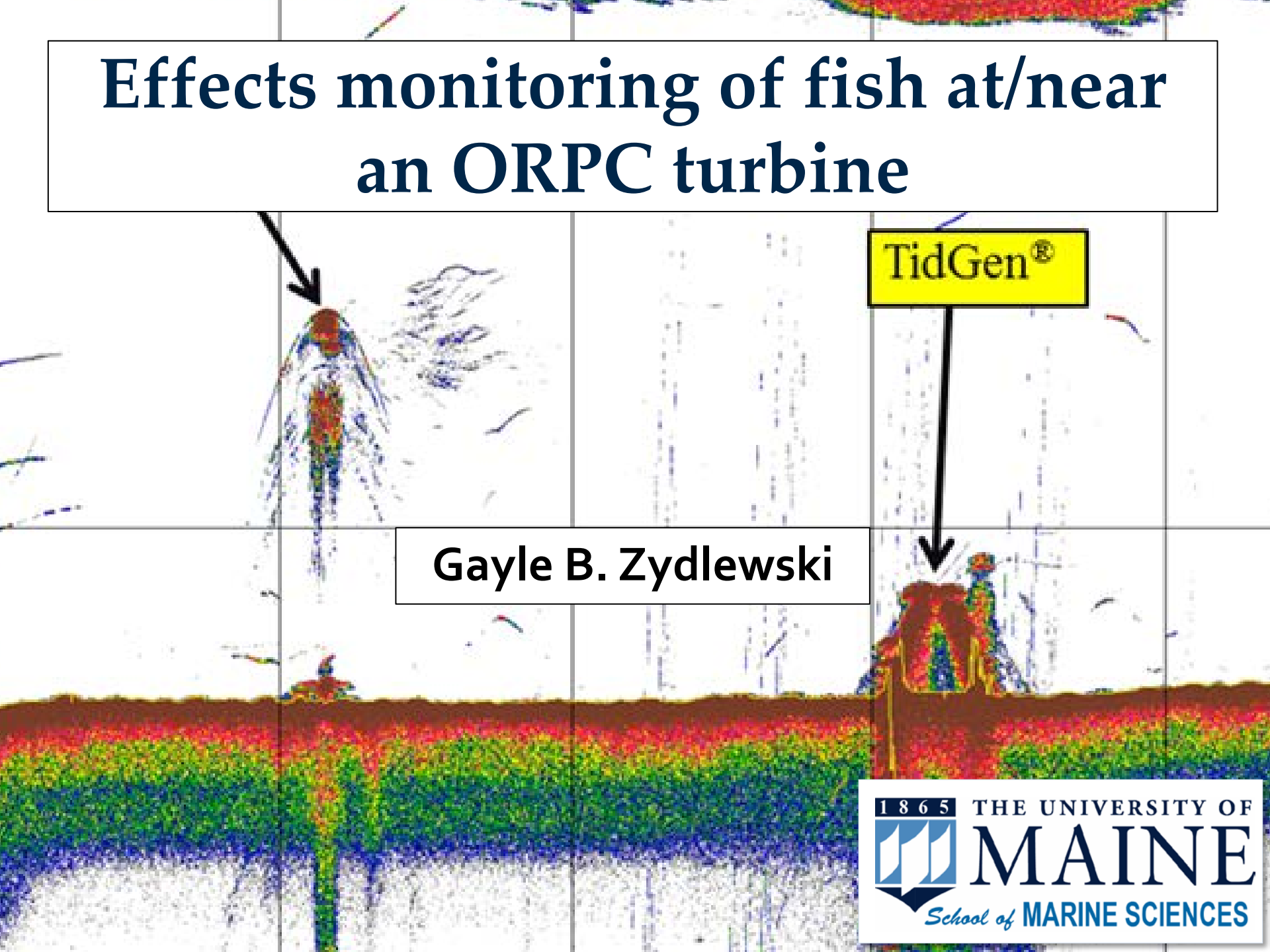
Effects monitoring of fish at/near an ORPC turbine



Gayle B. Zydlewski

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Perspective

- What information do **regulators** *need* to make decisions on permitting wave and tidal devices?
- What information do **developers** *want to supply* for permitting of wave and tidal devices?
- What information *can* **scientists** supply to assist with permitting of wave and tidal devices?

…relationship building

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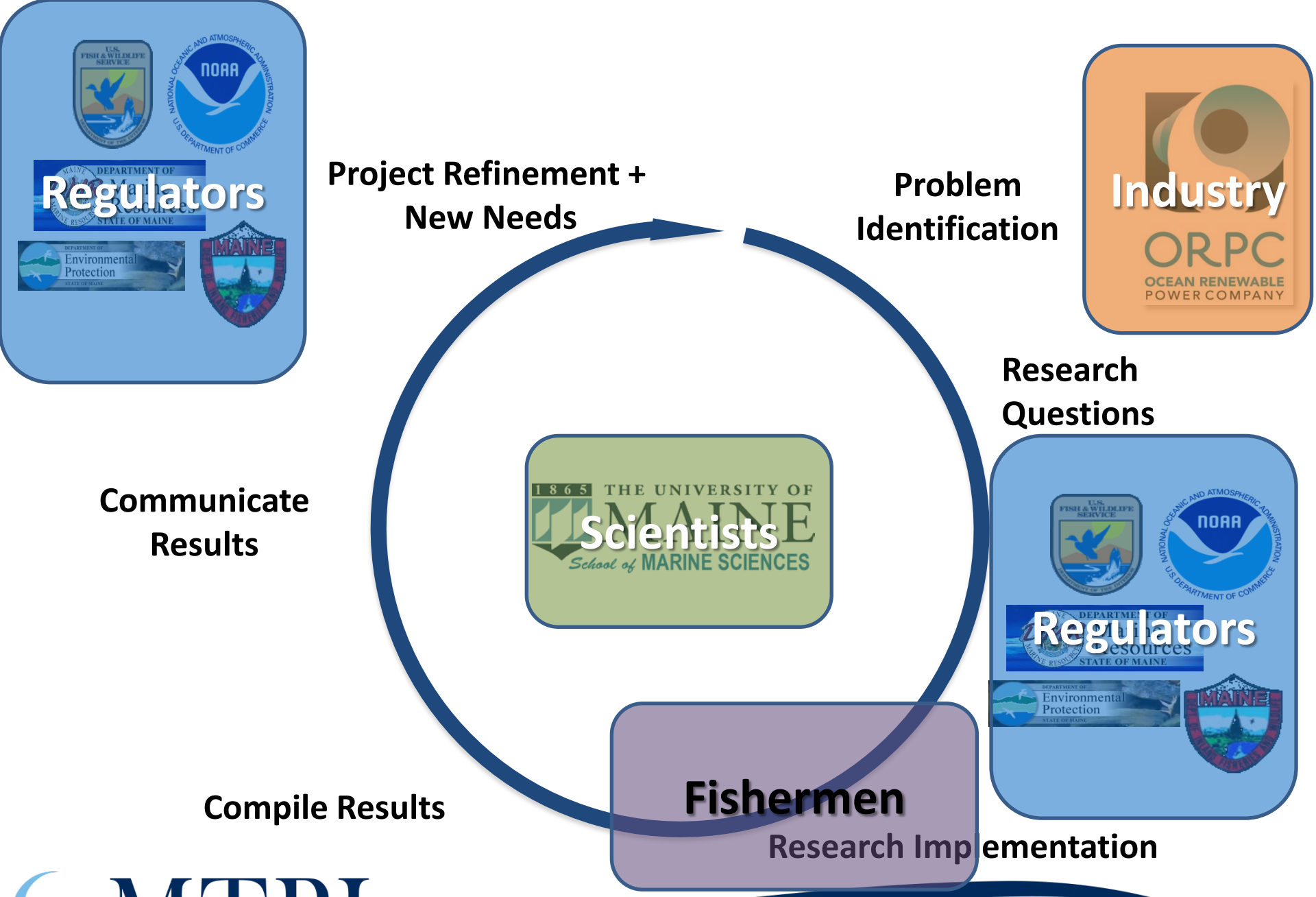
Defining the question

- **Areas of Special Concern <u>for Regulators</u>:**
  - Collision and ***evasion*** of marine animals with devices, particularly marine mammals and fish.
  - Effects of underwater sound from devices on marine animals, particularly marine mammals and fish.
  - Effects of electromagnetic fields (EMF) from power cables on marine animals, particularly fish and invertebrates (e.g. lobster).


Regulators
Project Refinement + New Needs
Problem Identification
Industry
ORPC
OCEAN RENEWABLE POWER COMPANY
Research Questions
Communicate Results
Scientists
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Regulators
Compile Results
Fishermen
Research Implementation

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Warning: the questions change
& depend on the law under consideration

Flexibility and communication are key

In our case:

1. At first
   - Industry: *What will happen to marine life?*
   - Regulators: *How will "essential fish habitat" be affected? What endangered species are there? What if they come in contact with the device?*
   - Scientists: *What can we assess?*
2. Then
   - Are we asking the right question?

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Potential effects are wide-ranging in scale and duration.

Effects depend on turbine design, may be positive or negative, and may differ for single turbines and arrays.

Combined effects may become impacts on the local ecosystem or fish populations.

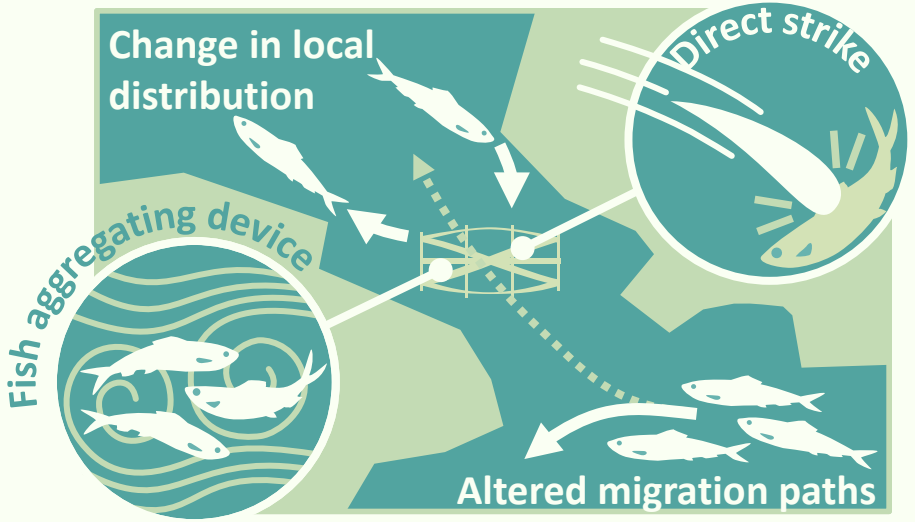

Image designed and produced by Haley Viehman

- How do you assess animal-device encounter?
- At what scale can we detect collision/evasion/attraction?

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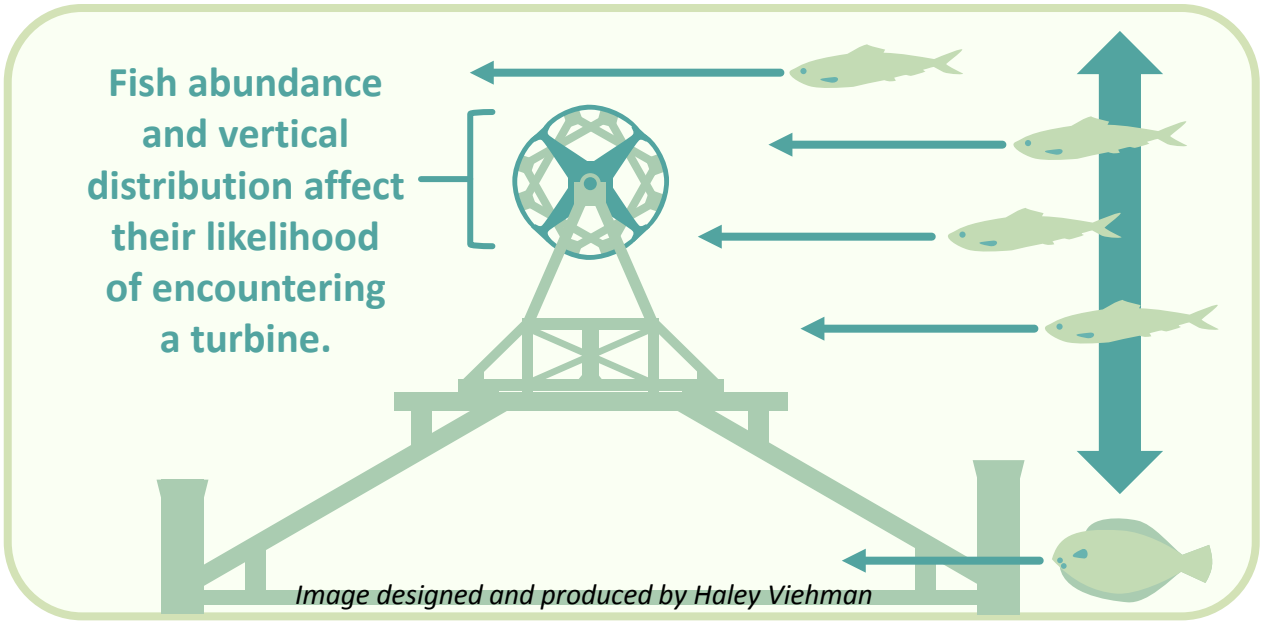
Fish abundance and vertical distribution affect their likelihood of encountering a turbine.
Image designed and produced by Haley Viehman

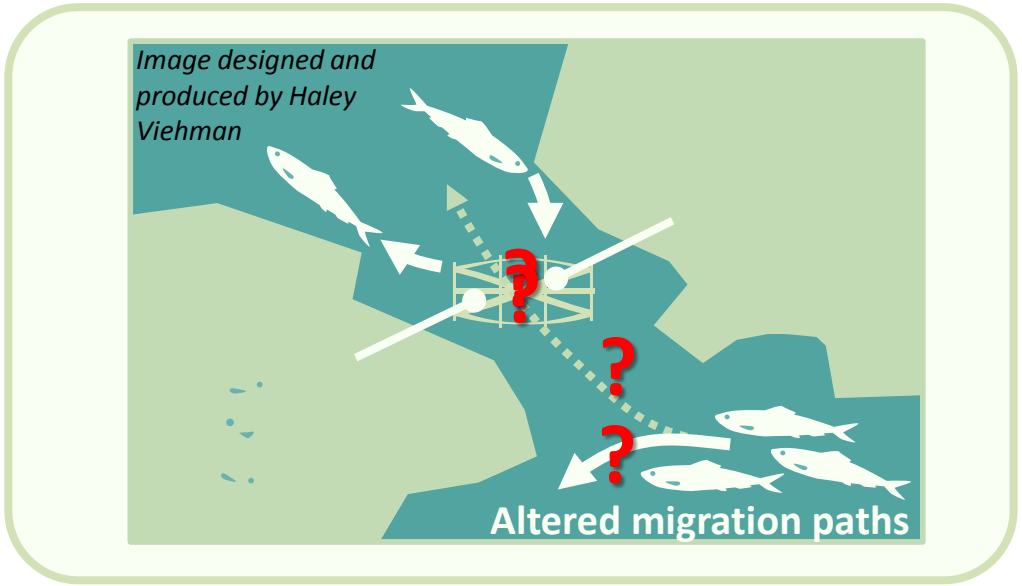
Image designed and produced by Haley Viehman
Altered migration paths

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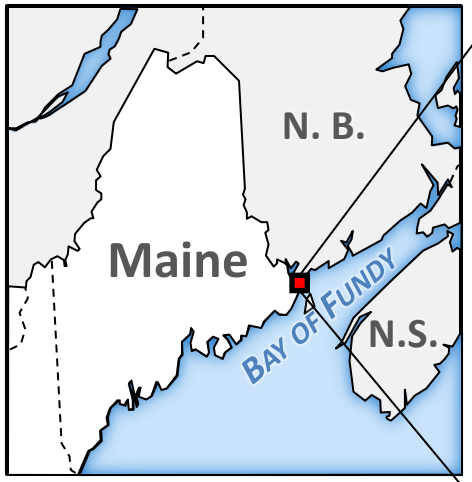

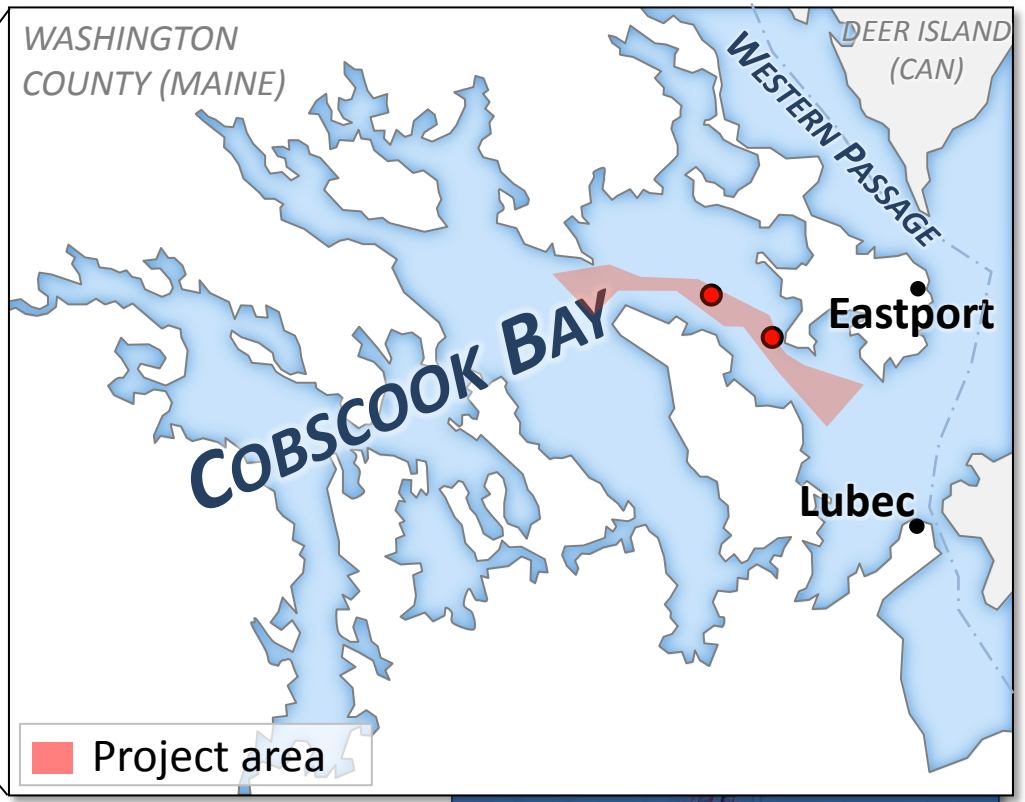

Ocean Renewable Power Company's research platform, turbine raised.

Photo: J. McLeave

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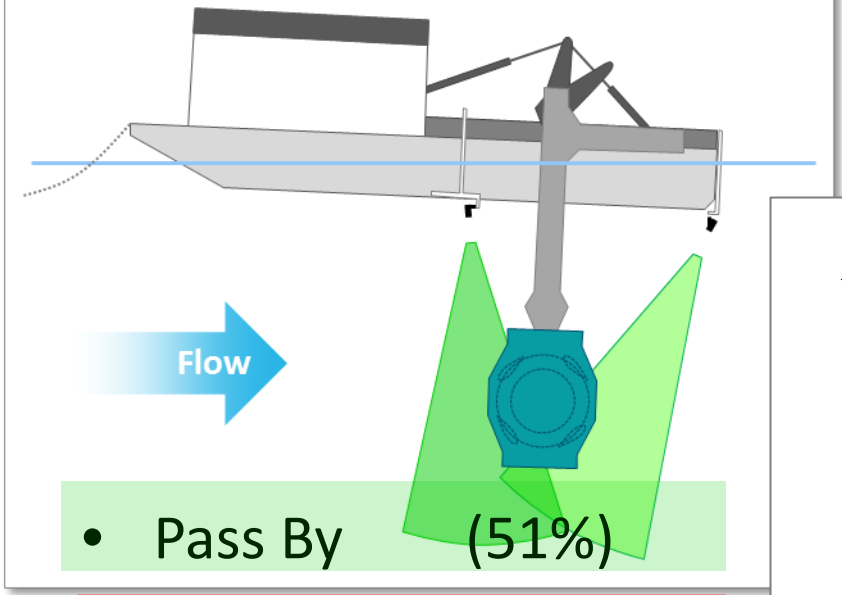
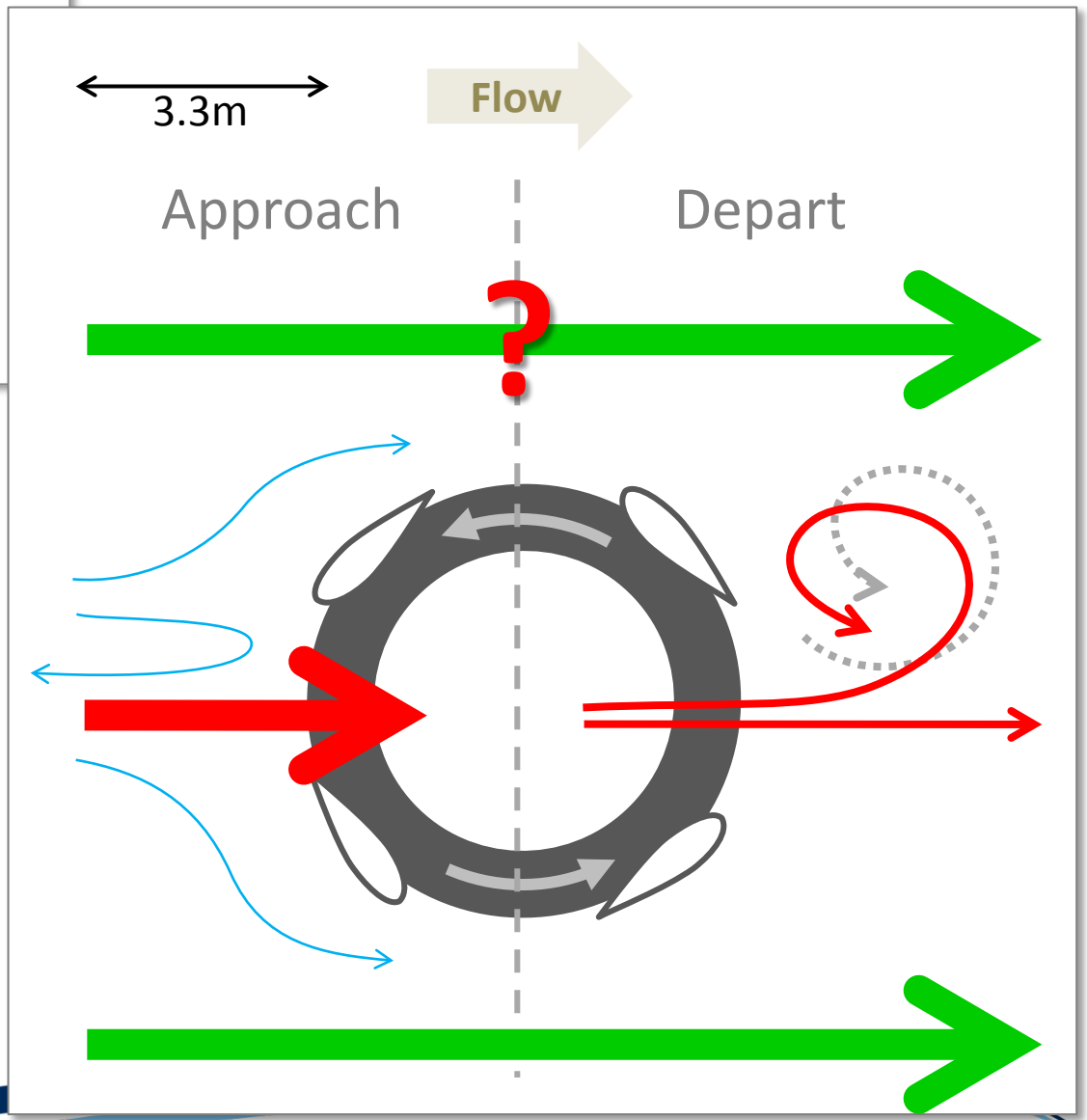
Within 5 m



- Pass By (51%)

- Through Turbine (48%):
  - Into Turbine
  - Out of turbine
- Active Avoidance (1%):
  - Above
  - Reverse
  - Below



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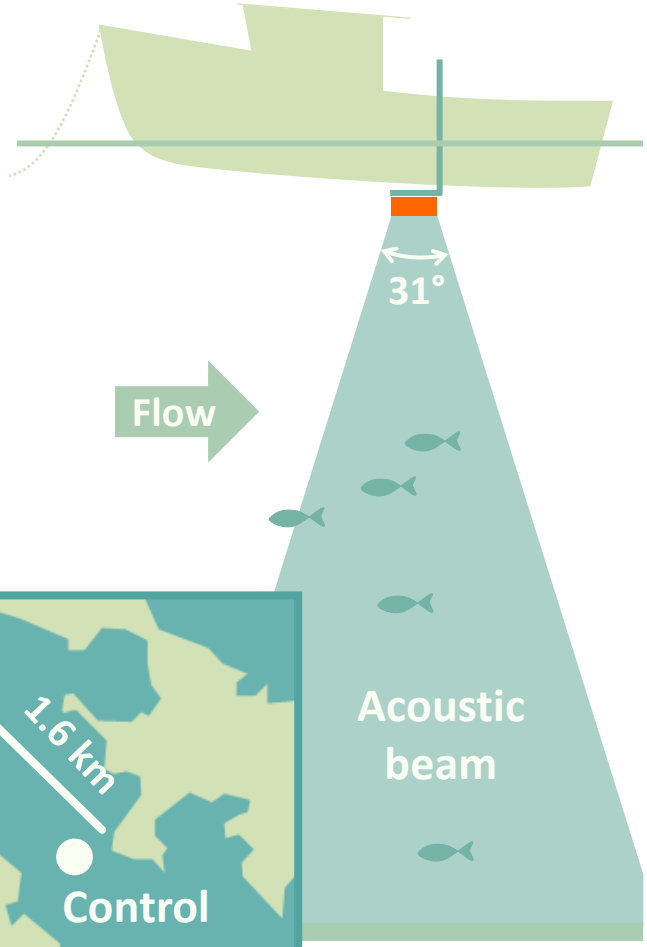
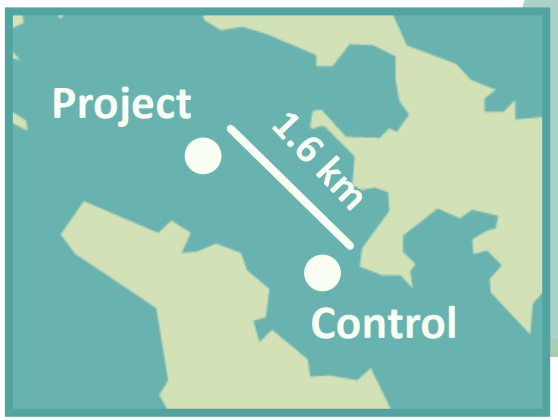
Viehman and Zydlewski. 2014. *Estuaries and Coasts*.

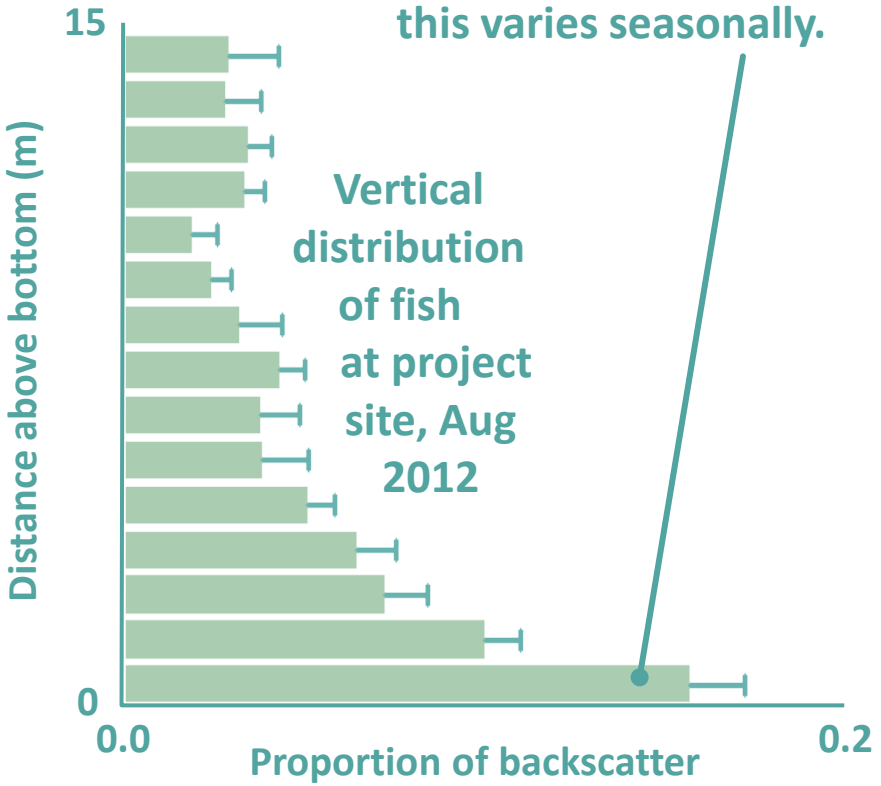
Further-field, longer term

2010-2013





Fish density usually highest near the sea floor (below the depth of the turbine), though this varies seasonally.



Images designed and produced by Haley Viehman

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Probability of encounter

1. **Near-field** - DIDSON (Viehman and Zydlewski 2014) – **p1**

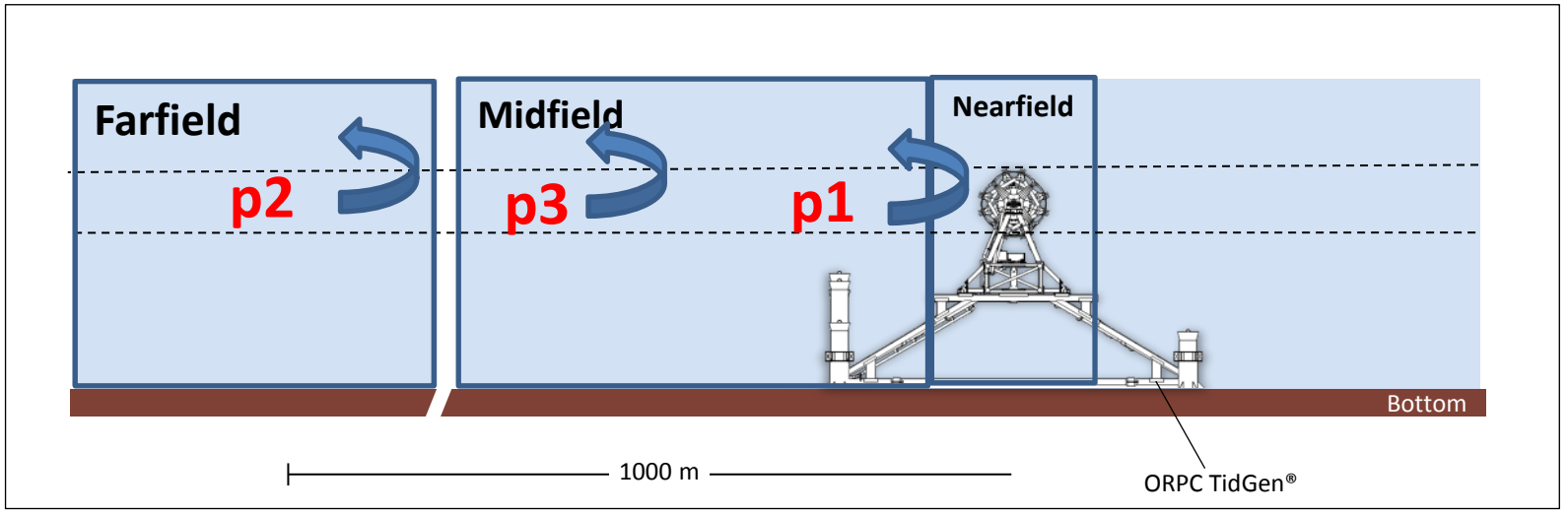
   Within 3.3m, only 1% of fish at turbine level avoided

2. **Far-field** - Abundance & distribution (Viehman et al. 2014) – **p2**

   Proportion of fish at turbine depth, with and without the turbine

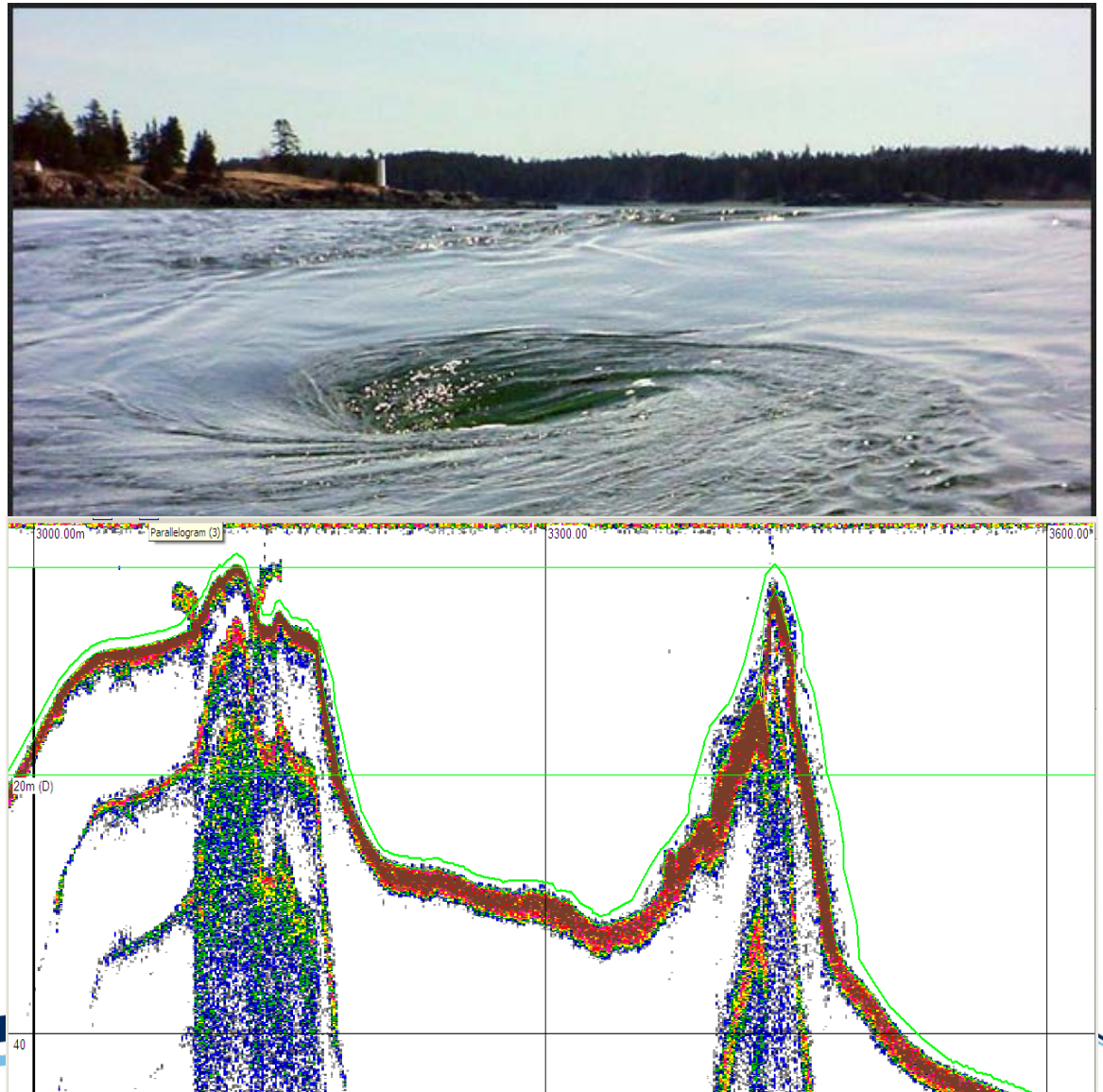
3. **Mid-field** - Mobile transects – **p3**

   Proportion of fish at turbine depth, with turbine



p_x = f(time of day, tide, month, year)

Difficult environments…



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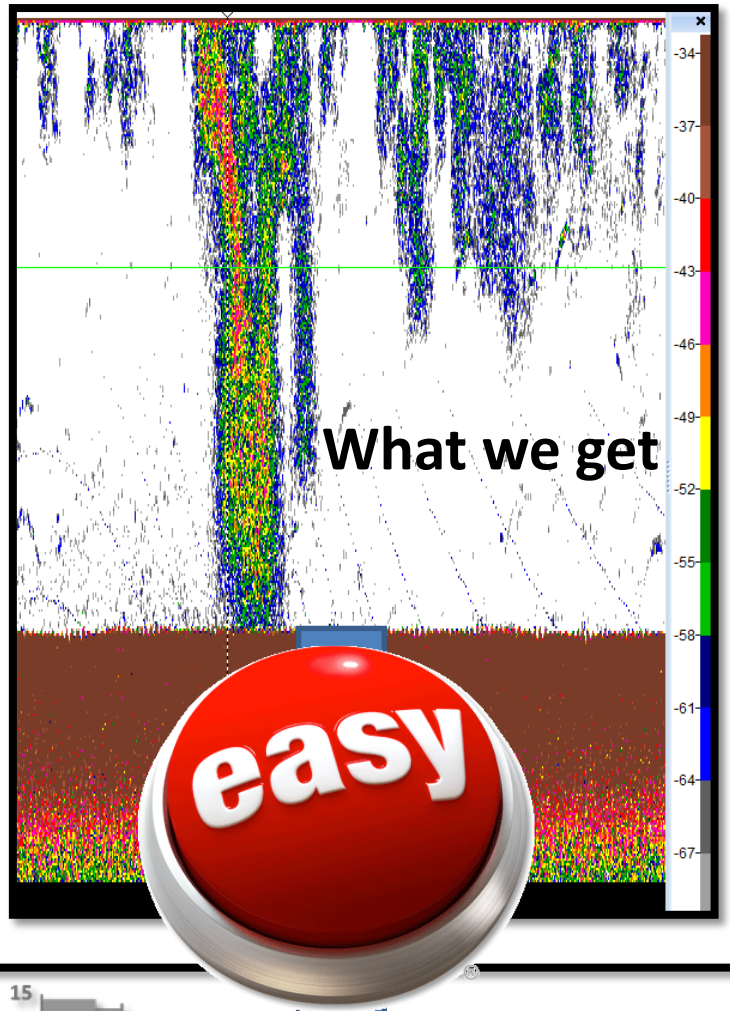
Translation…



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    - W
    - Pr
  - Indu questions?

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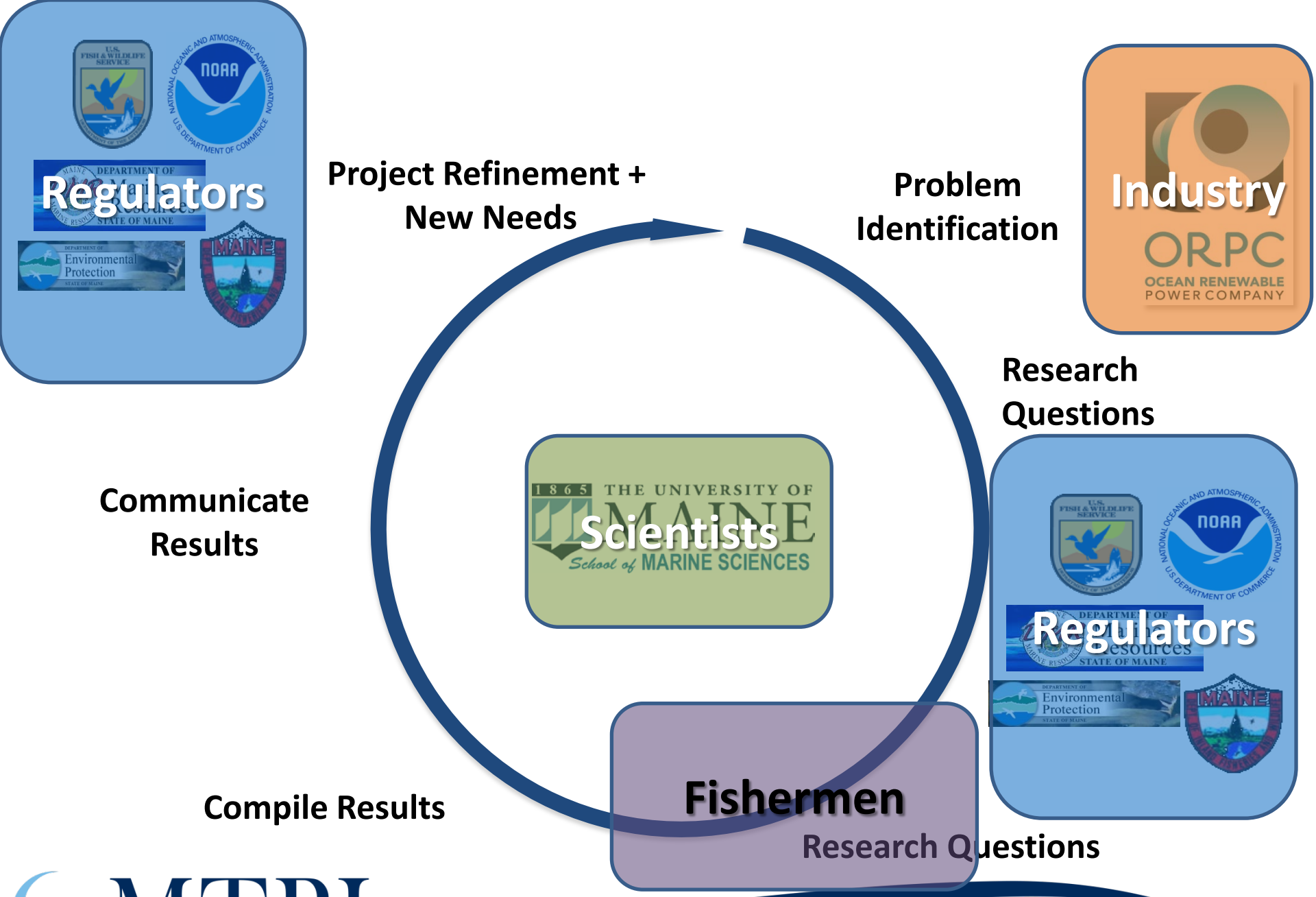
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Final Considerations: *flexibility & communication*

- Scientists
  - Maintain some consistency & *flexibility*
    - What we did: Long-term design *ADD new options*
- Regulators - What is enough monitoring?
  - Cobscook Bay
    - Broad scale questions were scaled back
- Industry - What is enough monitoring?
  - Location, location, location…
    - If you know the system/variability BEFORE deployment, then monitoring can be designed based on that
    - If not, start examining multiple scales and refine

Thank you…

Maine Tidal Power Initiative

Fish Assessment Study Team

- Dr. James D. McCleave
- Garrett Staines
- Jeffrey Vieser
- Dr. Haixue Shen
- Megan Altenritter
- Brittney Fleenor
- Alex Jensen

Captain Butch Harris and crew

Echoview support team

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Sea Grant Maine

NSF

MAINE EPSCoR

Award EPS-0904155