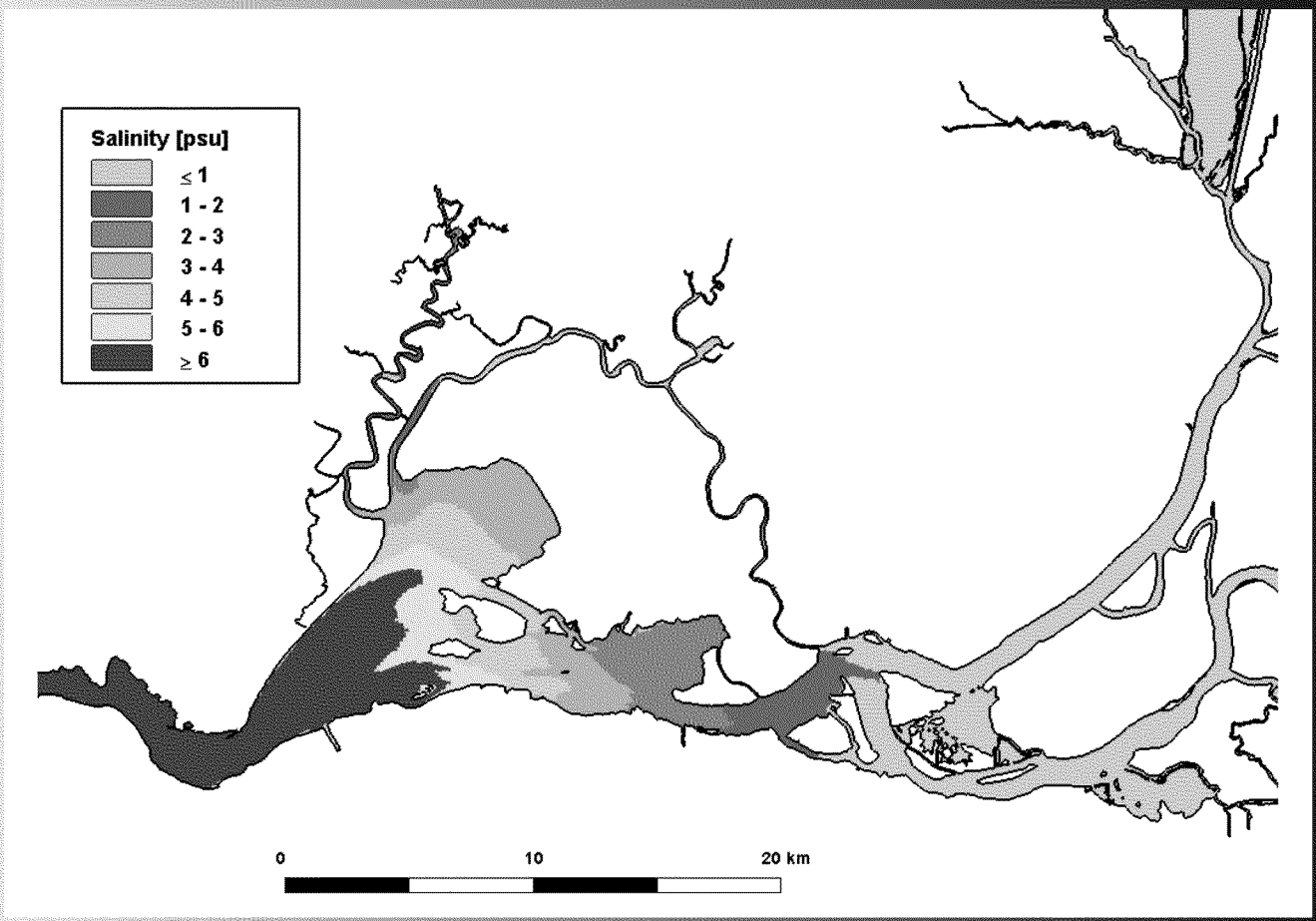
Low Salinity Zone Flip Book



DELTA MODELING ASSOCIATES

Version 0.9

June 15, 2012

About

- The Low Salinity Zone (LSZ) Flip Book developed out of a collaboration between Michael MacWilliams (Delta Modeling Associates, Inc.) and Bruce Herbold (US EPA) with input from Larry Brown (USGS).
- The goal of this document is to encourage discussion of ways of thinking about X2 and the LSZ both spatially and temporally.
- Comments and suggestions for ways to improve the usefulness of this document are welcome. Please email comments to: michael@deltamodeling.com

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Overview

- In this analysis the Low Salinity Zone (LSZ) is defined as the region where the daily-averaged depth-averaged salinity is between 1 and 6 psu.
- The 3-D UnTRIM San Francisco Bay-Delta Model (MacWilliams et al., 2008; MacWilliams et al., 2009) was applied to simulate an eighteen-month period between April 1994 and September 1995.
- The model validation for the salinity predictions during this period will be documented in an upcoming paper in collaboration with Wim Kimmerer and Edward Gross.

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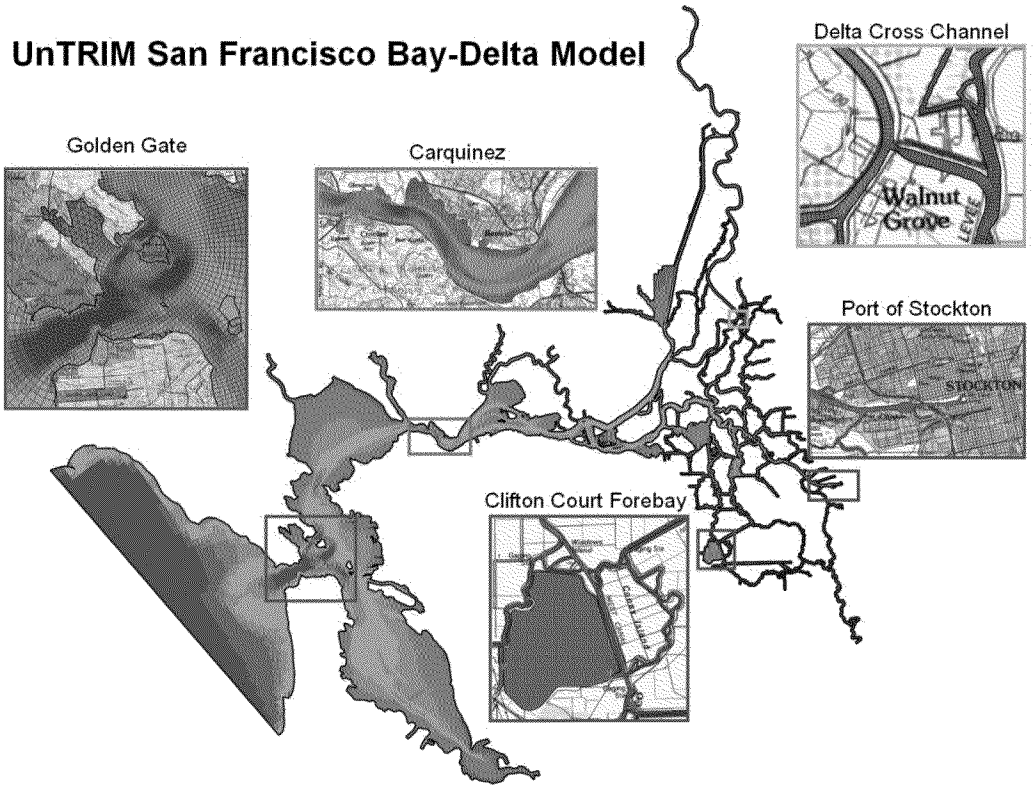
UnTRIM Bay-Delta Model

- The UnTRIM Bay-Delta model is a three-dimensional hydrodynamic model of San Francisco Bay and the Sacramento-San Joaquin Delta.



- Additional information about the UnTRIM Bay-Delta Model can be found at: http://www.deltamodeling.com/untrimbaydeltamodel.html

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LSZ Modeling Approach

- For each model time step (90 seconds) the depth-averaged salinity is calculated within each mode grid cell in the model domain. The daily-averaged depth-averaged salinity is calculated as the average of the depth-averaged salinity at each of 960 modeled time steps in each day.
- The daily-averaged LSZ area for each day is calculated as the summation of all grid cells with daily-averaged depth-averaged salinity between 1 and 6 psu.
- The time that the LSZ is within each grid cell is calculated from the depth-averaged salinity saved hourly for each day to allow for visualization of LSZ tidal excursion.

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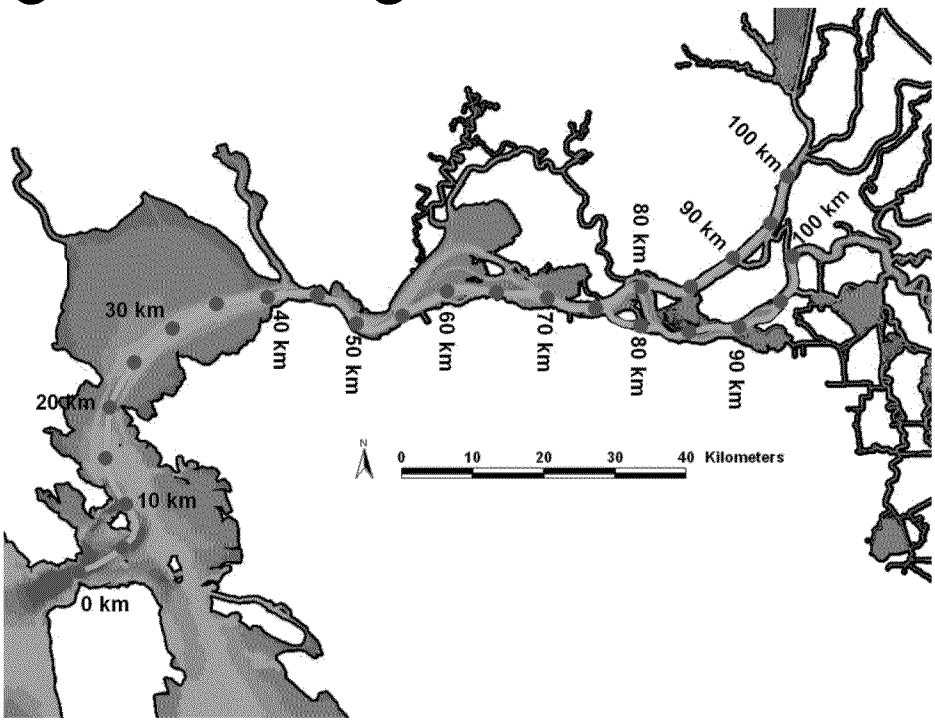
X2 Modeling Approach

- X2 is defined as the position of the 2 psu bottom salinity value, measured along the axis of the estuary in km from the Golden Gate.
- X2 is calculated on each day from the model simulations using the daily-averaged near-bed salinity along the transects shown below. When X2 is greater than 74, X2 is calculated as the average X2 along the two transects.



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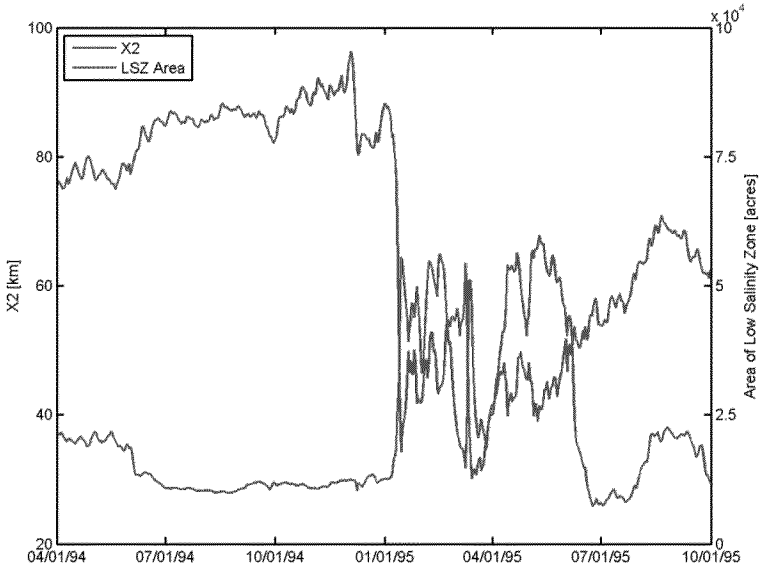
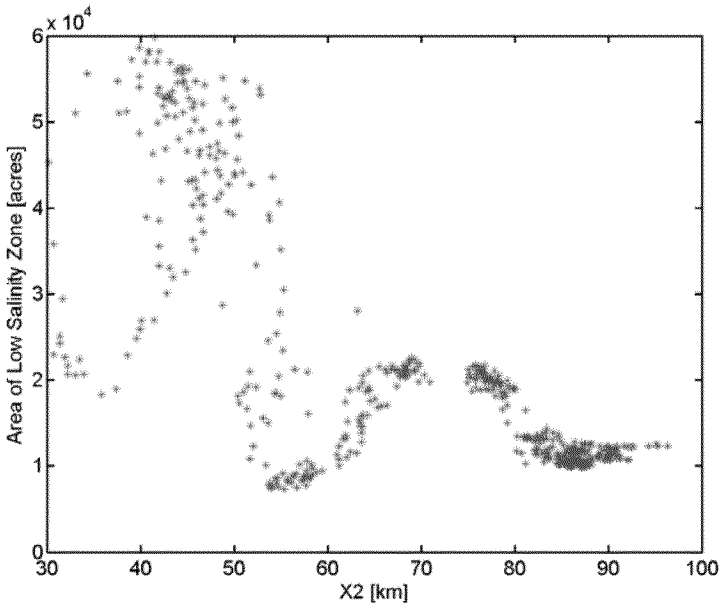
Relationship Between LSZ and X2

- The top figure shows X2 and the LSZ area calculated for each day during the 18-month simulation.



- The bottom figure shows the LSZ area plotted as a function of X2 using values calculated on 548 days.



How to use the LSZ Flip Book

- The LSZ Flip Book is designed to provide an easy way to visualize both the average position of the LSZ and the tidal excursion of the LSZ over a range of X2.
- From the eighteen-month simulation period, individual days were selected to show the position and tidal excursion of the LSZ for a range of conditions with X2 between 55 and 95 km.
- Conditions shown for a given X2 are specific to a single day. To the extent possible the days are selected to provide representative conditions for a given X2.
- Not all X2 values are shown in part because some X2 values did not exactly occur within the period simulated.

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How not to use the LSZ Flip Book

- The LSZ Flip Book is not designed to give an exact representation of the LSZ position for a specified X2.
- The model has been validated using available salinity data, however limited data are available for calibration outside of the channel and in Suisun Marsh.
- The calculated X2 on a each day is typically within 0.1 km of the value reported on the top of each page.
- The position of the LSZ can vary significantly for a given X2 depending on antecedent conditions (see page 31).
- The tidal excursion of the LSZ changes over the spring-neap cycle.
- Thus, the LSZ maps serve as a general guide given the above caveats.

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LSZ Flip Book Layout

(Pages 10-29)

- Title: The approximate X2 calculated from the near-bed salinity for the day plotted below.

- Top Panel: This figure shows the daily-averaged depth-average salinity between Carquinez Strait and the Western Delta for a specific day from the 1994-1995 simulation during which the predicted X2 is similar to the target value shown at the top of the figure. Due to the influence of antecedent conditions, this day may not necessarily be representative of all days with a similar X2.

- Bottom Panel: For the day shown in the top panel, this figure shows the percentage of the day that salinity is between 1 psu and 6 psu based on twenty-four hourly depth-average salinity calculations. Tidal excursion varies significantly over the spring-neap cycle so this may not be representative for all days with a similar X2.

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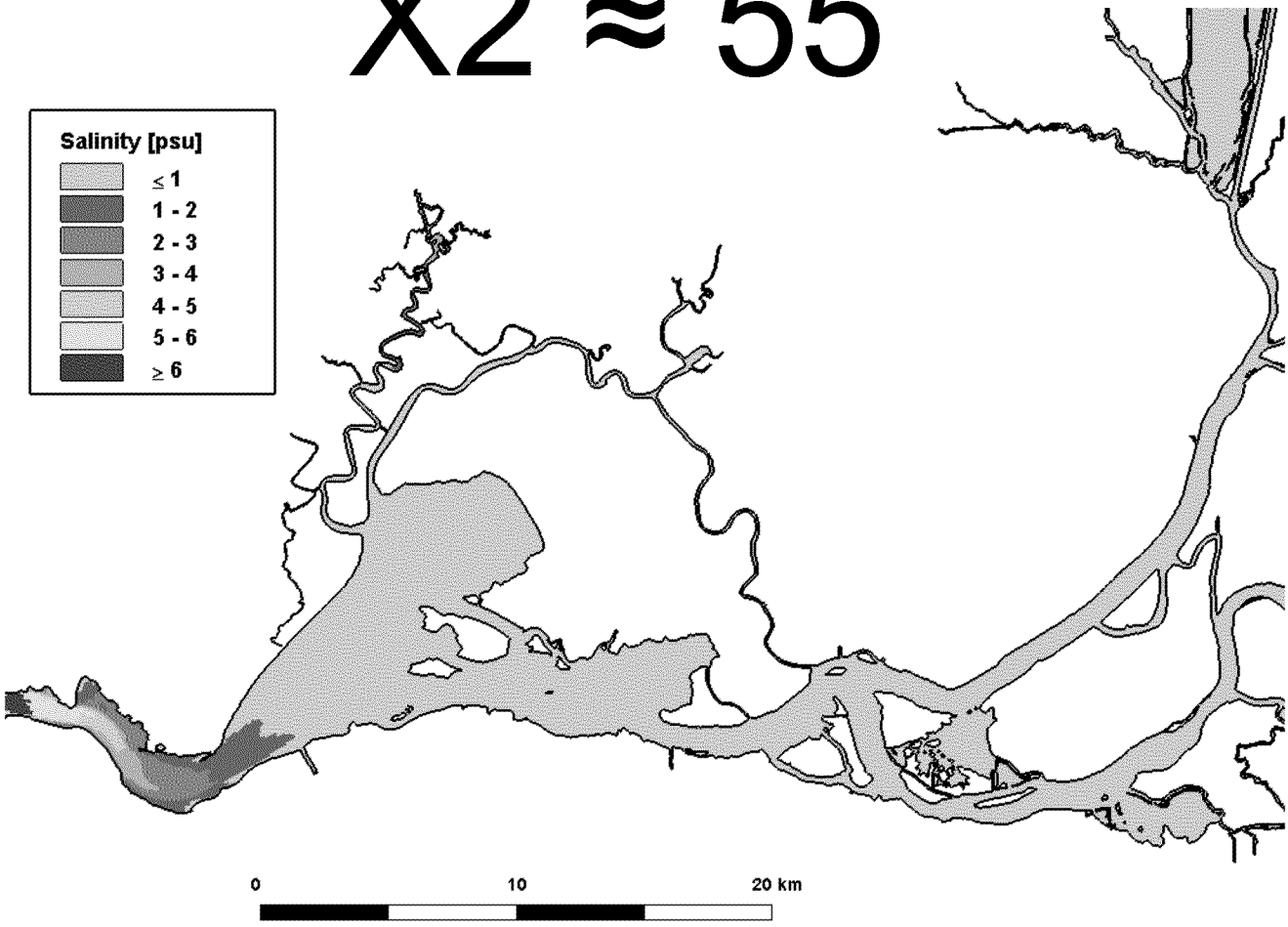
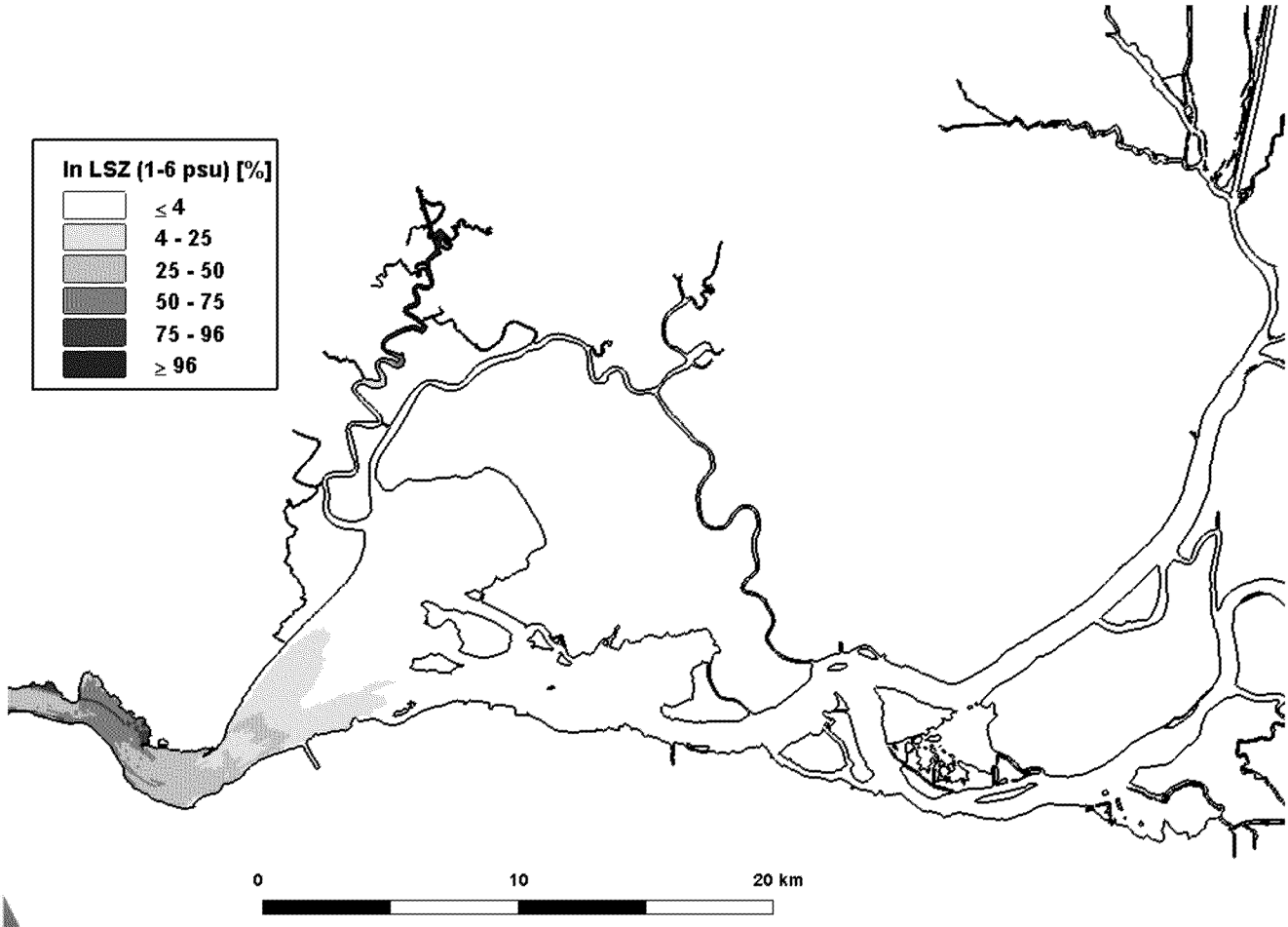
X2 ≈ 55

Daily-average Depth-averaged Salinity



Percentage of Day in Low Salinity Zone (LSZ)



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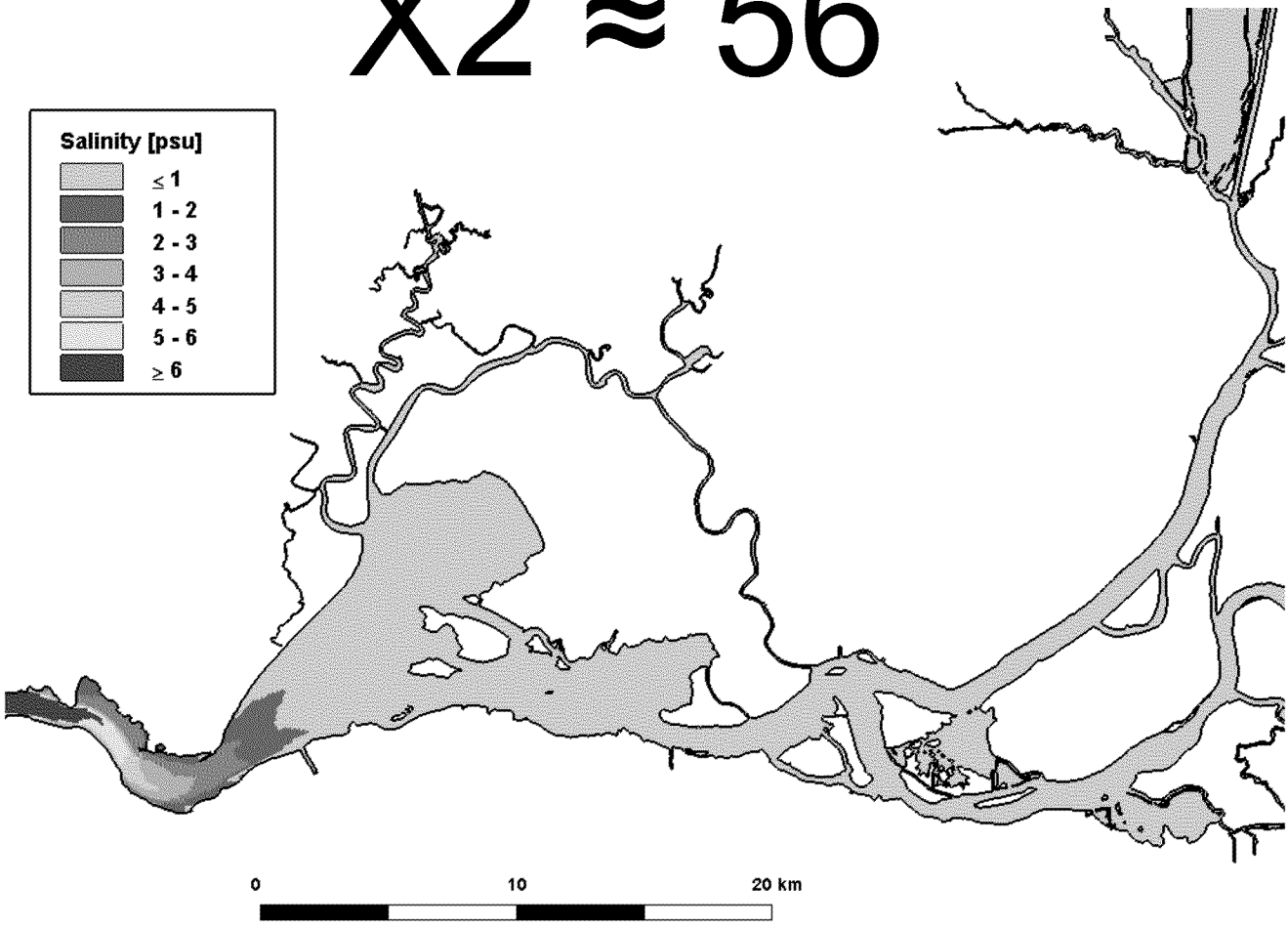
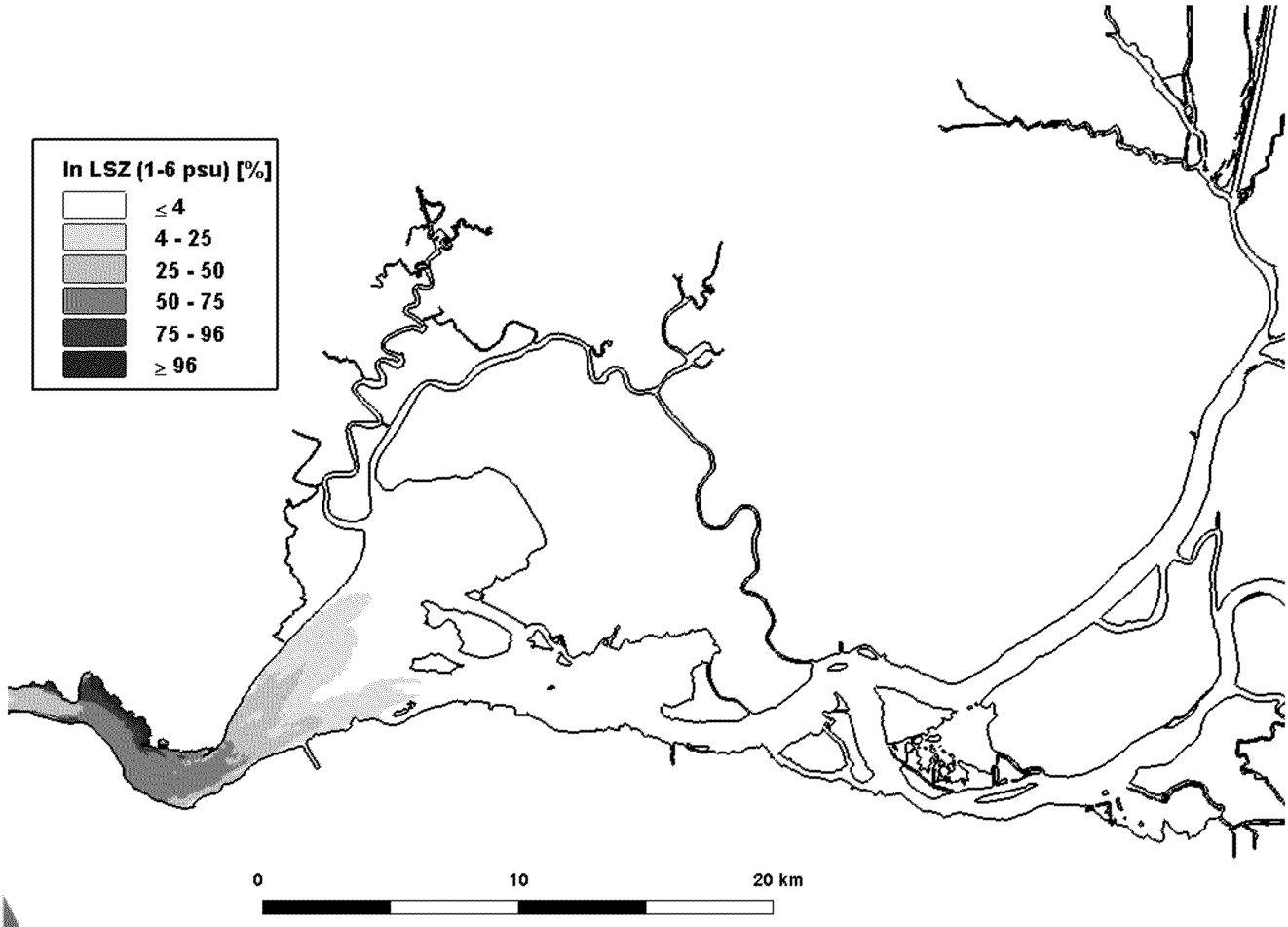
X2 ≈ 56

Daily-average Depth-averaged Salinity

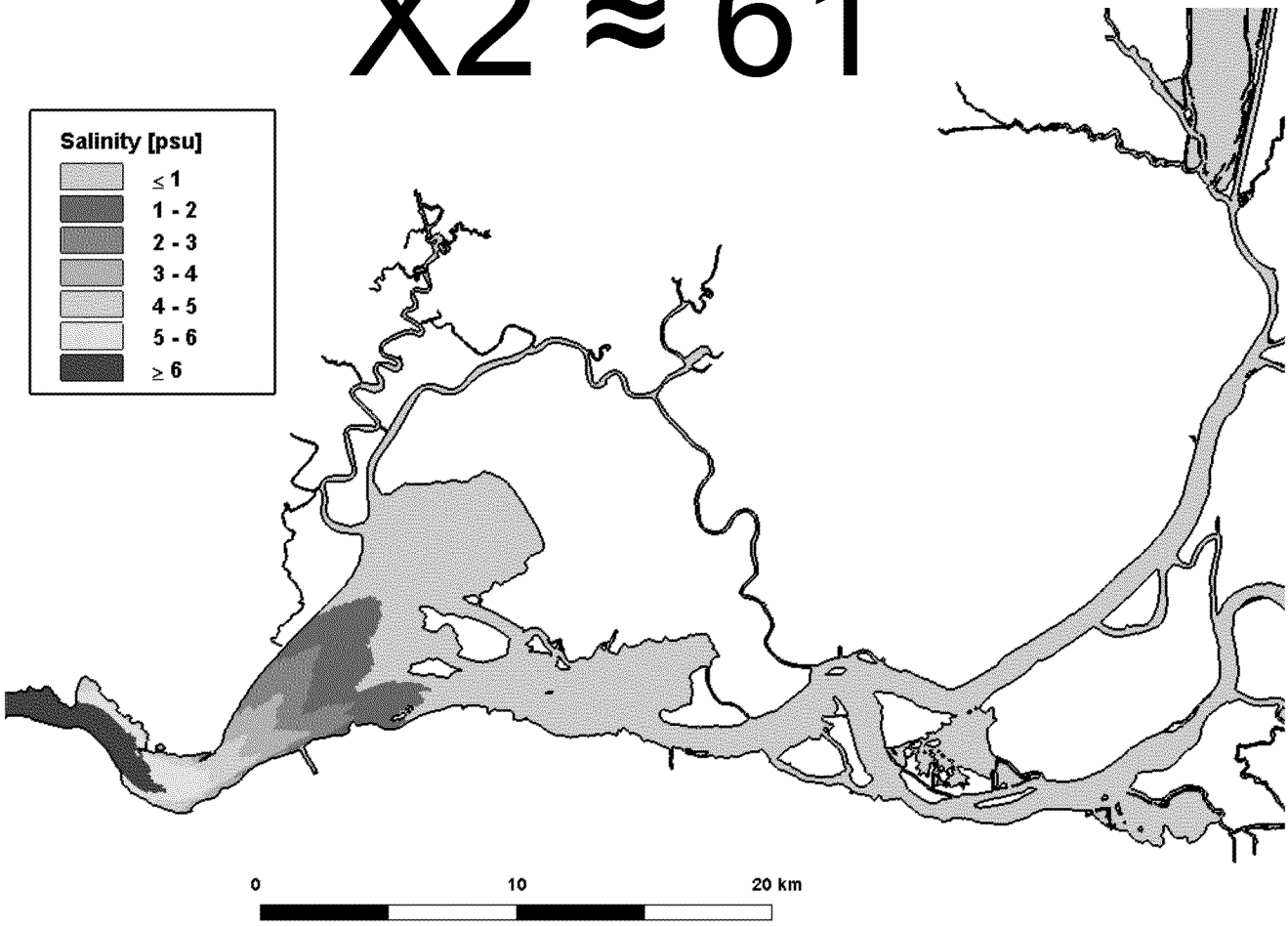


Percentage of Day in Low Salinity Zone (LSZ)

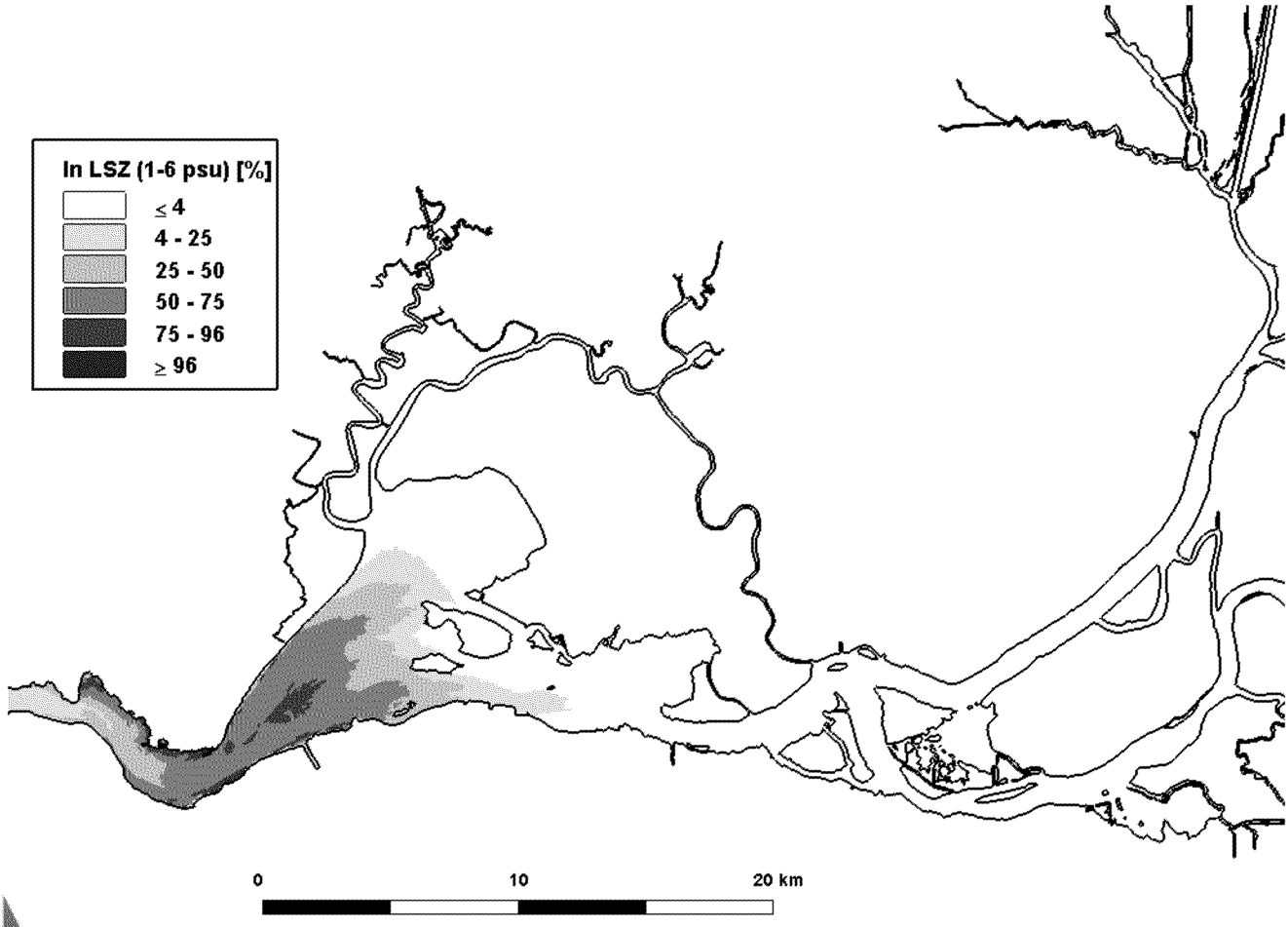


X2 ≈ 61

Daily-average Depth-averaged Salinity



Percentage of Day in Low Salinity Zone (LSZ)



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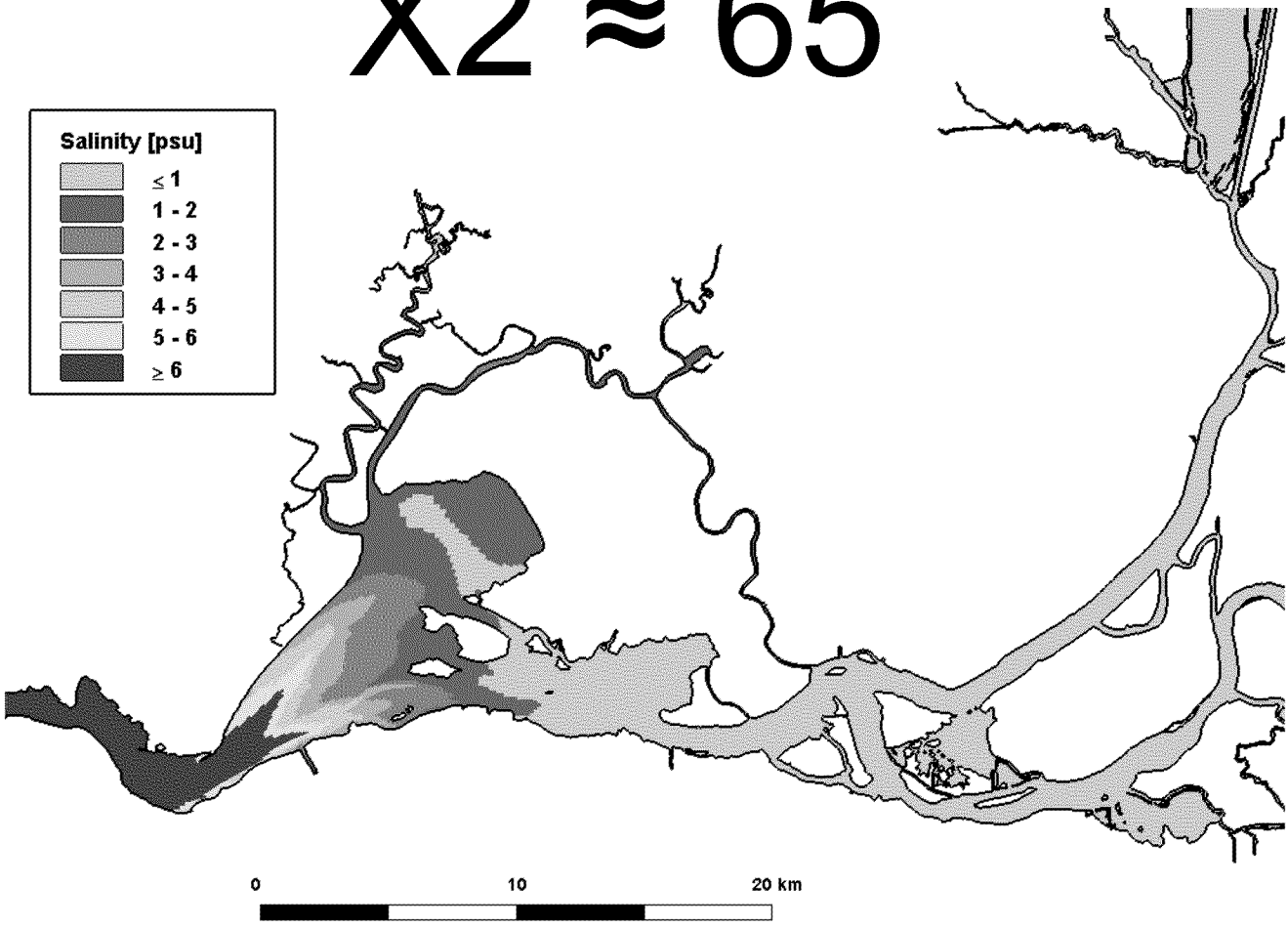
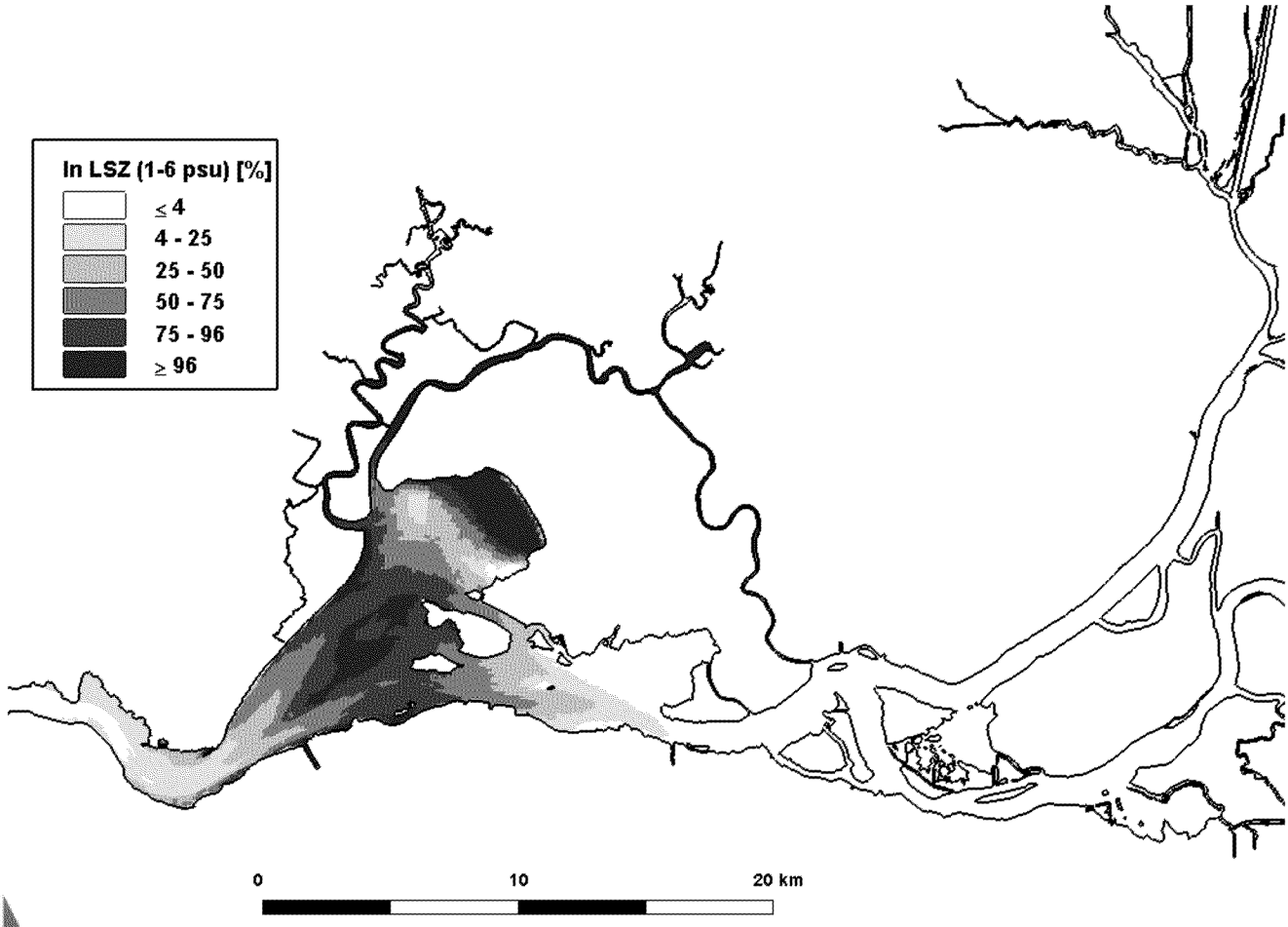
X2 ≈ 65

Daily-average Depth-averaged Salinity



Percentage of Day in Low Salinity Zone (LSZ)



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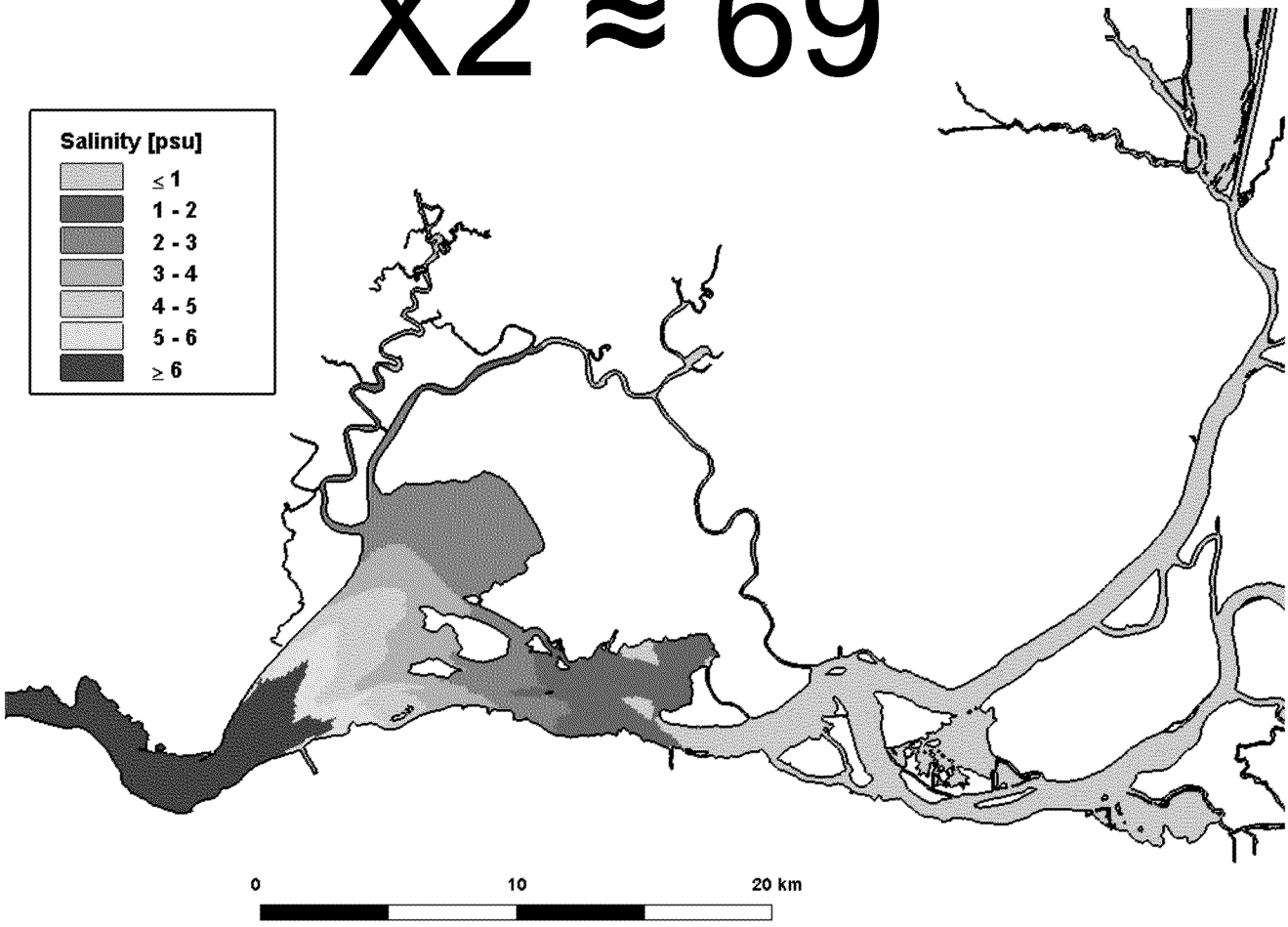
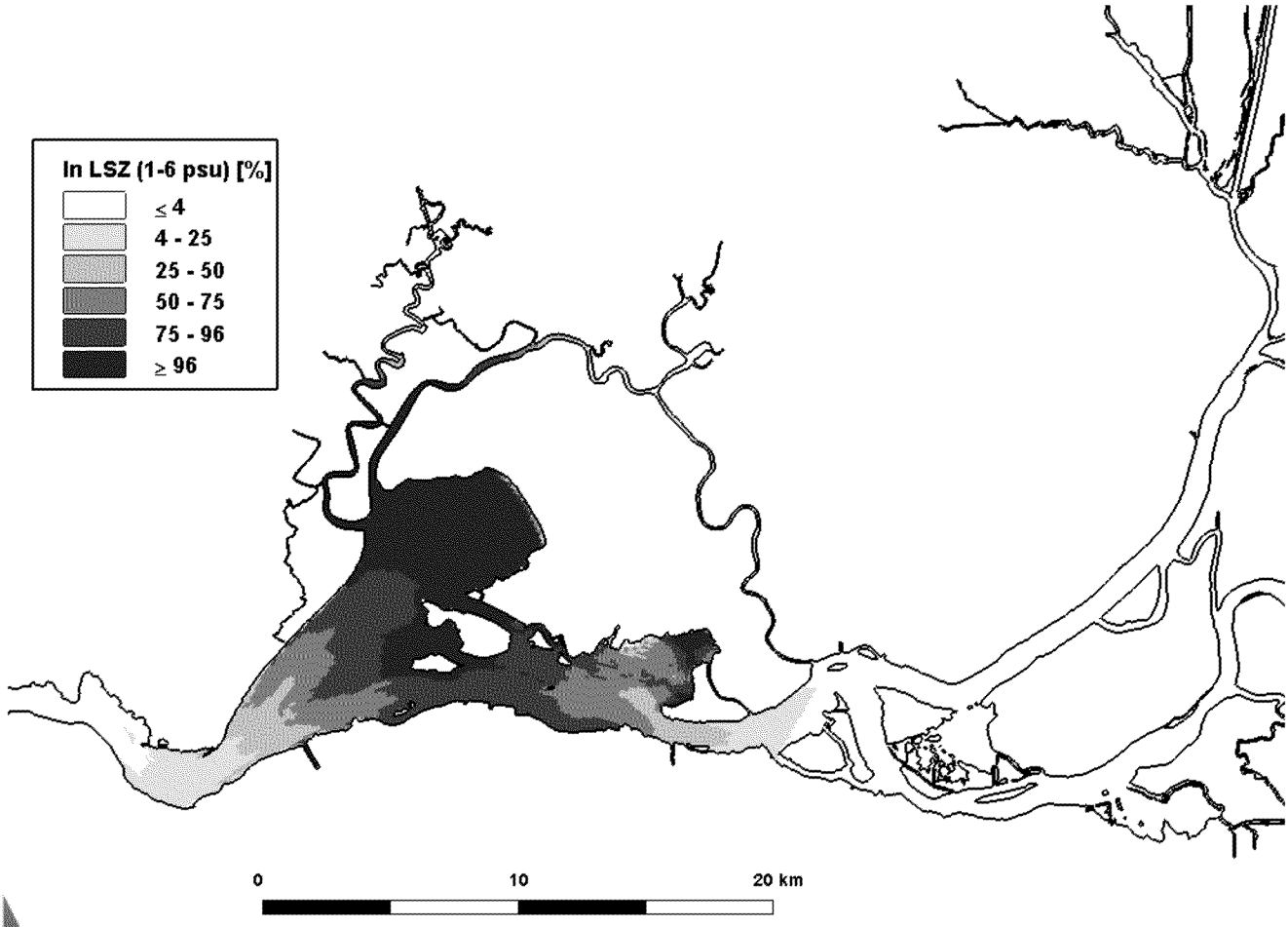
X2 ≈ 69

Daily-average Depth-averaged Salinity

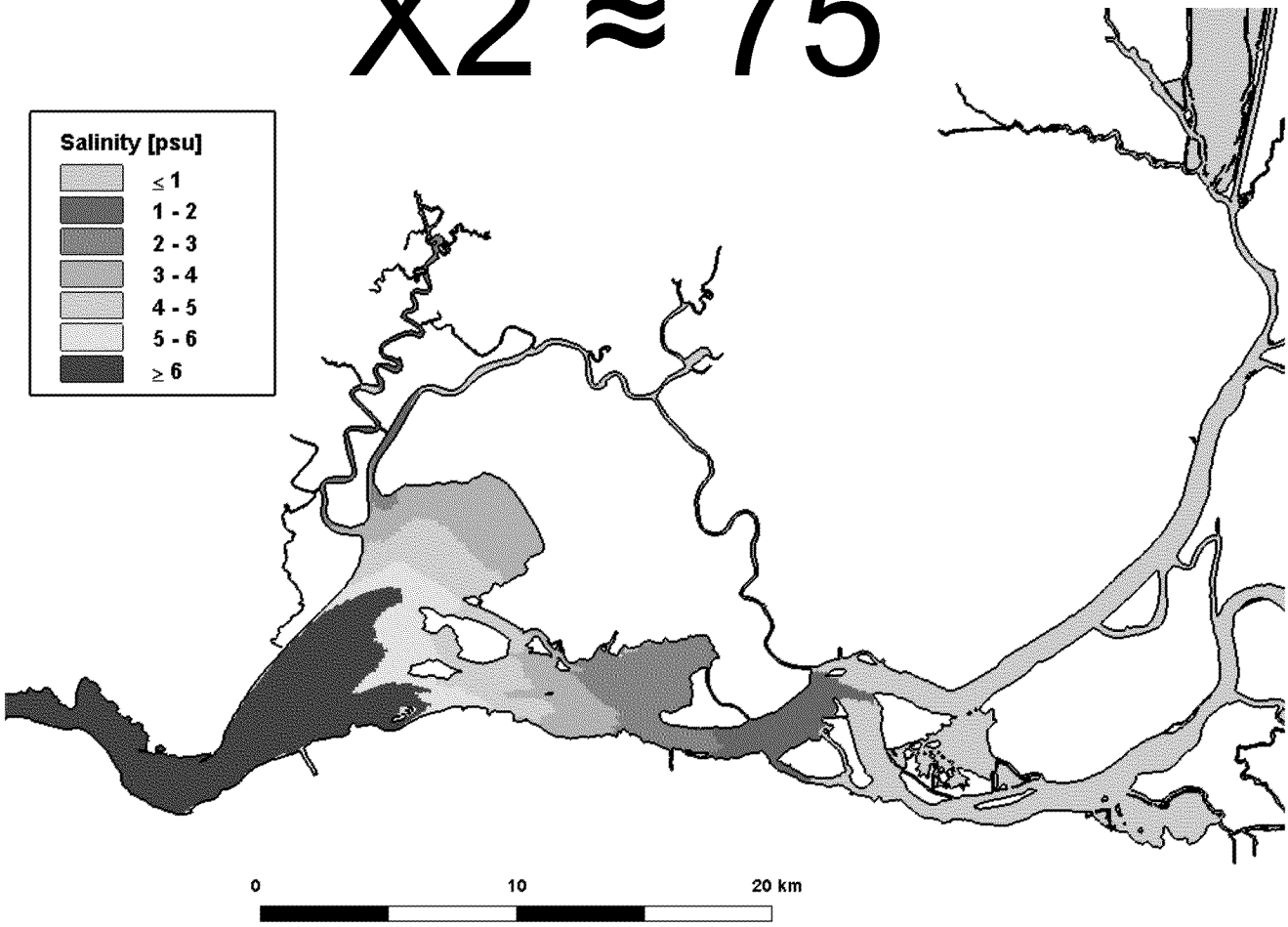


Percentage of Day in Low Salinity Zone (LSZ)

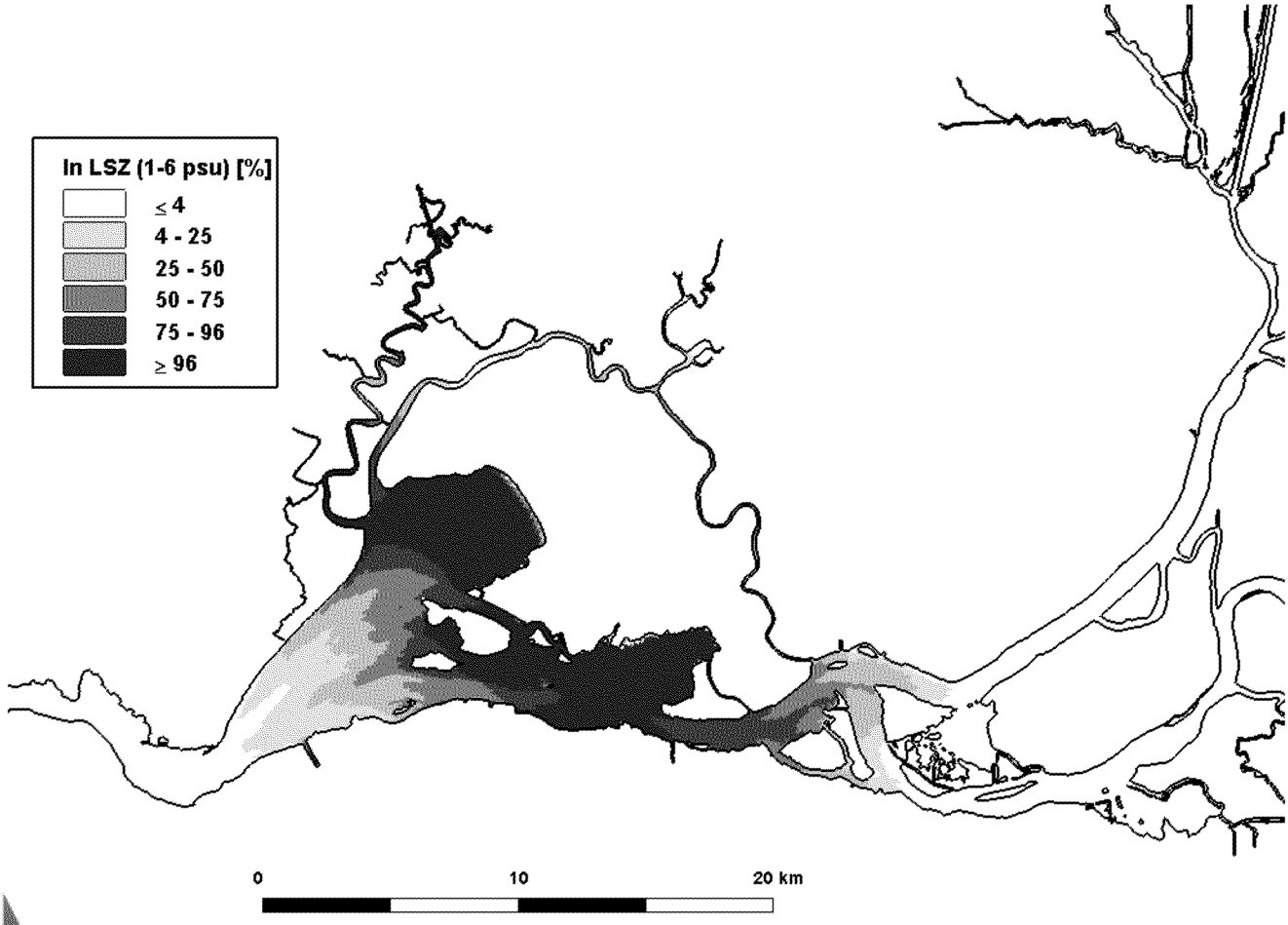


X2 ≈ 75

Daily-average Depth-averaged Salinity



Percentage of Day in Low Salinity Zone (LSZ)



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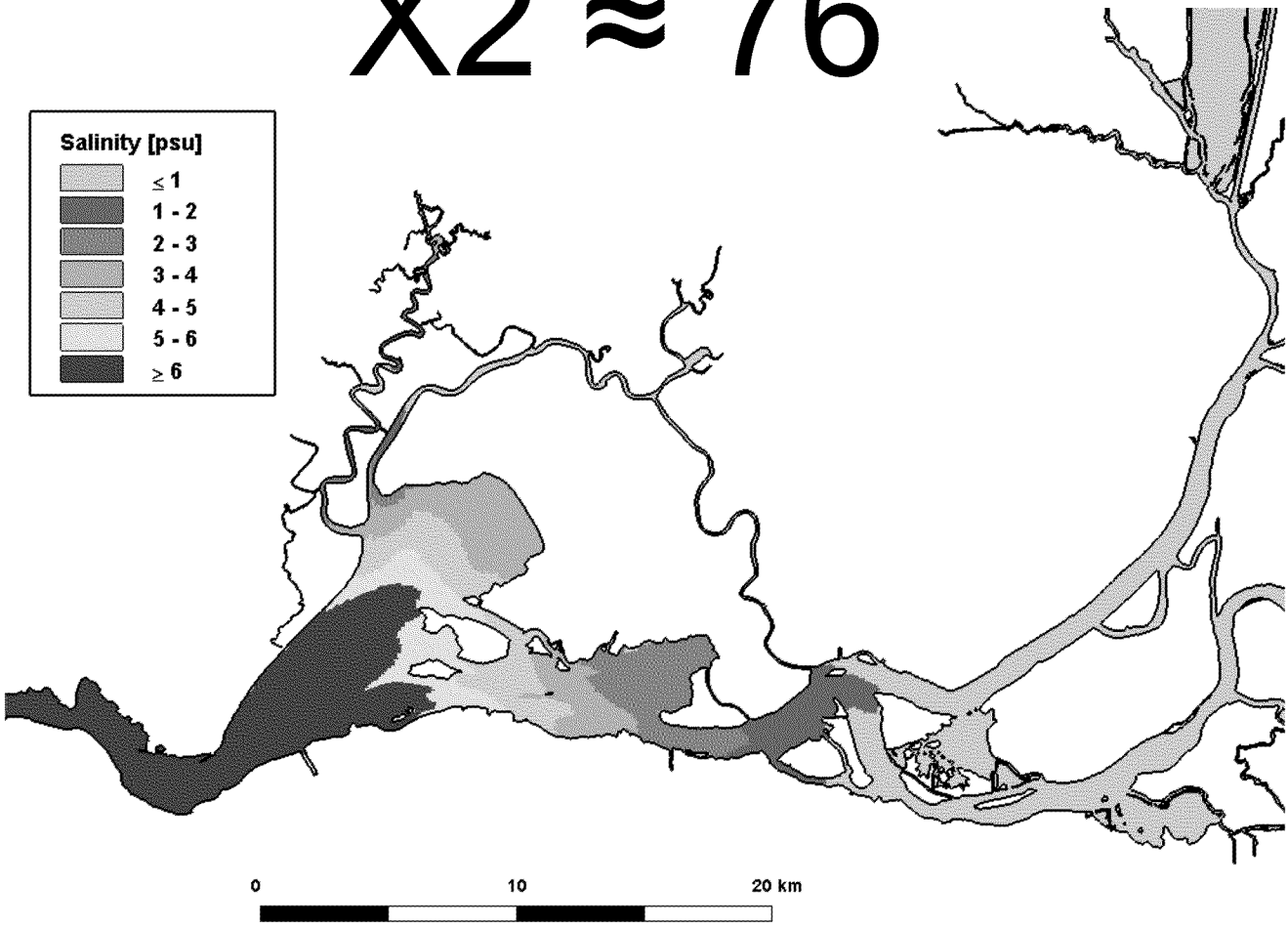
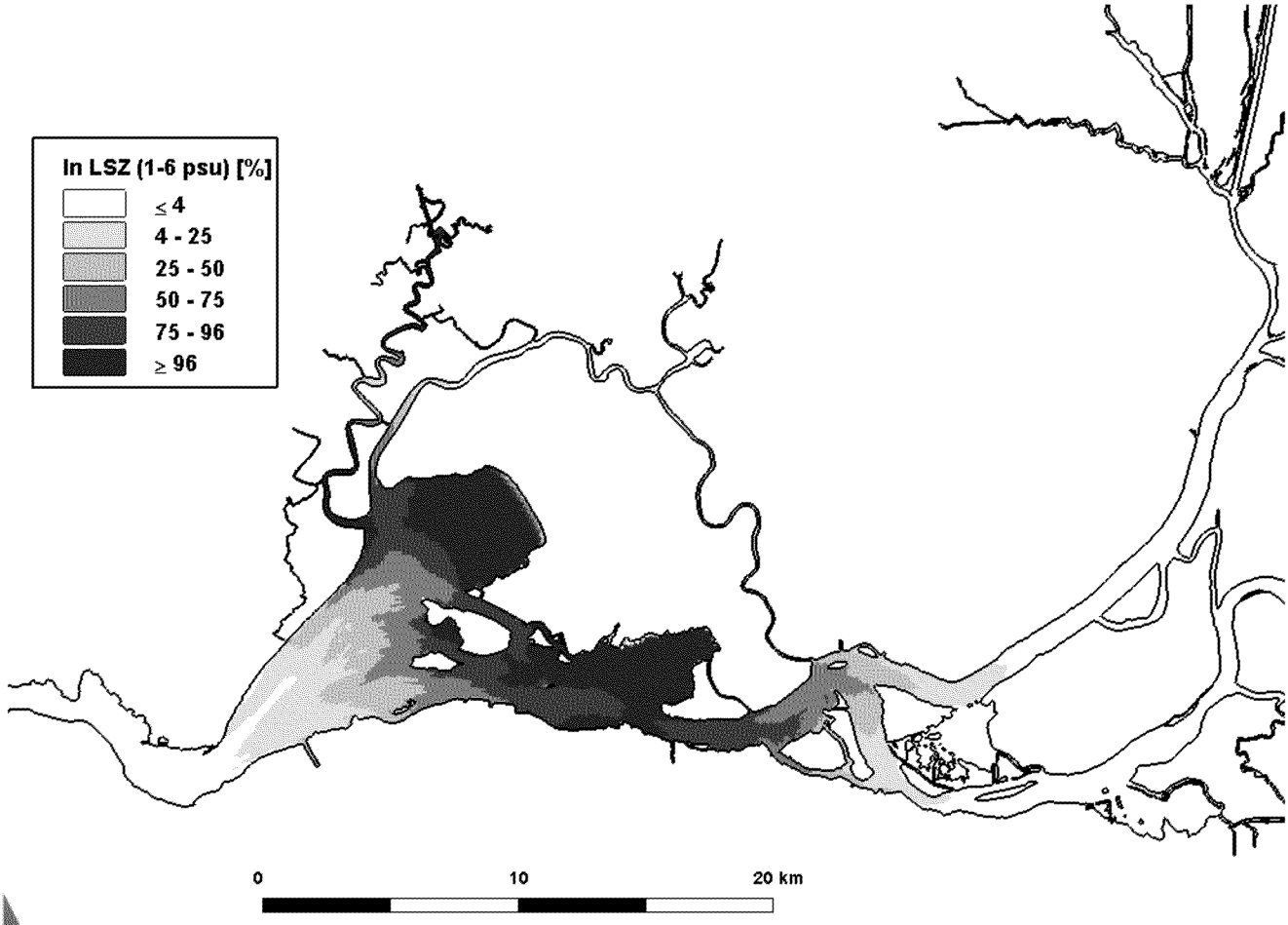
X2 ≈ 76

Daily-average Depth-averaged Salinity



Percentage of Day in Low Salinity Zone (LSZ)



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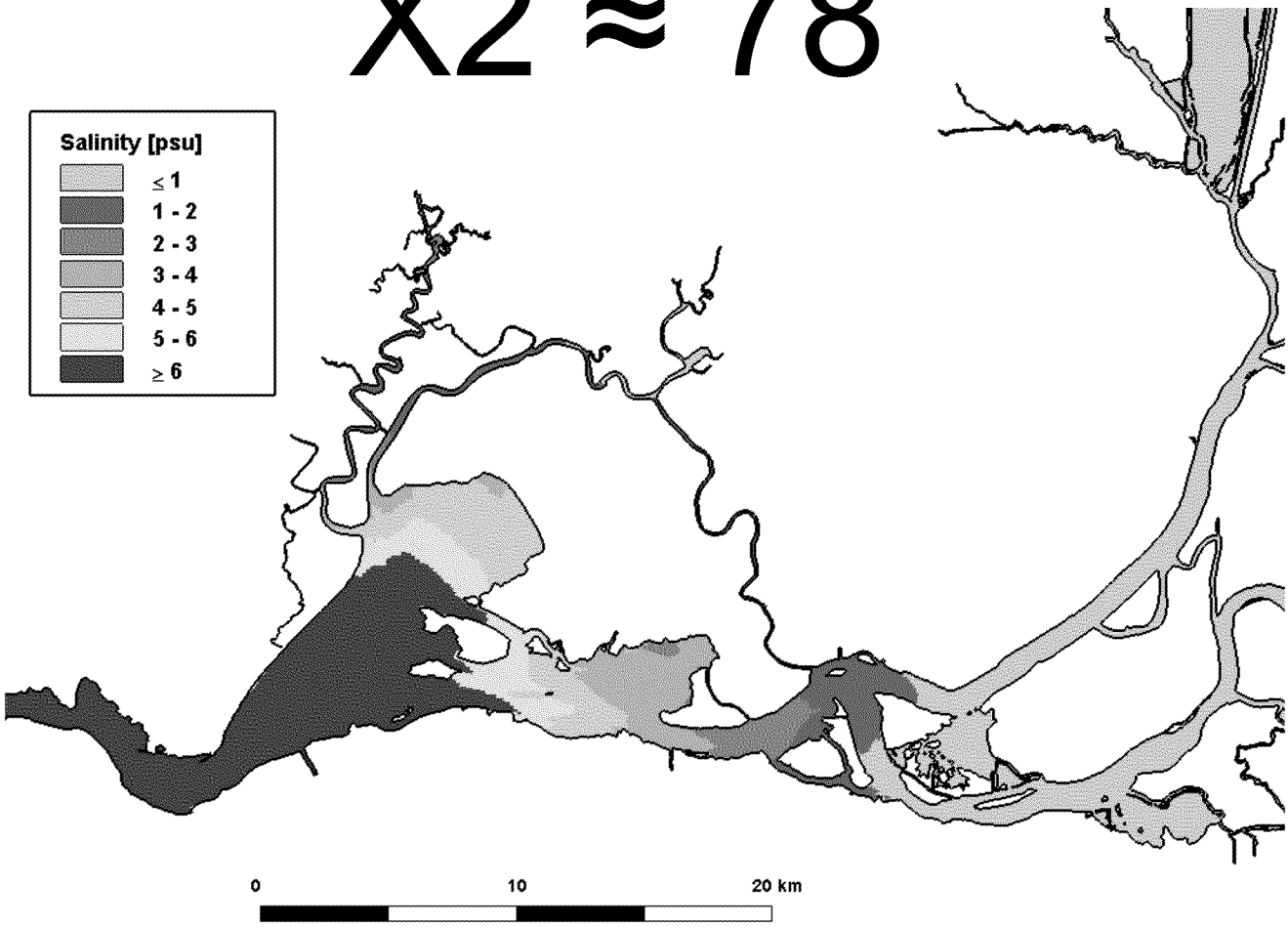
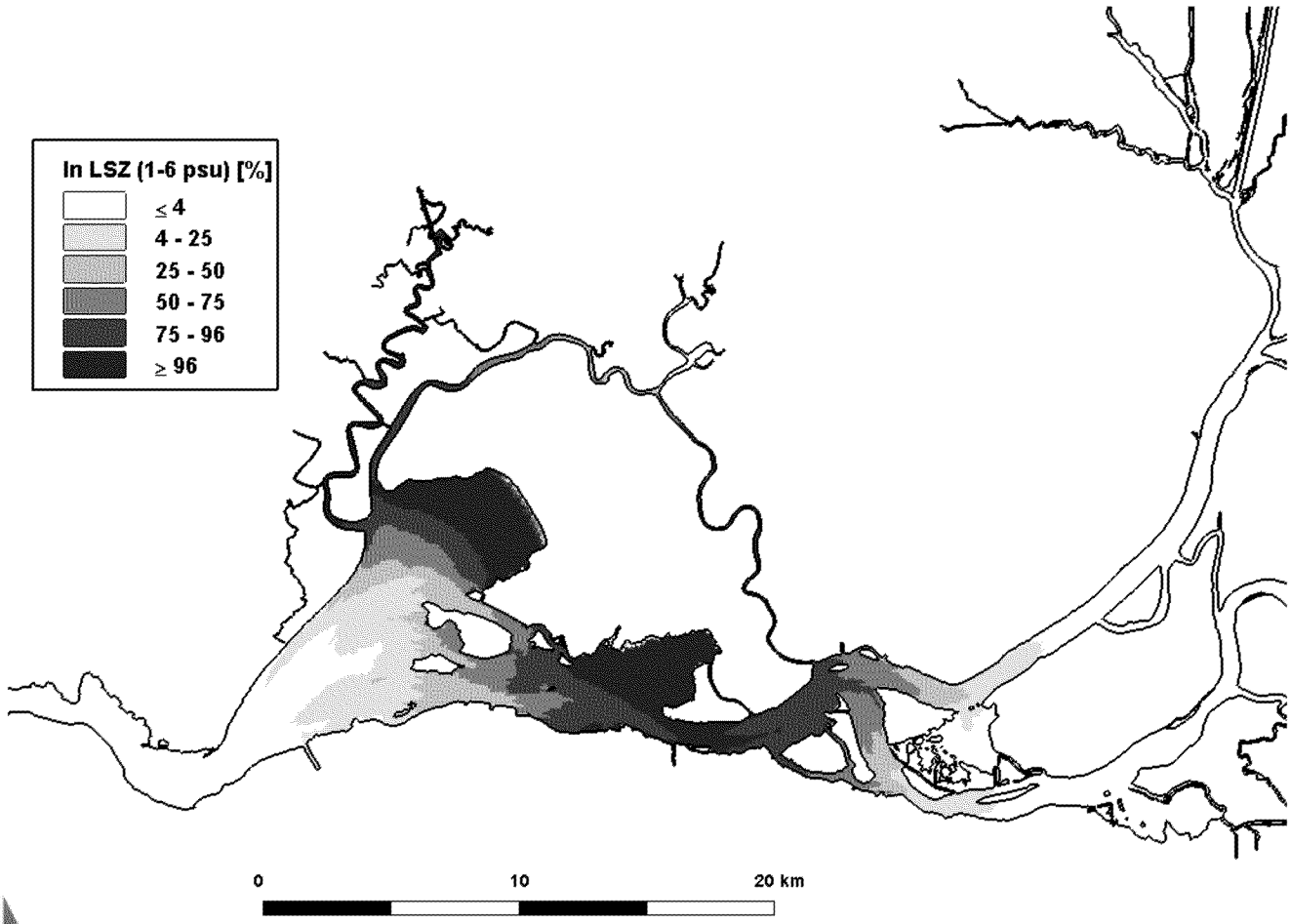
X2 ≈ 78

Daily-average Depth-averaged Salinity

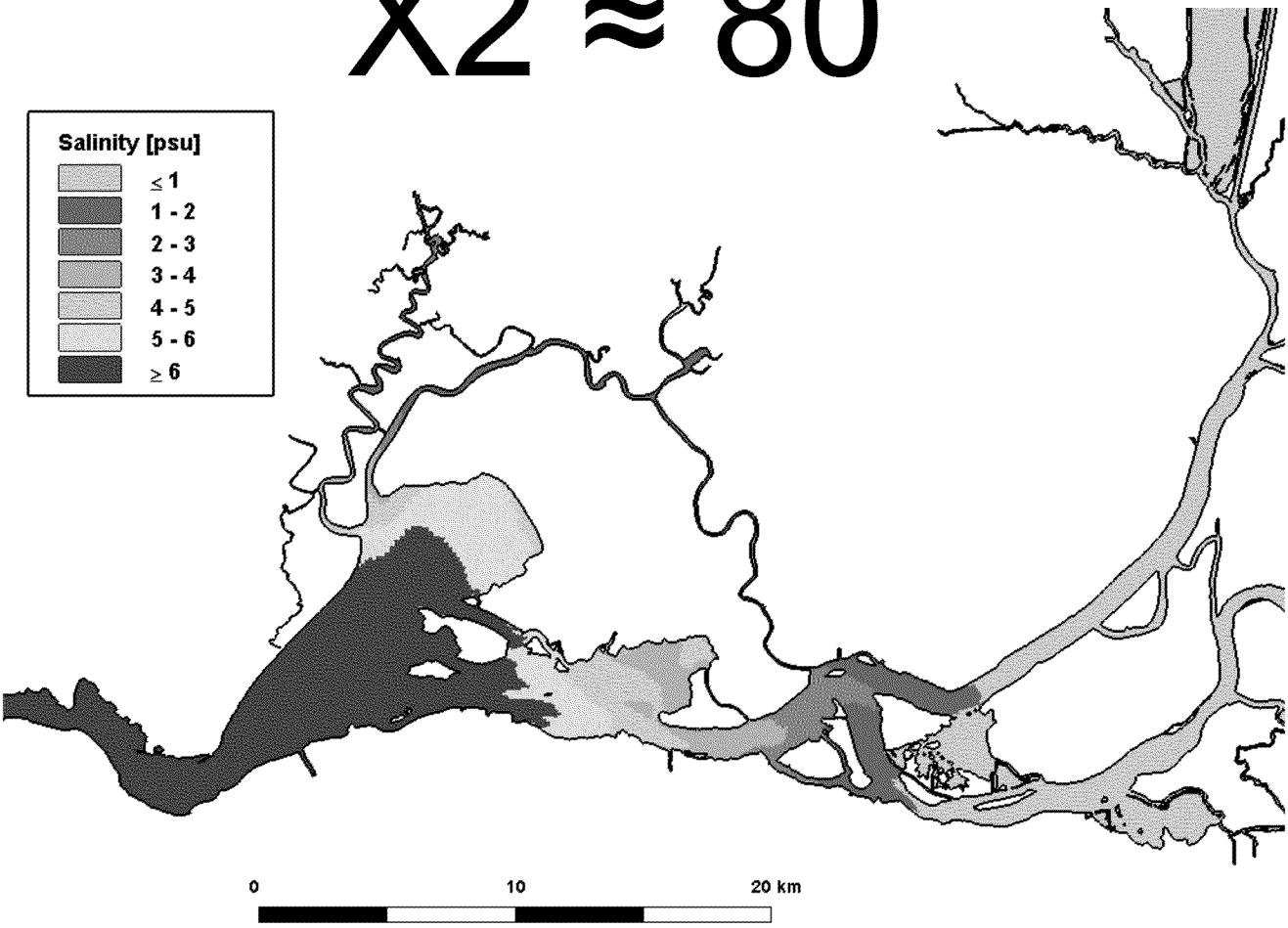


Percentage of Day in Low Salinity Zone (LSZ)

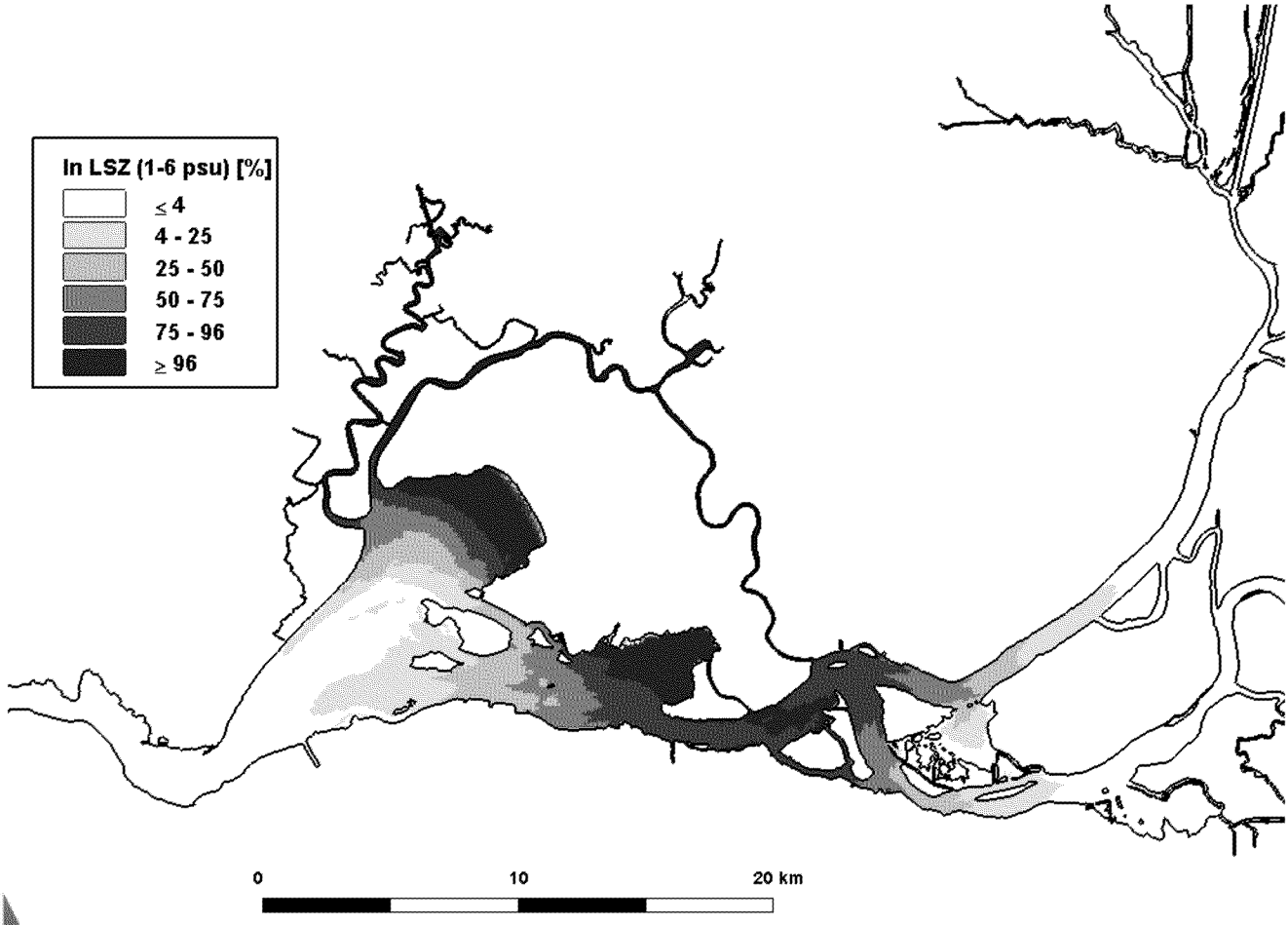


X2 ≈ 80

Daily-average Depth-averaged Salinity

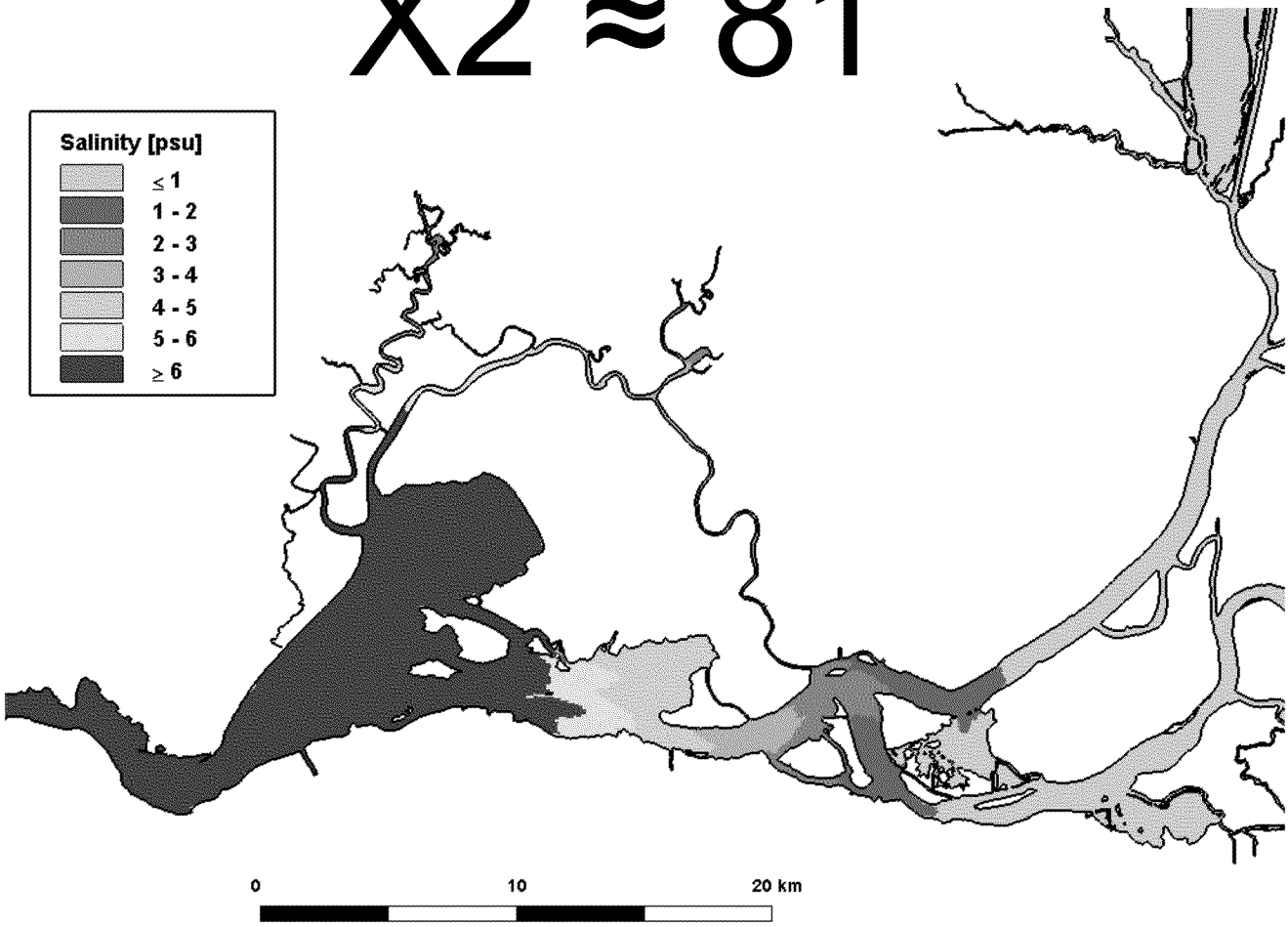


Percentage of Day in Low Salinity Zone (LSZ)

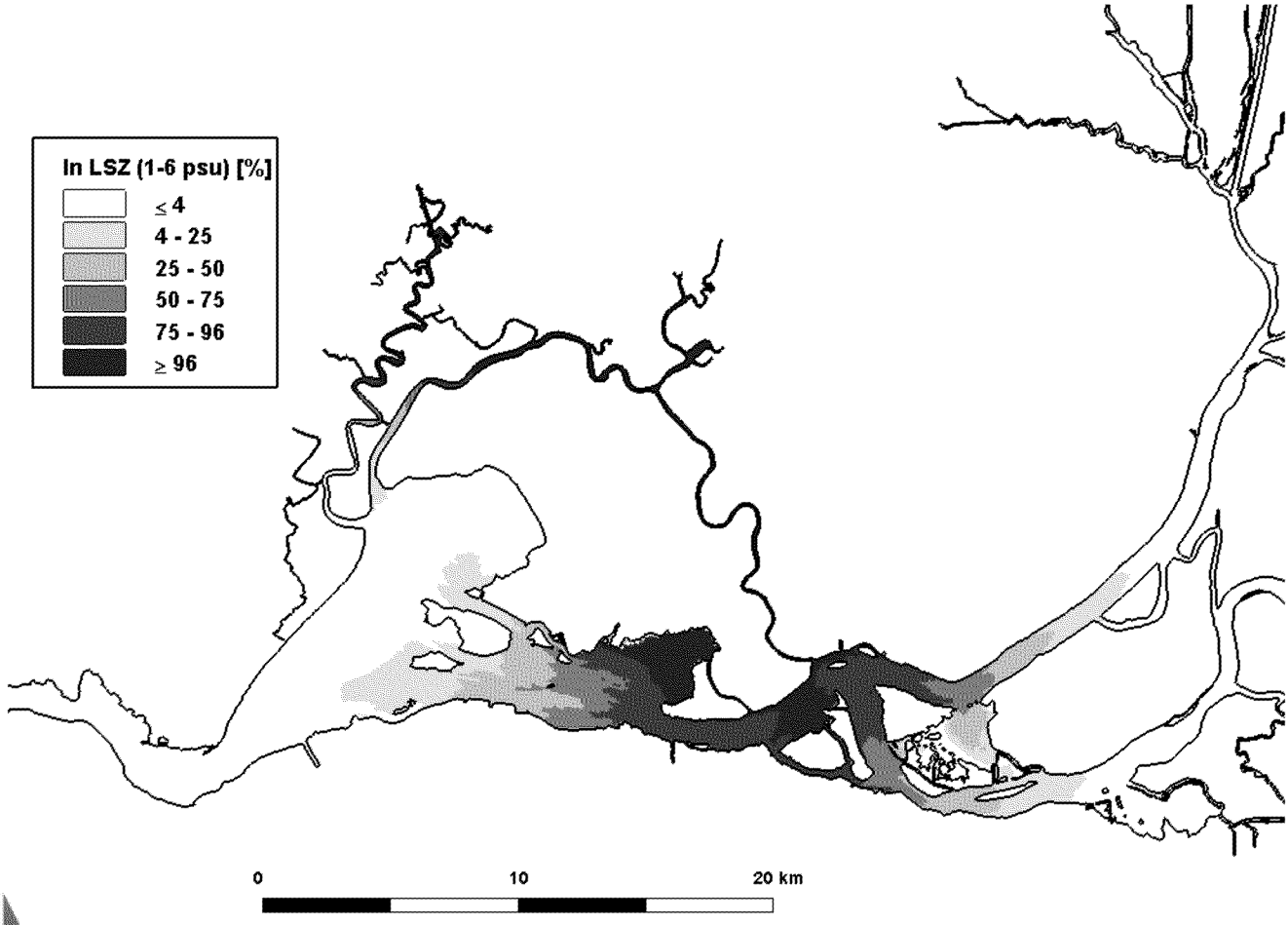


X2 ≈ 81

Daily-average Depth-averaged Salinity



Percentage of Day in Low Salinity Zone (LSZ)



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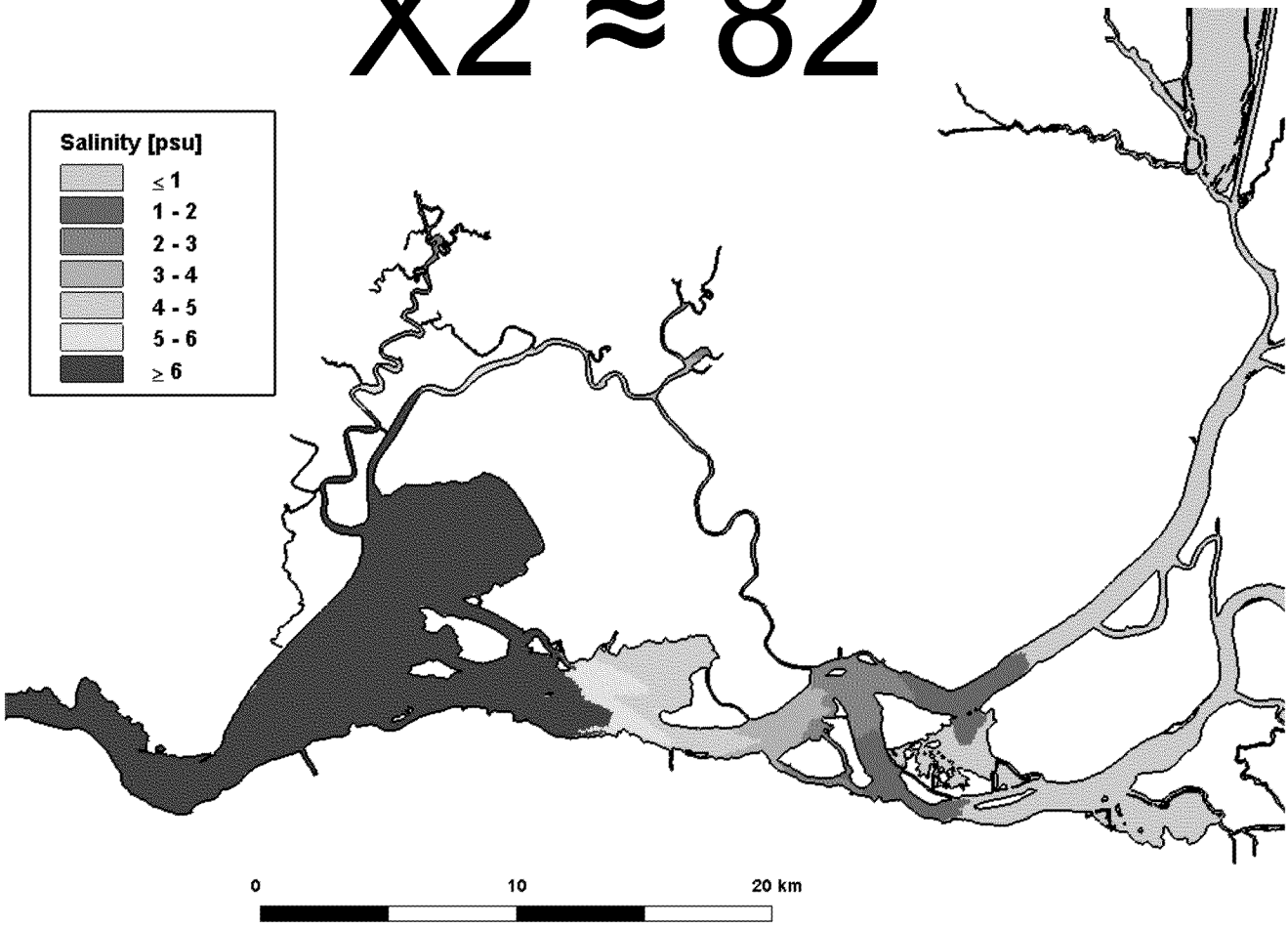
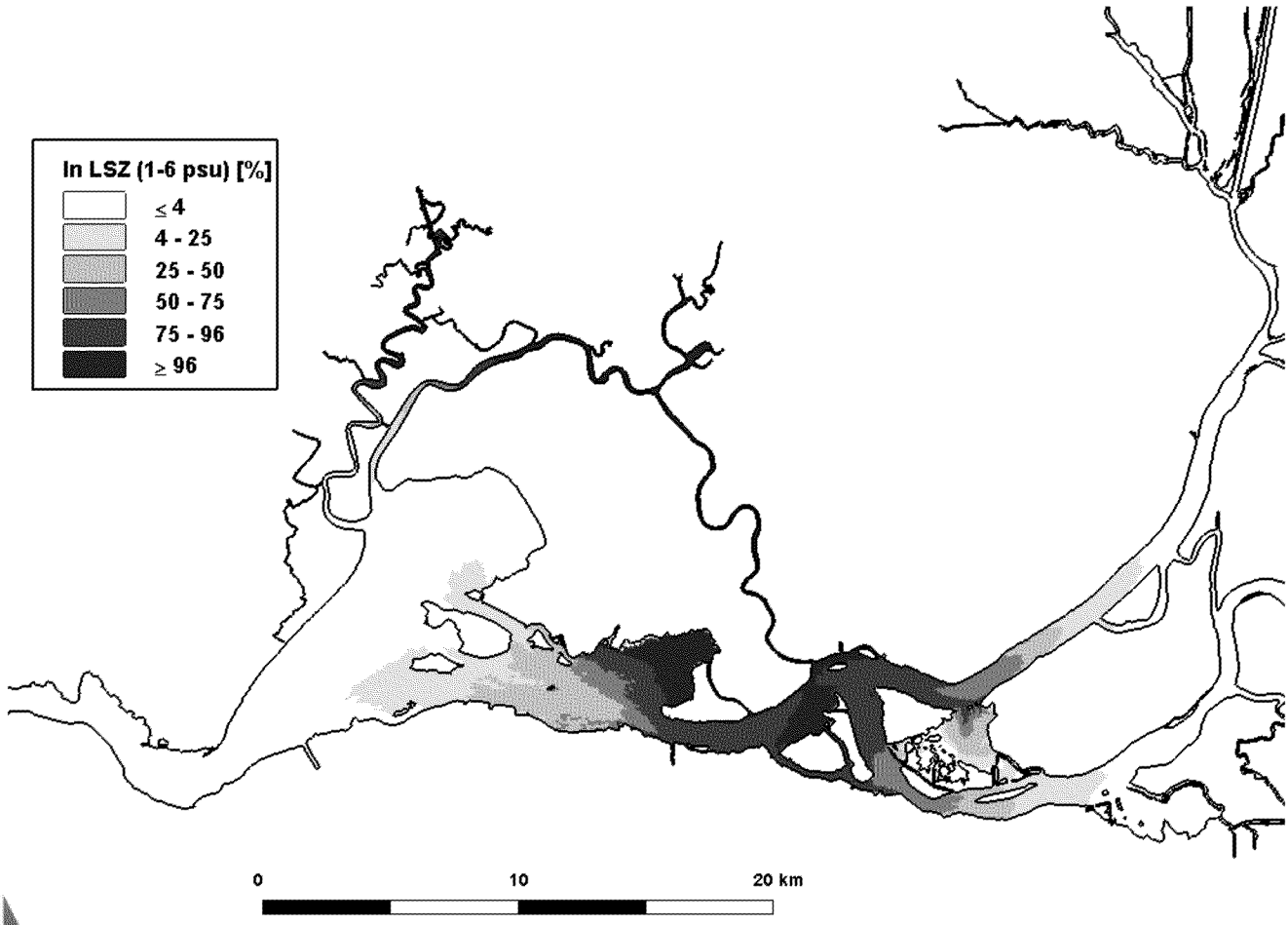
X2 ≈ 82

Daily-average Depth-averaged Salinity



Percentage of Day in Low Salinity Zone (LSZ)



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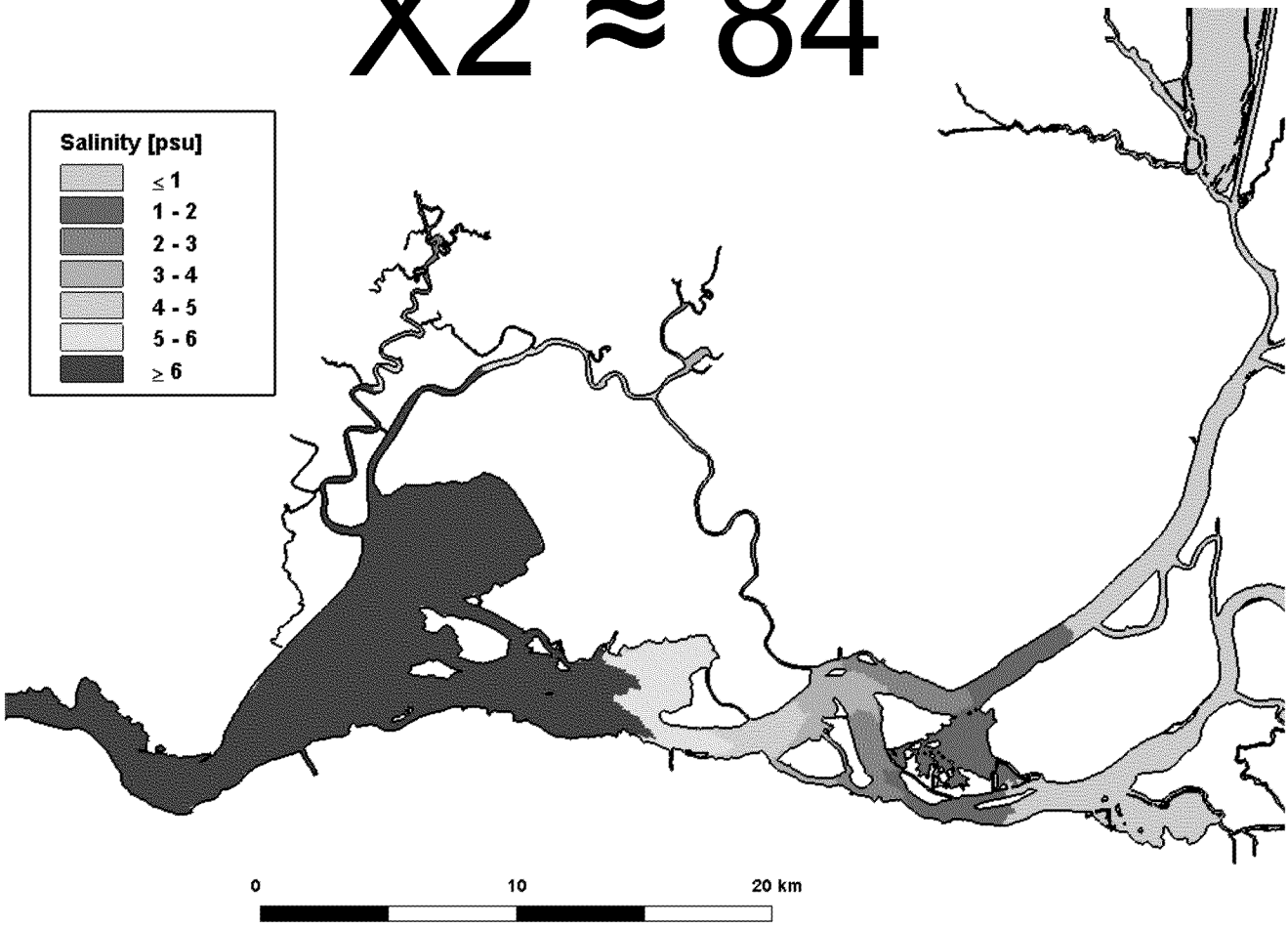
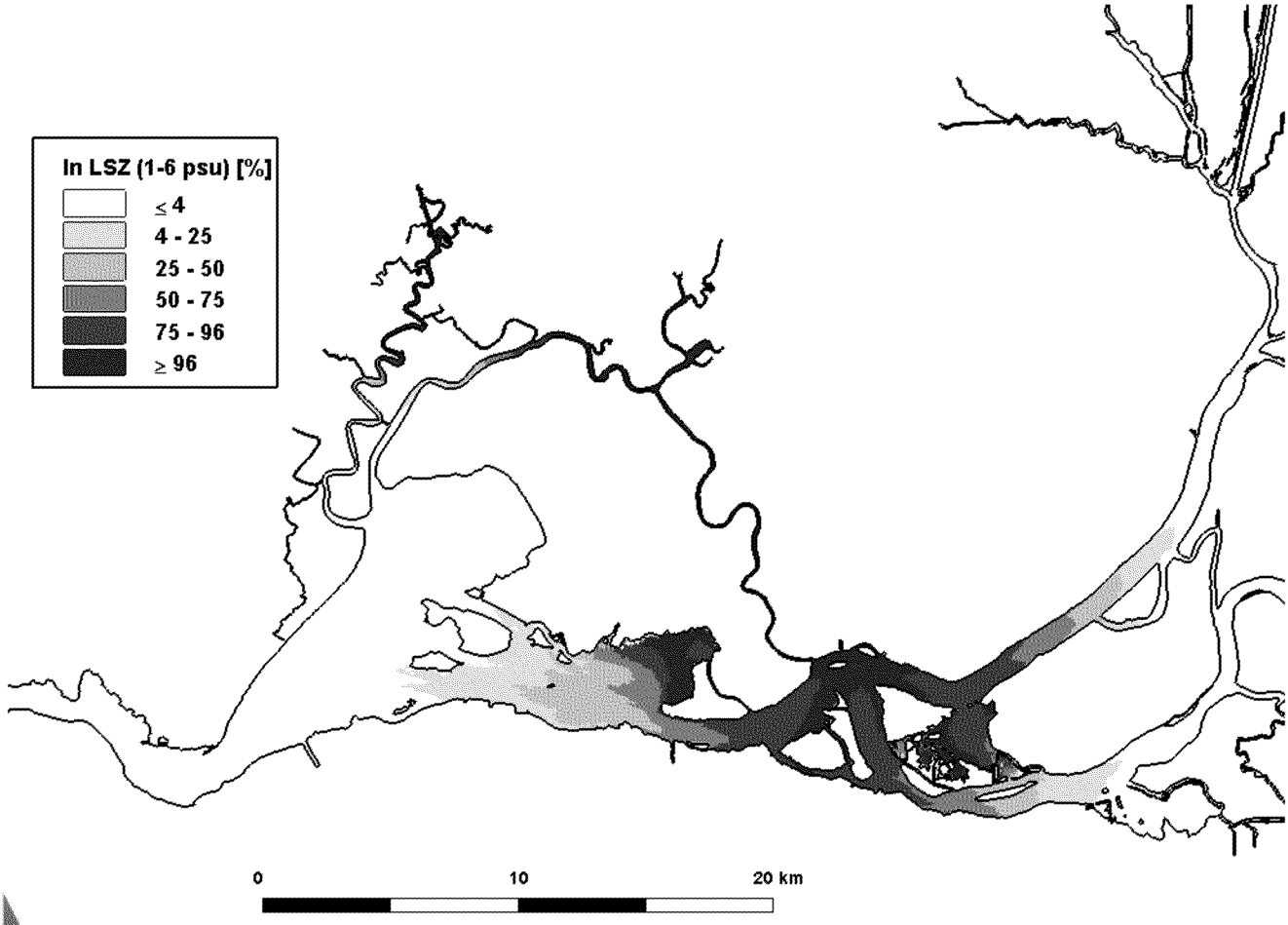
X2 ≈ 84

Daily-average Depth-averaged Salinity



Percentage of Day in Low Salinity Zone (LSZ)



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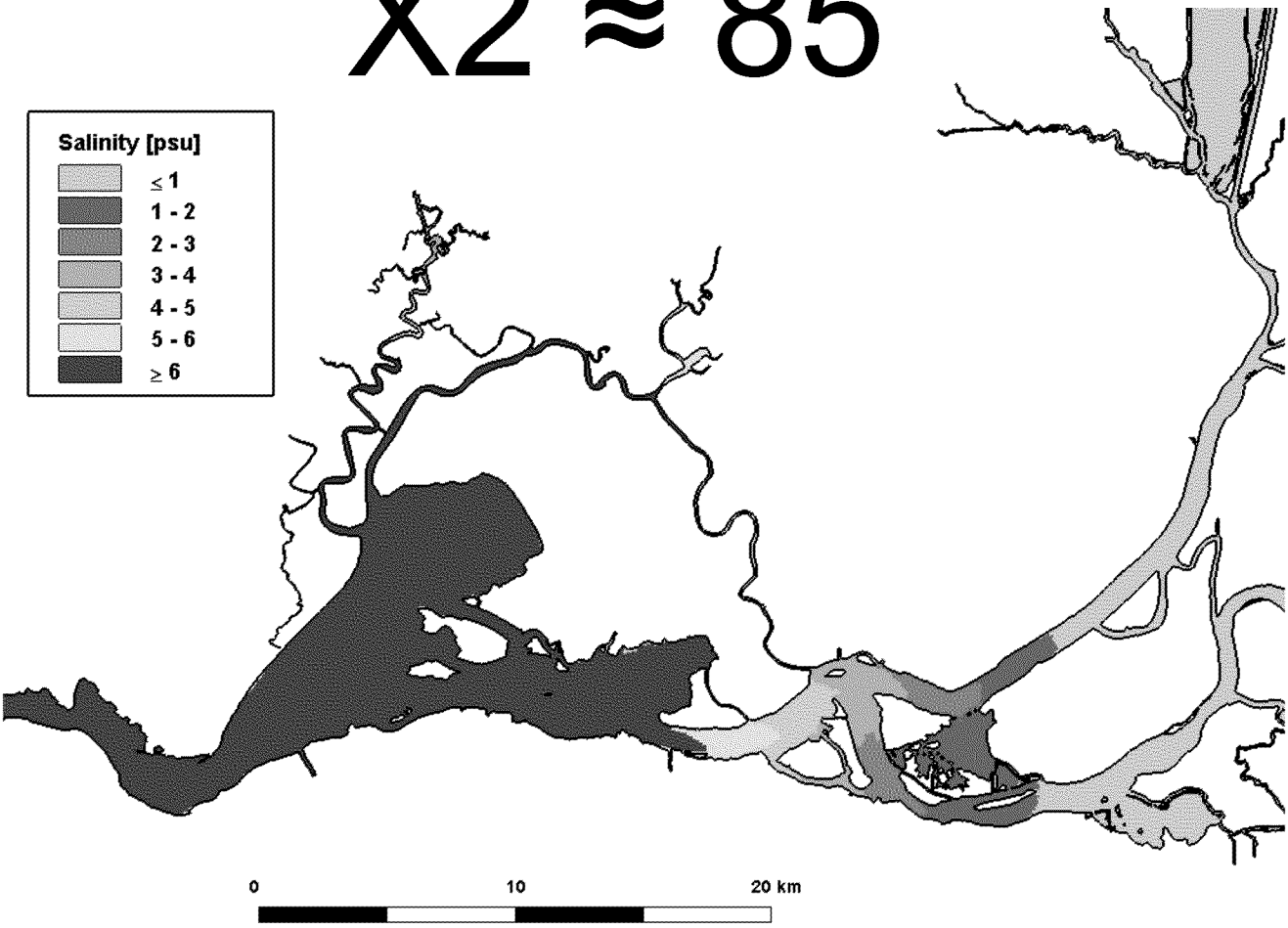
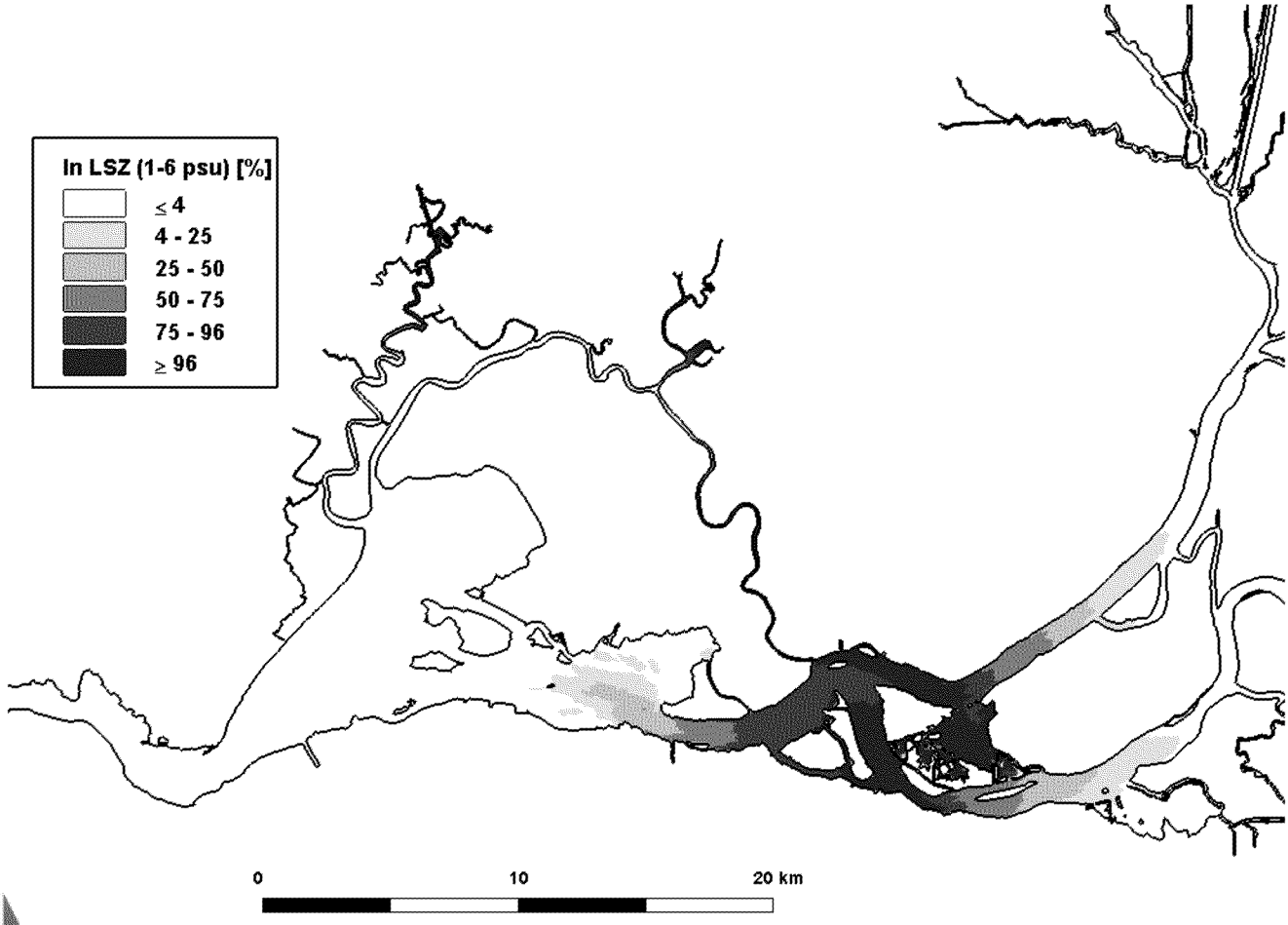
X2 ≈ 85

Daily-average Depth-averaged Salinity



Percentage of Day in Low Salinity Zone (LSZ)



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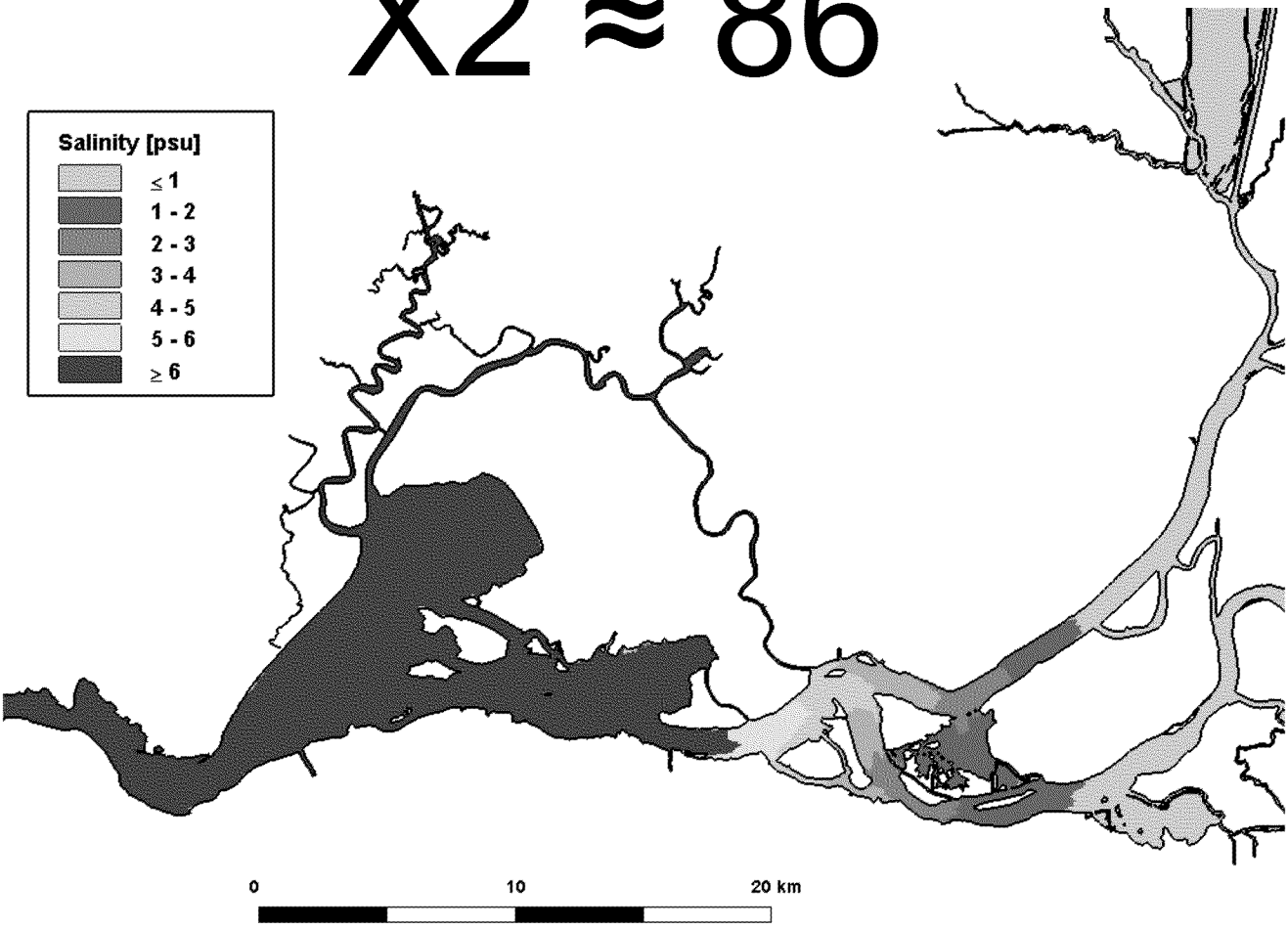
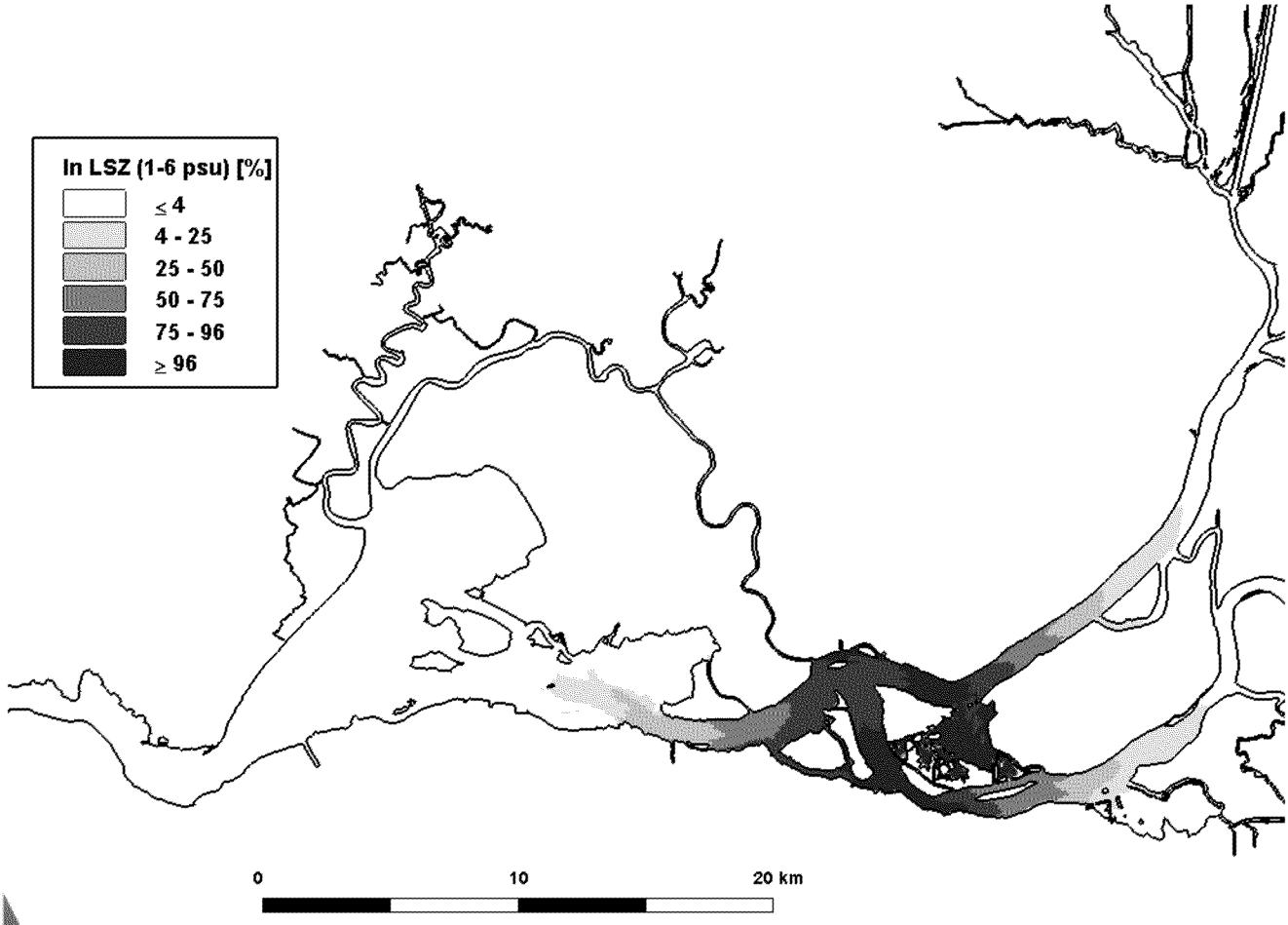
X2 ≈ 86

Daily-average Depth-averaged Salinity



Percentage of Day in Low Salinity Zone (LSZ)



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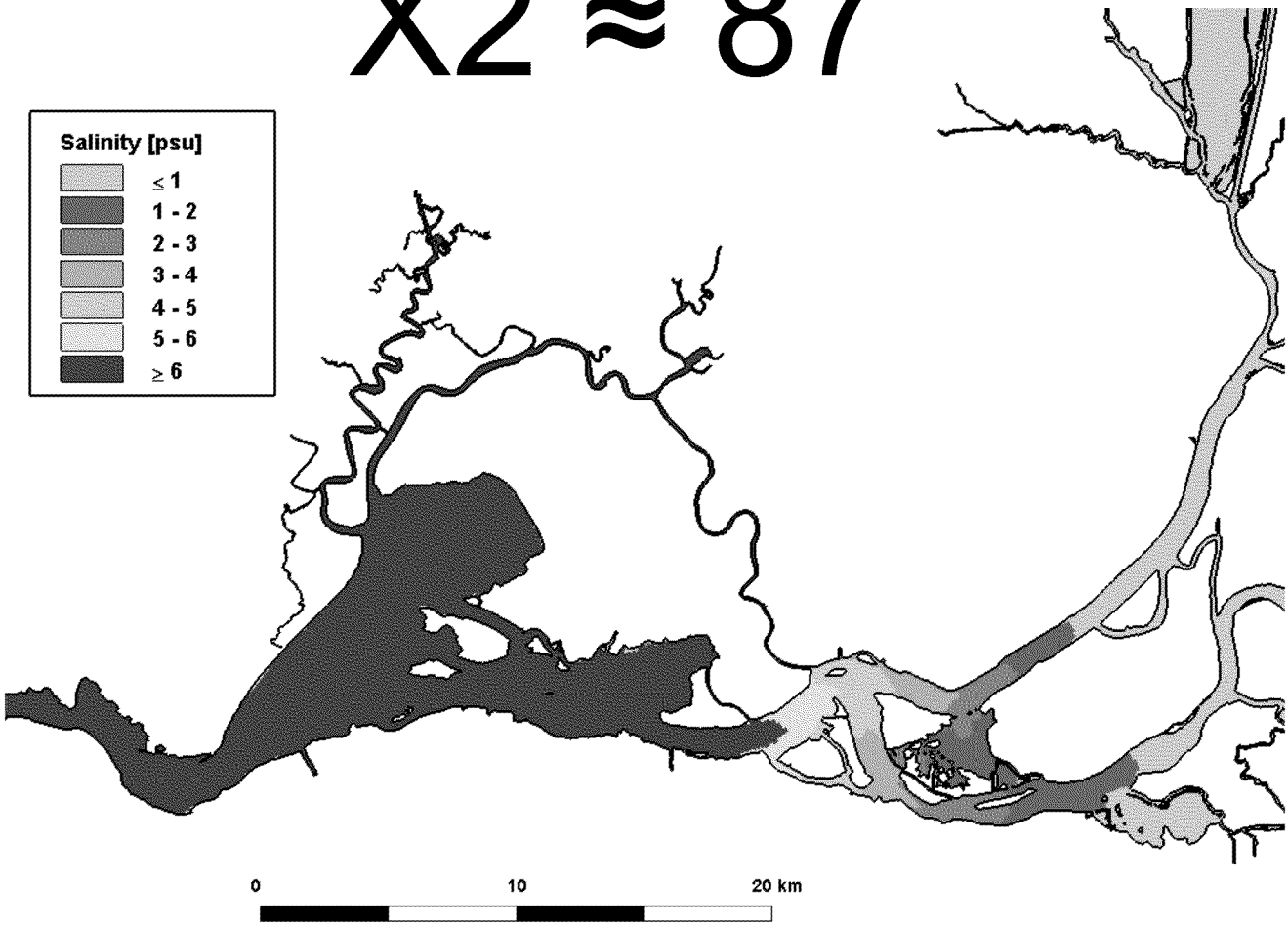
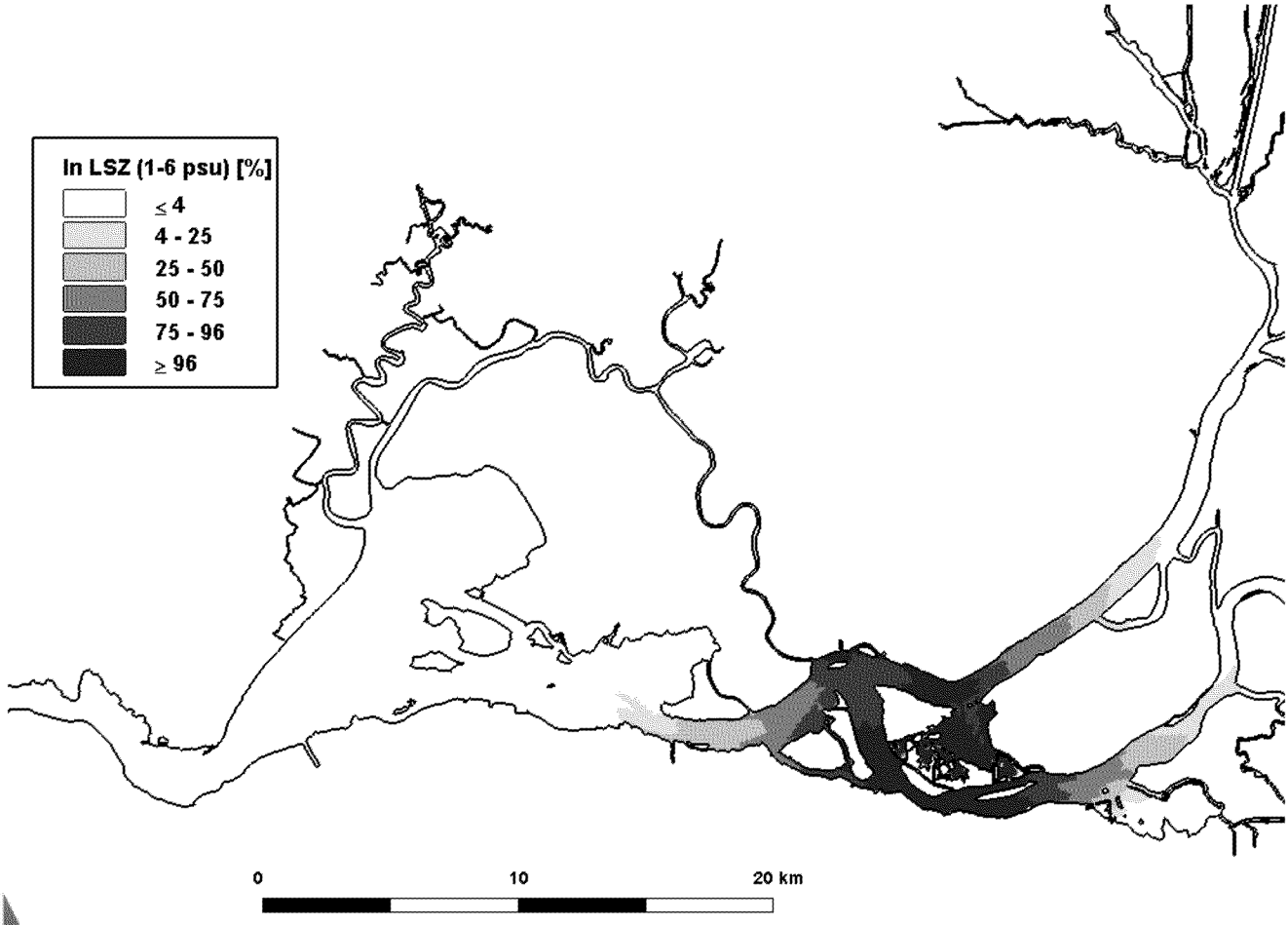
X2 ≈ 87

Daily-average Depth-averaged Salinity



Percentage of Day in Low Salinity Zone (LSZ)



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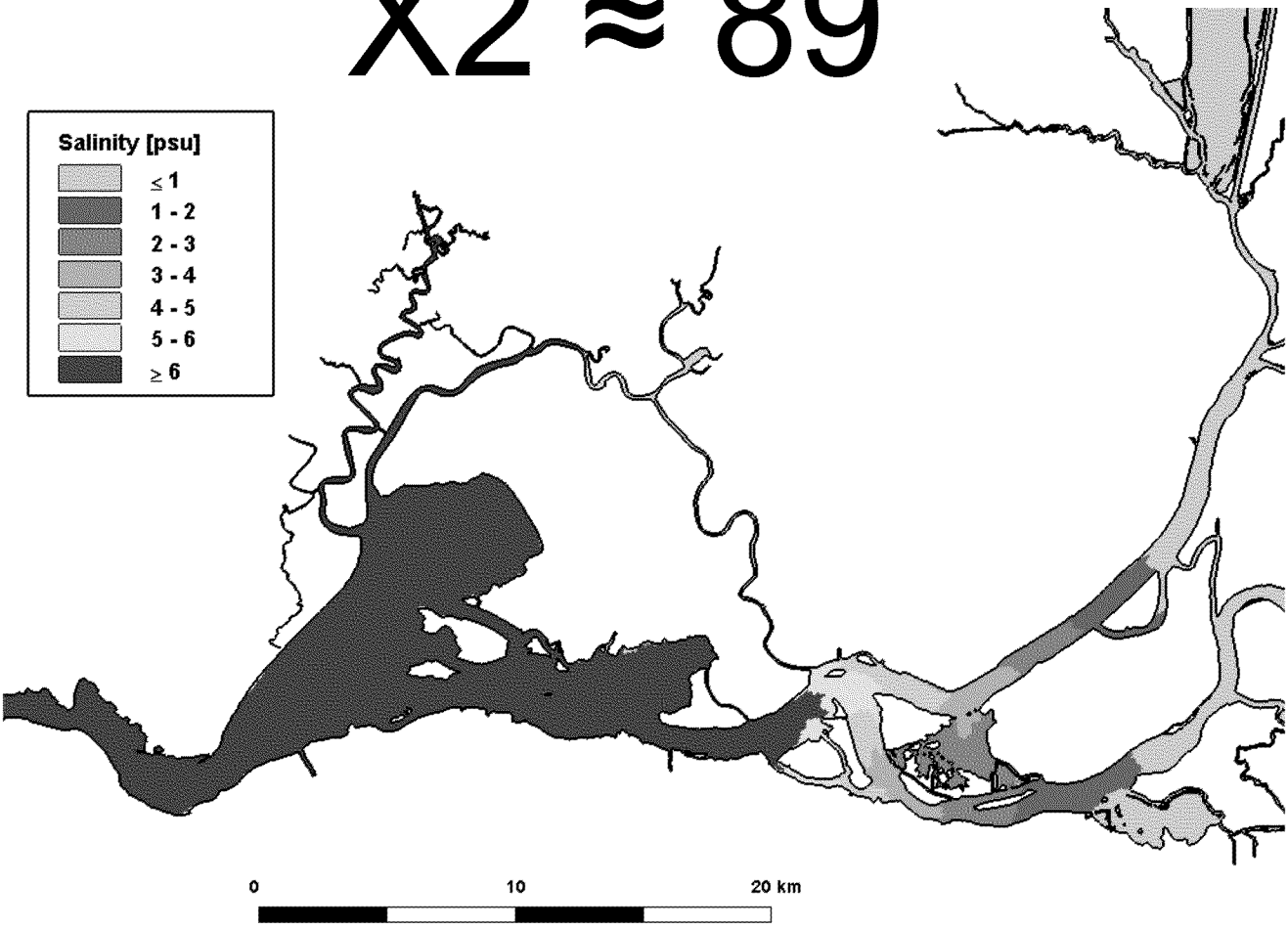
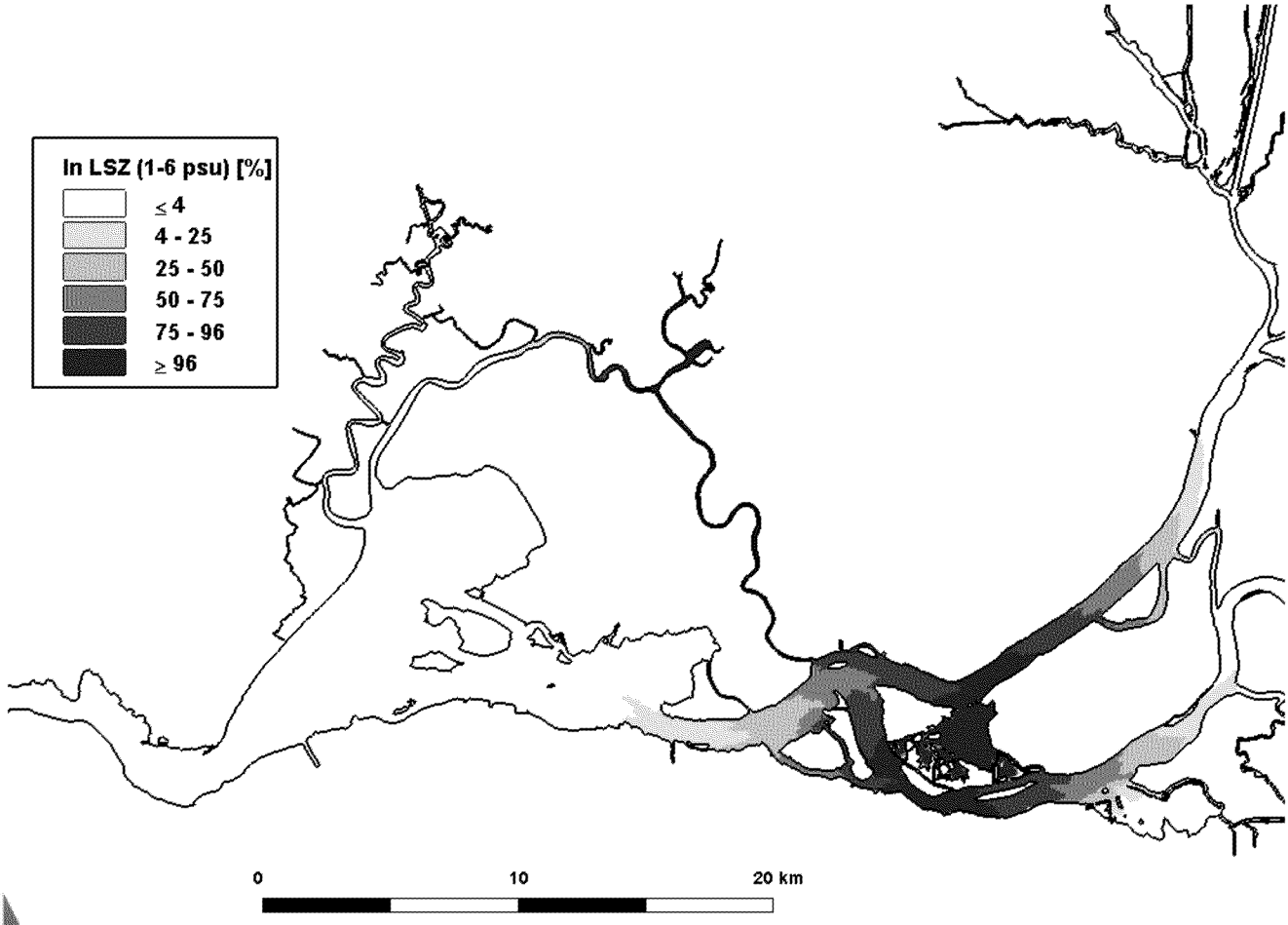
X2 ≈ 89

Daily-average Depth-averaged Salinity



Percentage of Day in Low Salinity Zone (LSZ)



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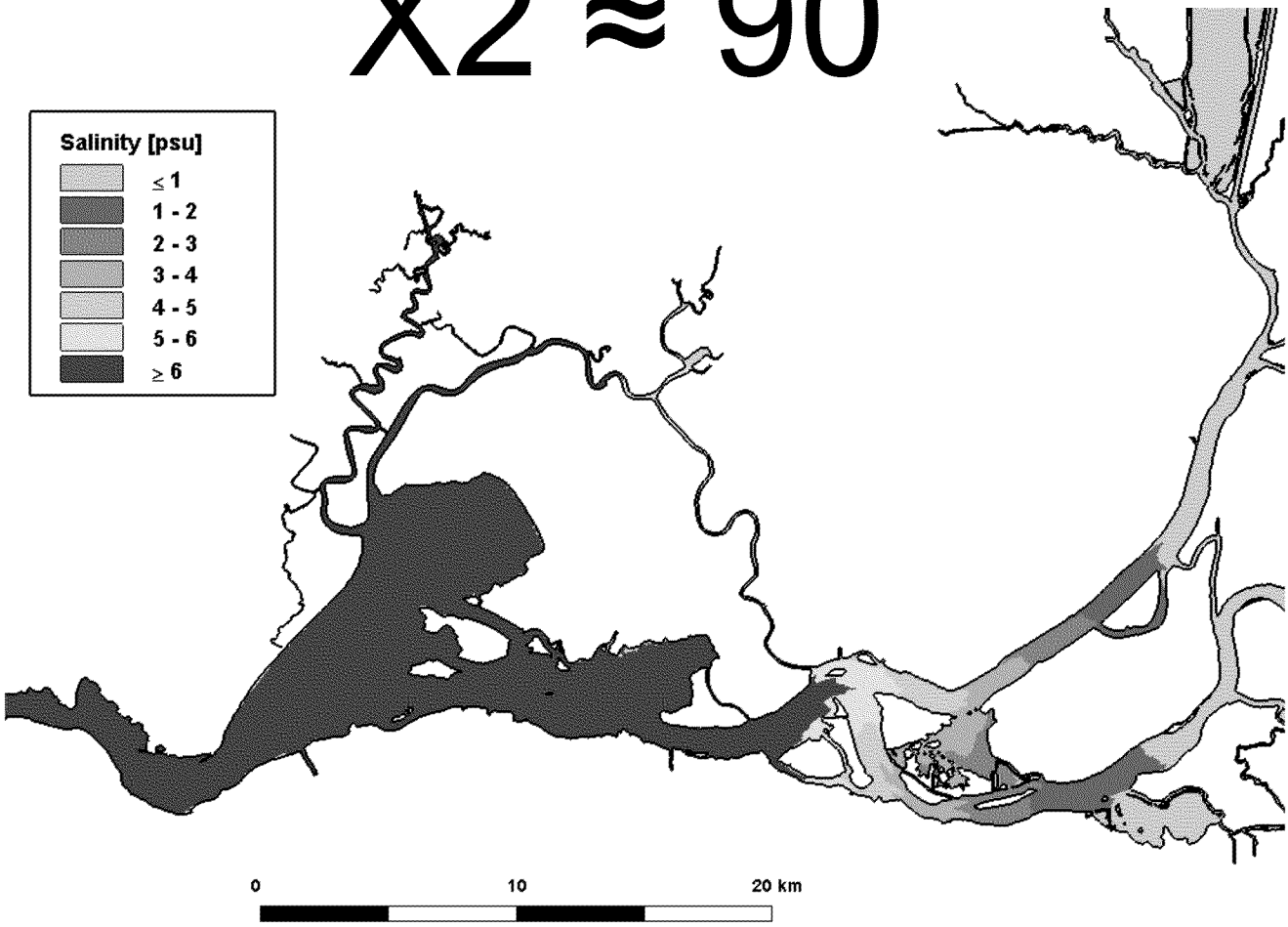
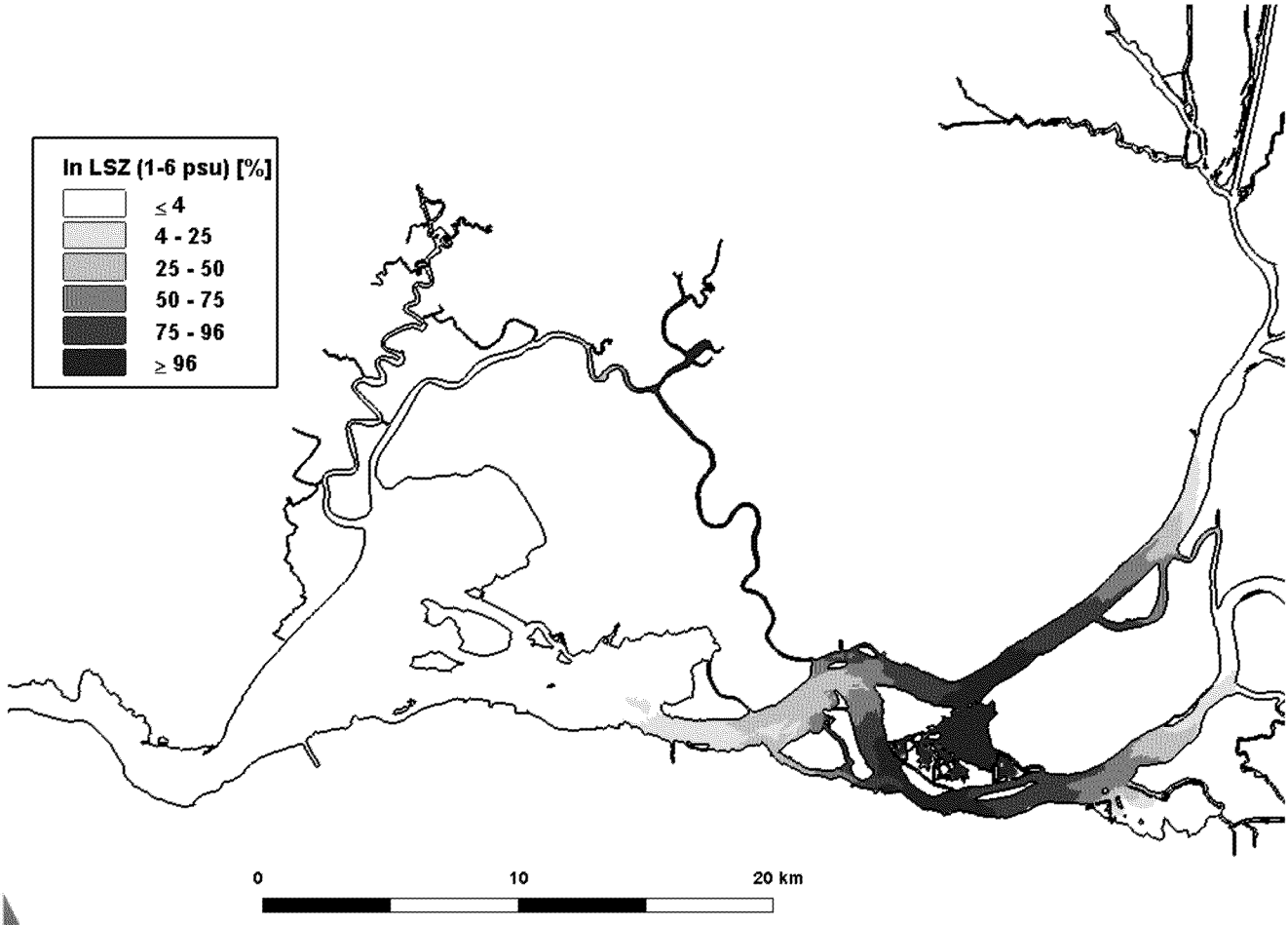
X2 ≈ 90

Daily-average Depth-averaged Salinity



Percentage of Day in Low Salinity Zone (LSZ)



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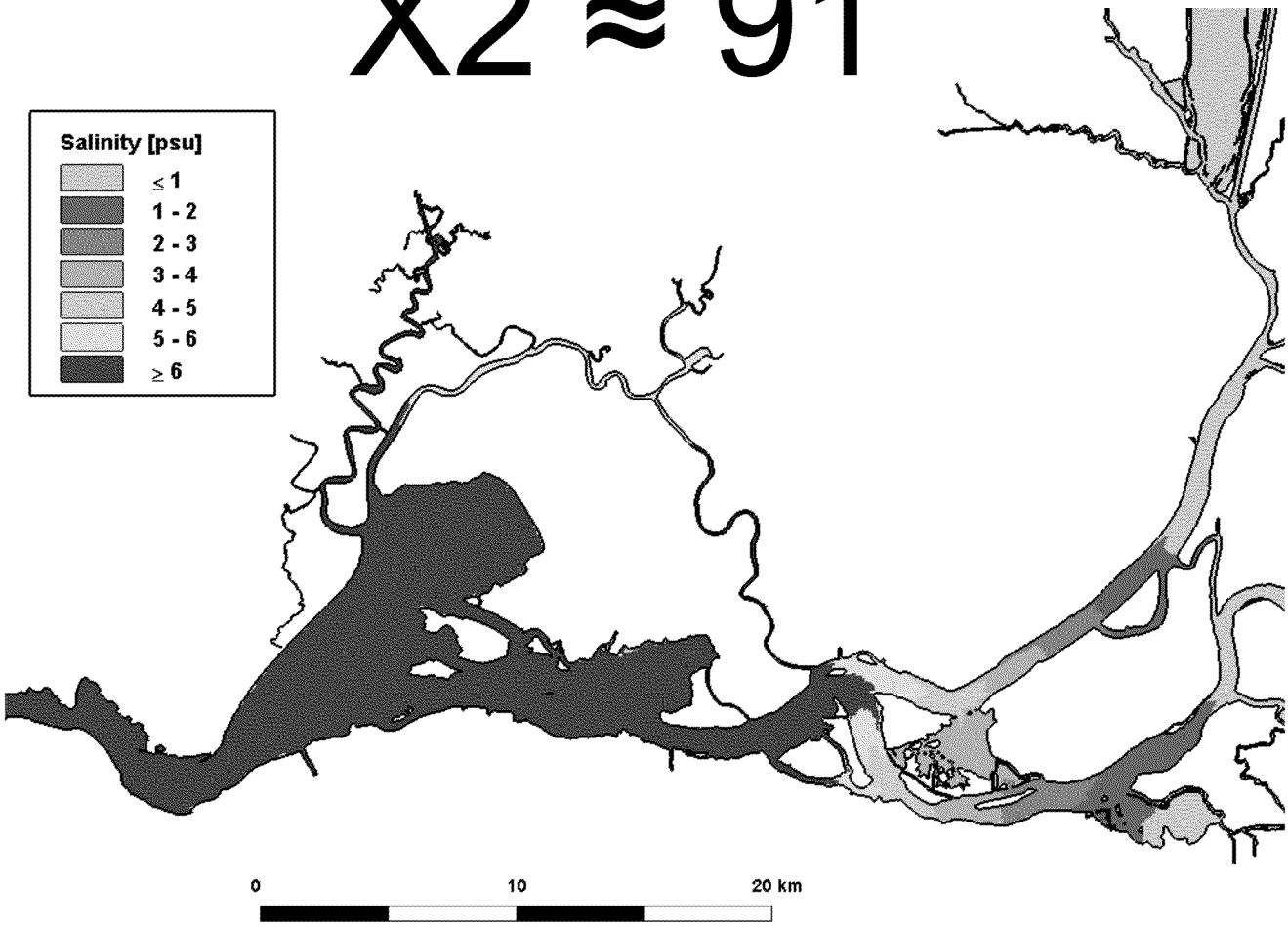
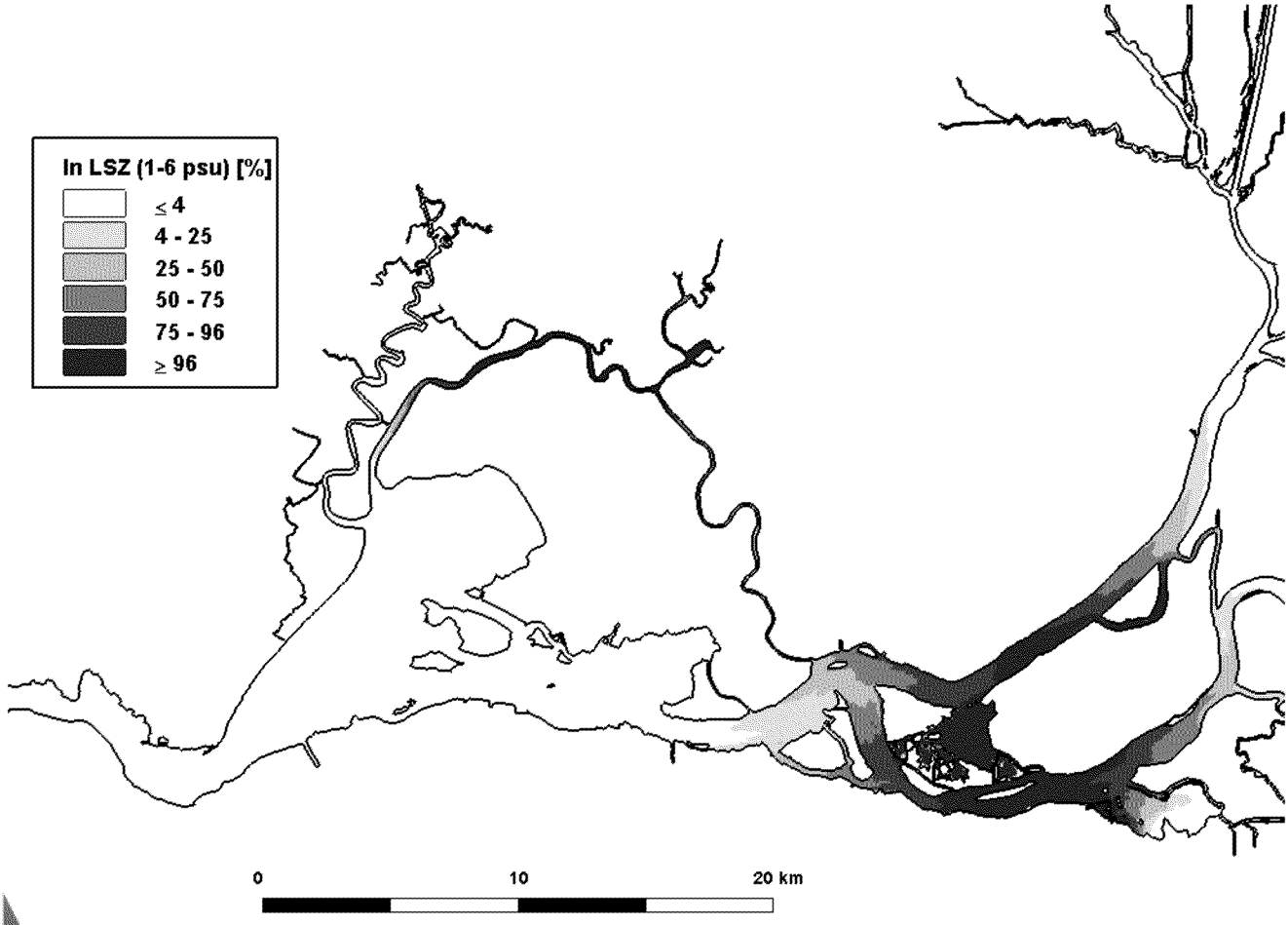
X2 ≈ 91

Daily-average Depth-averaged Salinity



Percentage of Day in Low Salinity Zone (LSZ)



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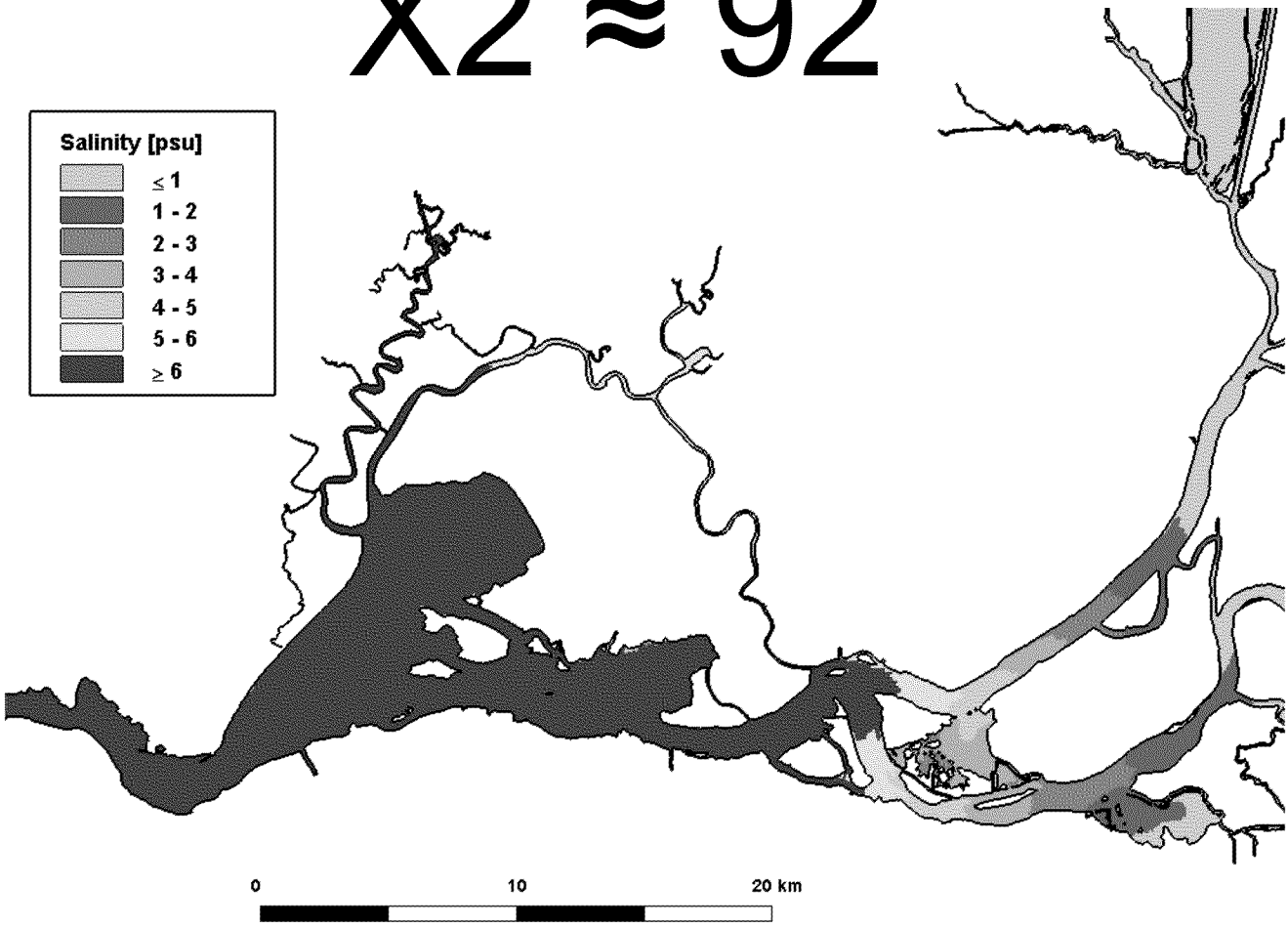
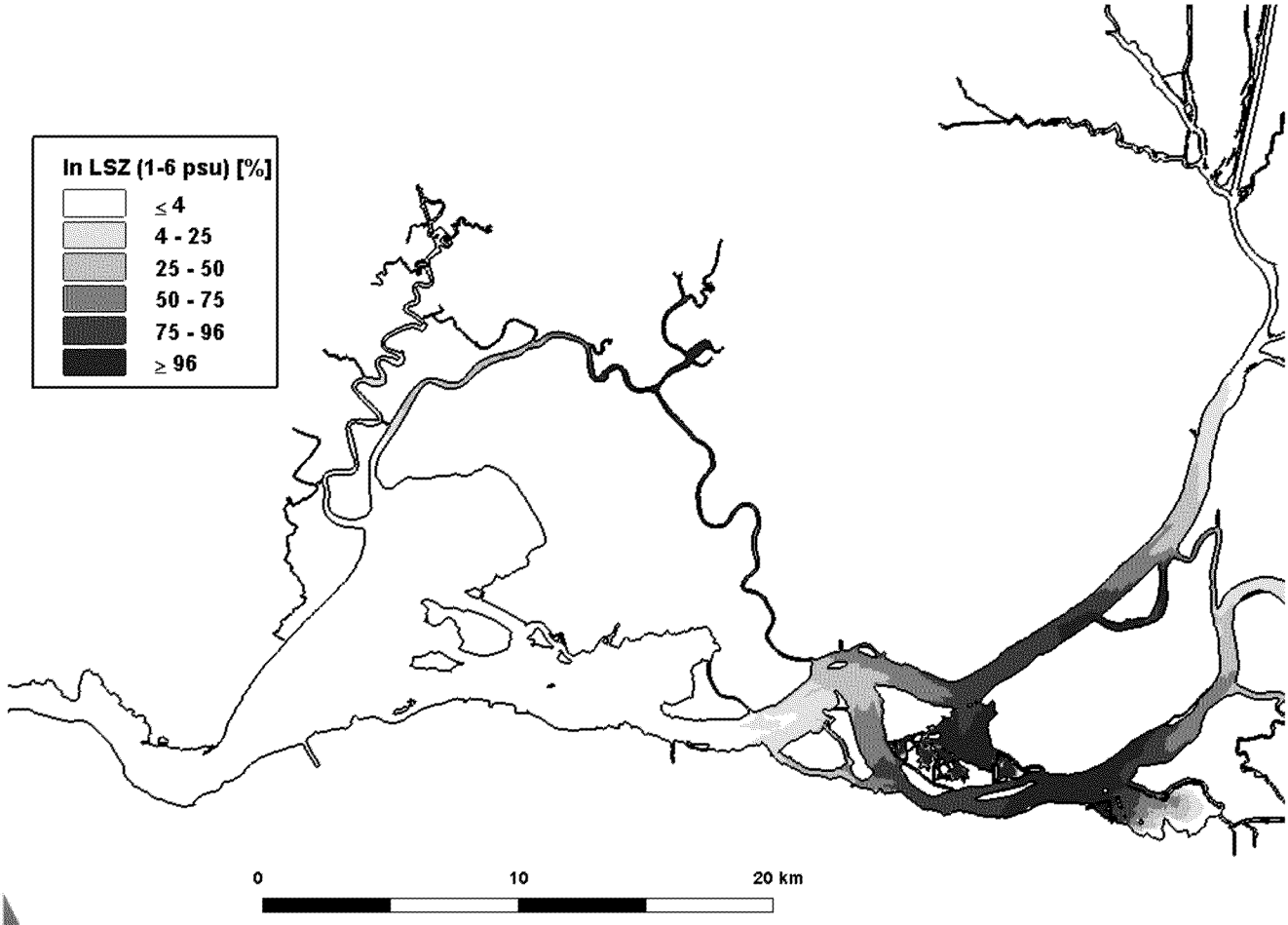
X2 ≈ 92

Daily-average Depth-averaged Salinity



Percentage of Day in Low Salinity Zone (LSZ)



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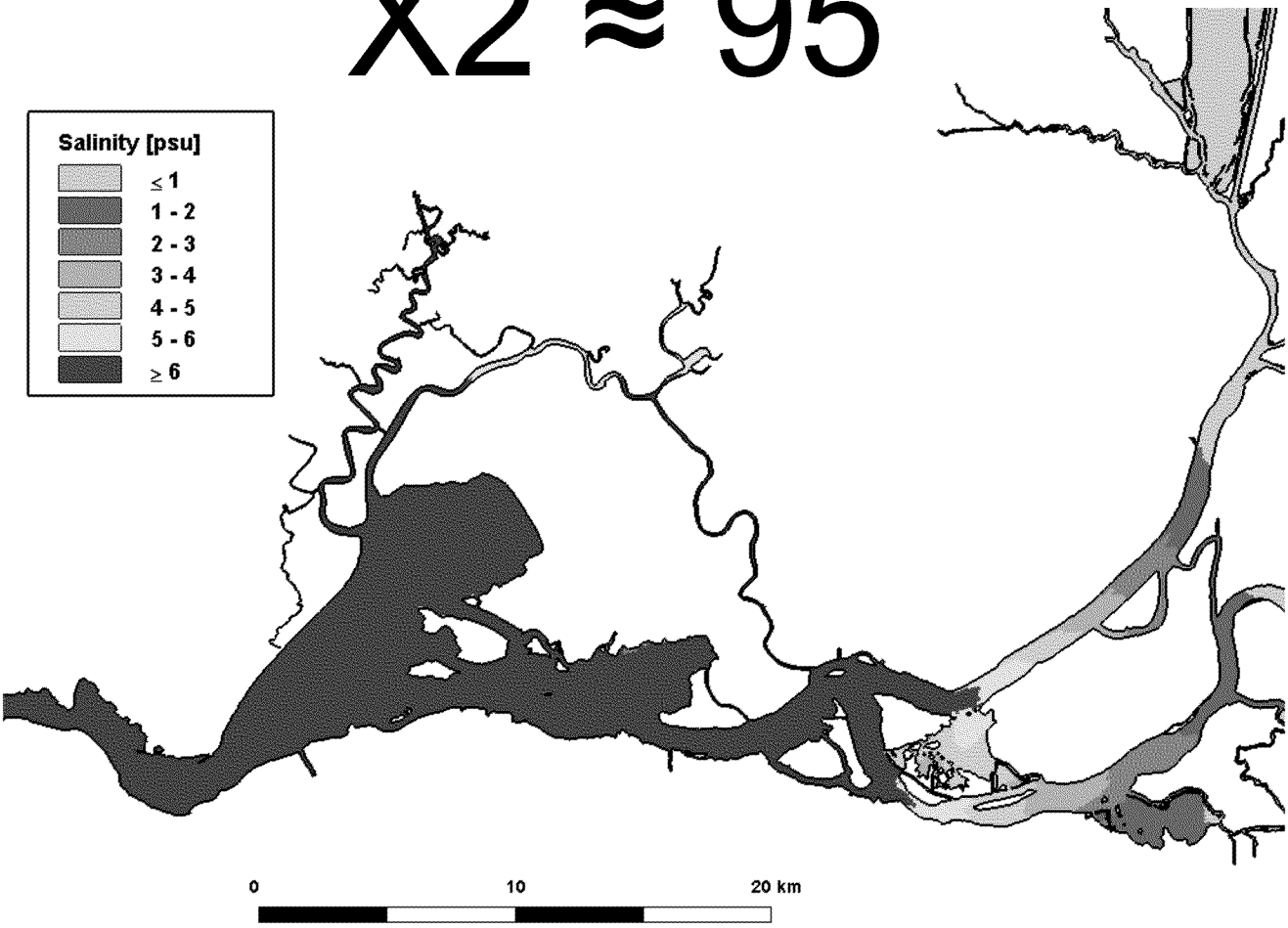
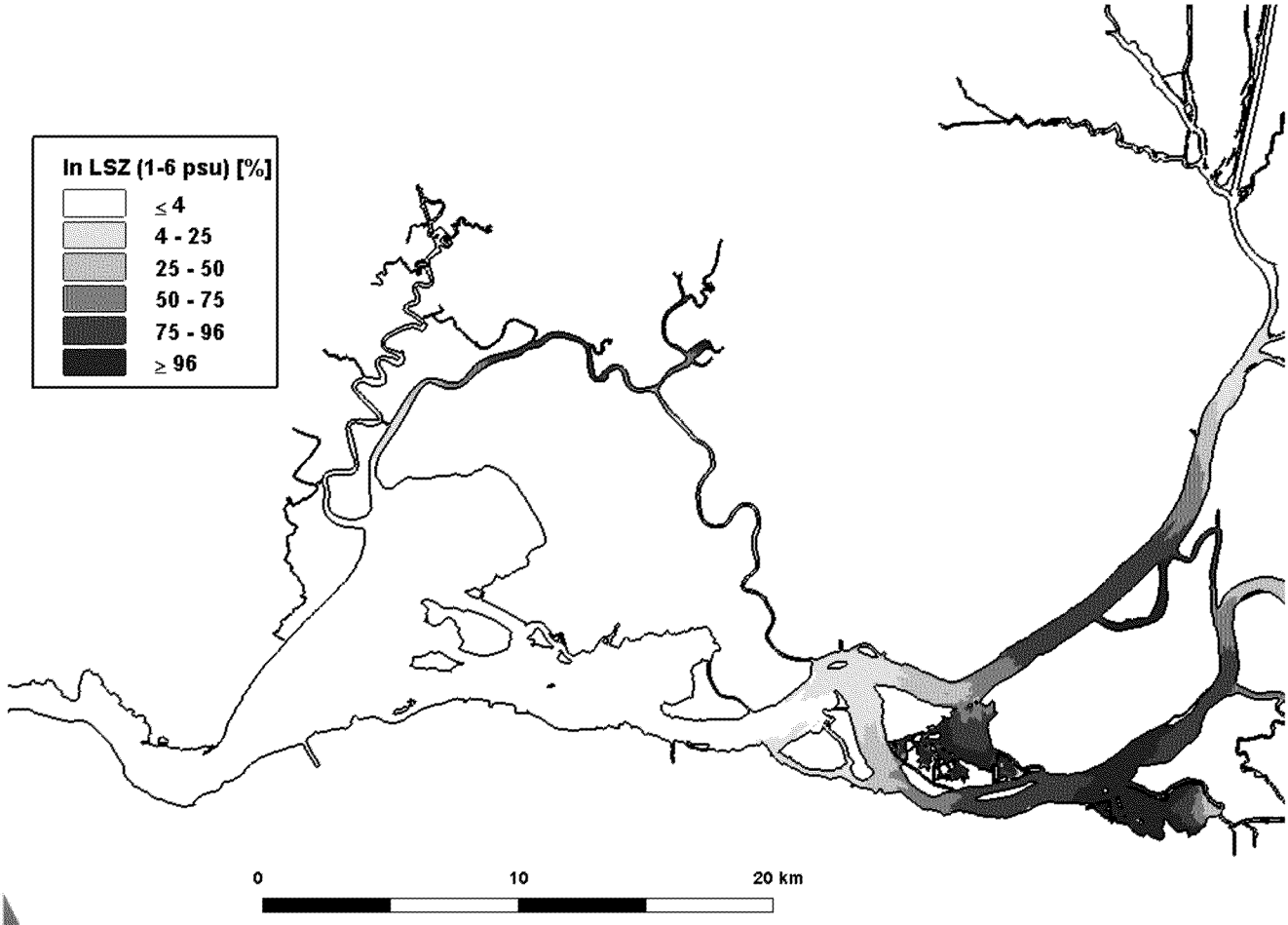
X2 ≈ 95

Daily-average Depth-averaged Salinity



Percentage of Day in Low Salinity Zone (LSZ)



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Discussion

- The spatial distribution of the LSZ for a given X2 is influenced by the antecedent conditions.
- For example, from X2≈80 to X2≈81 (page 18-19) the LSZ shifts out of Grixzzly Bay with a relatively small increase in X2. However, these two figures show two days that are 41 days apart during which X2 varies between 75 and 81 km.
- Similarly, for X2≈63 (page 31), the distribution of the LSZ is strongly influenced by antecedent conditions and whether X2 is decreasing or increasing.

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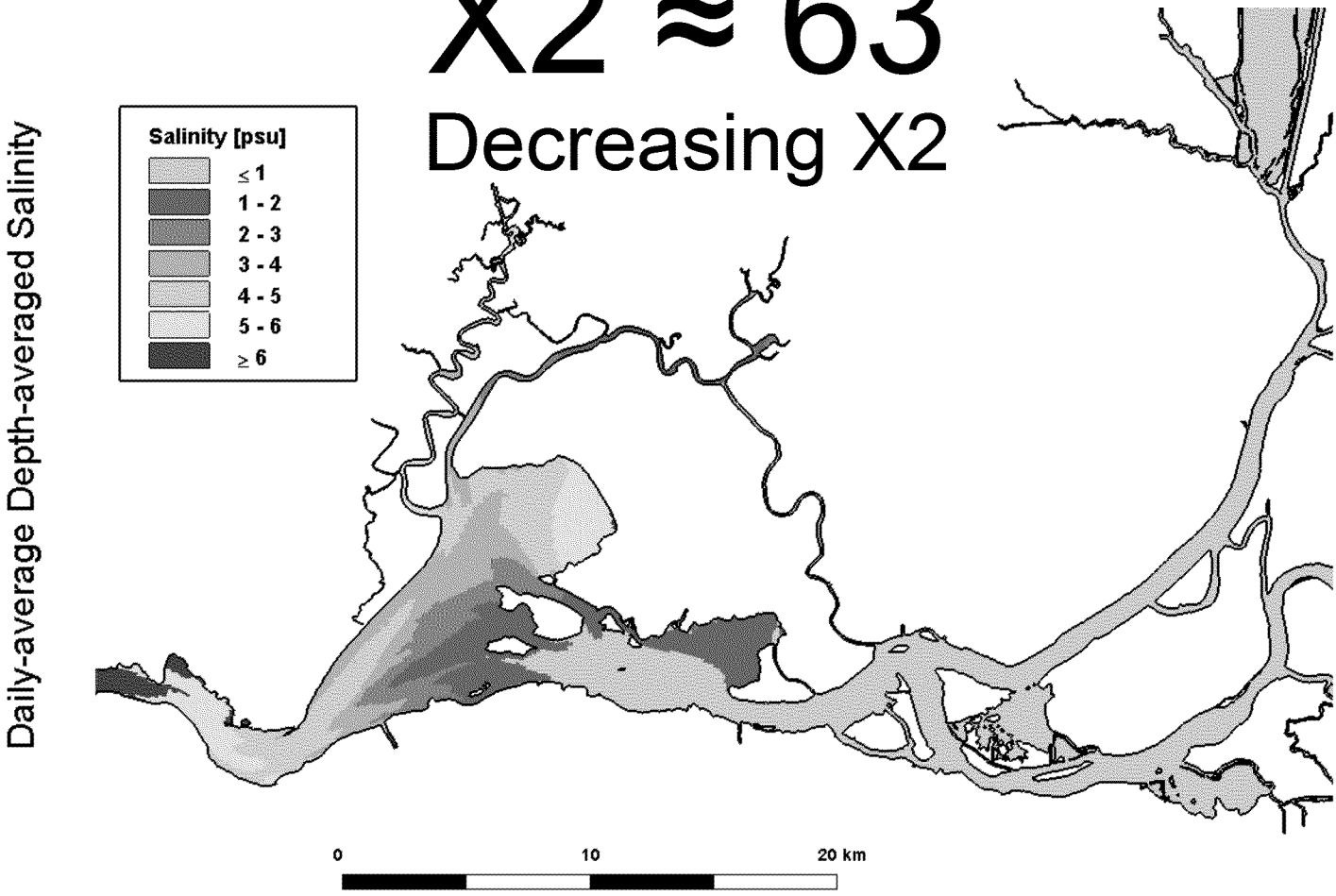
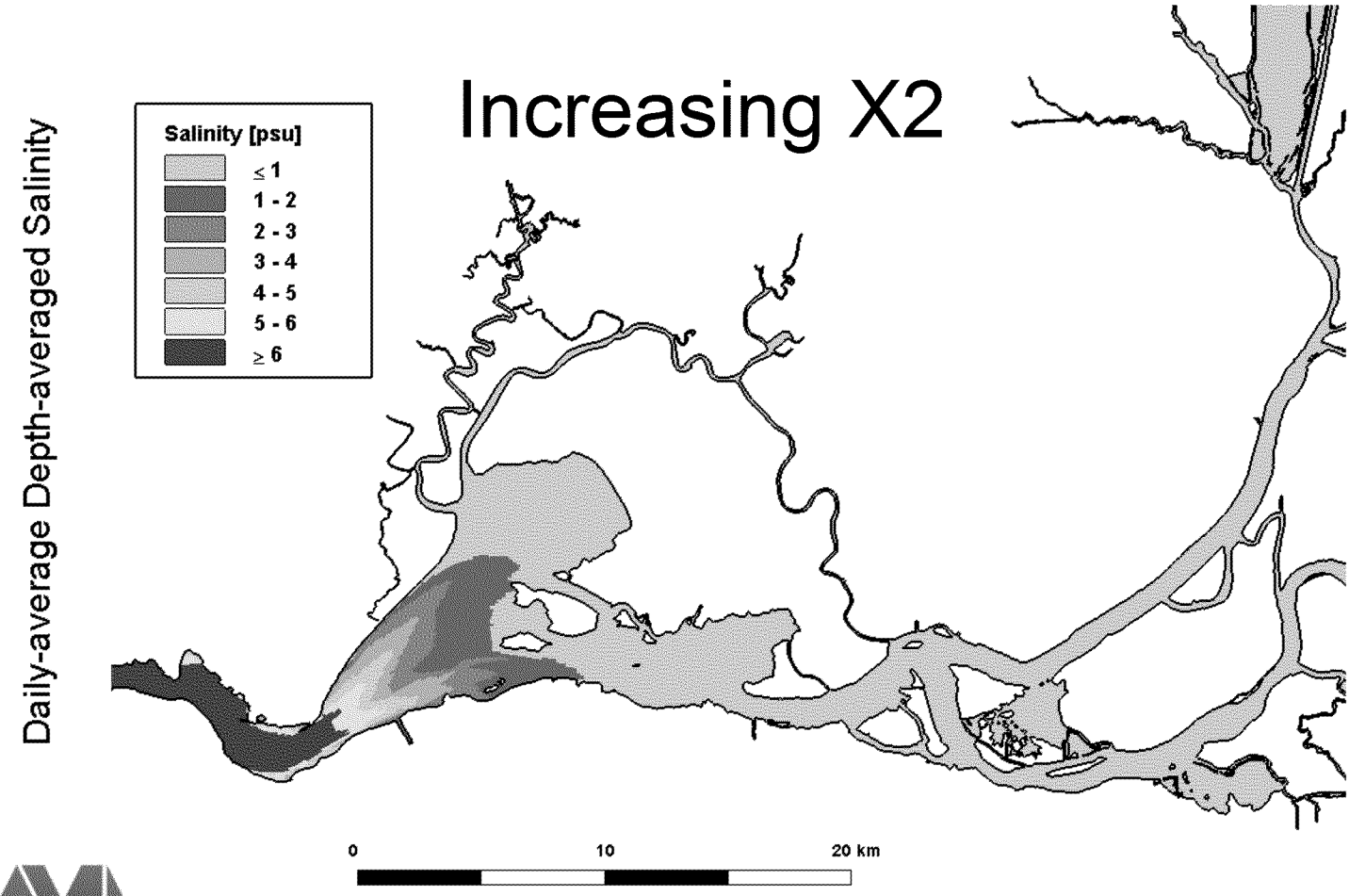
X2 ≈ 63

Decreasing X2



Increasing X2



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Comments and Suggestions

- The “Low Salinity Zone Flip Book” is intended as a dynamic document.
- The goal of this document is to encourage discussion of ways of thinking about X2 and the LSZ both spatially and temporally.
- Comments and suggestions for additional analysis to be included in future revisions are welcome.
- Please address any comments to:

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