

WASHINGTON SEA GRANT PROGRESS REPORT
for the period 2/1/2008 – 1/31/2009

WSG Project Number: **R/ES-67**
Project Title: Scales of residence-time variation in Northwest estuaries

Principal Investigator(s) and Affiliation:
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1. ABSTRACT ELEMENTS

OBJECTIVES

1) to determine the patterns of flushing and retention on scales from 10 m to 10 km created by tidal and bathymetric complexity in two PNW estuaries, Willapa Bay and Yaquina Bay; 2) to generalize from these results to produce improved predictions of residence time for the full set of PNW outer-coast estuaries, on scales useful for decision-making concerning susceptibility to nutrient loading; 3) to document small-scale (10-100 m) variation in oyster growth, phytoplankton standing stock, and tidal and tidally-averaged circulation in Willapa Bay, in order to determine the physical and biological mechanisms behind variation in aquaculture production on that scale

METHODOLOGY

1) Extremely high-resolution (~ 10 m) tidal models for Willapa Bay and Yaquina Bay, the Willapa model to be built using a new integrated bathymetry created as part of this project; 2) Idealized models of tidal flow in curving and dendritic channel structures, to allow us to abstract and generalize from results in Willapa and Yaquina; 3) Measurement of oyster growth across tide flats (~ 1 km, at sites of equivalent tidal elevation) in Willapa Bay, with concurrent time-series observations of temperature, salinity, and chlorophyll.

RATIONALE

Residence time is a critical metric of estuaries. It predicts the retention of harmful pollutants and beneficial larvae of fished species; similarly, it helps determine the flux of material from outside and the estuary's carrying capacity for aquaculture. Despite its importance, no general principle exists for determining, for a particular management application, how much observational or model detail is enough to accurately predict estuarine residence time. The models developed during this project will be applied at small scales (10 m to 1 km) not previously possible in PNW estuaries, and they will be tested with biological data that demonstrate small-scale spatial heterogeneity whose cause is currently unknown.

2. ACCOMPLISHMENTS AND OUTCOMES

We have identified and resolved a series of issues in the implementation of the model (installing and running ROMS in parallel on a new platform, creation of input files, bugs in the ROMS implementation of wetting and drying) and now have two model implementations running: a higher-resolution tidal model of Willapa Bay, which will address Objective 1, and a family of idealized curving channels (which vary in curvature, depth, width, etc.) which will be used to diagnose general relationships between morphology and residence time (Objective 2). We have ground-truthed the new Willapa intertidal bathymetry against observations in the Stackpole region and made adjustments to the bathymetry as necessary, to ensure that our model grid qualitatively matches the study area closely. In the field component (Objective 3), we collected data on water properties across Stackpole flats nearly continuously from June 8 to Aug. 28, 2008 (81 days). These measurements included temperature, salinity, and chlorophyll, with additional information on water flow velocities at 2 locations over 2 weeks. Oyster growth and condition were measured throughout the year.

3. IMPACTS

Note: Field and model results will need to be combined prior to effecting behavioral, policy, or economic changes.

4. PERFORMANCE MEASURES

Measure 1: Economic and societal benefits derived from the discovery and application of new sustainable coastal, ocean, and Great Lakes products from the sea.

Actual (reporting period covered by this report):

N/A

Anticipated (12-month period following this reporting period):

N/A

Measure 2: Cumulative number of coastal, marine, and Great Lakes issue-based forecast capabilities developed and used for management.

Actual (reporting period covered by this report):

N/A

Anticipated (12-month period following this reporting period):

N/A

Measure 3: Percentage/number of tools, technologies, and information services that are used by managers (NOAA and/or its partners and customers) to improve ecosystem-based management.

Note: Integrated bathymetry for Willapa Bay has been developed at the Olympia Natural Resources Center and involves “stitching” together subtidal bathymetry based on Army Corps surveys of several decades ago, with LIDAR information about the 3-D structure of intertidal flats. While inaccurate in some respects, particularly as sediment has shifted within the bay over time, ONRC’s bathymetry has been suitable for our circulation modeling after relatively small modifications at the intertidal/subtidal border and based on ground-truthing the position of intertidal sloughs.

Actual (reporting period covered by this report):

N/A

Anticipated (12-month period following this reporting period):

N/A

5. PUBLICATIONS

Please refer to instructions for hardcopy reprint requirements and citation formats.

A. Journal articles:

Wheat, E., N. S. Banas, J. Ruesink. In preparation. [tentative title] Small-scale variation in production of benthic suspension-feeders across a tidelflat in Willapa Bay, Washington, USA. [to include spatial pattern of chlorophyll measured at stationary sensors, calculation of nontidal (i.e., slower than tidal) variation in chlorophyll concentrations, and correlation (or lack thereof) with

growth and condition of outplanted oysters]

N. S. Banas, M. Lodgson, E. Wheat, J. Ruesink. In preparation. Spatial scales of residence time variation in a complex, macrotidal estuary. [Analysis of flushing and retention patterns in the Willapa intertidal zone, from the new model using new bathymetry, validated against salinity observations in the Stackpole region]

B. Theses and dissertations:

Wheat, E. In preparation. [tentative title] Top-down control by benthic suspension-feeders: causes and consequences.

C. Book chapters: none

D. Book or Monograph: none

E. Paper in Proceedings: none

F. Proceedings or Symposia: none

G. Technical reports: none

H. Advisory publications (e.g. handbooks, manuals, guides): none

I. Magazine articles: none

J. Media Placements: none

K. Other publications (e.g., videos, DVDs, software, websites): none

6. PRESENTATIONS - inc. Conference (Poster or Oral), Seminar & Public

Wheat, E. Drivers of local variation in oyster growth: food limitation or tidal circulation? Western Society of Naturalists, November 2008, Vancouver, Washington.

7. PATENTS AND COPYRIGHTS

None

8. NEW BUSINESSES OR JOBS CREATED

None

9. LIST ALL STUDENTS SUPPORTED BY OR AFFILIATED WITH THIS PROJECT

_____ no students involved (check here if no students were involved in the project)

Student Name: Elizabeth Wheat

Department: Biology

Major/Degree field: Biology

Major Professor: Dr J Ruesink

Student Type (Ph.D., M.S., M.A., B.S., B.A. J.D., etc): Ph.D.

Dissertation/Thesis title: [tentative title] Top-down control by benthic suspension-feeders: causes and consequences.

Date of graduation (actual or anticipated): 2010

Total support or affiliation period (e.g., Jan – June 2005): Was supported in year 1 and will be supported in year 3.

Type of support (RA, research costs, conferences – list all that apply): RA

Current employment if applicable: N/A

10. INTERACTIONS

We continue to interact directly with shellfish growers during field work. This is a venue for on-going discussions of the spatial pattern of oyster productivity and possible causes.

11. OUTREACH AND INFORMATION/TECHNOLOGY TRANSFER

None.

12. FUTURE ACTIVITIES

Model scenarios: With the ROMS model now functioning for Willapa Bay, we will carry out multiple runs that test the sensitivity of circulation and retention to how the intertidal zone is represented. There are 4 basic scenarios: a) actual intertidal 3-D structure; b) linear slope from high water to low water; c) convex curve from high water to low water; and d) concave curve from high water to low water. This allows us to test the importance of high-resolution bathymetric information for predictions of residence time at different spatial scales.

Idealized modeling: We will generalize these results to other Northwest coast estuaries by analyzing residence time patterns in a family of idealized models representing sinuous channels (with varying depth, width, sinuosity, intertidal depth profile, etc.).

Data-model comparisons: We will carry out point-by-point data-model comparisons involving field data for salinity (a conserved tracer) and water flow velocities across the Stackpole flats. This will provide a test of the ability of the ROMS model to capture major features of circulation and retention at smaller (1-km) scales in the intertidal zone.

Communication of results: We will present results from completed field studies in both written and oral forms (e.g. manuscripts in preparation, presentation at NSA/PCSGA).