Volume by Year and Block
Year=2001 Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



Percent Change in Volume by Year and Block
Year=2002 Block=1
05% Reduction
10% Reduction
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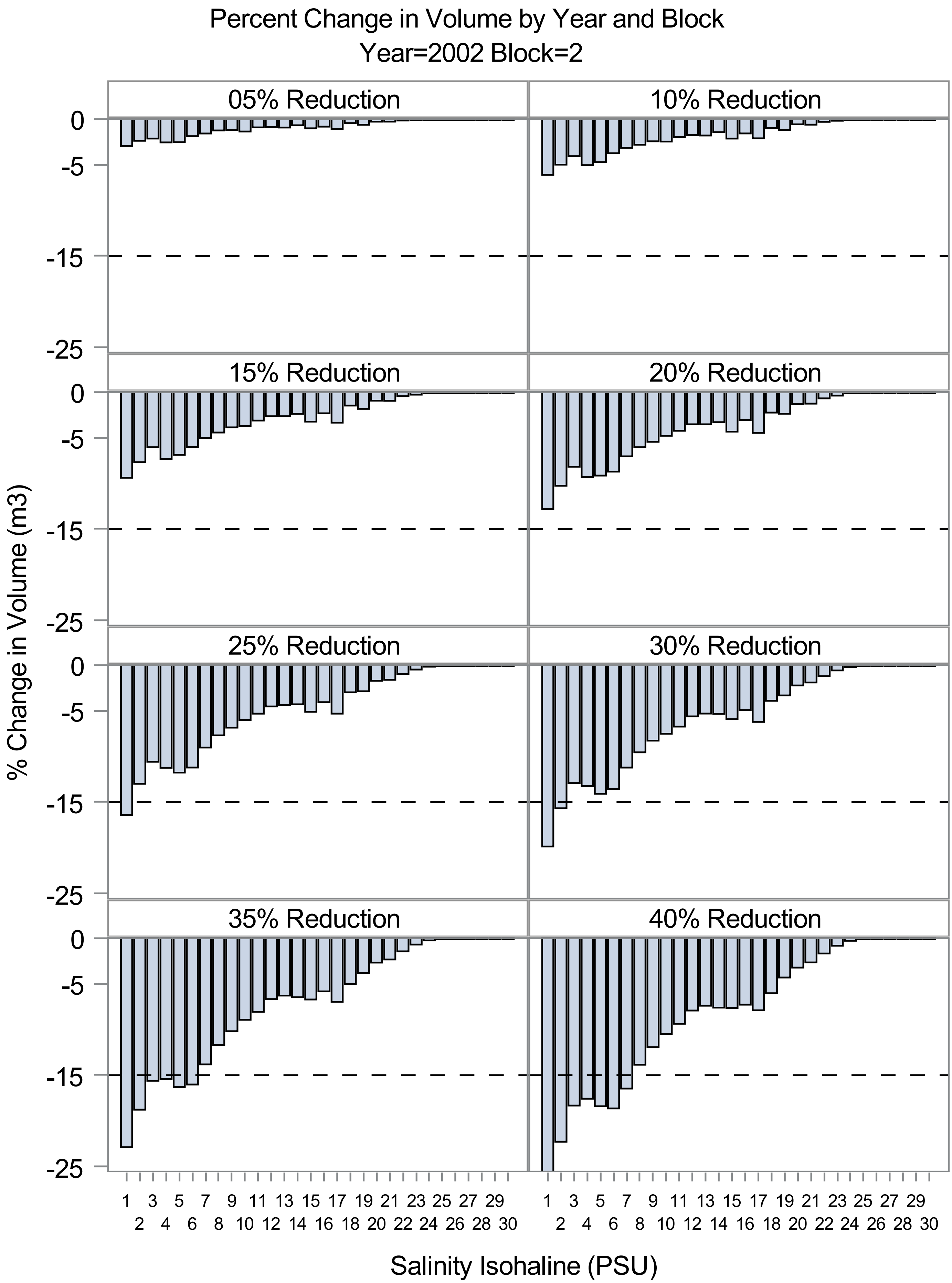
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)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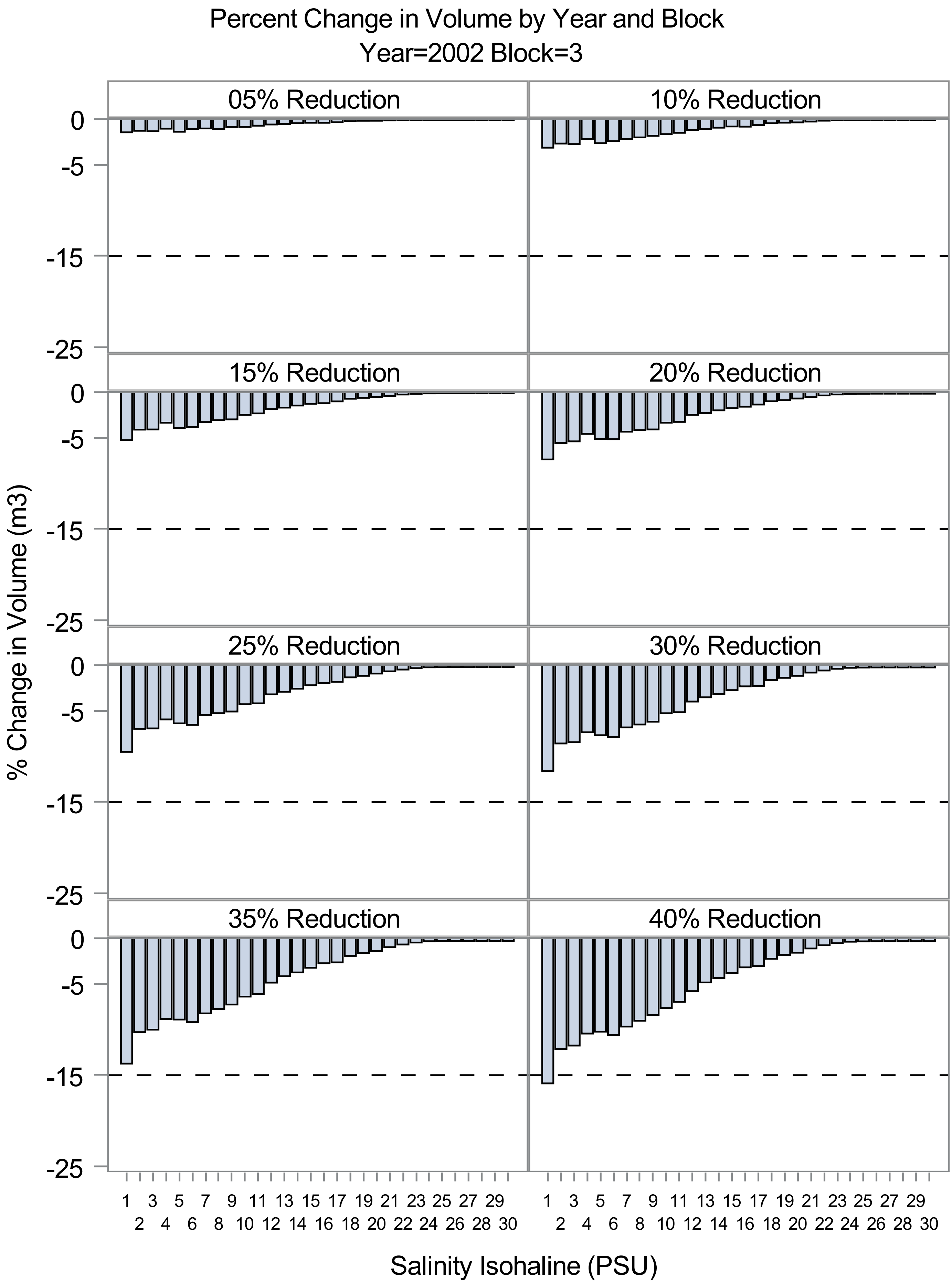
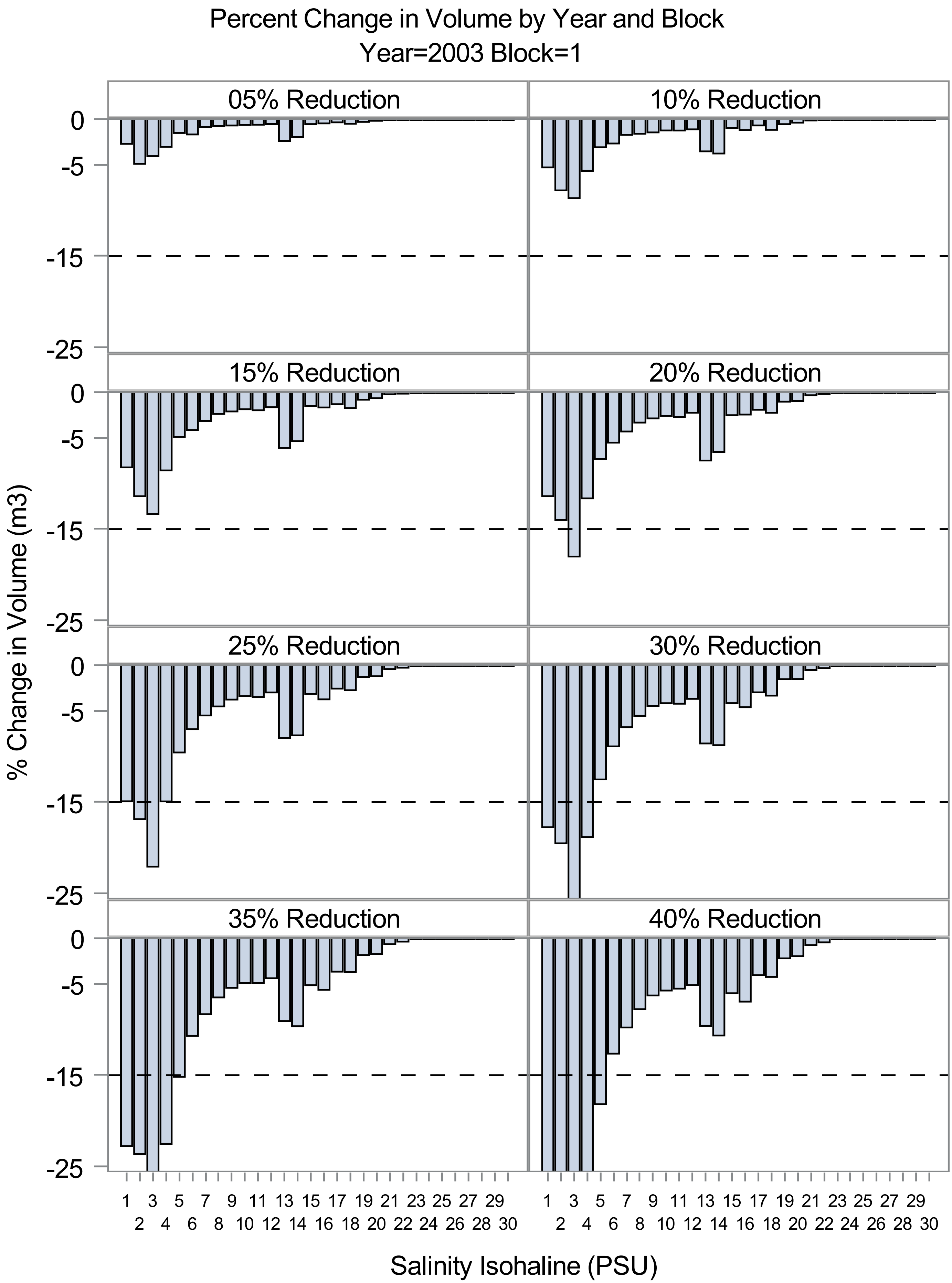
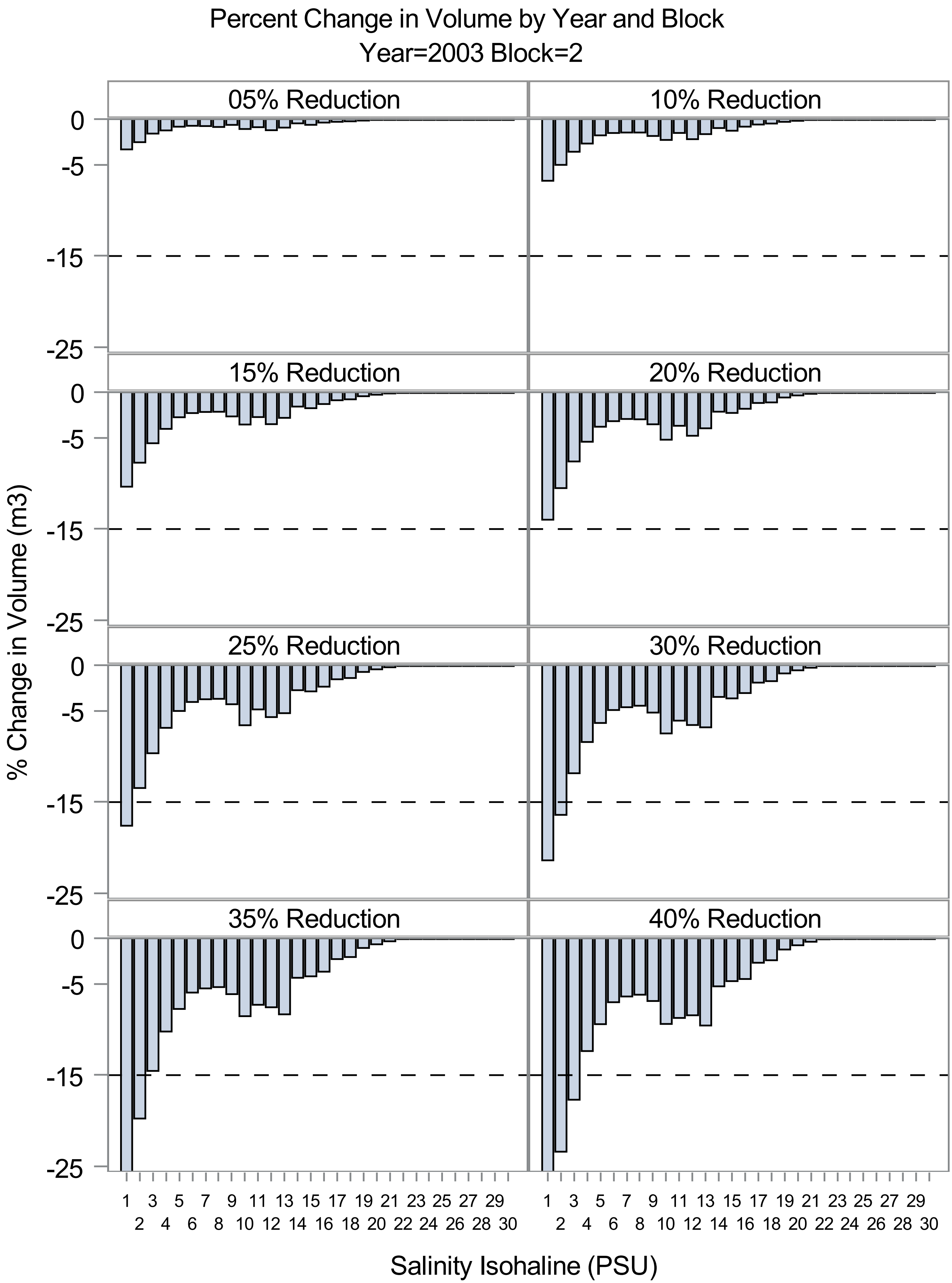
-15
-25
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)

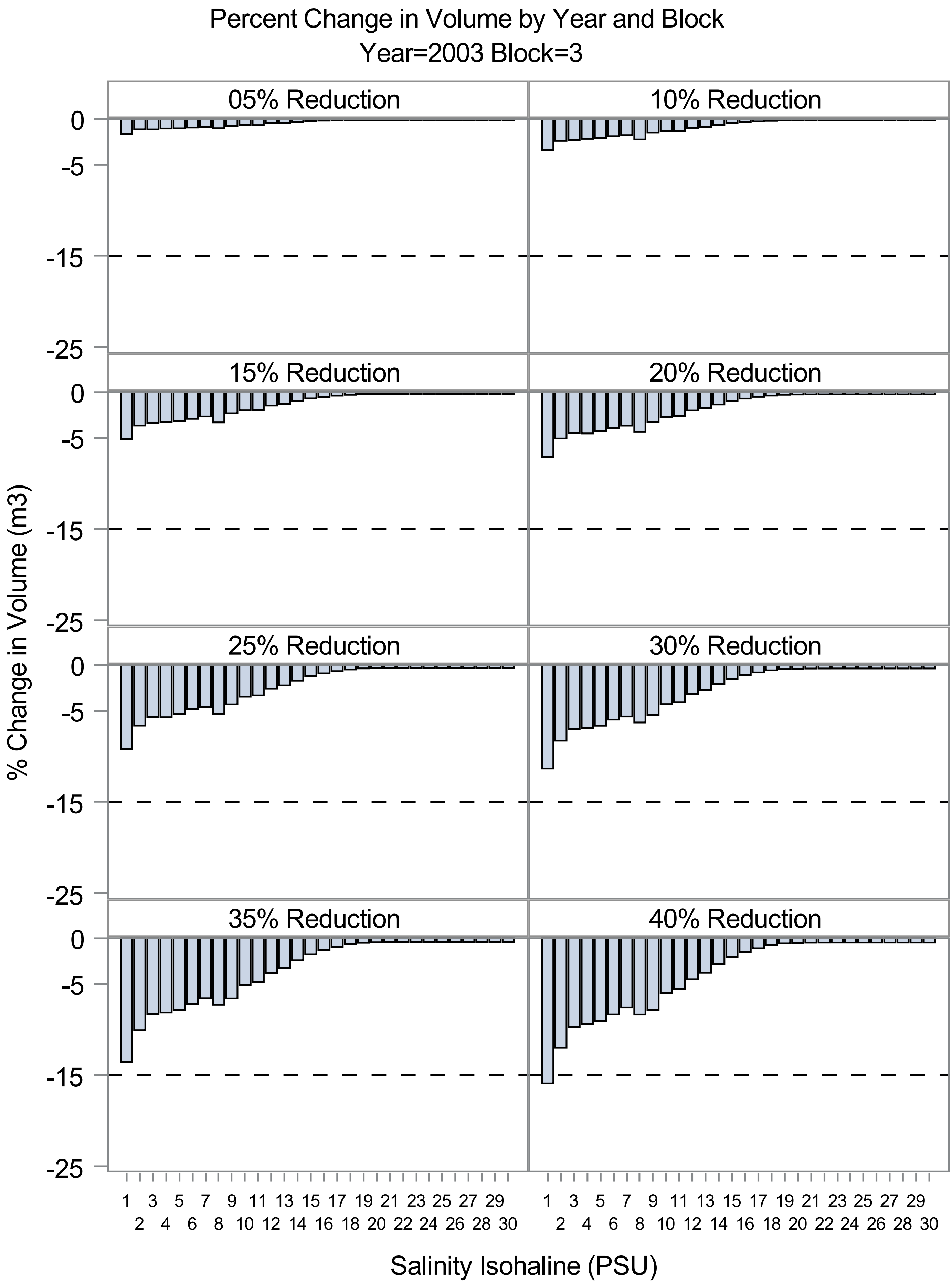


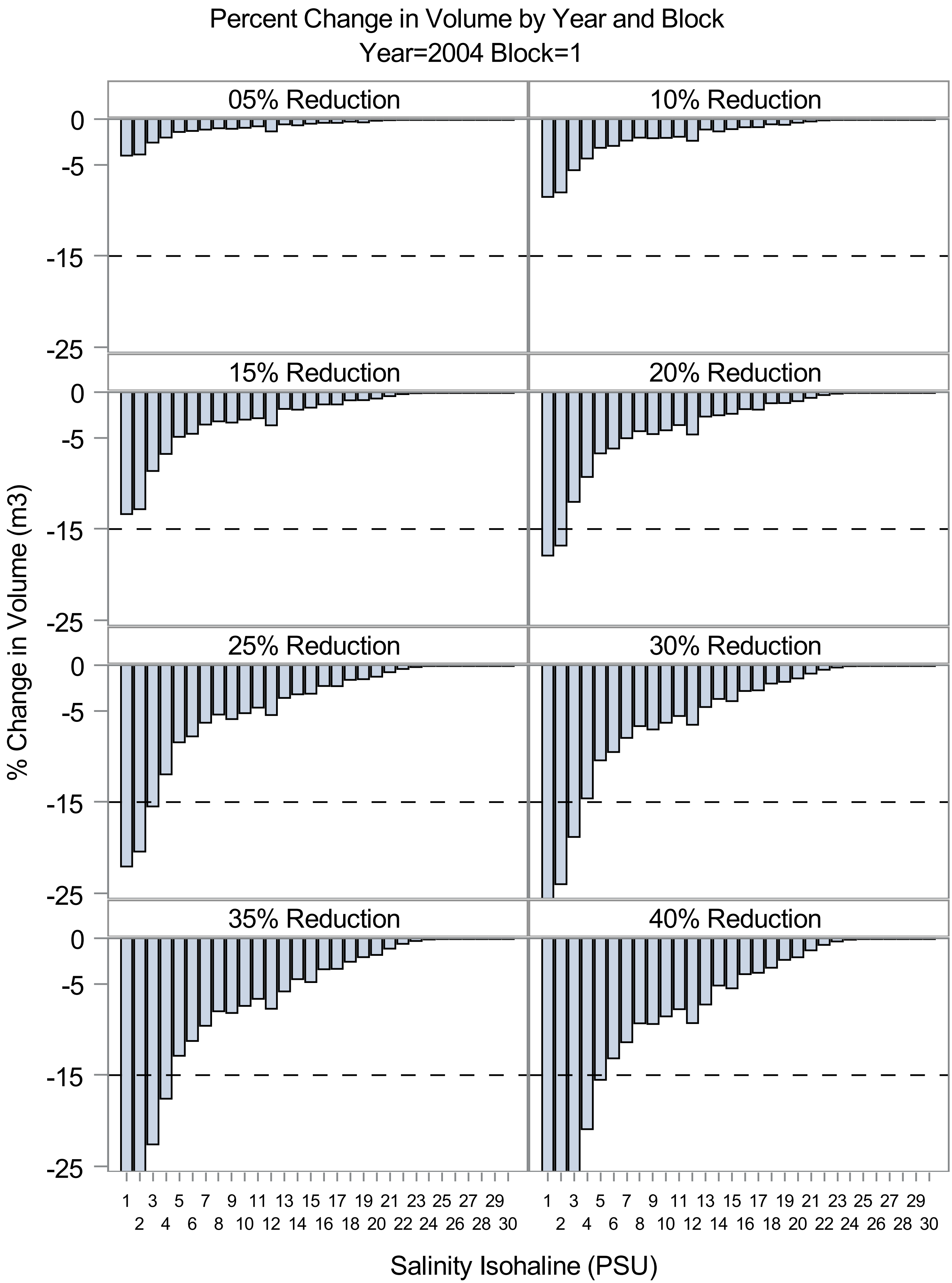
Percent Change in Volume by Year and Block
Year=2002 Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)


Percent Change in Volume by Year and Block
Year=2003 Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

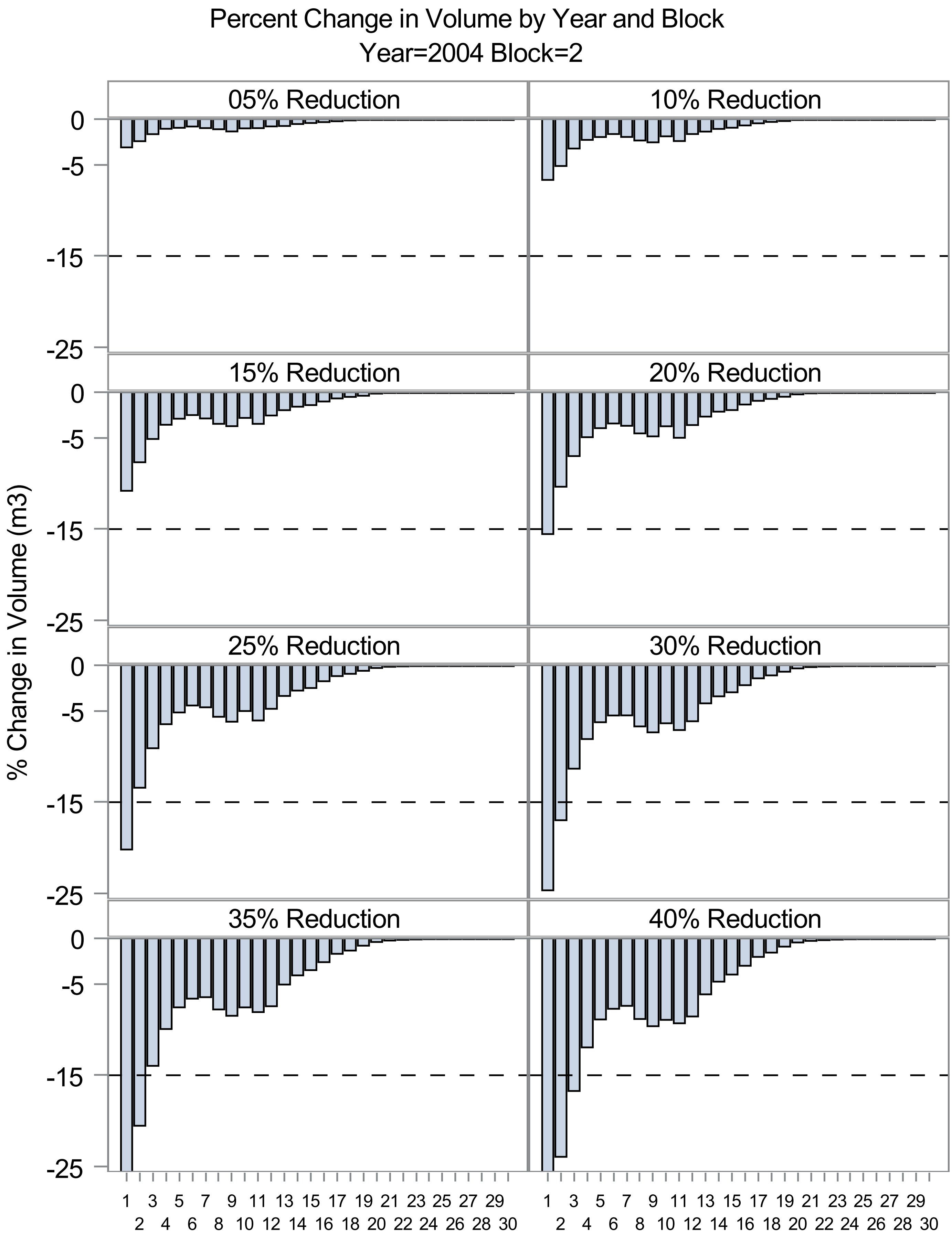


Percent Change in Volume by Year and Block
Year=2003 Block=2
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)

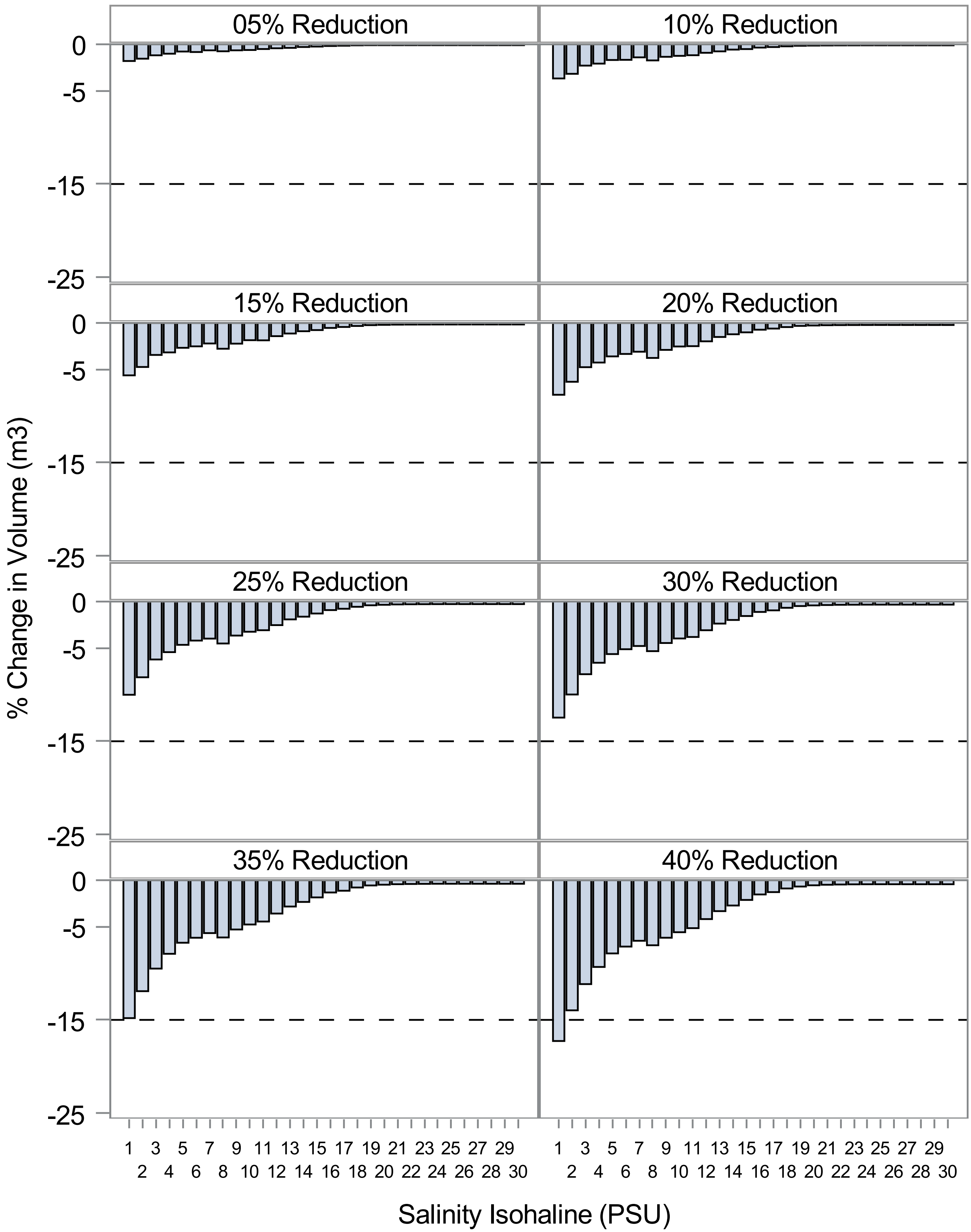

Percent Change in Volume by Year and Block
Year=2003 Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



Percent Change in Volume by Year and Block
Year=2004 Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

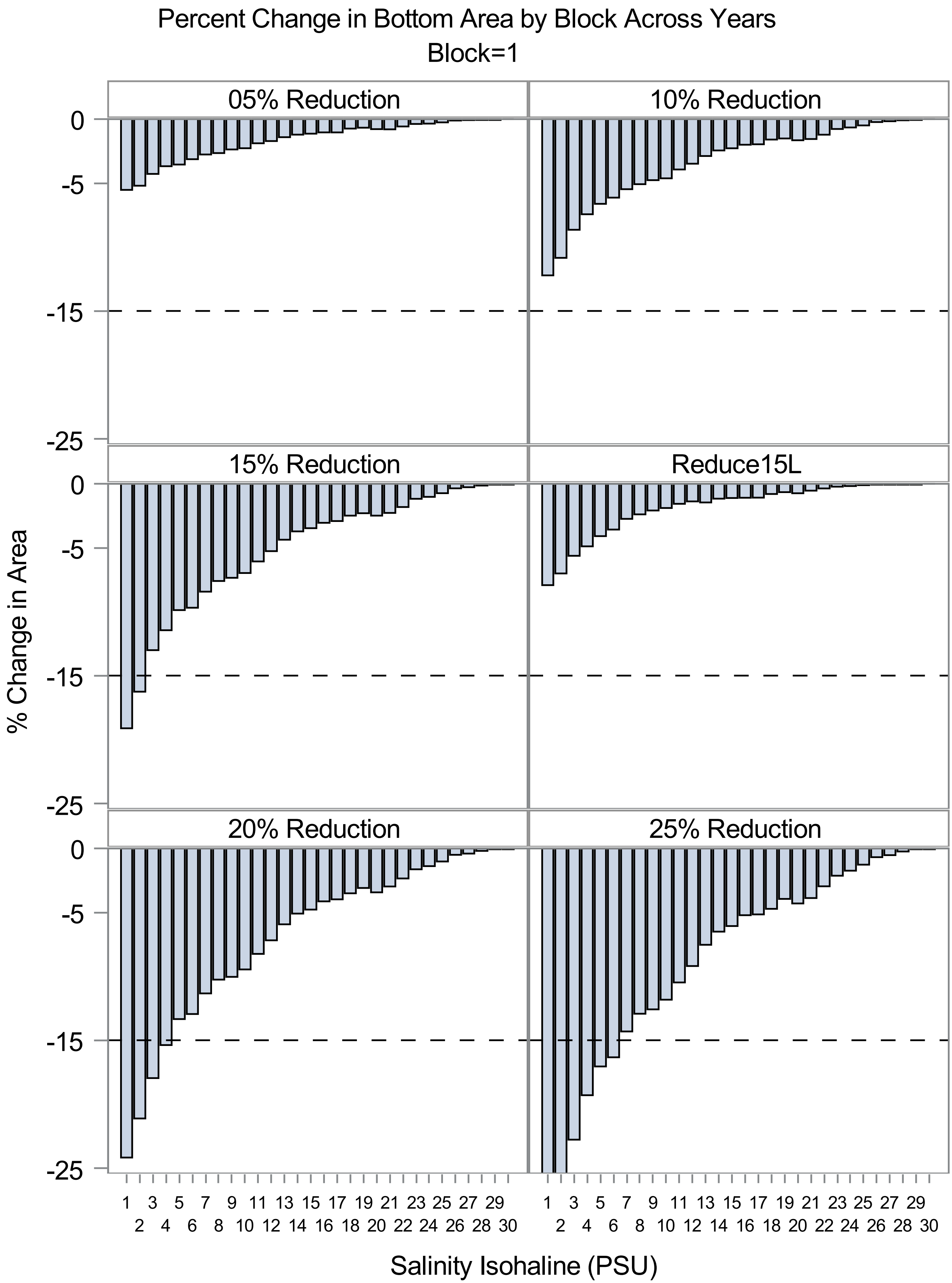

Percent Change in Volume by Year and Block
Year=2004 Block=2
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)

Percent Change in Volume by Year and Block
Year=2004 Block=3

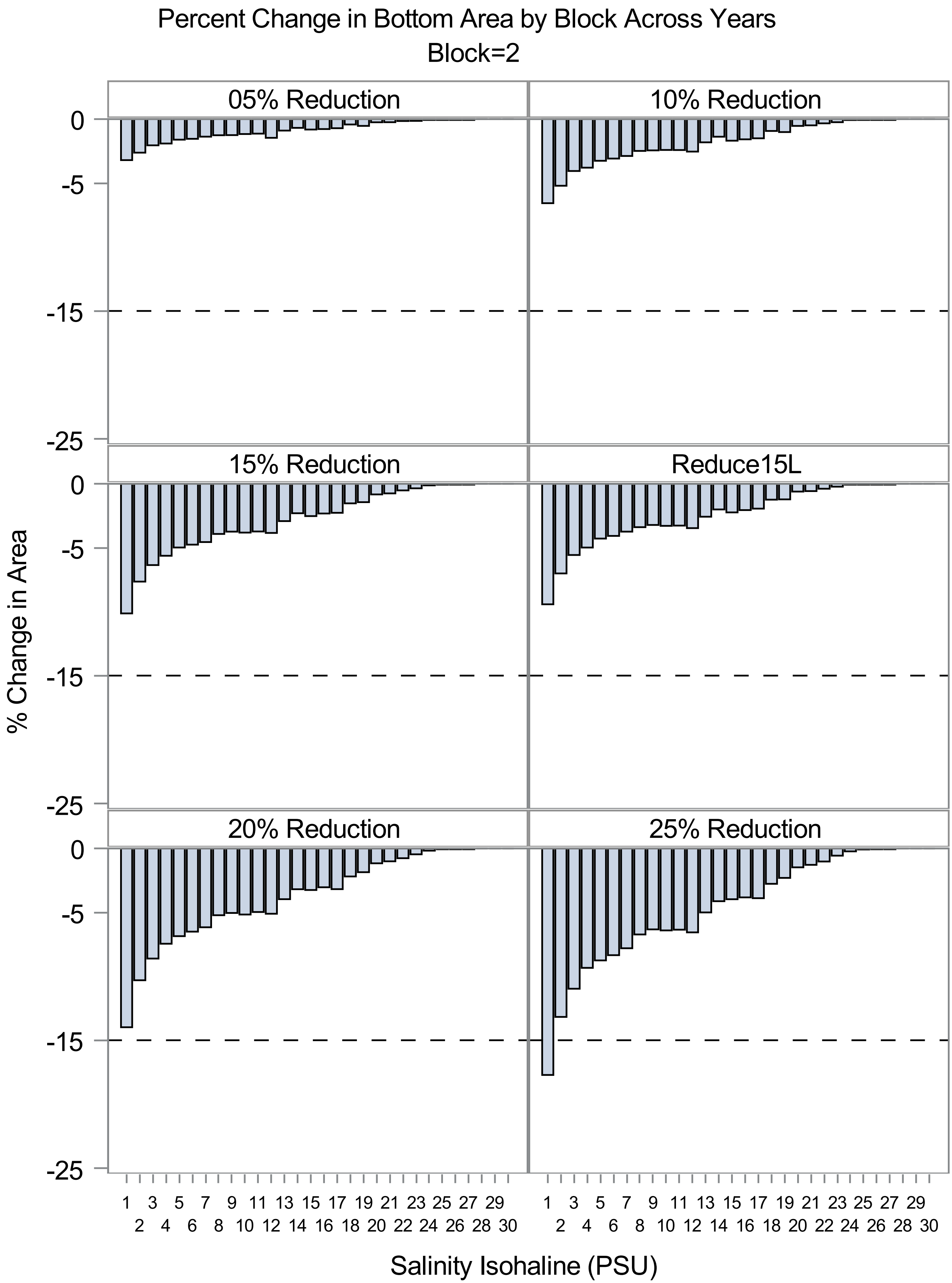


Appendix D

Evaluation of the Effects of the 15% Reduction with a Low Flow Threshold (LFT) on Salinity Isohaline Bottom Area and Volume by Block, Year, and Year/Block Combinations

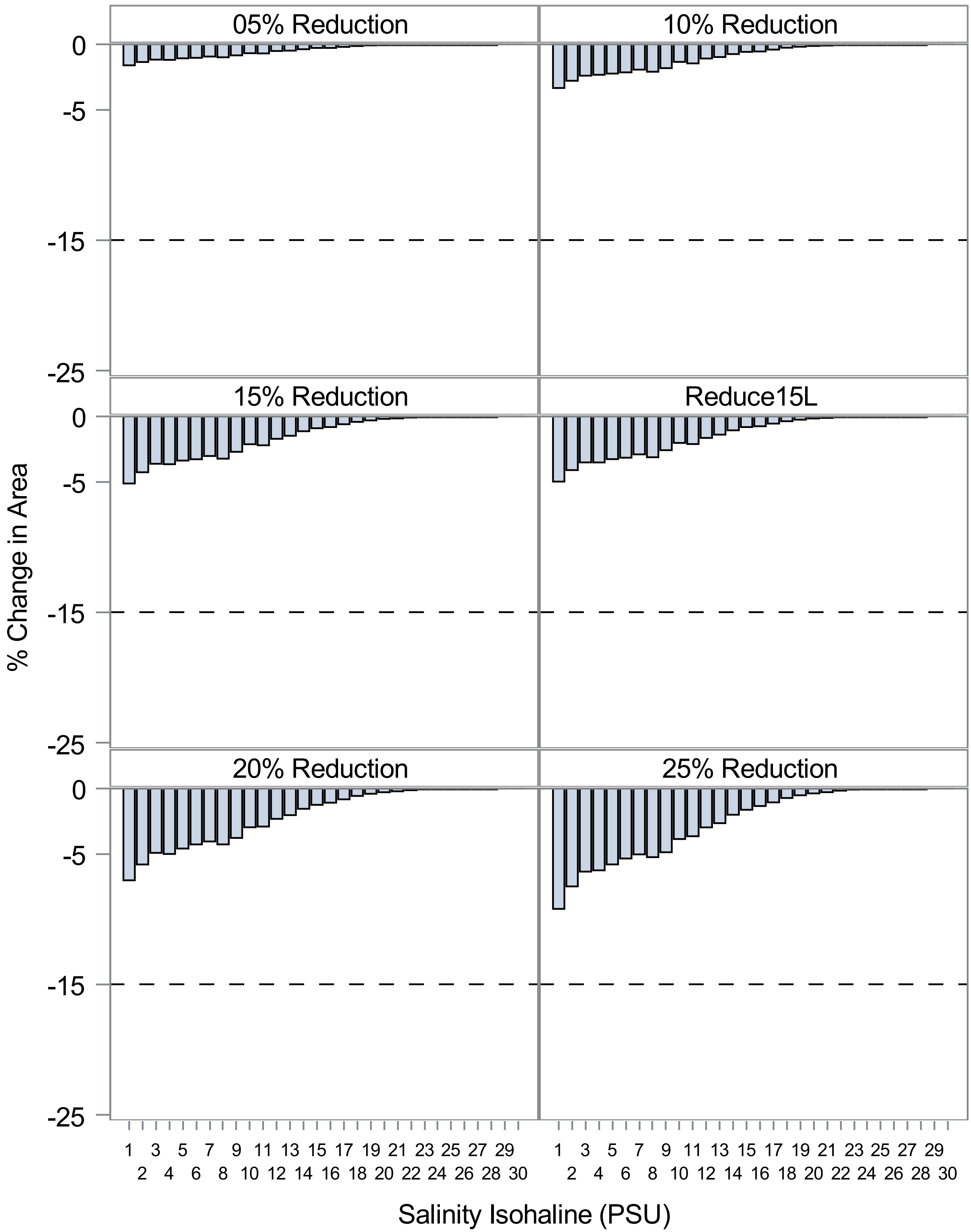


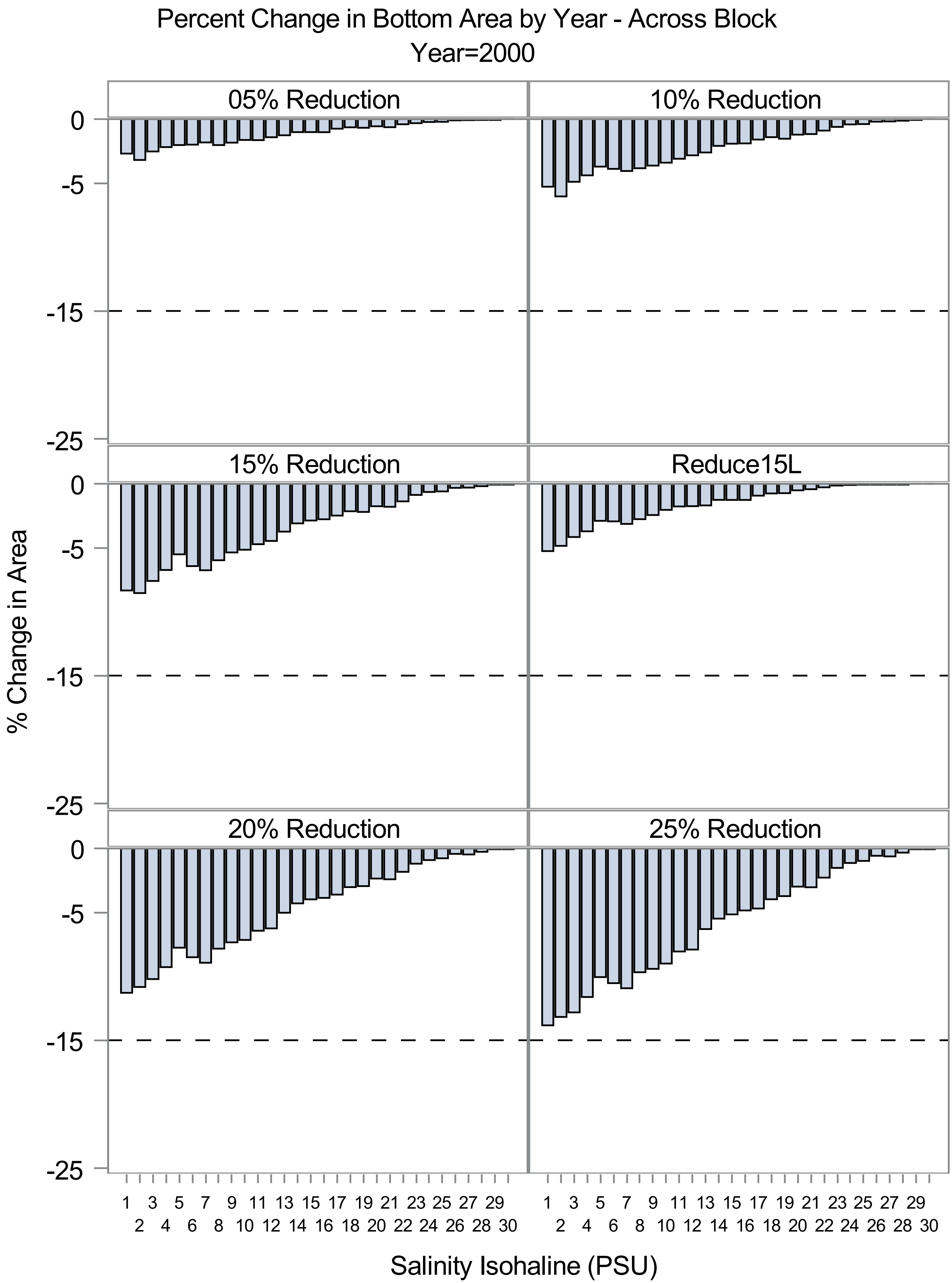
Percent Change in Bottom Area by Block Across Years
Block=1
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
% Change in Area
0
-5
-15
-25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



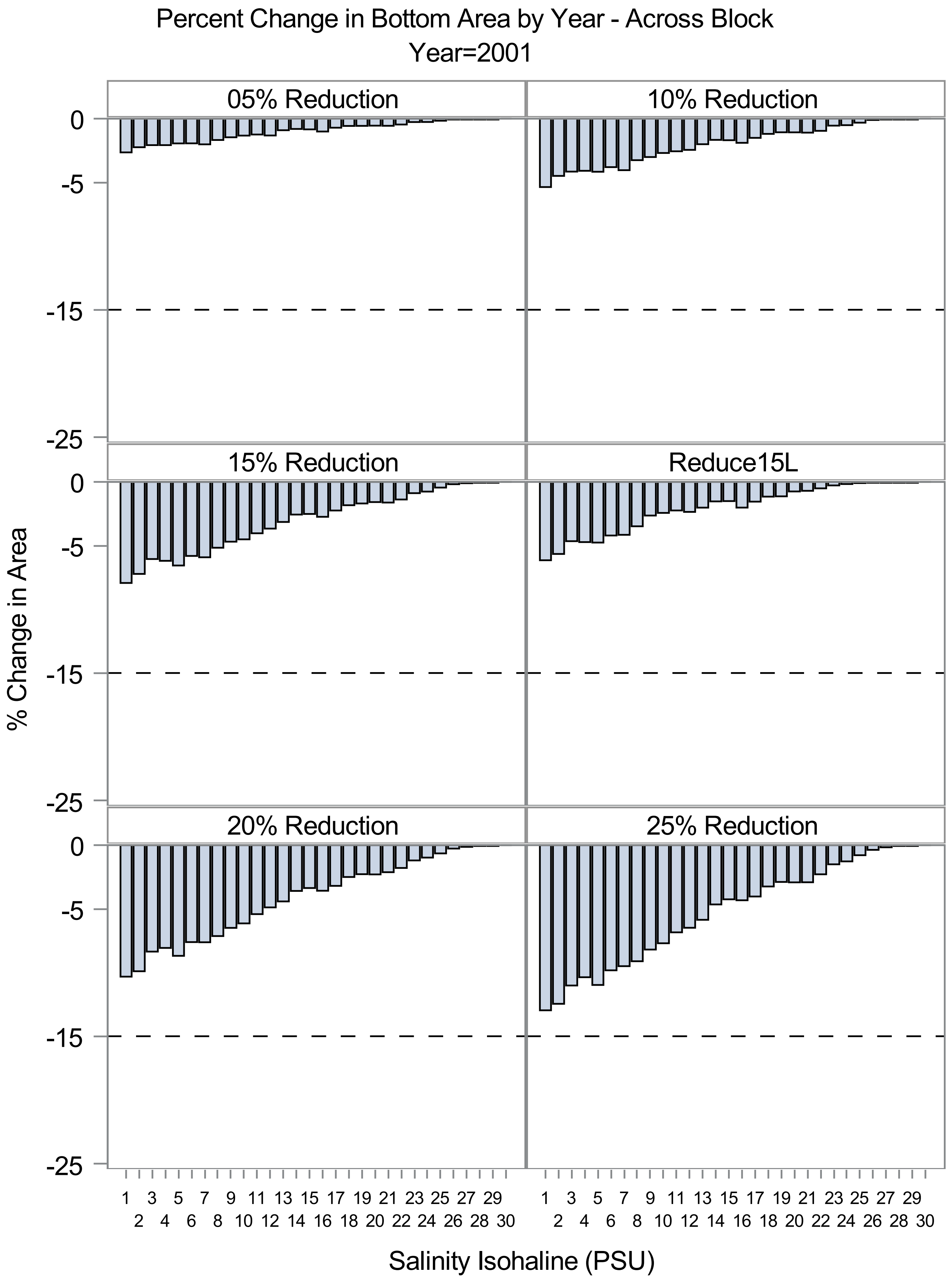
Percent Change in Bottom Area by Block Across Years
Block=2
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)

Percent Change in Bottom Area by Block Across Years
Block=3

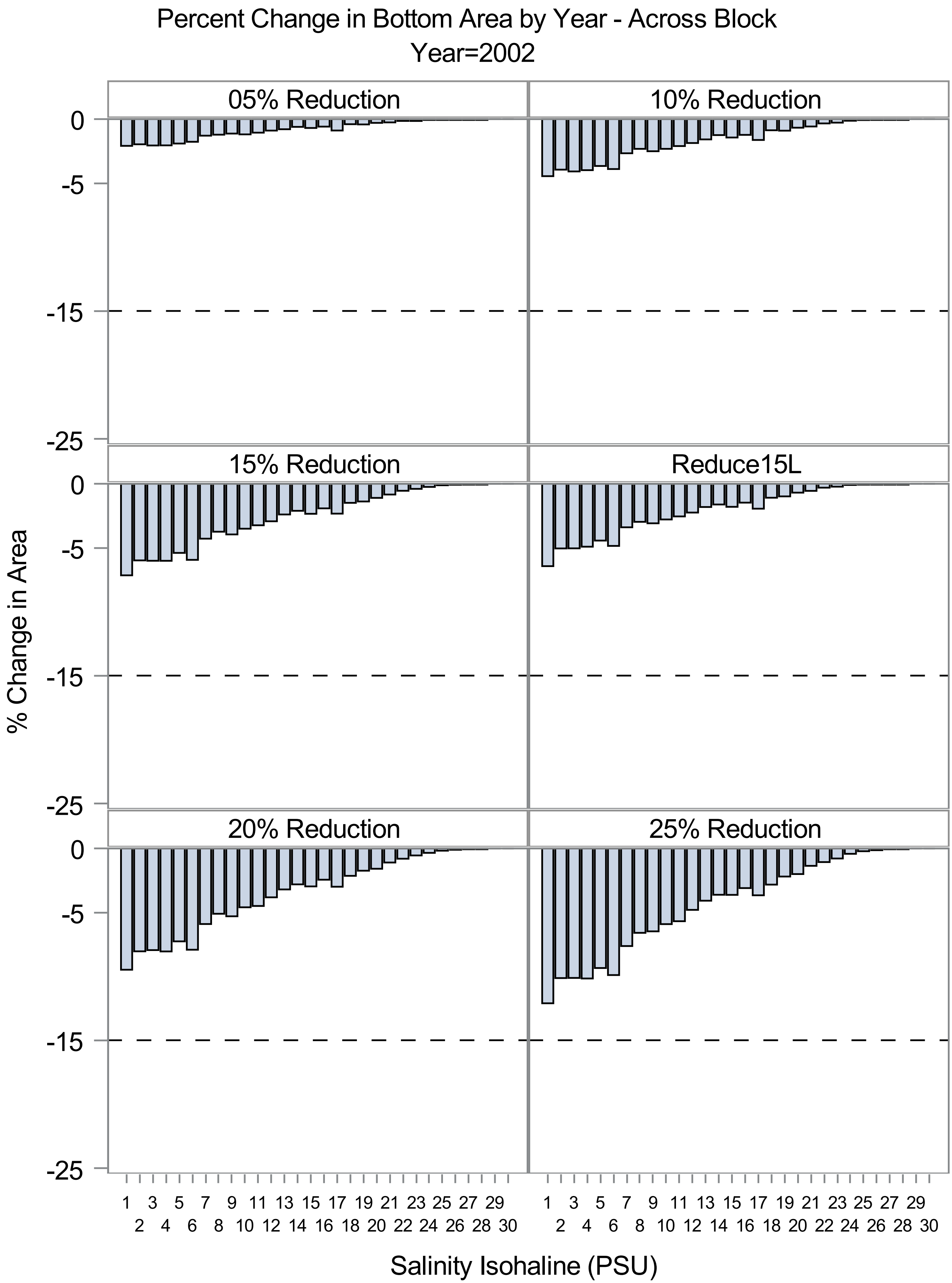




Percent Change in Bottom Area by Year - Across Block
Year=2000
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

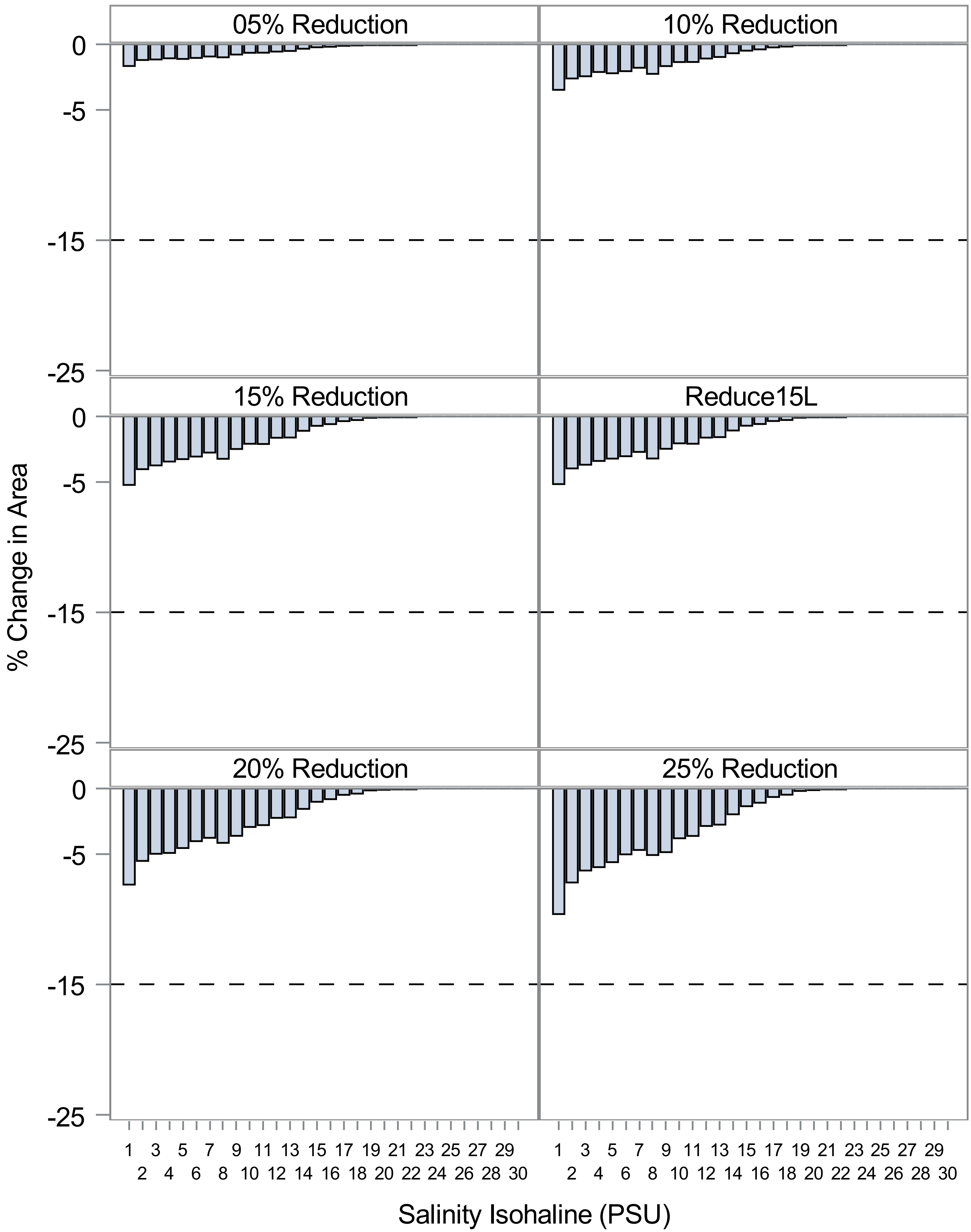


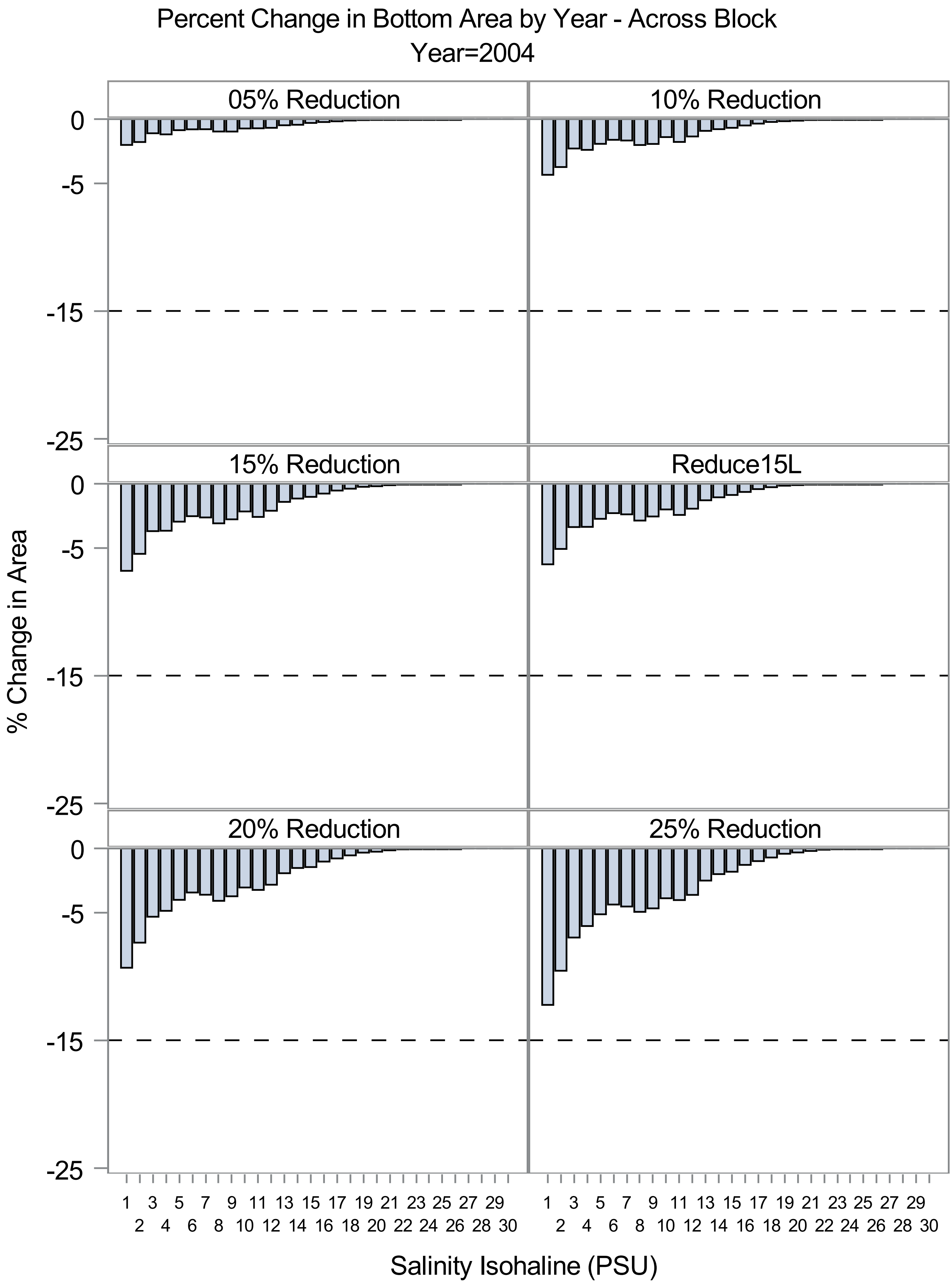
Percent Change in Bottom Area by Year - Across Block
Year=2001
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)



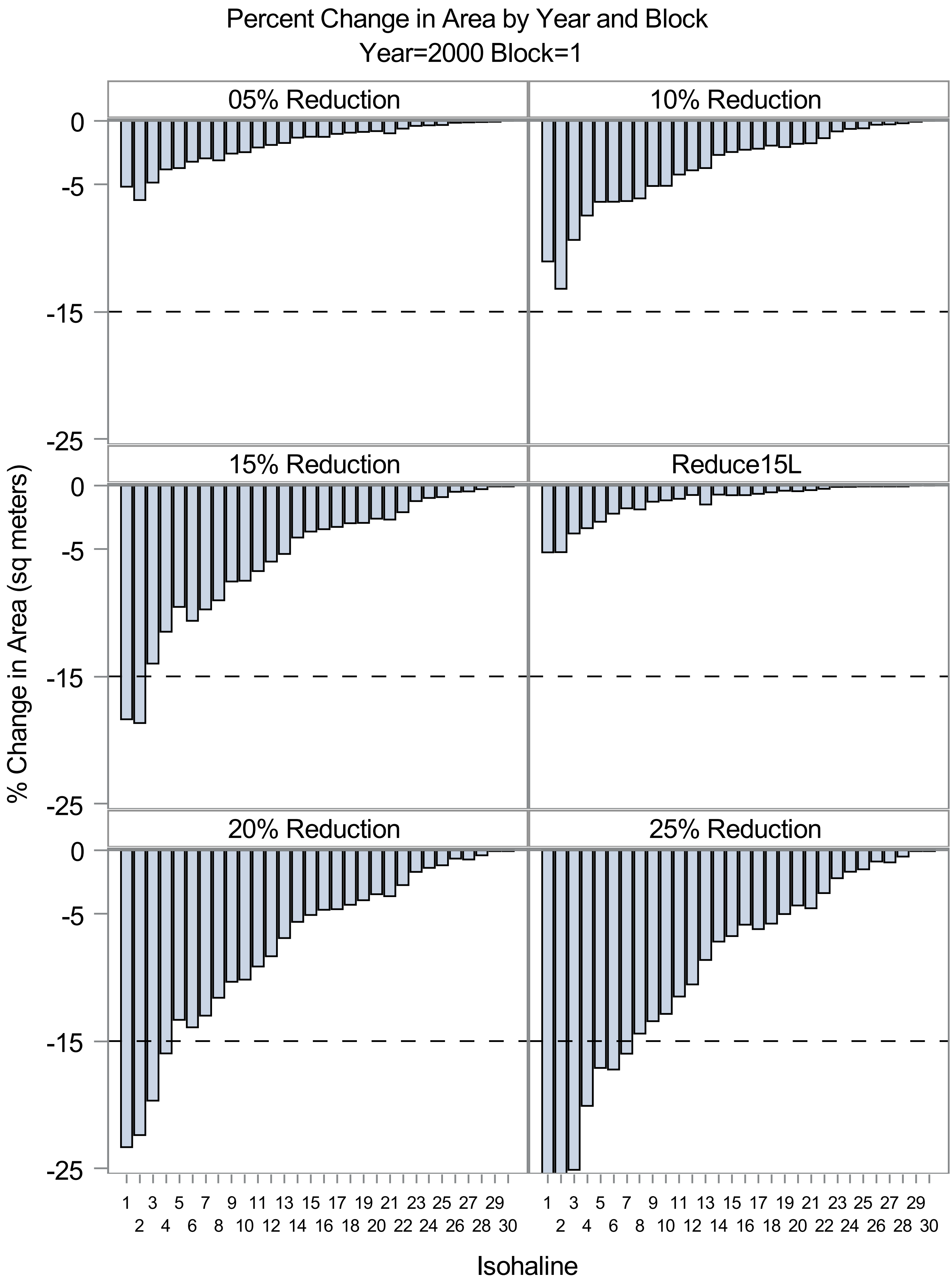
Percent Change in Bottom Area by Year - Across Block
Year=2002
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

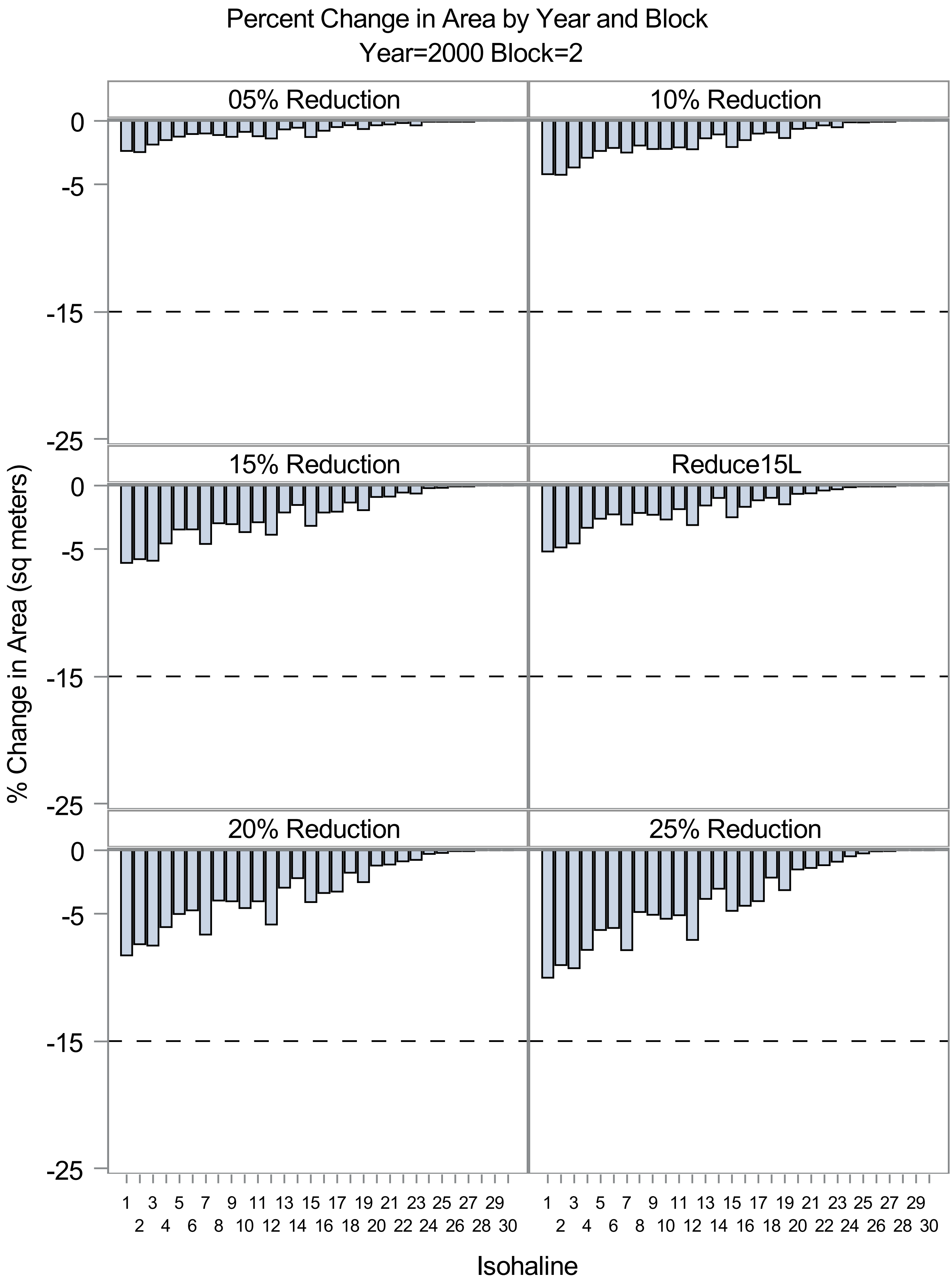
Percent Change in Bottom Area by Year - Across Block
Year=2003



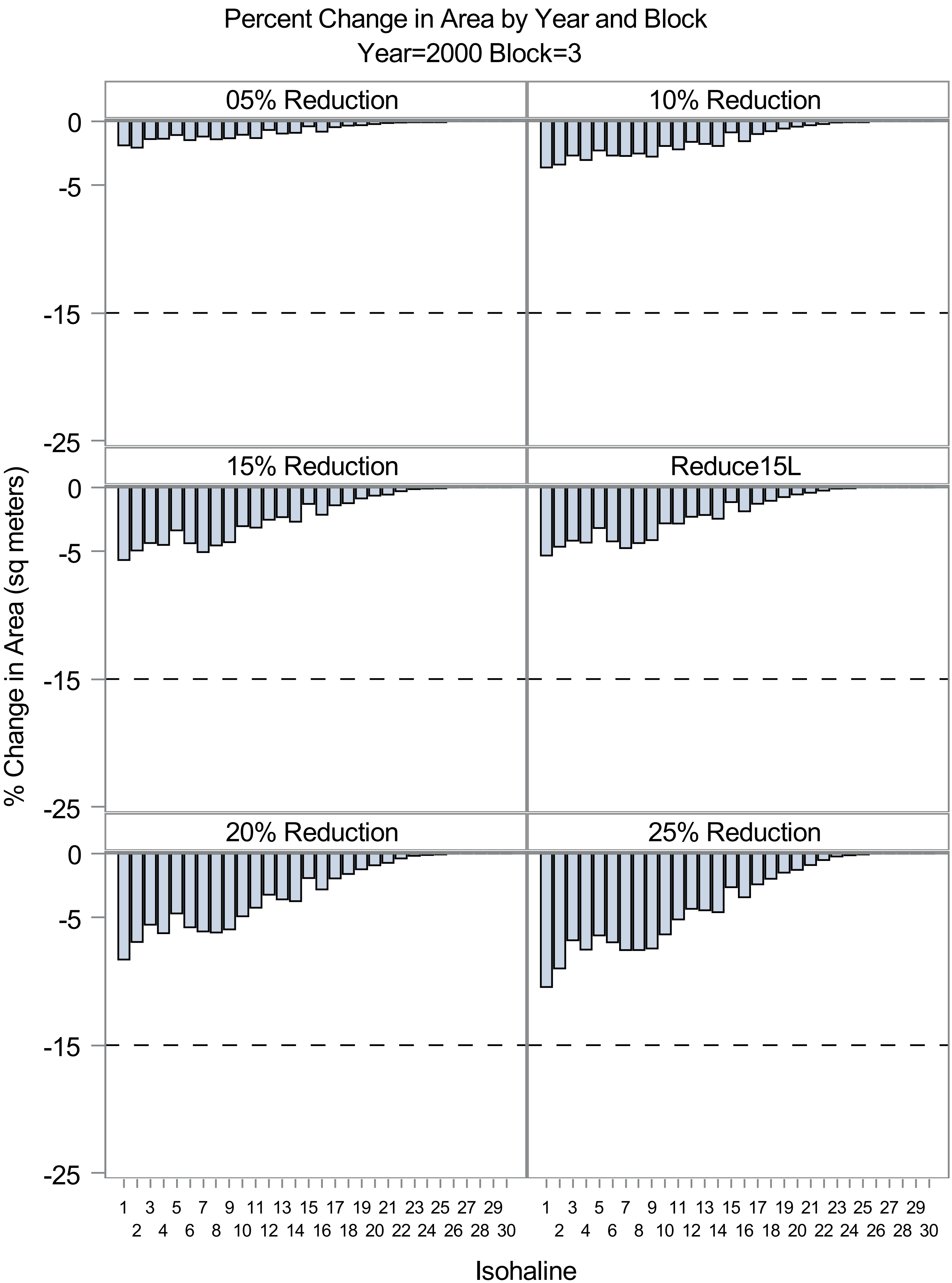


Percent Change in Bottom Area by Year - Across Block
Year=2004
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

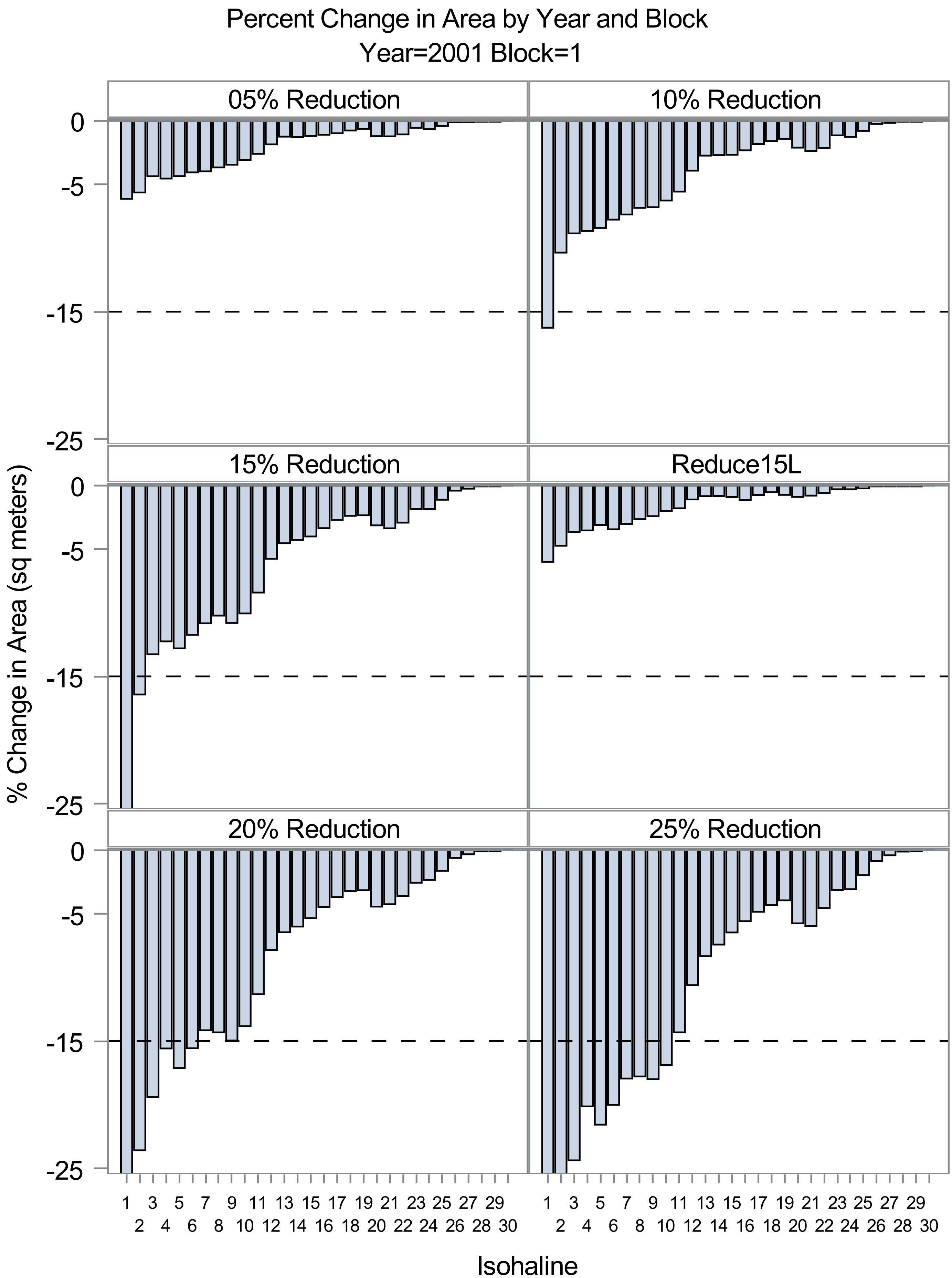

Percent Change in Area by Year and Block
Year=2000 Block=1
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area (sq meters)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Isohaline



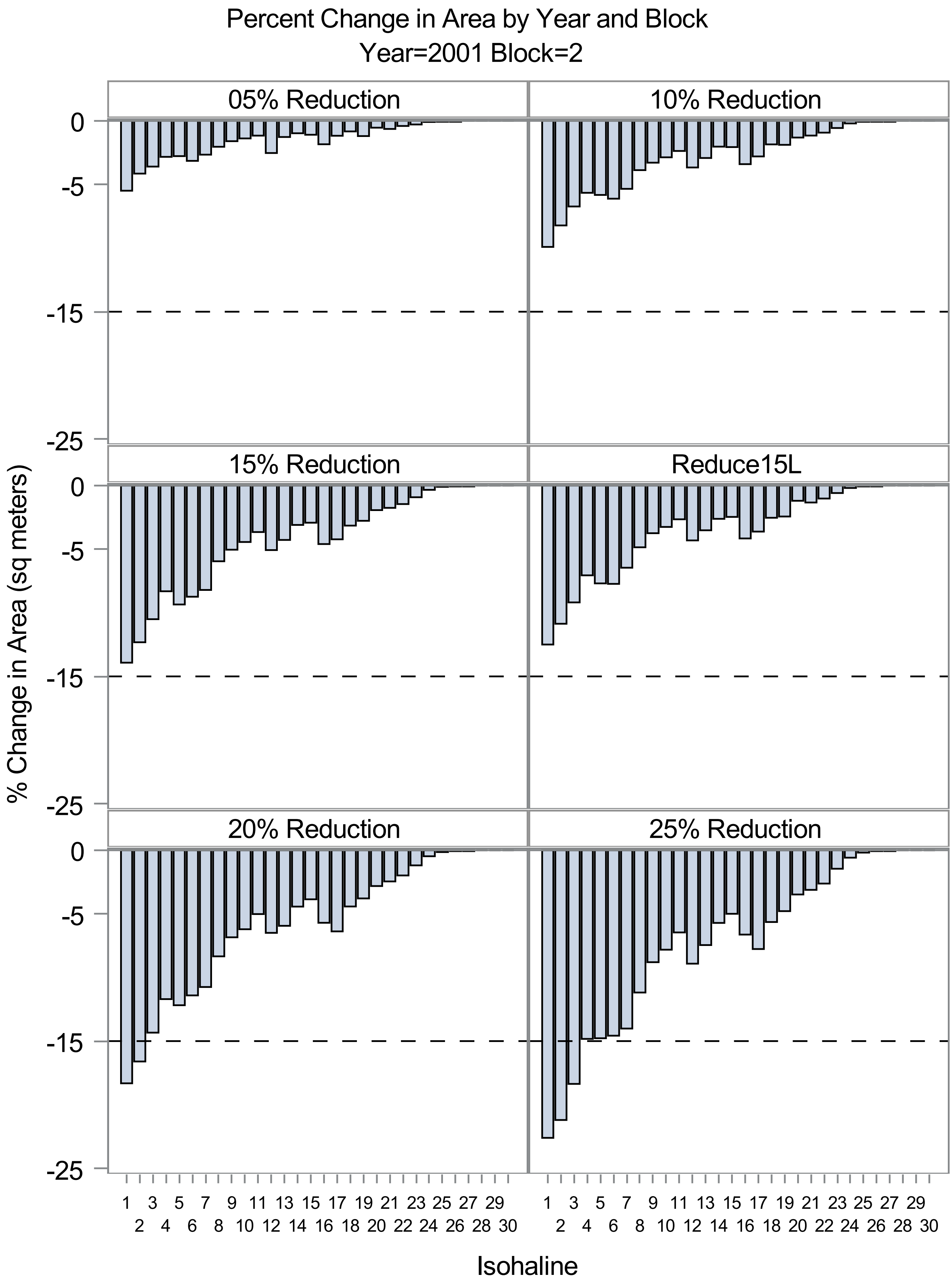
Percent Change in Area by Year and Block
Year=2000 Block=2
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
% Change in Area (sq meters)
0
-5
-15
-25
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Isohaline



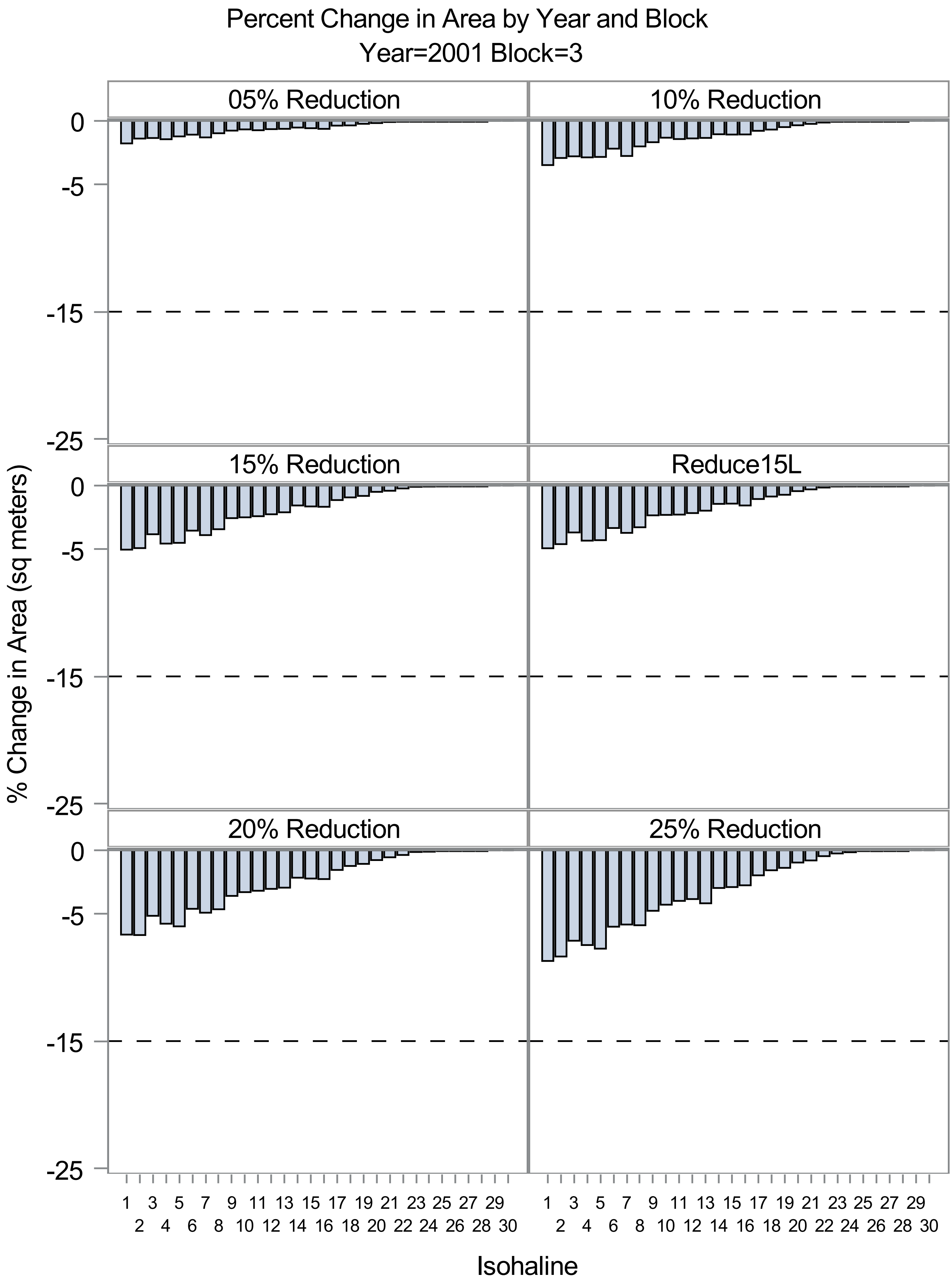
Percent Change in Area by Year and Block
Year=2000 Block=3
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline

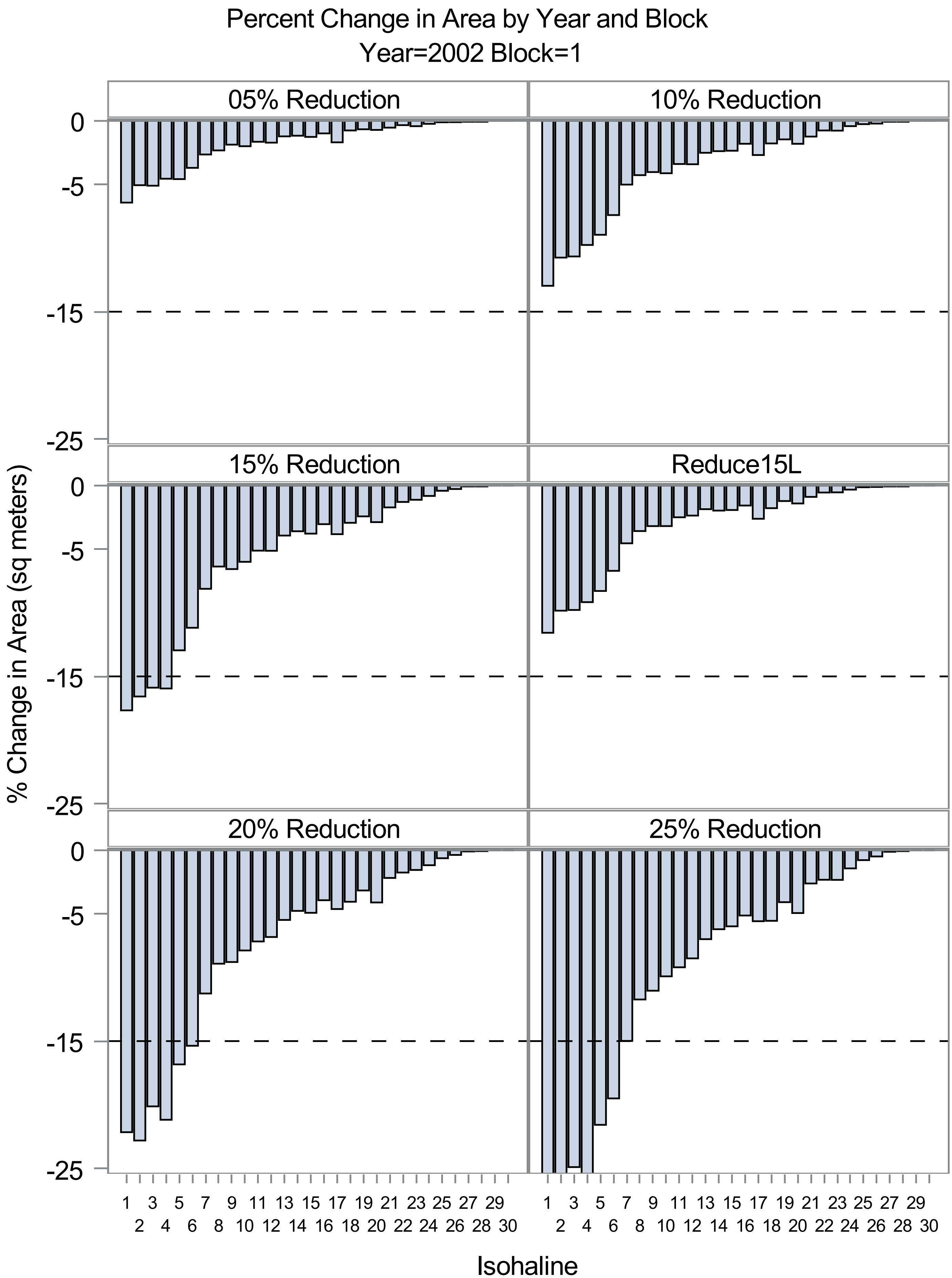


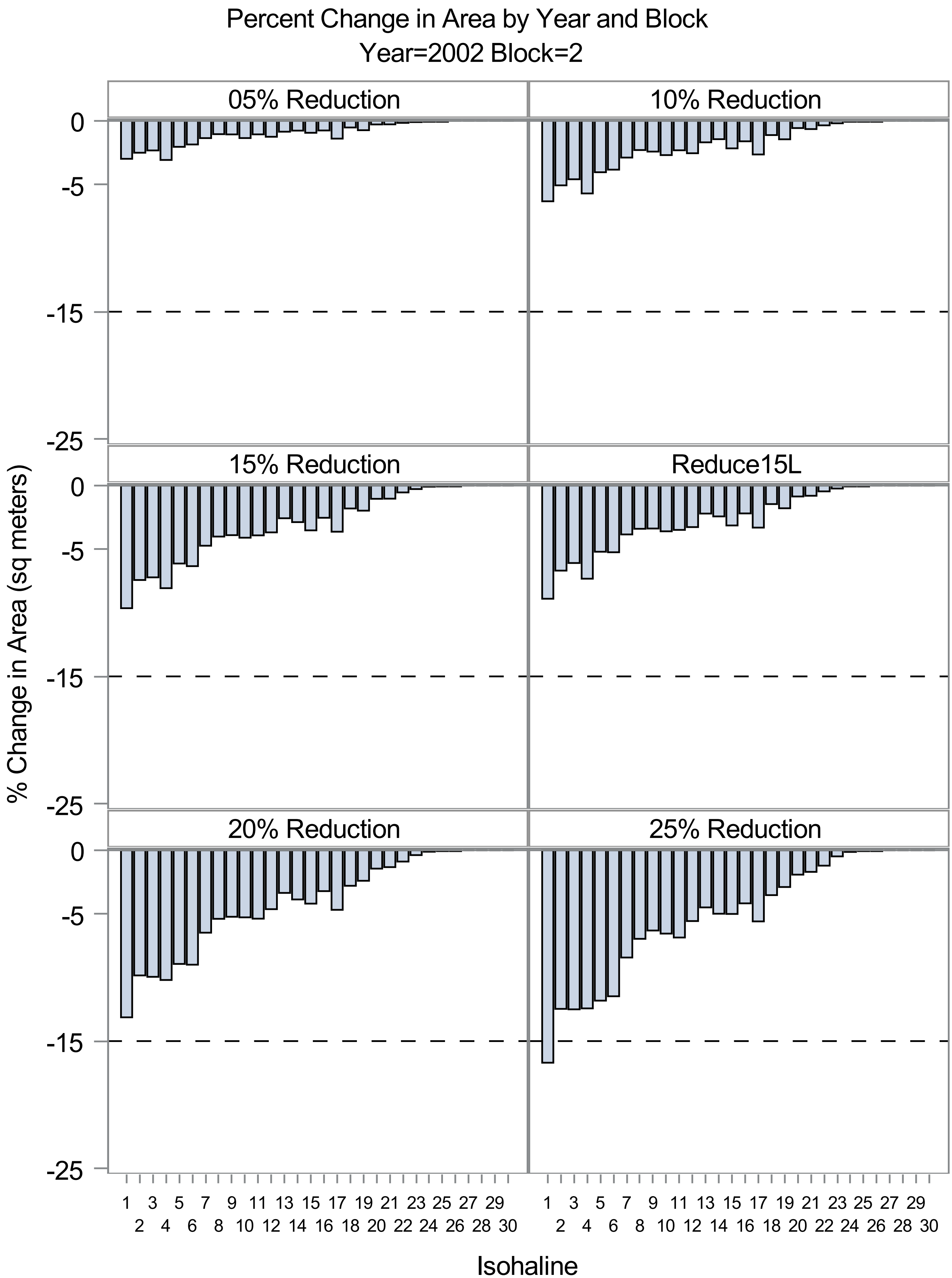
Percent Change in Area by Year and Block
Year=2001 Block=1
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area (sq meters)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Isohaline



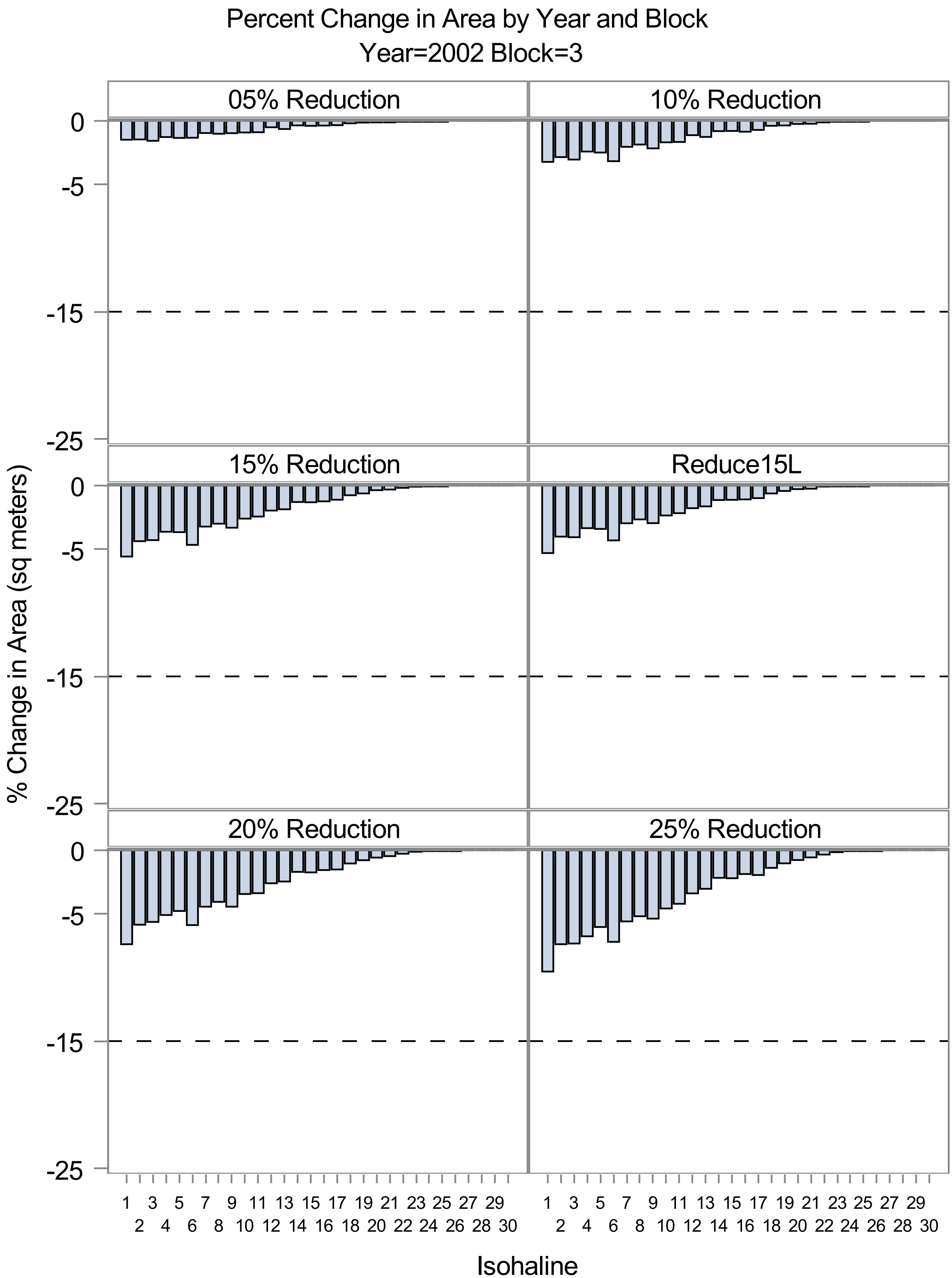
Percent Change in Area by Year and Block
Year=2001 Block=2
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area (sq meters)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Isohaline


Percent Change in Area by Year and Block
Year=2001 Block=3
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area (sq meters)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Isohaline

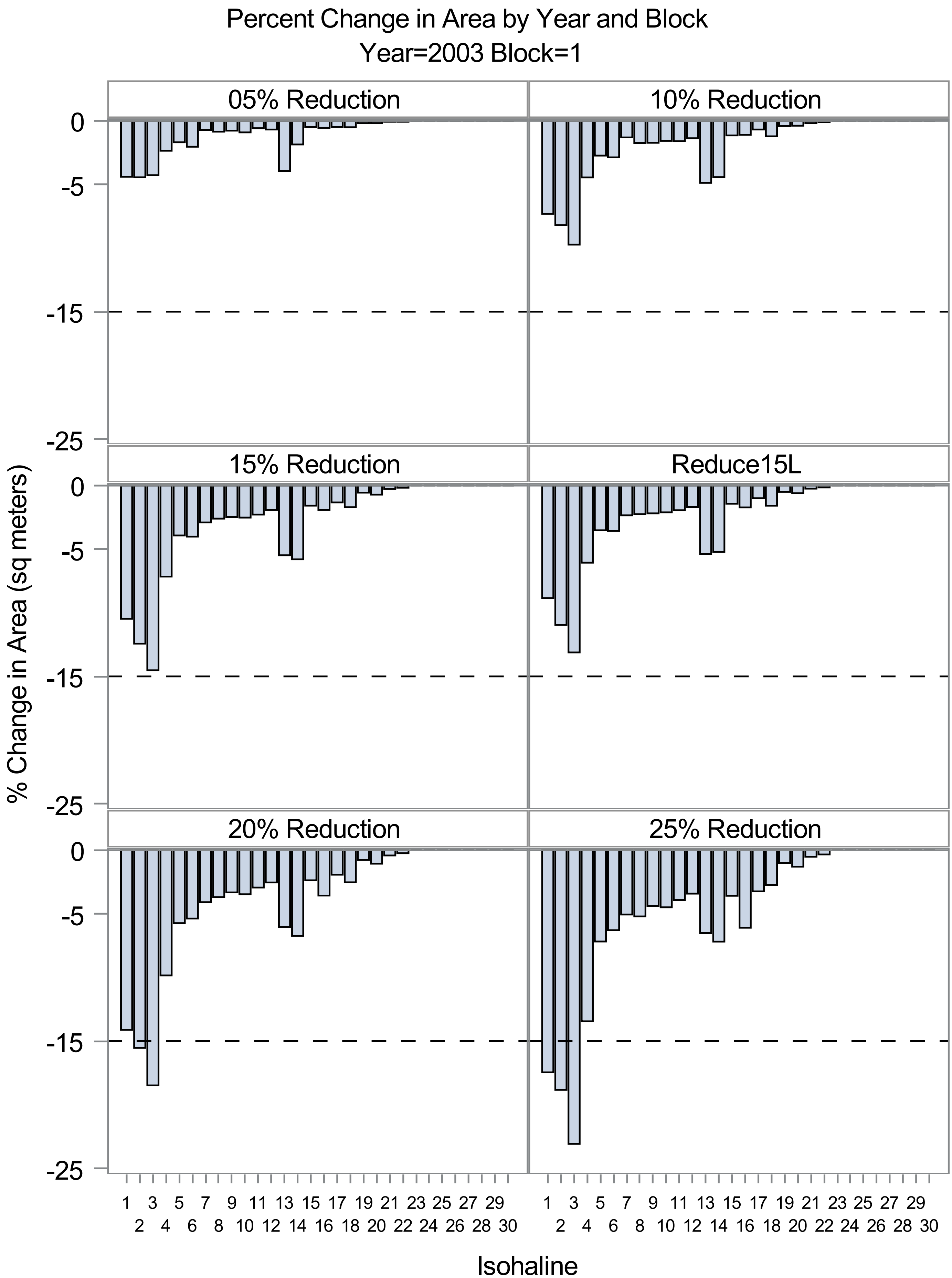

Percent Change in Area by Year and Block
Year=2002 Block=1
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
% Change in Area (sq meters)
0
-5
-15
-25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline



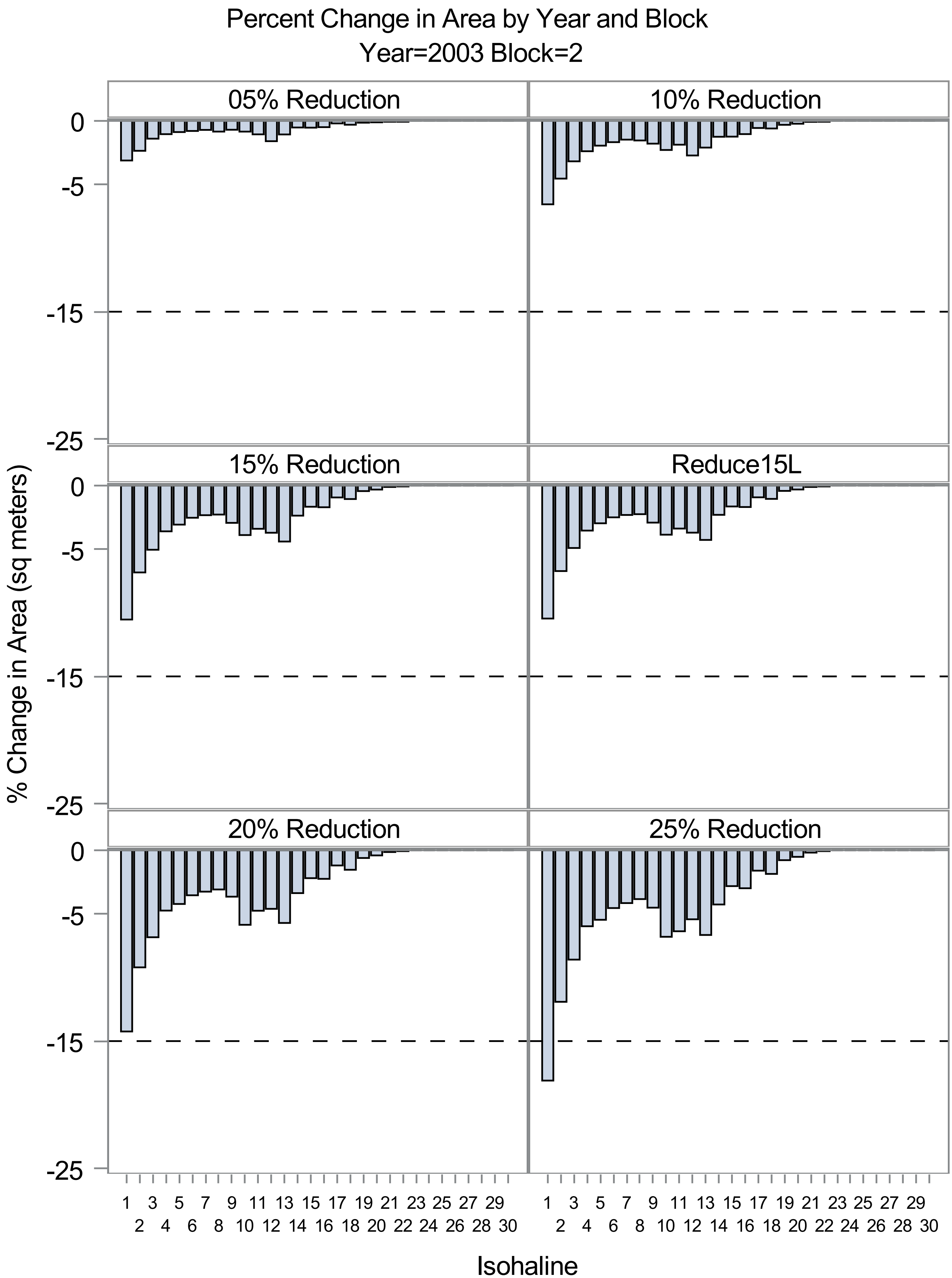
Percent Change in Area by Year and Block
Year=2002 Block=2
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area (sq meters)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Isohaline

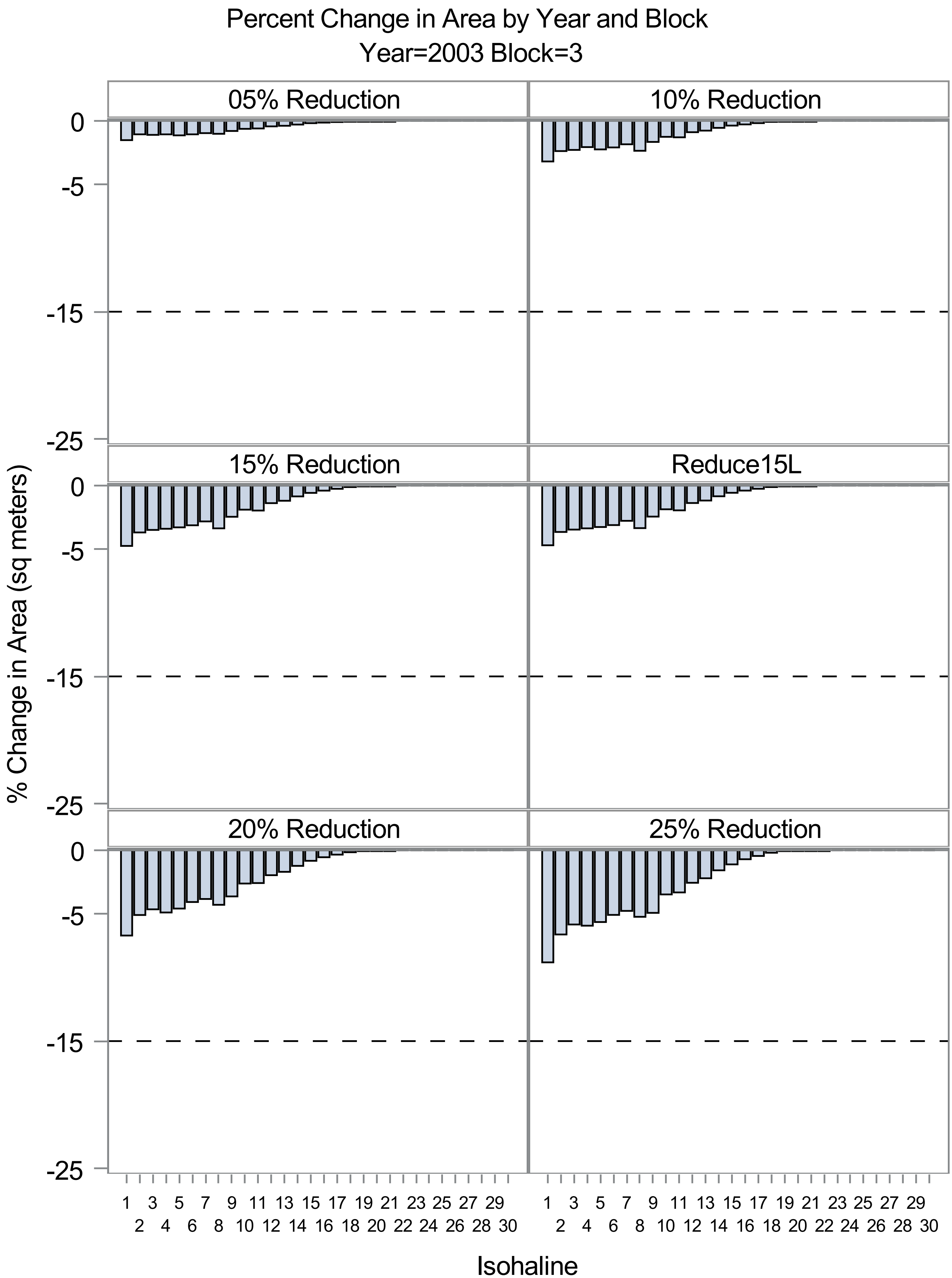


Percent Change in Area by Year and Block
Year=2002 Block=3
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area (sq meters)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Isohaline

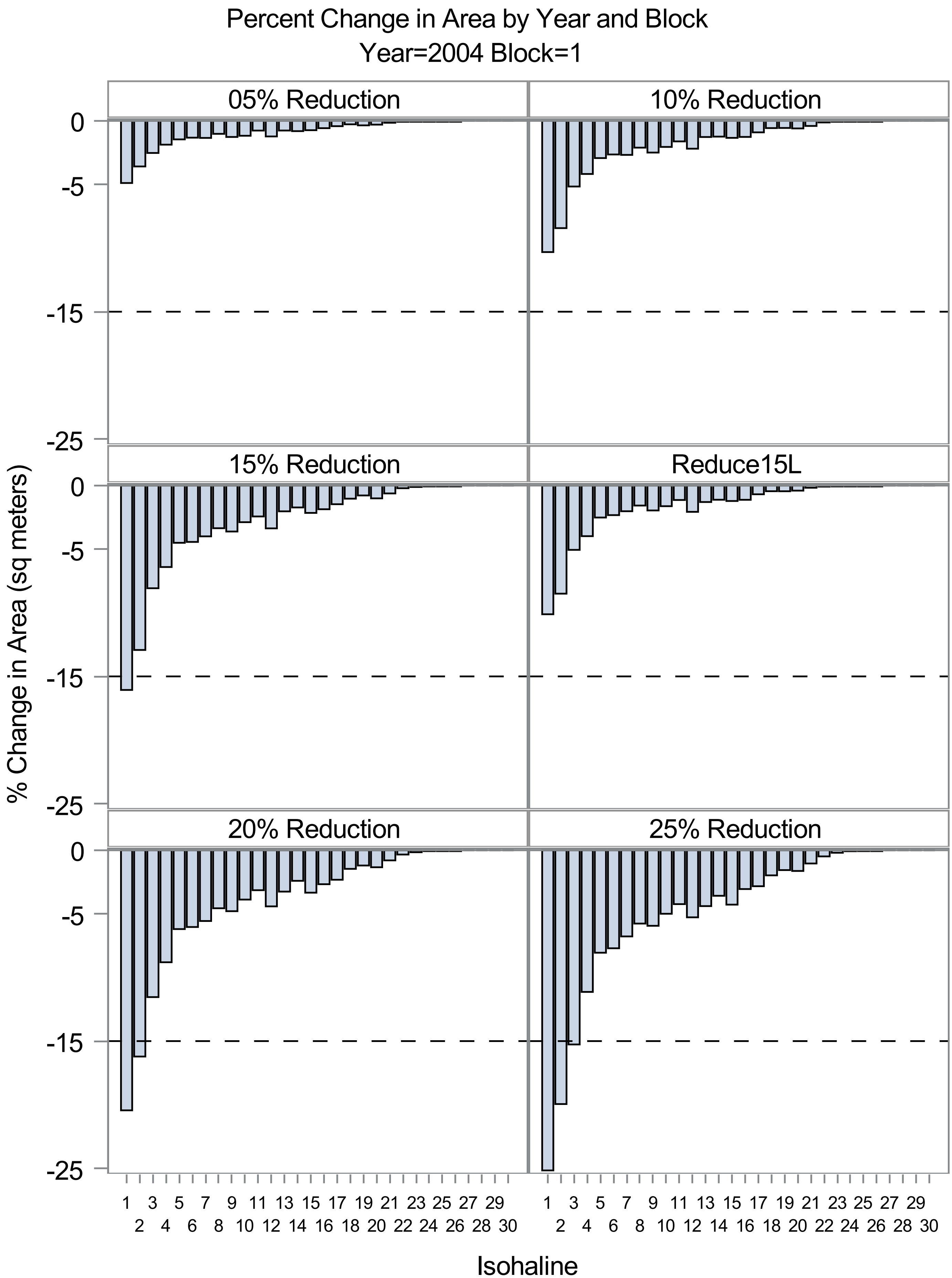


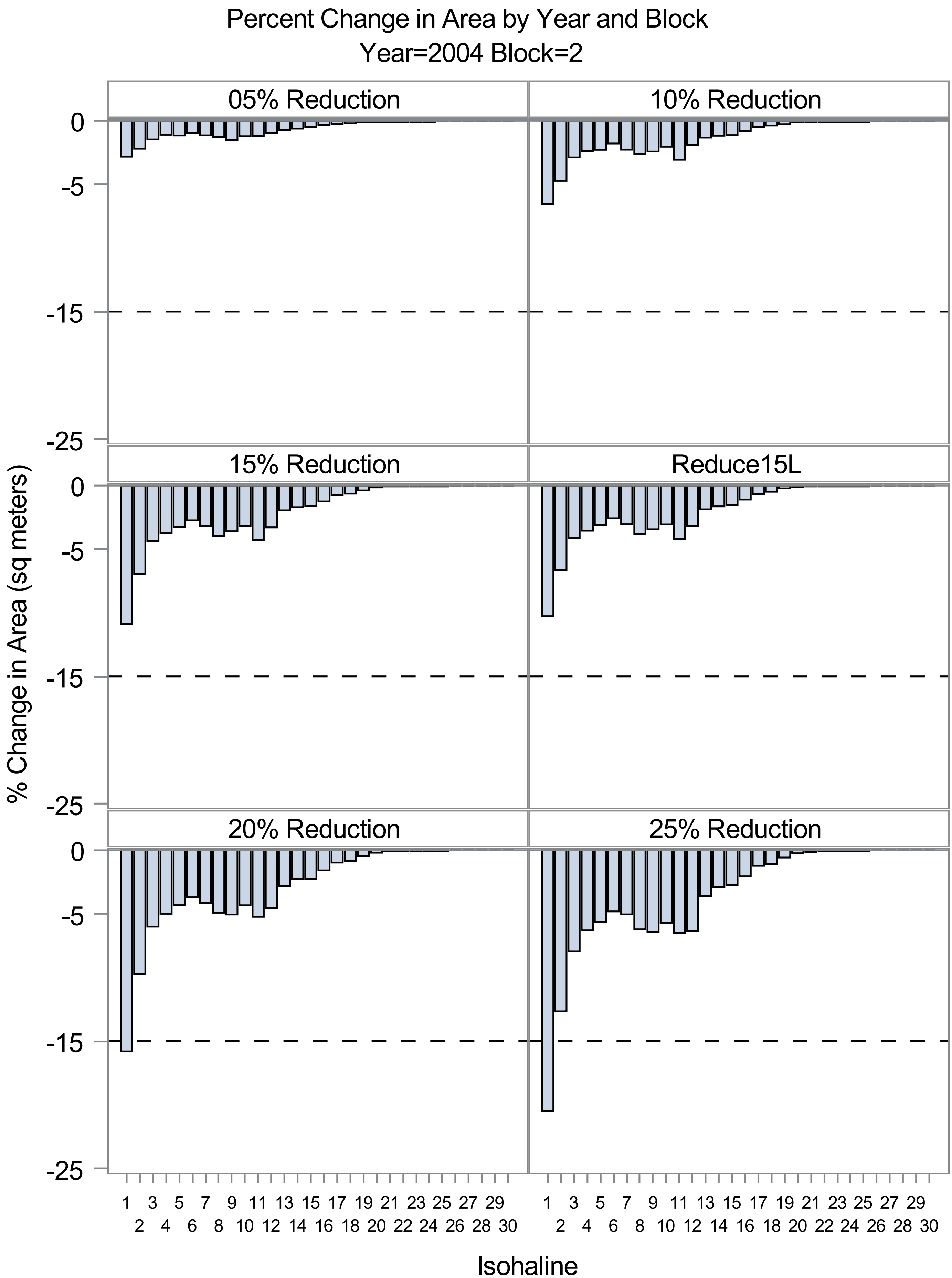
Percent Change in Area by Year and Block
Year=2003 Block=1
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline

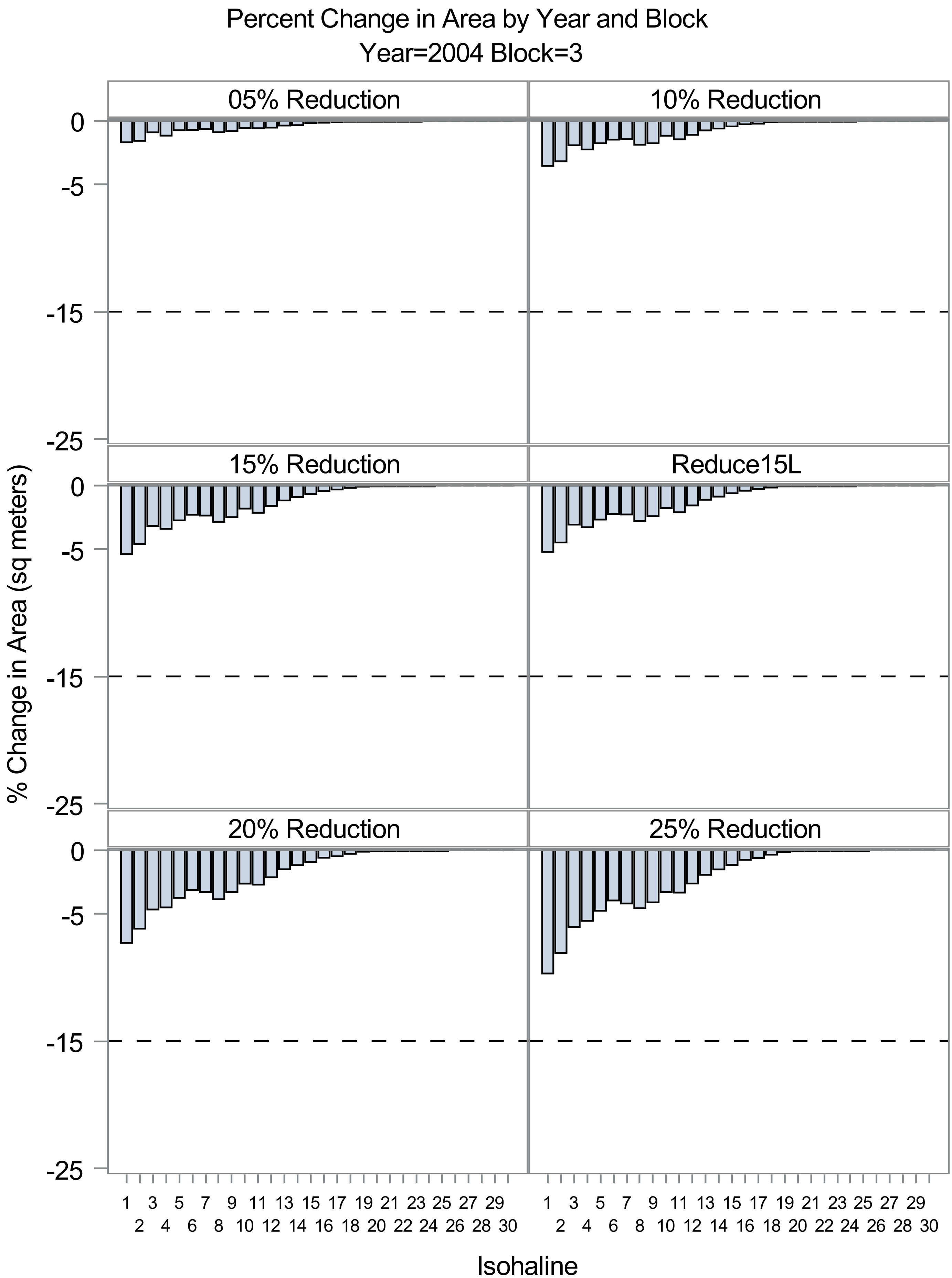

Percent Change in Area by Year and Block
Year=2003 Block=2
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline

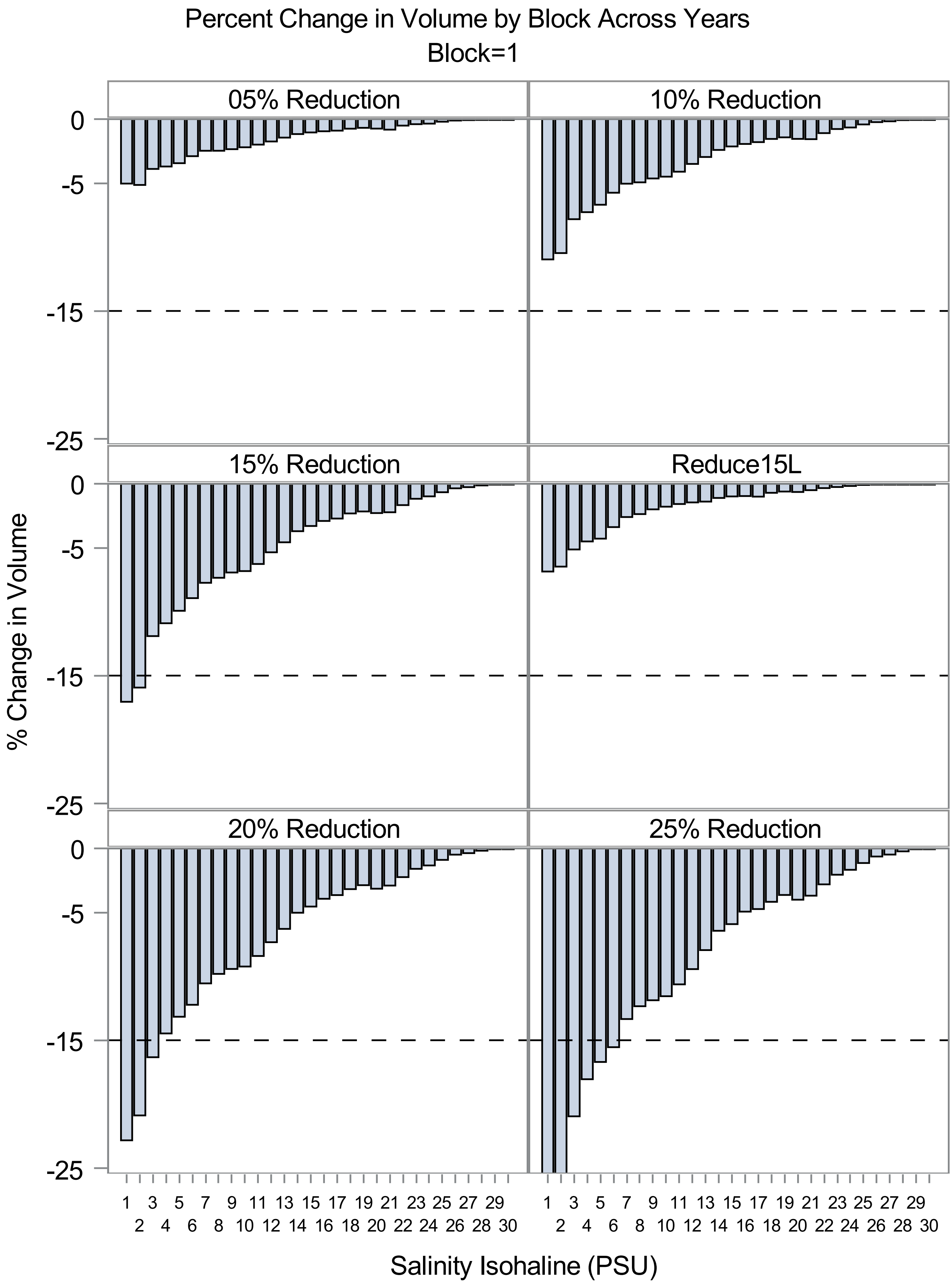


Percent Change in Area by Year and Block
Year=2003 Block=3
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline

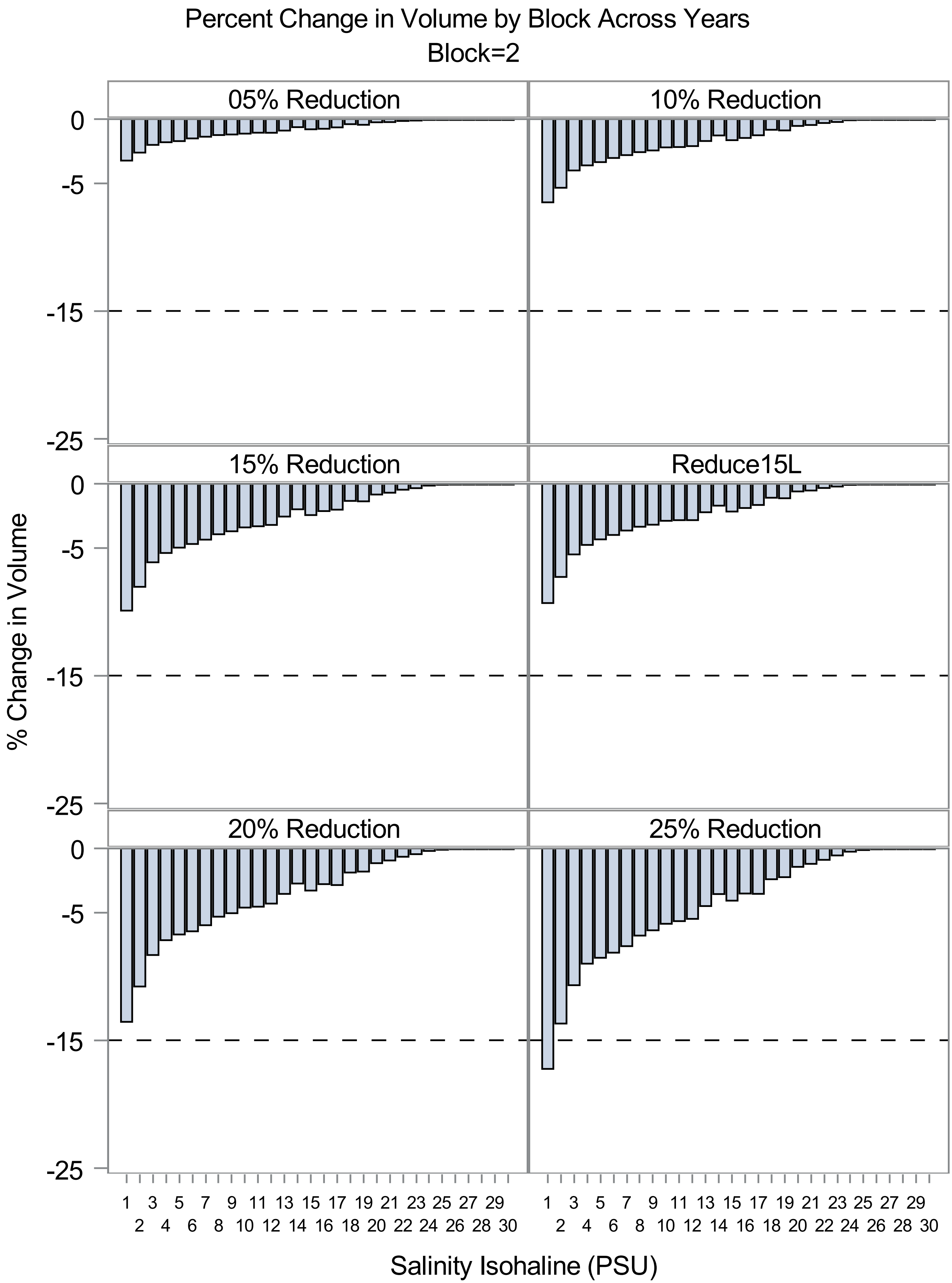

Percent Change in Area by Year and Block
Year=2004 Block=1
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline


Percent Change in Area by Year and Block
Year=2004 Block=2
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
% Change in Area (sq meters)
0
-5
-15
-25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline

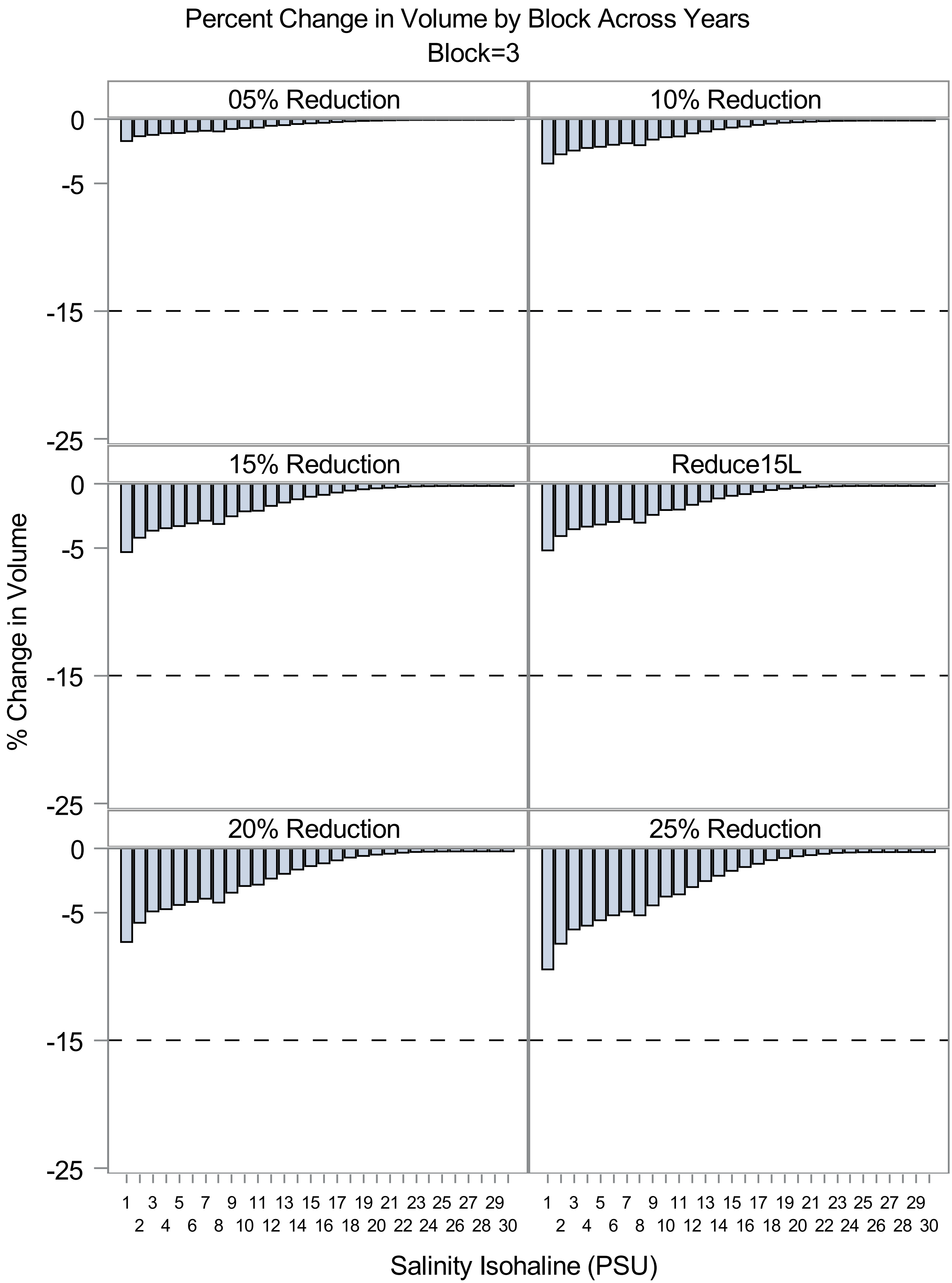

Percent Change in Area by Year and Block
Year=2004 Block=3
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area (sq meters)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Isohaline



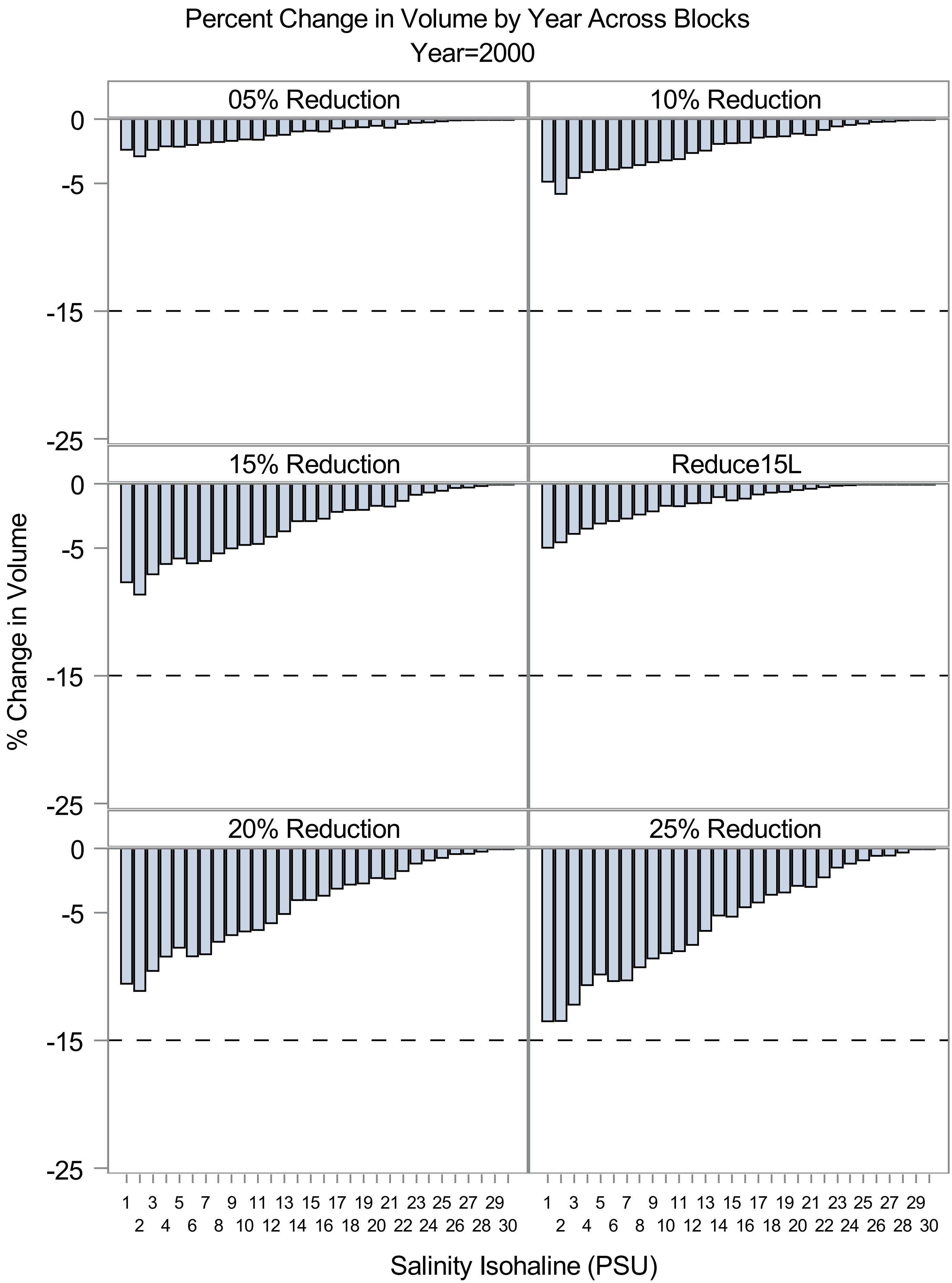
Percent Change in Volume by Block Across Years
Block=1
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
% Change in Volume
0
-5
-15
-25
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)

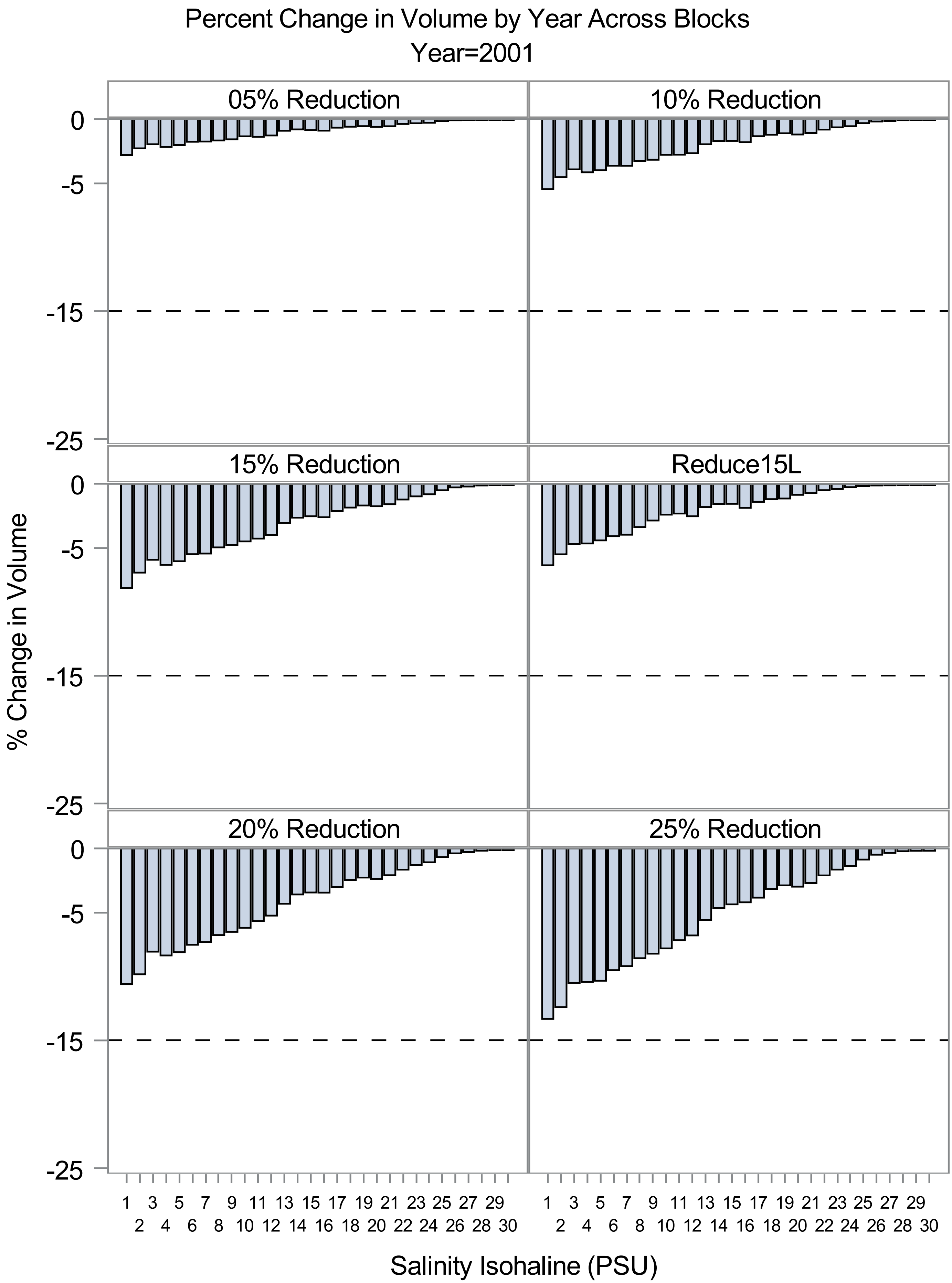


Percent Change in Volume by Block Across Years
Block=2
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

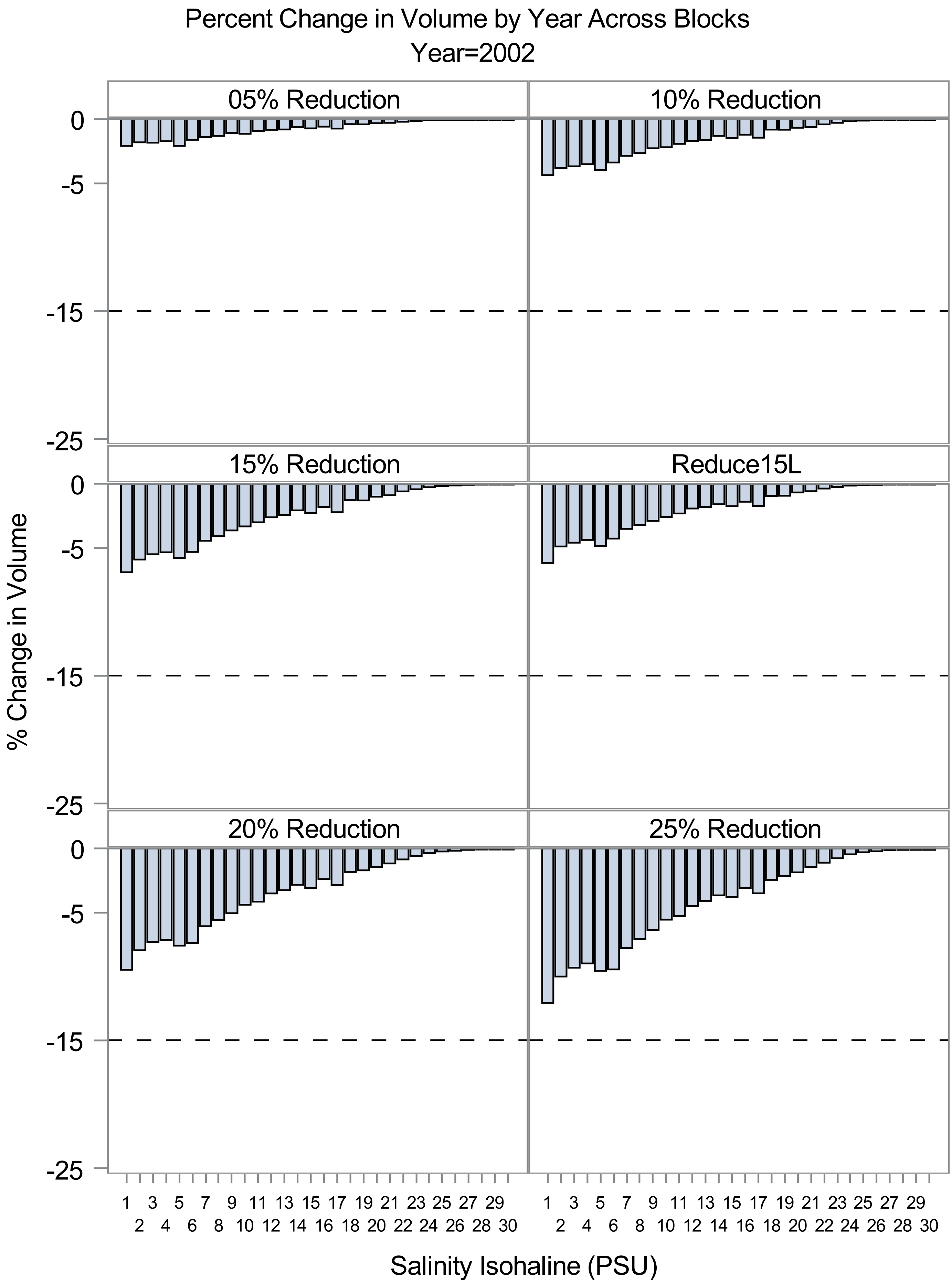


Percent Change in Volume by Block Across Years
Block=3
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

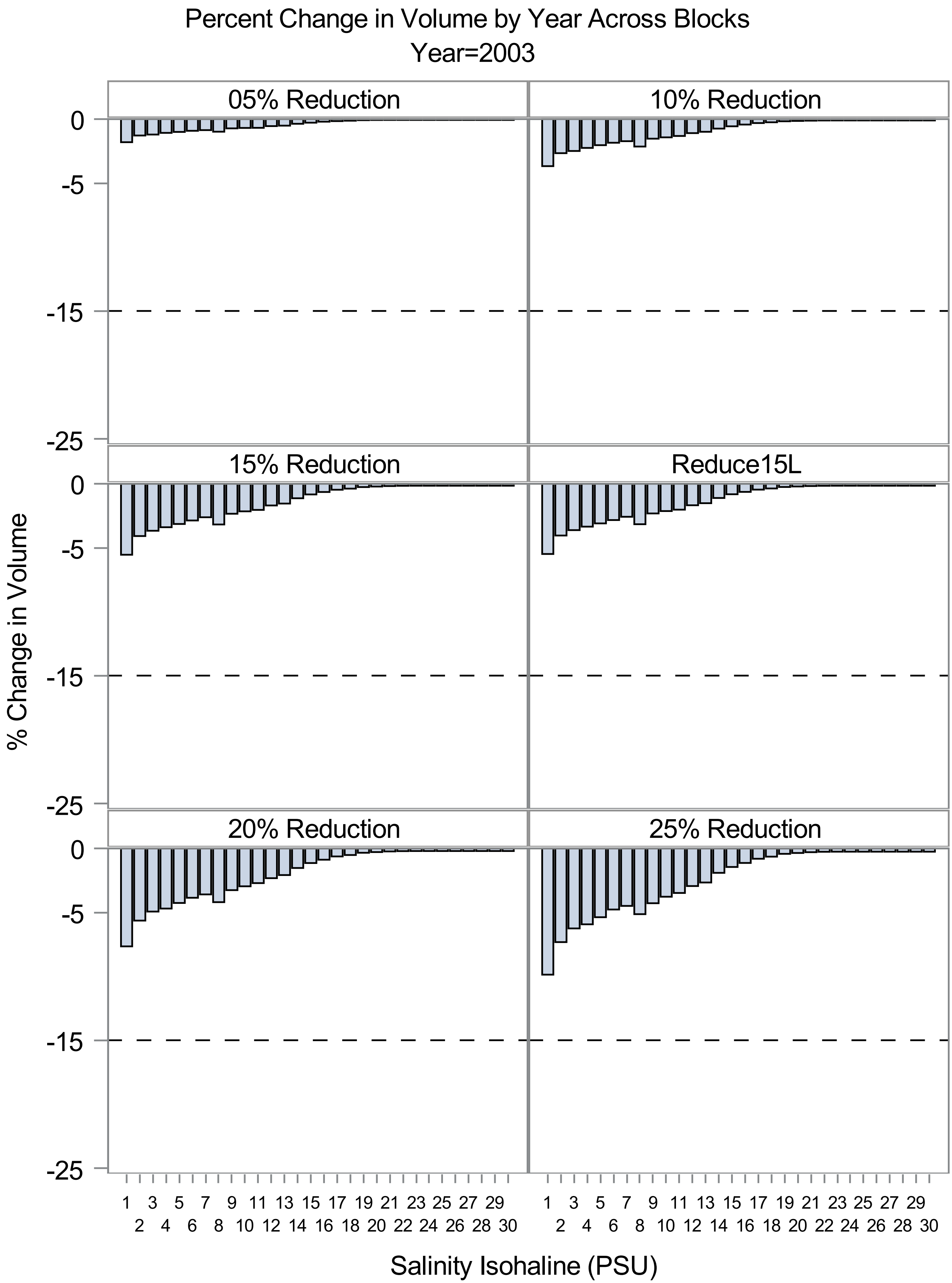

Percent Change in Volume by Year Across Blocks
Year=2000
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

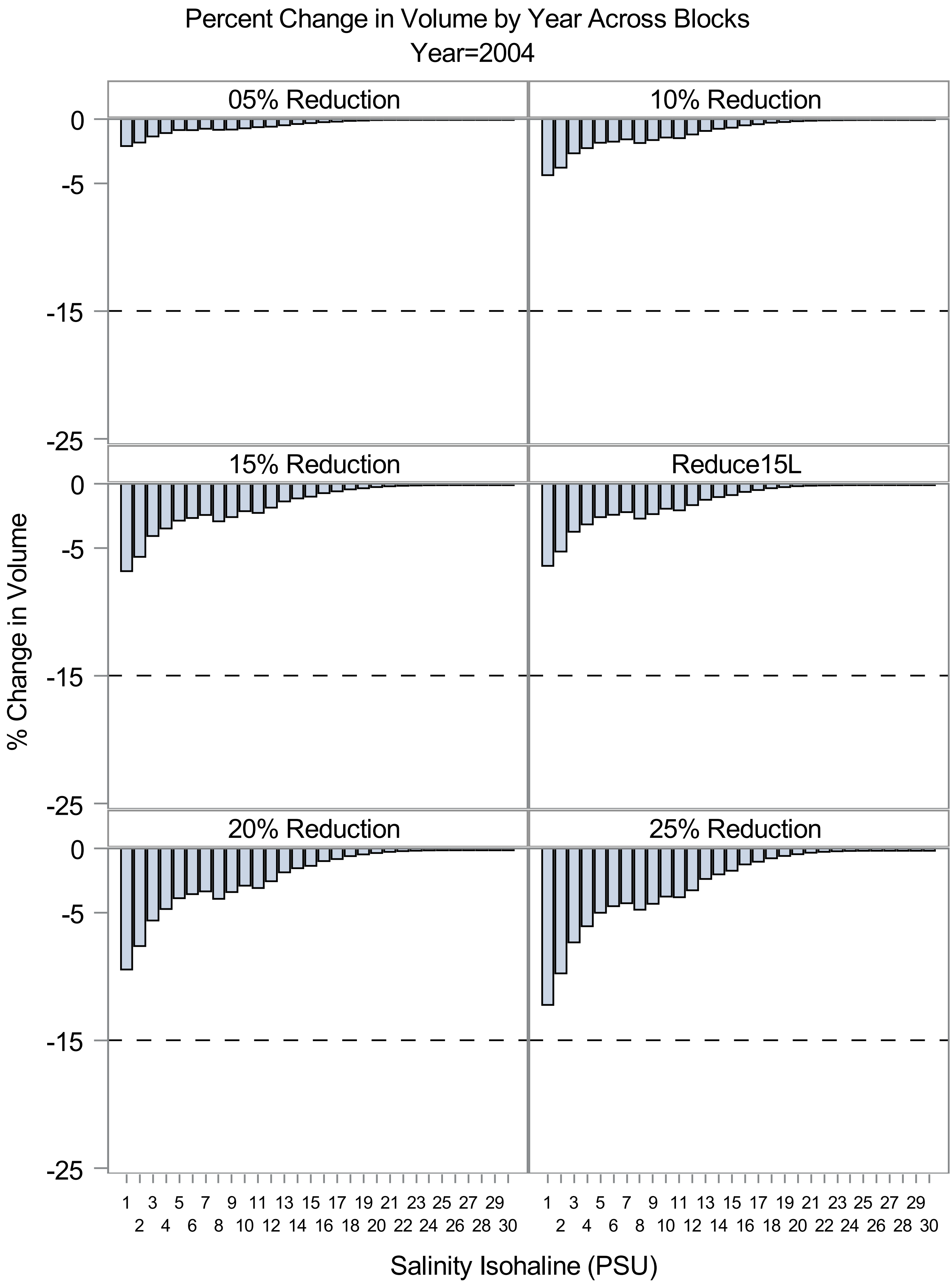


Percent Change in Volume by Year Across Blocks
Year=2001
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

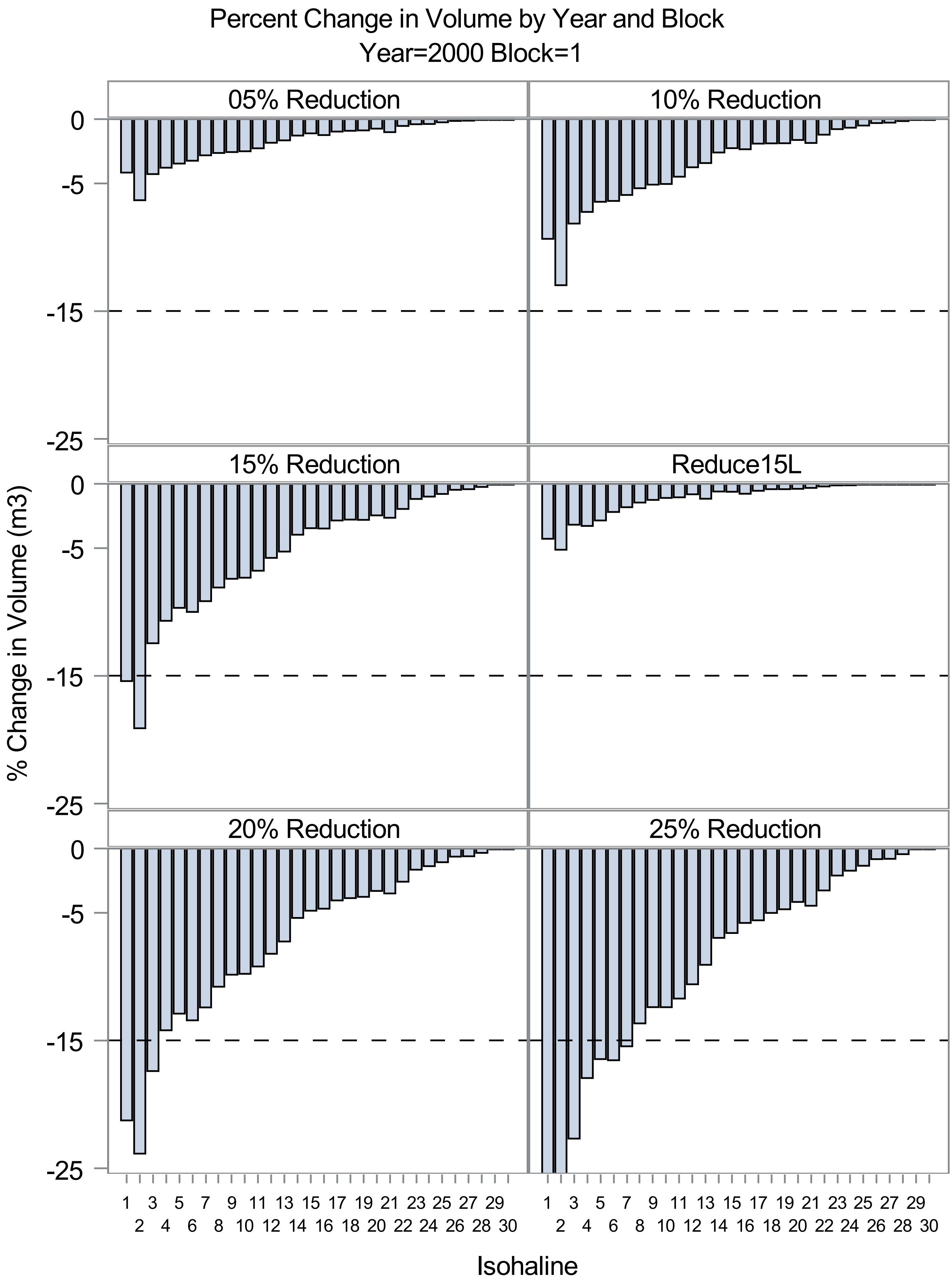


Percent Change in Volume by Year Across Blocks
Year=2002
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

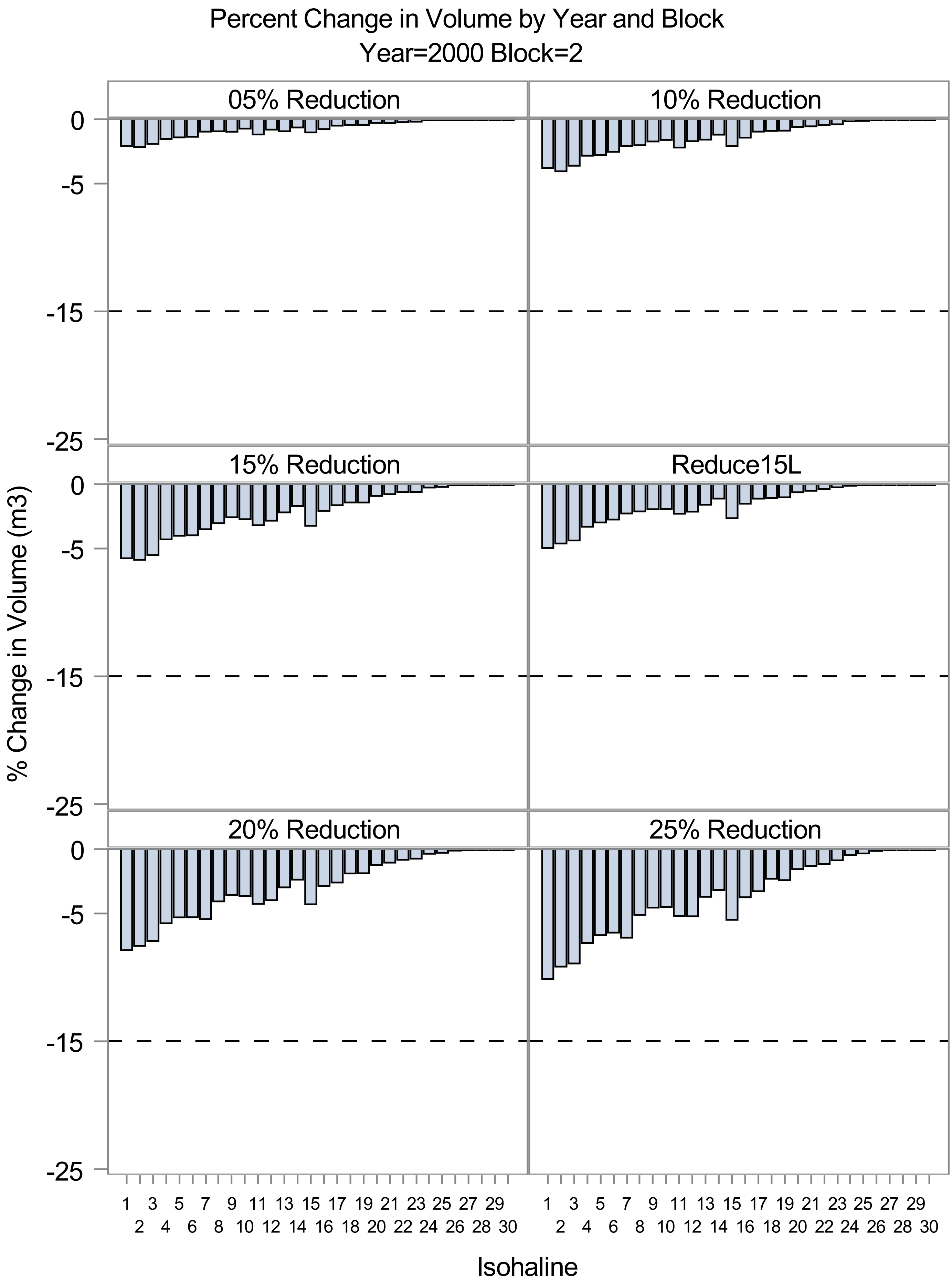

Percent Change in Volume by Year Across Blocks
Year=2003
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



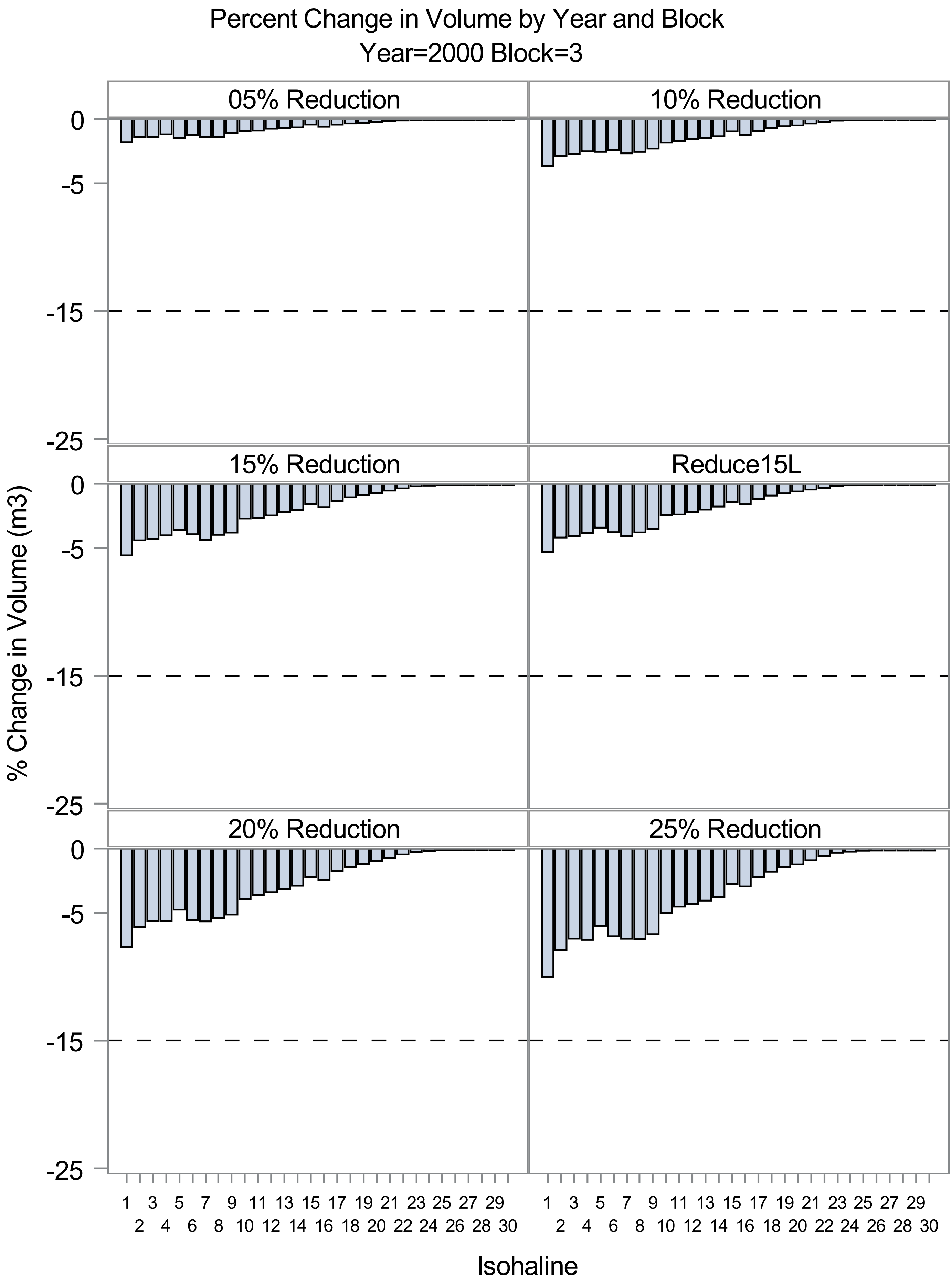
Percent Change in Volume by Year Across Blocks
Year=2004
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



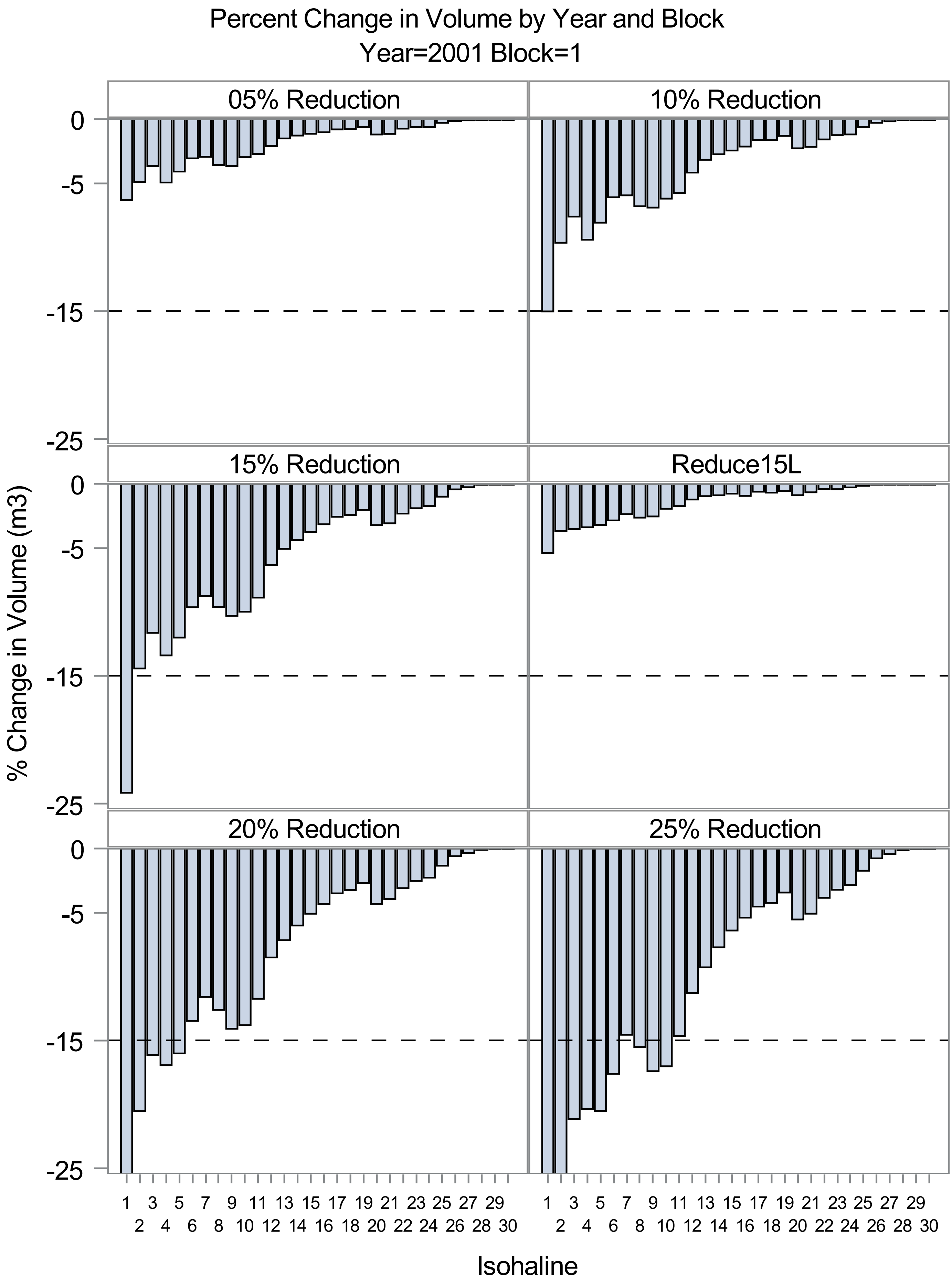
Percent Change in Volume by Year and Block
Year=2000 Block=1
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Isohaline



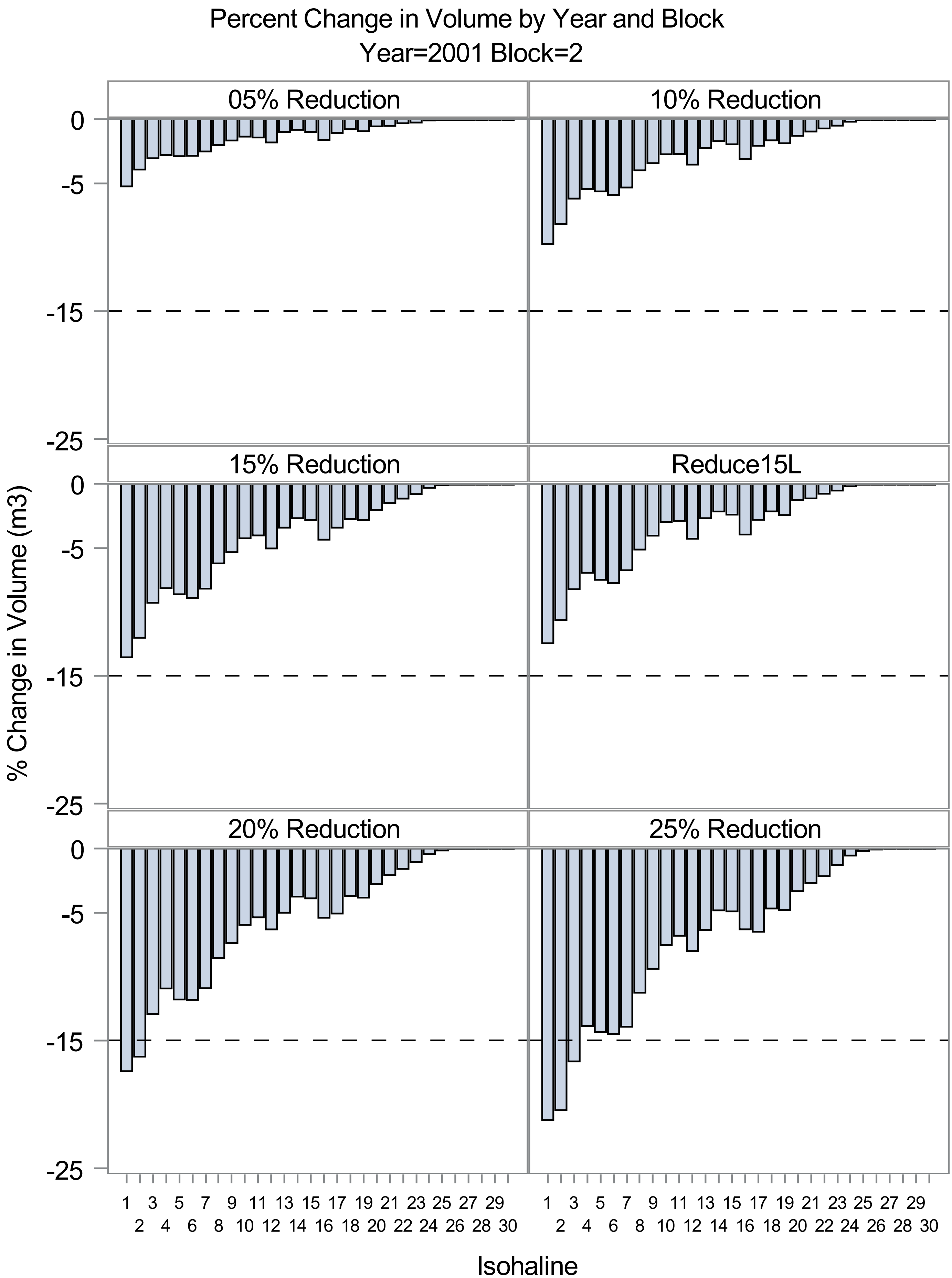
Percent Change in Volume by Year and Block
Year=2000 Block=2
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Isohaline



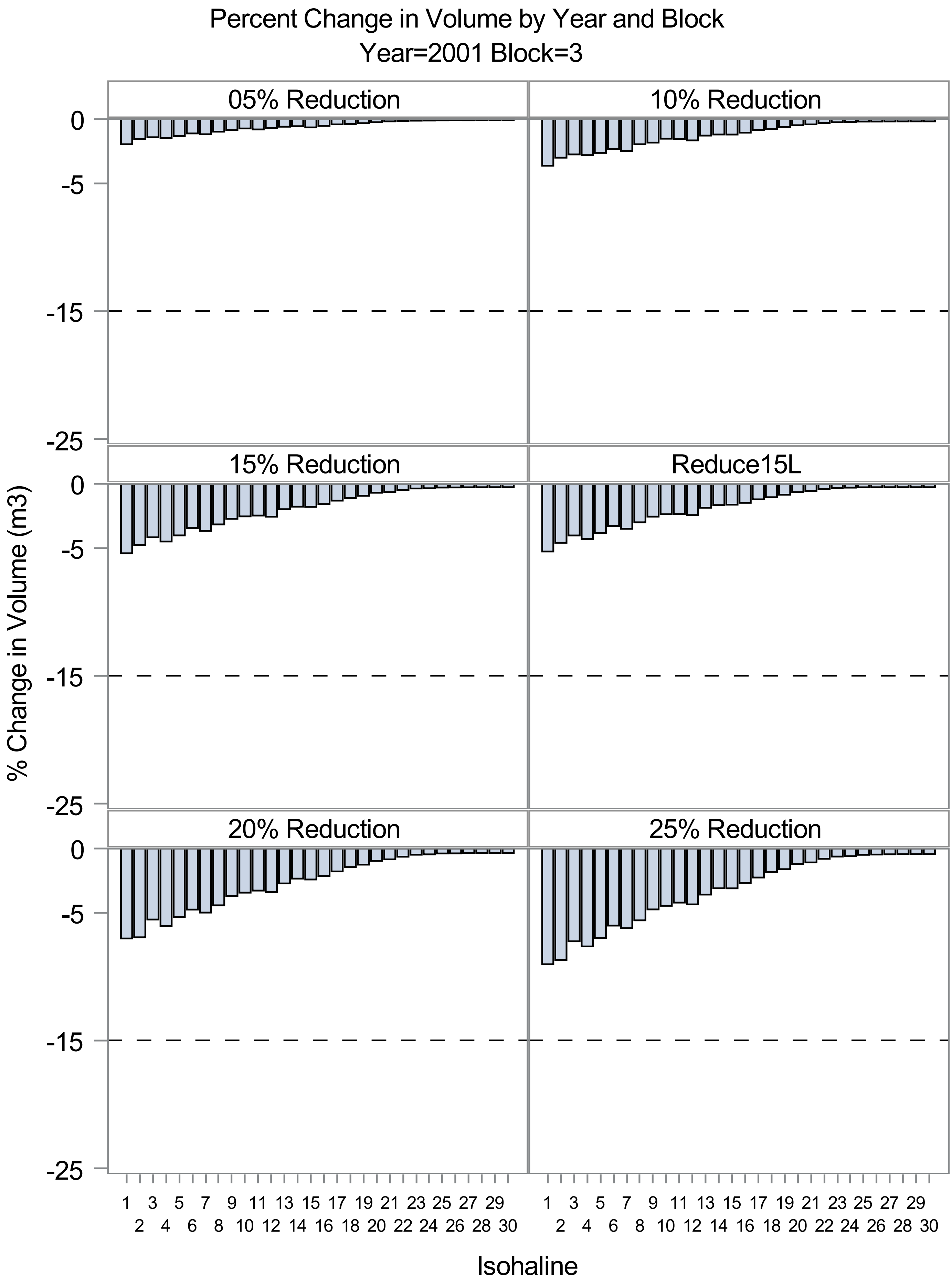
Percent Change in Volume by Year and Block
Year=2000 Block=3
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Isohaline

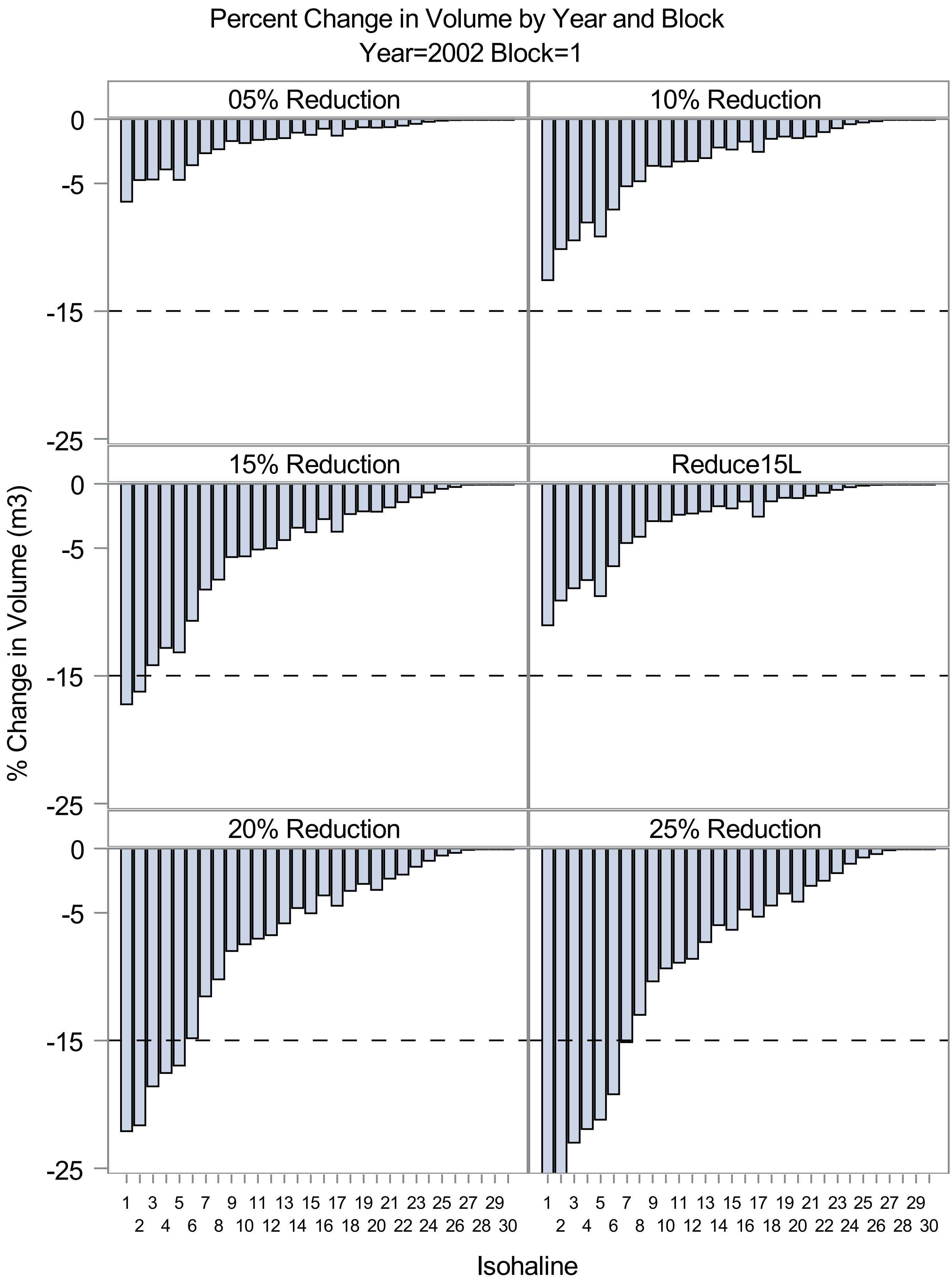


Percent Change in Volume by Year and Block
Year=2001 Block=1
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Isohaline

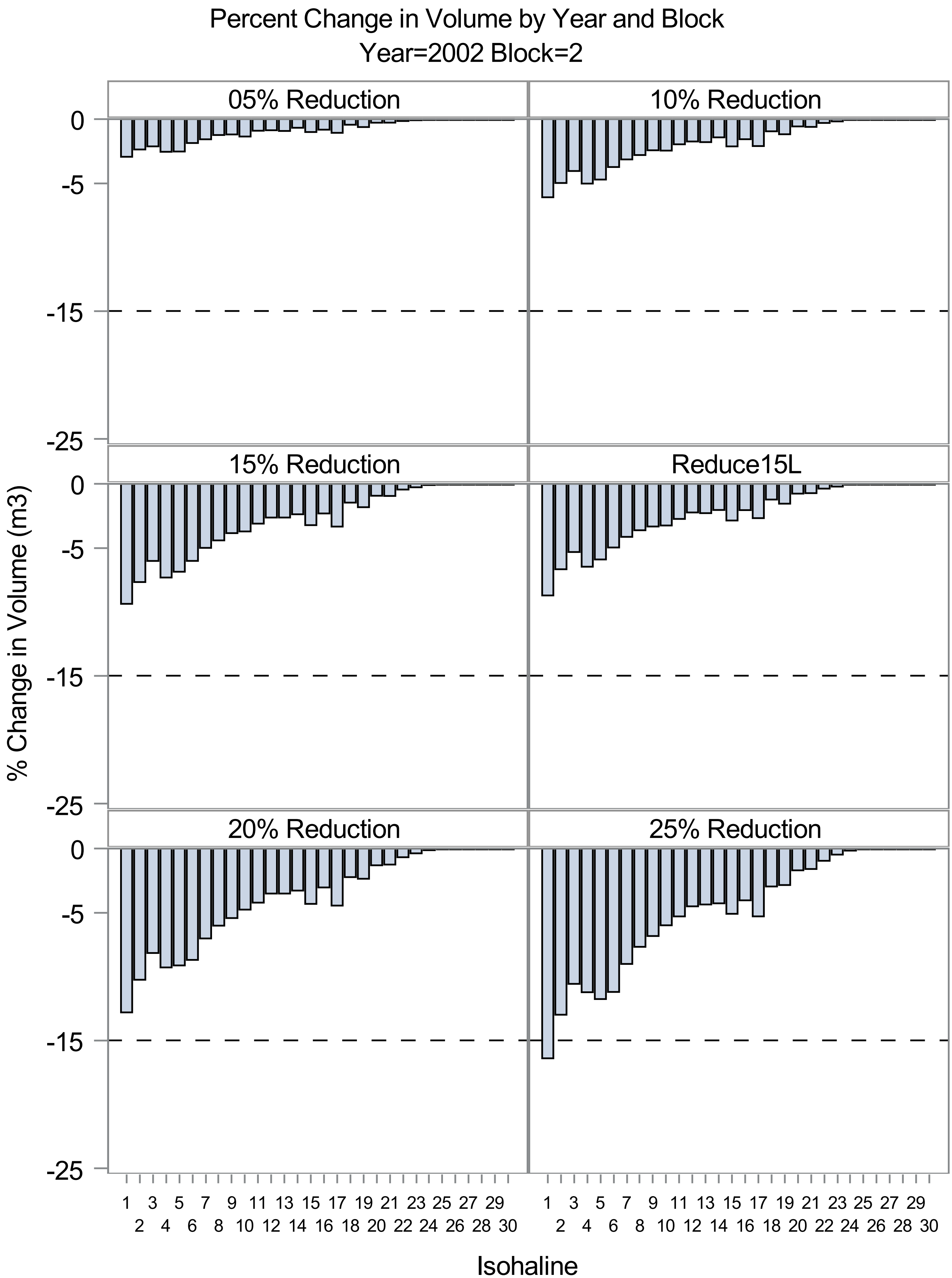


Percent Change in Volume by Year and Block
Year=2001 Block=2
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline

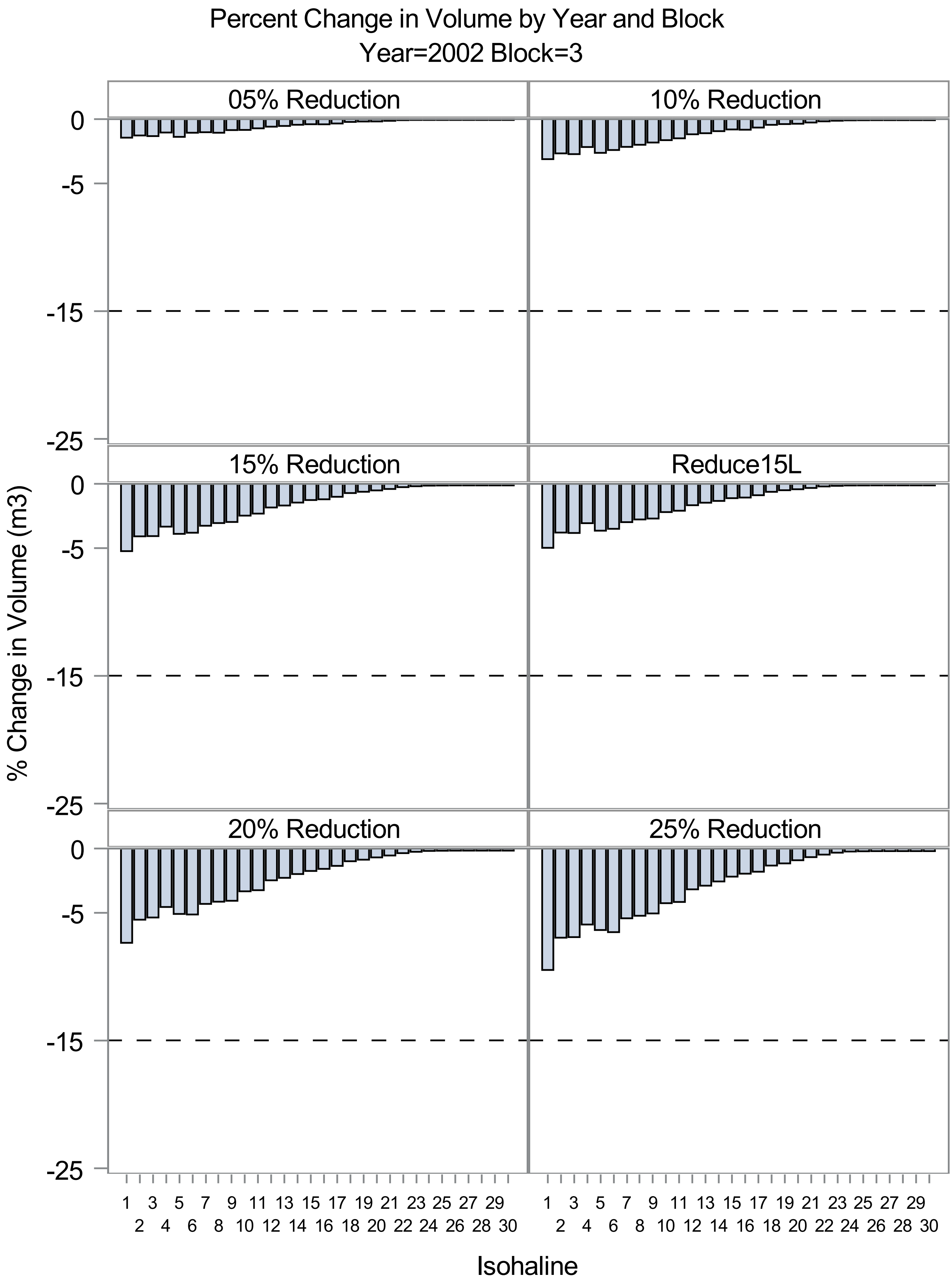

Percent Change in Volume by Year and Block
Year=2001 Block=3
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
% Change in Volume (m3)
0
-5
-15
-25
Isohaline
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30



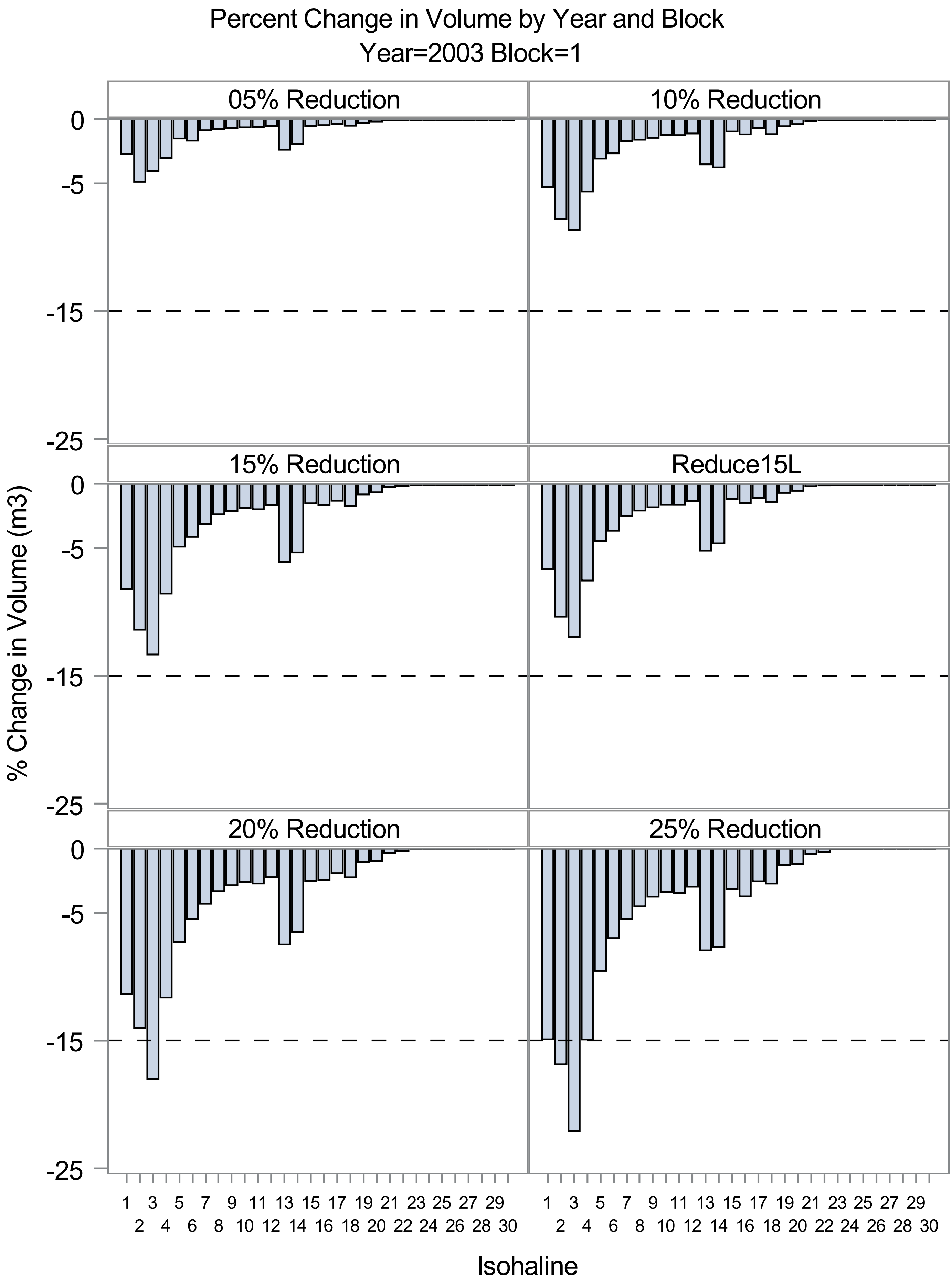
Percent Change in Volume by Year and Block
Year=2002 Block=1
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline



Percent Change in Volume by Year and Block
Year=2002 Block=2
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline



Percent Change in Volume by Year and Block
Year=2002 Block=3
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline


Percent Change in Volume by Year and Block
Year=2003 Block=1
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
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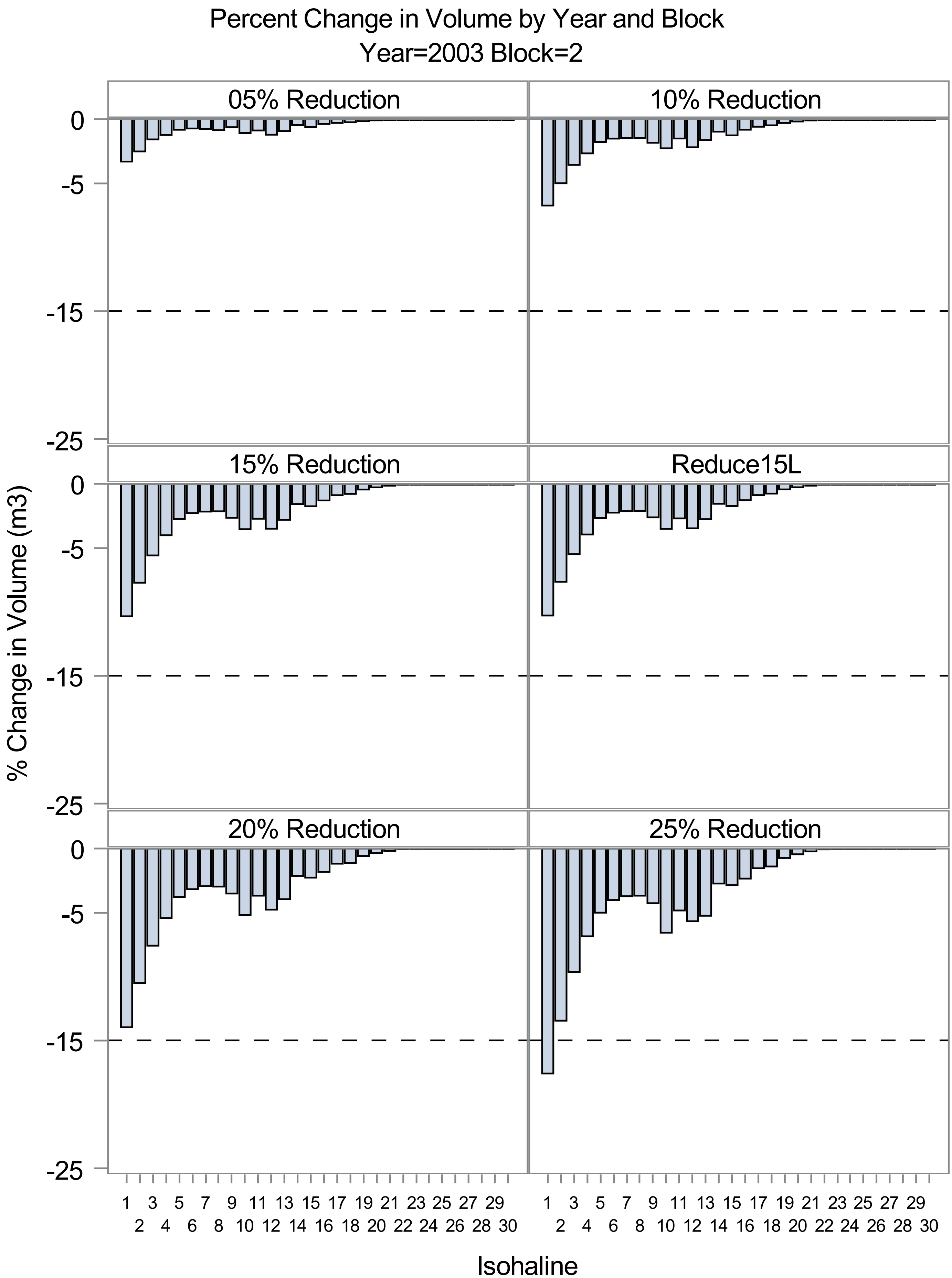
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline



Percent Change in Volume by Year and Block
Year=2003 Block=2
05% Reduction
10% Reduction
15% Reduction
Reduce15L
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25% Reduction
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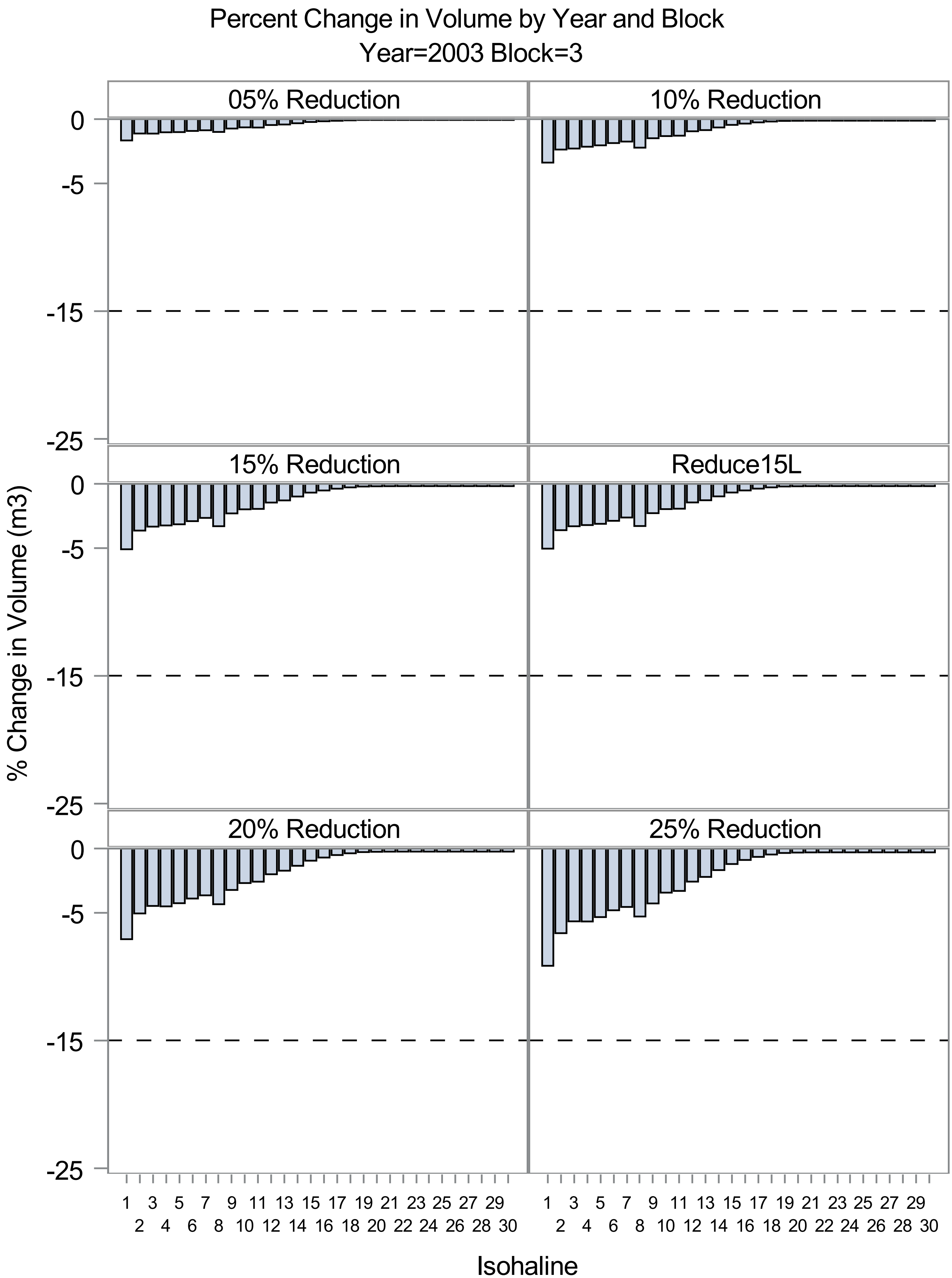
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline



Percent Change in Volume by Year and Block
Year=2003 Block=3
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
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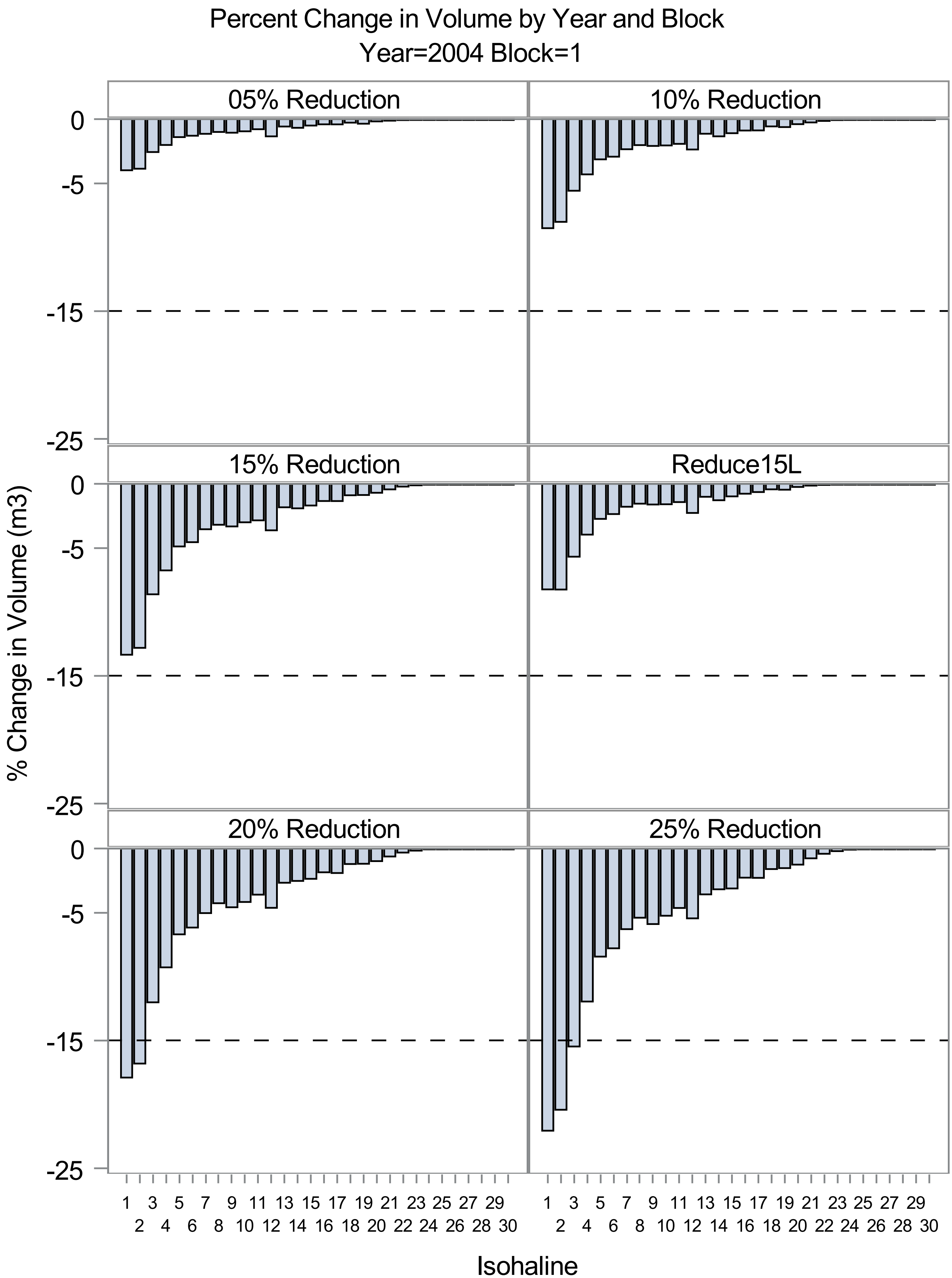
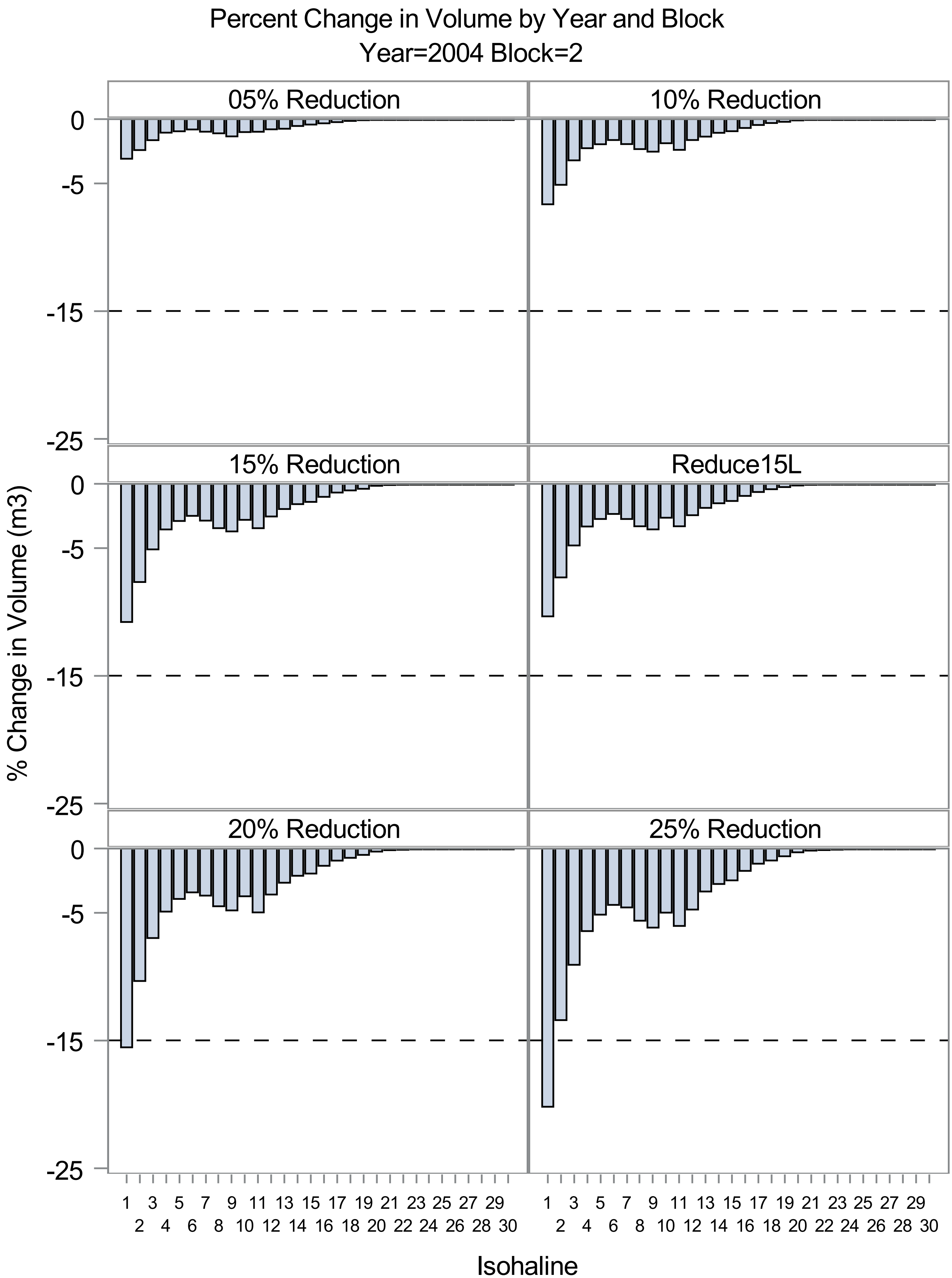
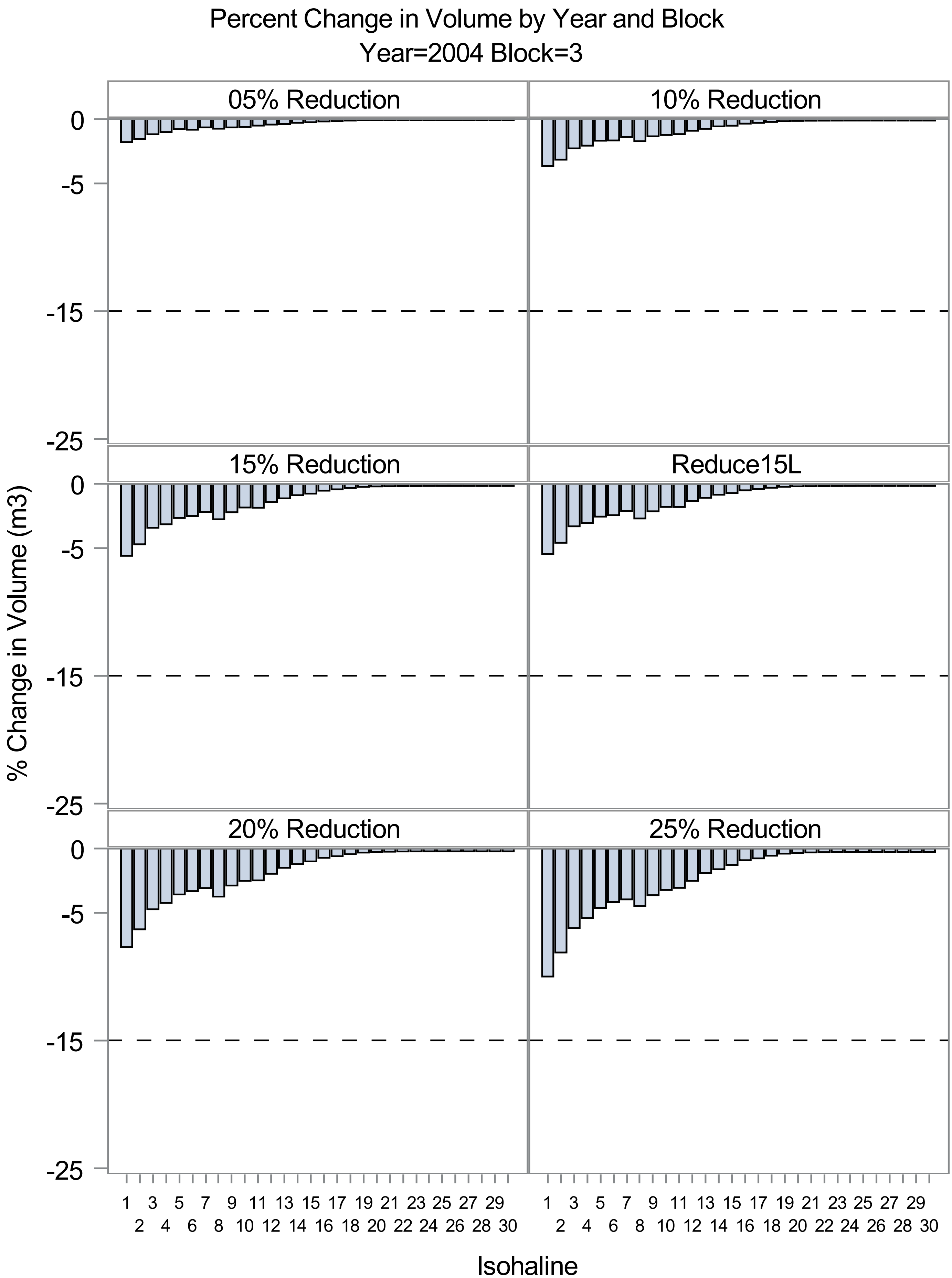
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline



Percent Change in Volume by Year and Block
Year=2004 Block=1
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
% Change in Volume (m3)
0
-5
-15
-25
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Isohaline



Percent Change in Volume by Year and Block
Year=2004 Block=2
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
% Change in Volume (m3)
0
-5
-15
-25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline



Percent Change in Volume by Year and Block
Year=2004 Block=3
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline

Appendix A

Investigation into the Original Hard-Coded EFDC Salinity Isohaline Bottom Area and Volume Output

This appendix was part of an initial draft memorandum delivered to the District for review comparing the hard coded EFDC model output constructed by FSU (“FSU)” relative to the output generated by outputting the hourly salinity area and volumes for each cell (“TX”) and summing across cells within a day.

A comparison plot of the 5 ppt isohaline is provided in Figure 1 where the bottom area prediction timeseries for the full model simulation period overlay one another with some extremely minor differences in predicted areas over the entire period. The 15 ppt isohaline (Figure 2) was also similar with some minor differences presumably due to differences in how the area calculations were performed (original FSU EFDC code used dx*dy while the TX code uses area estimates assigned using Geographic Information Systems (GIS) since the cells may not be exactly rectangular.

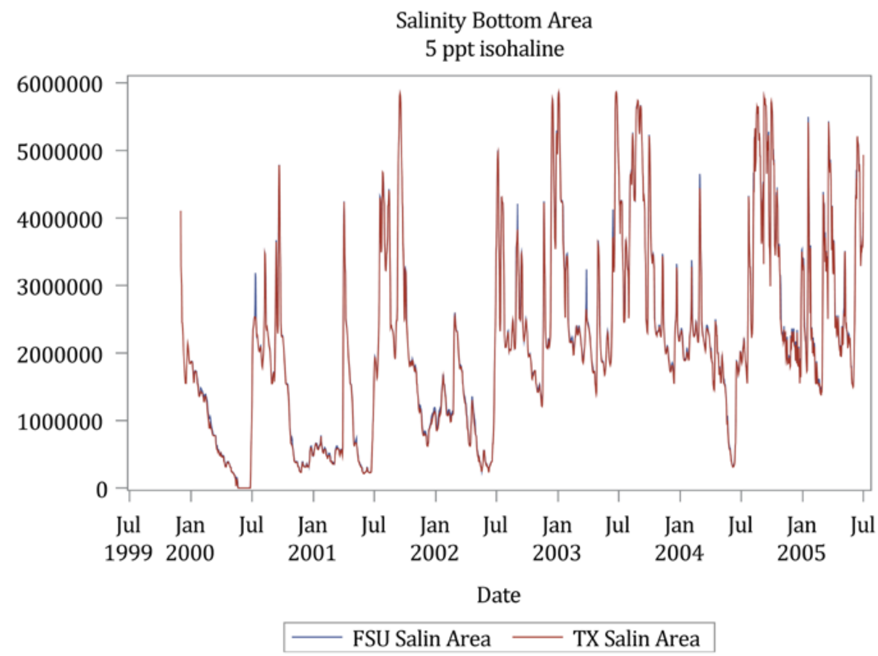


Figure 1. Comparison of salinity bottom area for the 5 ppt isohaline using the original FSU output format (blue line) and the modified TX format (red line).

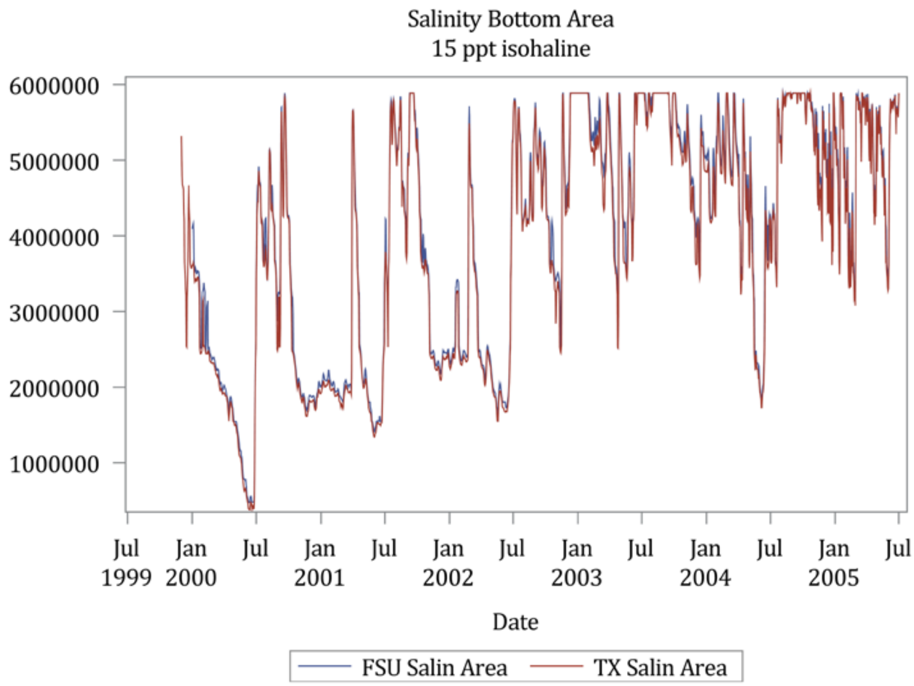


Figure 2. Comparison of salinity bottom area for the 5 ppt isohaline using the original FSU output format (blue line) and the TX format (red line).

However, the volume estimates comparison suggested larger discrepancies between the FSU and TX output, especially at the higher volume isohalines (Figure 3). The FSU output appears to have a lunar signal in the timeseries which led us to investigate the hard-coded calculations in the efdc8.f subroutine of the model.

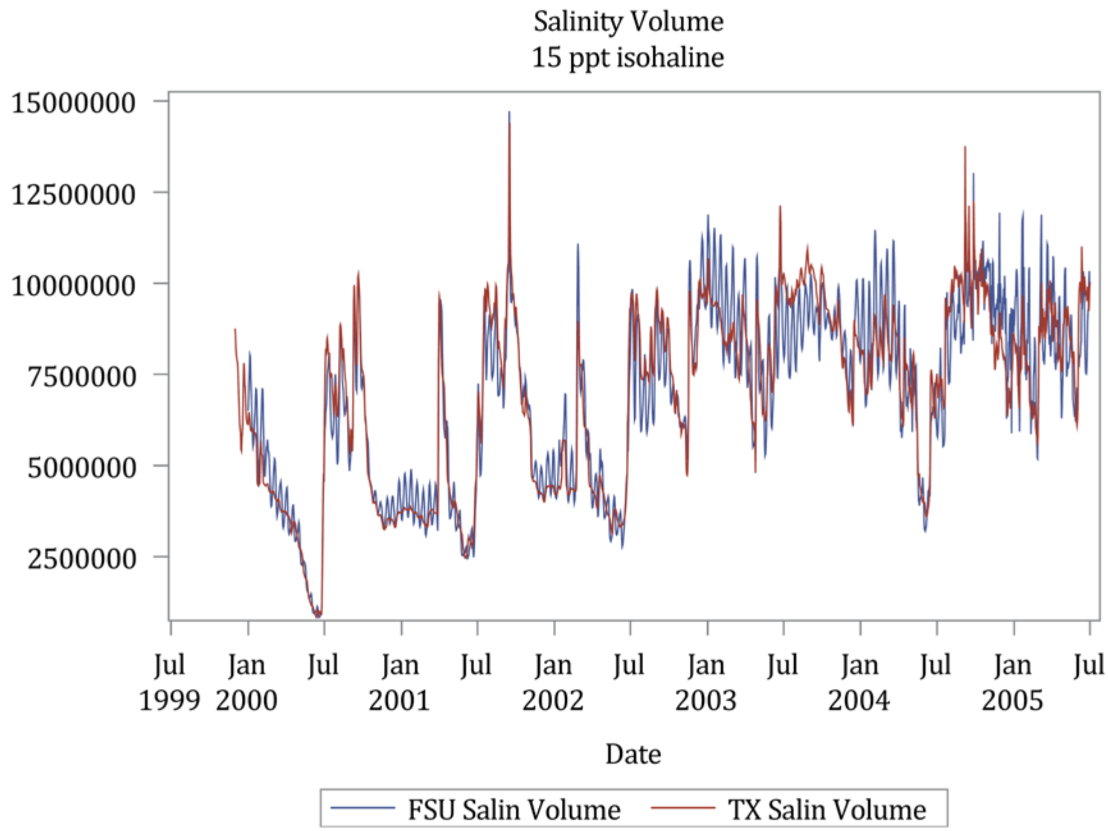


Figure 3. Comparison of salinity volumes for the 15 ppt isohaline using the original FSU output format (blue line) and the TX format (red line).

Investigation of the original FORTRAN source code for the EFDC model, specifically in the file efdc8.f subroutine SALVOLAREA, found that while the salinity was generated as a daily average, the volume assigned to the cell was determined by using the volume of each cell at the end of the day. Since tidal amplitude plays a significant role in the volume of the surface layer in the model this artifact of the calculation imparts a sine wave signal into the volume estimates.

Figure 4 illustrates this artifact, using tides at the NOAA gage at St. Petersburg (Station ID: 8726520**)** for January and June of 2013. In this example, the hourly water surface elevation (WSEL) timeseries is provided in the blue line, the red dot is the WSEL at hour 23, and the green broken line is the daily average. The red dots illustrate how sampling at a particular time of each day results in sampling at a different part of the tidal cycle. Since tides in west Florida are mixed diurnal and semi-diurnal, the pattern is not completely consistent over time. In fact, higher high tides tend to occur during the day in June 2013 at the NOAA site, resulting in the tendency for samples at hour 23 to be taken at below average tides. This artifact affected the volume estimates in the SALVOLUUM.OUT files, i.e., in the original FSU model output.

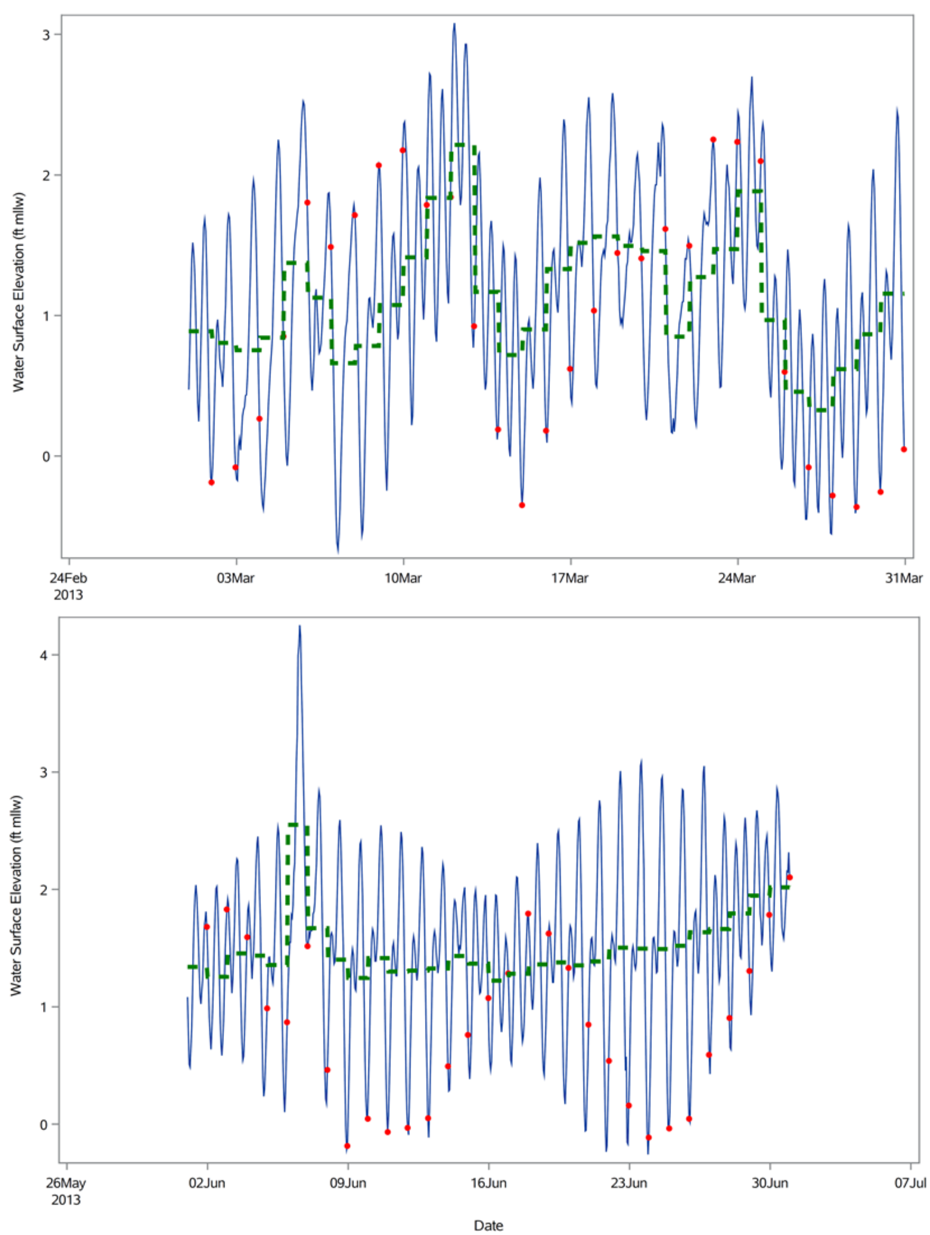


Figure 4. Two examples showing effects of selecting a specific time of day to characterize water surface elevations for March (top) and June of 2013 at the NOAA gage site Station ID: 8726520 at St. Petersburg, FL.

Despite this artifact, since the differences due to the flow reduction scenarios are summarized over fairly long temporal windows, the effect of this artifact is thought to be averaged-out over time. To investigate this hypothesis, comparisons of model output from the two methods, i.e., using the FSU and TX output, were generated for flow reduction scenarios ranging from 5 to 40%, in 5% increments. Example results for the year 2000 are provided in Figure 5 and indicate that on annual-basis, change in bottom area associated with the most sensitive isohalines (typically isohalines of 3 or less) does not exceed 15% until the flows are reduced by 30%. Similar results were observed for salinity isohaline volumes based on the FSU and TX output (Figure 6), and both sets of results were consistent with findings reported in Janicki

Environmental (2018). Therefore, despite this discrepancy, the averaging period tends to ameliorate any bias in the salinity volume calculations reported in the original model results. For accuracy, all results reported in the parent technical memo to this appendix use the TX output.

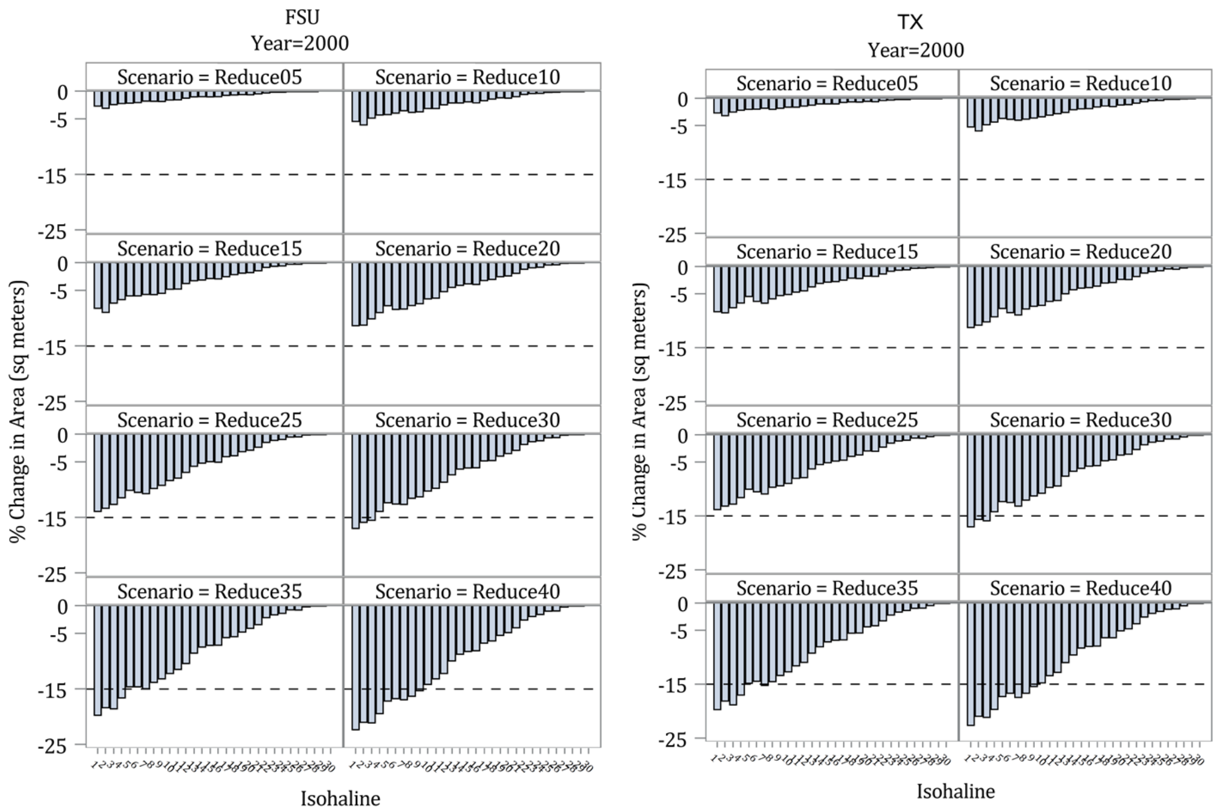


Figure 5. Comparison of predicted effects of flow reduction scenarios on salinity isohaline bottom area changes based on the original EFDC model output (FSU, left) and the cell-specific output (TX, right) for the year 2000.

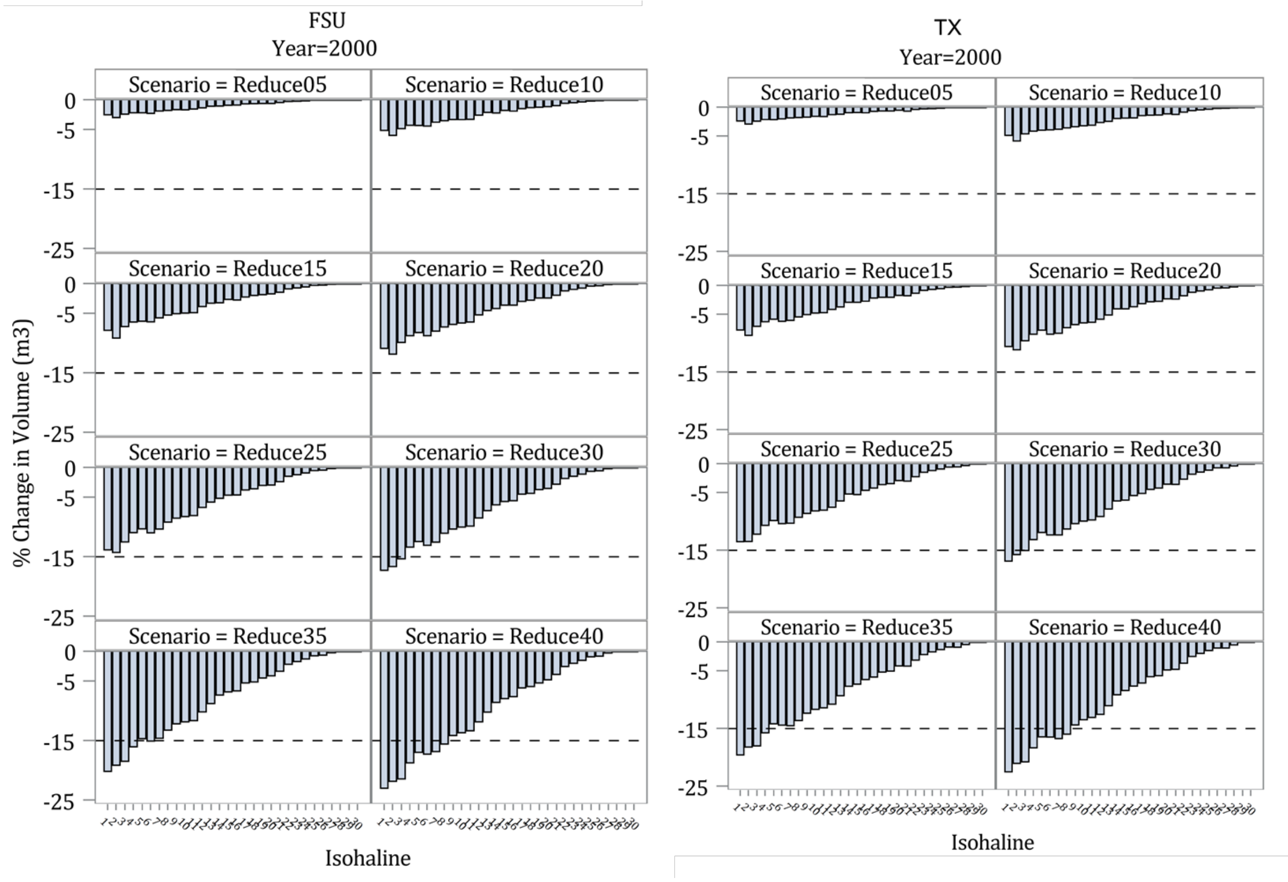
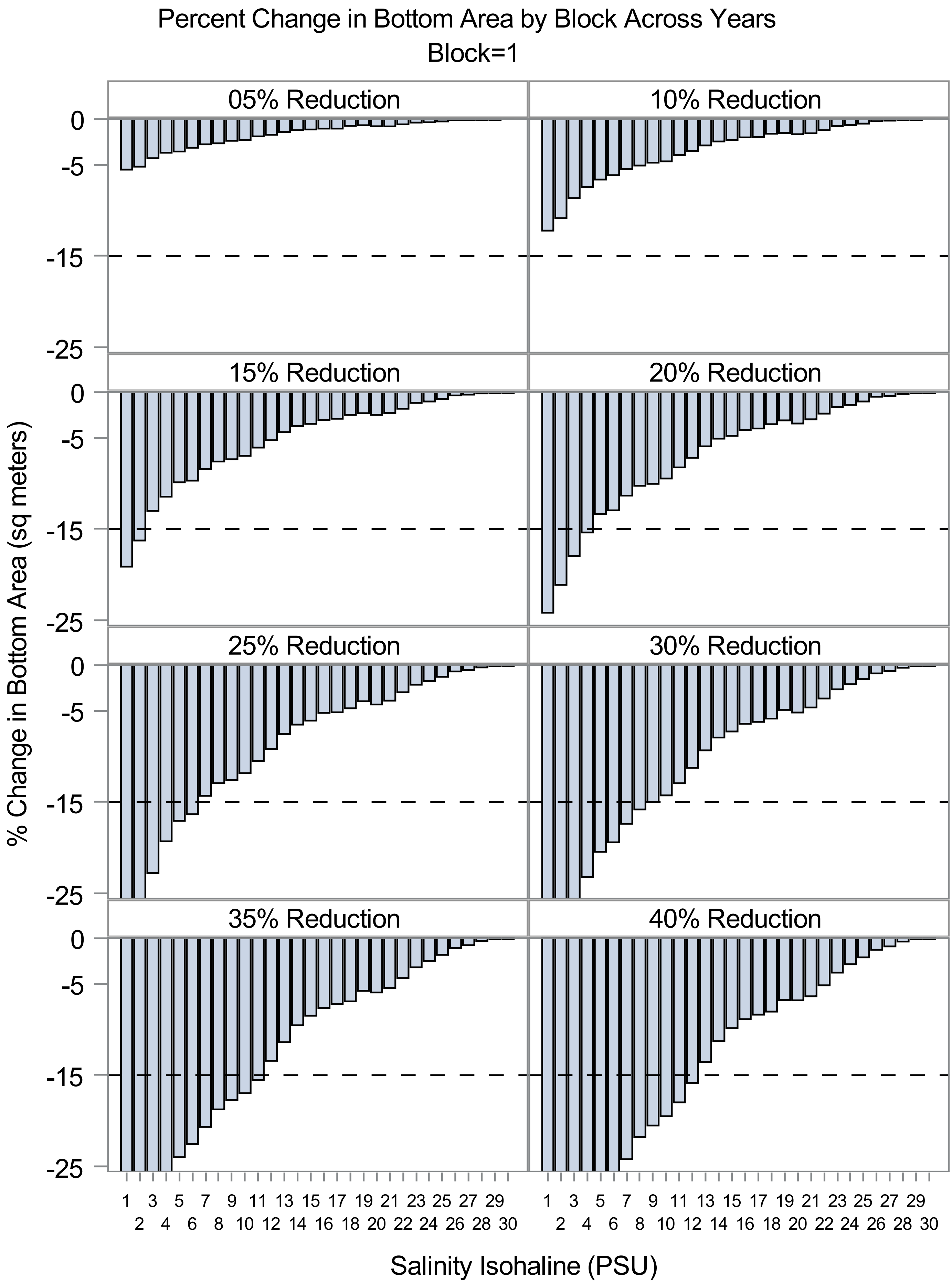
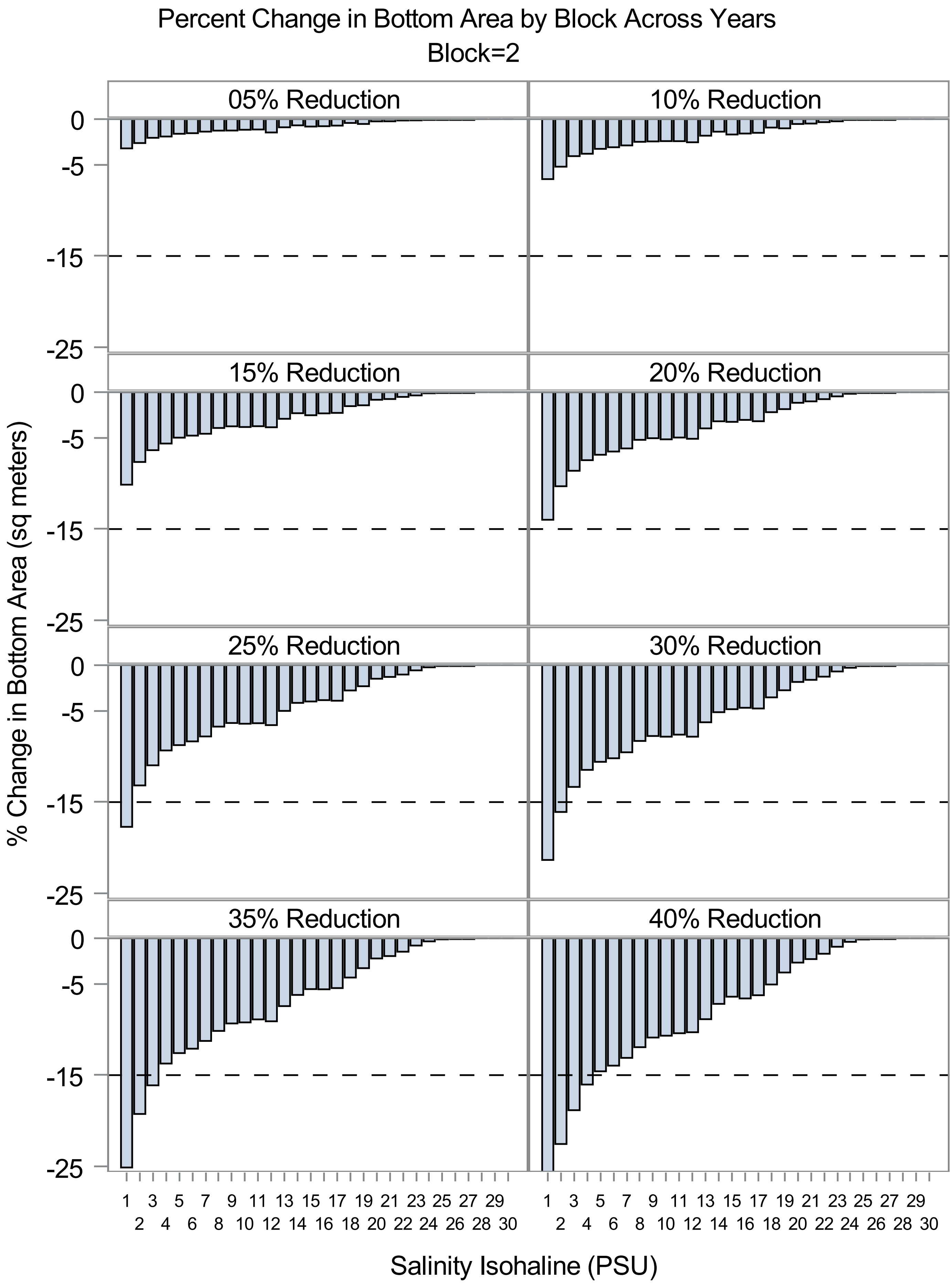


Figure 6. Comparison of predicted effects of flow reduction scenarios on salinity isohaline volume changes based on the original EFDC model output (FSU, left) and the cell-specific output (TX, right) for the year 2000.

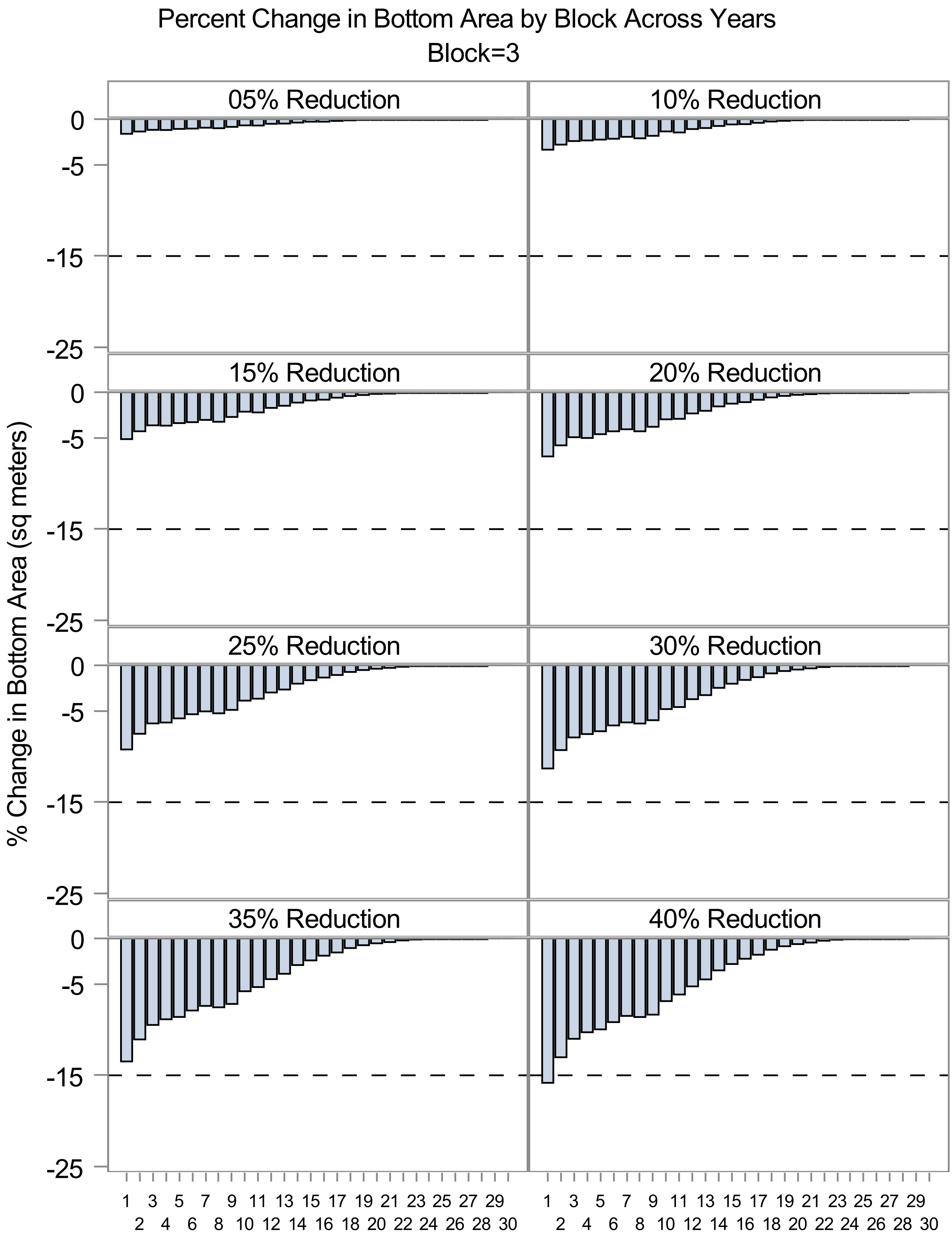
Appendix B

Plots of Percent Reductions in Salinity Isohaline Bottom Area by Block, Year, and Year/Block Combinations

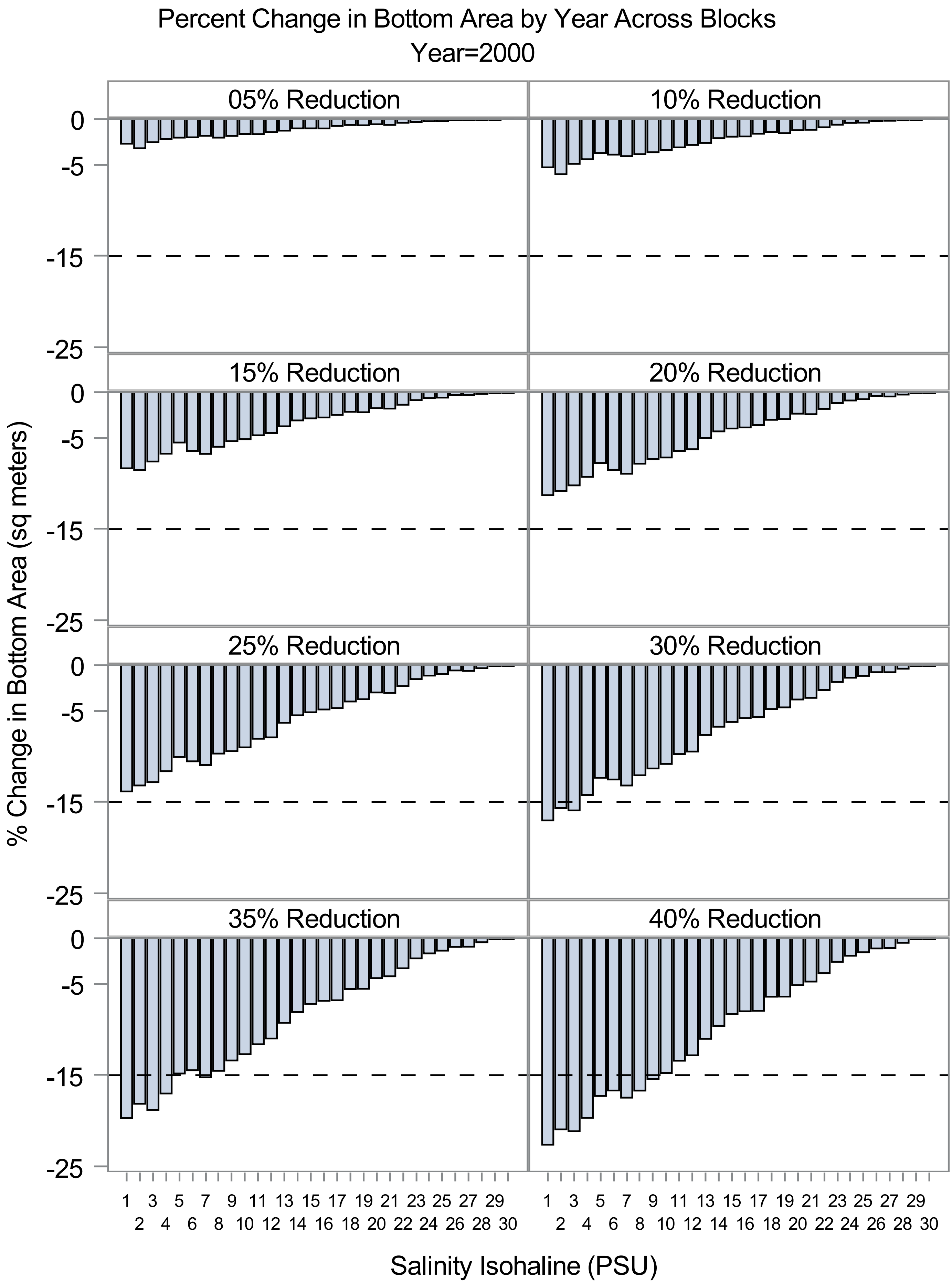

Percent Change in Bottom Area by Block Across Years
Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



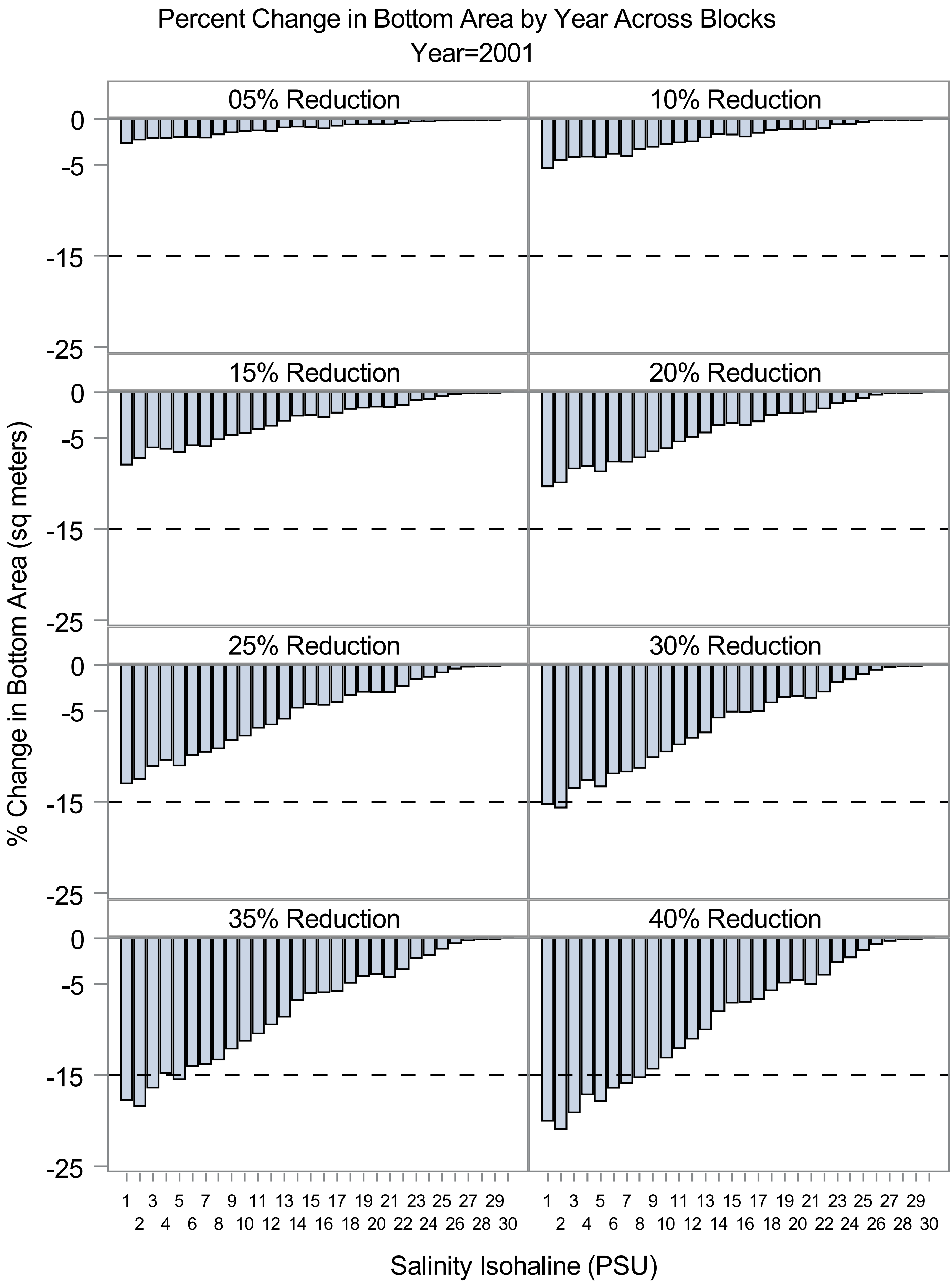
Percent Change in Bottom Area by Block Across Years
Block=2
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
Salinity Isohaline (PSU)



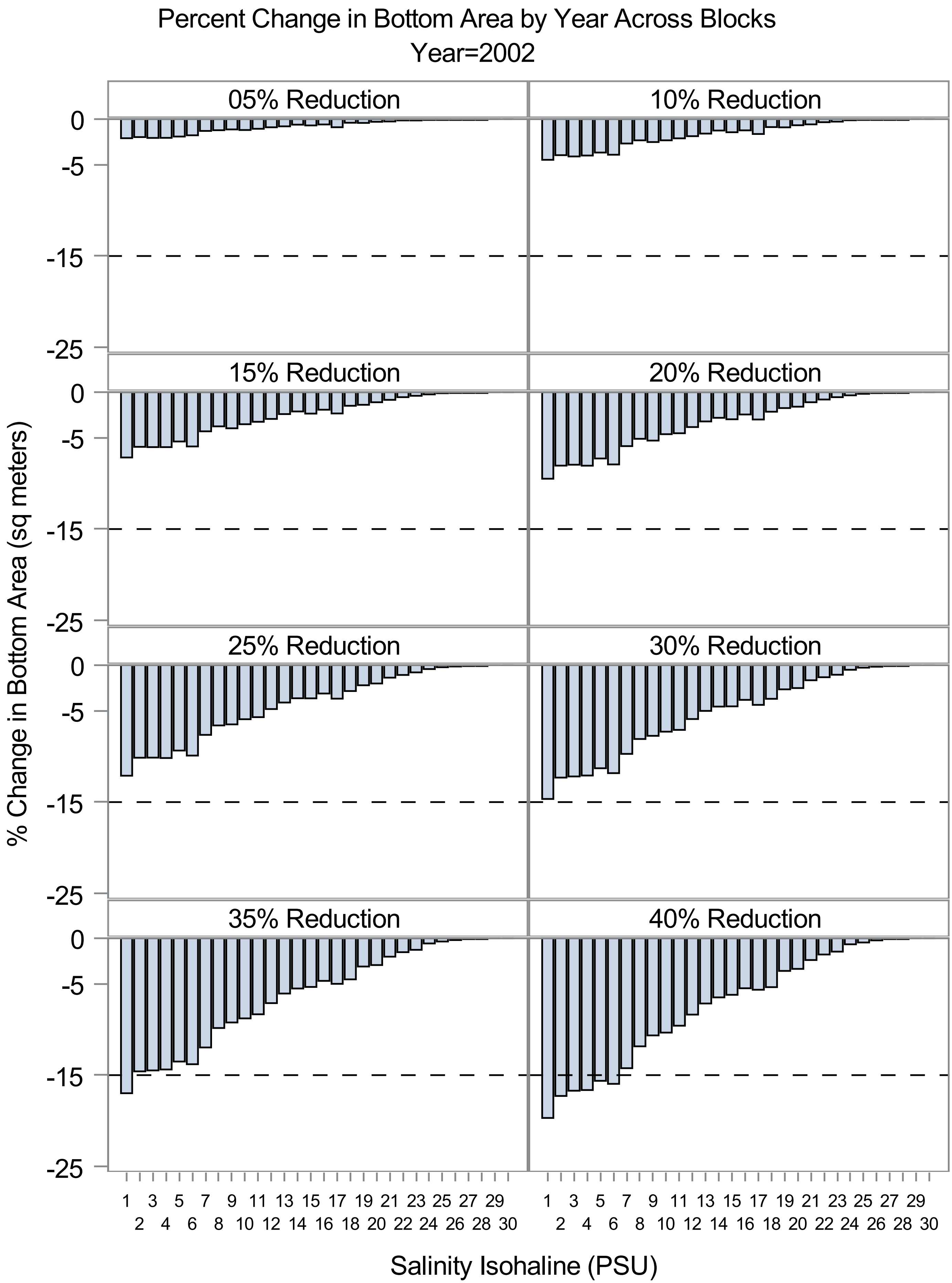
Percent Change in Bottom Area by Block Across Years
Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



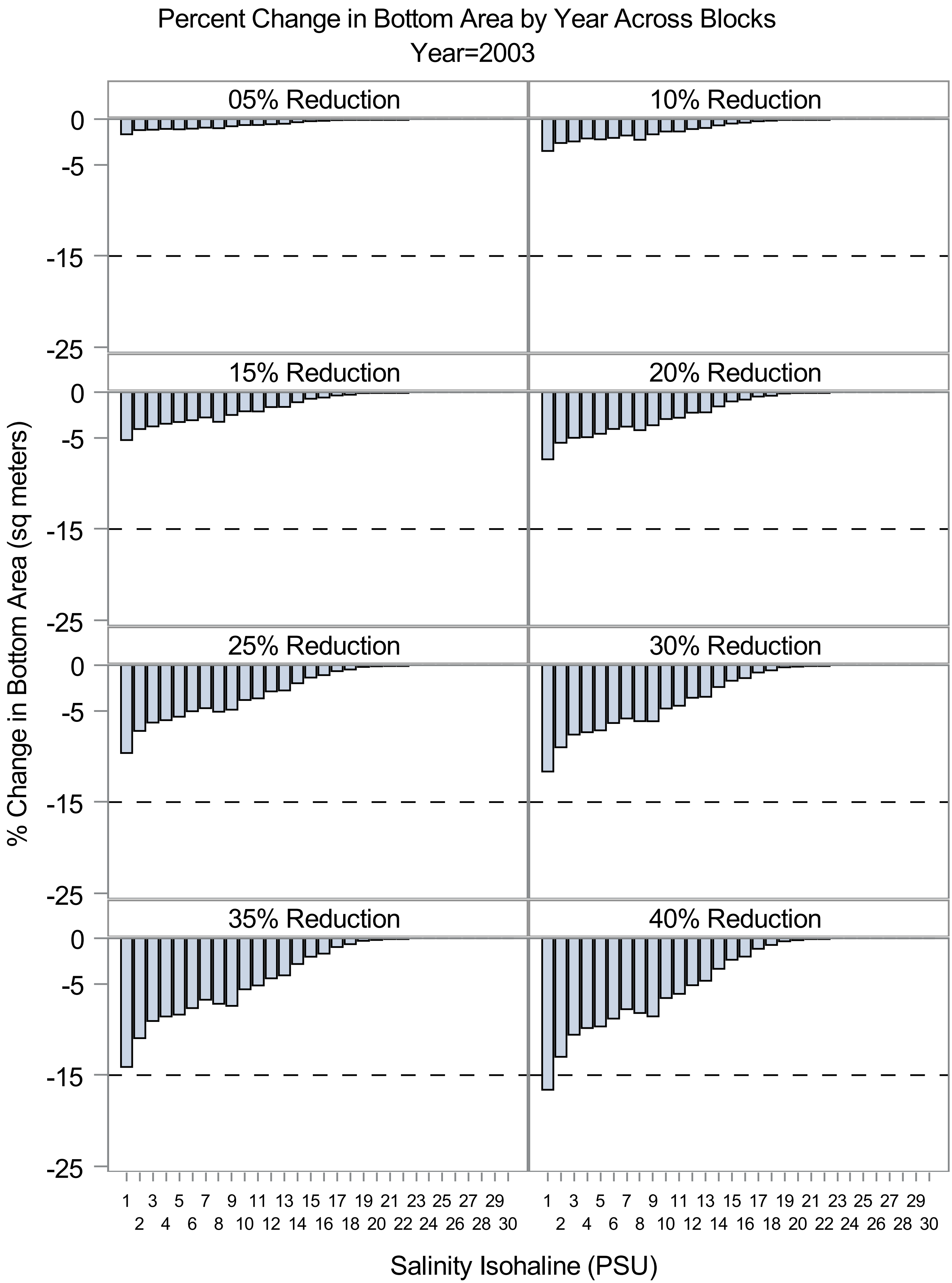
Percent Change in Bottom Area by Year Across Blocks
Year=2000
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
% Change in Bottom Area (sq meters)
0
-5
-15
-25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



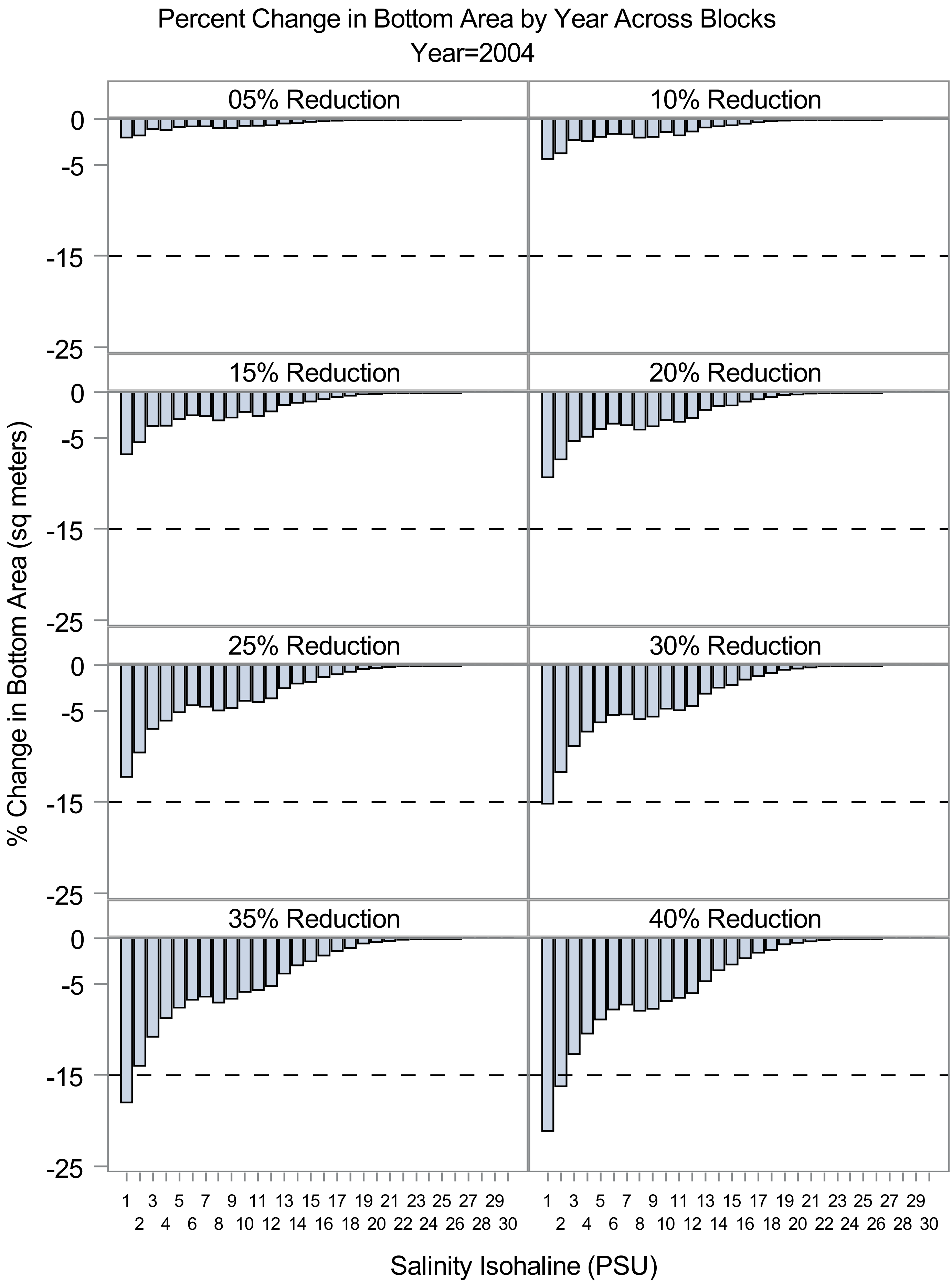
Percent Change in Bottom Area by Year Across Blocks
Year=2001
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



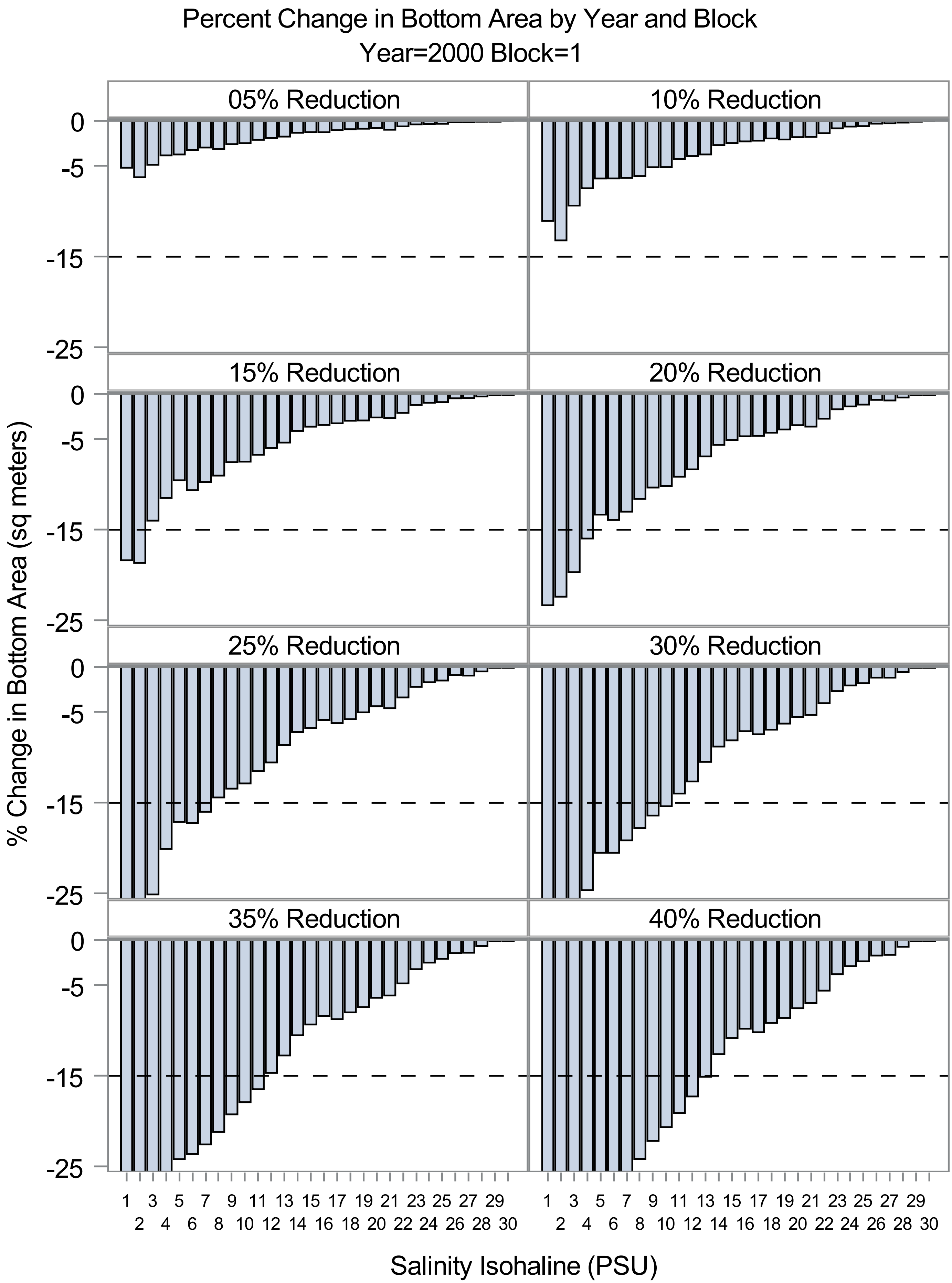
Percent Change in Bottom Area by Year Across Blocks
Year=2002
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)

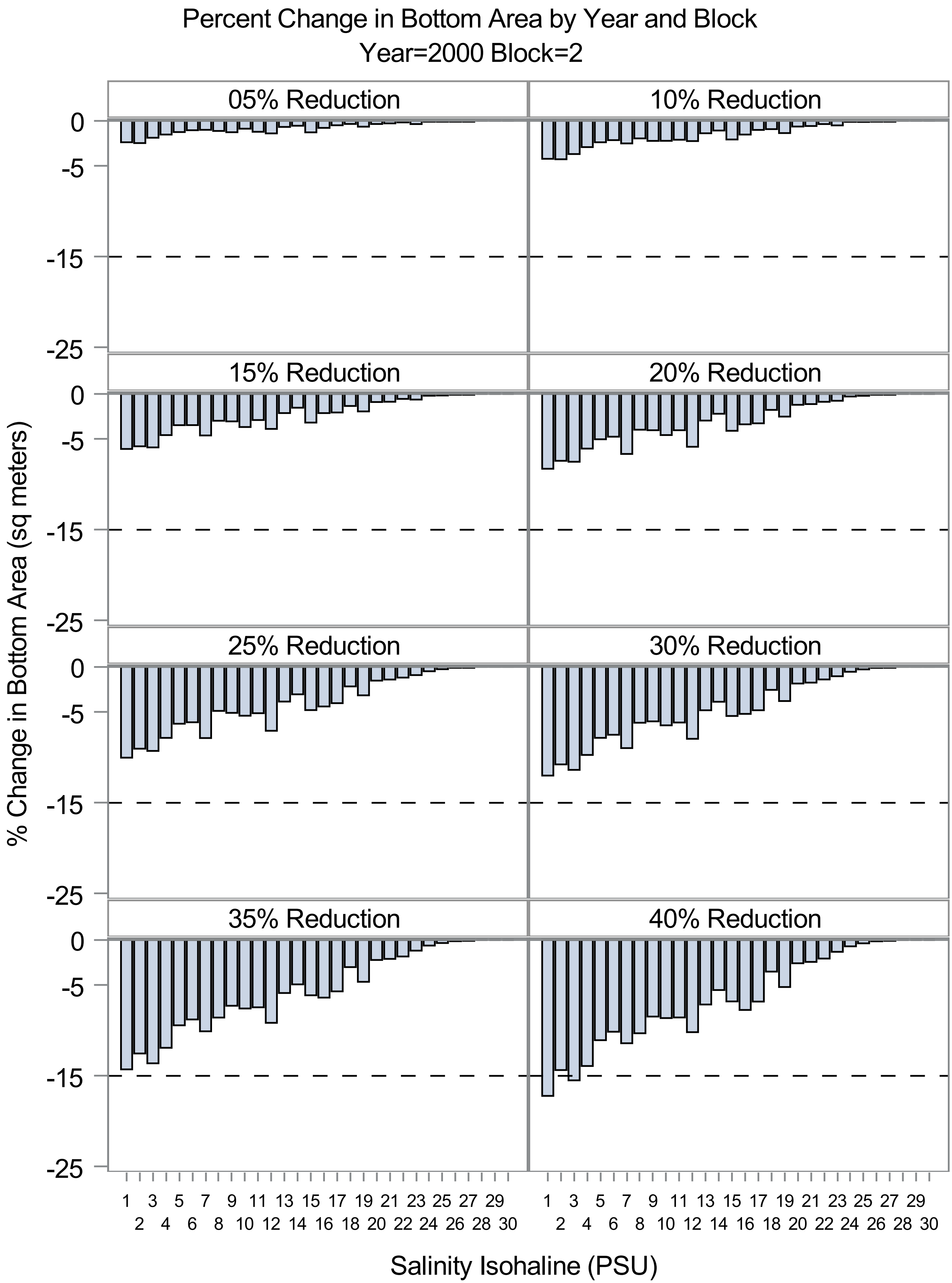


Percent Change in Bottom Area by Year Across Blocks
Year=2003
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
% Change in Bottom Area (sq meters)
0
-5
-15
-25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

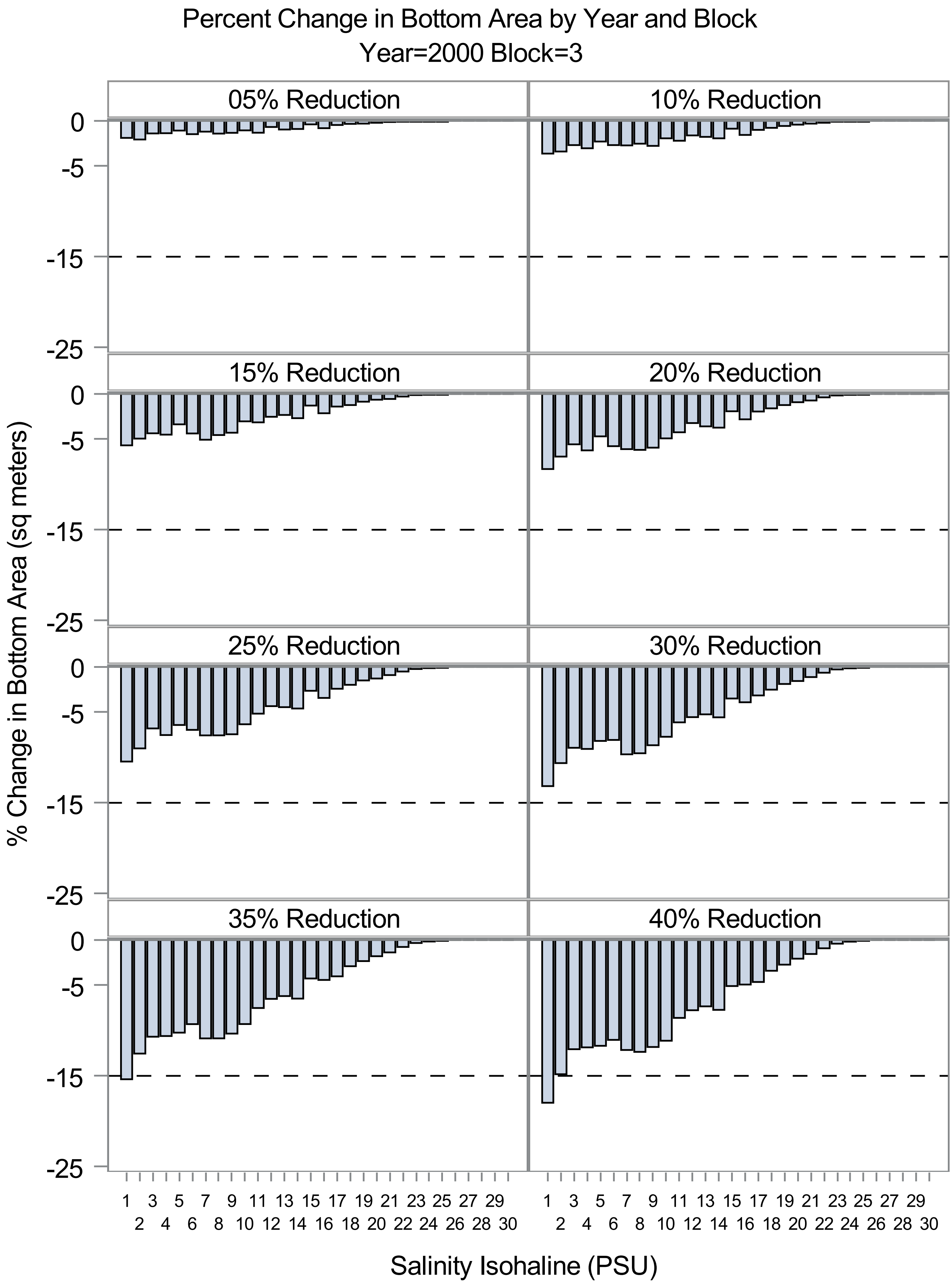


Percent Change in Bottom Area by Year Across Blocks
Year=2004
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

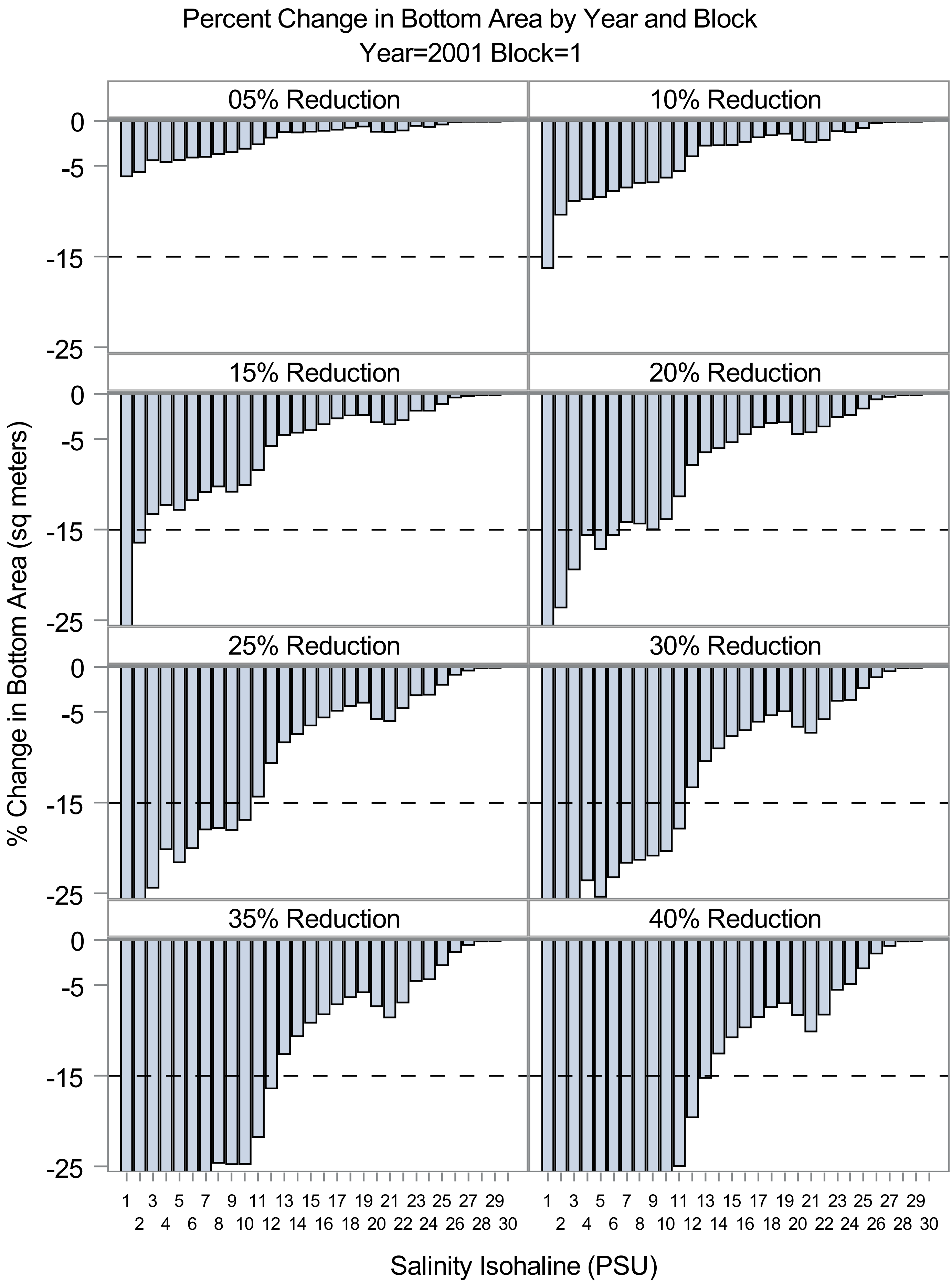

Percent Change in Bottom Area by Year and Block
Year=2000 Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



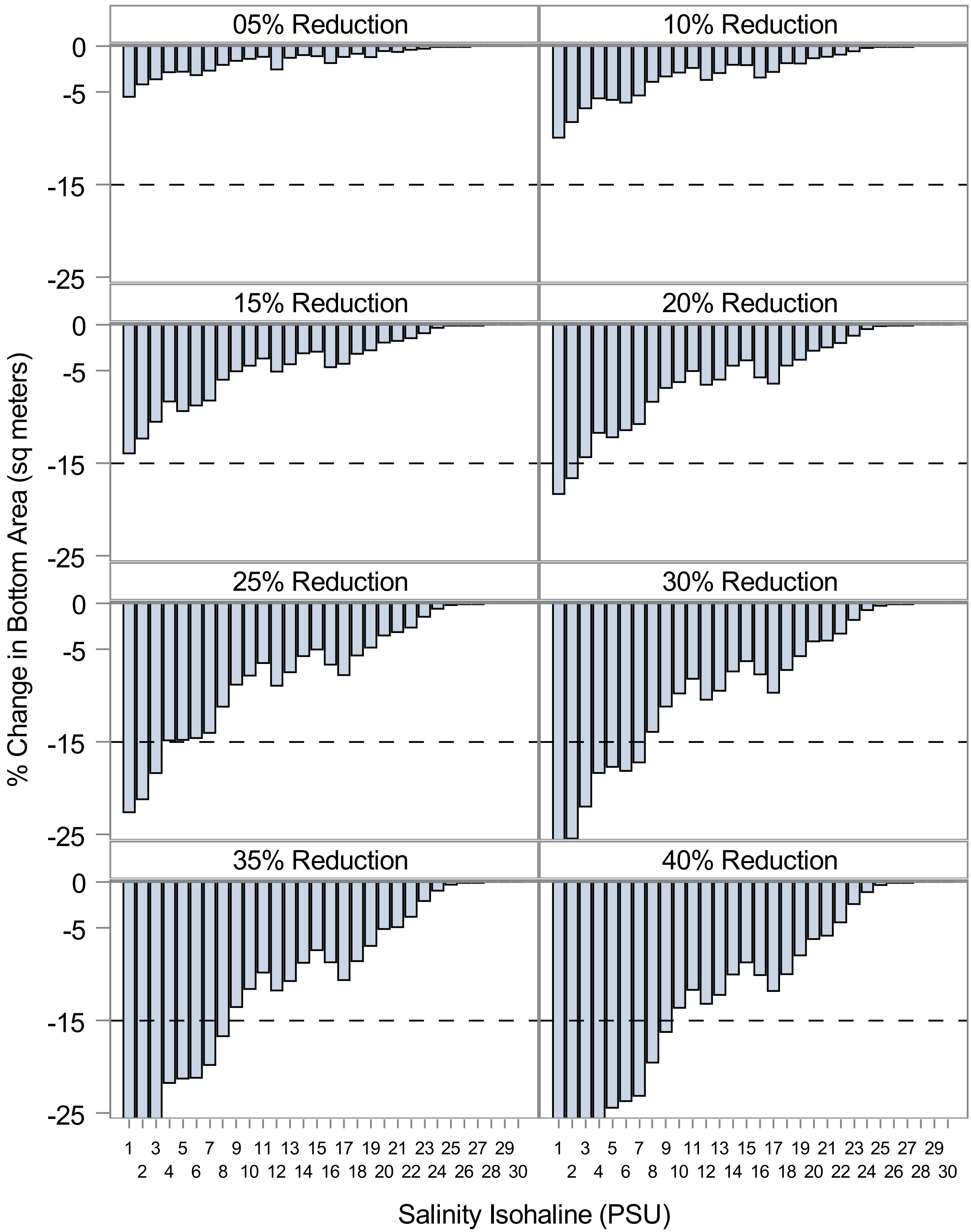
Percent Change in Bottom Area by Year and Block
Year=2000 Block=2
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

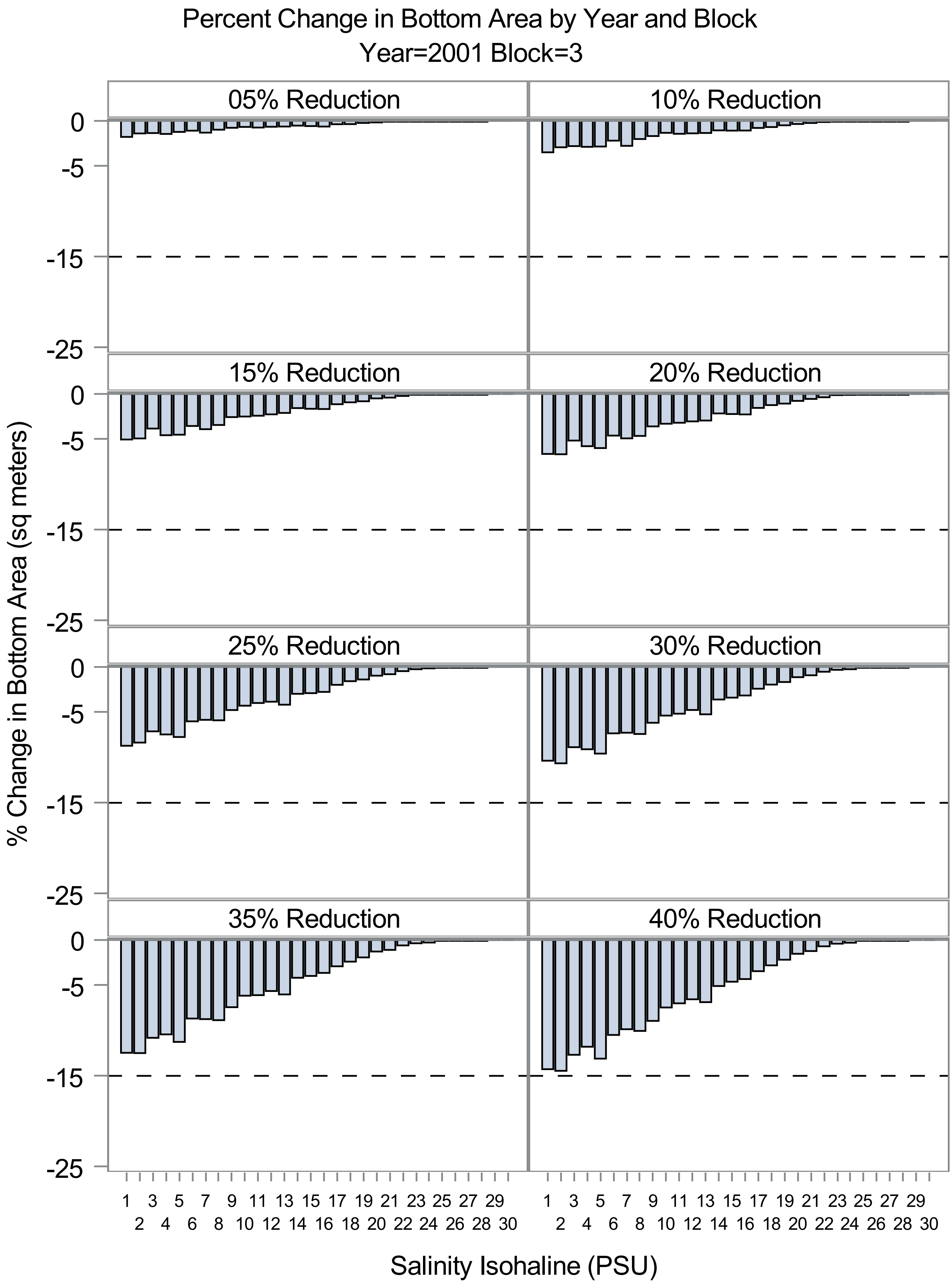


Percent Change in Bottom Area by Year and Block
Year=2000 Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

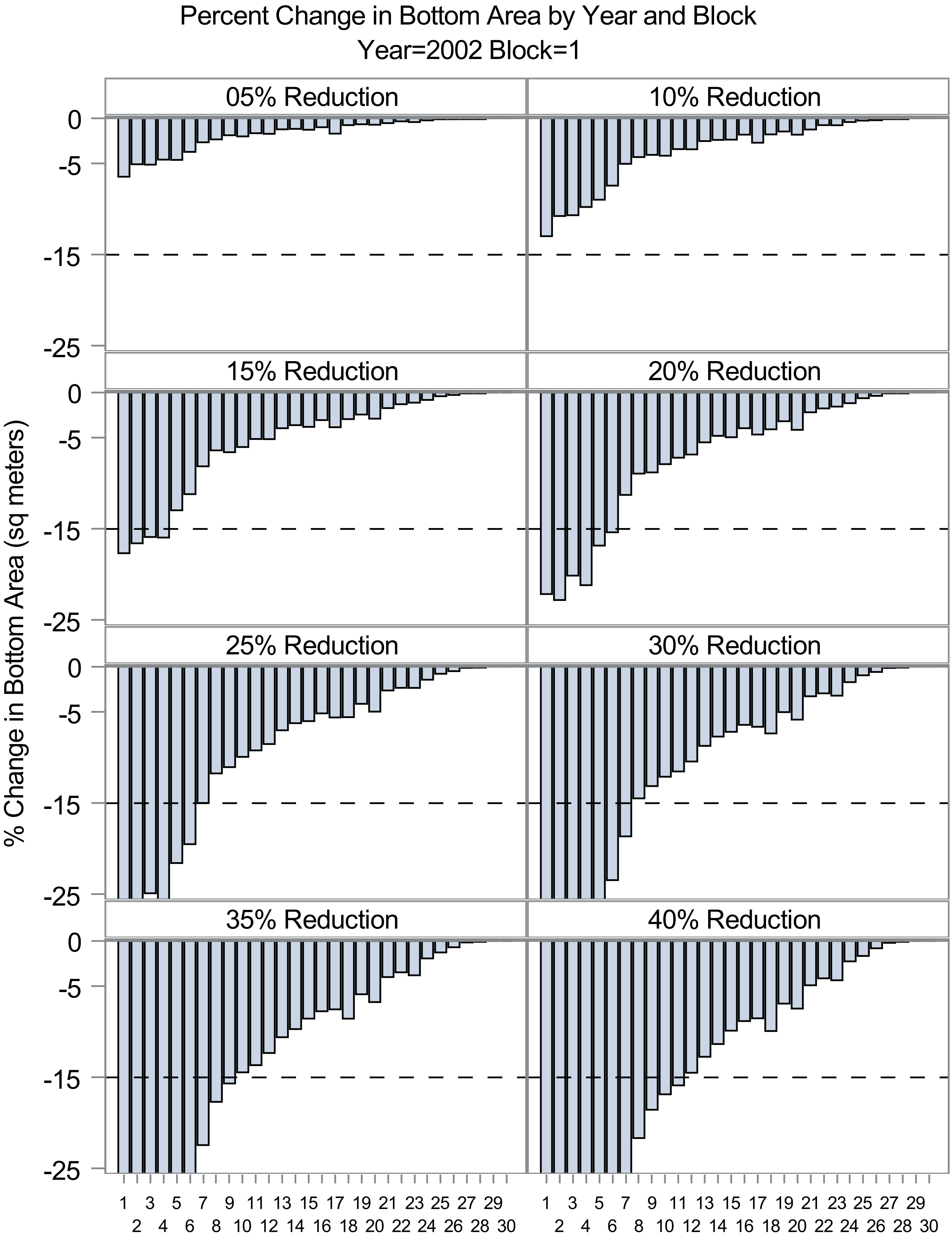

Percent Change in Bottom Area by Year and Block
Year=2001 Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
% Change in Bottom Area (sq meters)
0
-5
-15
-25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

Percent Change in Bottom Area by Year and Block
Year=2001 Block=2

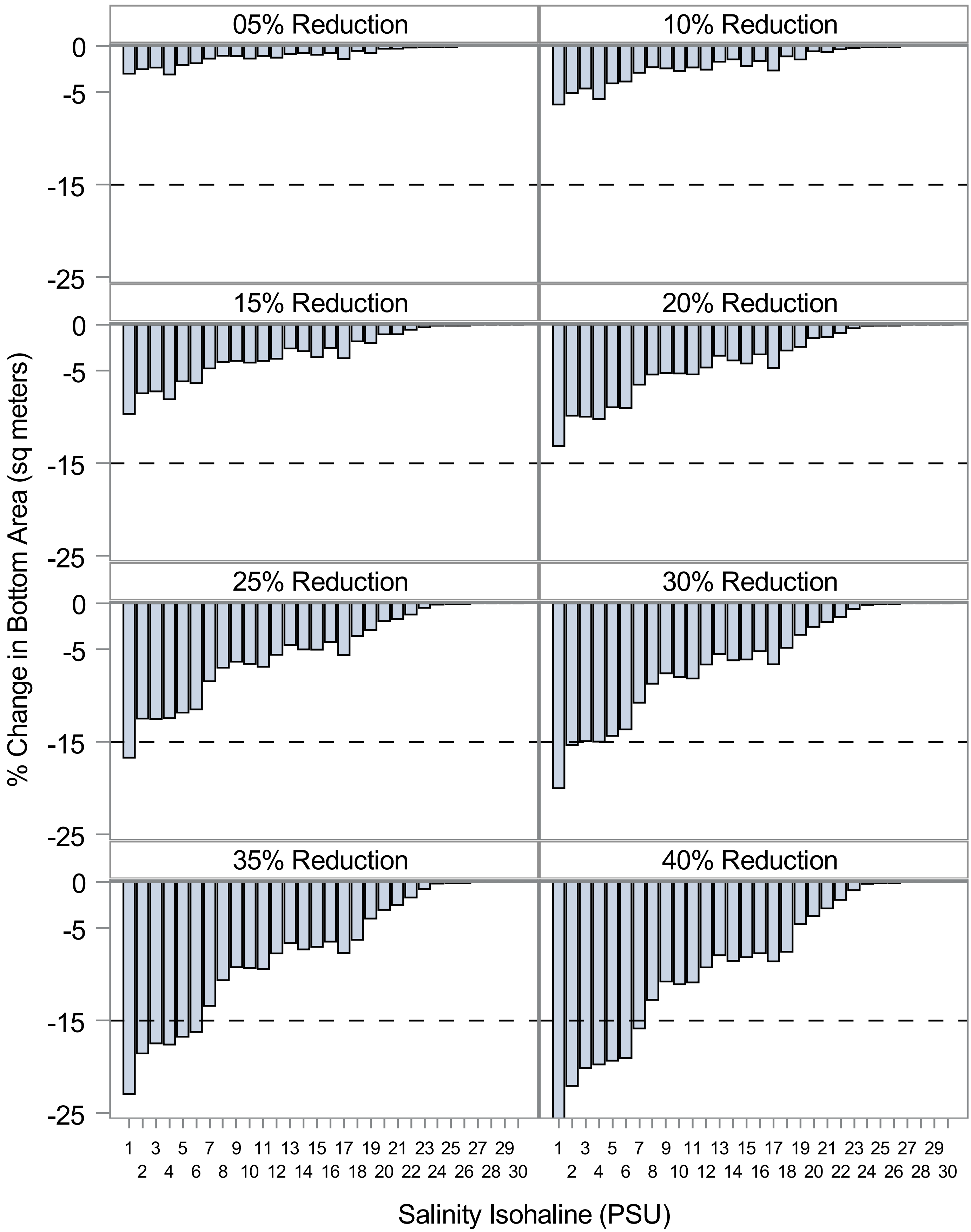


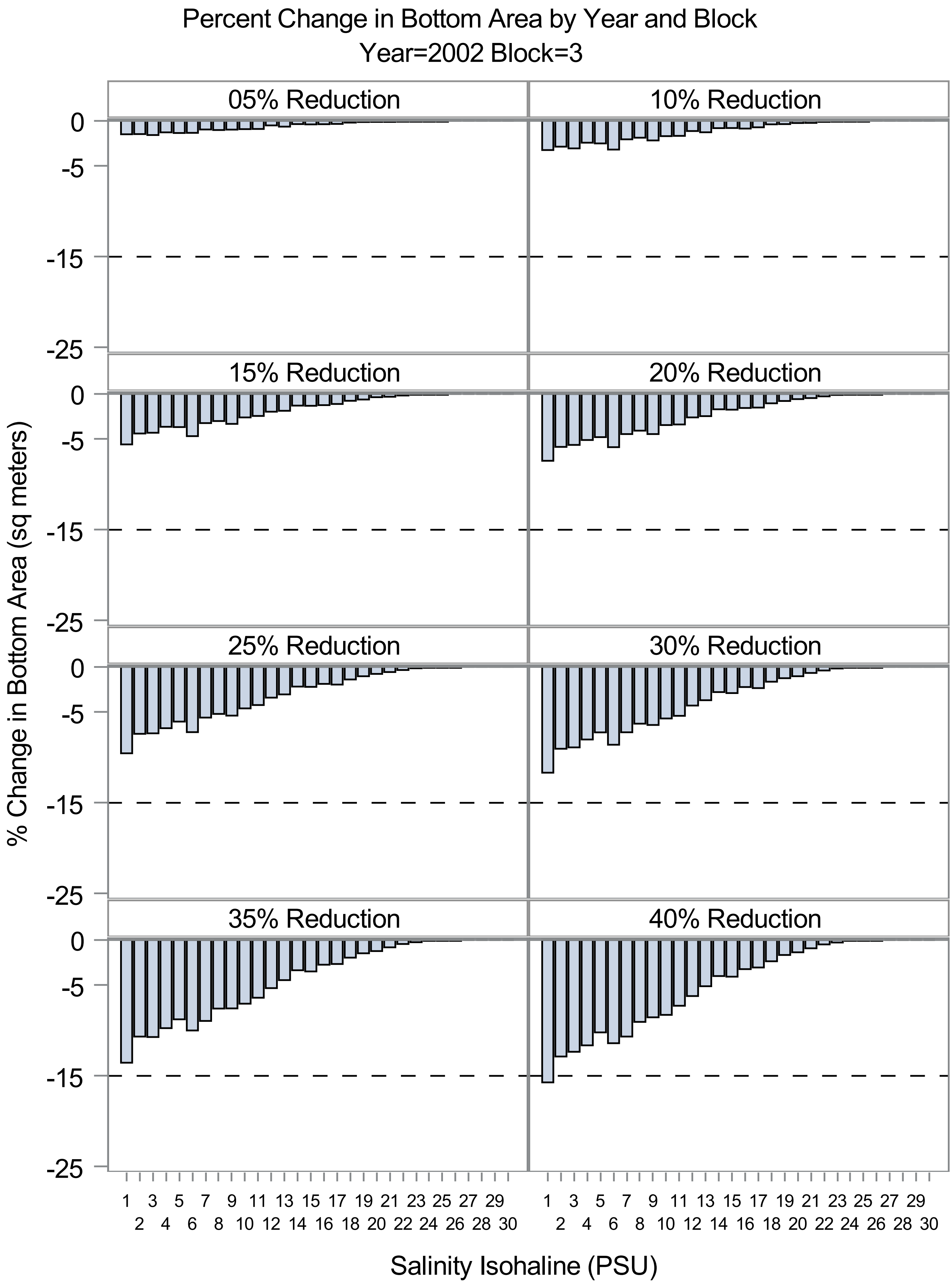


Percent Change in Bottom Area by Year and Block
Year=2001 Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

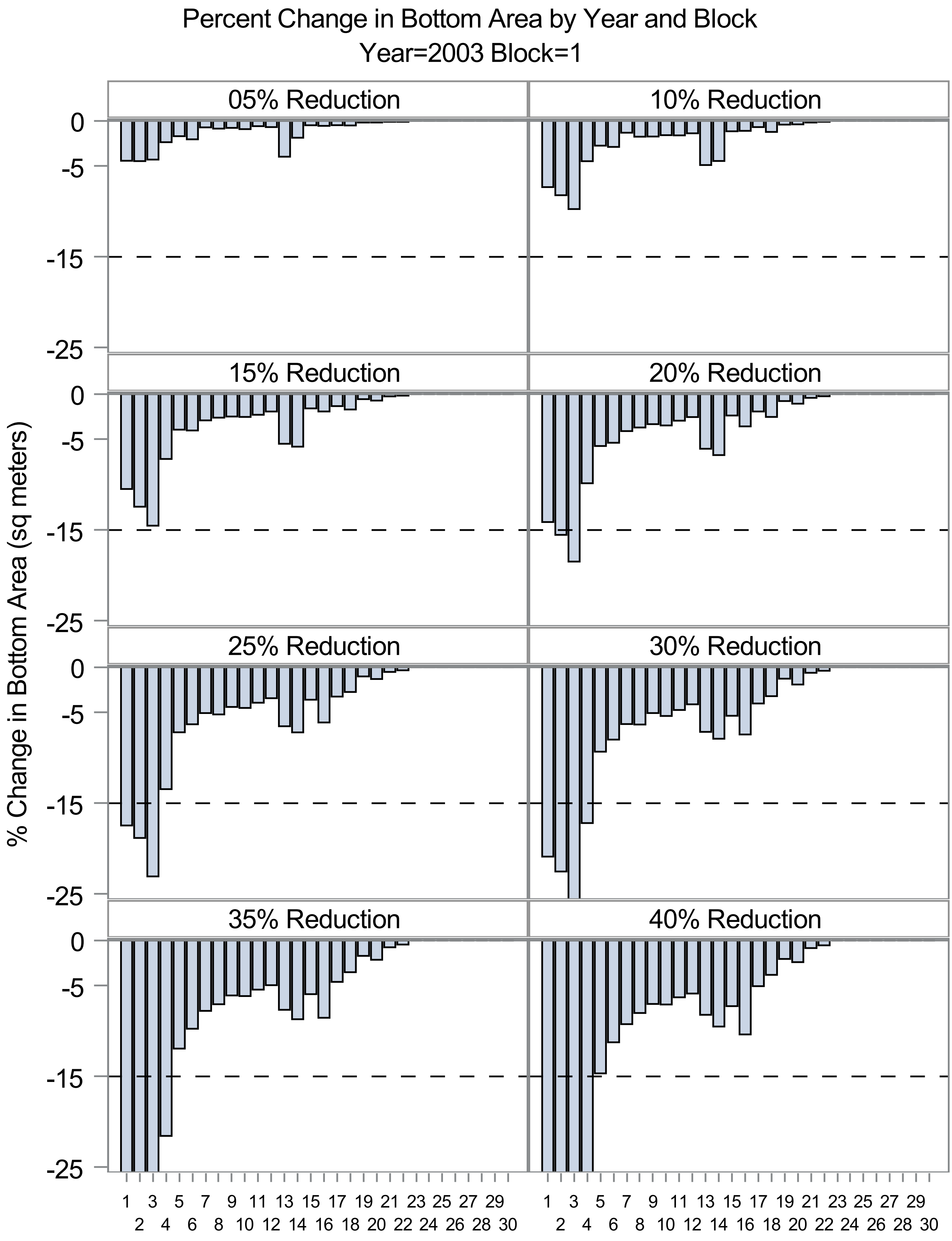

Percent Change in Bottom Area by Year and Block
Year=2002 Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)

Percent Change in Bottom Area by Year and Block
Year=2002 Block=2

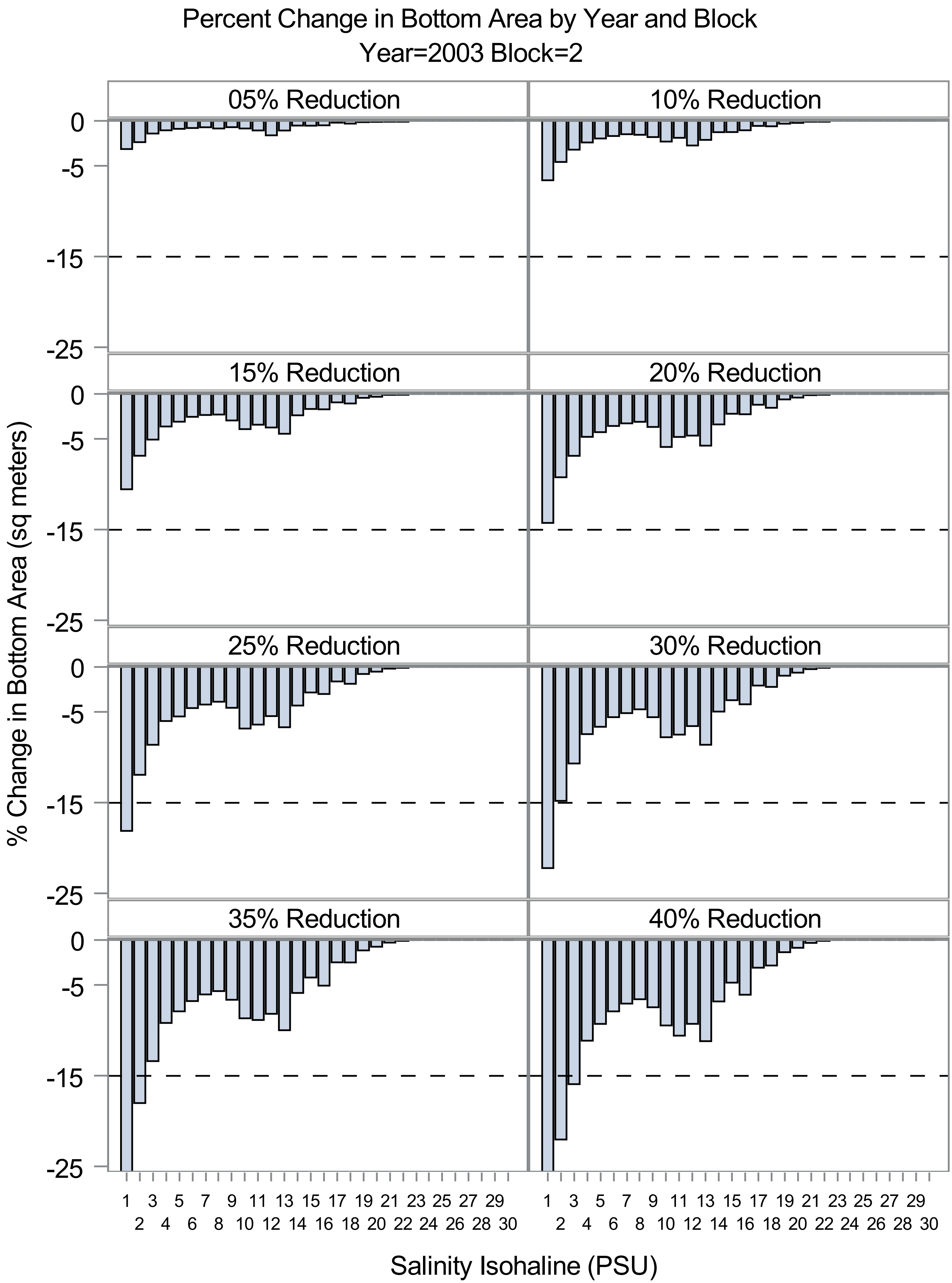




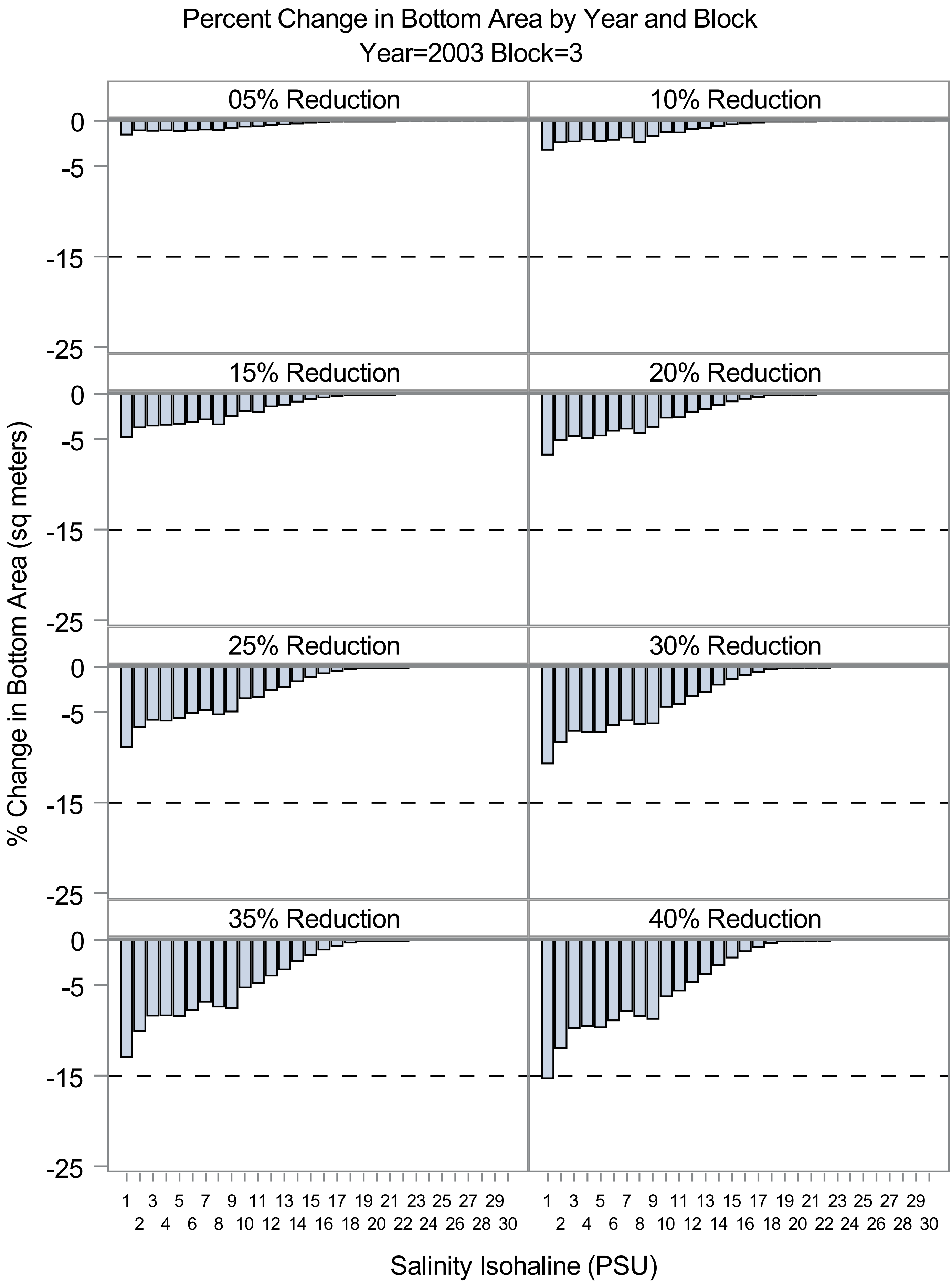
Percent Change in Bottom Area by Year and Block
Year=2002 Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



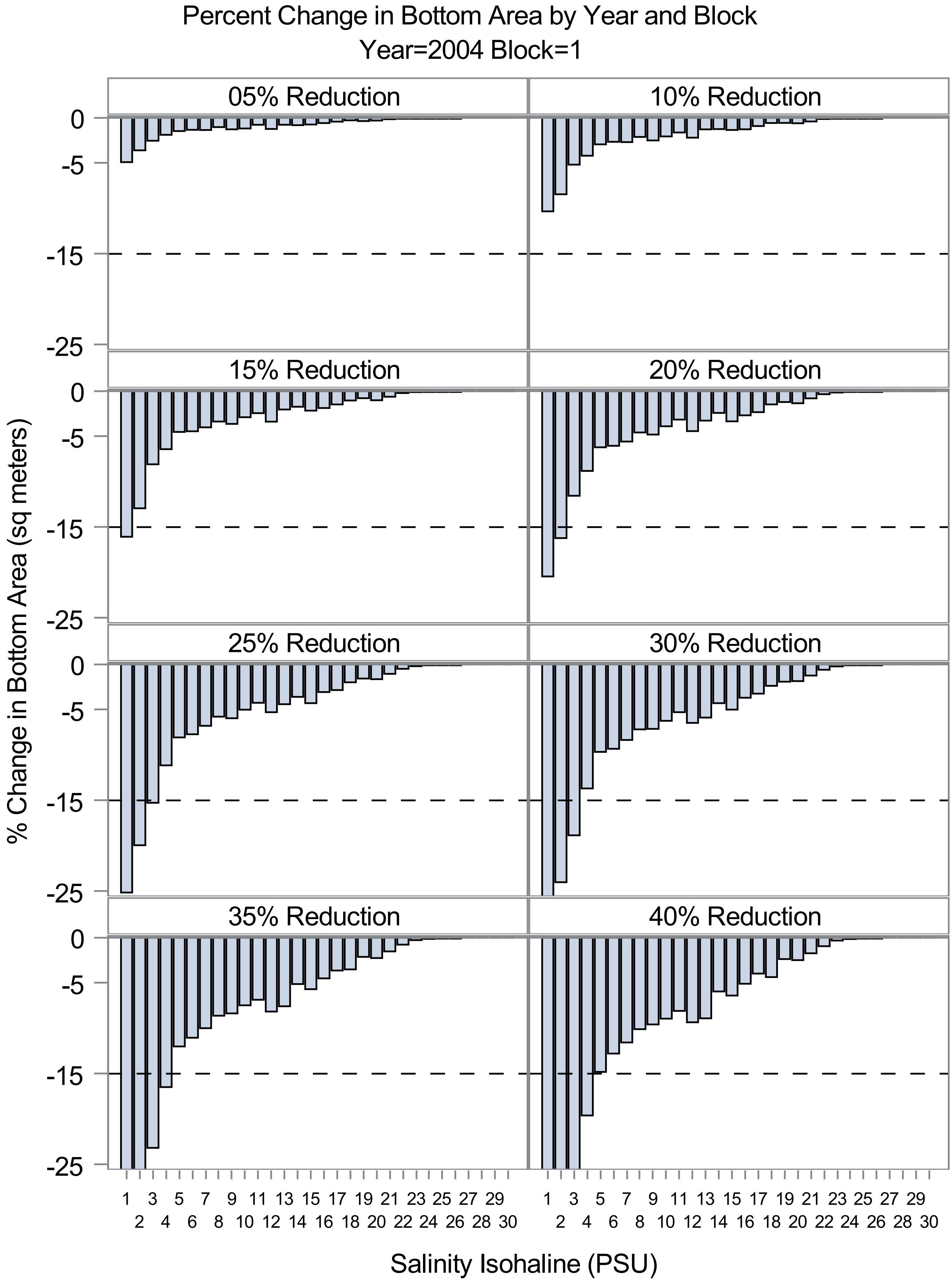
Percent Change in Bottom Area by Year and Block
Year=2003 Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



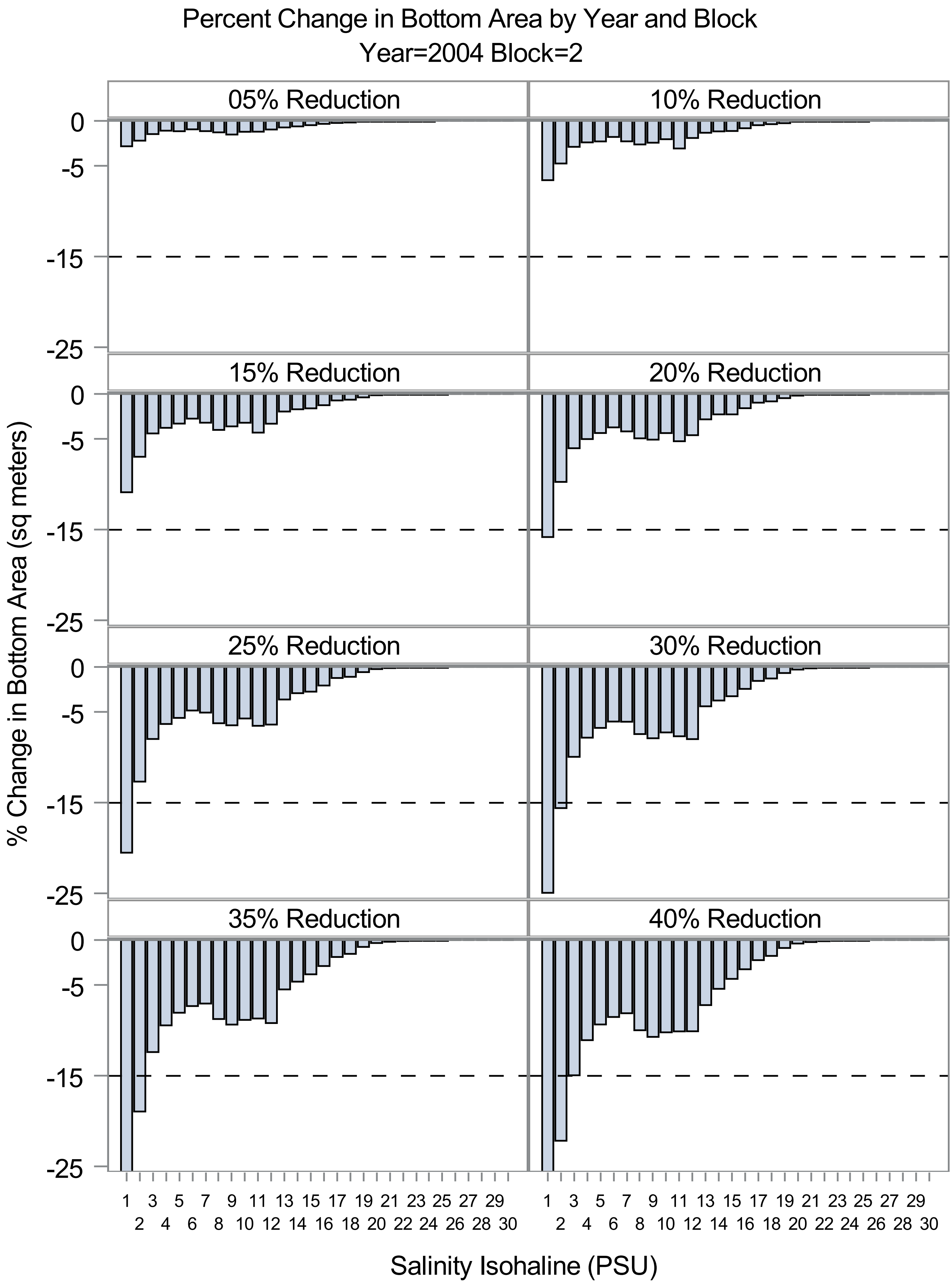
Percent Change in Bottom Area by Year and Block
Year=2003 Block=2
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)



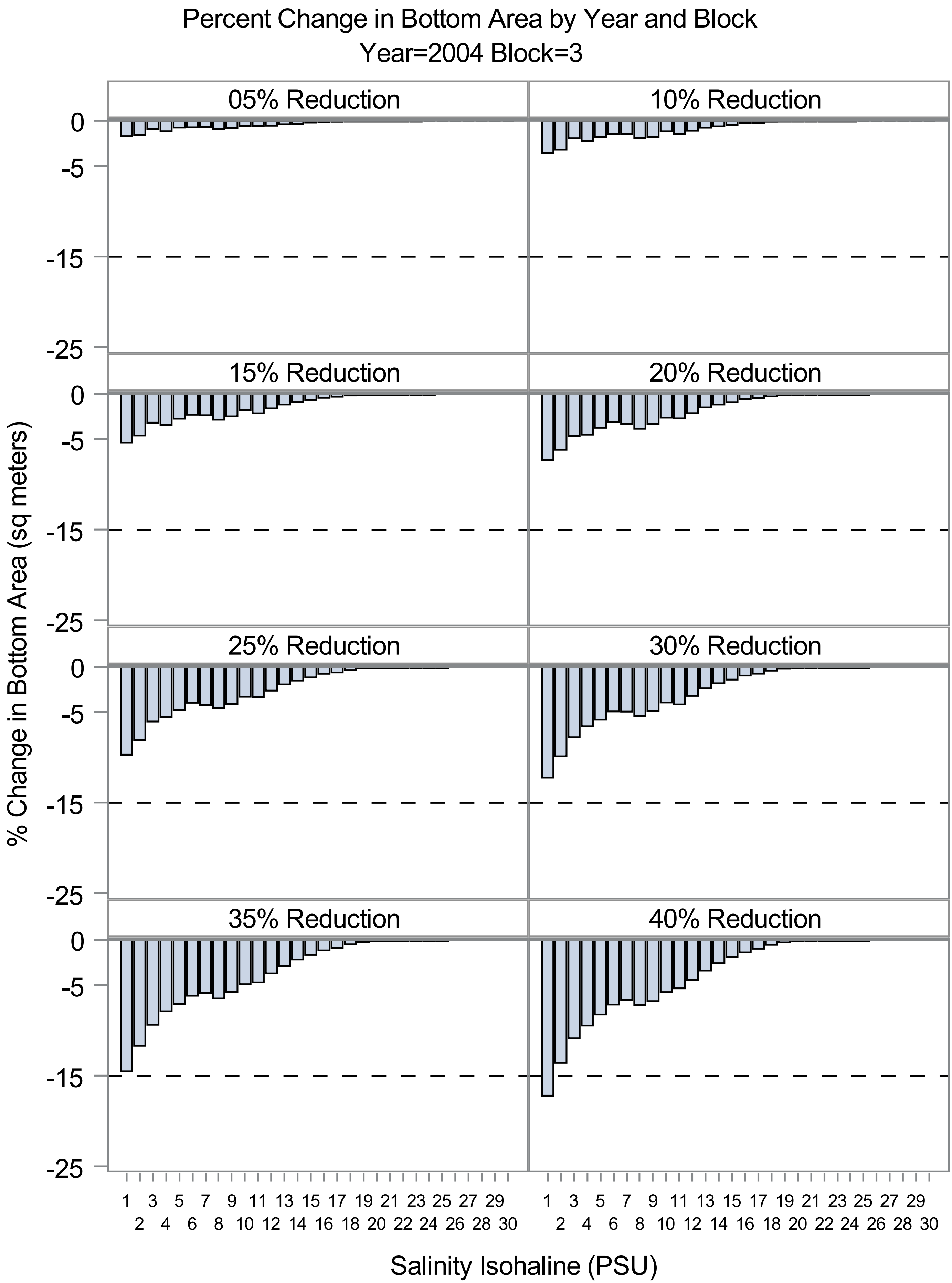
Percent Change in Bottom Area by Year and Block
Year=2003 Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



Percent Change in Bottom Area by Year and Block
Year=2004 Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)



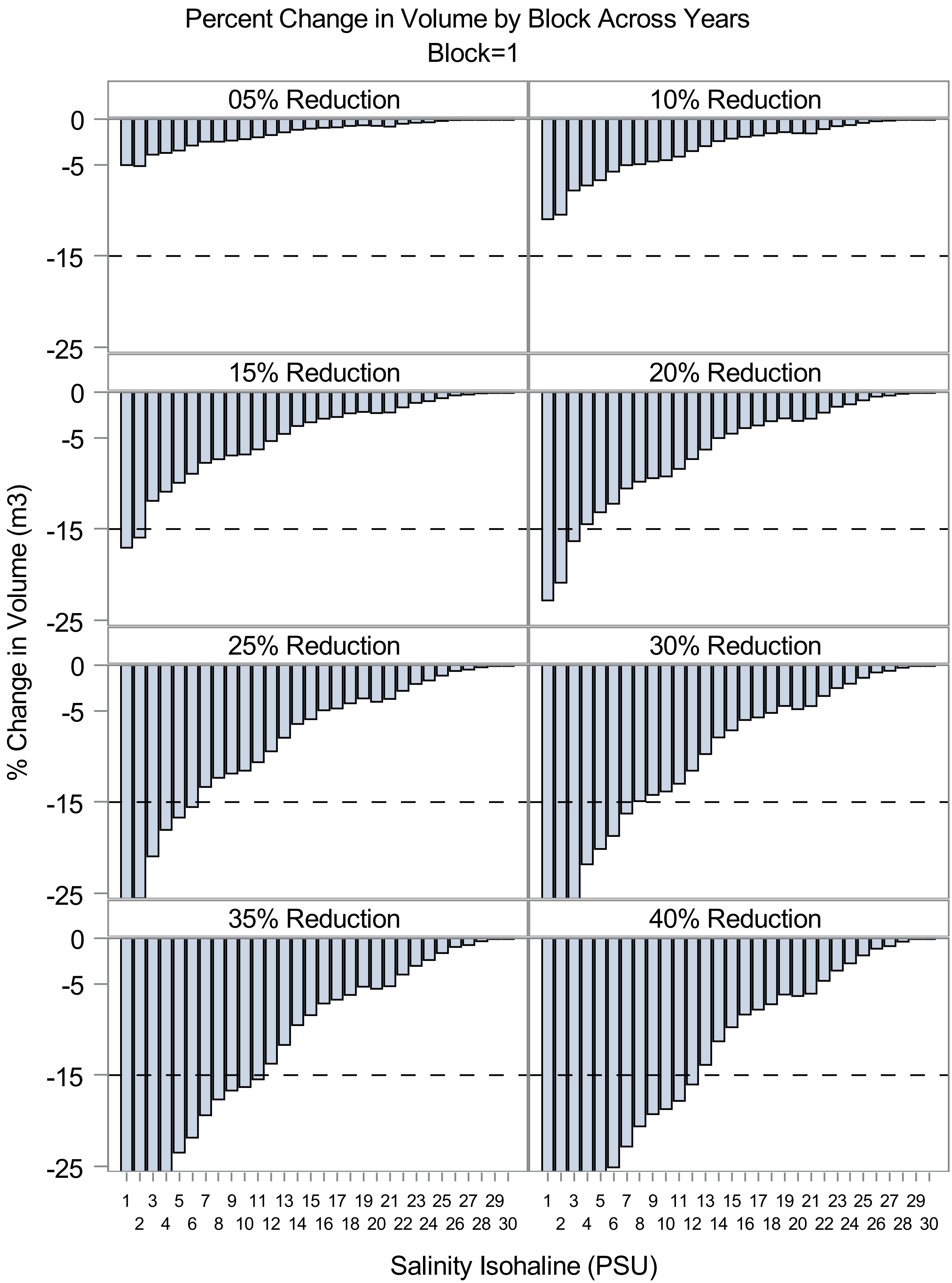
Percent Change in Bottom Area by Year and Block
Year=2004 Block=2
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



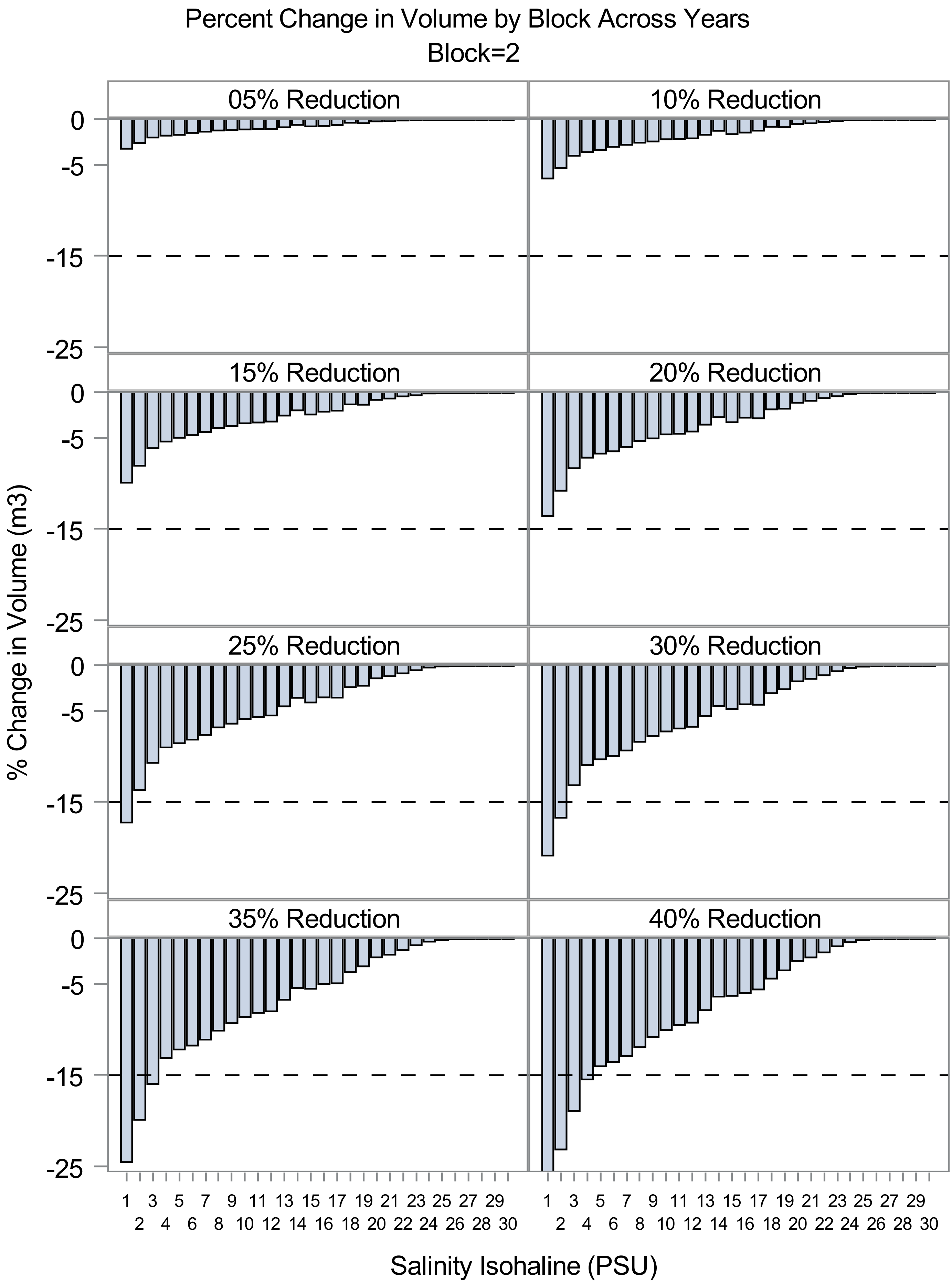
Percent Change in Bottom Area by Year and Block
Year=2004 Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Bottom Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

Appendix C

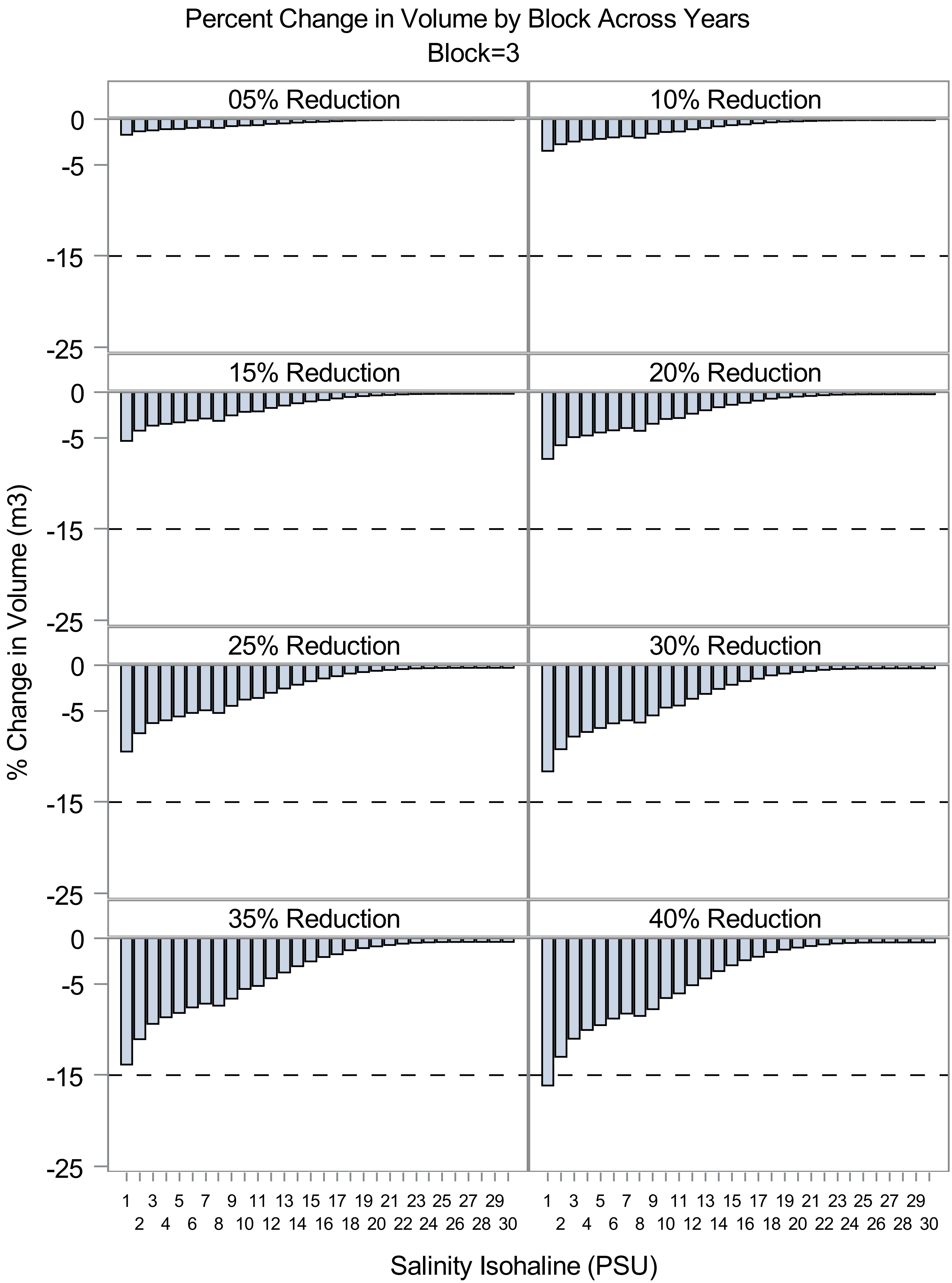
Plots of Percent Reductions in Salinity Isohaline Volume by Block, Year, and Year/Block Combinations



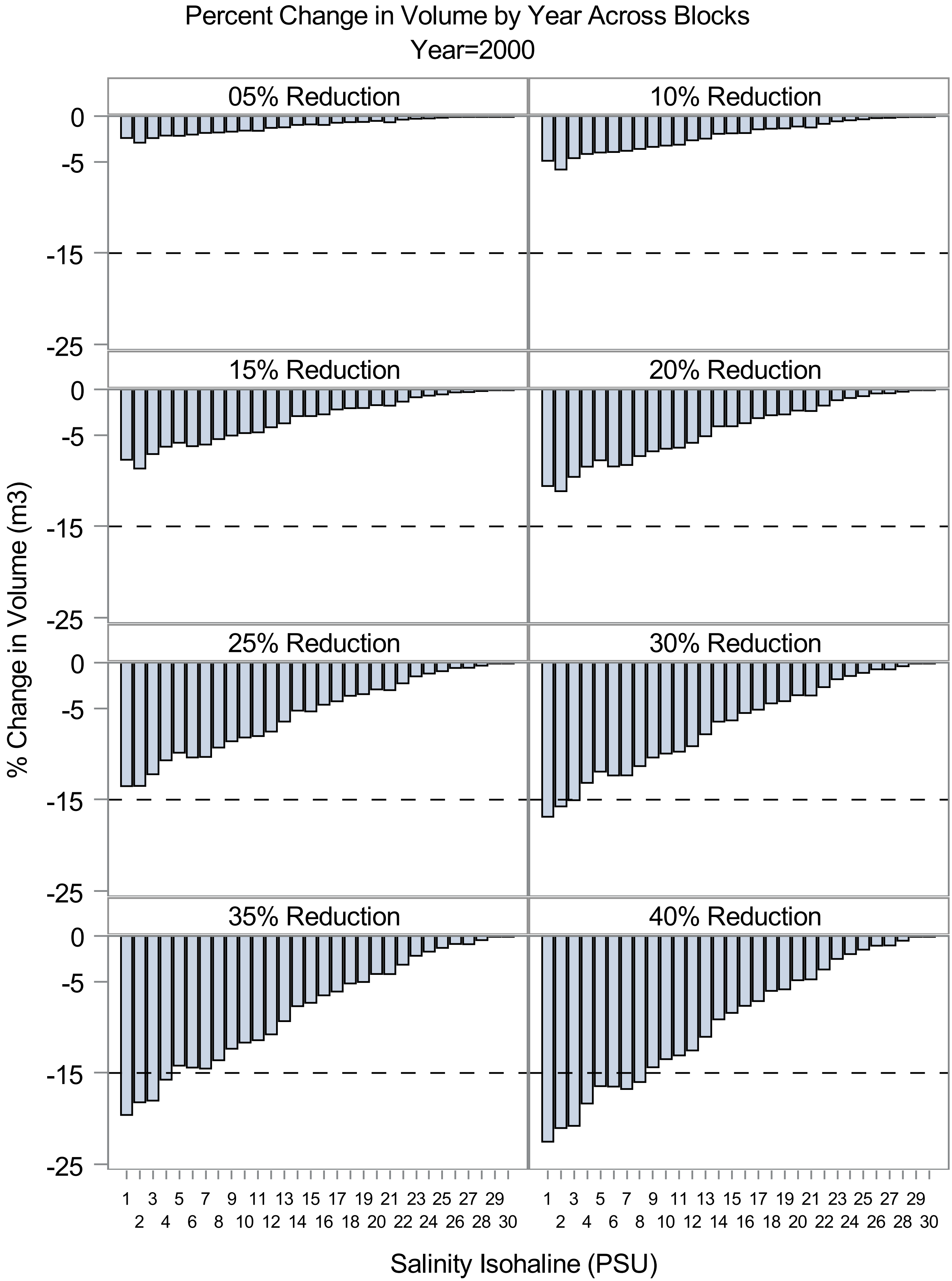
Percent Change in Volume by Block Across Years
Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



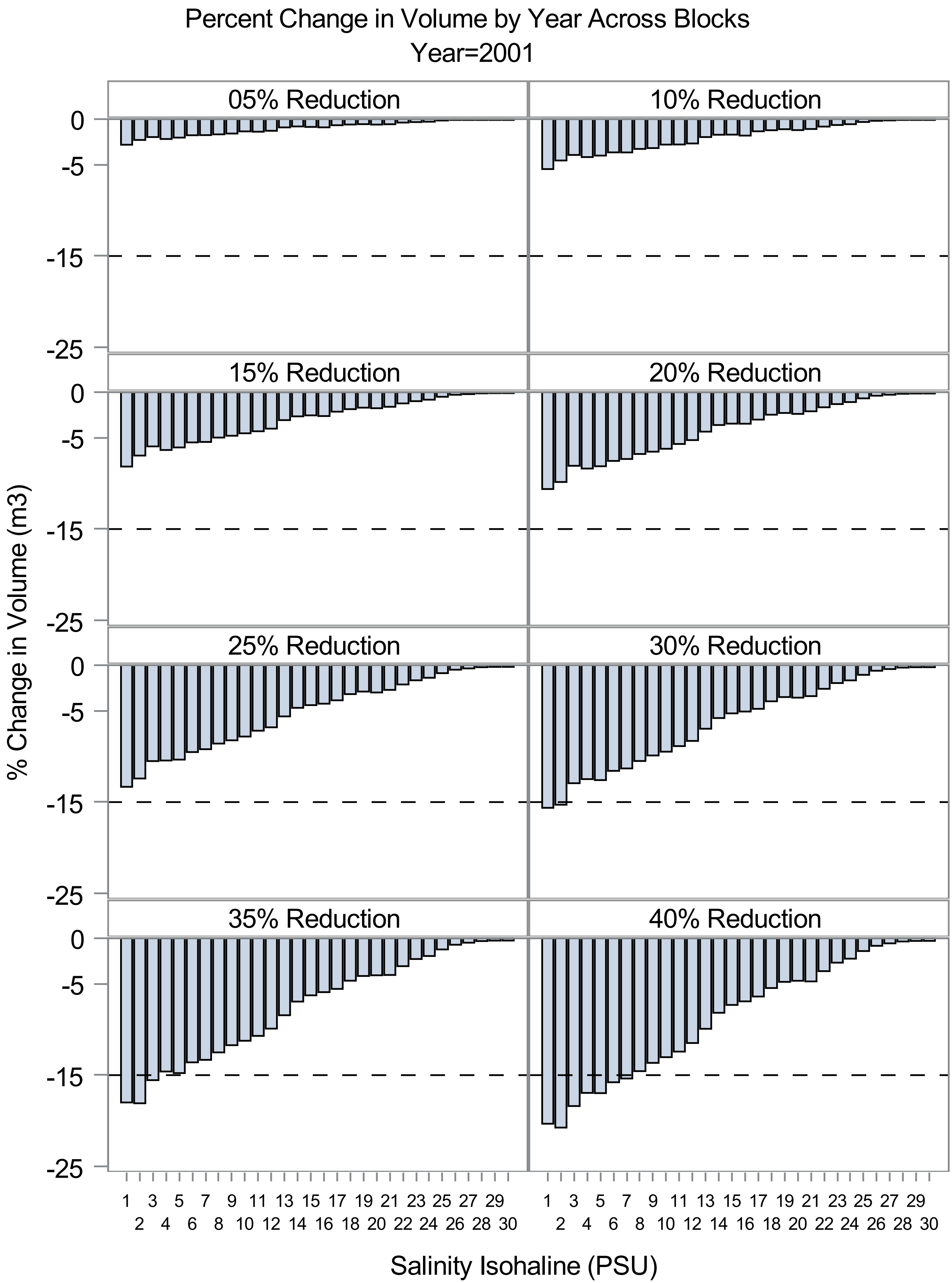
Percent Change in Volume by Block Across Years
Block=2
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



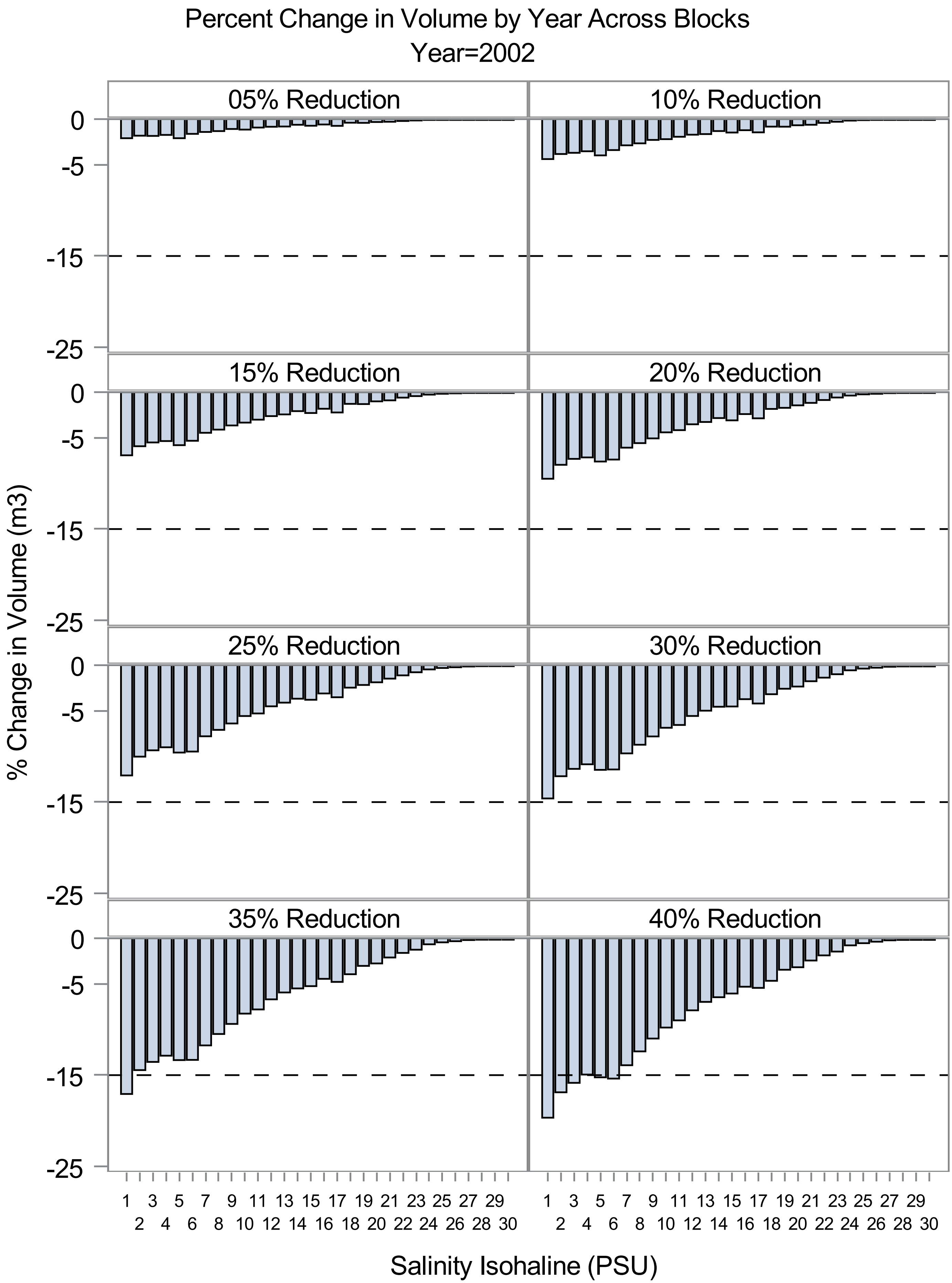
Percent Change in Volume by Block Across Years
Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



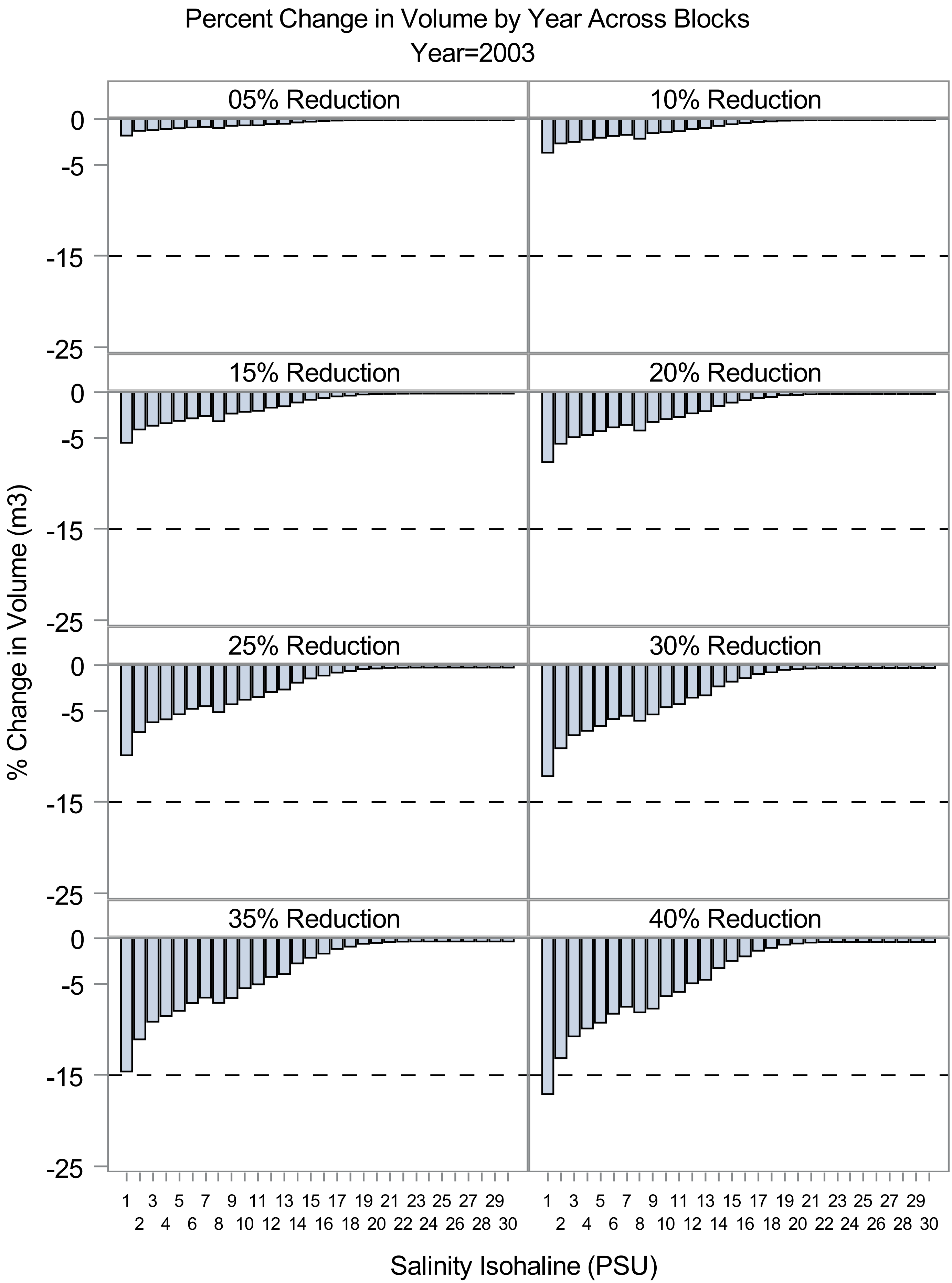
Percent Change in Volume by Year Across Blocks
Year=2000
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



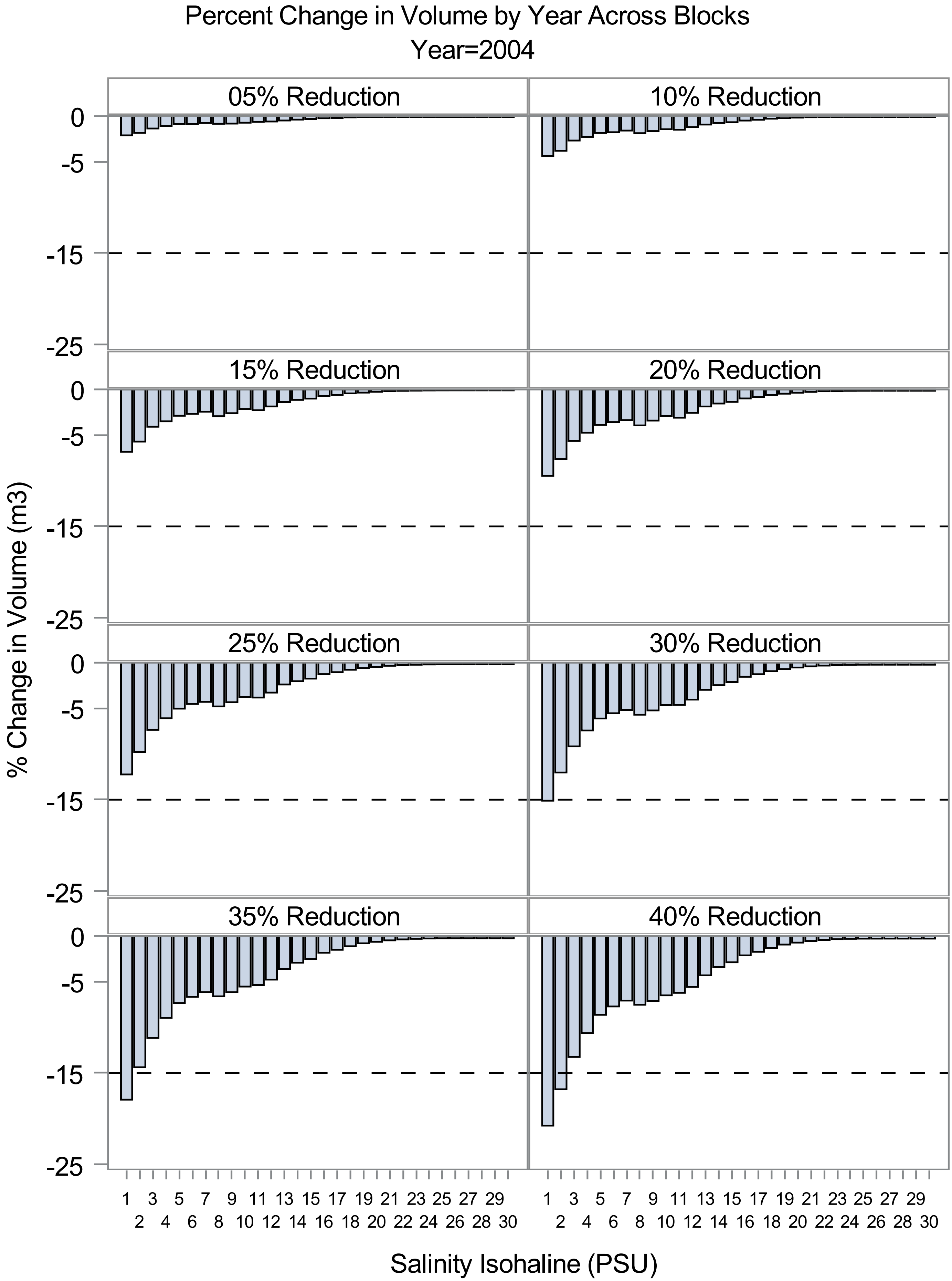
Percent Change in Volume by Year Across Blocks
Year=2001
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



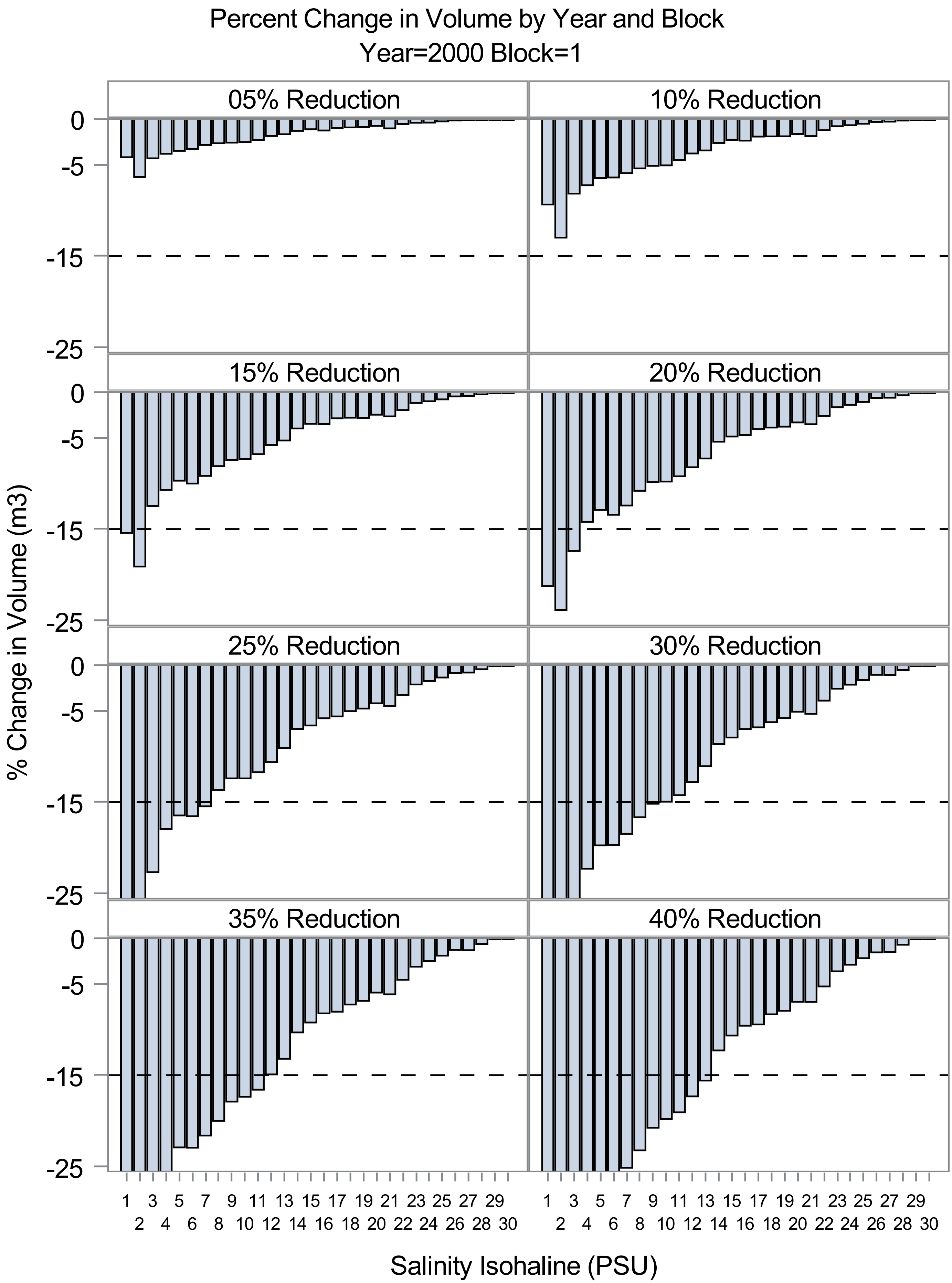
Percent Change in Volume by Year Across Blocks
Year=2002
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



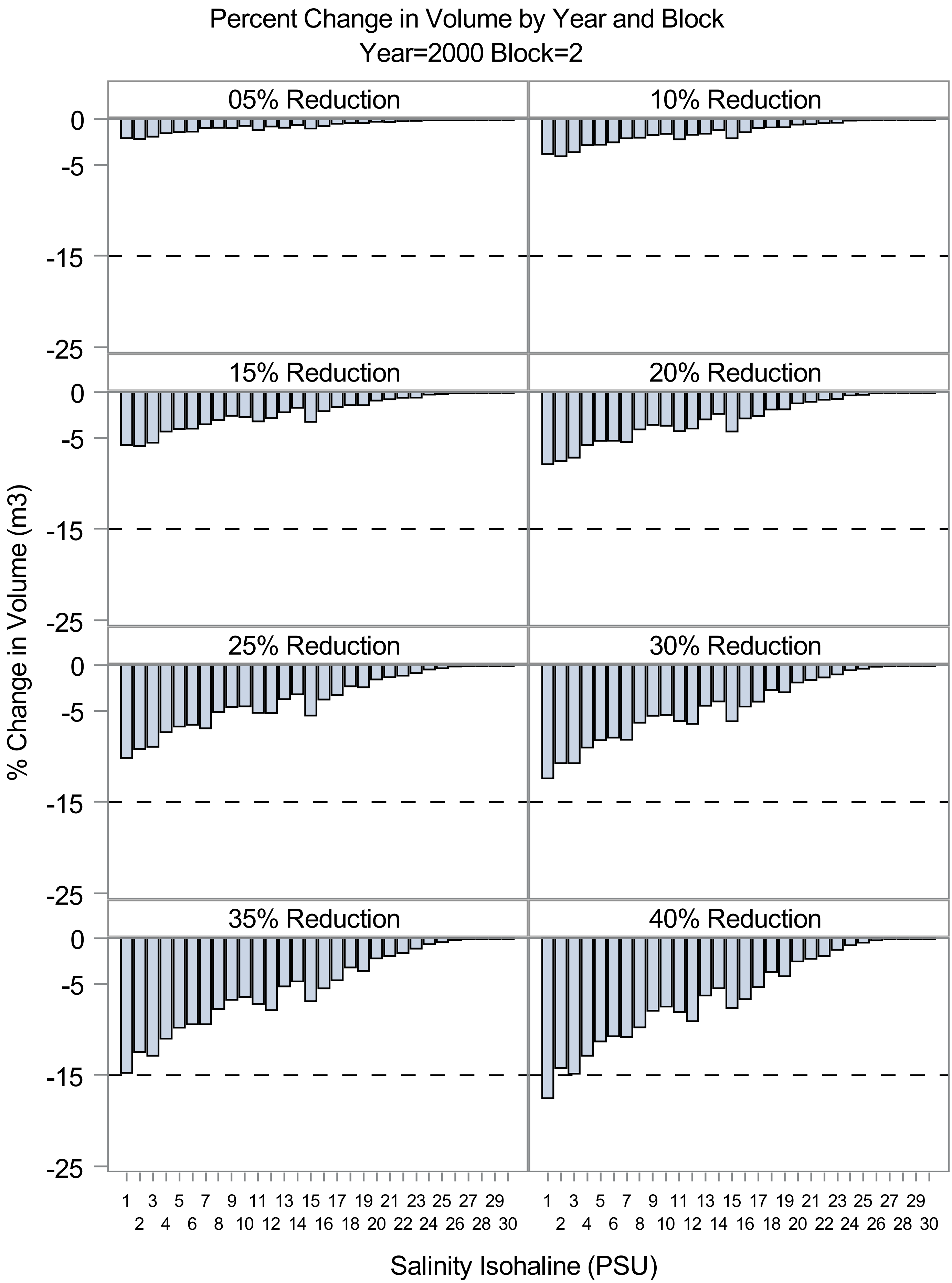
Percent Change in Volume by Year Across Blocks
Year=2003
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



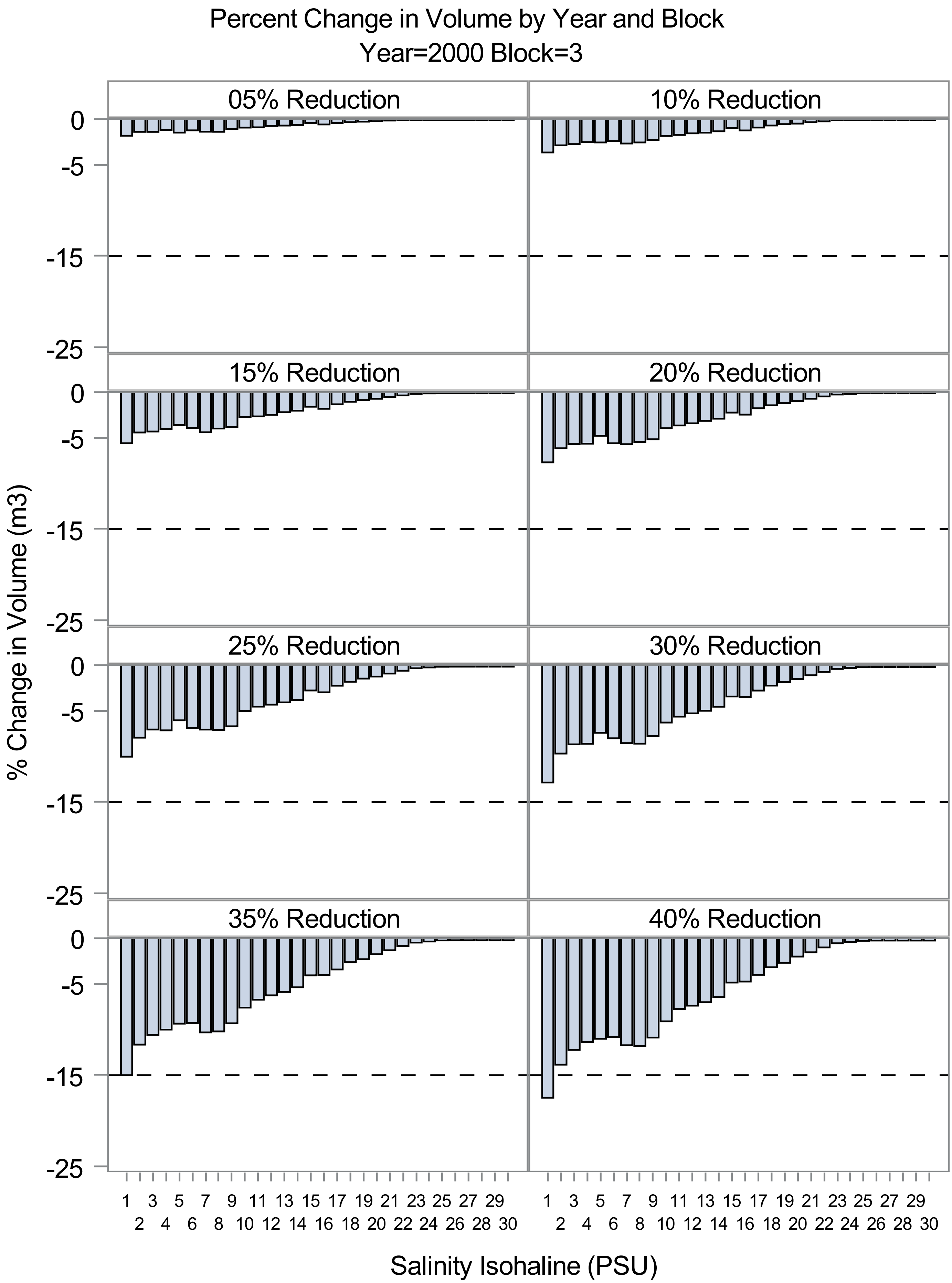
Percent Change in Volume by Year Across Blocks
Year=2004
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



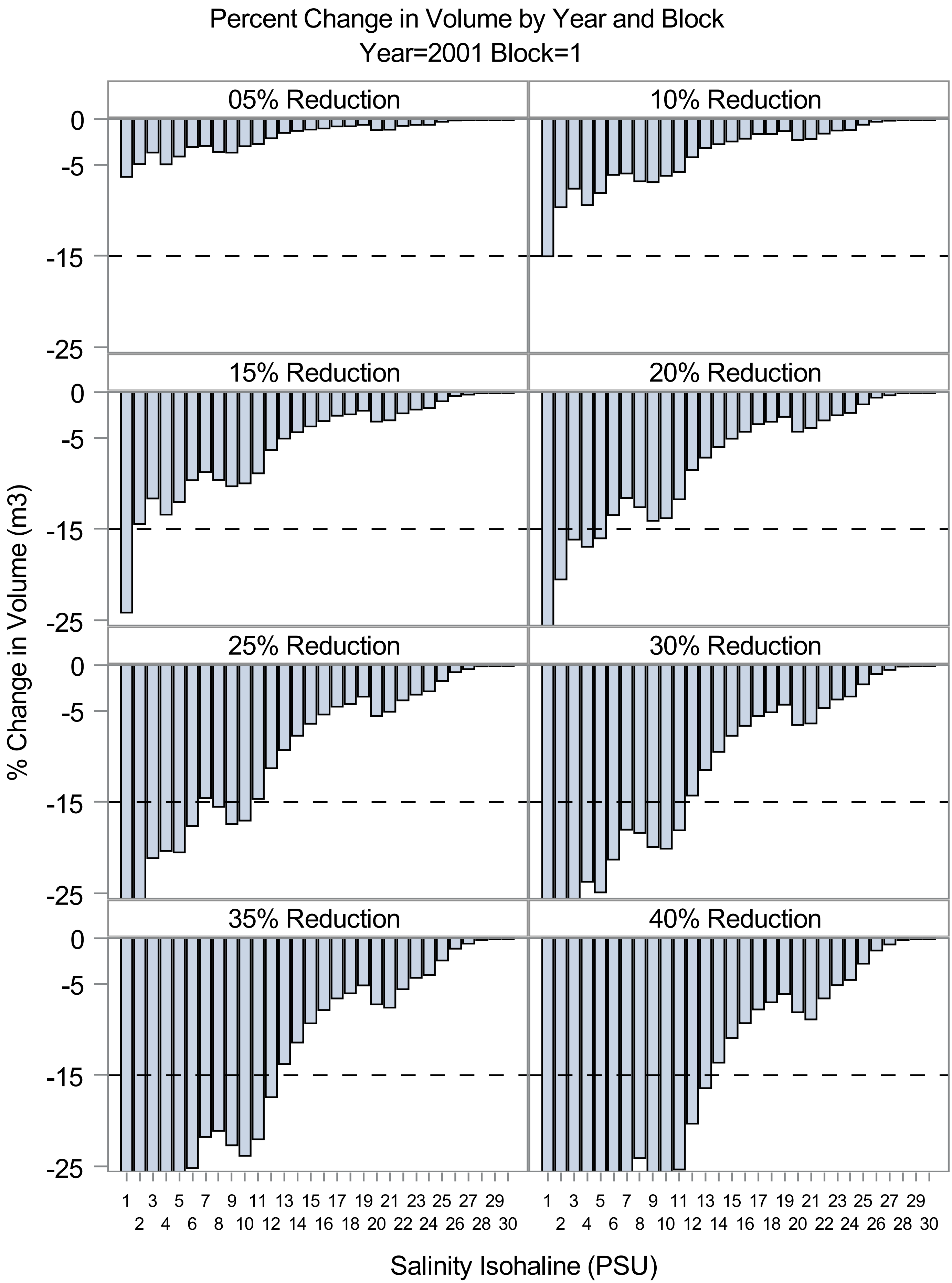
Percent Change in Volume by Year and Block
Year=2000 Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)



Percent Change in Volume by Year and Block
Year=2000 Block=2
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)

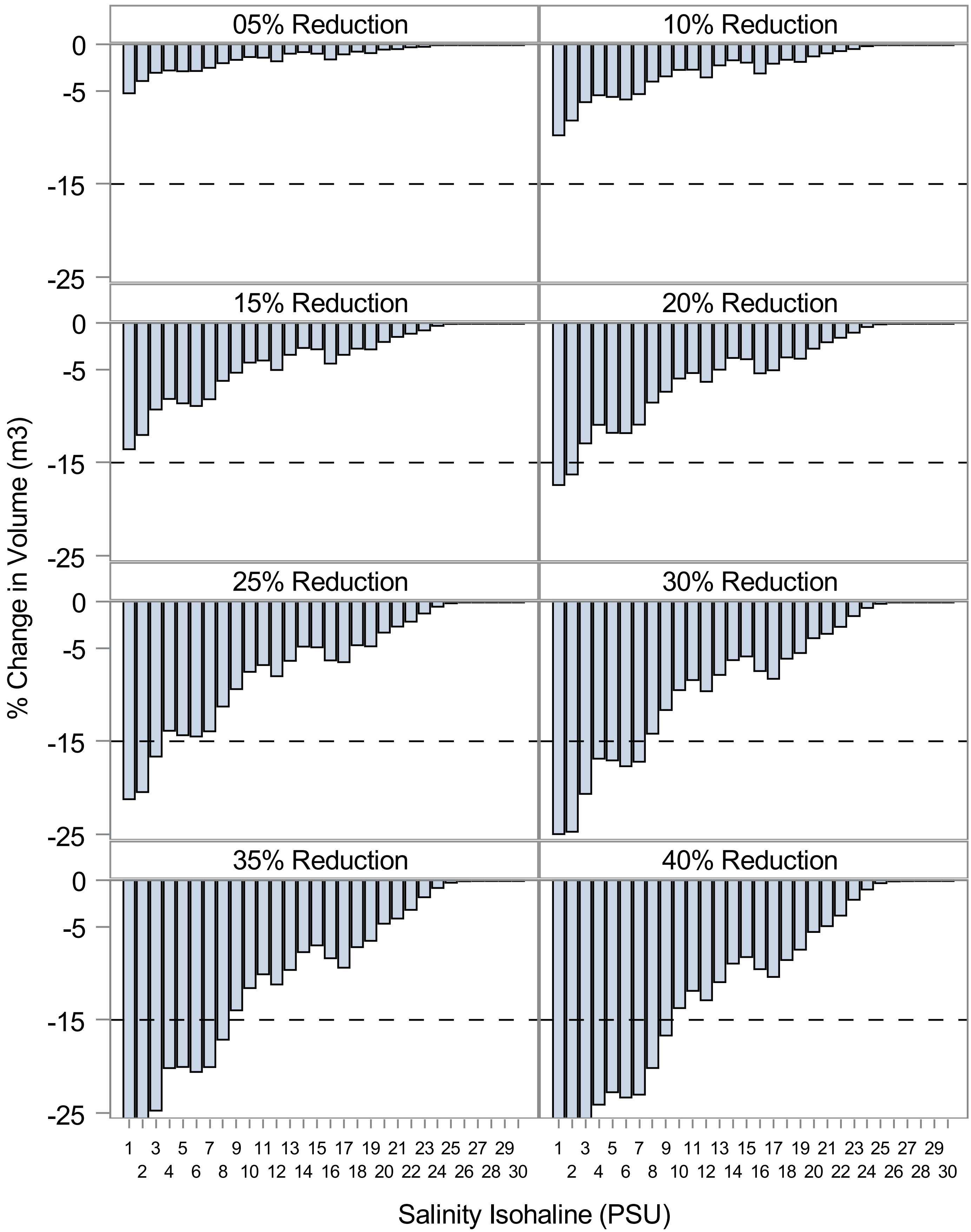


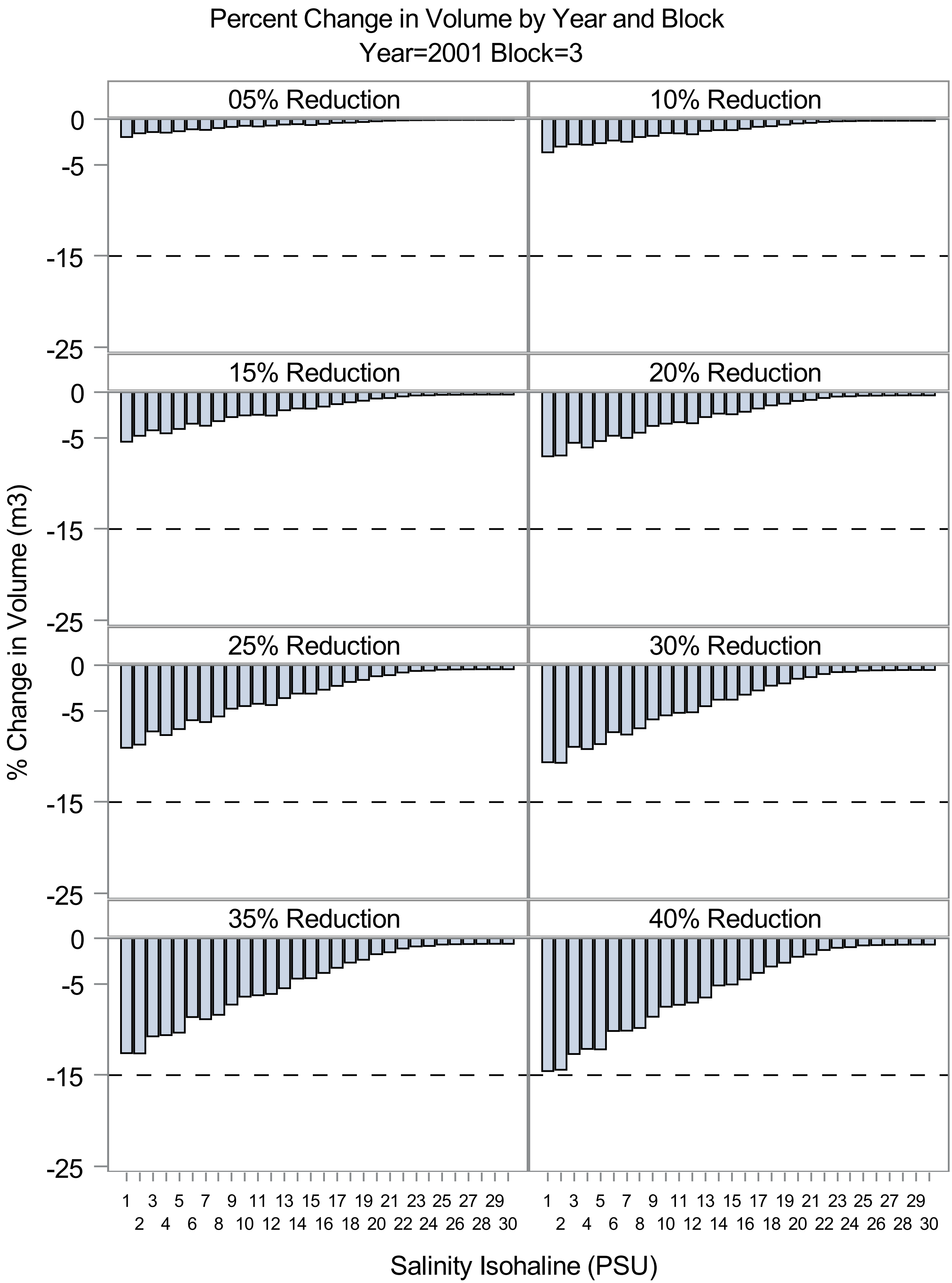
Percent Change in Volume by Year and Block
Year=2000 Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

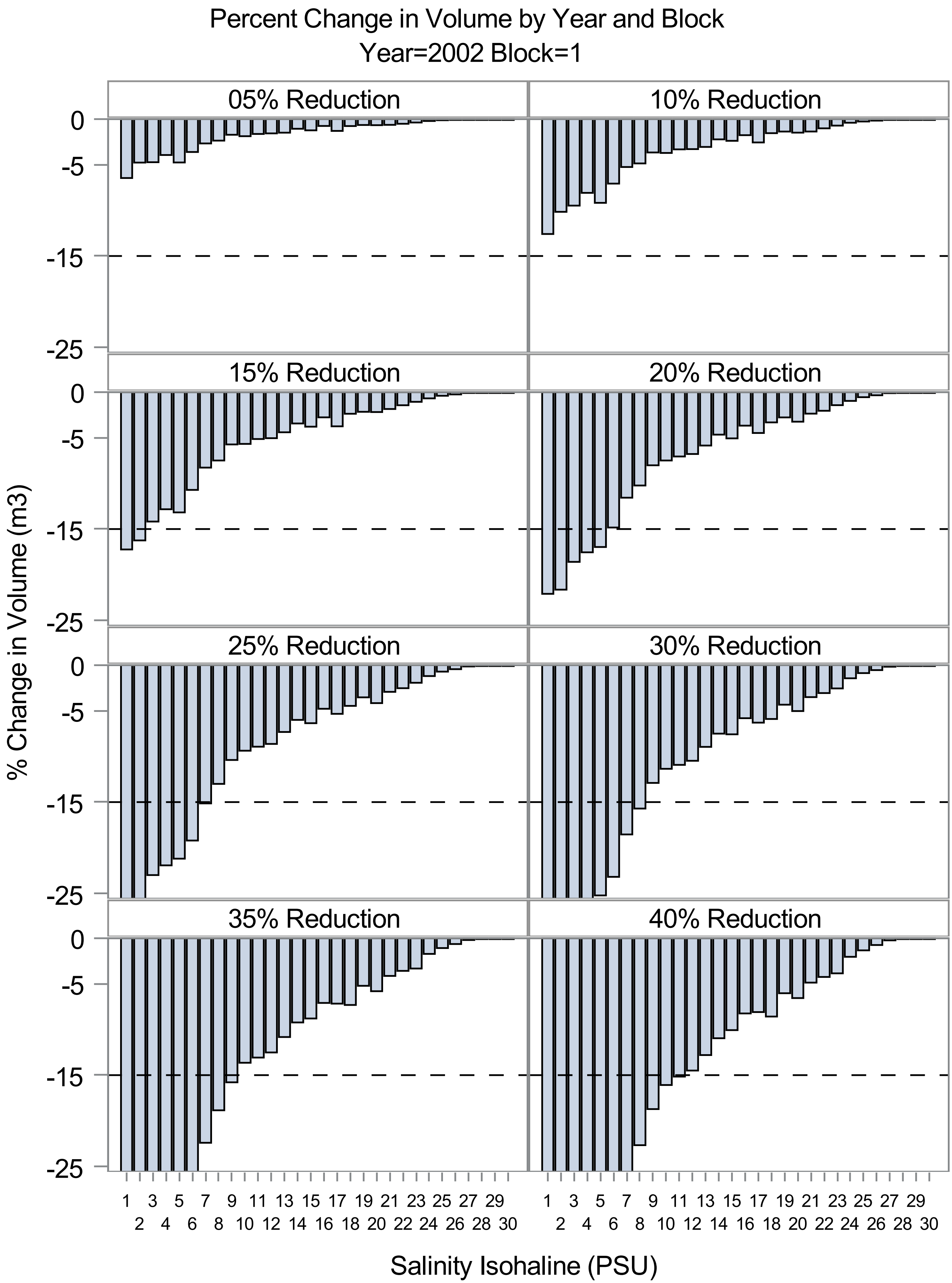


Percent Change in Volume by Year and Block
Year=2001 Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

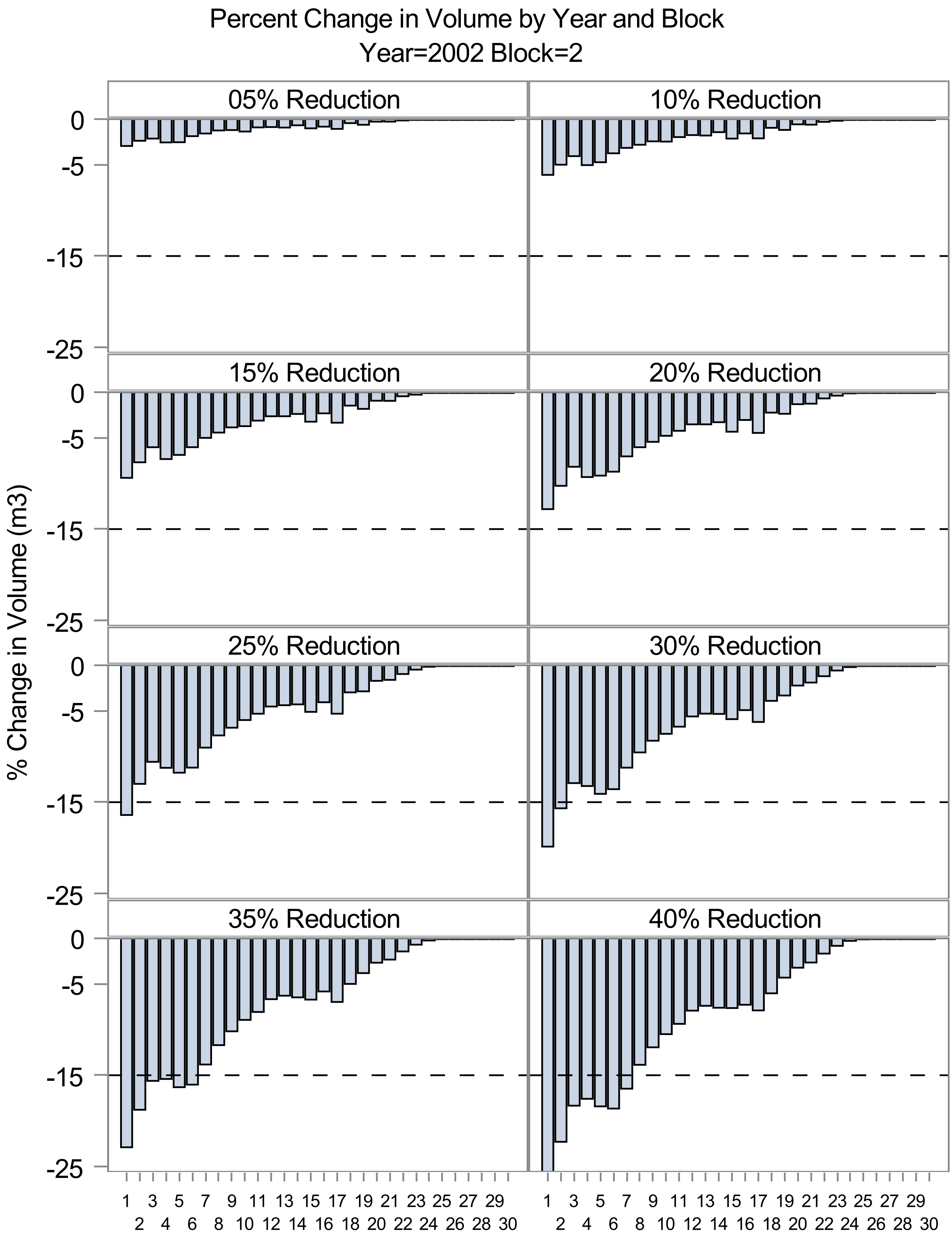
Percent Change in Volume by Year and Block
Year=2001 Block=2

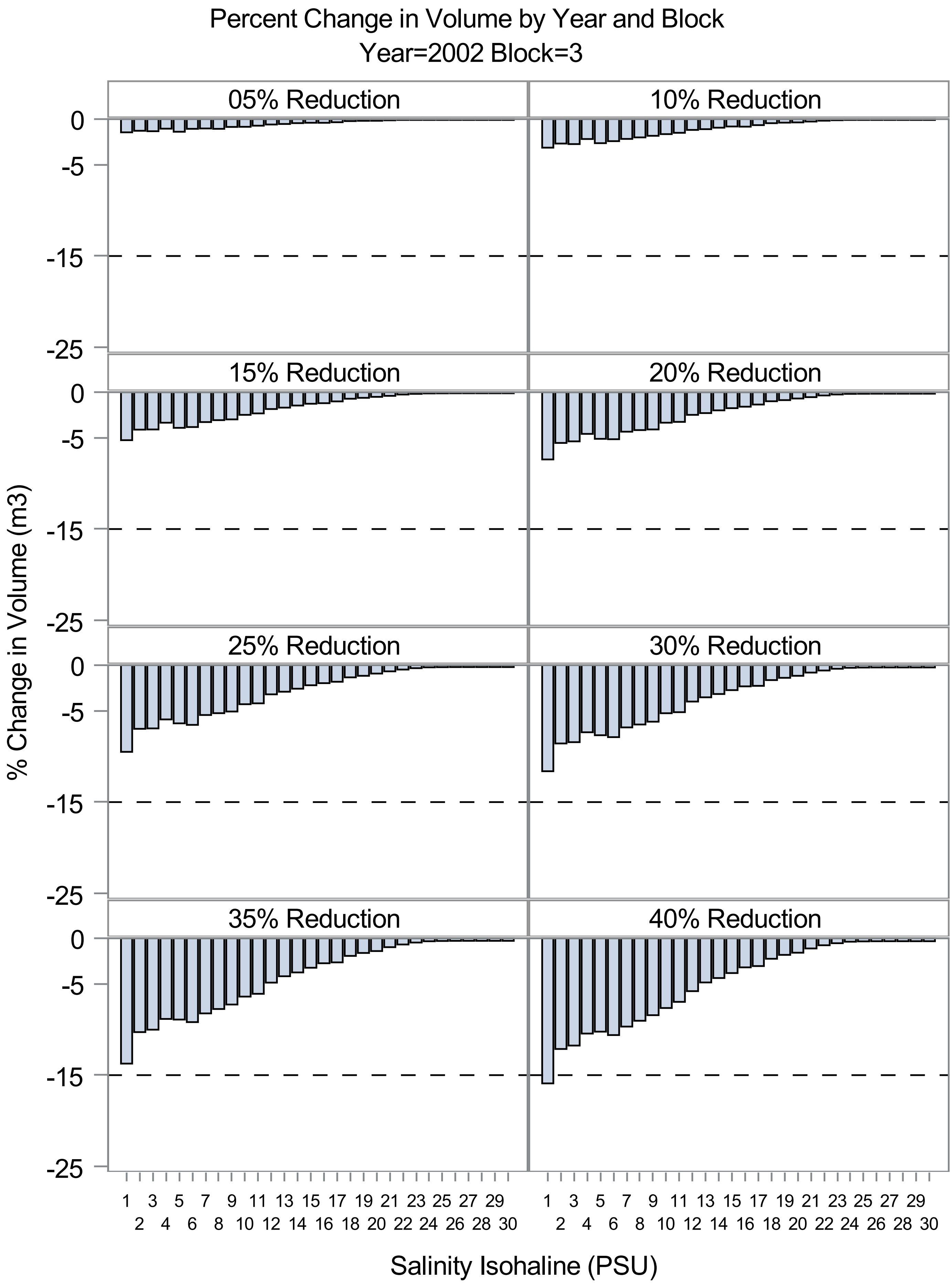



Percent Change in Volume by Year and Block
Year=2001 Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
% Change in Volume (m3)
0
-5
-15
-25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

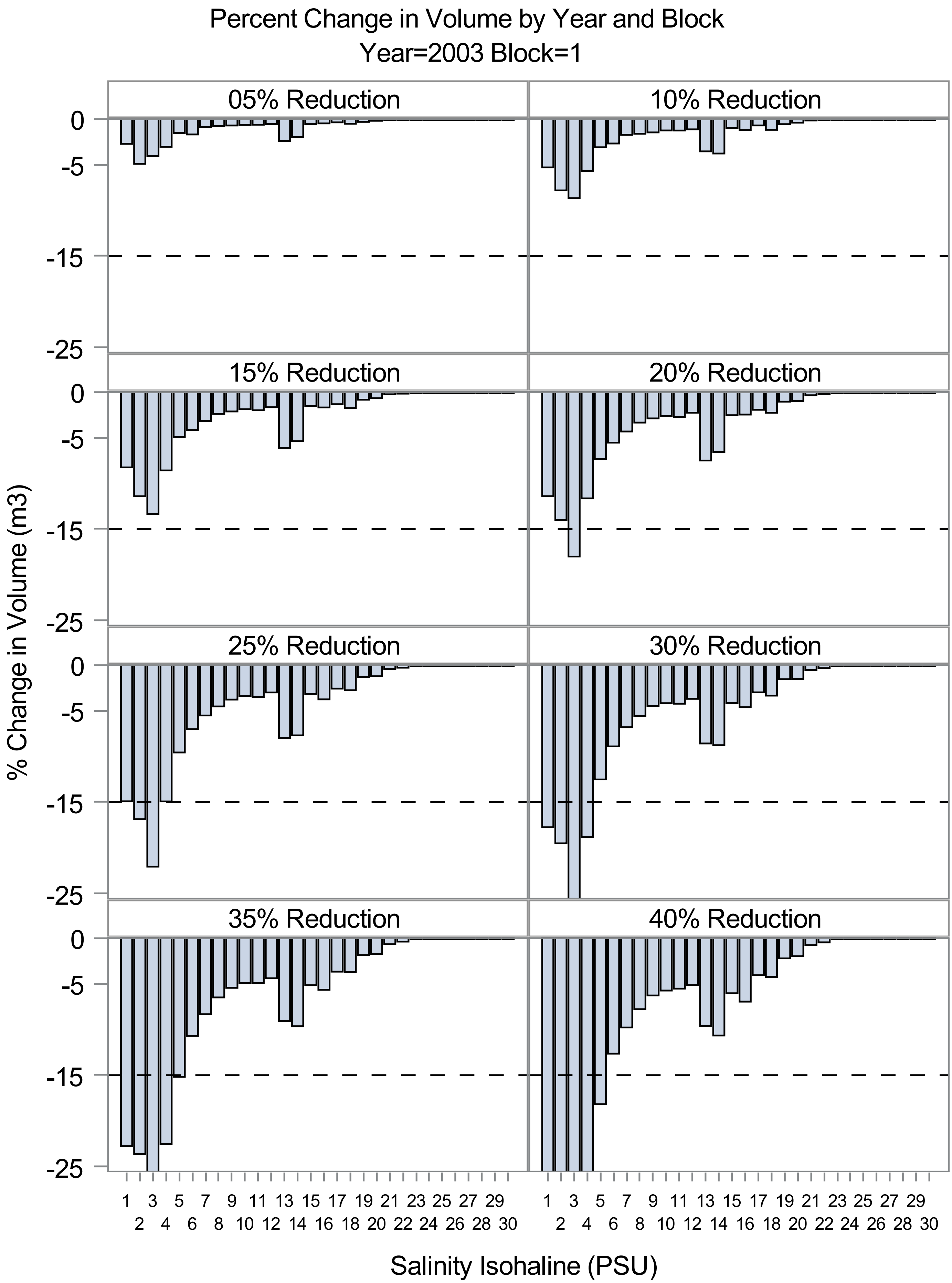


Percent Change in Volume by Year and Block
Year=2002 Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

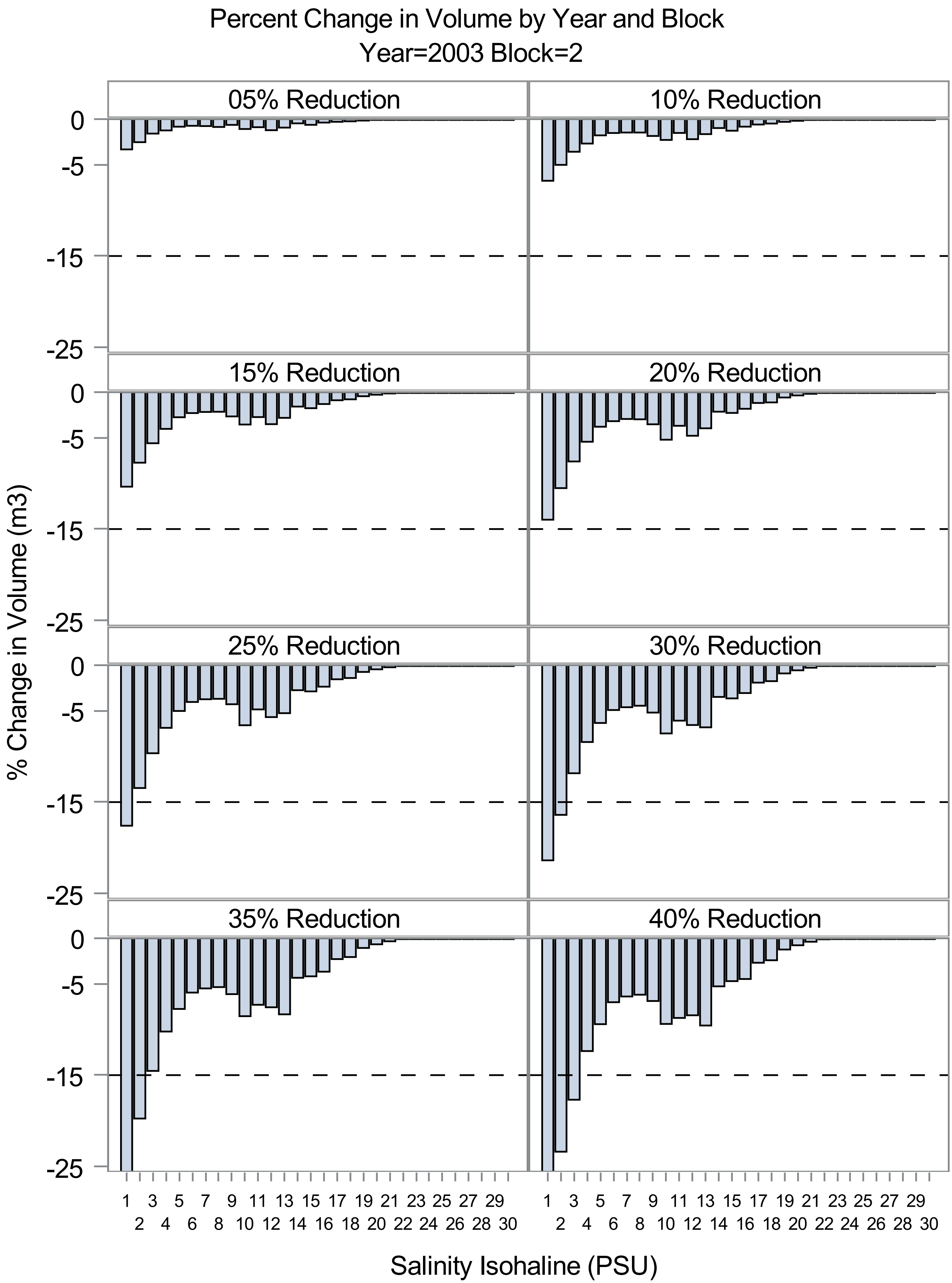

Percent Change in Volume by Year and Block
Year=2002 Block=2
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



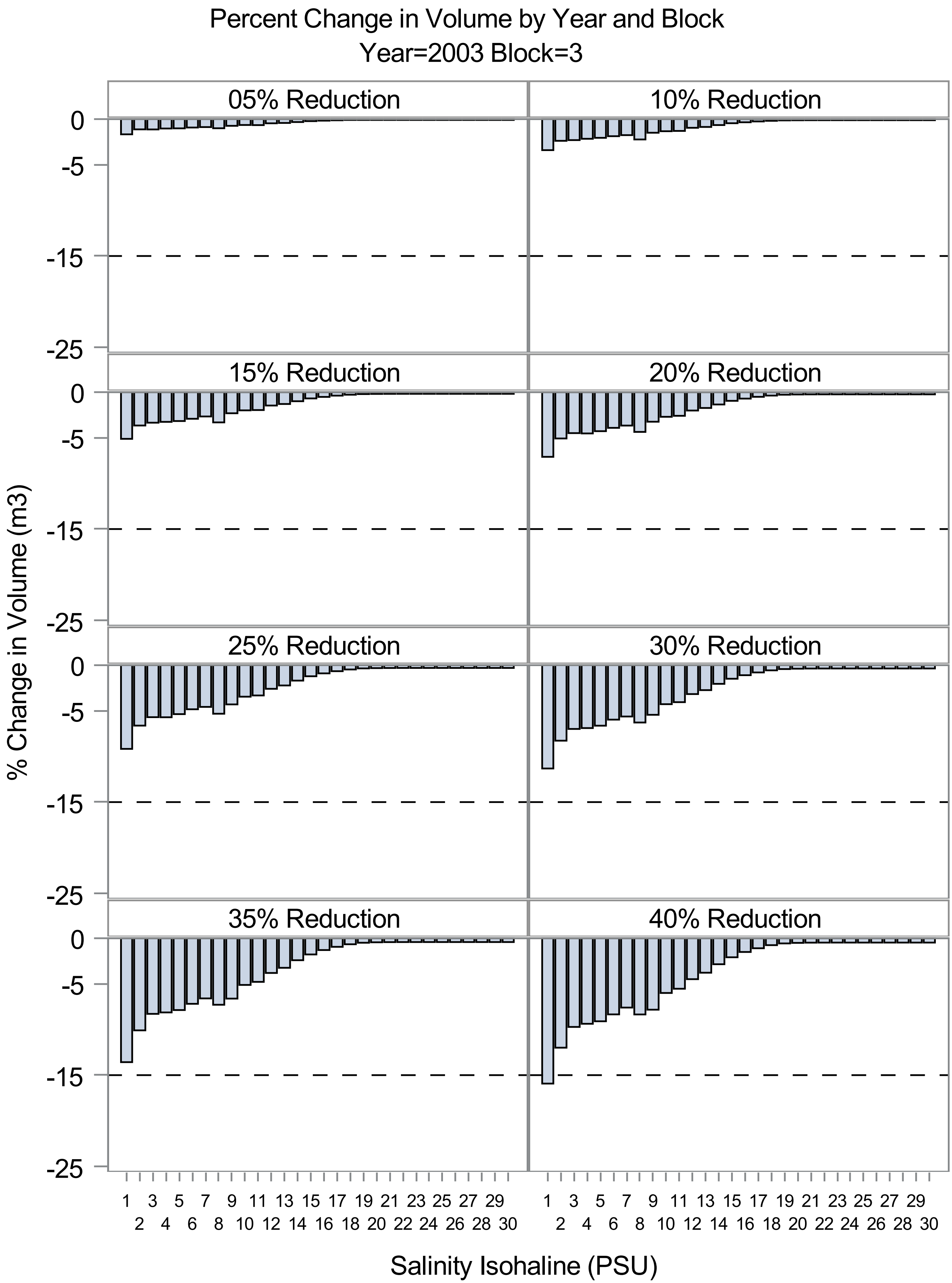
Percent Change in Volume by Year and Block
Year=2002 Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)



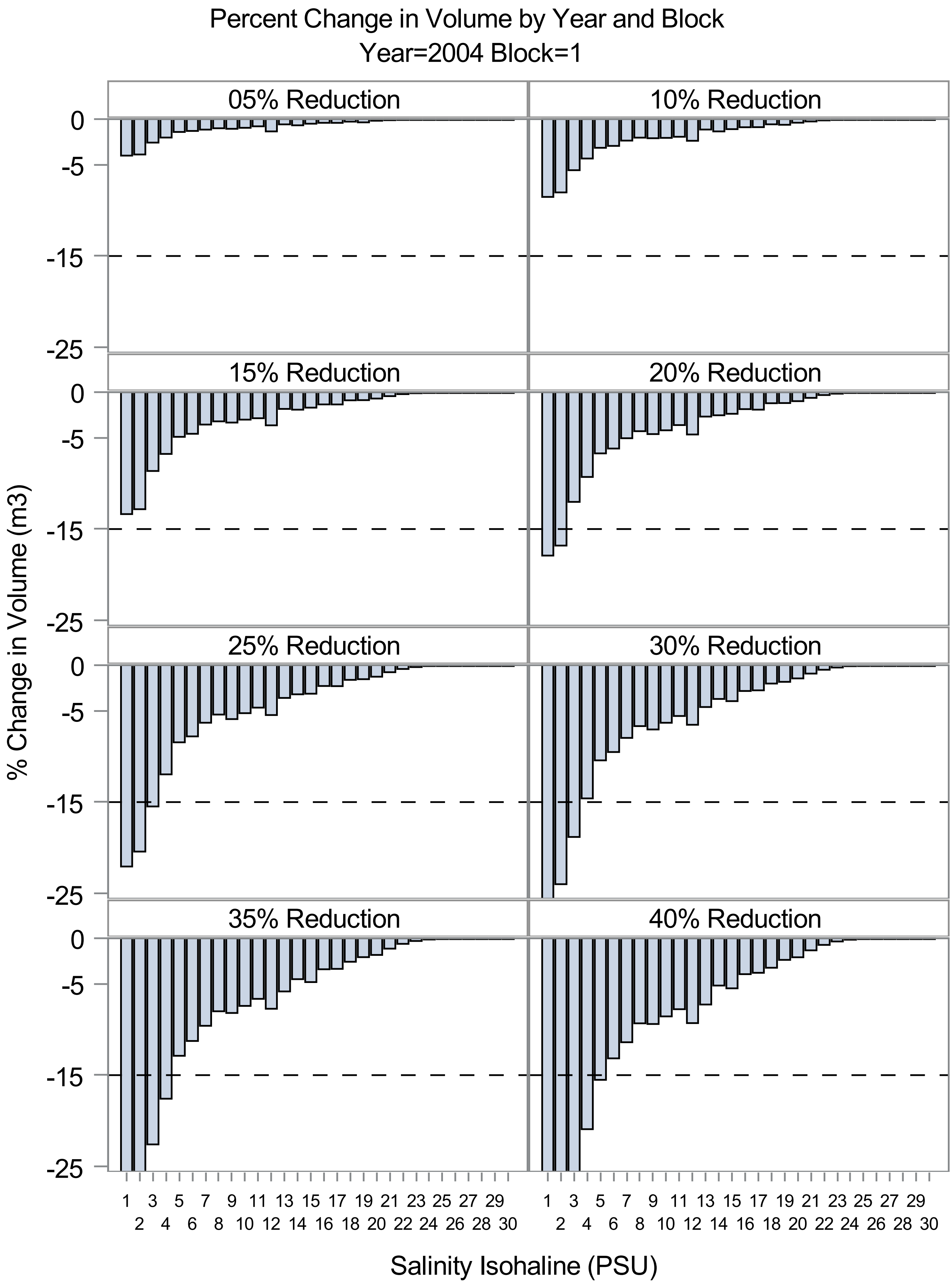
Percent Change in Volume by Year and Block
Year=2003 Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



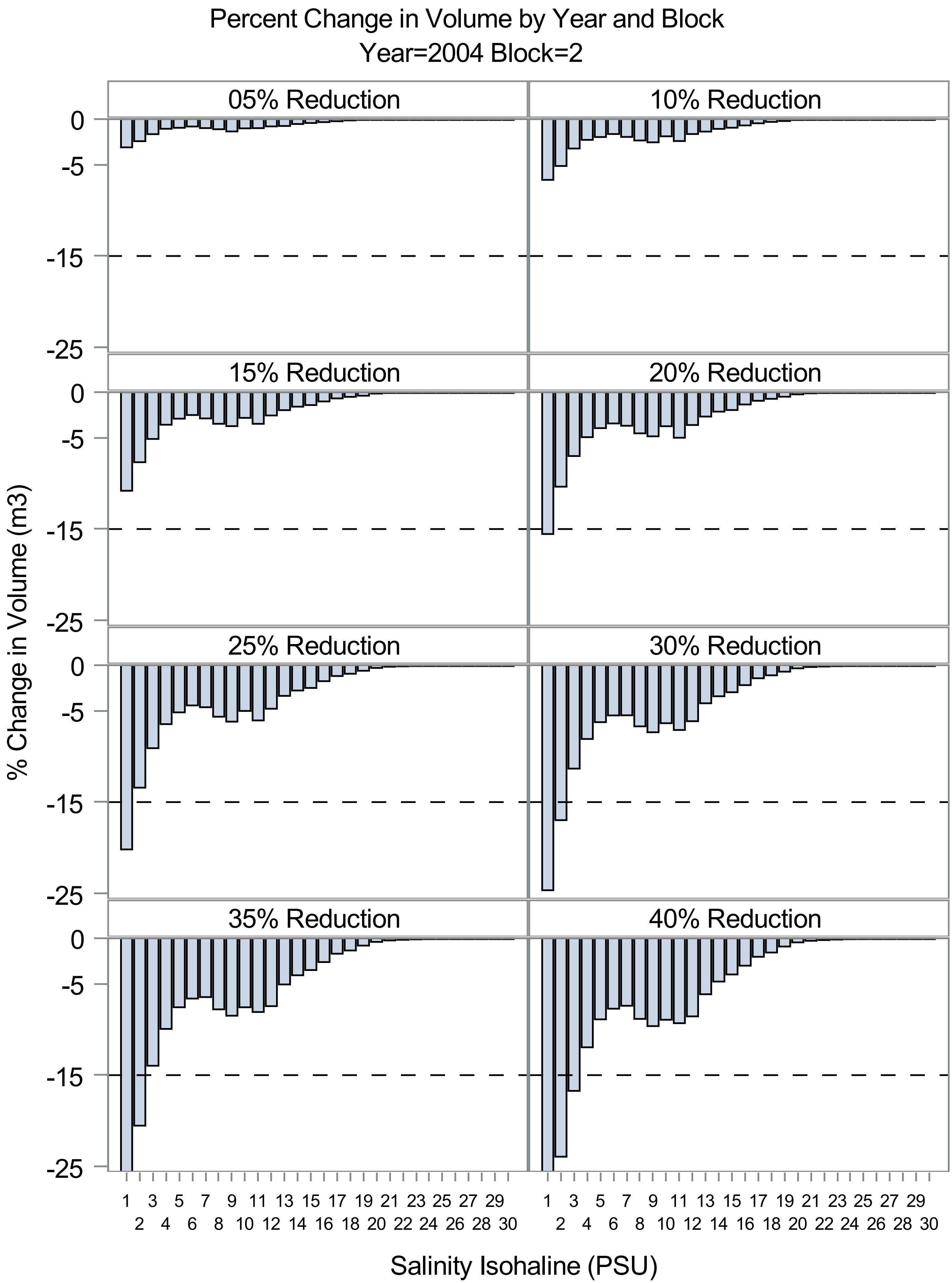
Percent Change in Volume by Year and Block
Year=2003 Block=2
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)



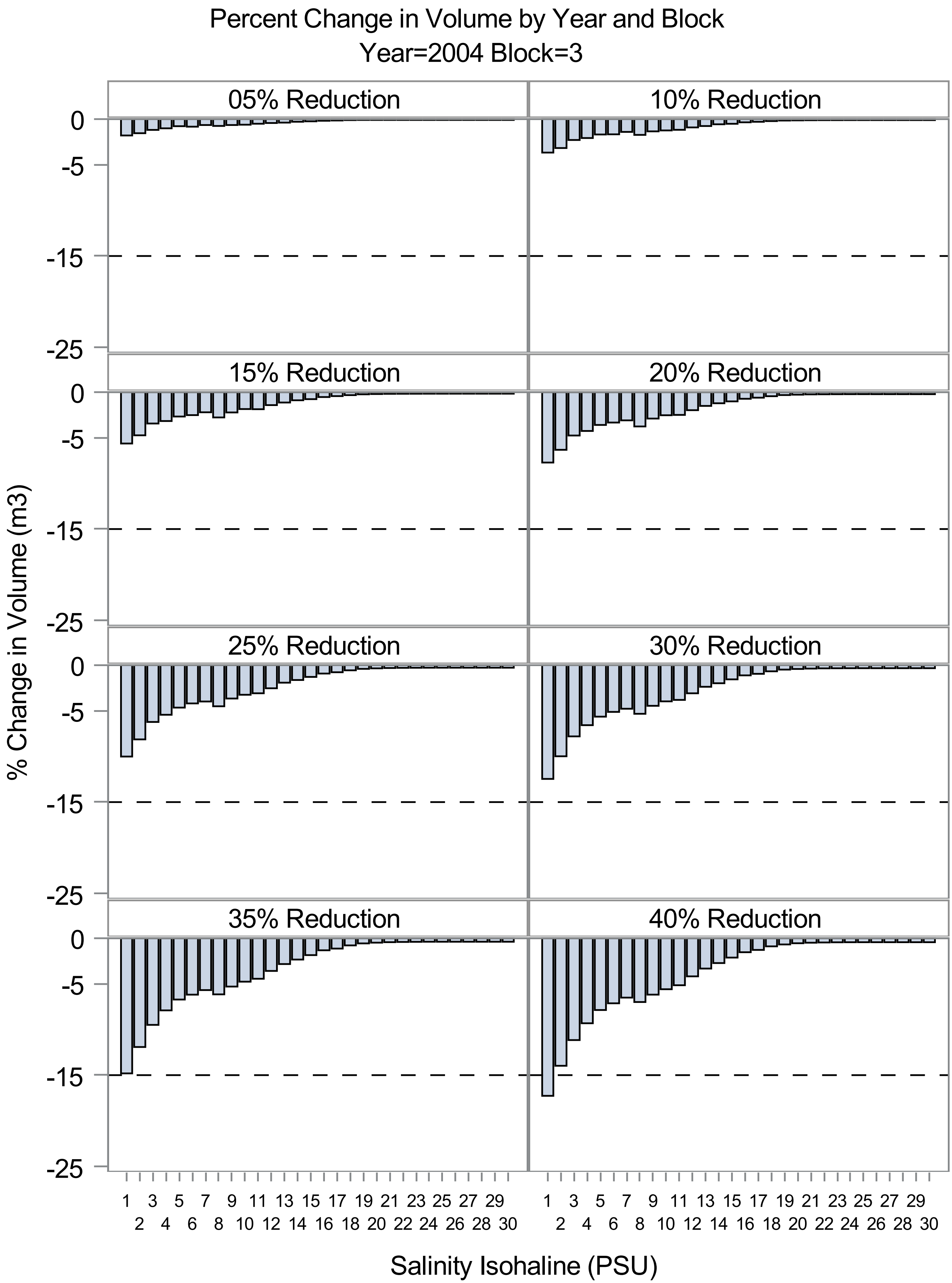
Percent Change in Volume by Year and Block
Year=2003 Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



Percent Change in Volume by Year and Block
Year=2004 Block=1
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
% Change in Volume (m3)
0
-5
-15
-25
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)

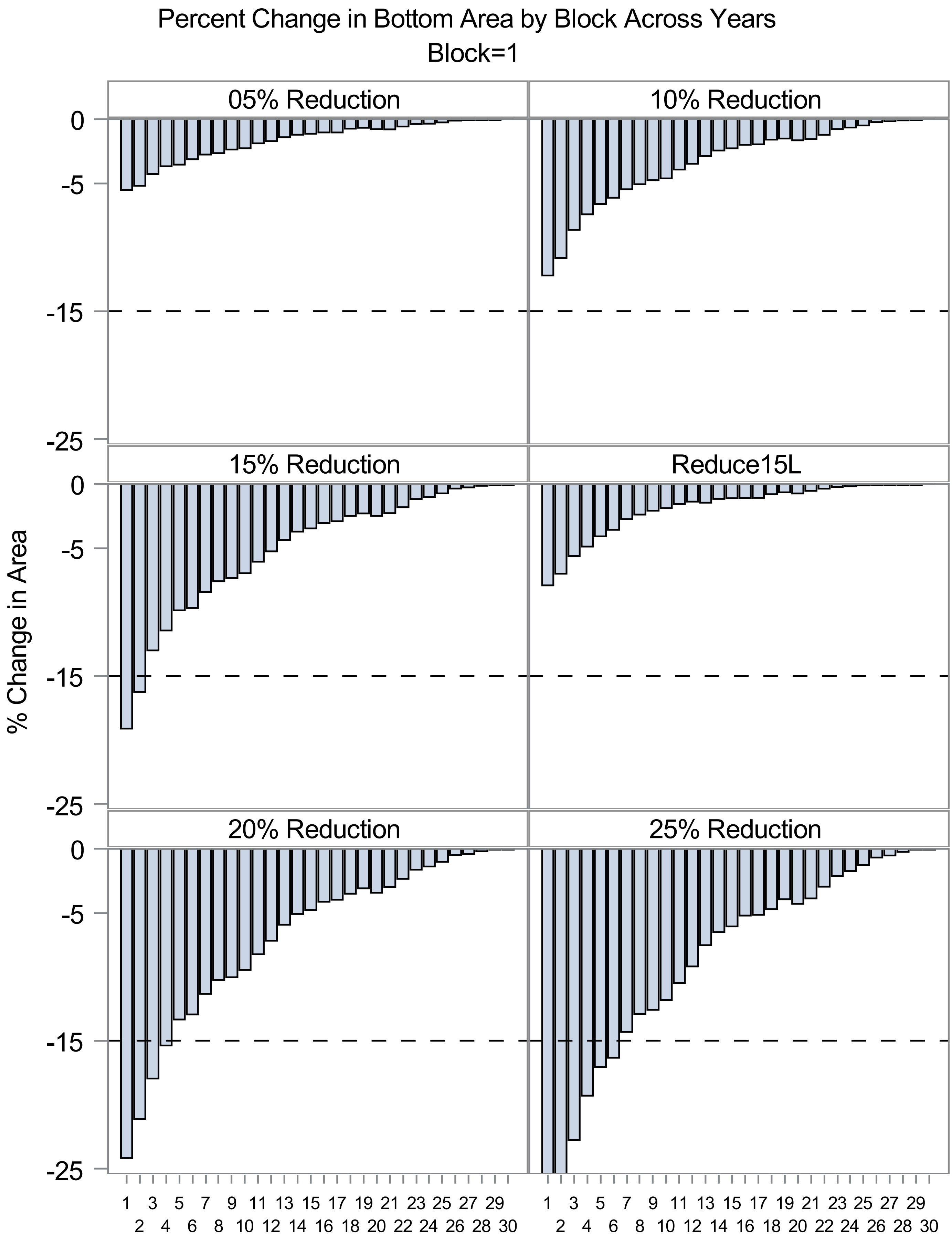


Percent Change in Volume by Year and Block
Year=2004 Block=2
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

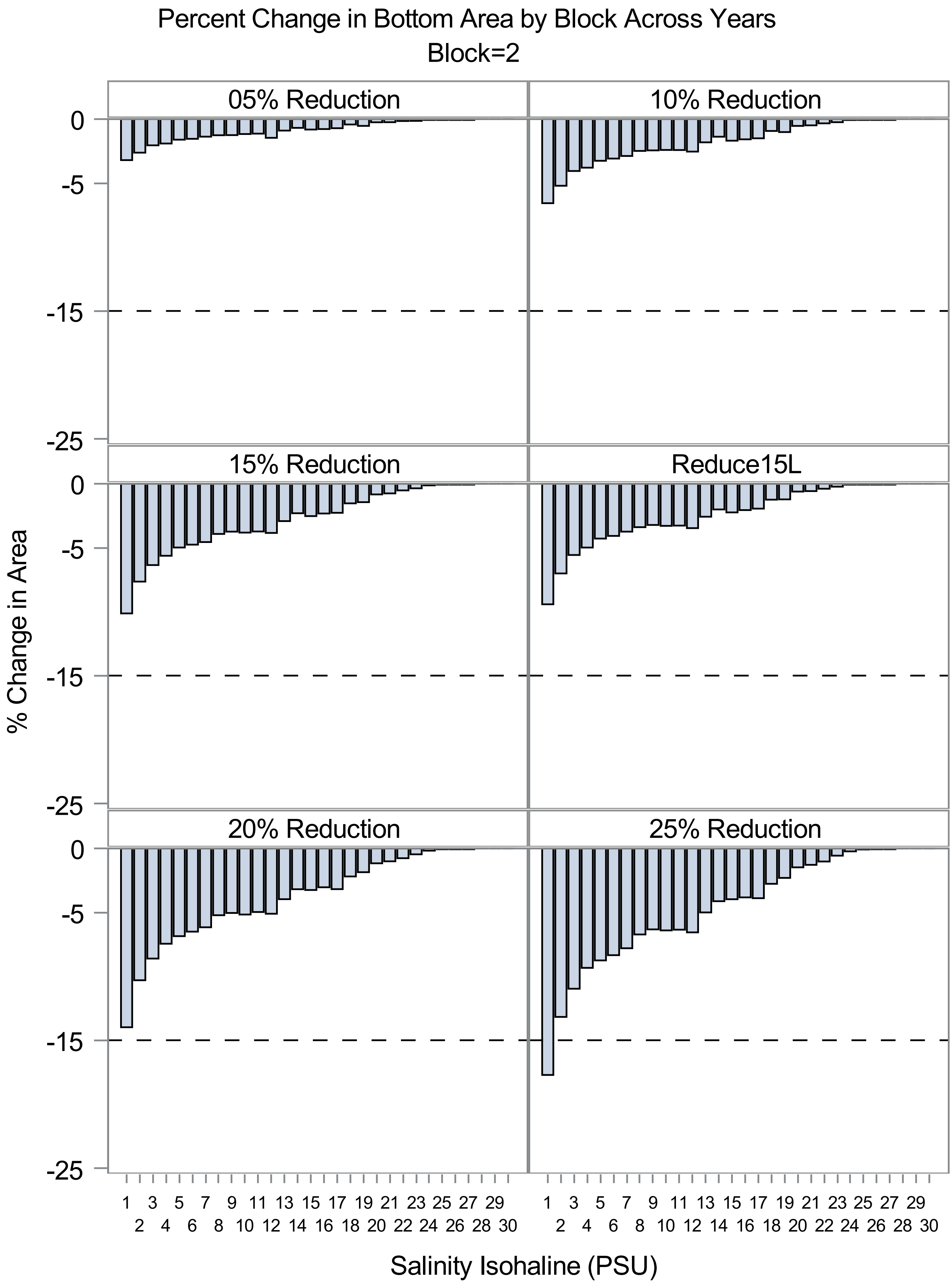

Percent Change in Volume by Year and Block
Year=2004 Block=3
05% Reduction
10% Reduction
15% Reduction
20% Reduction
25% Reduction
30% Reduction
35% Reduction
40% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

Appendix D

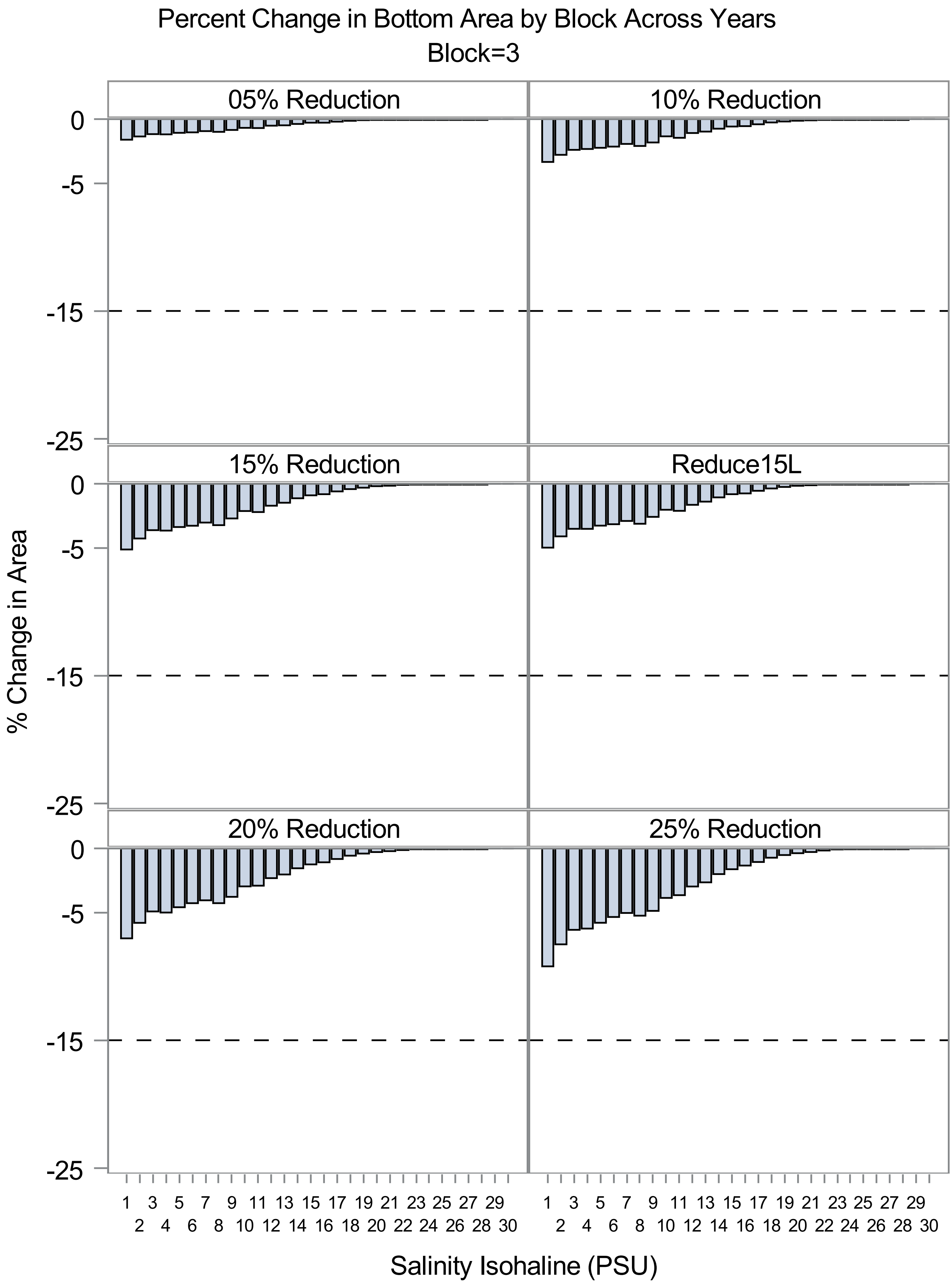
Evaluation of the Effects of the 15% Reduction with a Low Flow Threshold (LFT) on Salinity Isohaline Bottom Area and Volume by Block, Year, and Year/Block Combinations



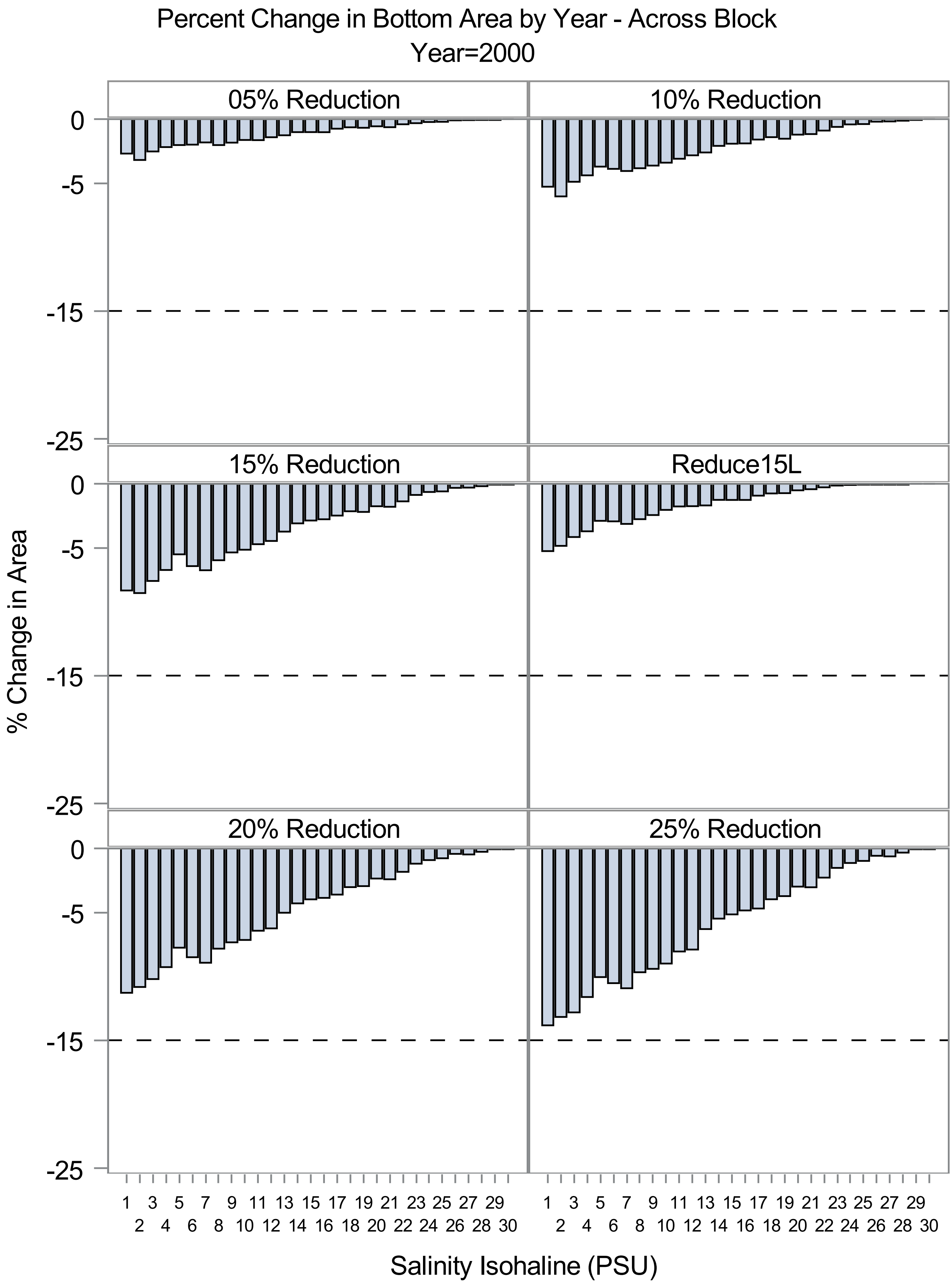
Percent Change in Bottom Area by Block Across Years
Block=1
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
% Change in Area
0
-5
-15
-25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



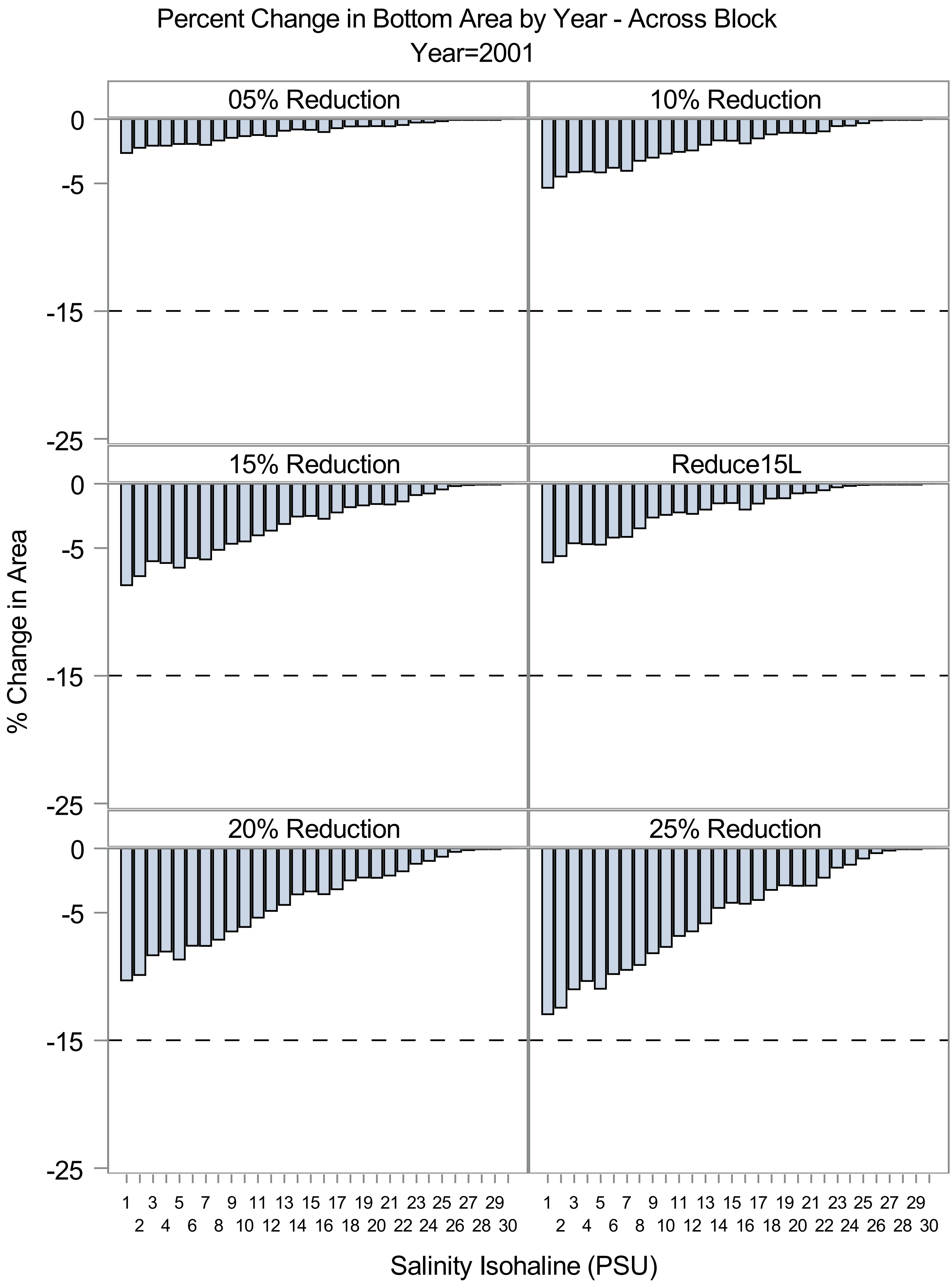
Percent Change in Bottom Area by Block Across Years
Block=2
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
% Change in Area
0
-5
-15
-25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



Percent Change in Bottom Area by Block Across Years
Block=3
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

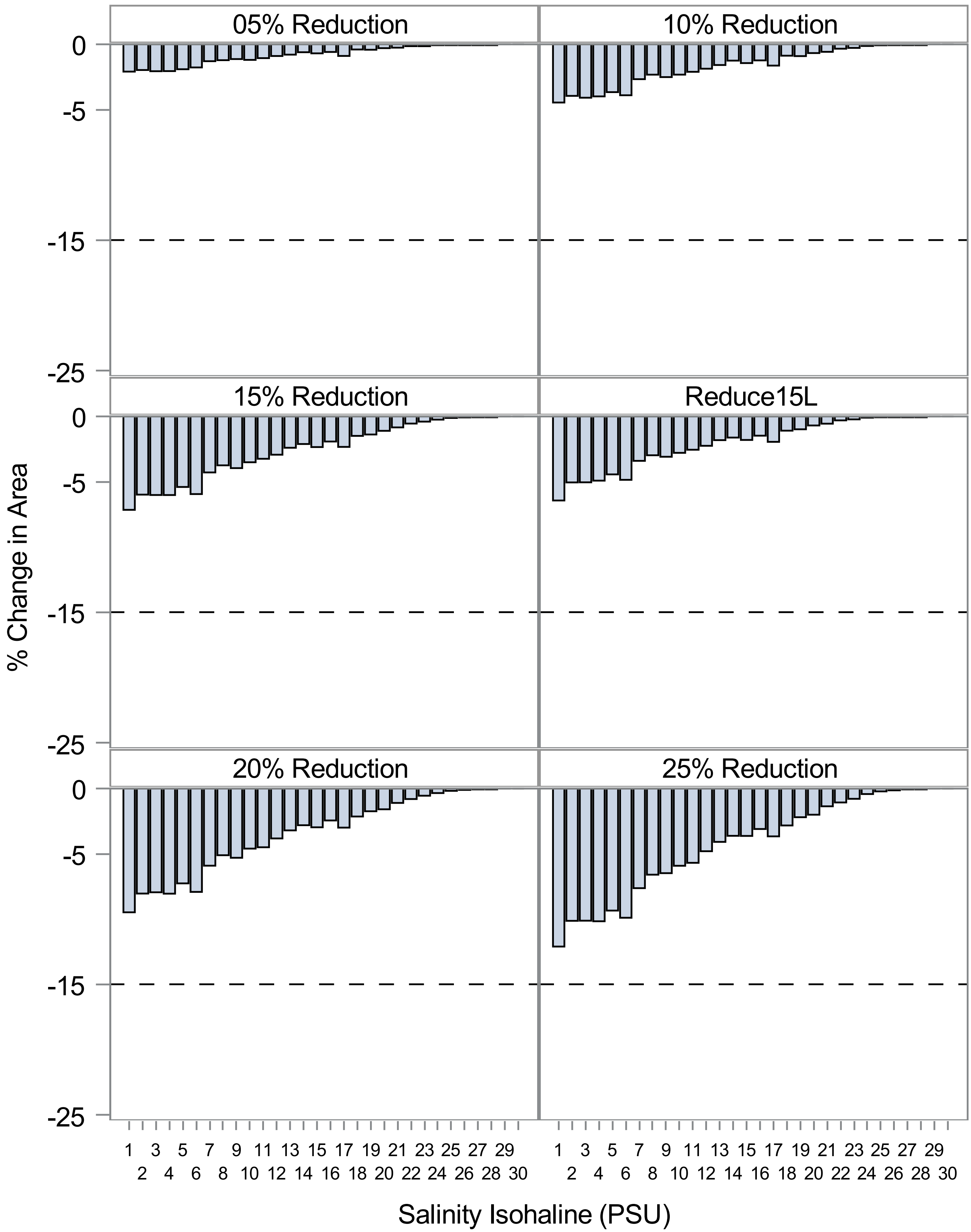


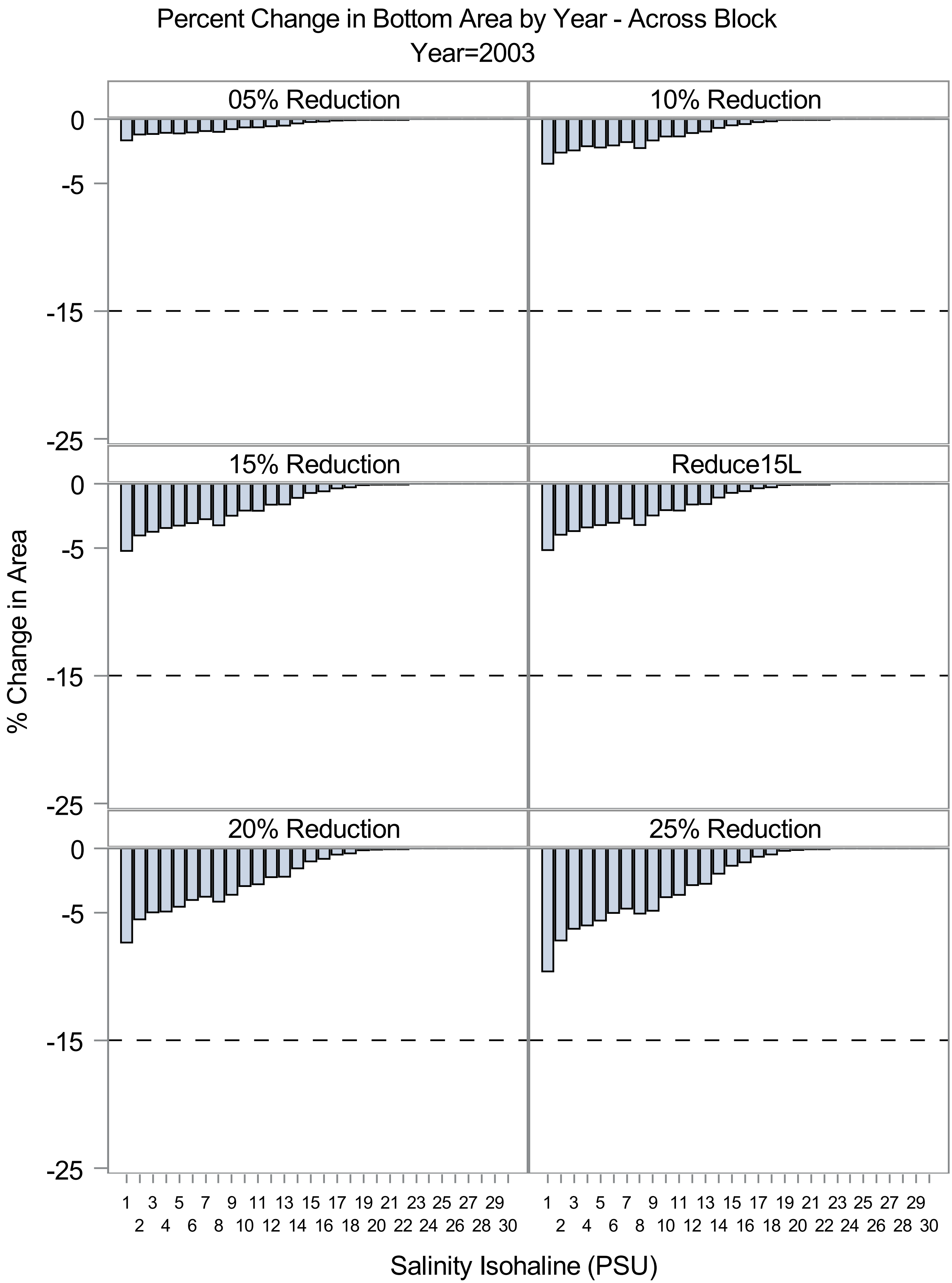
Percent Change in Bottom Area by Year - Across Block
Year=2000
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

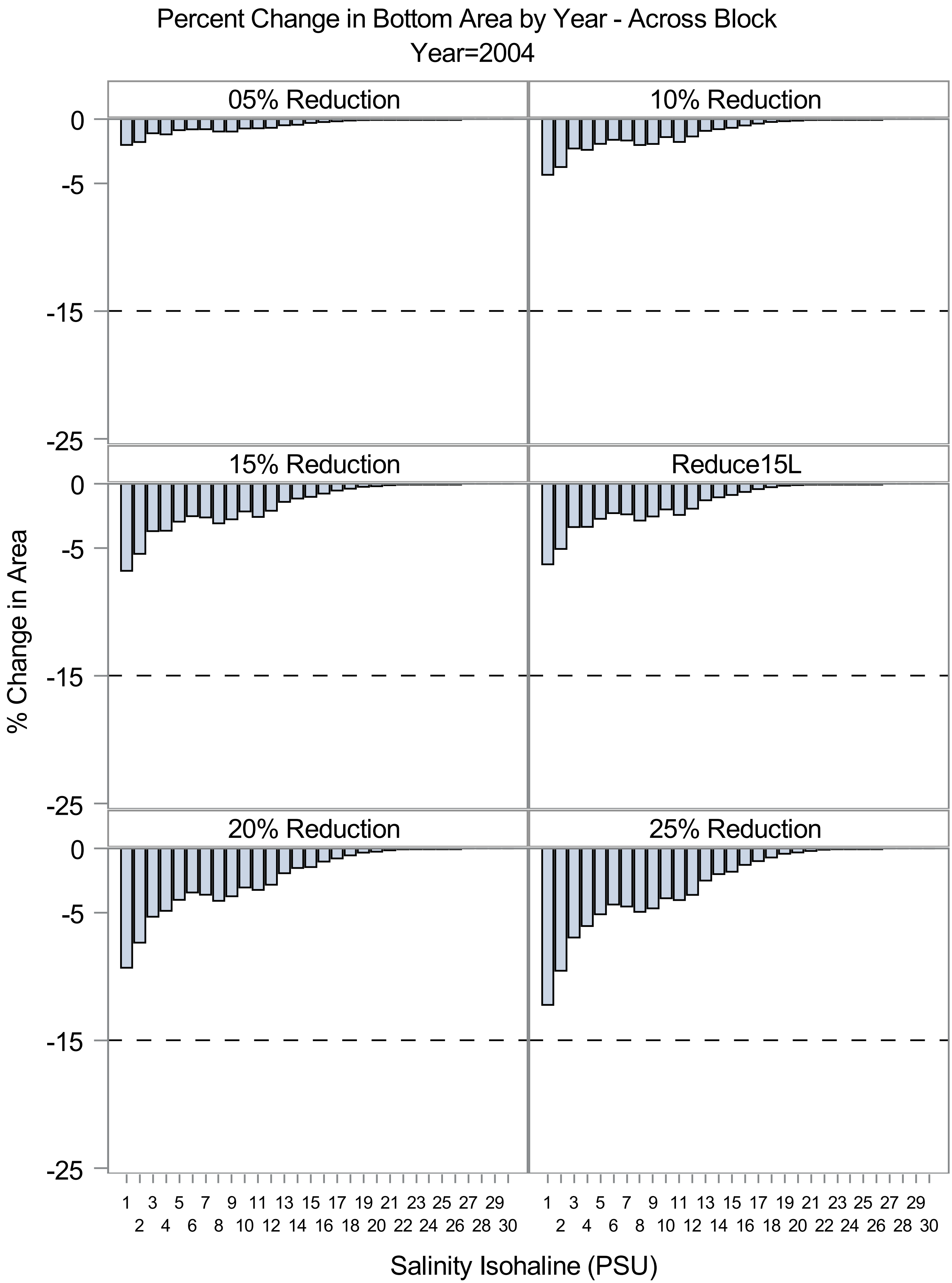


Percent Change in Bottom Area by Year - Across Block
Year=2001
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
% Change in Area
0
-5
-15
-25
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)

Percent Change in Bottom Area by Year - Across Block
Year=2002

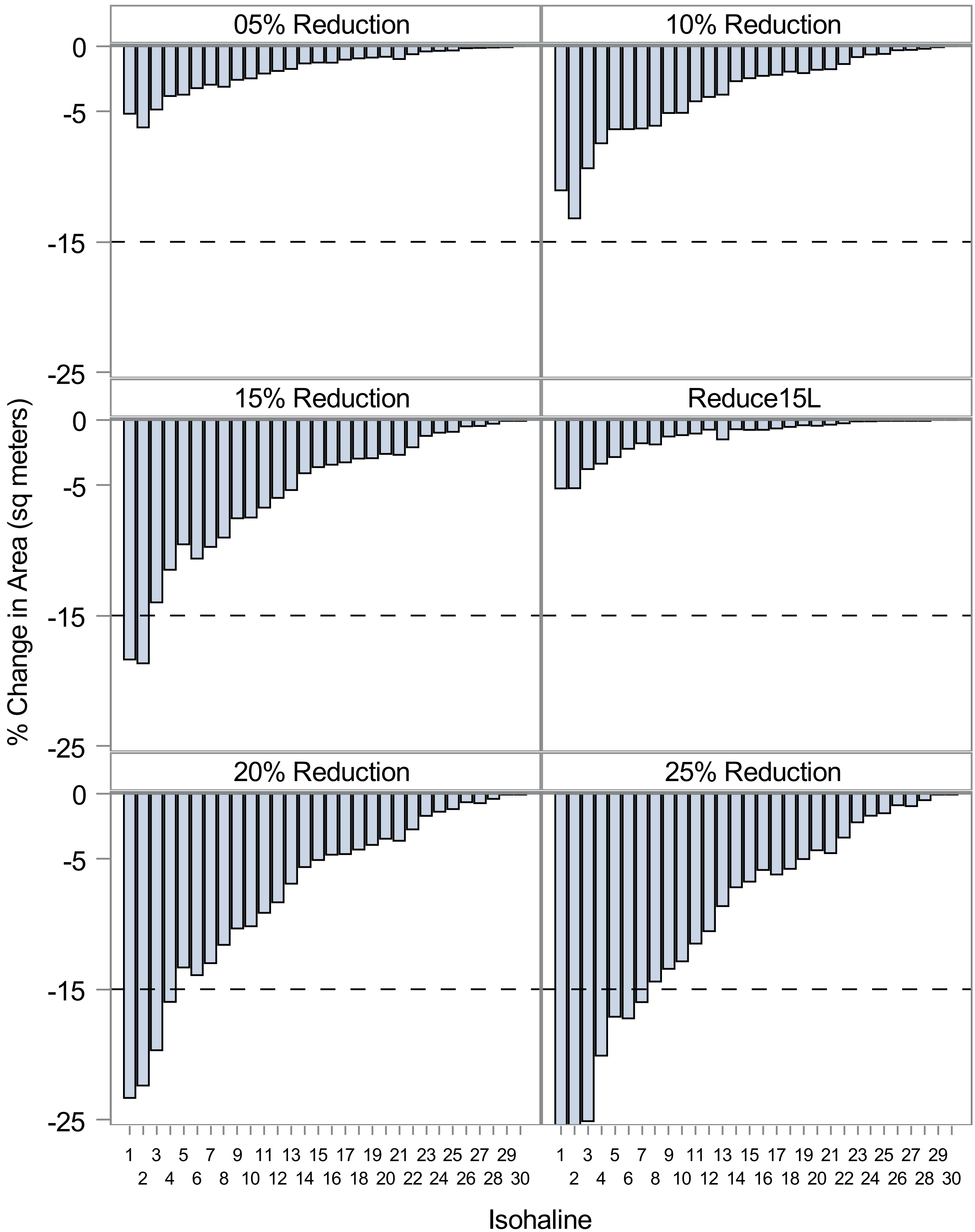


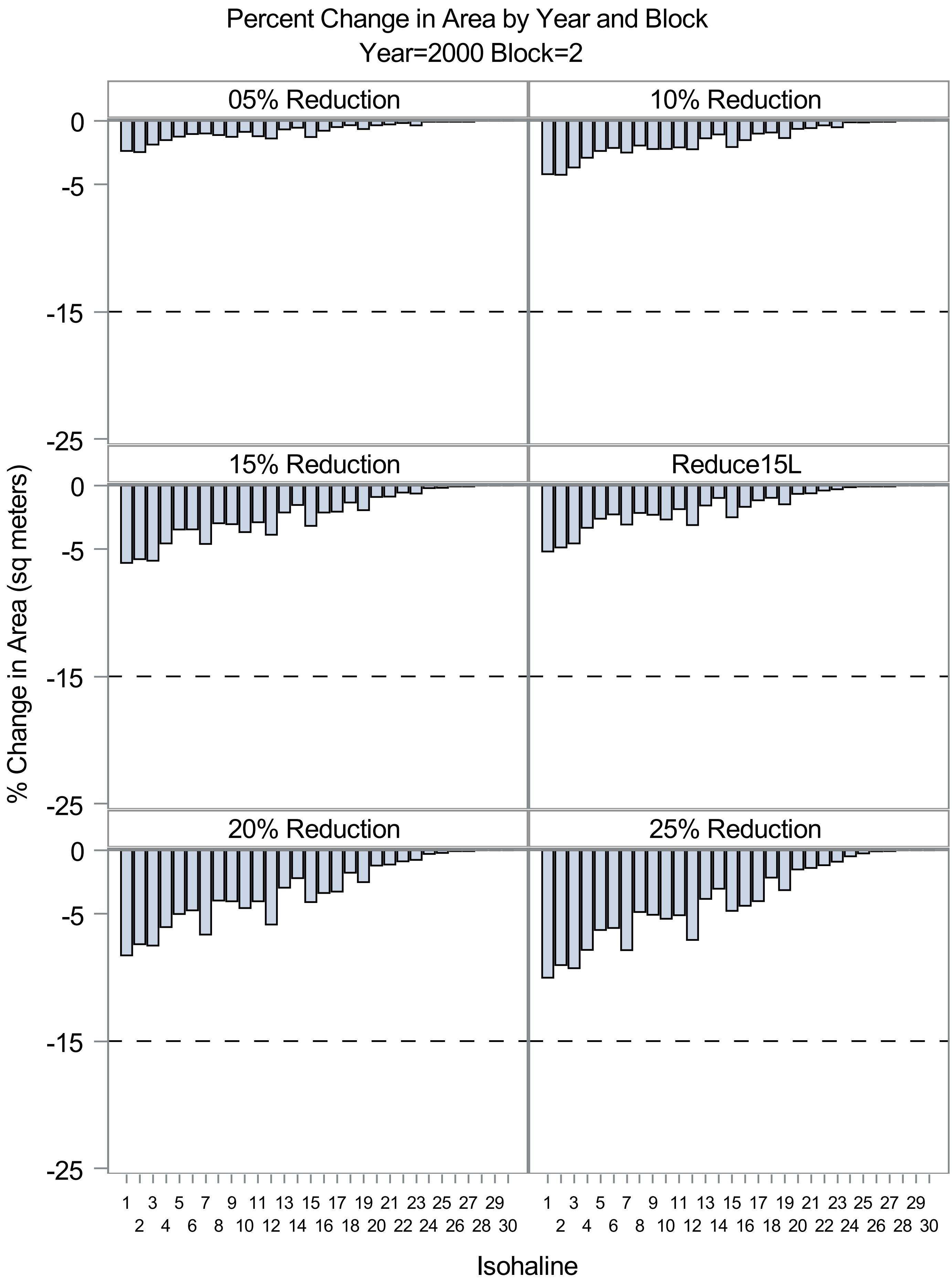

Percent Change in Bottom Area by Year - Across Block
Year=2003
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
% Change in Area
0
-5
-15
-25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



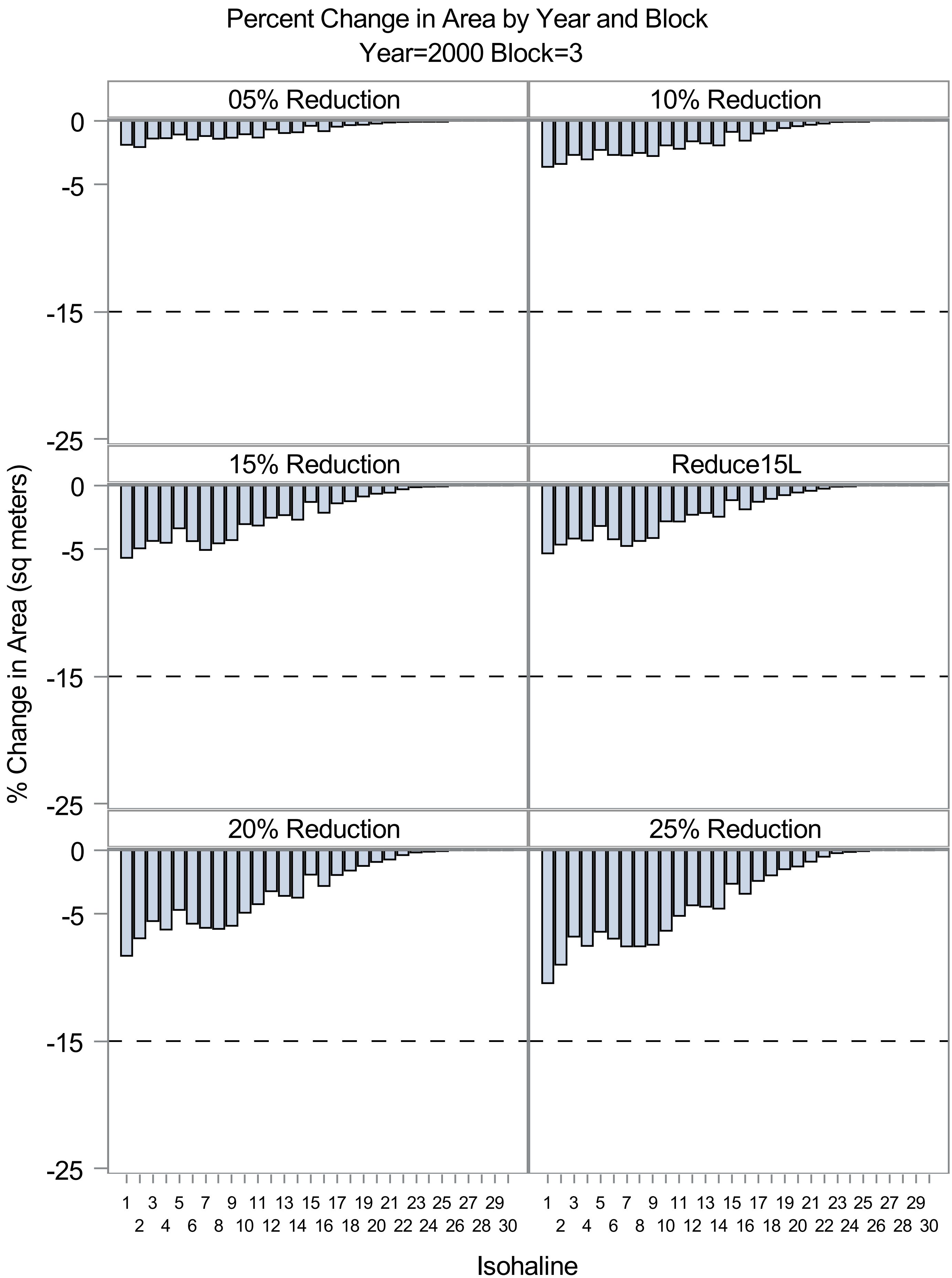
Percent Change in Bottom Area by Year - Across Block
Year=2004
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

Percent Change in Area by Year and Block
Year=2000 Block=1

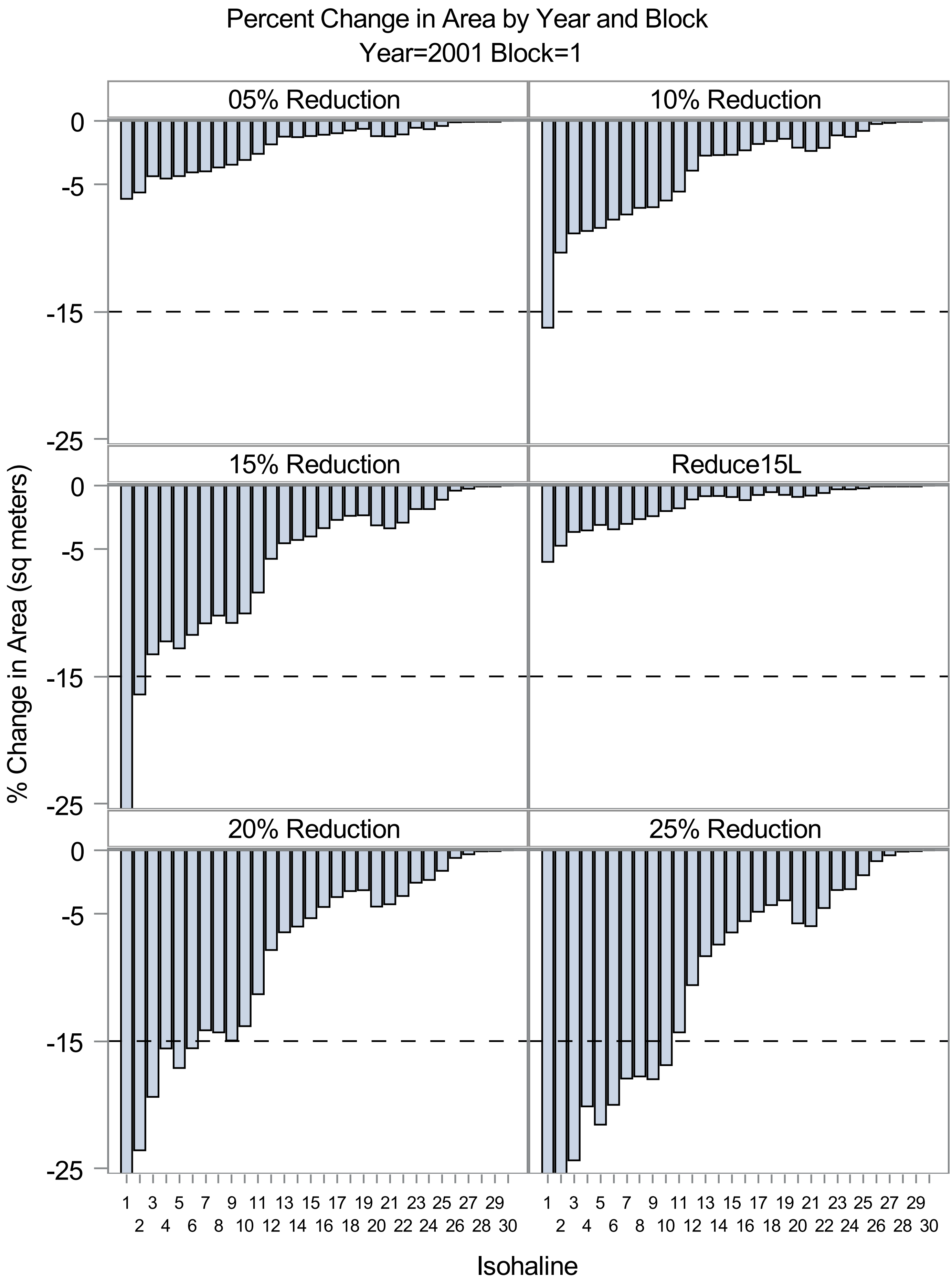




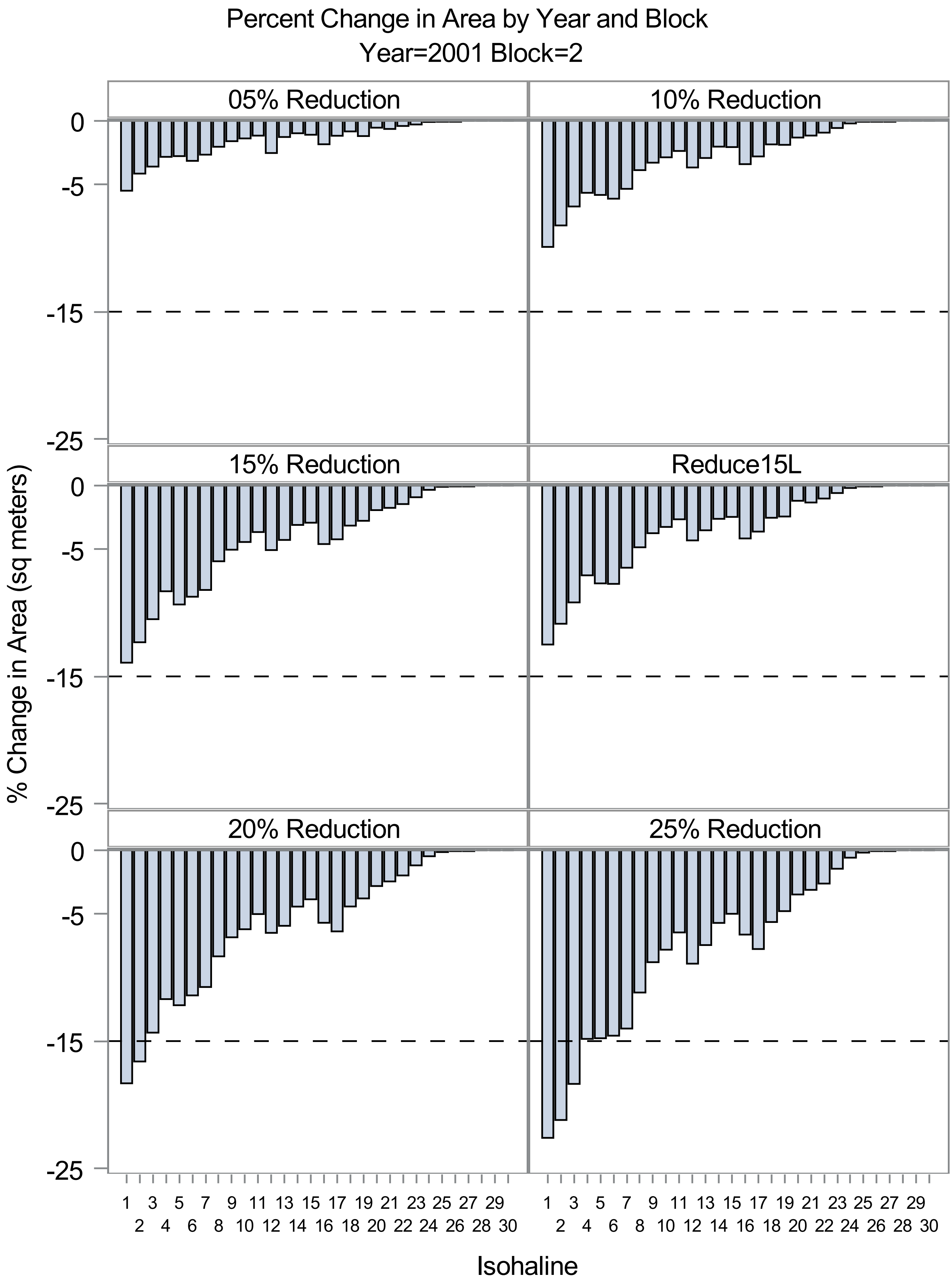
Percent Change in Area by Year and Block
Year=2000 Block=2
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area (sq meters)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Isohaline



Percent Change in Area by Year and Block
Year=2000 Block=3
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area (sq meters)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline



Percent Change in Area by Year and Block
Year=2001 Block=1
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
% Change in Area (sq meters)
0
-5
-15
-25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline



Percent Change in Area by Year and Block
Year=2001 Block=2
05% Reduction
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15% Reduction
Reduce15L
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25% Reduction
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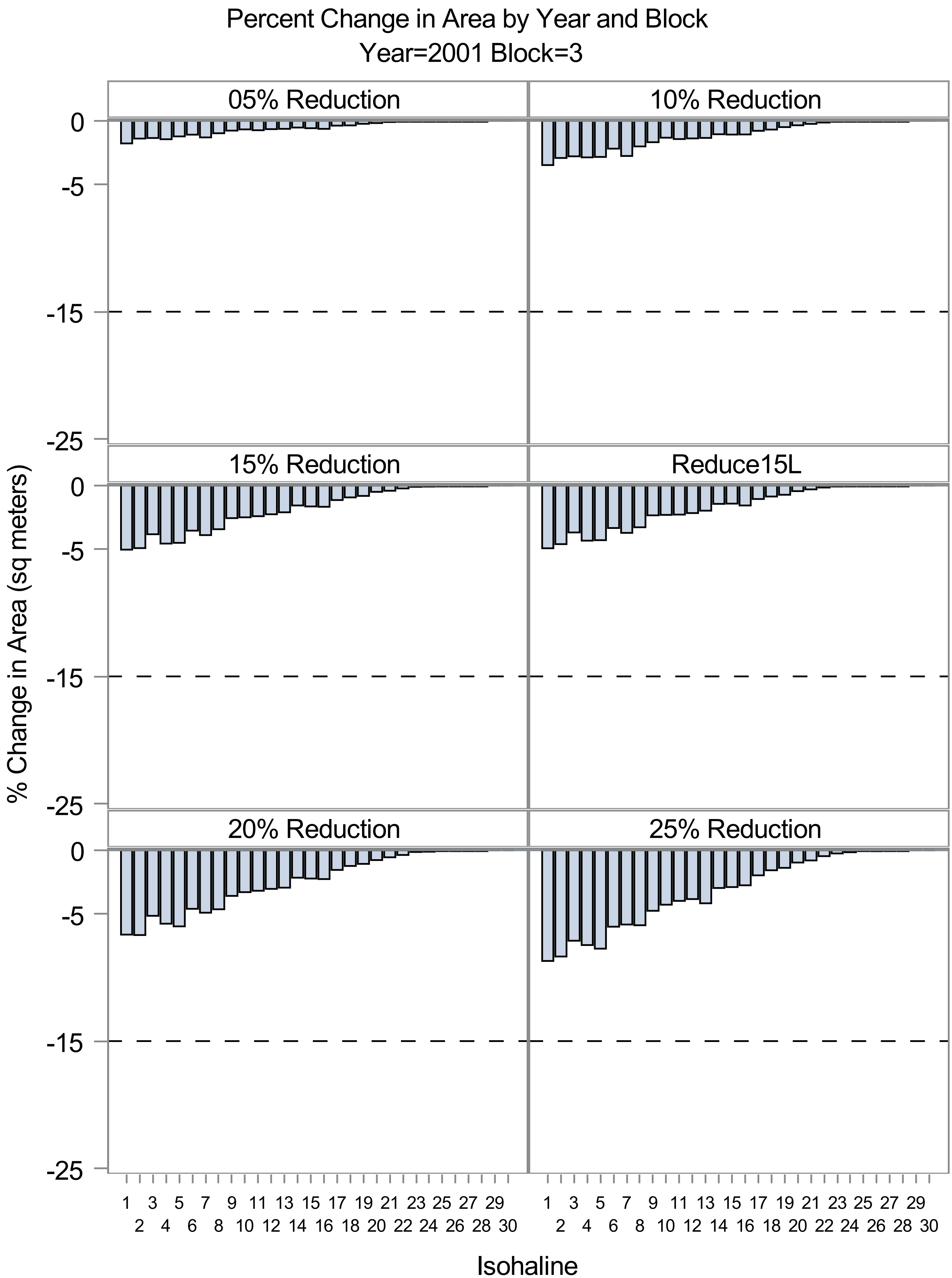
Isohaline



Percent Change in Area by Year and Block
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Reduce15L
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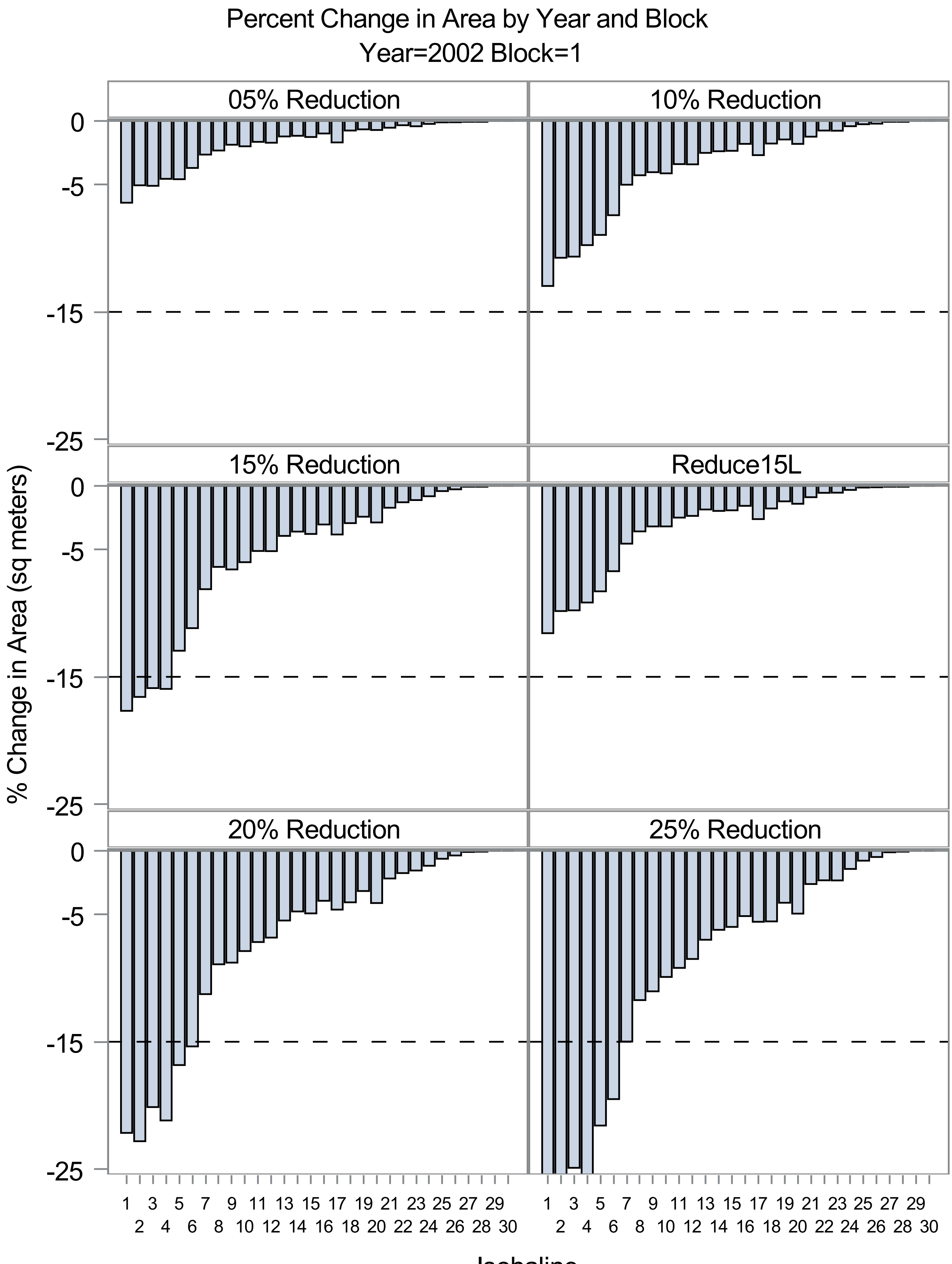

Percent Change in Area by Year and Block
Year=2002 Block=1
05% Reduction
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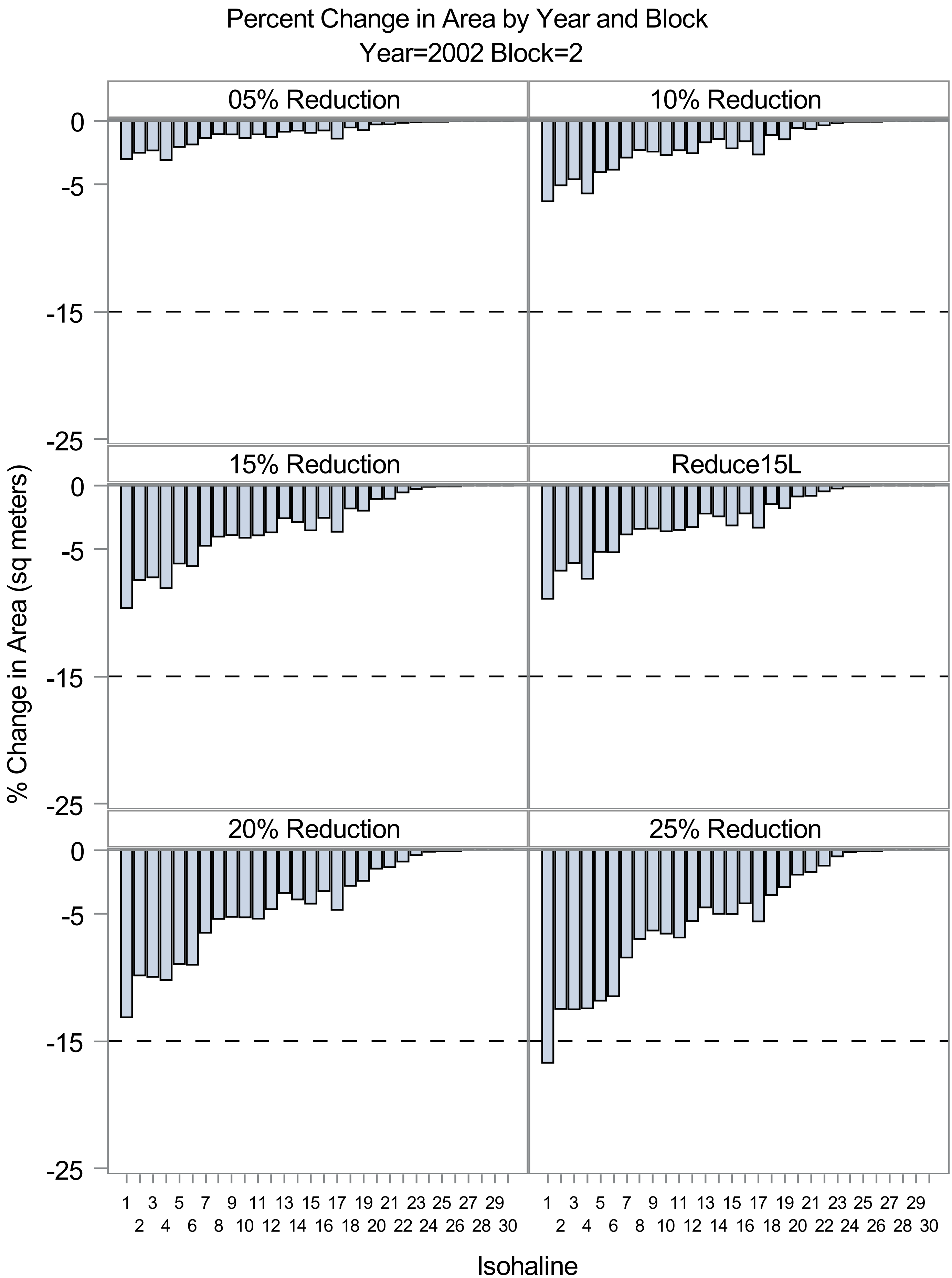

Percent Change in Area by Year and Block
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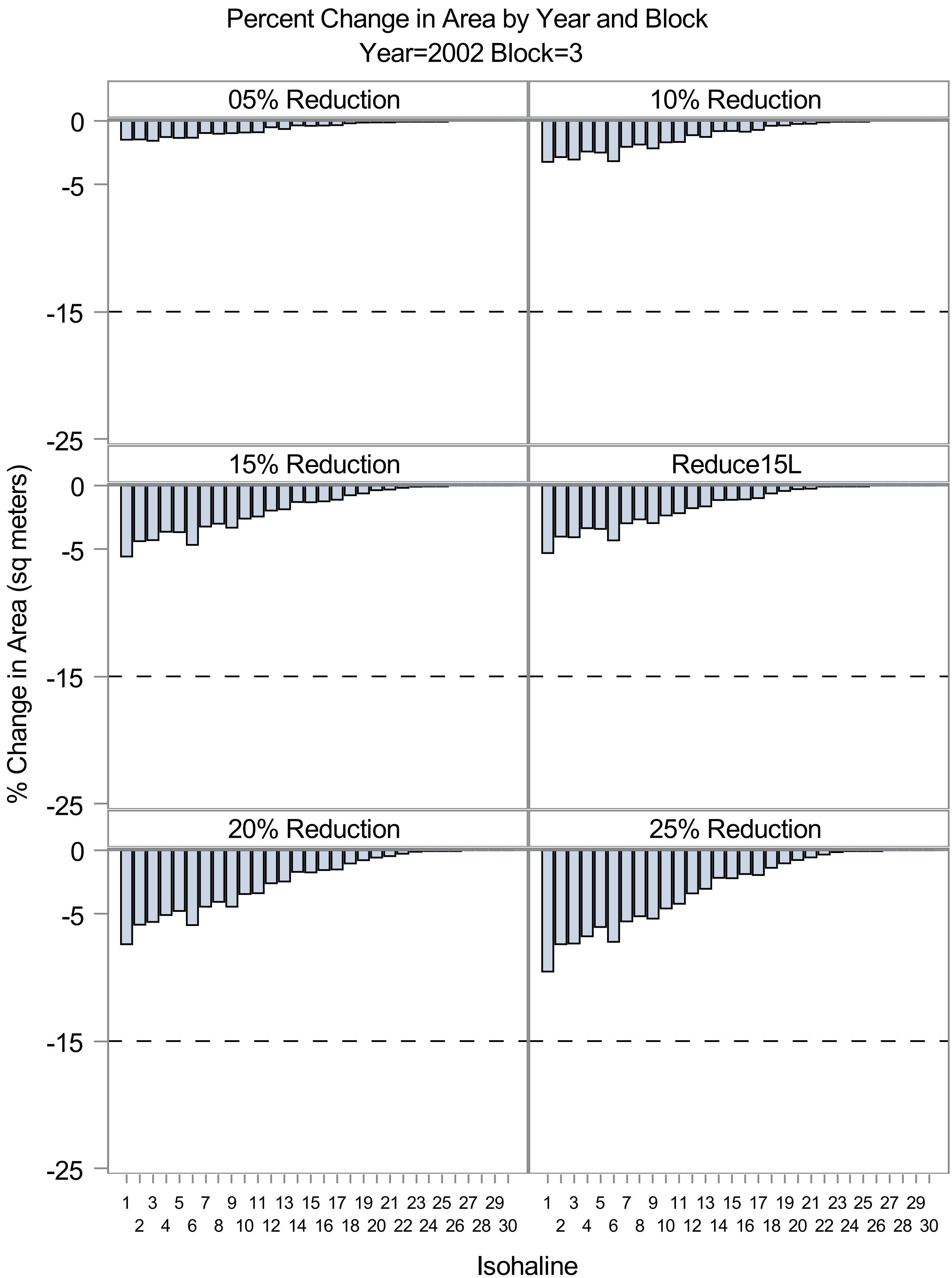

Percent Change in Area by Year and Block
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15% Reduction
Reduce15L
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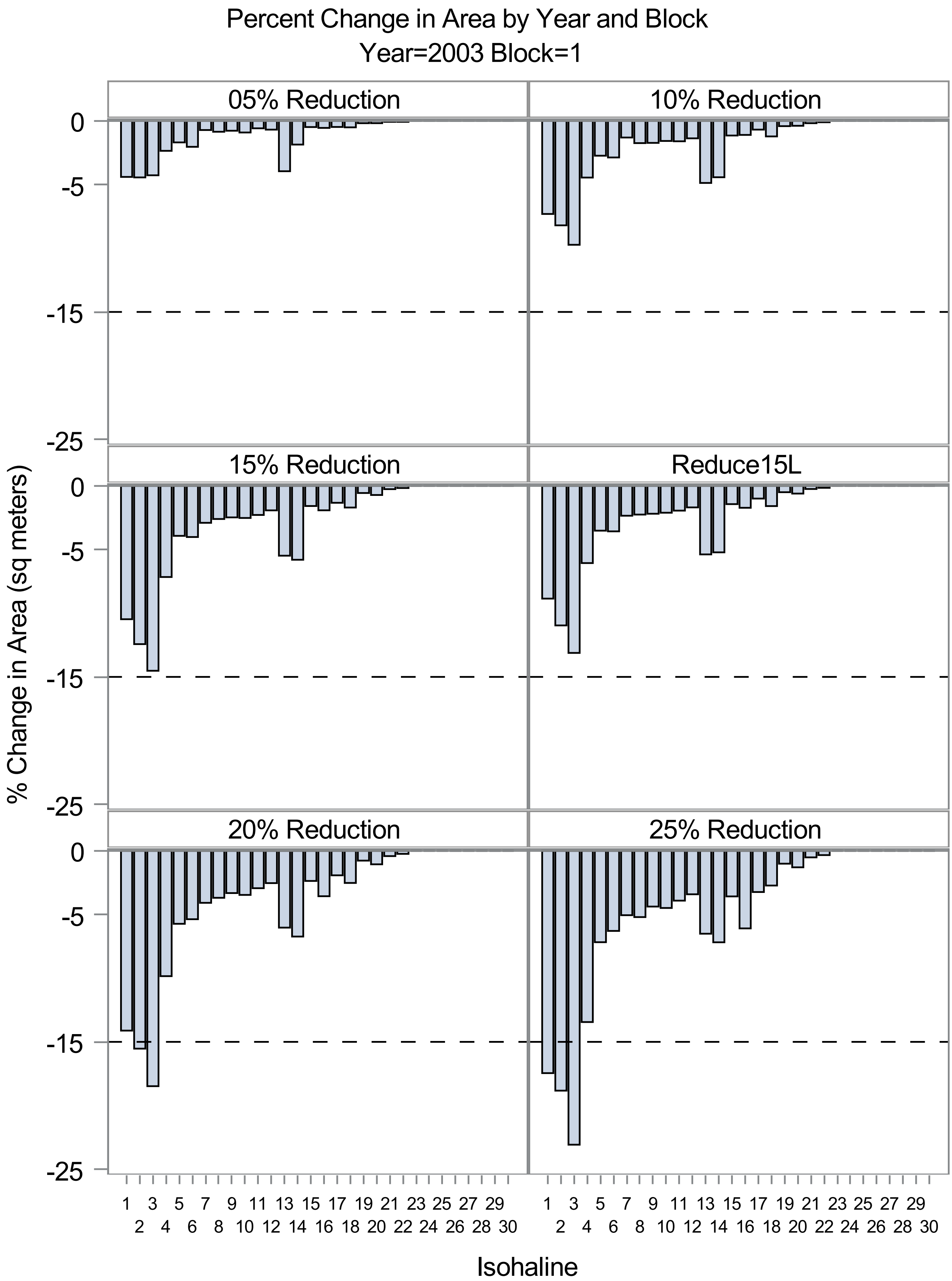

Percent Change in Area by Year and Block
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25% Reduction
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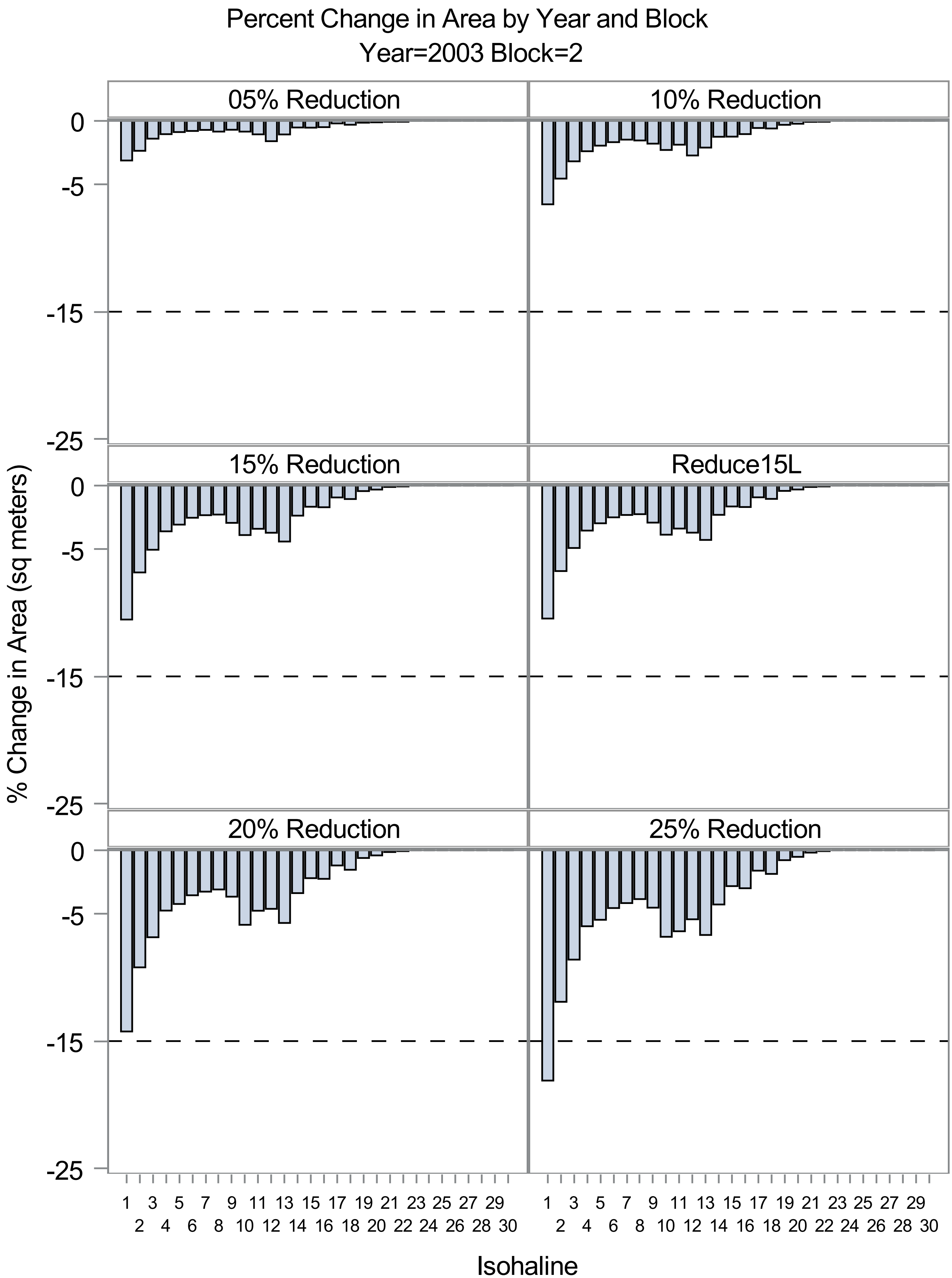
Isohaline



Percent Change in Area by Year and Block
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Reduce15L
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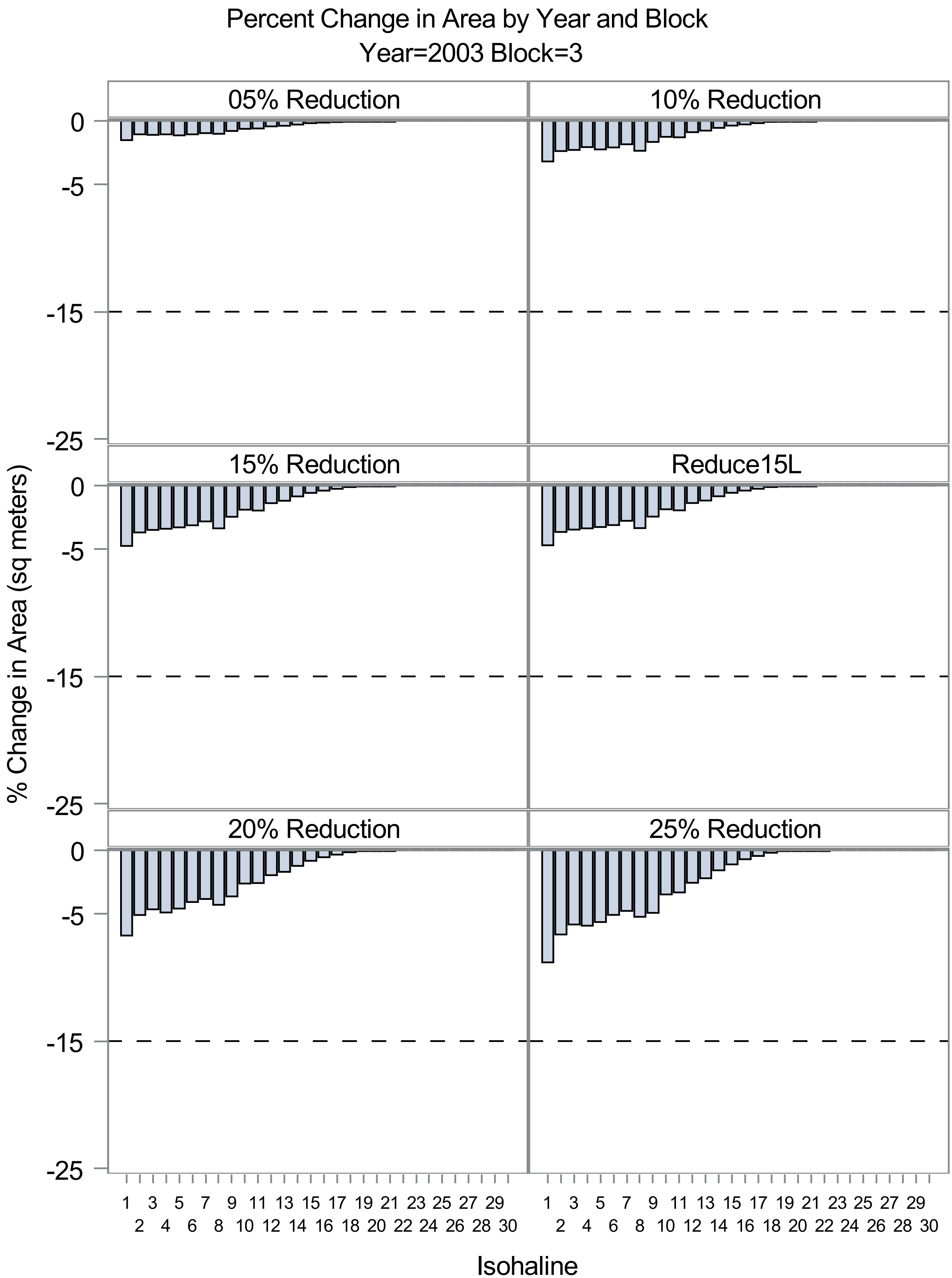
Isohaline



Percent Change in Area by Year and Block
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10% Reduction
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Reduce15L
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25% Reduction
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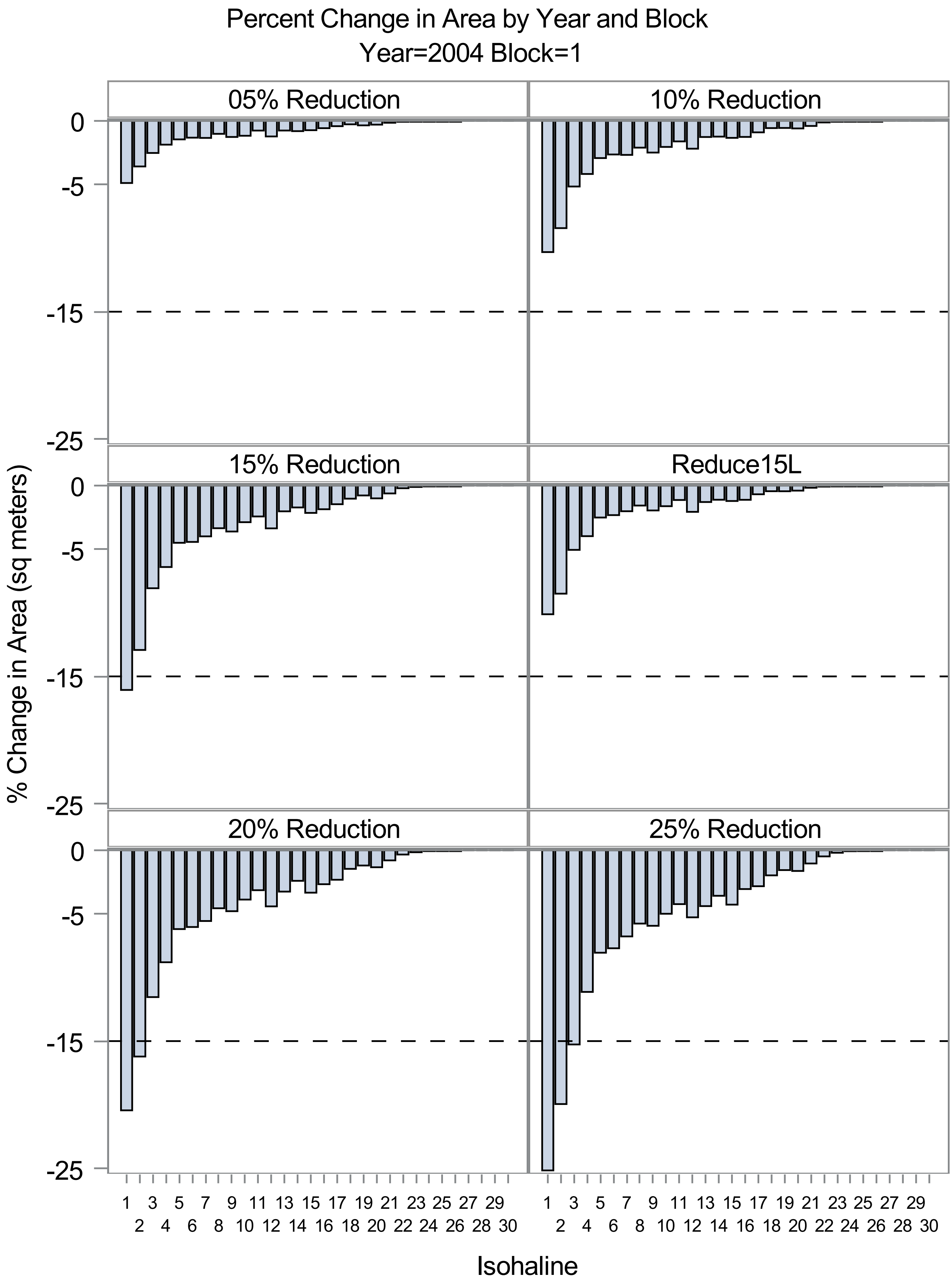
Isohaline



Percent Change in Area by Year and Block
Year=2004 Block=1
05% Reduction
10% Reduction
15% Reduction
Reduce15L
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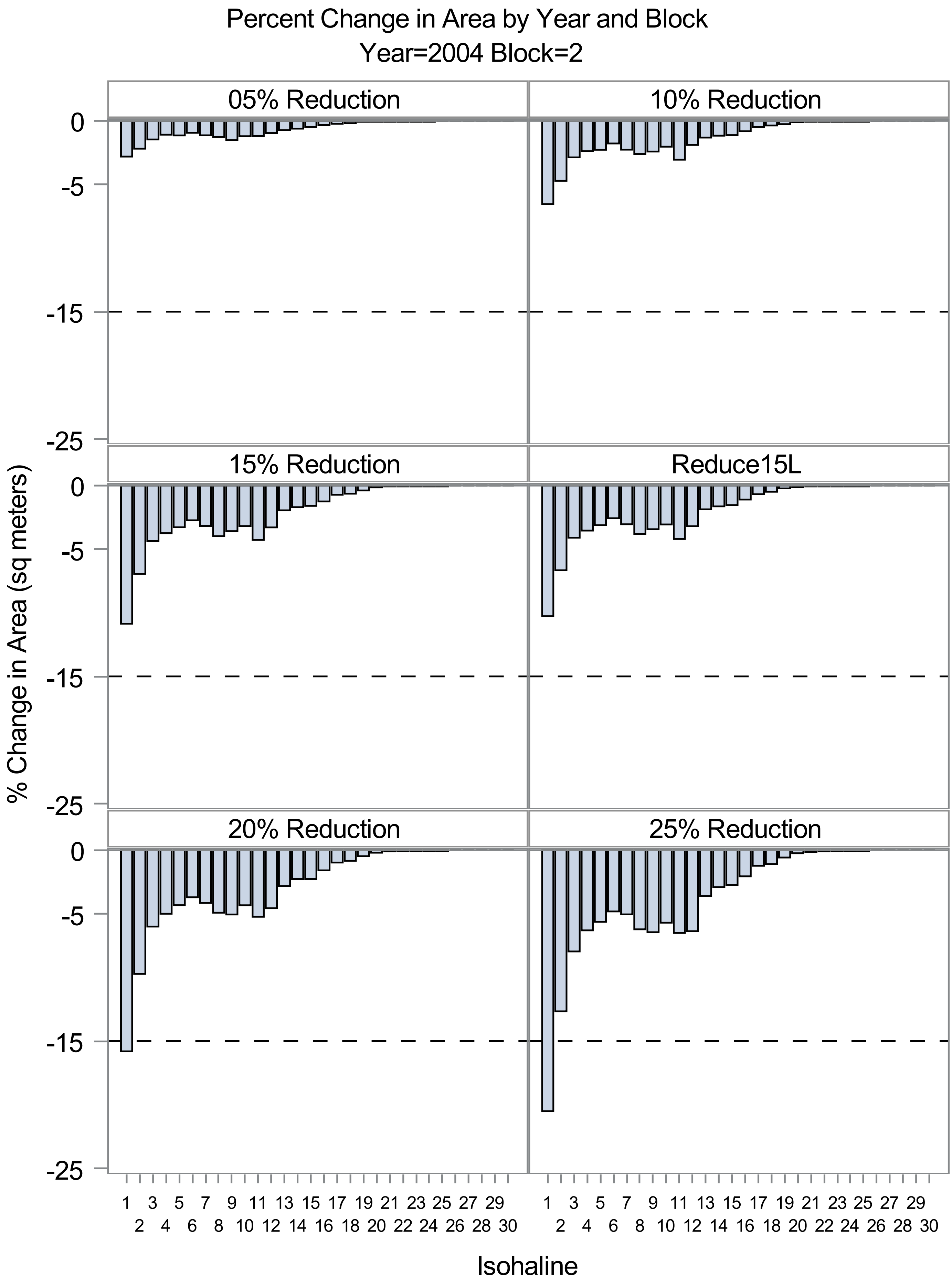
Isohaline


Percent Change in Area by Year and Block
Year=2004 Block=2
05% Reduction
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Reduce15L
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-15
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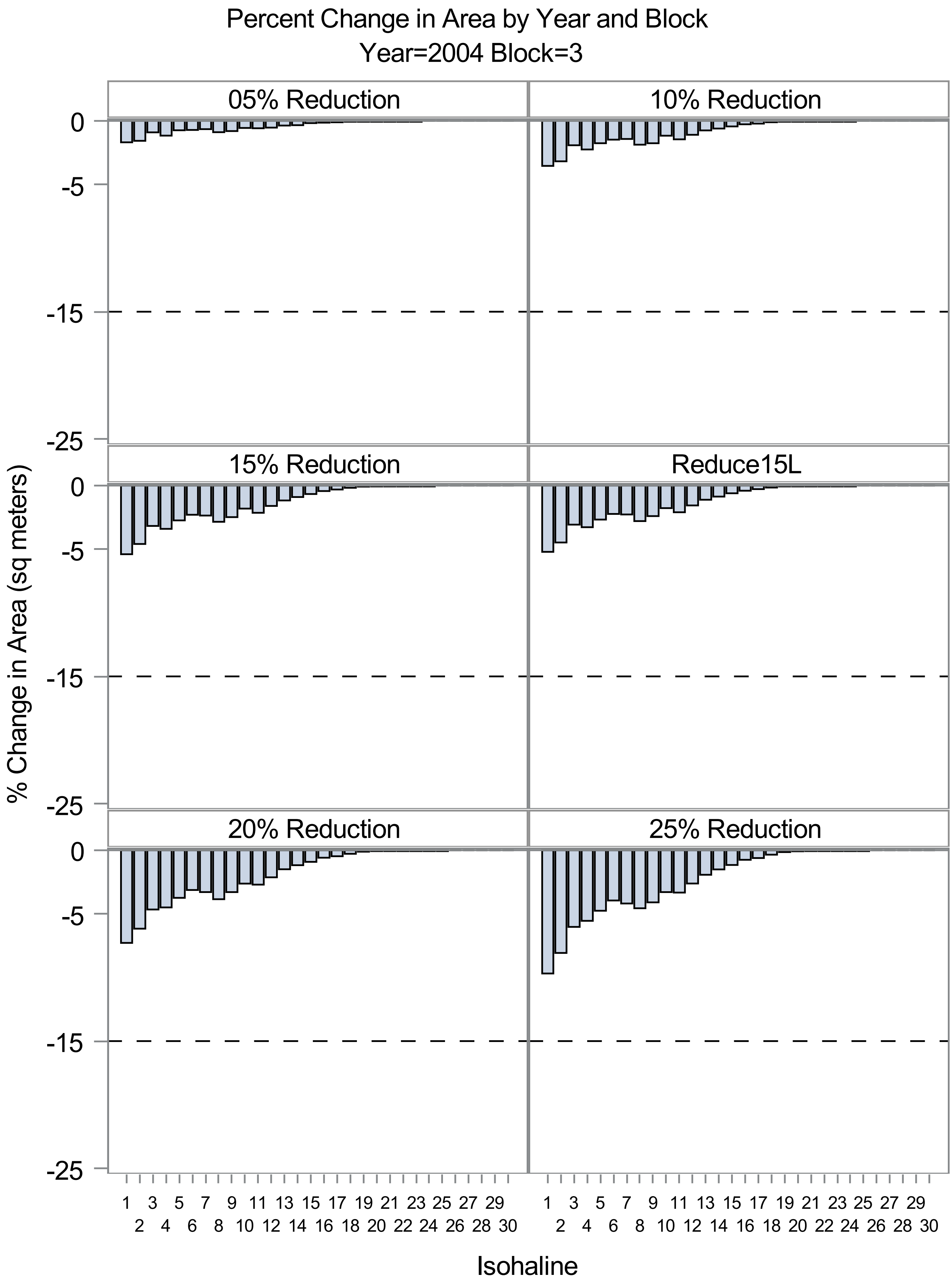
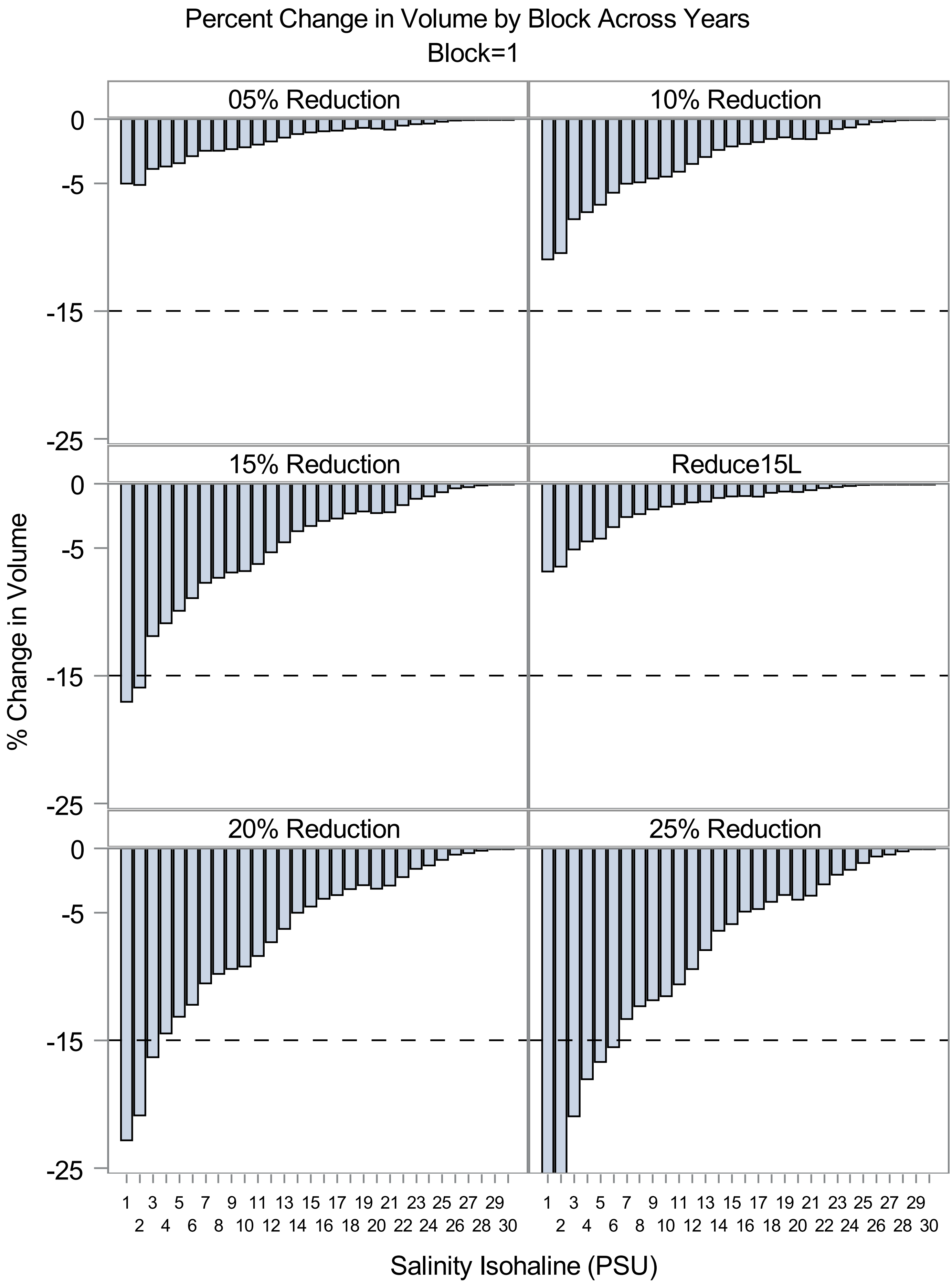
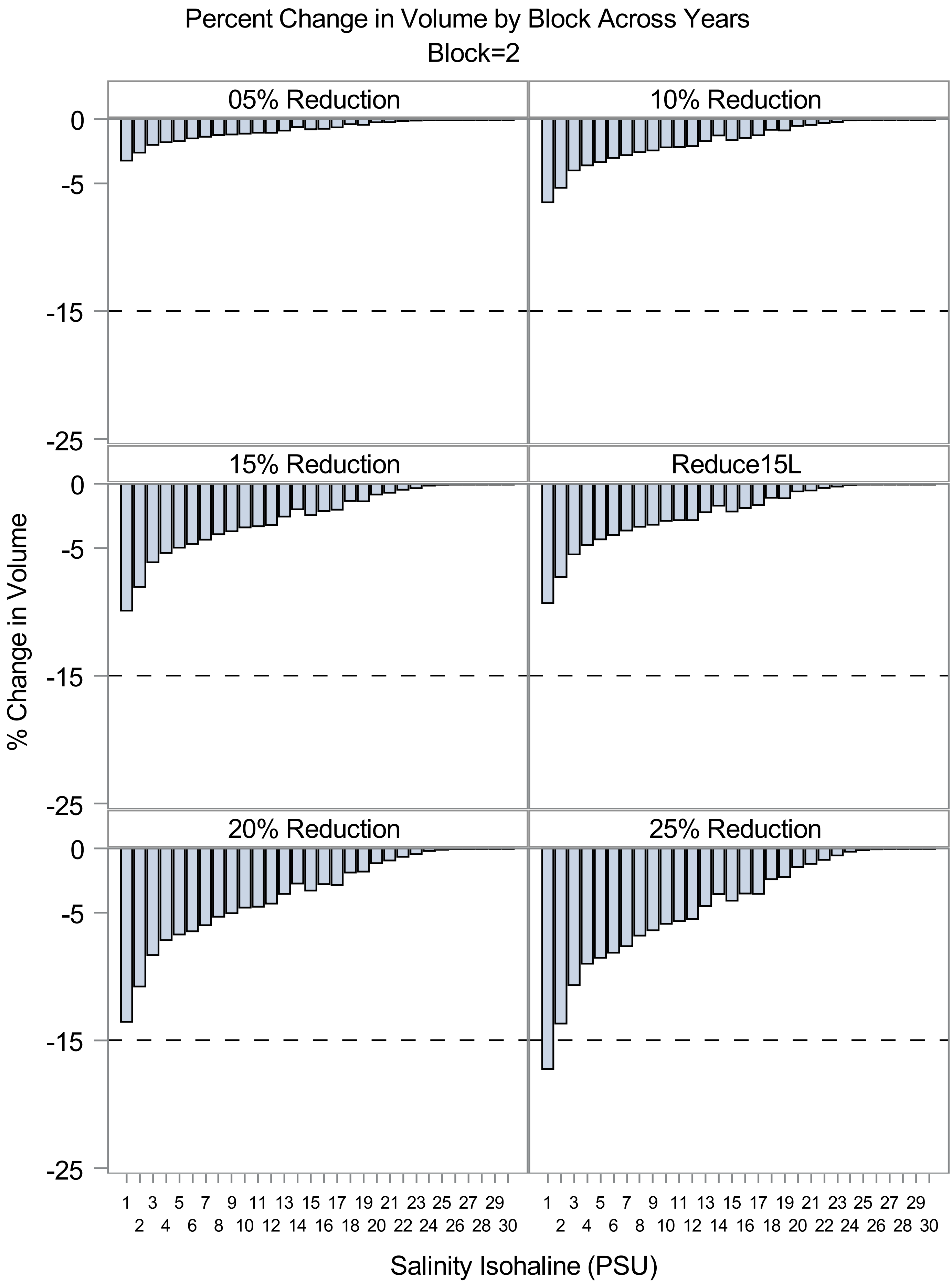
Isohaline



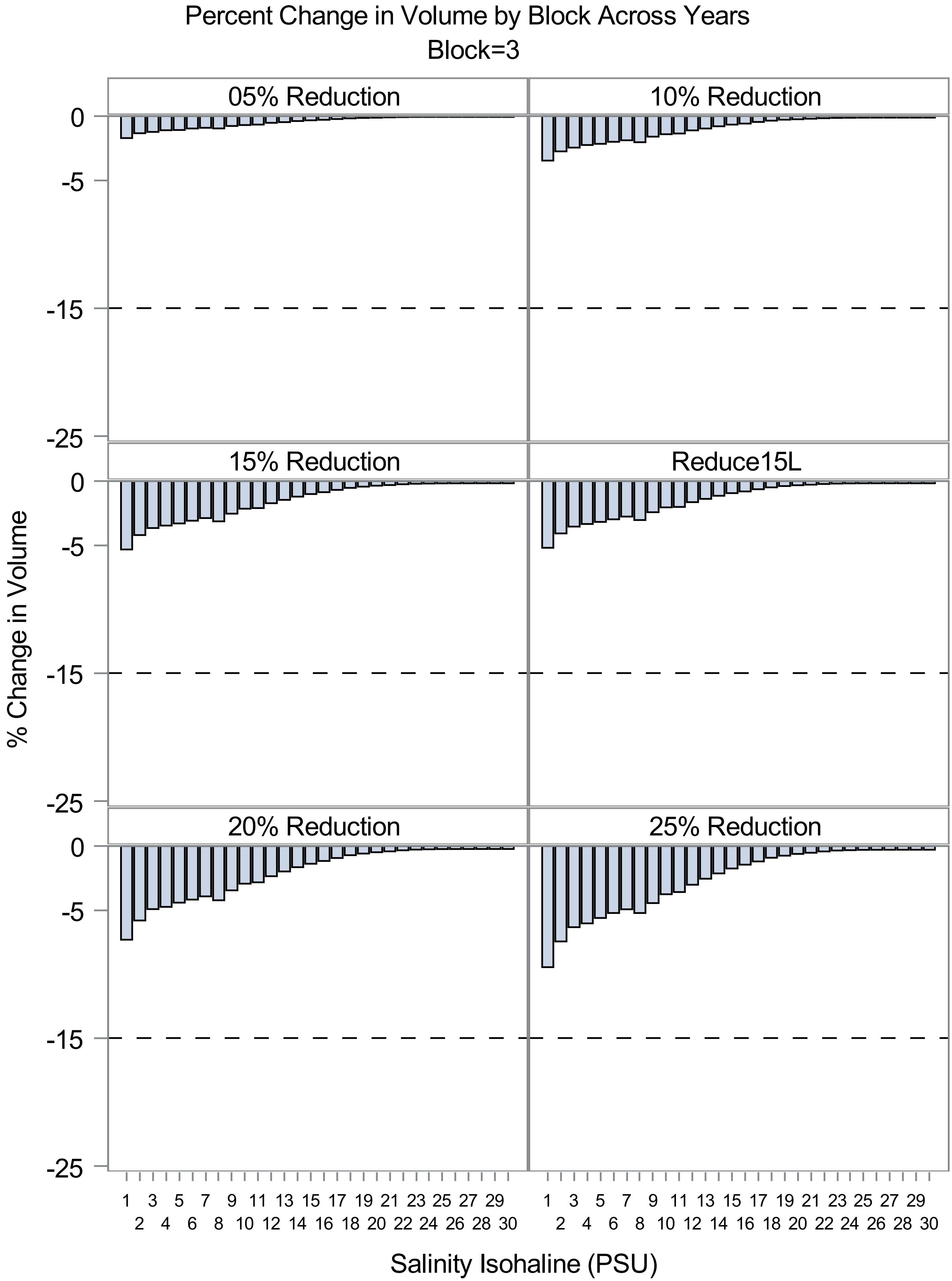
Percent Change in Area by Year and Block
Year=2004 Block=3
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Area (sq meters)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Isohaline



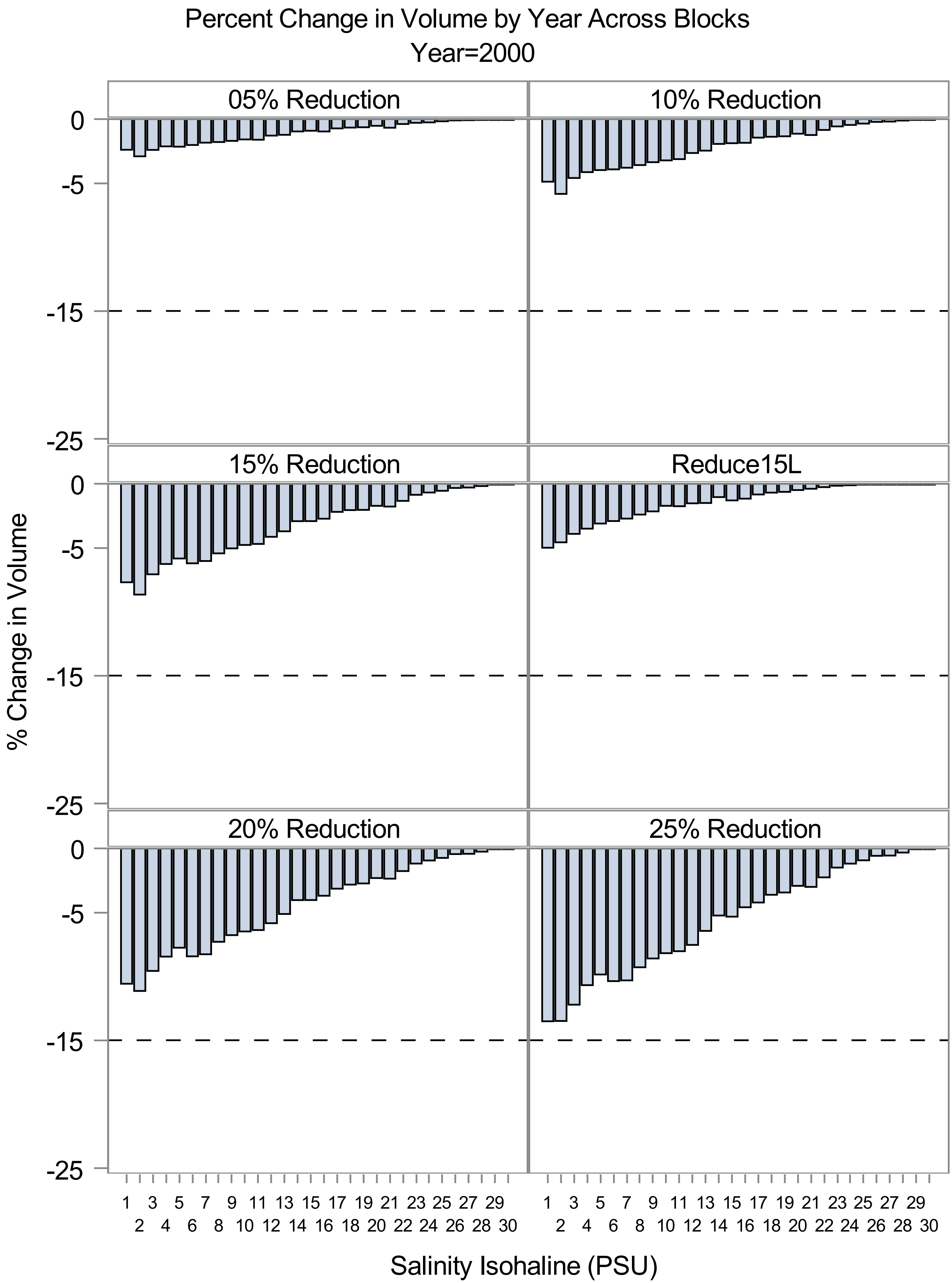
Percent Change in Volume by Block Across Years
Block=1
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

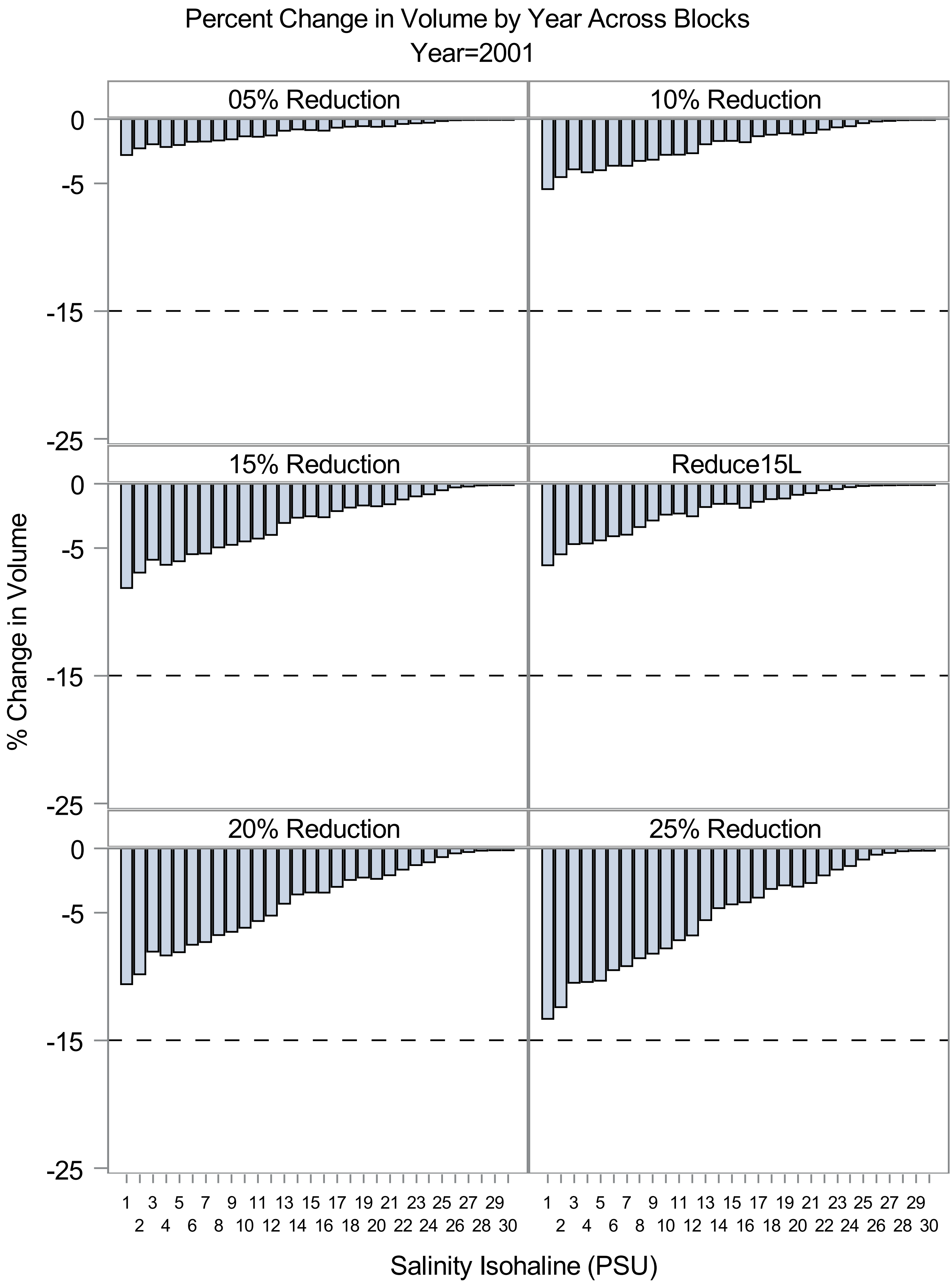


Percent Change in Volume by Block Across Years
Block=2
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
% Change in Volume
0
-5
-15
-25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)



Percent Change in Volume by Block Across Years
Block=3
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)


Percent Change in Volume by Year Across Blocks
Year=2000
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)


Percent Change in Volume by Year Across Blocks
Year=2001
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
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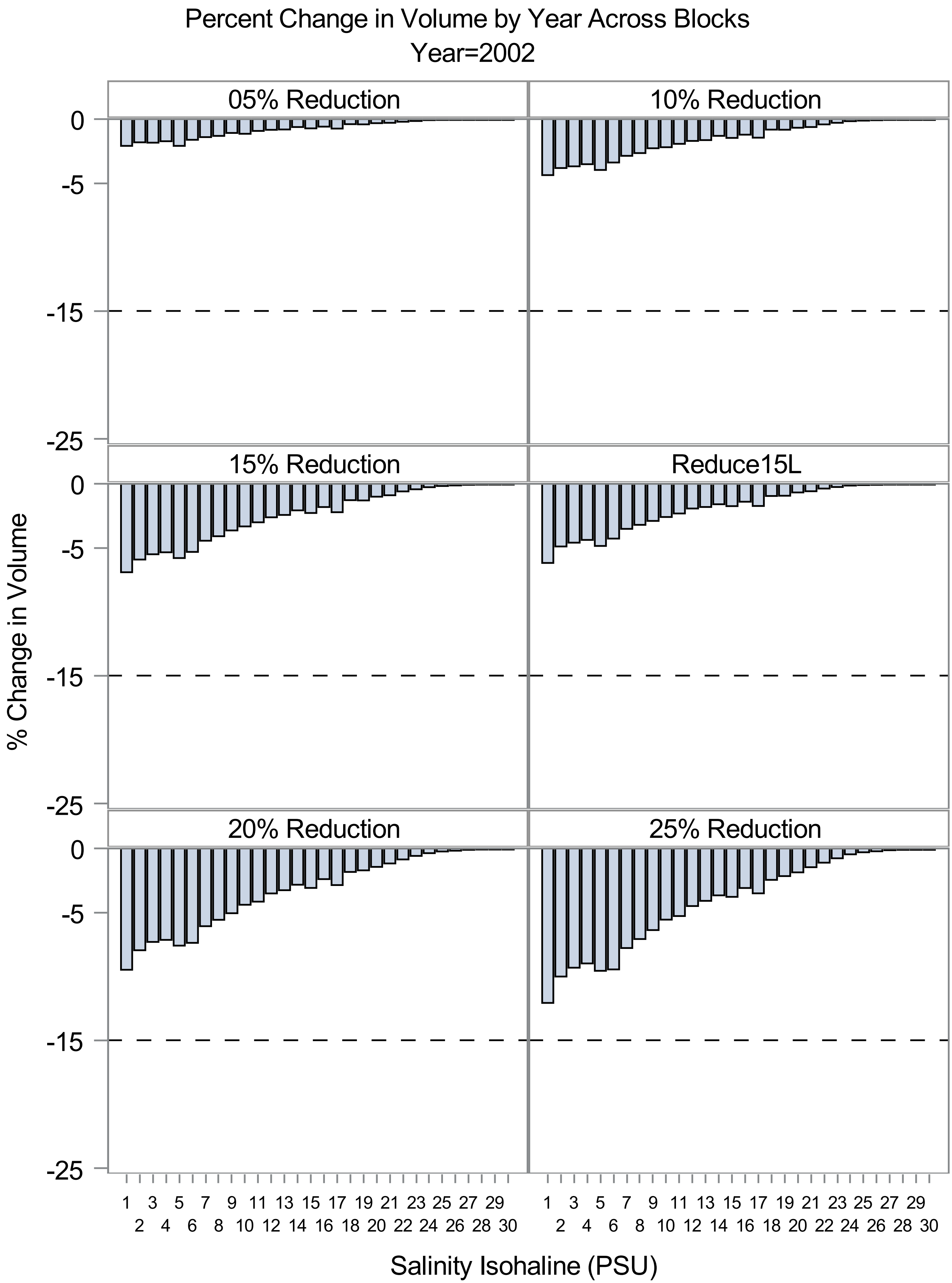
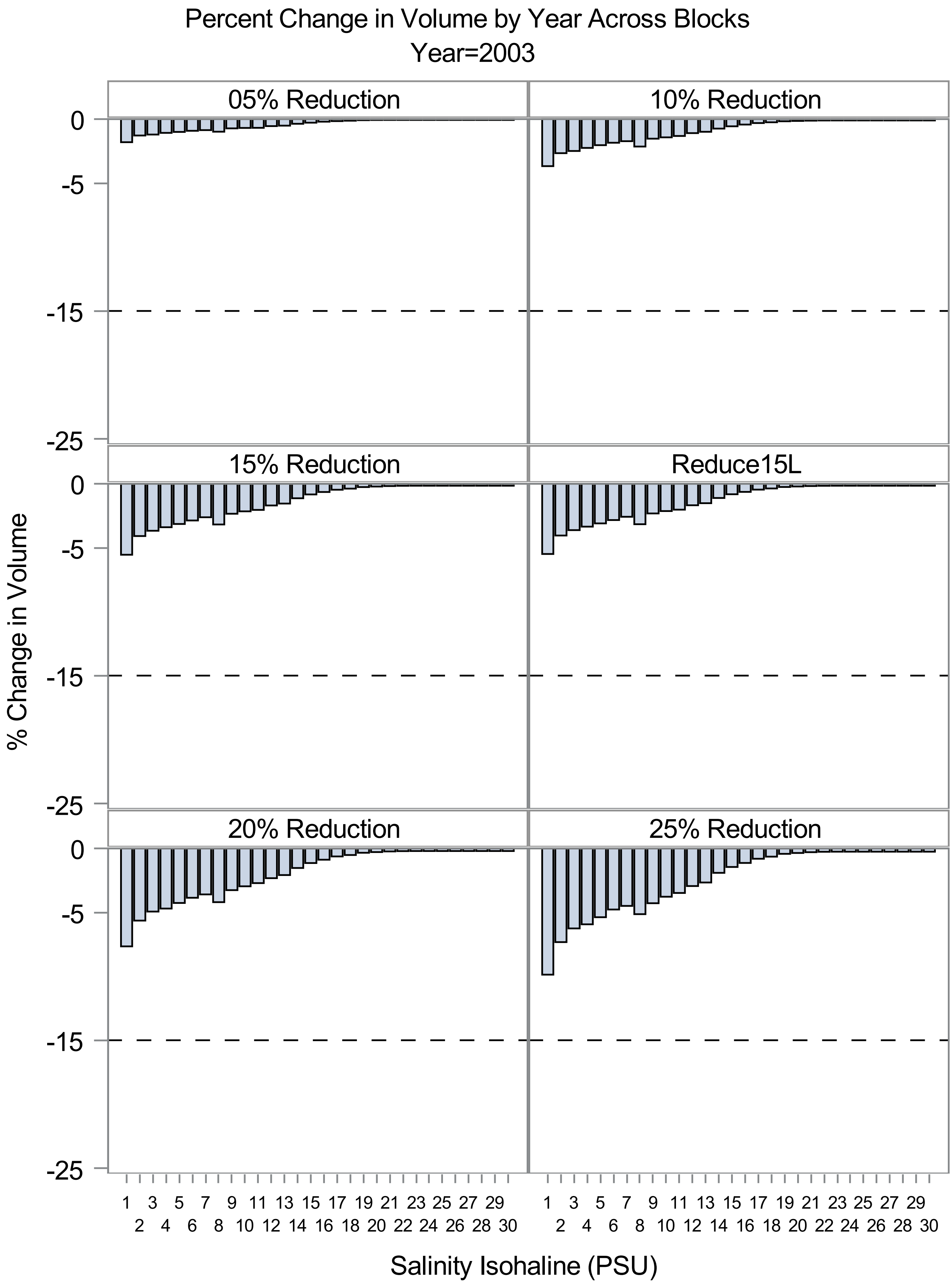
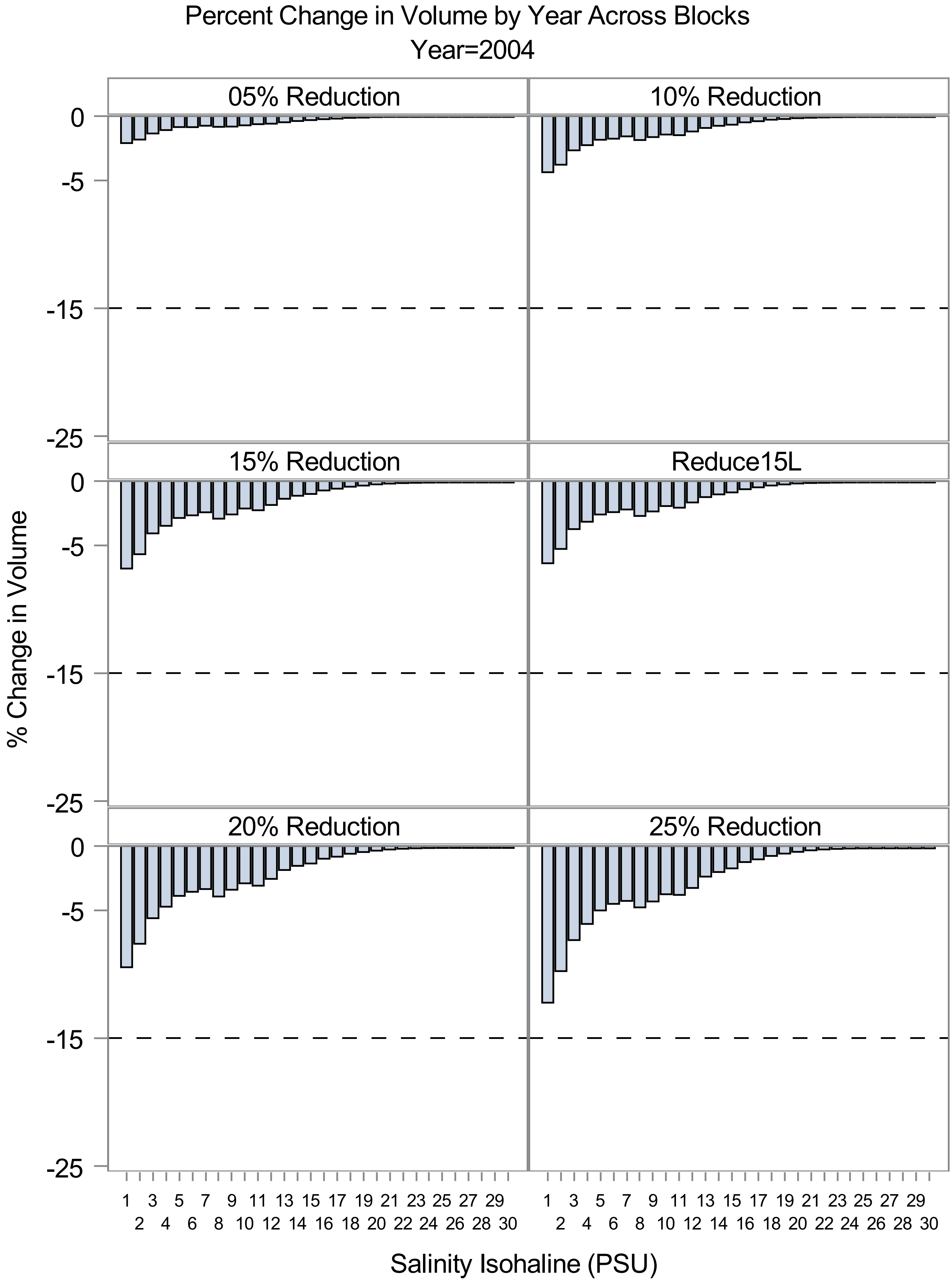
Salinity Isohaline (PSU)



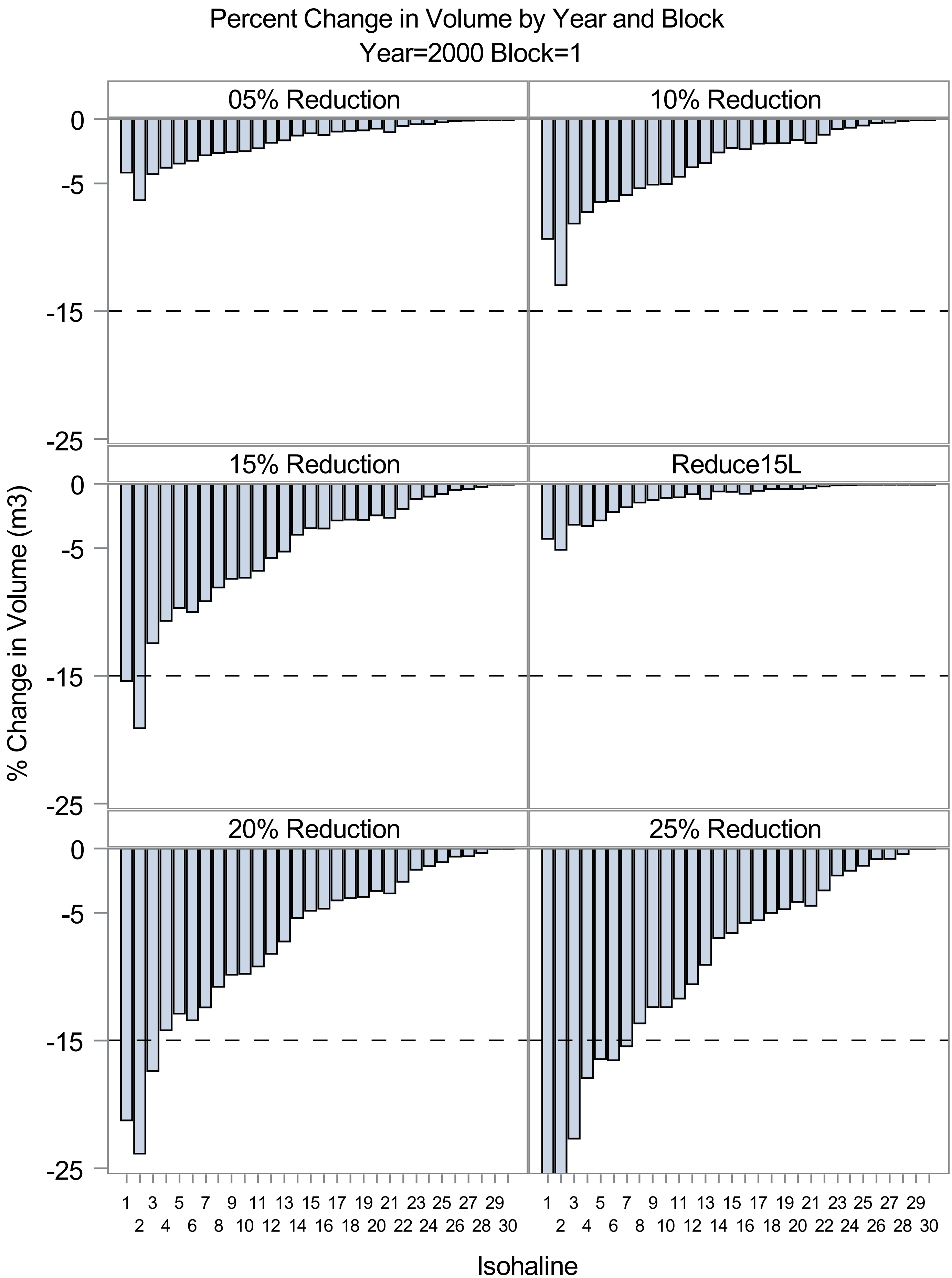
Percent Change in Volume by Year Across Blocks
Year=2002
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

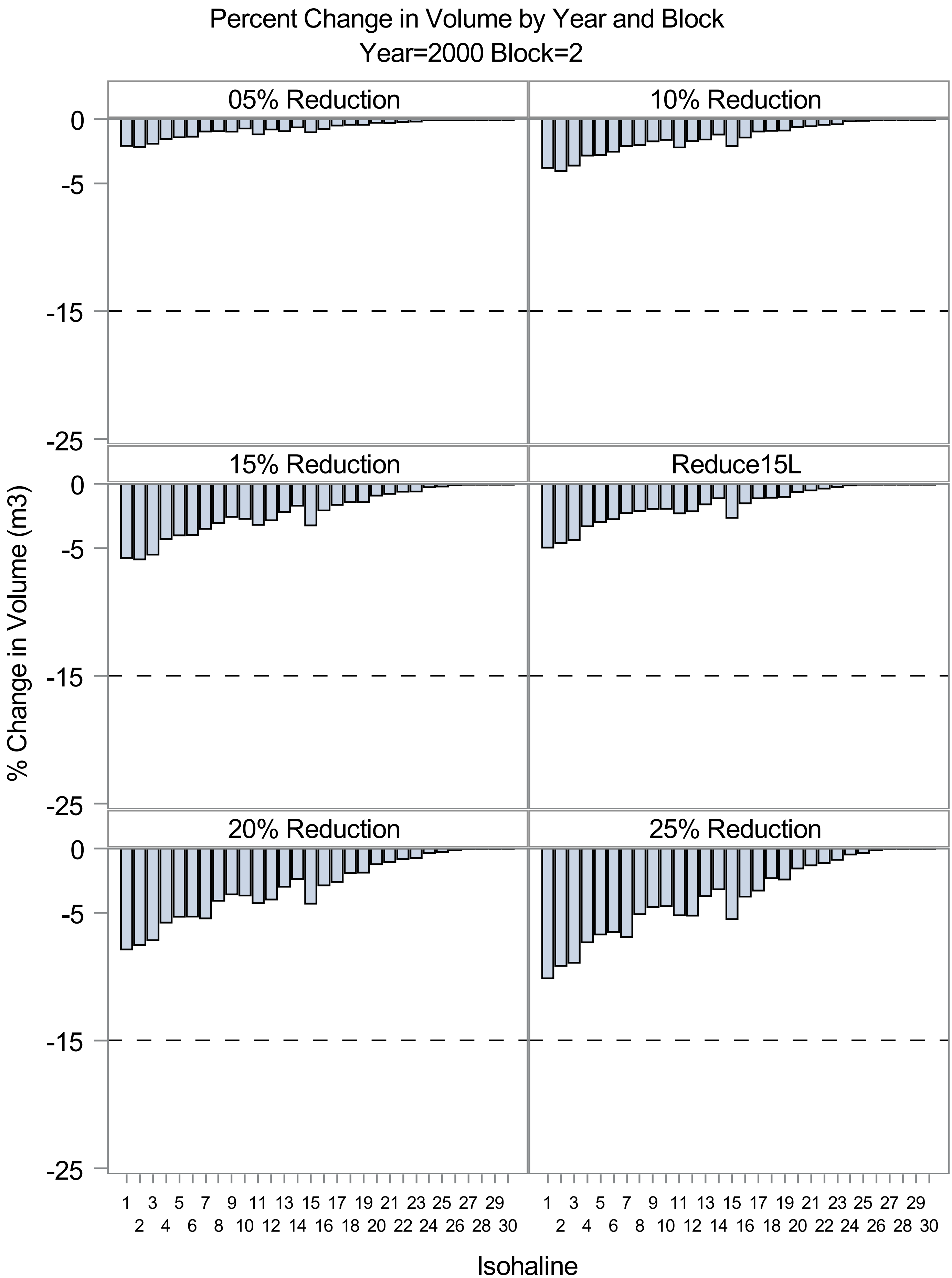


Percent Change in Volume by Year Across Blocks
Year=2003
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Salinity Isohaline (PSU)

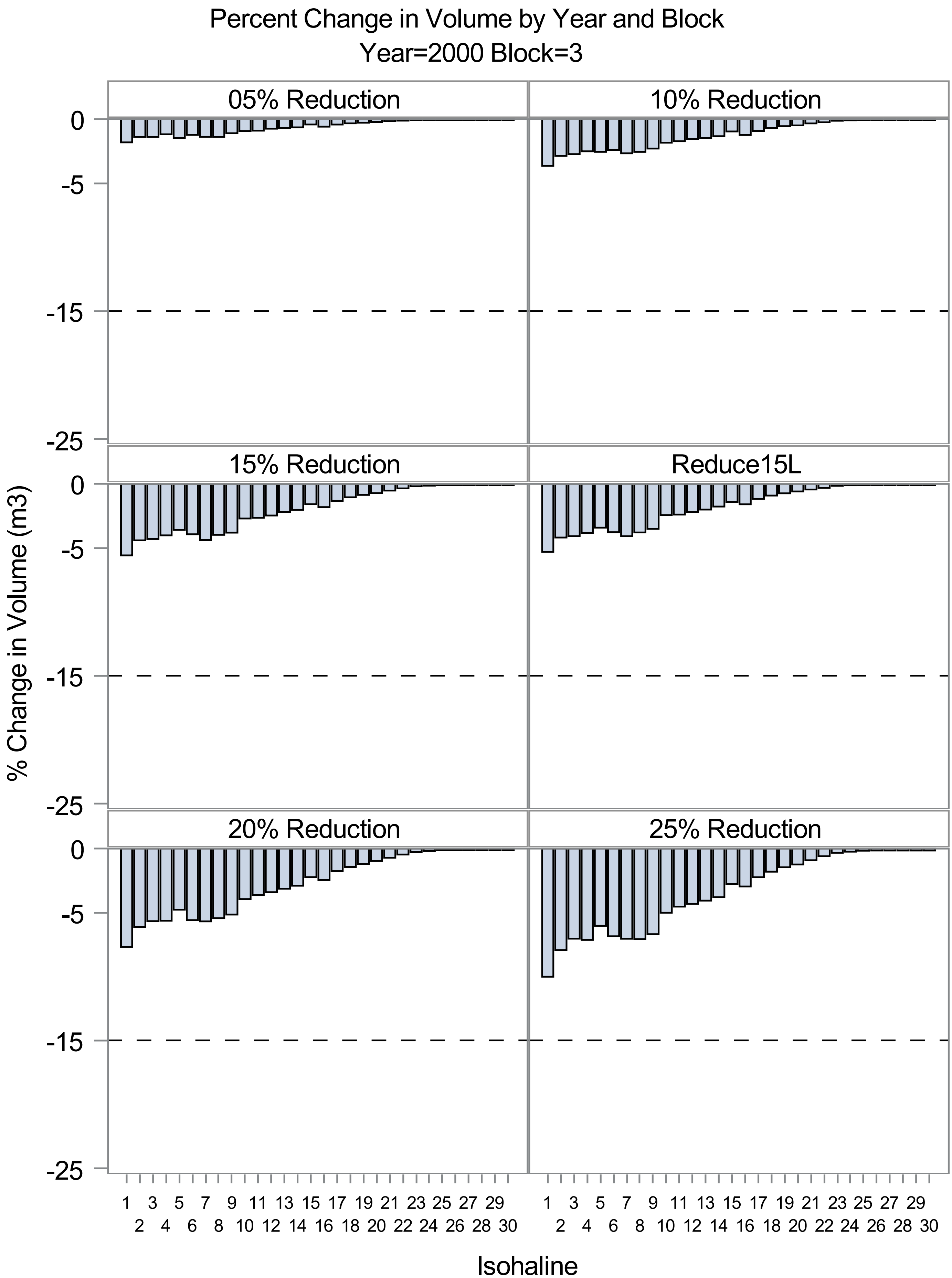


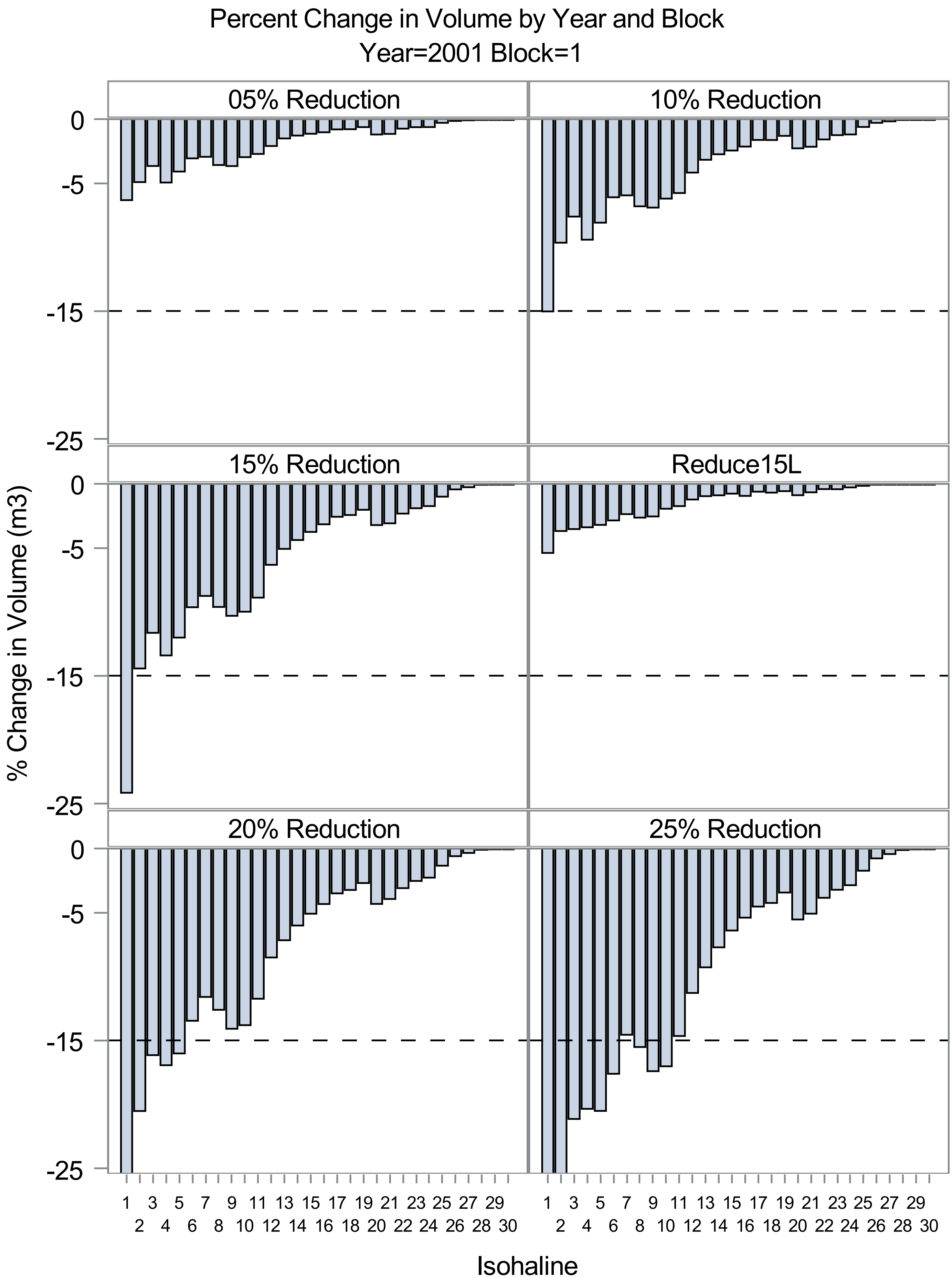
Percent Change in Volume by Year Across Blocks
Year=2004
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
% Change in Volume
0
-5
-15
-25
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Salinity Isohaline (PSU)


Percent Change in Volume by Year and Block
Year=2000 Block=1
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline



Percent Change in Volume by Year and Block
Year=2000 Block=2
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline


Percent Change in Volume by Year and Block
Year=2000 Block=3
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Isohaline



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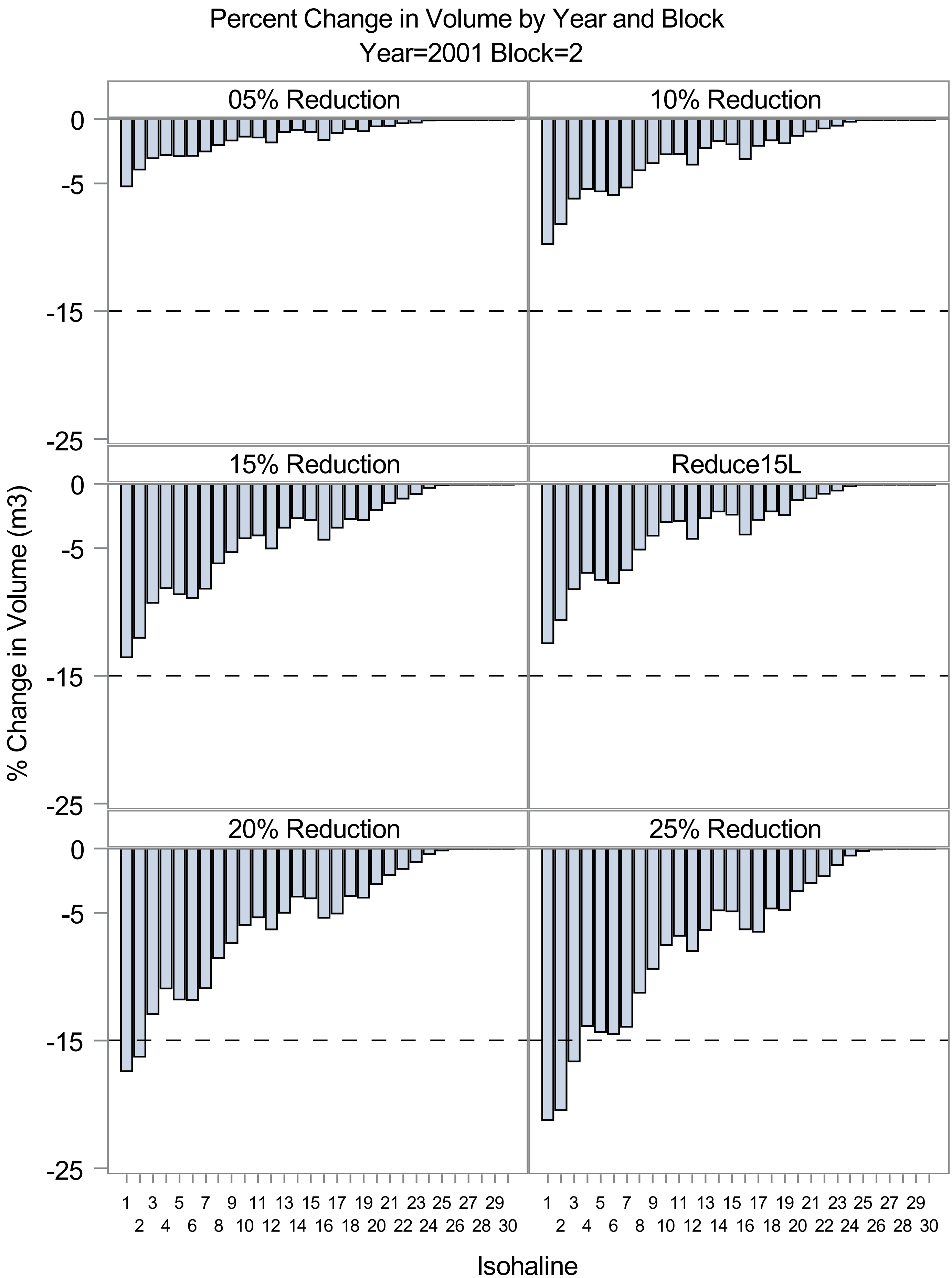

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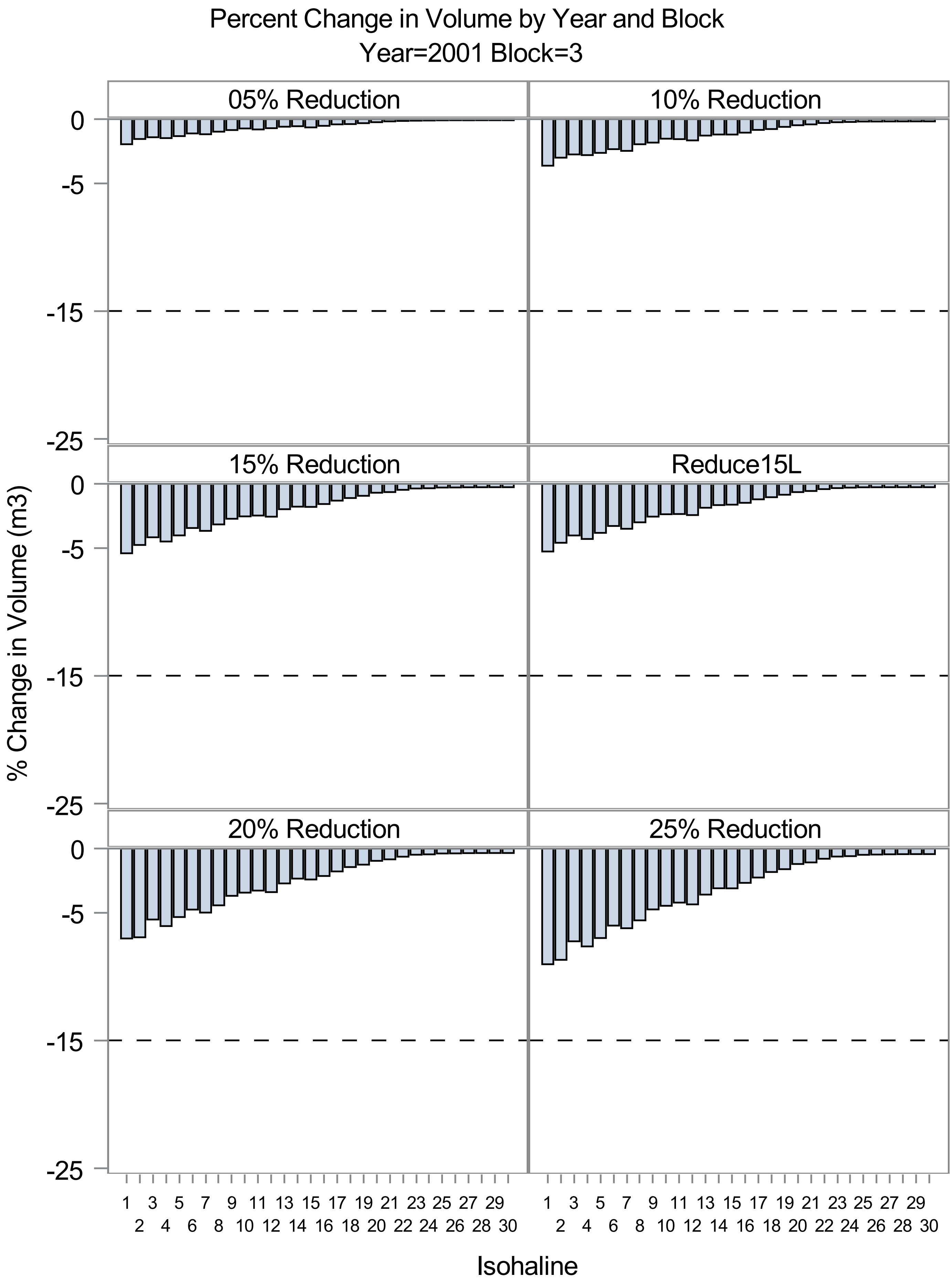

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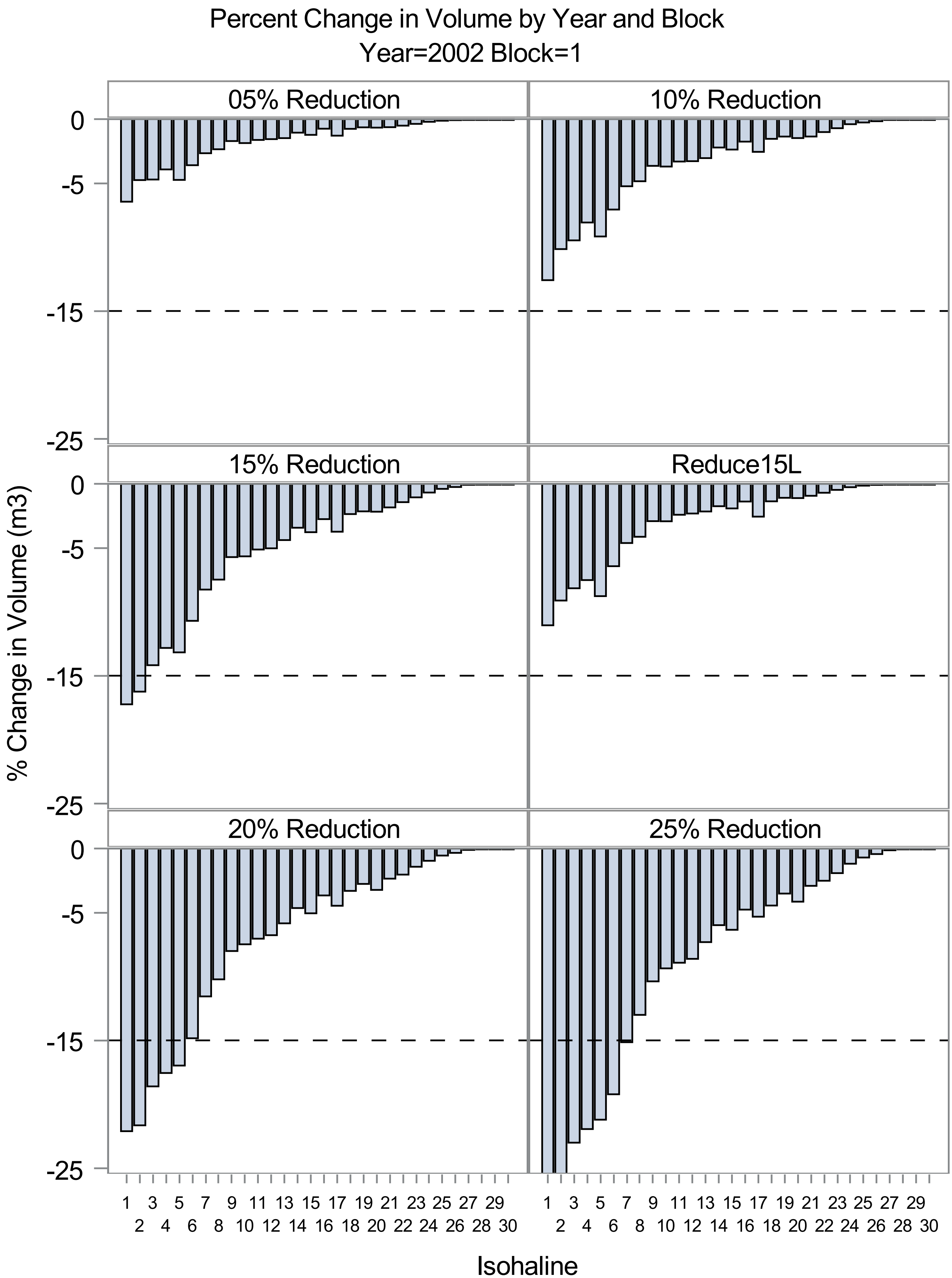
Percent Change in Volume by Year and Block
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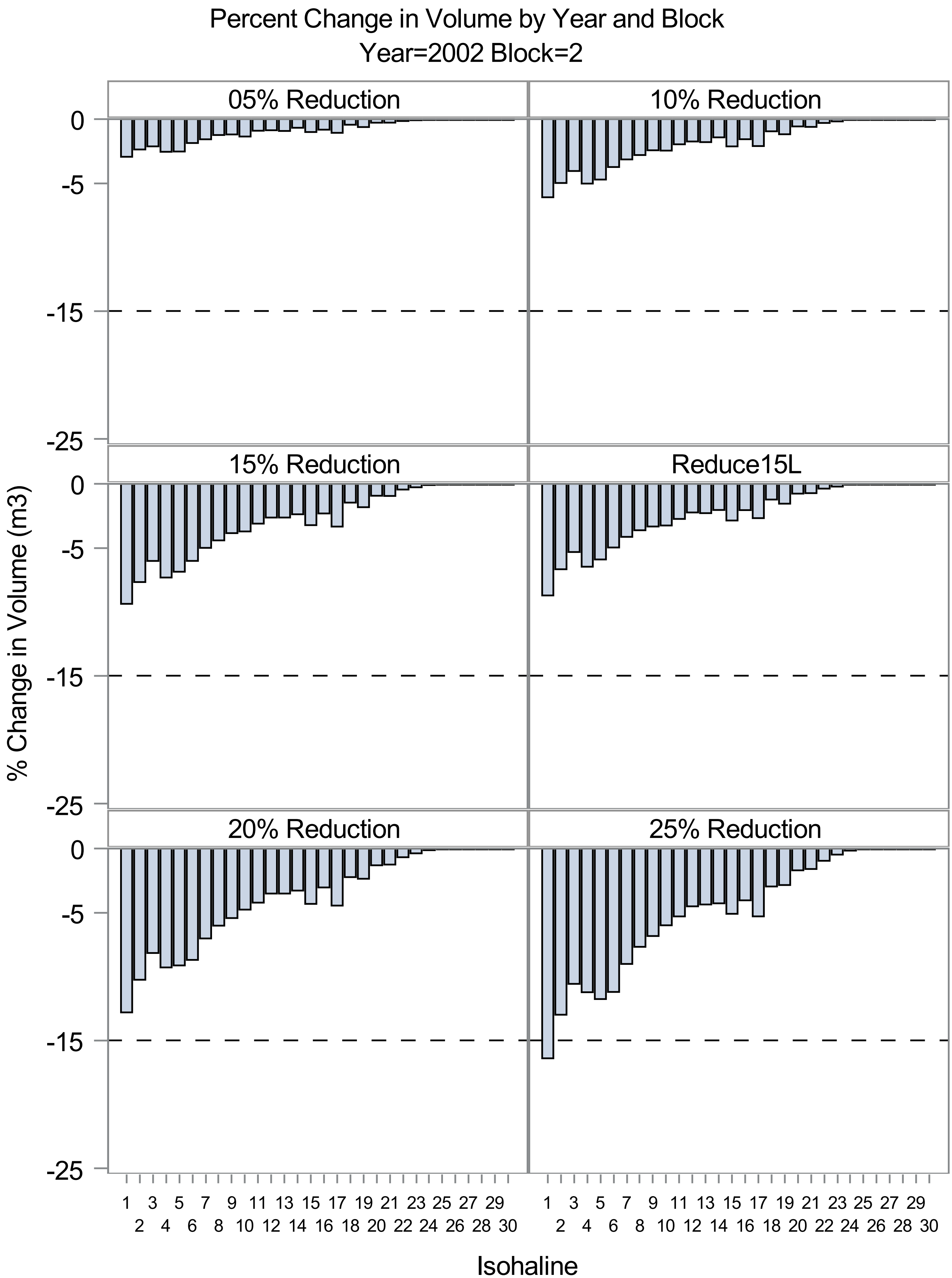
Isohaline


Percent Change in Volume by Year and Block
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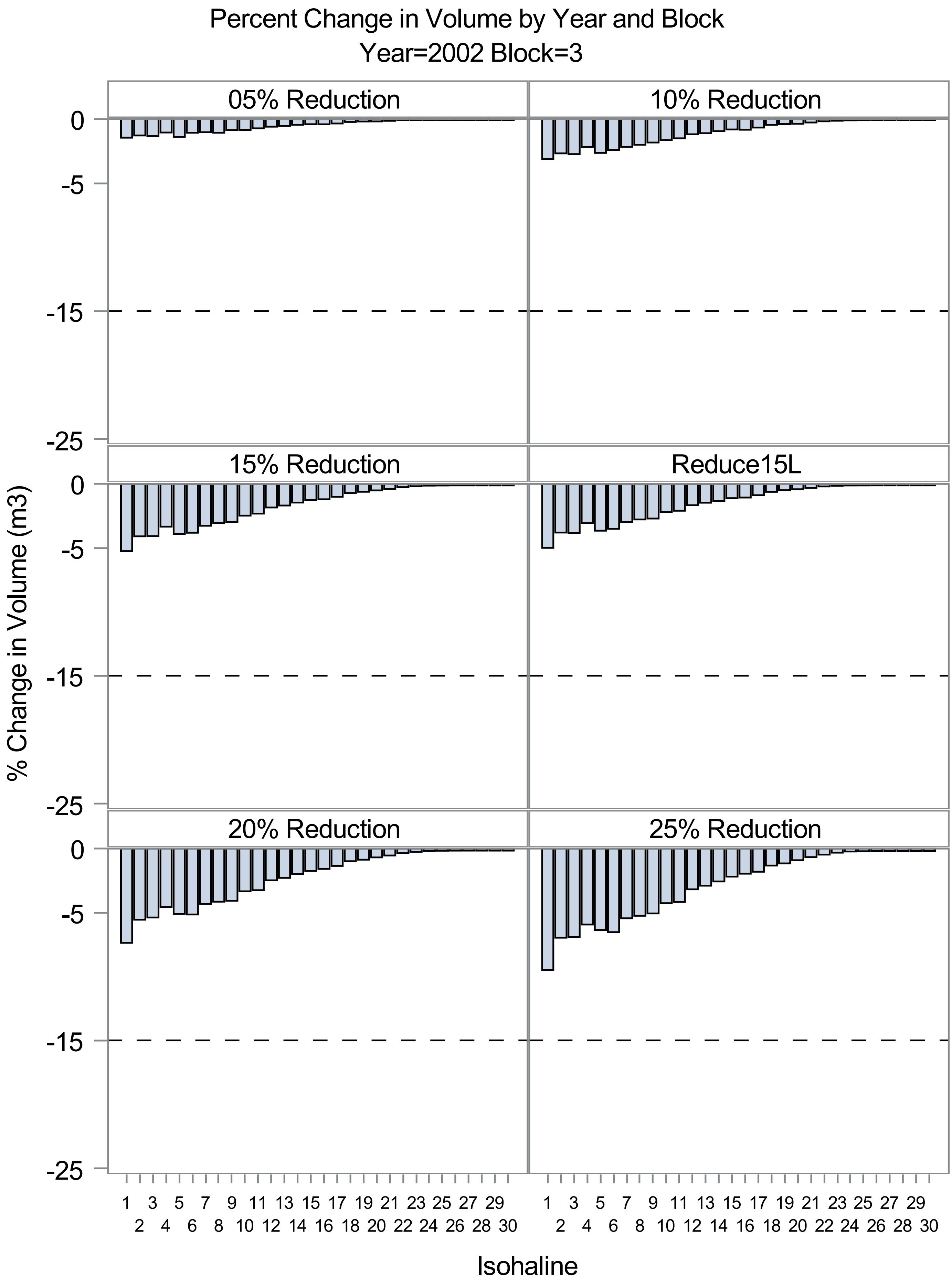

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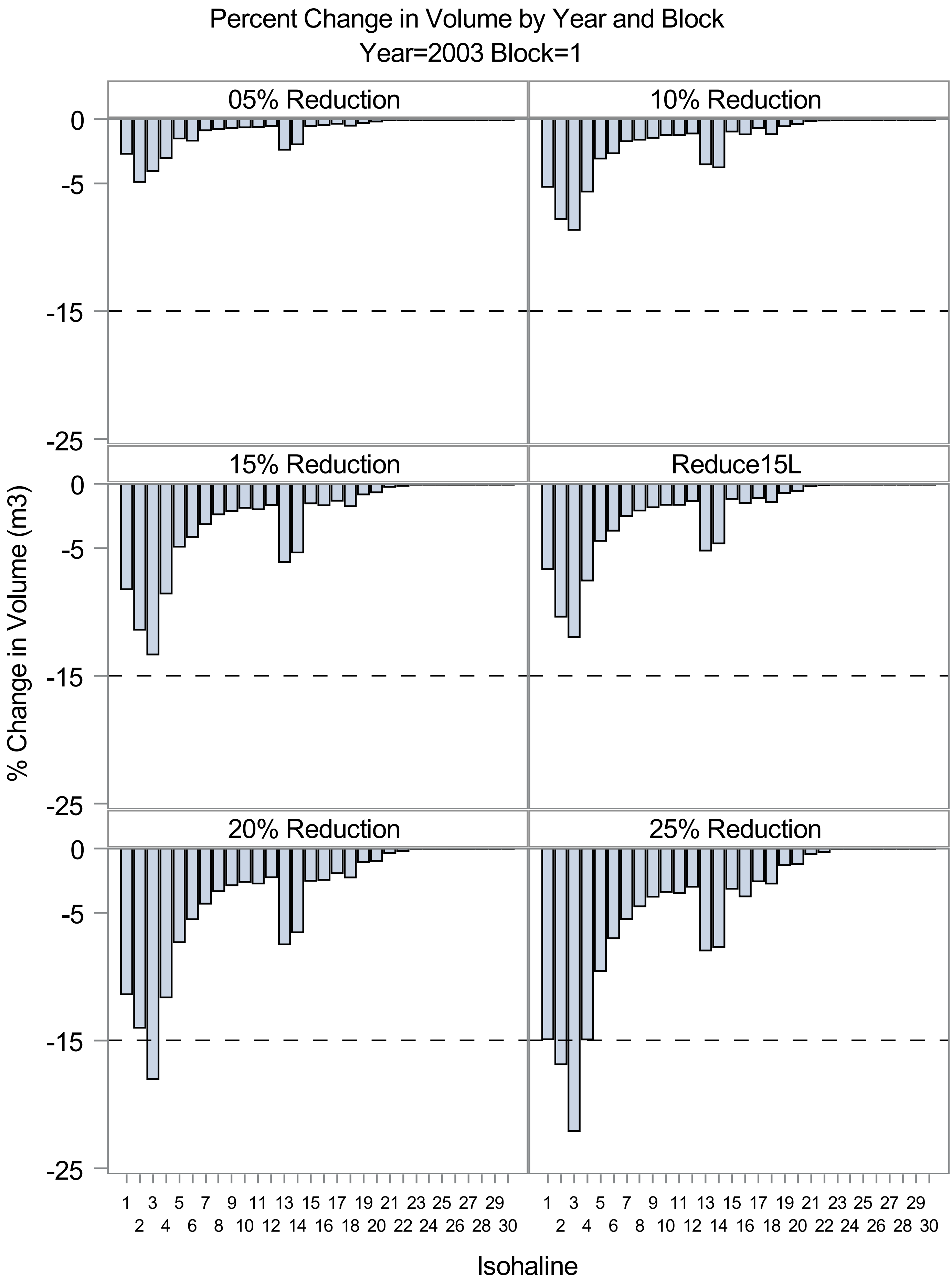
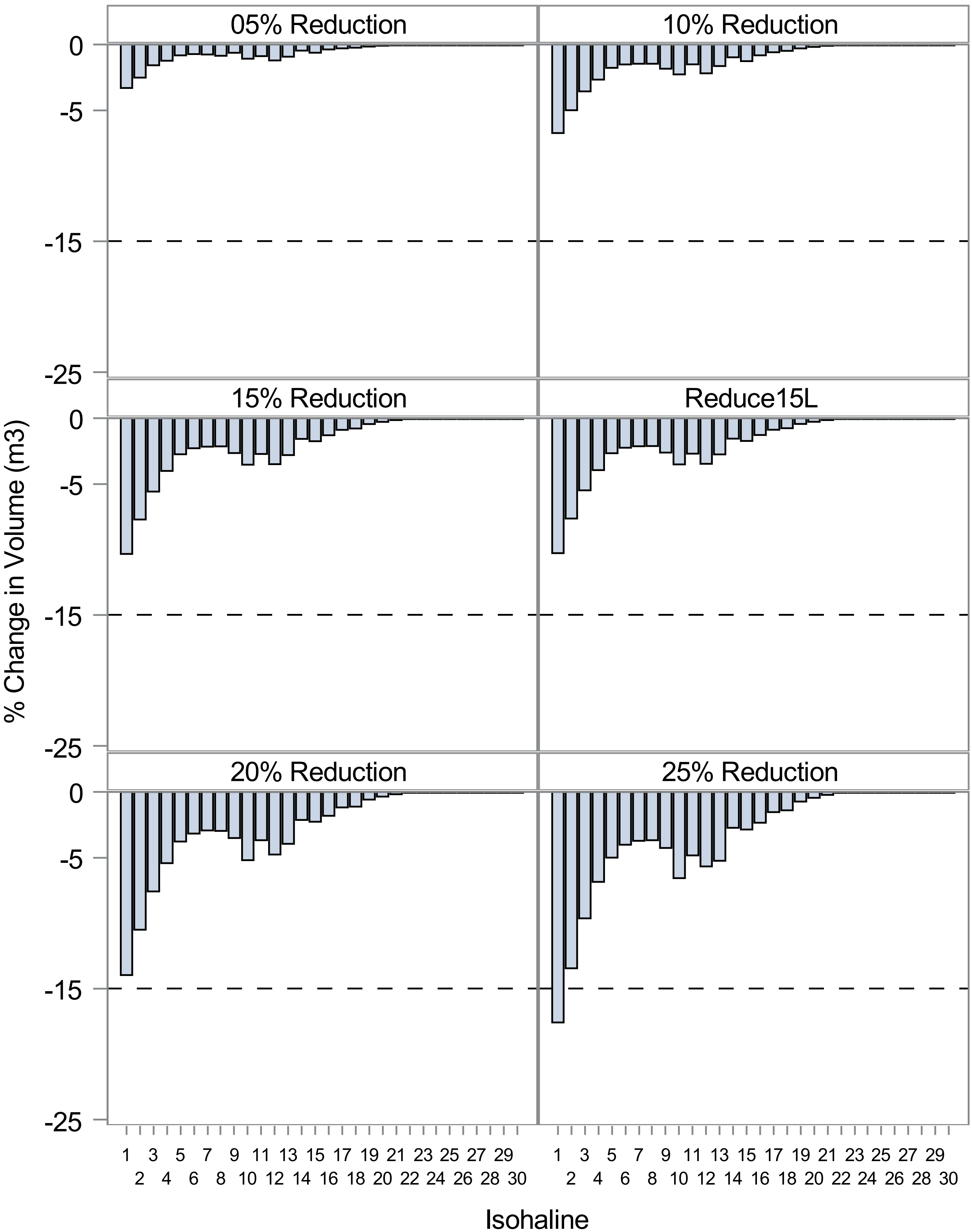
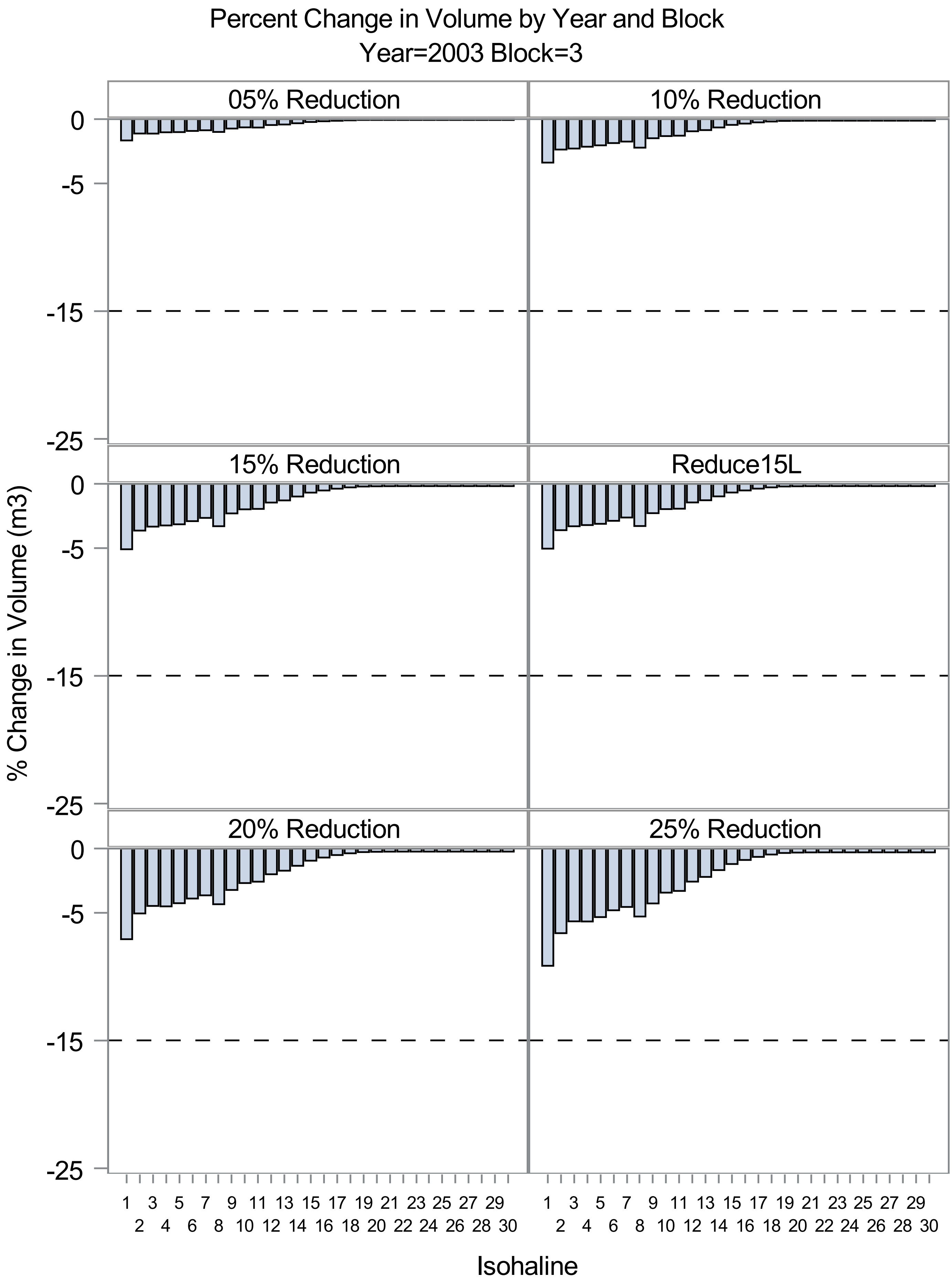
Isohaline



Percent Change in Volume by Year and Block
Year=2003 Block=1
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Isohaline

Percent Change in Volume by Year and Block
Year=2003 Block=2





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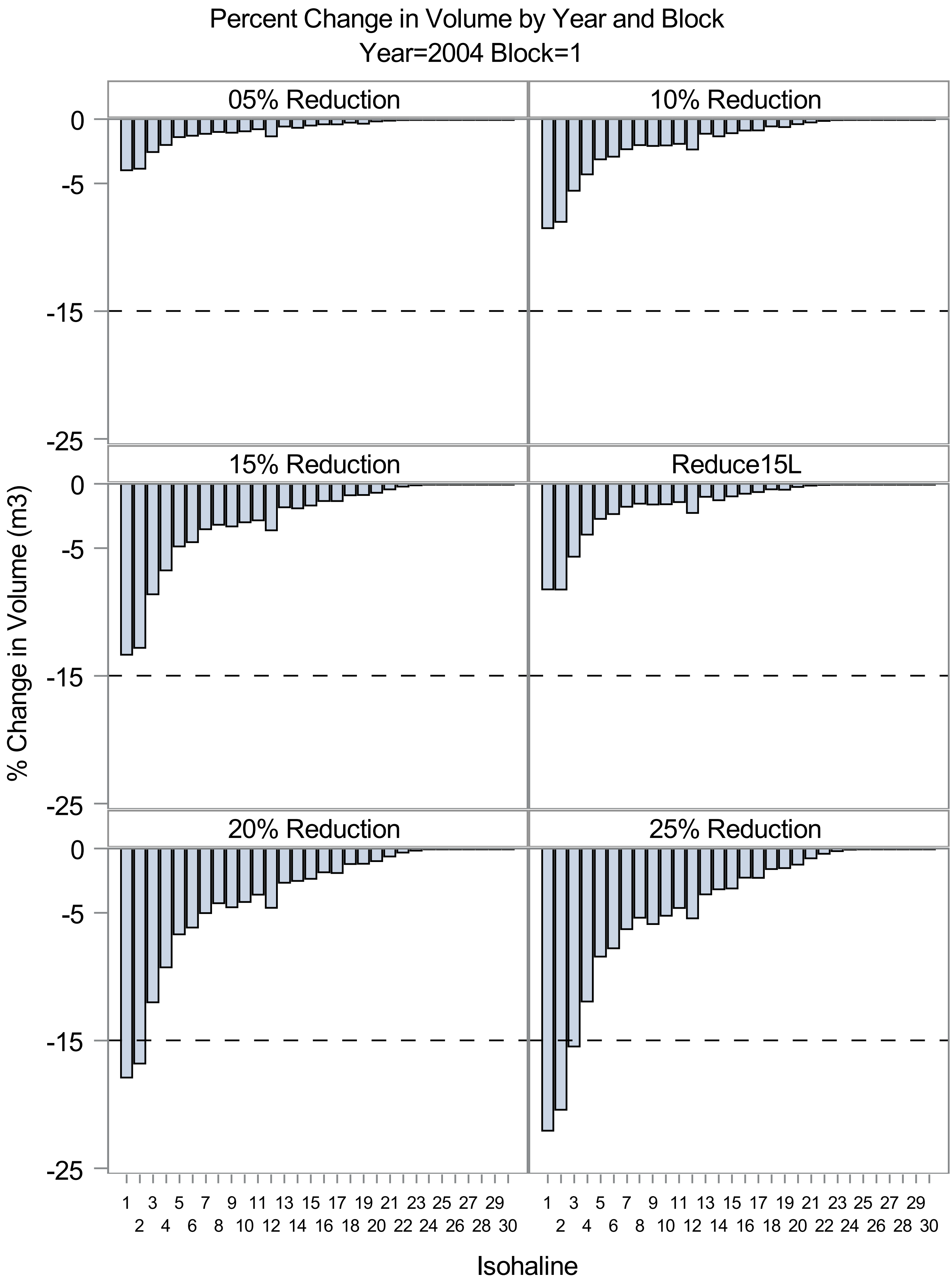
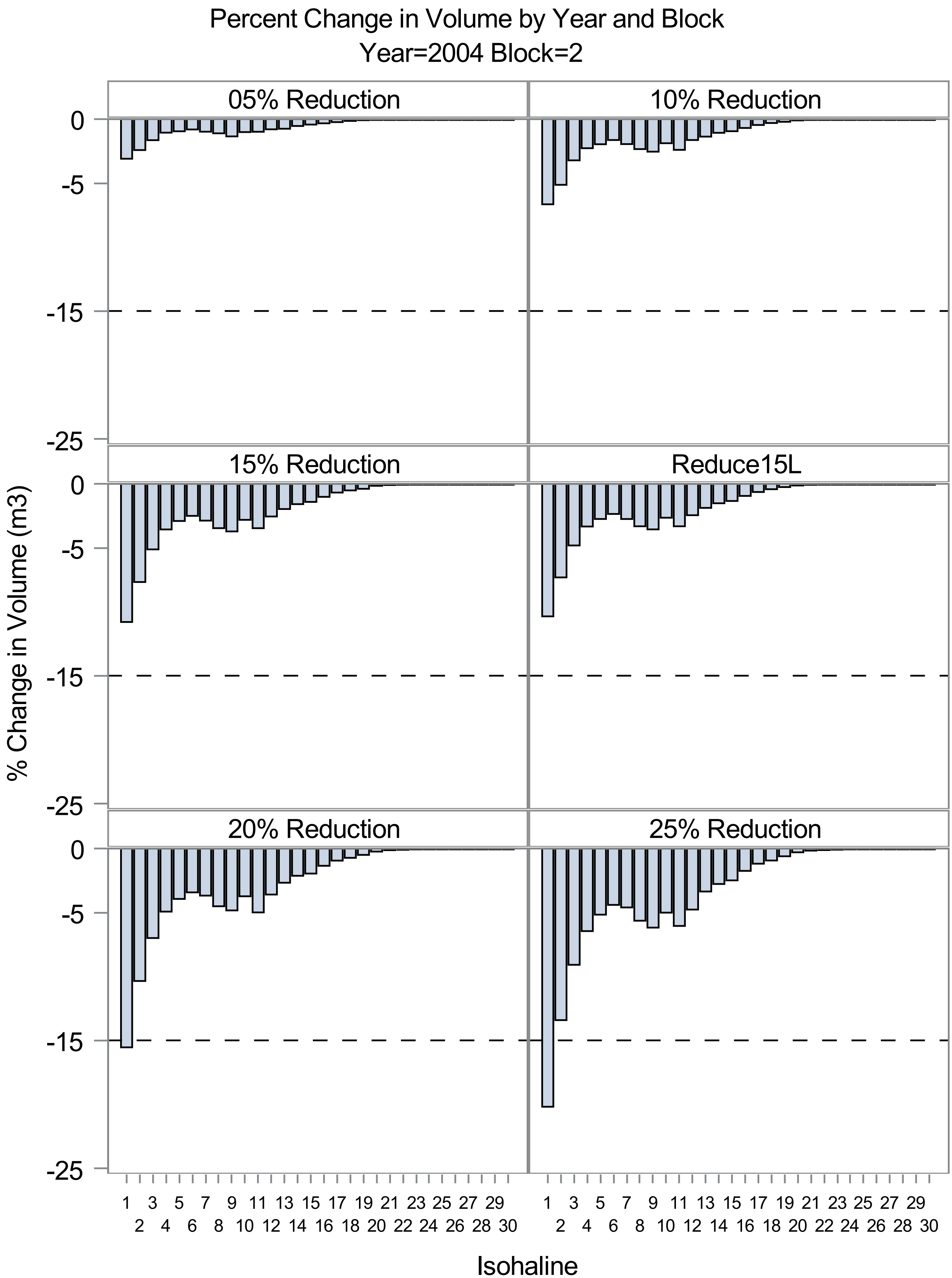
-25
% Change in Volume (m3)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Isohaline



Percent Change in Volume by Year and Block
Year=2004 Block=1
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
% Change in Volume (m3)
0
-5
-15
-25
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Isohaline



Percent Change in Volume by Year and Block
Year=2004 Block=2
05% Reduction
10% Reduction
15% Reduction
Reduce15L
20% Reduction
25% Reduction
0
-5
-15
-25
% Change in Volume (m3)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Isohaline

Percent Change in Volume by Year and Block
Year=2004 Block=3