# Tidal Hydrokinetic Energy

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NNMREC

- **Tidal Energy**
- Northwest National Marine Renewable Energy Center
- Materials Suitability

# Tidal Energy

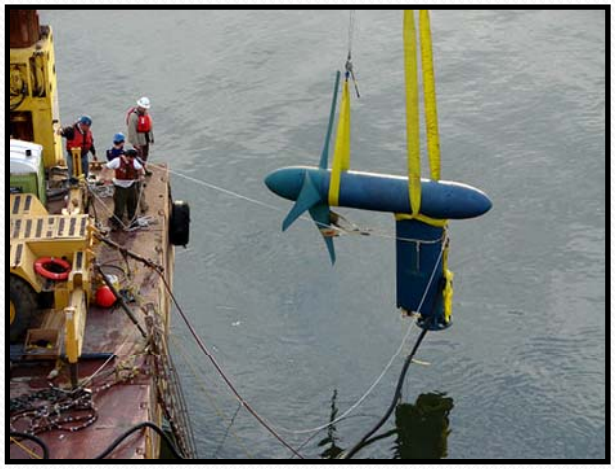
## Barrage

- Comparable to hydroelectric
- Very high cost and environmental footprint

## Hydrokinetic

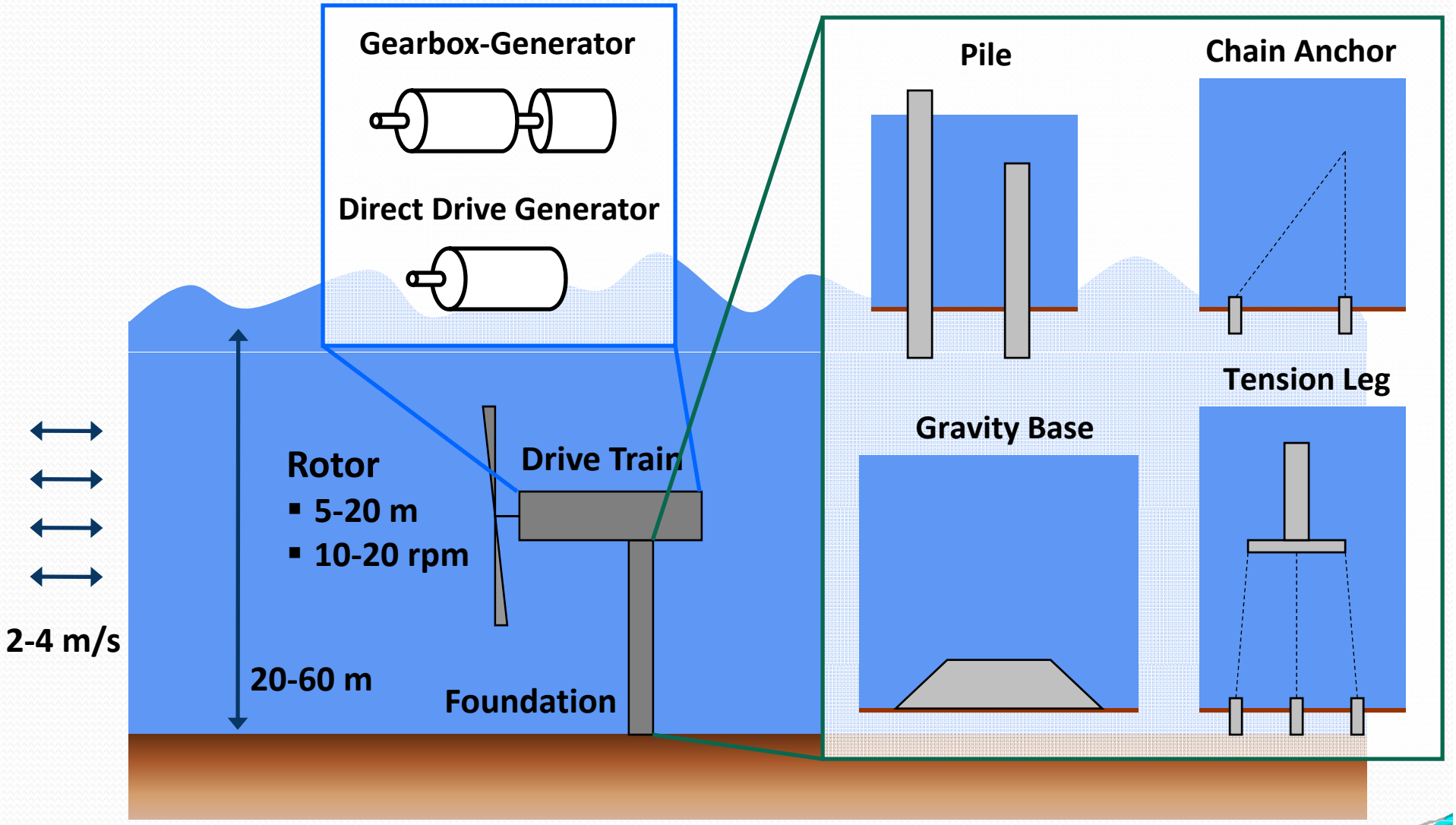
- Comparable to wind
- Potentially lower cost and environmental footprint

# Tidal Hydrokinetic Devices



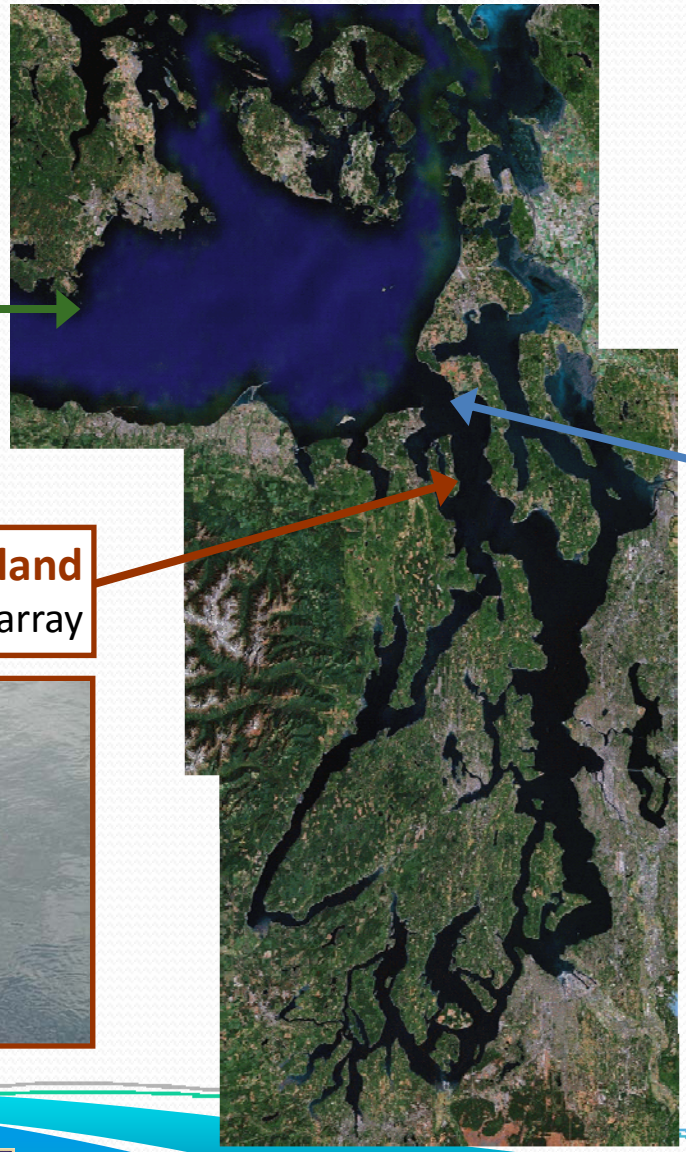


# "Typical" Sites and Devices



# Tidal Energy Projects in Puget Sound

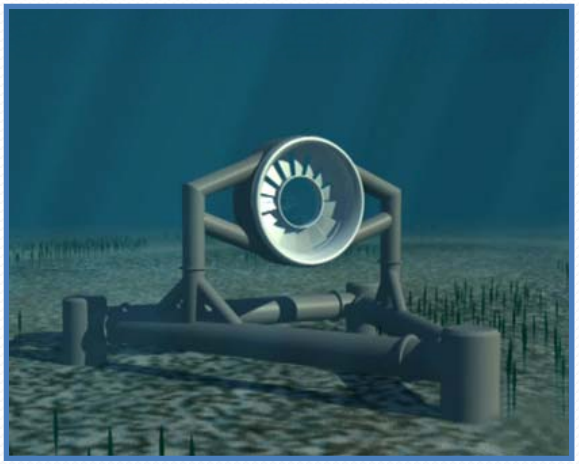
**Race Rocks**
Demonstration turbine



**100-200 avg. MW practically recoverable**

**Admiralty Inlet**
Pilot project

**Marrowstone Island**
Demonstration array



OSU UW

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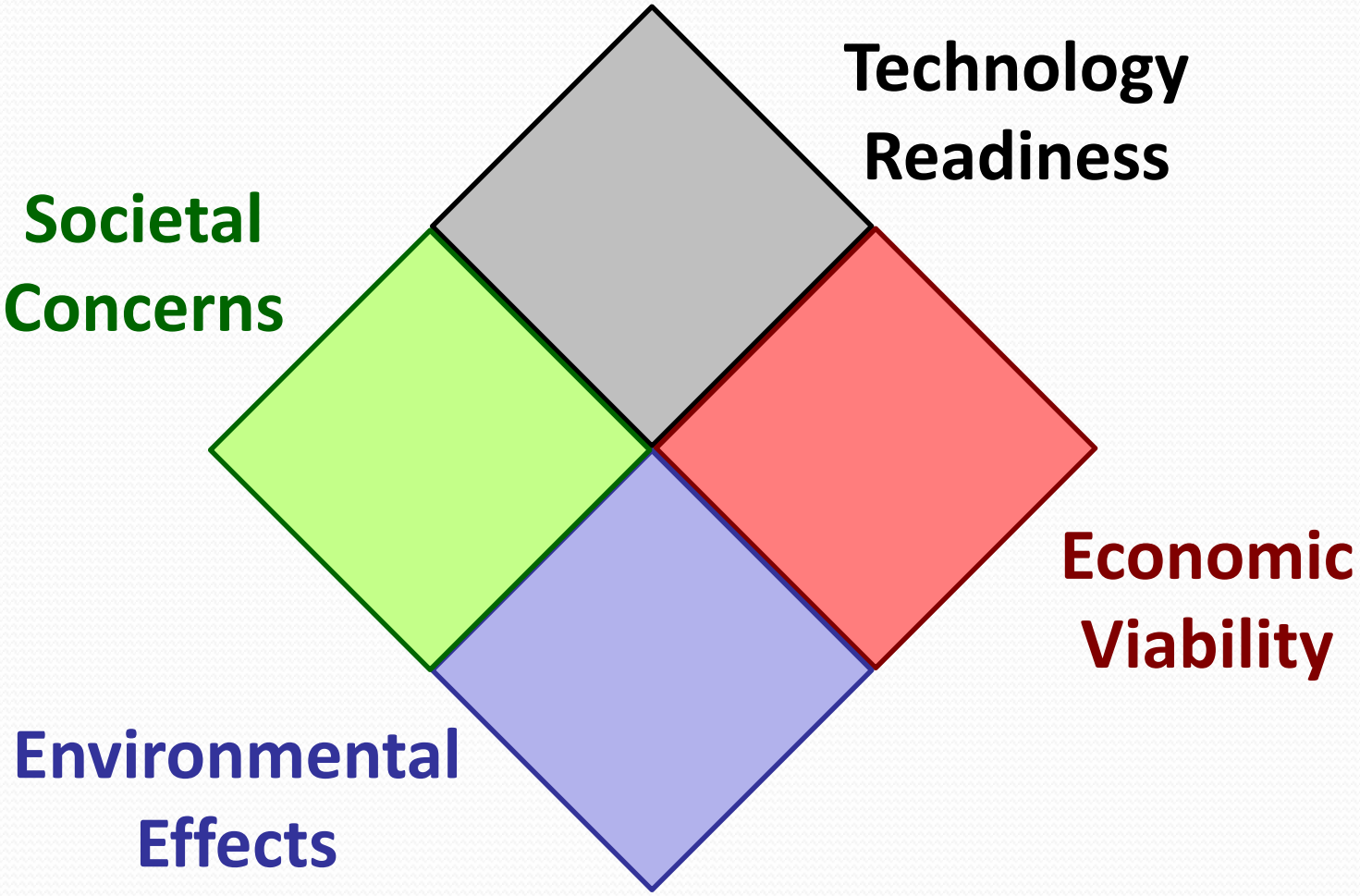
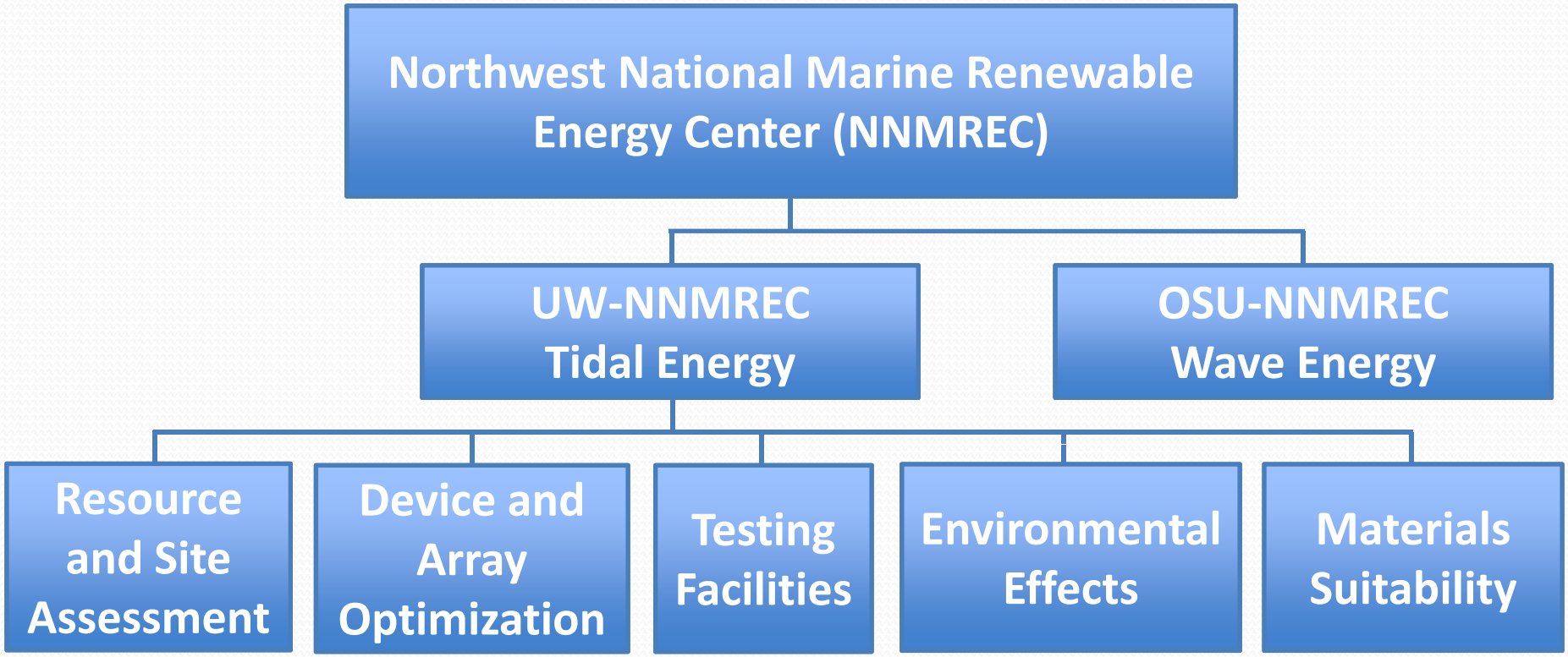
# Local Drivers

- **Initiative 937 obligations**
  - **15% renewable energy by 2020**
  - **Excludes conventional hydropower**
- **Limited transmission capacity for new wind energy**
- **Tidal energy advantages**
  - **Predictable resource**
  - **No $CO_2$ emissions**
  - **No visual impact**
  - **Close to load**

# Tidal Energy Challenges



- Tidal Energy
- **Northwest National Marine Renewable Energy Center**
- Materials Suitability




**8 Faculty members involved**

**6 Graduate student researchers supported**

# Resource and Site Assessment - Approach


**Seabed Instrumentation**

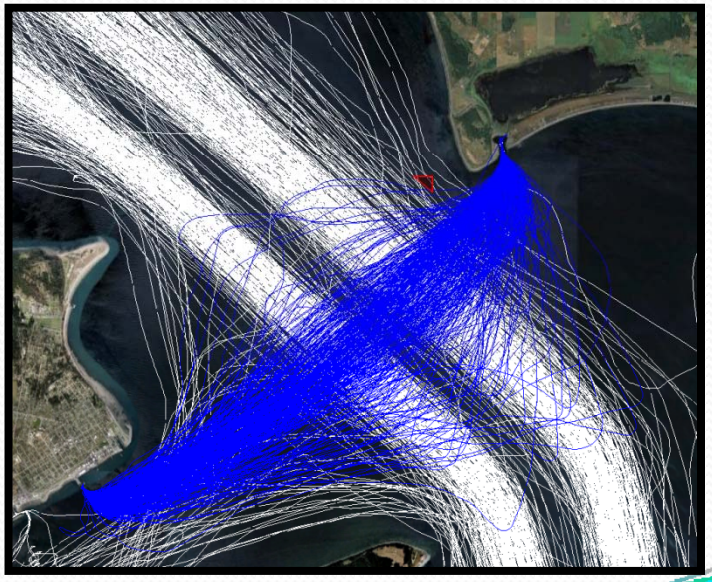
*Measurement Tripod*

**Shipboard Survey**

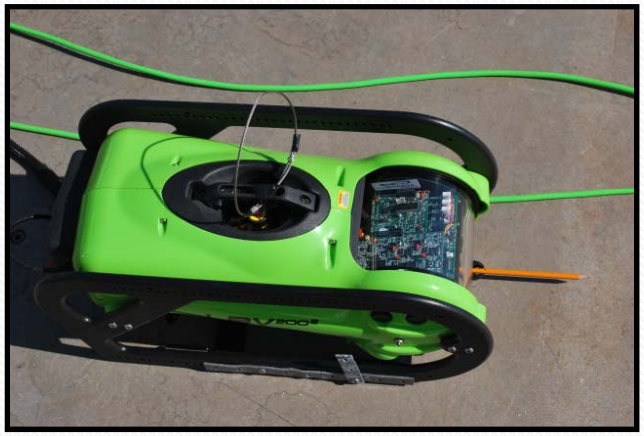
*R/V Jack Robertson*

**Land Observation**

*AIS Ship Tracks*



# ROV Surveys



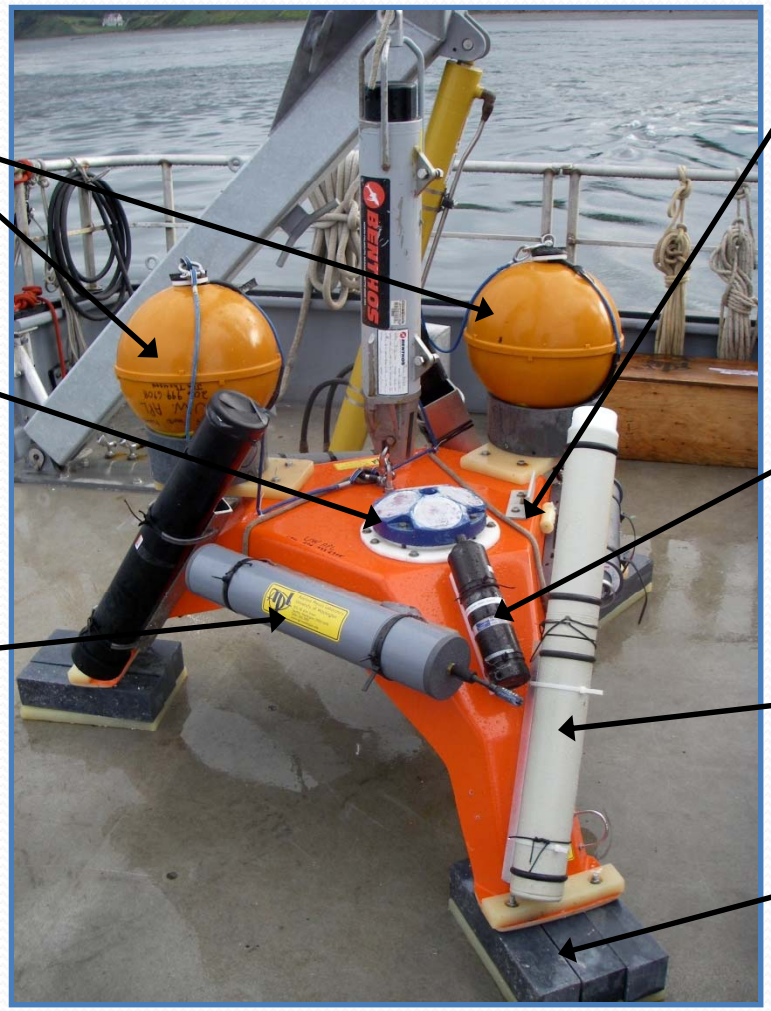
- **Seabed**
  - Cobbles (10-20cm)
  - Shell fragments
  - Sponges
  - Small slope
- **Less than 4m visibility (with lighting)**

# Sea Spider Instrumentation Tripod

**Acoustic release**
(redundant recovery)

**ADCP**
(Acoustic Doppler Current Profiler)

**Hydrophone**
(background noise)



**CTDO** (conductivity, temperature, depth, dissolved oxygen – partnership with WA Dept of Ecology)

**Fish Tag Recorder**
(partnership with NMFS)

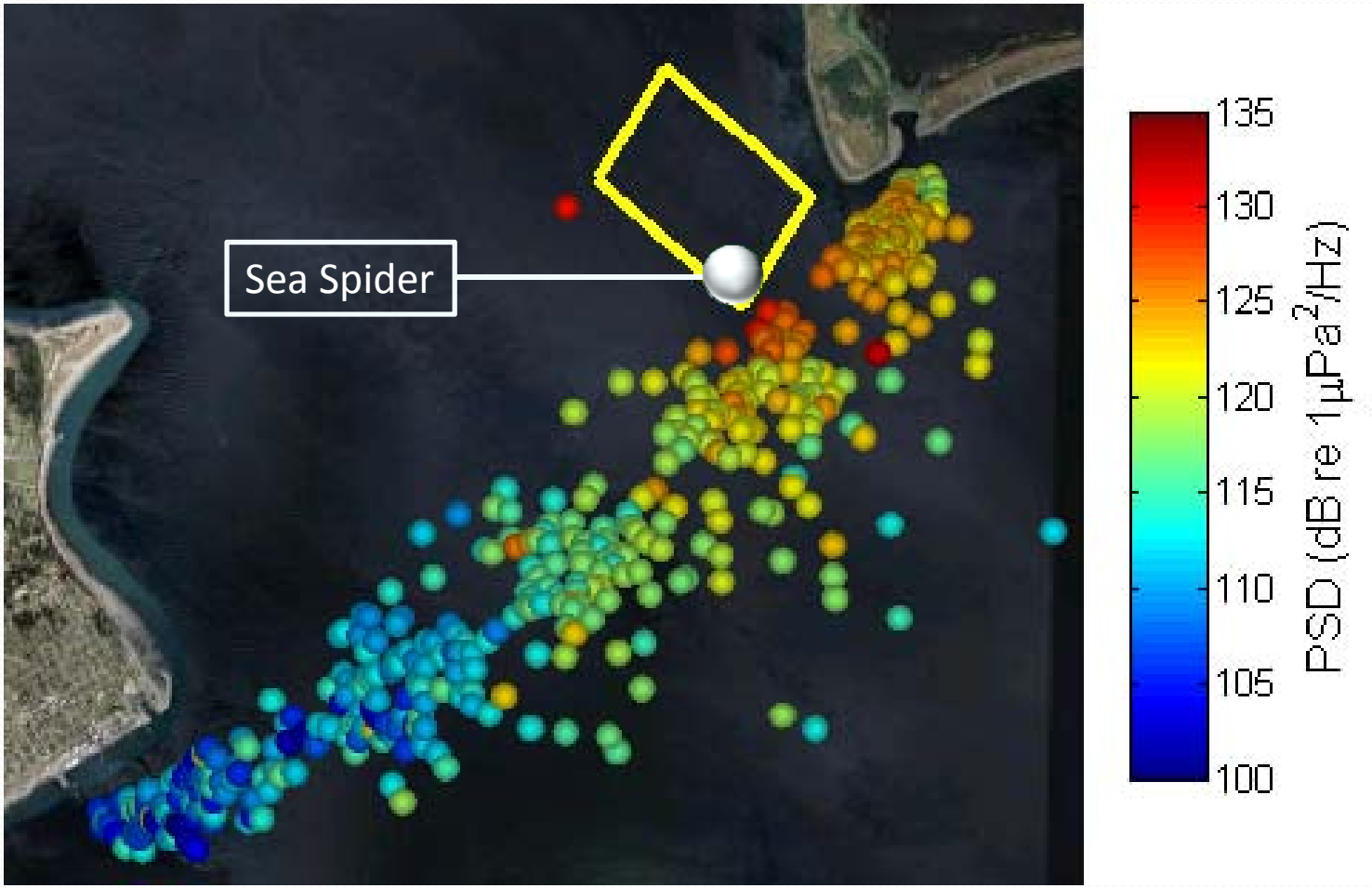
**T-Pod/C-Pod**
(porpoise clicks)

**Lead Weight**
(650 lbs)

**Programmed for 3 month deployments**

# Challenging Research Environment

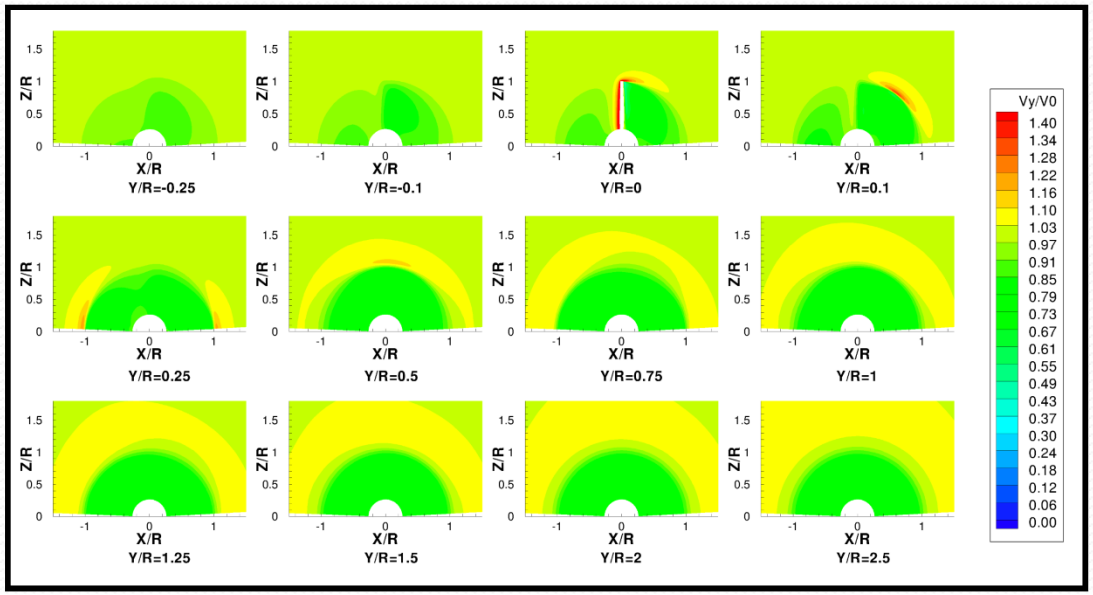
# Ferry Noise Study



# Device and Array Optimization

**Numerical Simulations:**

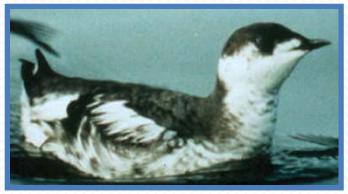
Parallel simulations of device and array performance




**Wave-Current Flume:**

Experimental studies of device wakes

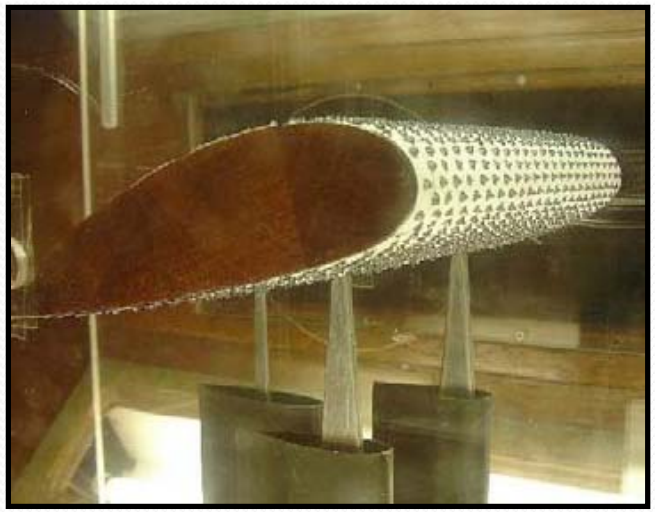
# Understanding Environmental Effects



- **Near-field Effects**
  - **Pressure drop (model)**
  - **Sediment transport (model)**
  - **Noise (experiment)**
- **Far-field Effects**
  - **Tidal regime (model)**

- Tidal Energy
- Northwest National Marine Renewable Energy Center
- **Materials Suitability**

# Materials Suitability



Orme, Masters, Griffiths (2001)

316 Stainless – 3 months immersion

- **Hydrodynamic performance**
- **Structural performance**
  - **Metal corrosion**
  - **Composite aging**
- **Long maintenance intervals**
  - **2-4 years for power train**
  - **20+ years for foundation**

# Approaches to Minimize Biofouling

- Biocides: “Anti-fouling”
  - Effective
  - Toxic
- Low friction: “Foul-release”
  - Cost
  - Long-term effectiveness

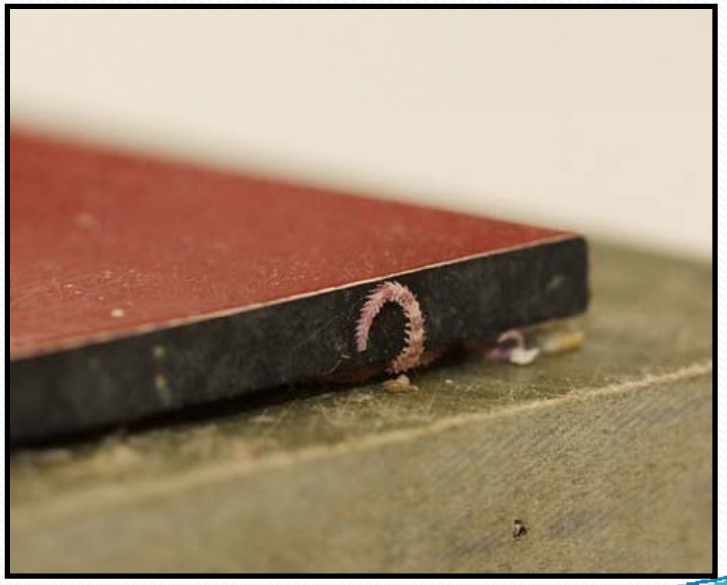
# Shallow Water Biofouling

## Clean Current turbine: 6 *months* deployment

**Before**


**After**

# Deep Water Biofouling



# Damage: Composite Aging

- **Water absorption, leading to loss of strength**
- ***In-situ* screening tests**
  - **9 – 18 months exposure**
  - **Four composite material systems**

# Thank You!

More about Tidal Energy:
http://depts.washington.edu/nnmrec

More about Wave Energy:
http://nnmrec.oregonstate.edu/