

Wave and Tidal Energy Research in the Pacific Northwest: The Northwest National Marine Renewable Energy Center

George Boehlert

Hatfield Marine Science Center, Oregon State University

Philip Malte

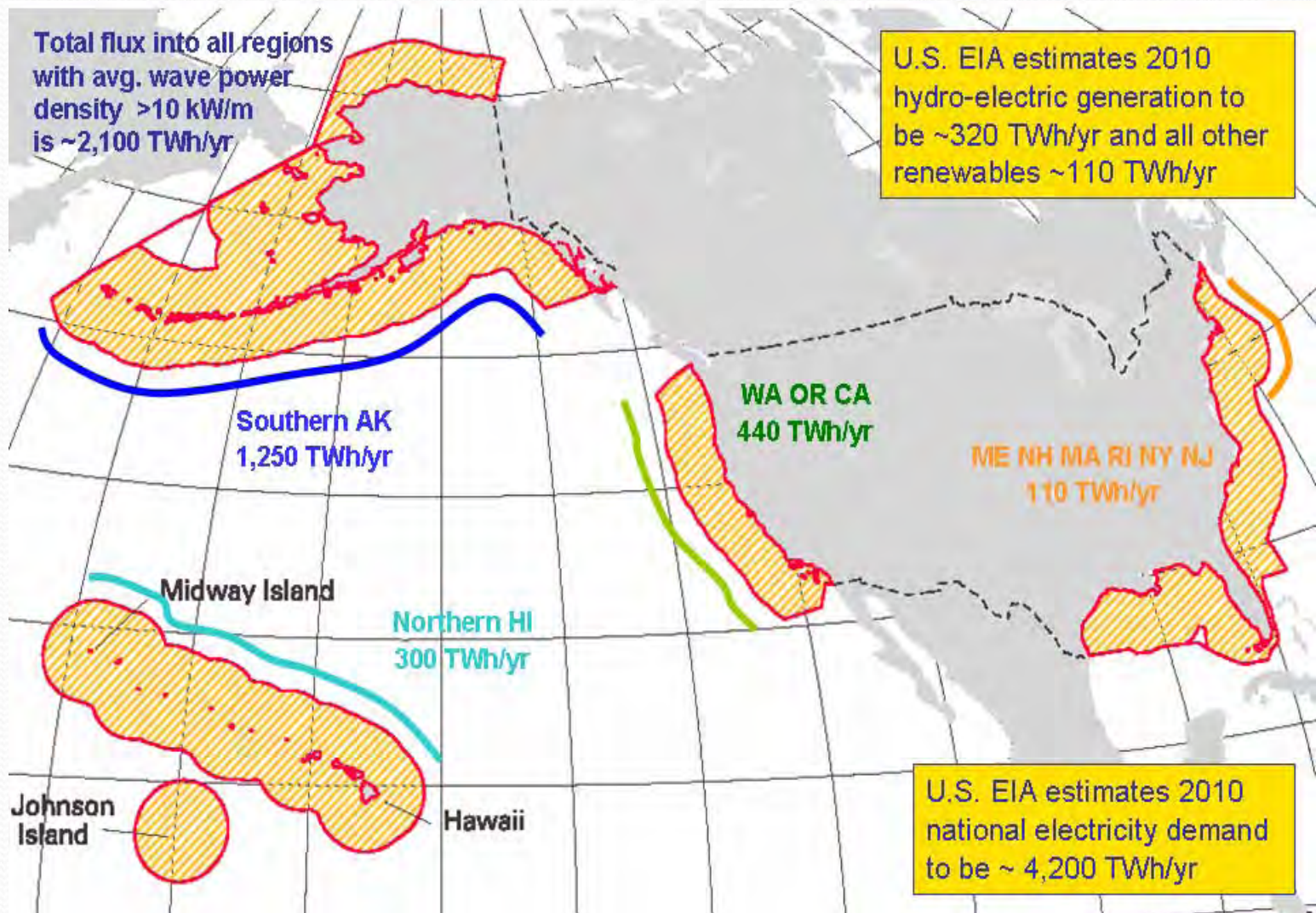
Energy and Environmental Combustion Laboratory, University of Washington



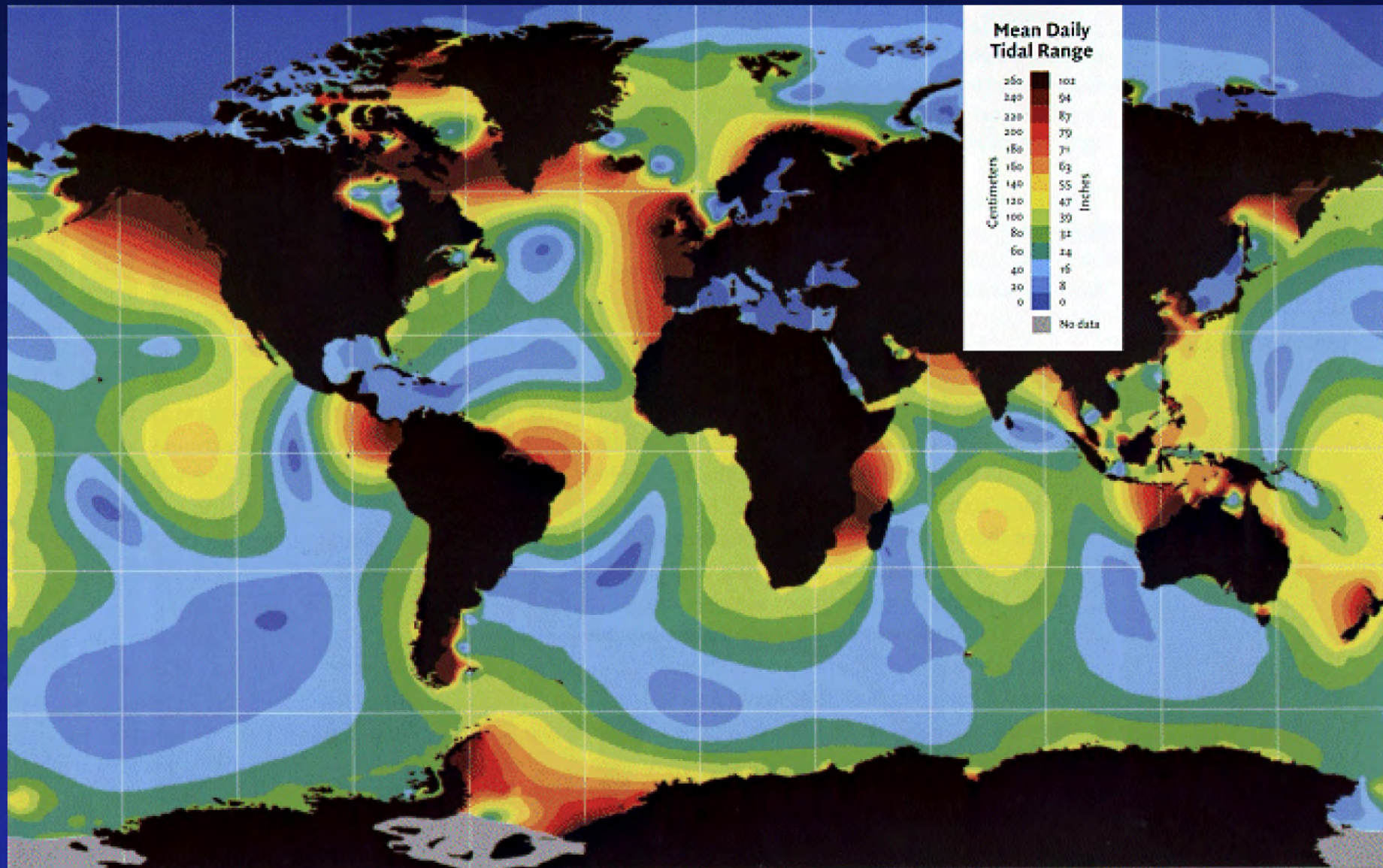
Brief Summary

- Why marine renewable energy research in the Pacific Northwest?
- Development of the US Department of Energy's Northwest National Marine Renewable Energy Center (NNMREC)
- Wave energy research at Oregon State University
- Tidal energy research at the University of Washington

Where is the Wave Energy?



Global Distribution of Tidal Range



The Northwest National Marine Renewable Energy Center (NNMREC)

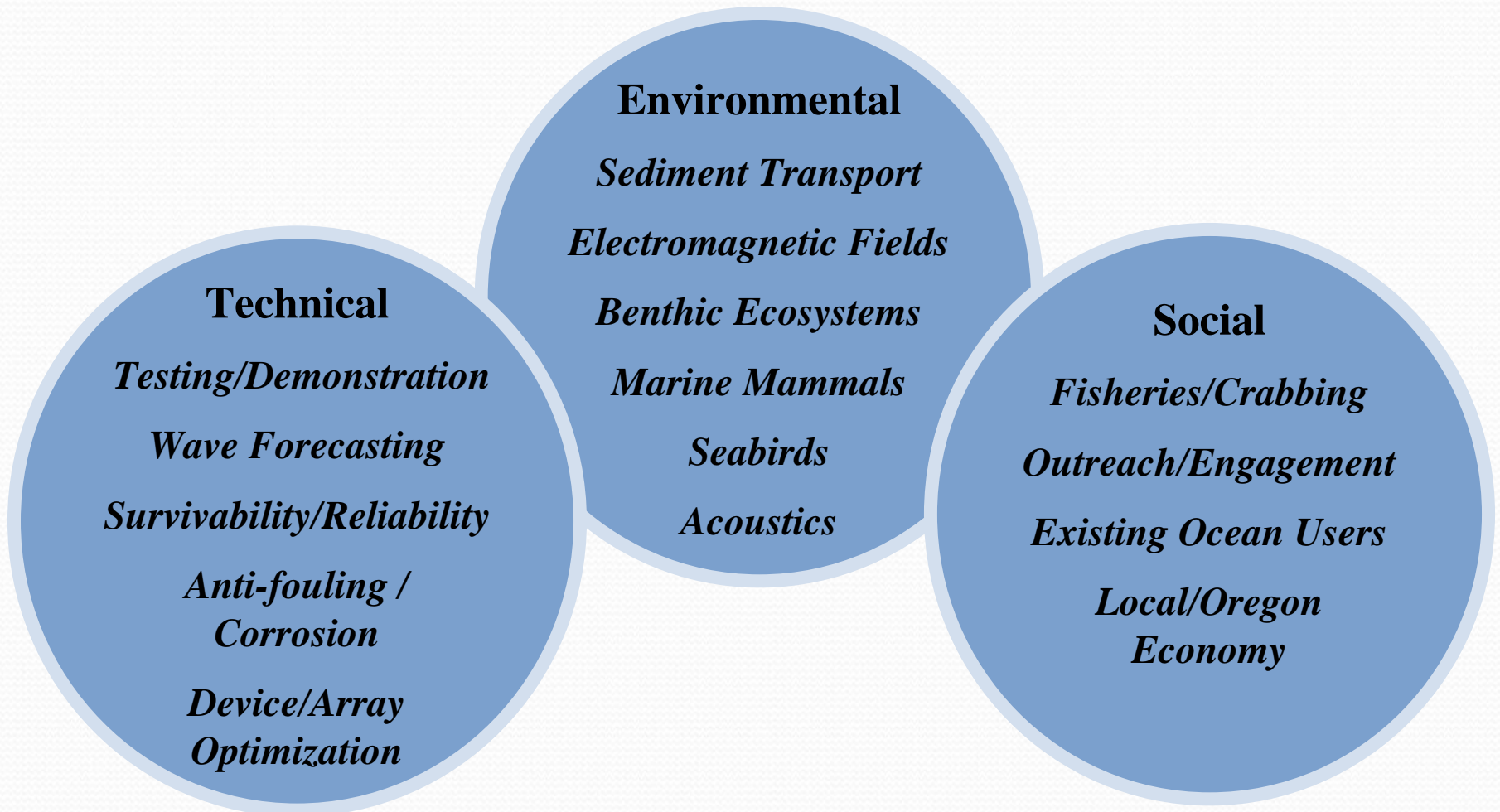
- A partnership between Oregon State University & the University of Washington funded by the U.S. Department of Energy, established 2008
- Co – Directors: Dr. Robert Paasch (OSU); Dr. Philip Malte (UW)
- Multiple partners in research program
- Center activities are structured to:
 - facilitate device development,
 - inform regulatory and policy decisions,
 - close key gaps in understanding.



State of Oregon



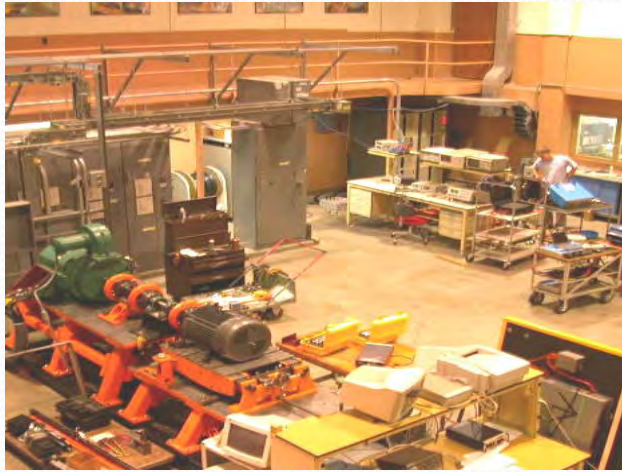
NNMREC – OSU; a virtual center focused on evaluation of evaluation of energy technologies



Marine Energy Testing Facilities

- Testing is conducted to understand and optimize devices
- EMEC as a model test facility
 - Four wave berths and five tidal (75% full)
 - Stimulated local renewable economy
 - Key factor in Scotland's success
- NNMREC aims to have full range of testing from small-scale to full-scale ocean facilities
- Currently, the U.S. marine energy industry is challenged by the lack of proper and standardized infrastructure to test and deploy WEC devices in the ocean.

OSU Development and Evaluation Resources



**OSU -- Wallace Energy
Systems & Renewables
Facility (WESRF)**



**OSU -- O.H. Hinsdale Wave
Research Lab
(HWRL)**

**Hatfield Marine Science Center
(HMSC); OSU, federal and state
ocean agencies, research vessels;
Full scale test berth development
site**



Proposed Mobile Ocean Test Berth Study Site

44.697764 , -124.148319

44.699034 , -124.108056

44.65403 , -124.145677

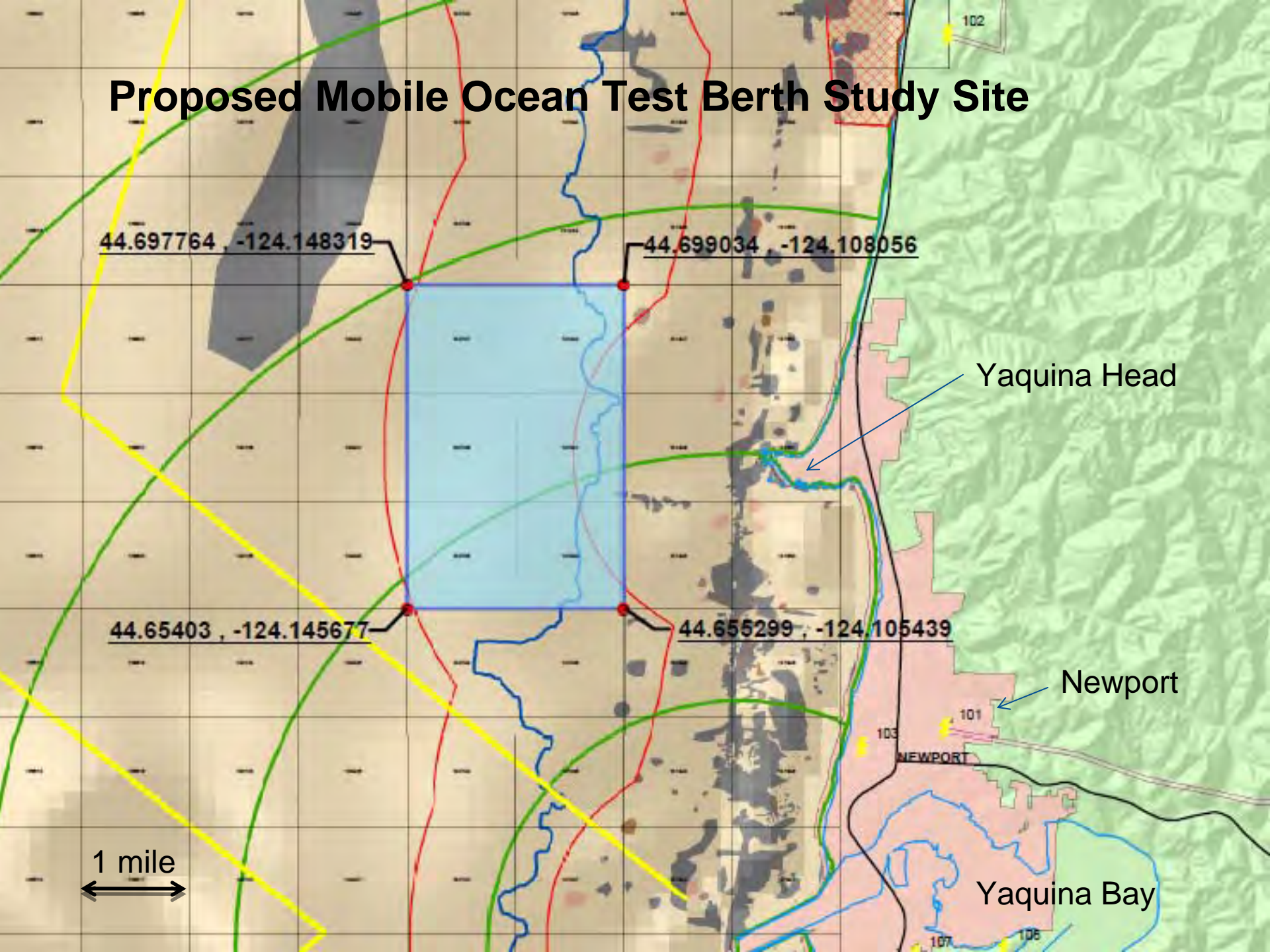
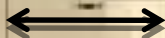
44.655299 , -124.105439

Yaquina Head

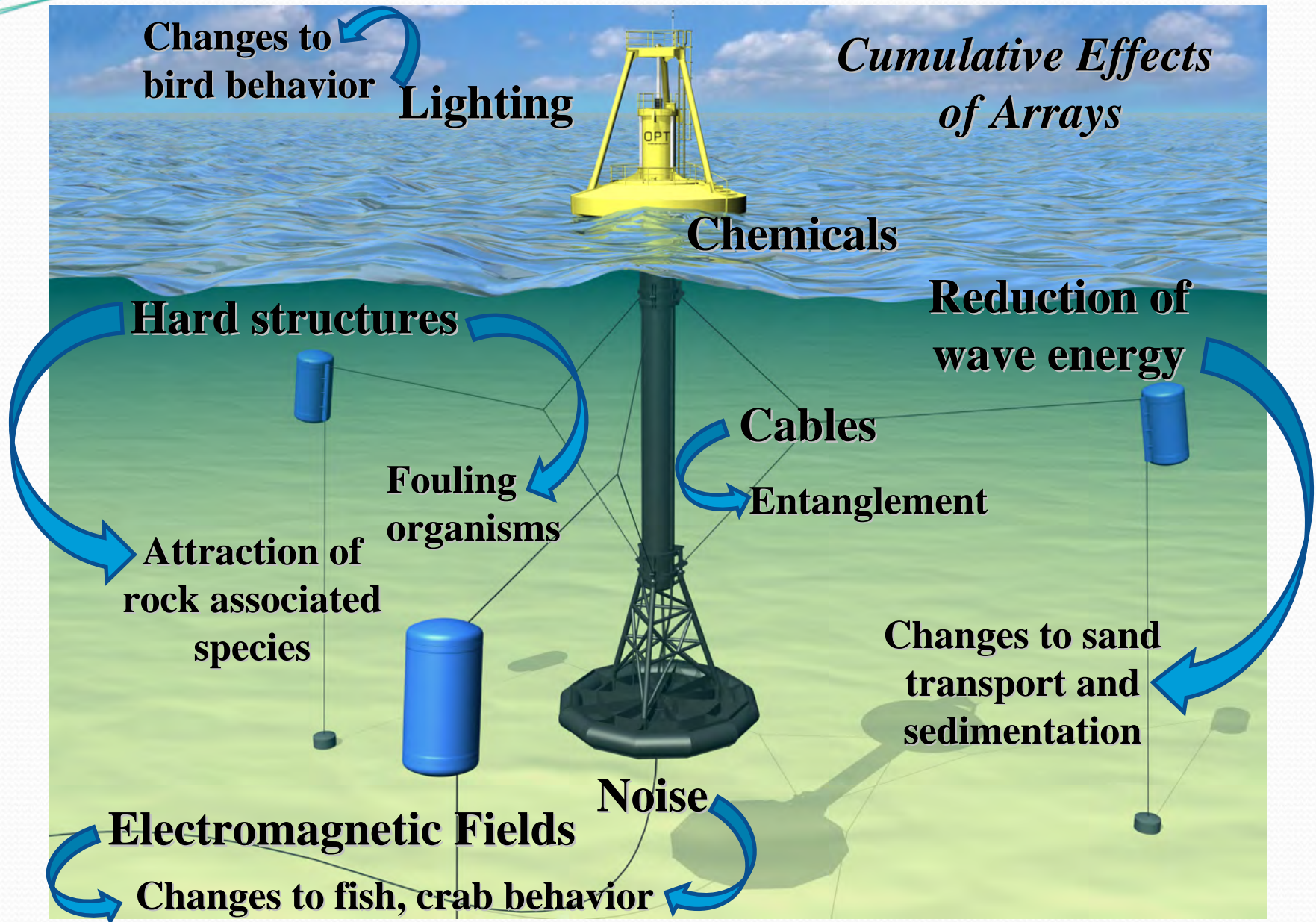
Newport

Yaquina Bay

1 mile



Potential Environmental Effects



Ecological Effects Workshop

Held at OSU's Hatfield Marine Science Center

Participants: 50 U.S. scientists (academic, agency, industry)

Agenda:

- Background presentations: technology, policy, environment, risk analysis
- Breakout groups focused on 'stressors' and 'receptors'

Ecological Effects of Wave Energy Development in the Pacific Northwest

A Scientific Workshop, October 11–12, 2007

George W. Boehlert, Gregory R. McMurray, and Cathryn E. Tortorici, editors



U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
NOAA Technical Memorandum NMFS-F/SPO-92

Available at:

<http://hdl.handle.net/1957/9426>

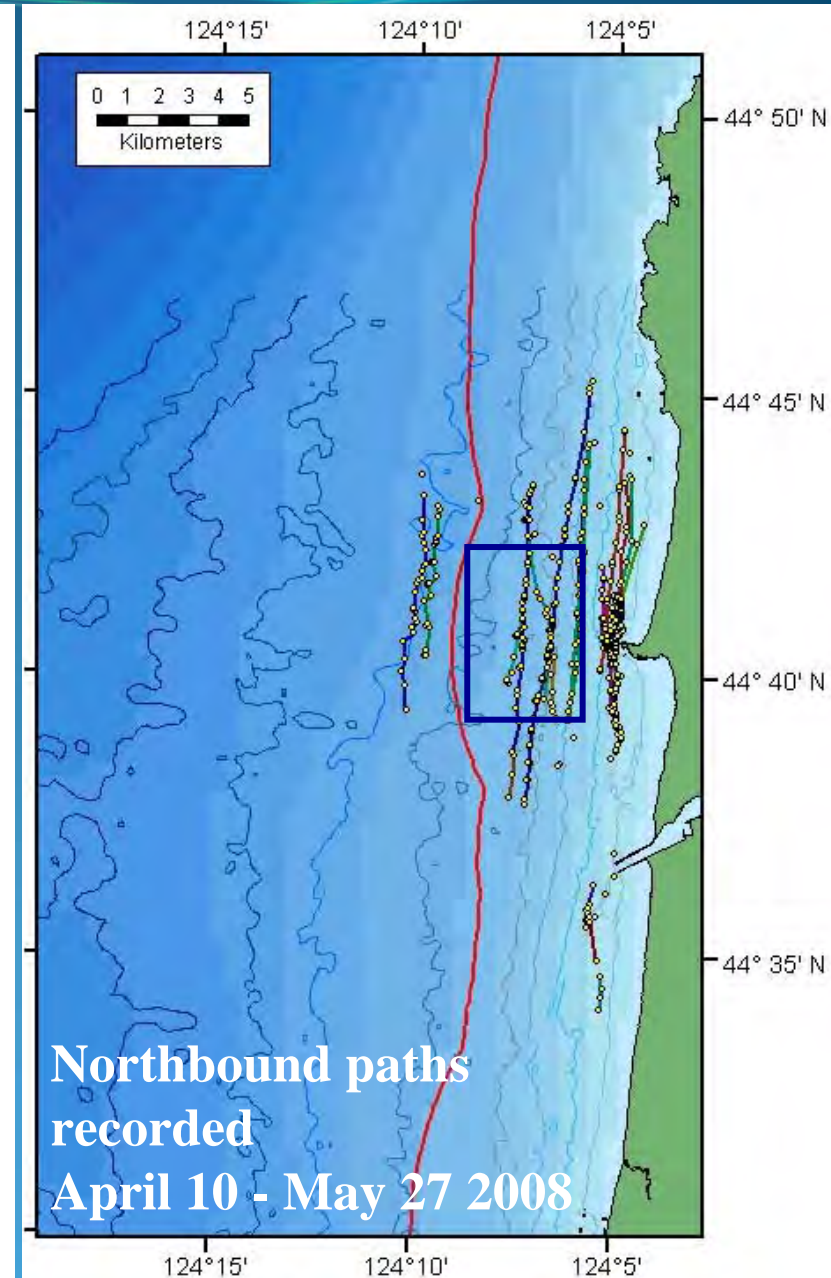
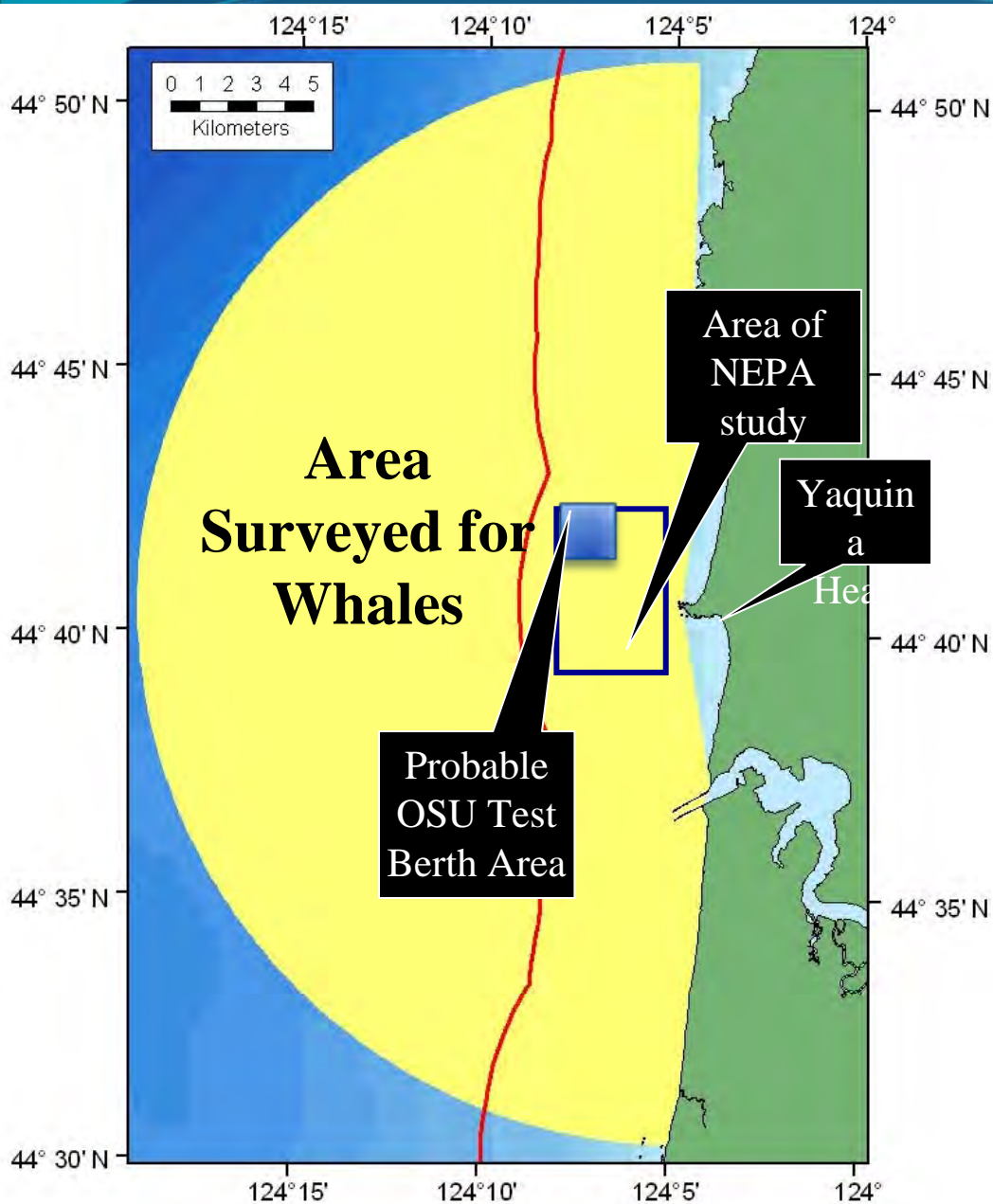


Significant NNMREC Progress

- Identification of area for first test berth deployment
- NEPA analysis of MOTB site
- Acoustic characterization
- Biofouling studies
- Sand transport modeling
- Current modeling
- Environmental characterization of test berth site
- Benthic habitat characterization of potential wave energy sites on the OCS in the Pacific Northwest (BOEM – MMS funding)
- Gray whale distribution studies
- Seabird distribution and ecology



Grey Whale Distributional Analysis – Test Berth Site (OSU-MMI)



Northwest National Marine Renewable Energy Center (NNMREC) - UW

UW-NNMREC
Tidal Energy

OSU-NNMREC
Wave Energy

Resource
and Site
Assessment

Device and
Array
Optimization

Testing
Facilities

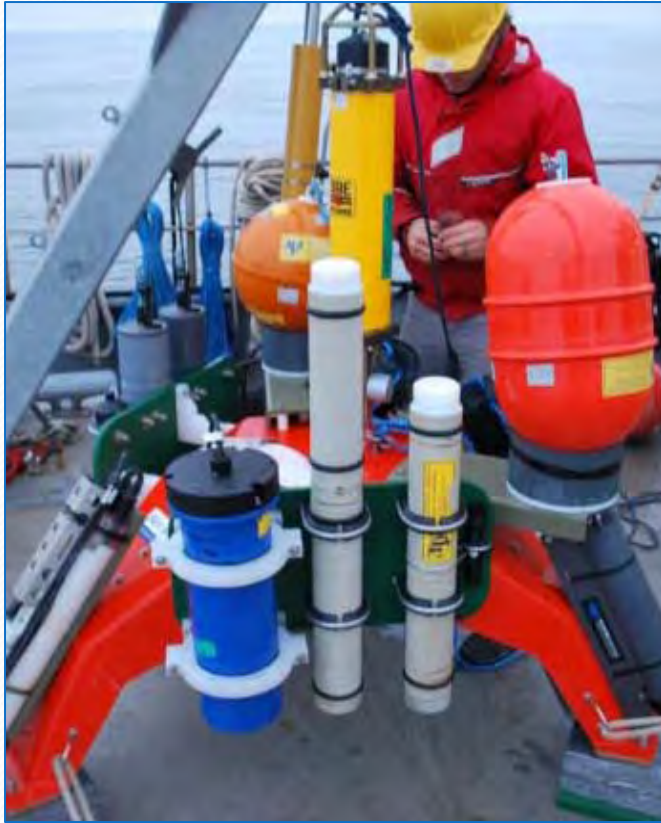
Environmental
Effects

Survivability
& Reliability

**NNMREC Partners with National Labs, Industry,
Universities, and Regional Organizations**



Area 1: Resource and Site Assessment



Seabed Instrumentation
Measurement Tripod



Shipboard Survey
R/V Jack Robertson

Land Observation

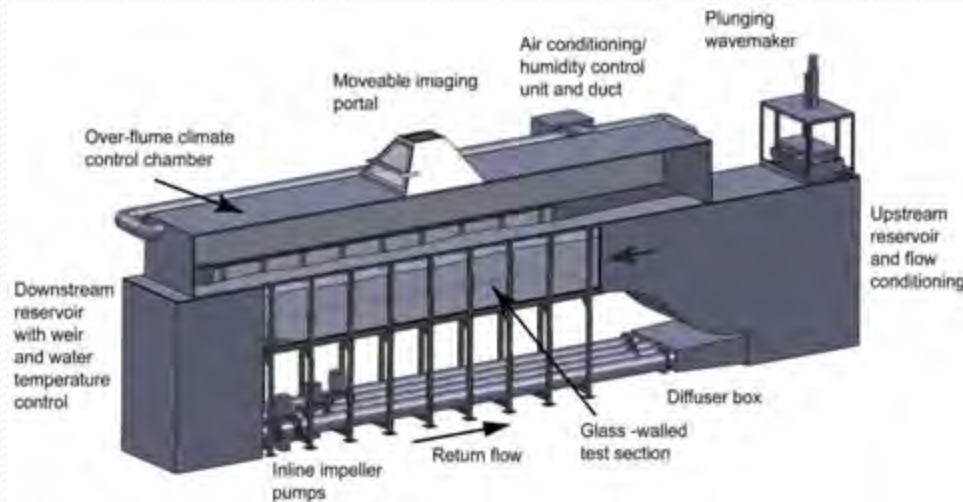
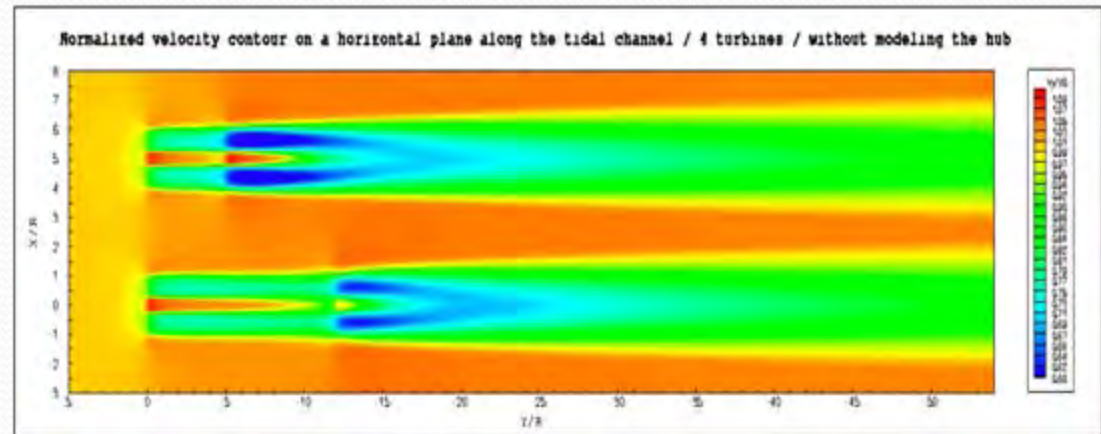
*AIS Ship Tracks
in northern
Admiralty Inlet*



Area 2: Device and Array Optimization

Numerical Simulations:

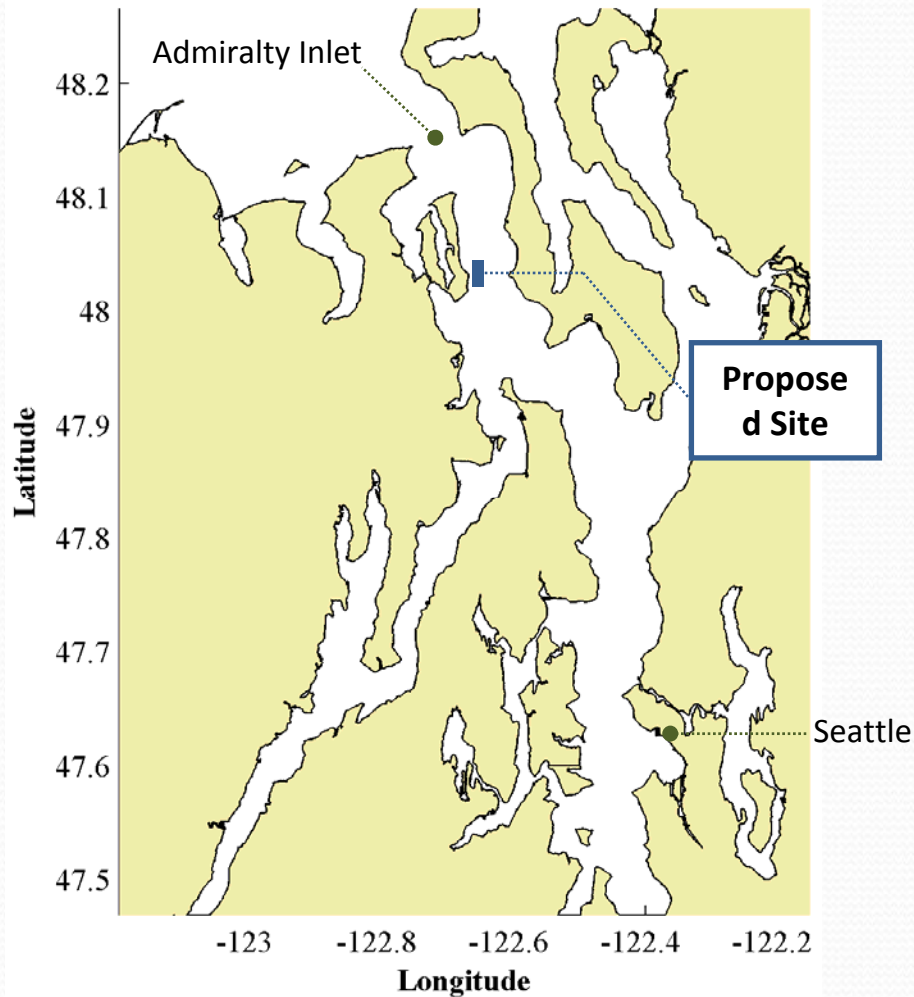
Simulations of device and array behavior and performance



Flume Measurements:

Experimental studies of device wakes

Area 3: Testing Facilities



Development

- Partnership with Sound and Sea Technology and Pacific Northwest National Laboratory
- Soliciting feedback on draft infrastructure and operations plan
- Device testing planned to begin in early

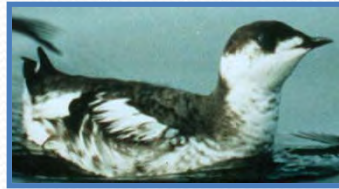
Test Berths (3)

- Cabled for power and performance data
- Permitted to operate under an adaptive management framework

Monitoring Nodes (10)

- Cabled for remote real-time observation
- Site-wide environmental monitoring
- Biological and physical effects

Area 4: Environmental Effects



- **Environmental effects workshop in March 2010**
- **Near-field Effects**
 - Models for pressure drop
 - Models for sediment transport
 - Experiments for turbine noise
- **Far-field Effects**
 - Models and scaling for changes to tidal regime

Area 5: Survivability and Reliability



Biofouling



Metal Corrosion



Composite Aging

Northwest National Marine Renewable Energy Center

Oregon State University
<http://nnmrec.oregonstate.edu/>

University of Washington
<http://depts.washington.edu/nnmrec>

