Fish interactions with marine renewable devices: lessons learned, from ecological design to improving cost-effectiveness

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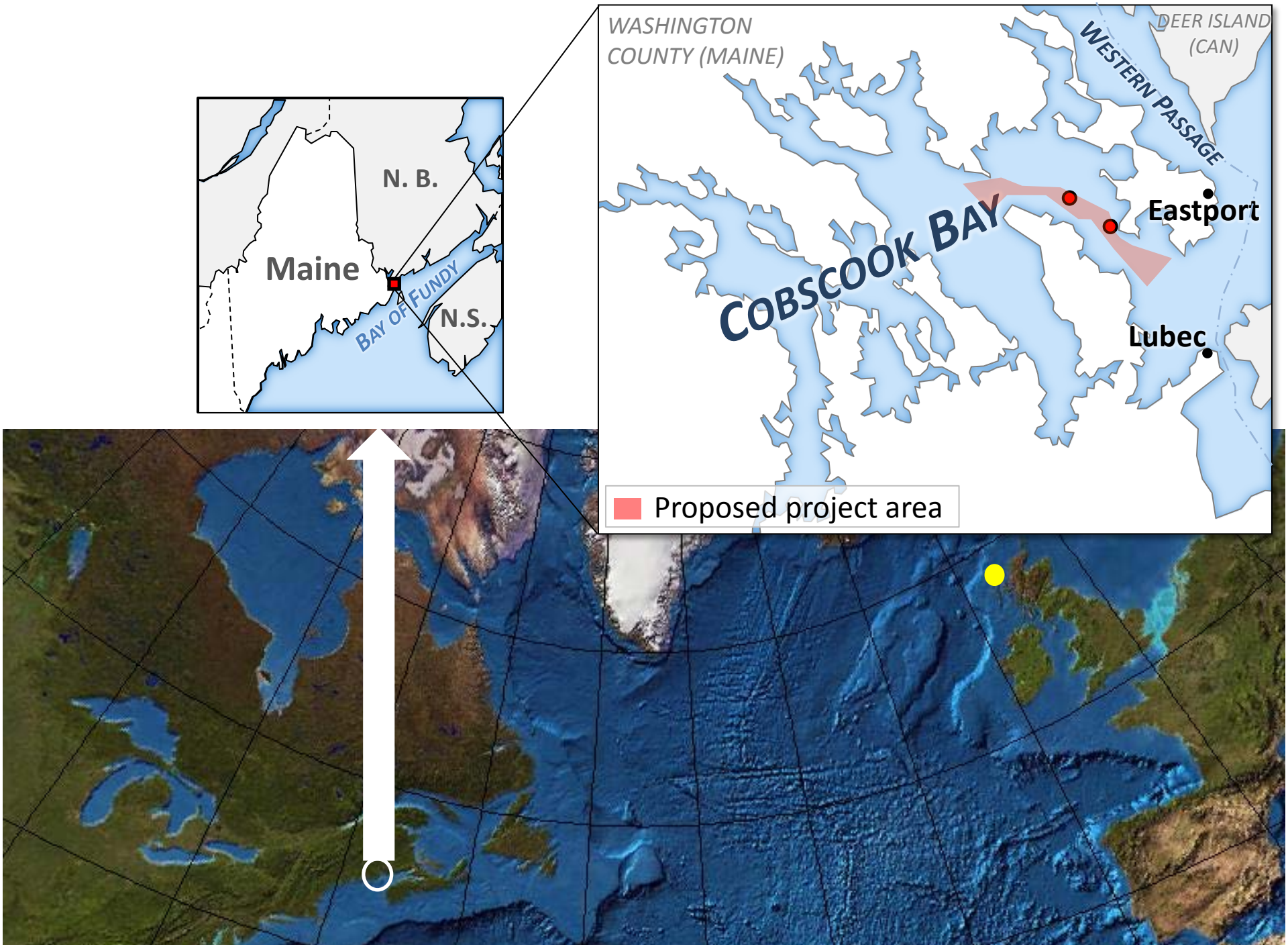
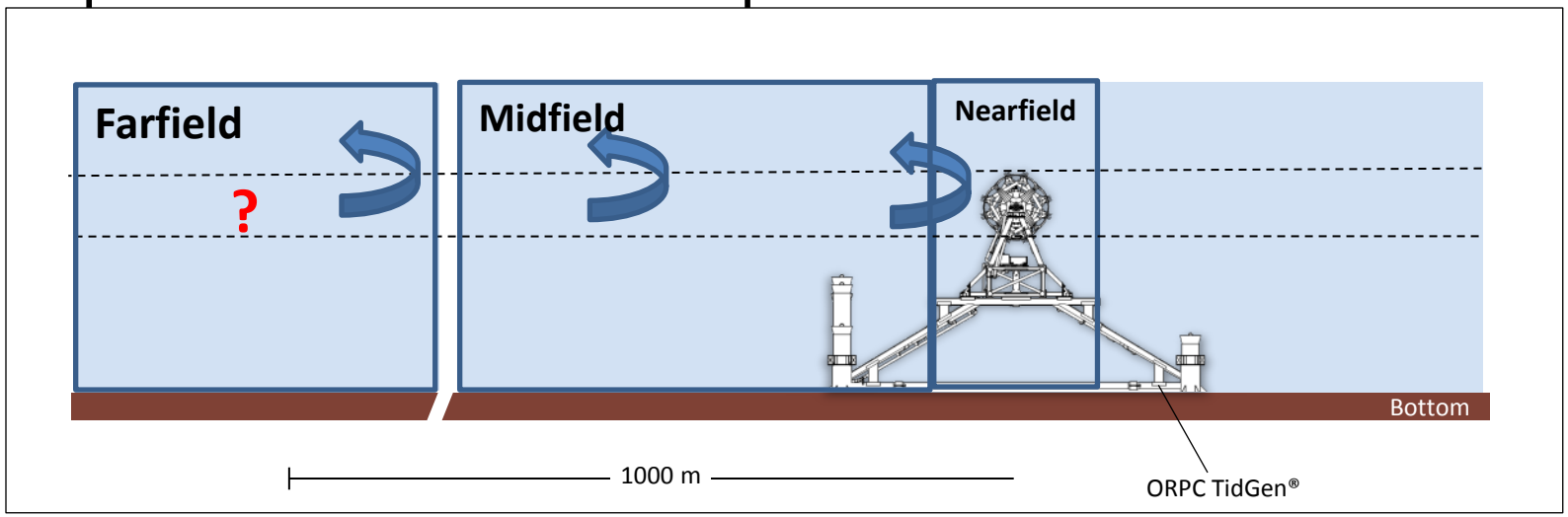
School of MARINE SCIENCES

MTPI
Maine Tidal Power Initiative
environment · resource · community · engineering

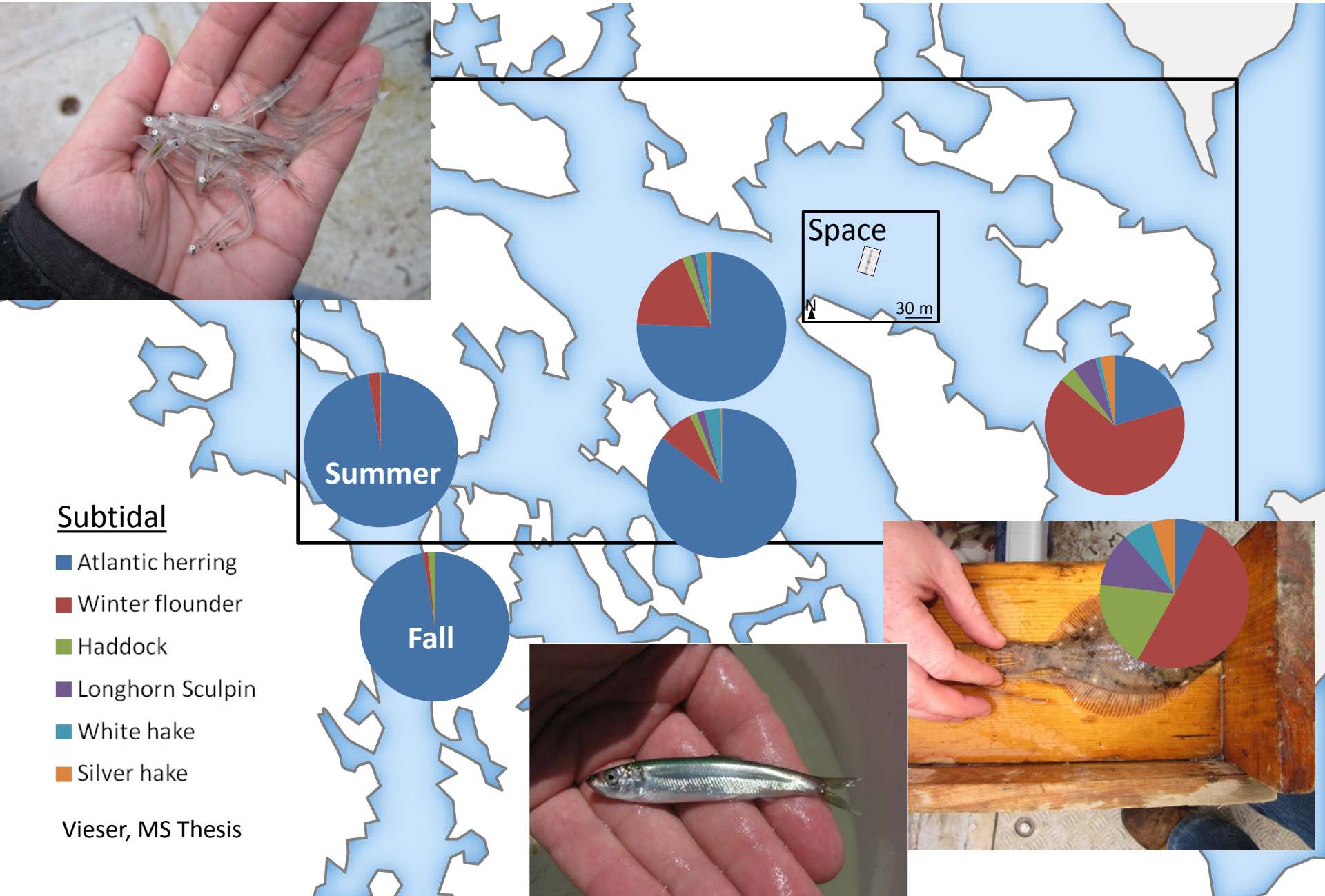

N. B.
Maine
BAY OF FUNDY
N.S.
WASHINGTON
COUNTY (MAINE)
DEER ISLAND
(CAN)
WESTERN PASSAGE
COBSCOOK BAY
Eastport
Lubec
Proposed project area

What is the probability that a fish will encounter an MHK device?

1. **<u>Near-field</u>** – within 5 m of a blade
   - DIDSON (Viehman and Zydlewski 2014)
2. **<u>Far-field</u>** –no expected effects of the device
   - Abundance & distribution (Viehman et al. 2014)
3. **<u>Mid-field</u>** – within the hydrodynamic effects, 100s m
   - Proportion of fish at the depth of the device

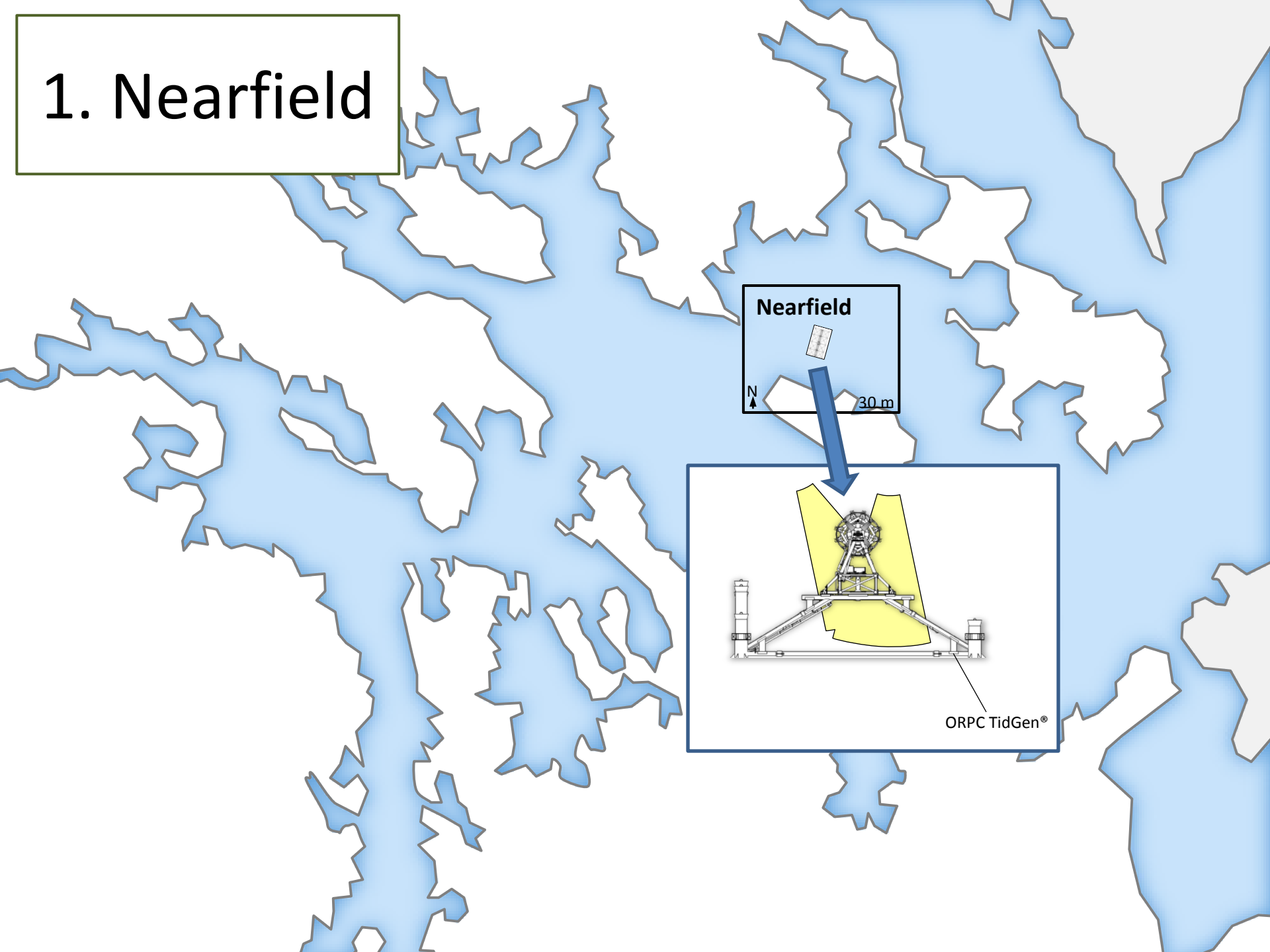


Why consider multiple space and time scales?

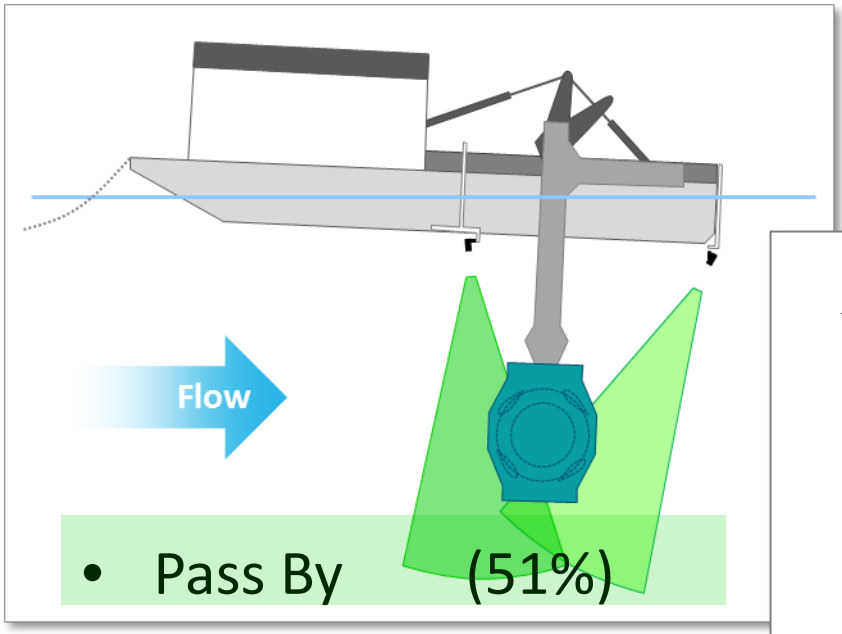


Vieser, MS Thesis

1. Nearfield



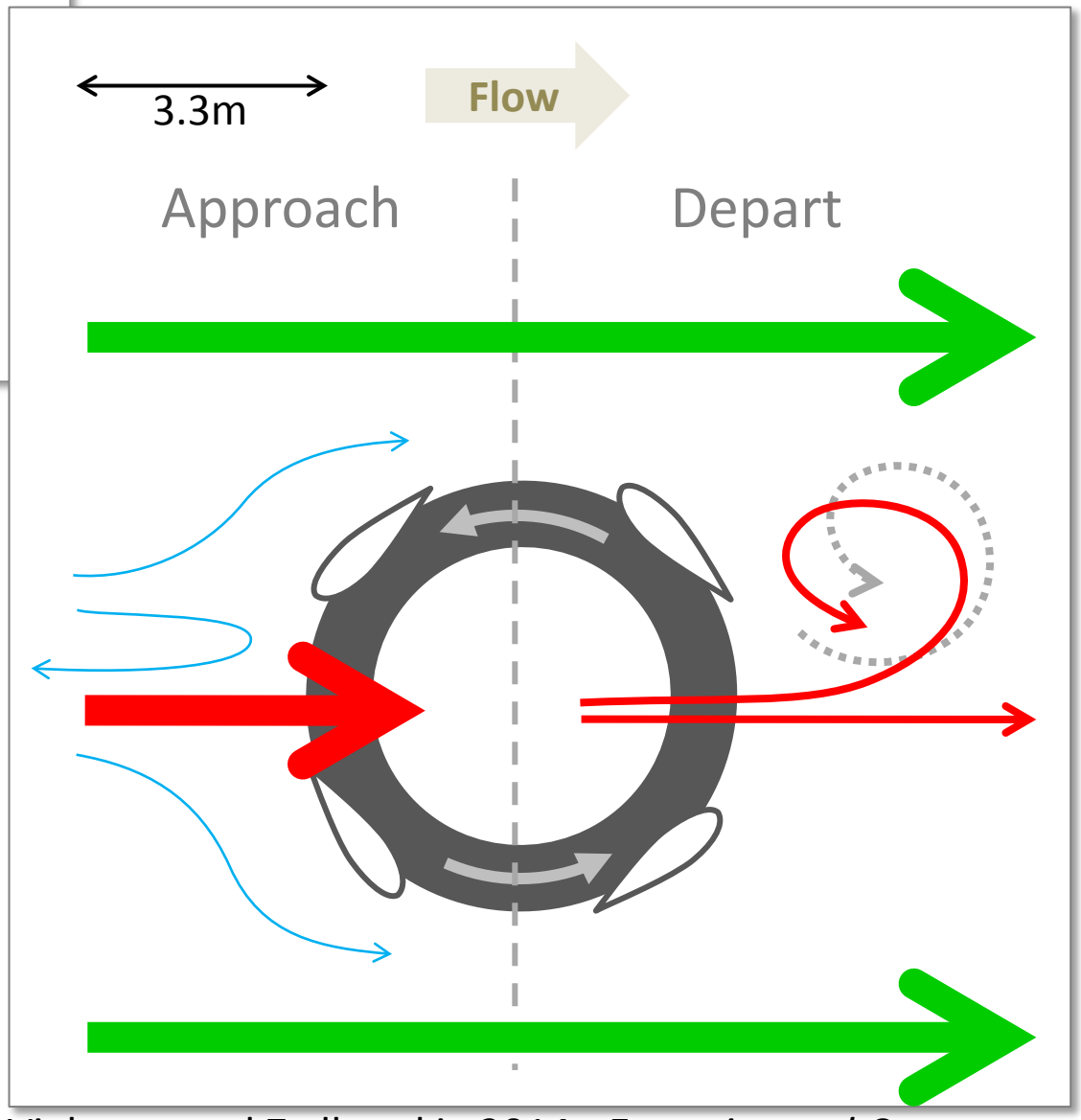
Spatial Scale: within 5 m



- Pass By (51%)

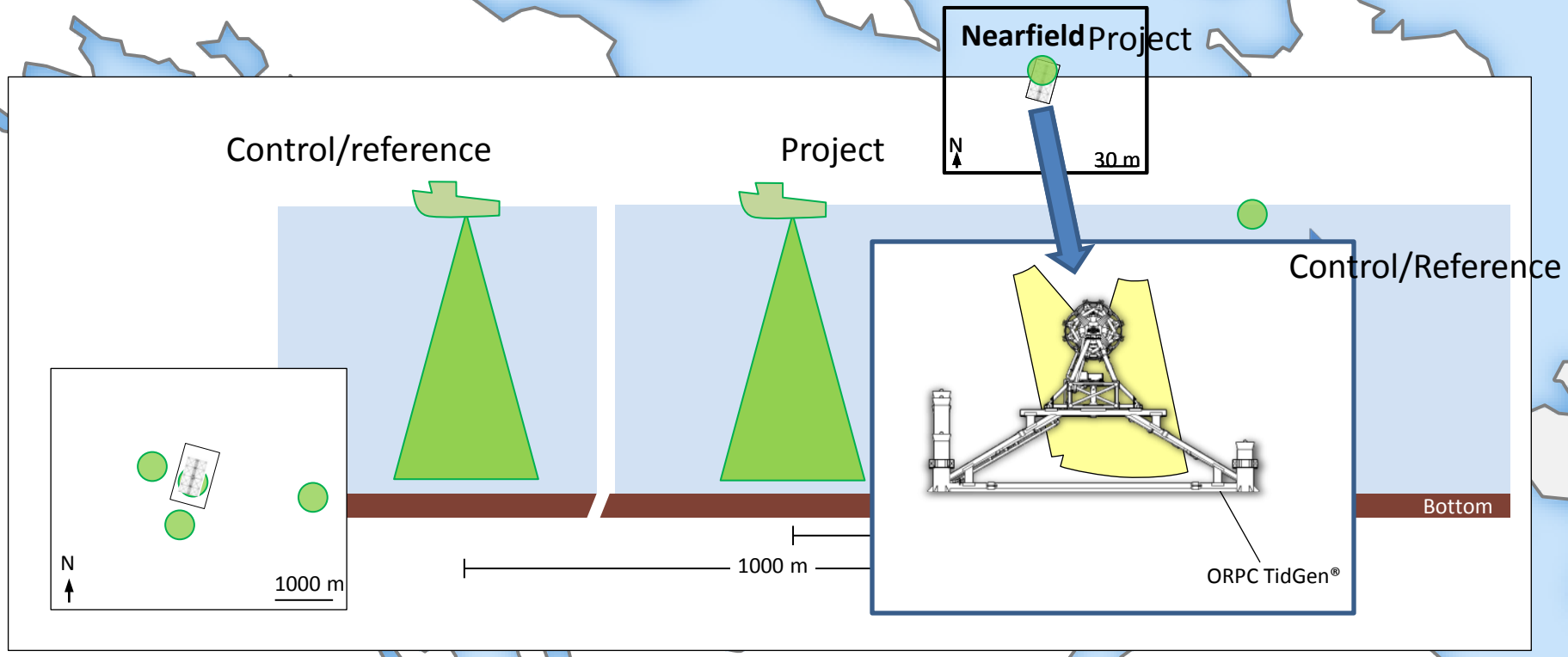
- Through Turbine (48%):
  - Into Turbine
  - Out of turbine

- Active Avoidance (1%):
  - Above
  - Reverse
  - Below

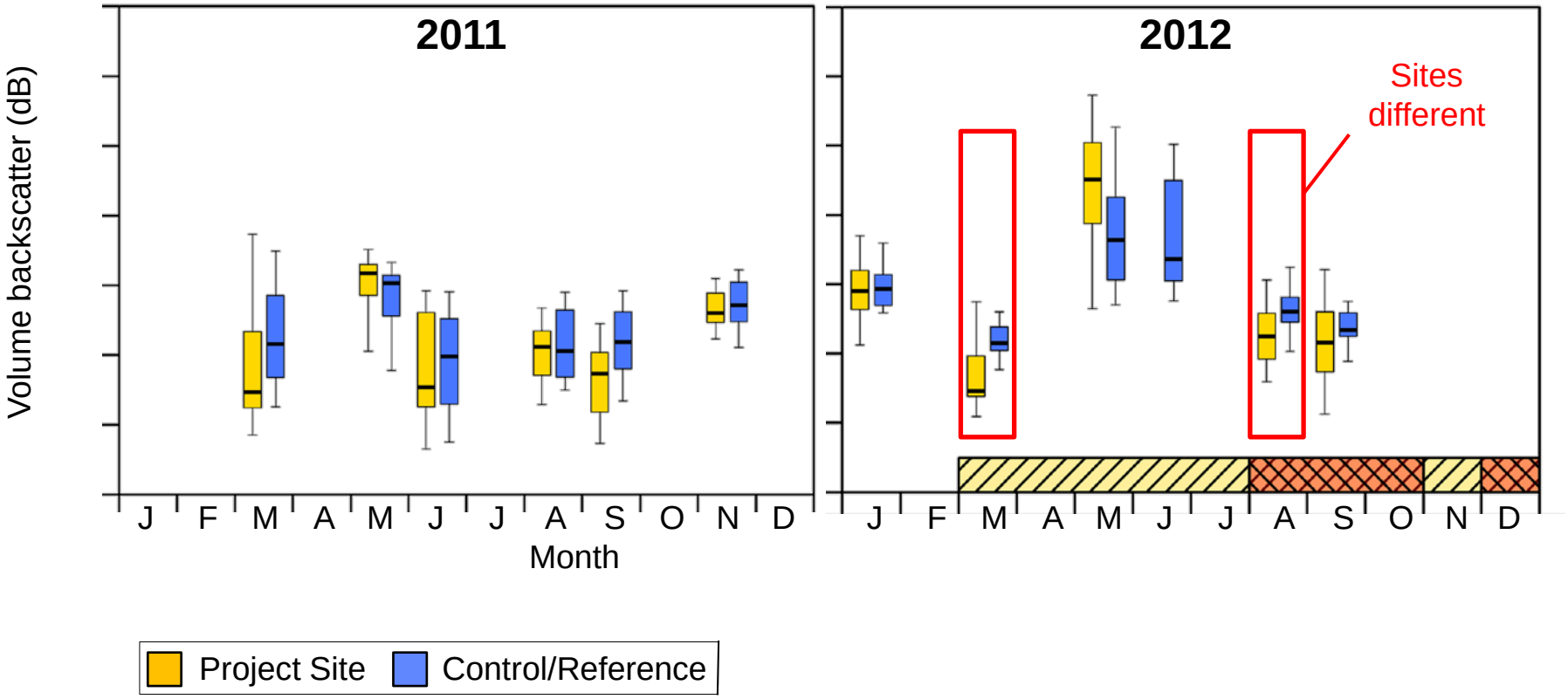


Viehman and Zydlewski. 2014. *Estuaries and Coasts*.

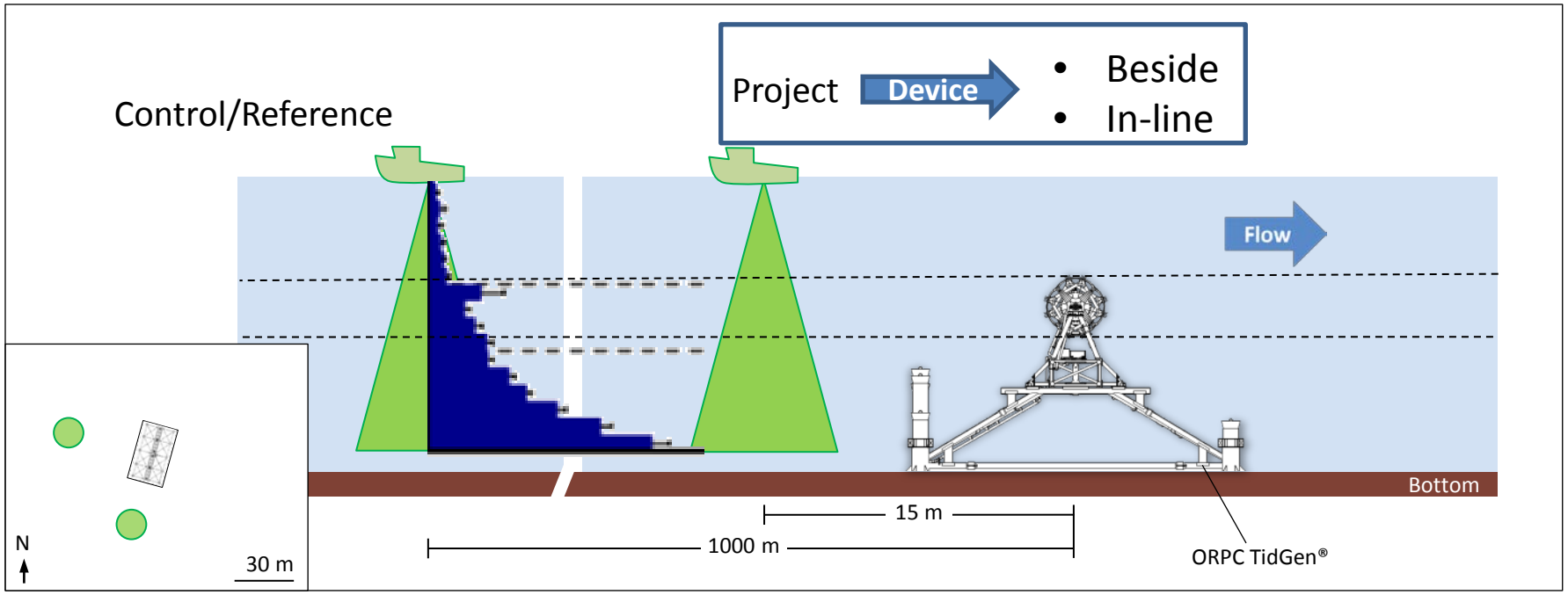
2. Farfield

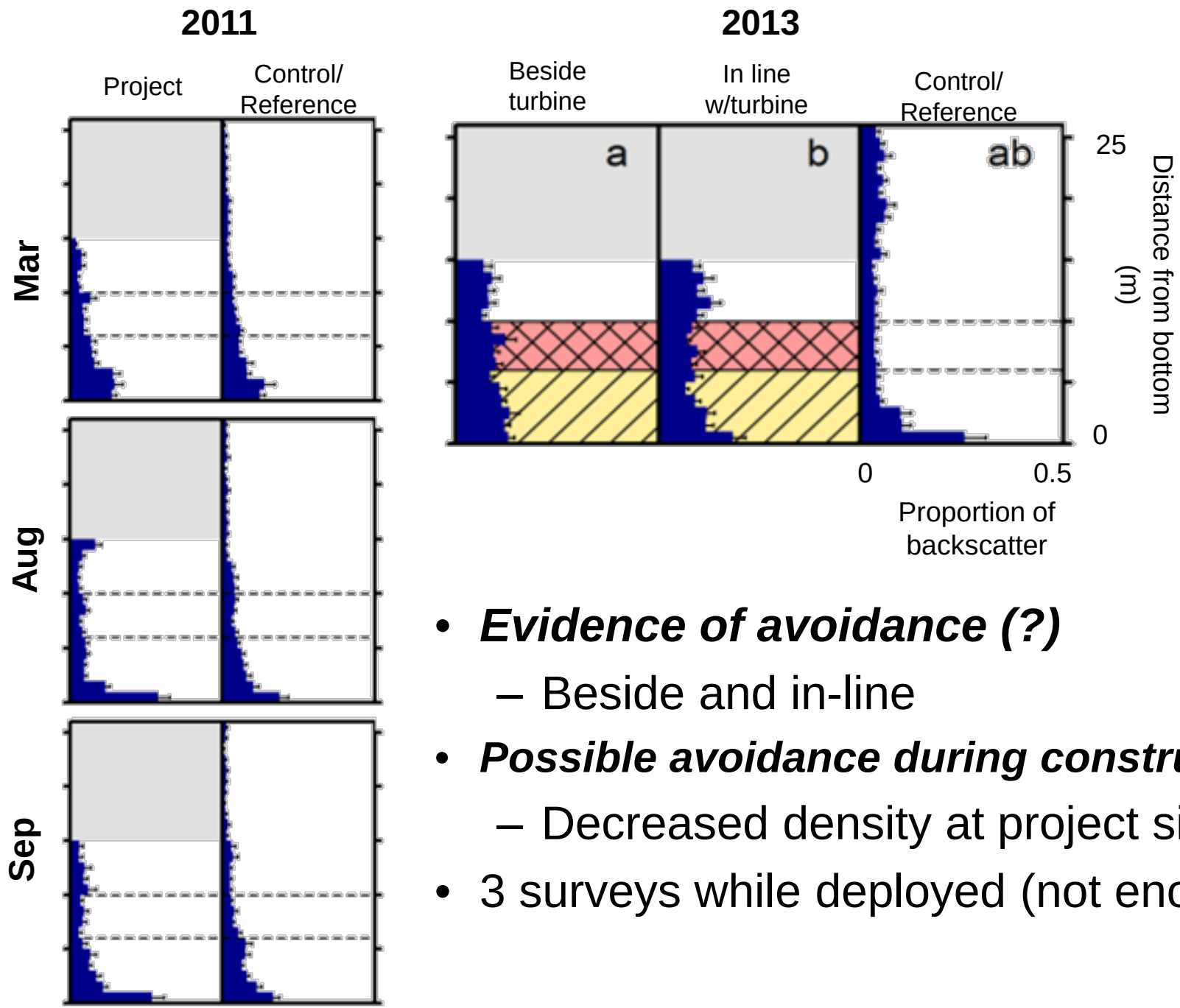

Nearfield Project
N
30 m
Control/reference
Project
Control/Reference
Bottom
N
1000 m
1000 m
ORPC TidGen®

Seasonal patterns of relative abundance



Proportion of fish at different depths

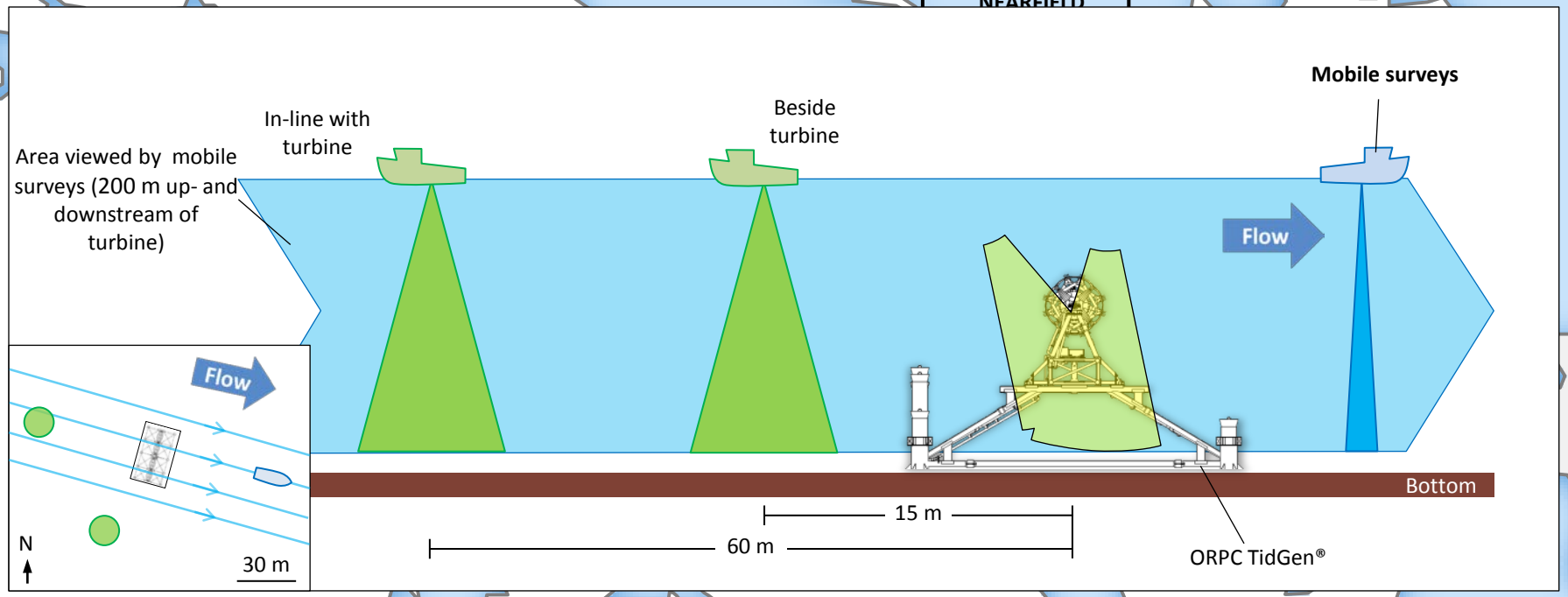




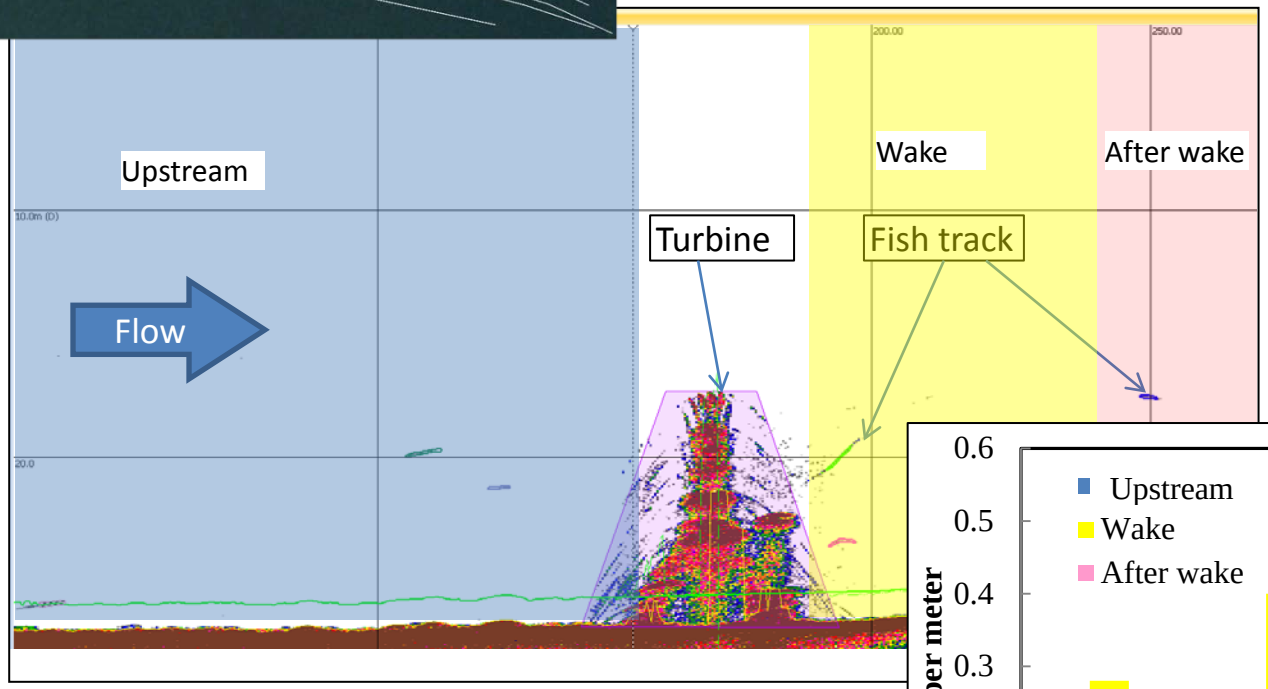
- ***Evidence of avoidance (?)***
  - Beside and in-line
- ***Possible avoidance during construction***
  - Decreased density at project site
- 3 surveys while deployed (not enough!)

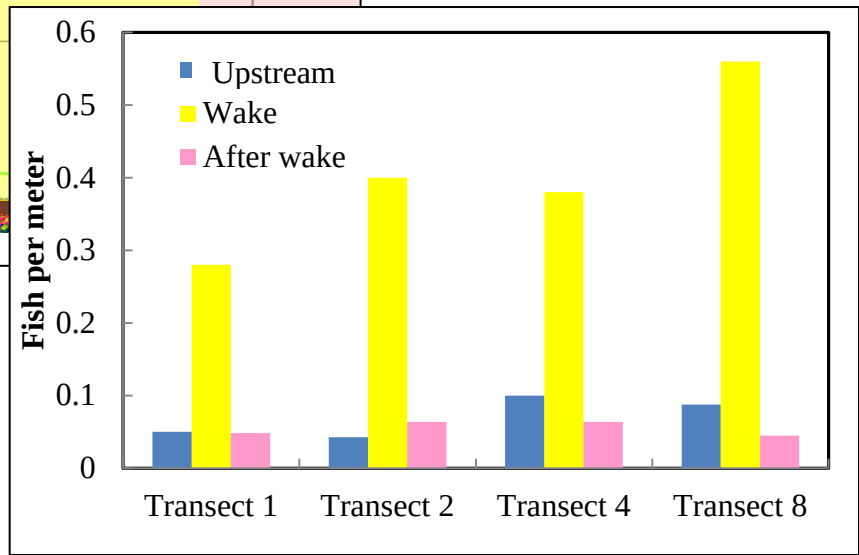
Viehman et al. 2014

3. Midfield: 100s m



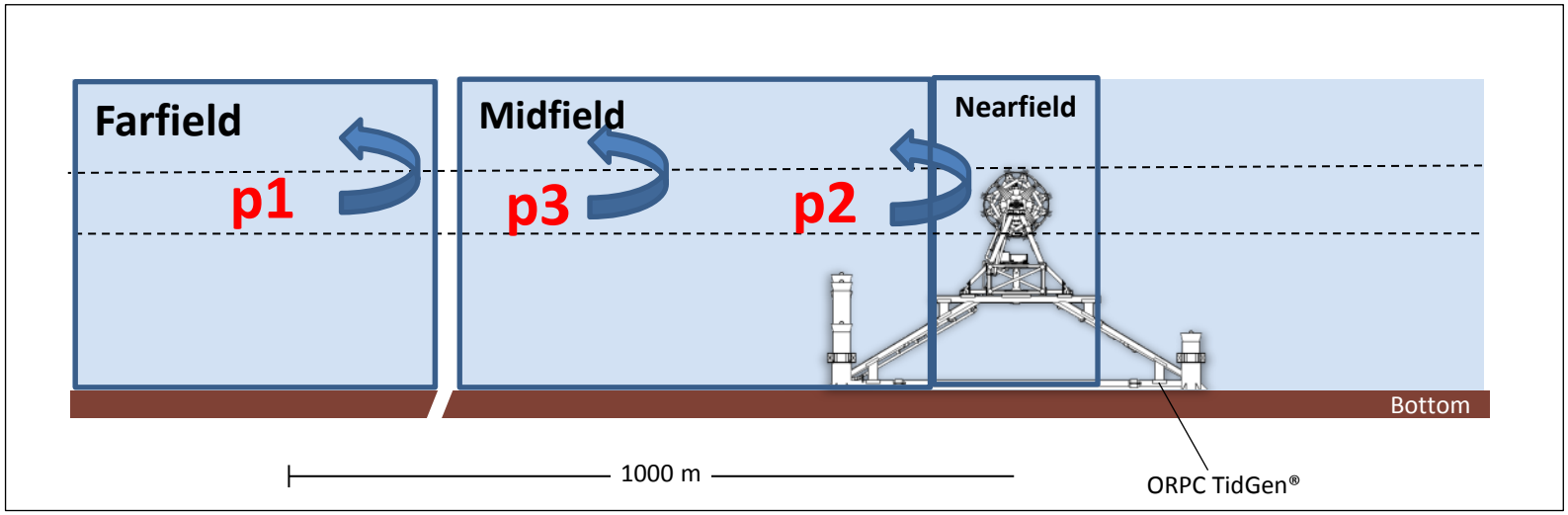
Spatial scale: 200 m





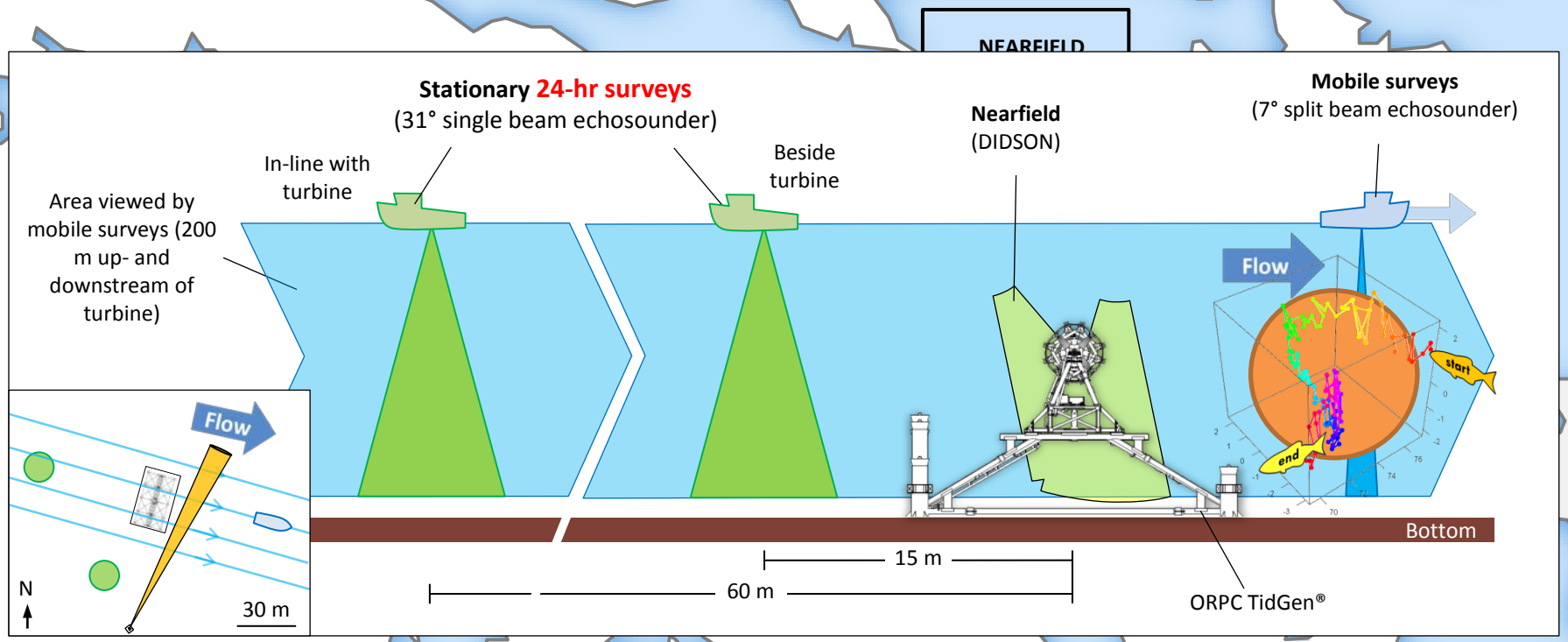
Project integration–Probability of encounter (P)

1. **<u>Near-field</u>** - DIDSON (Viehman and Zydlewski 2014)
   - Within 3.3m, only 1% of fish at turbine level avoided
2. **<u>Far-field</u>** - Abundance & distribution (Viehman et al. 2014)
   - Proportion of fish at turbine depth, without the turbine (p_1, p_2)
   - Proportion of fish at turbine depth, with turbine (p_2)
3. **<u>Mid-field</u>** - Mobile transects
   - Proportion of fish at turbine depth, with turbine (p_3)



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

Most of the picture…
What about temporal resolution?



Determine sampling periodicity to represent variability over a month

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- Fishermen and community partners
- UMaine's Sustainability Solutions Initiative
- ORPC

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Limitations

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

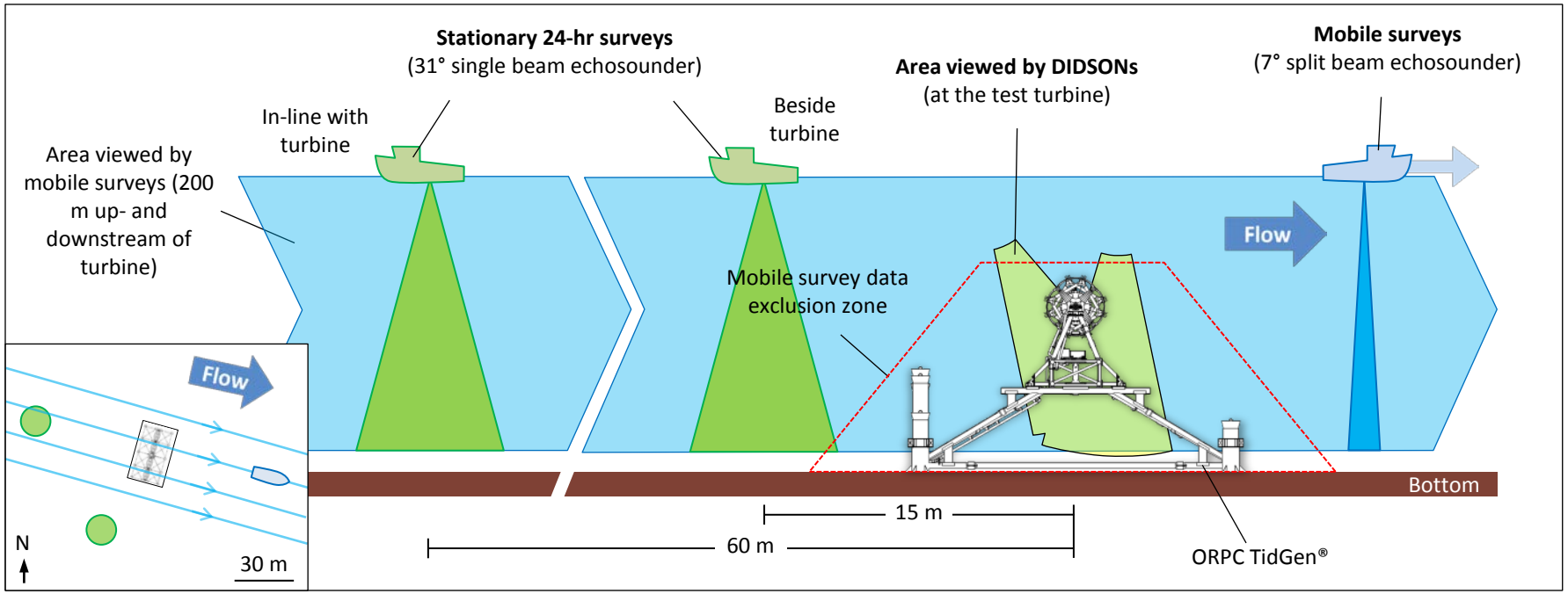
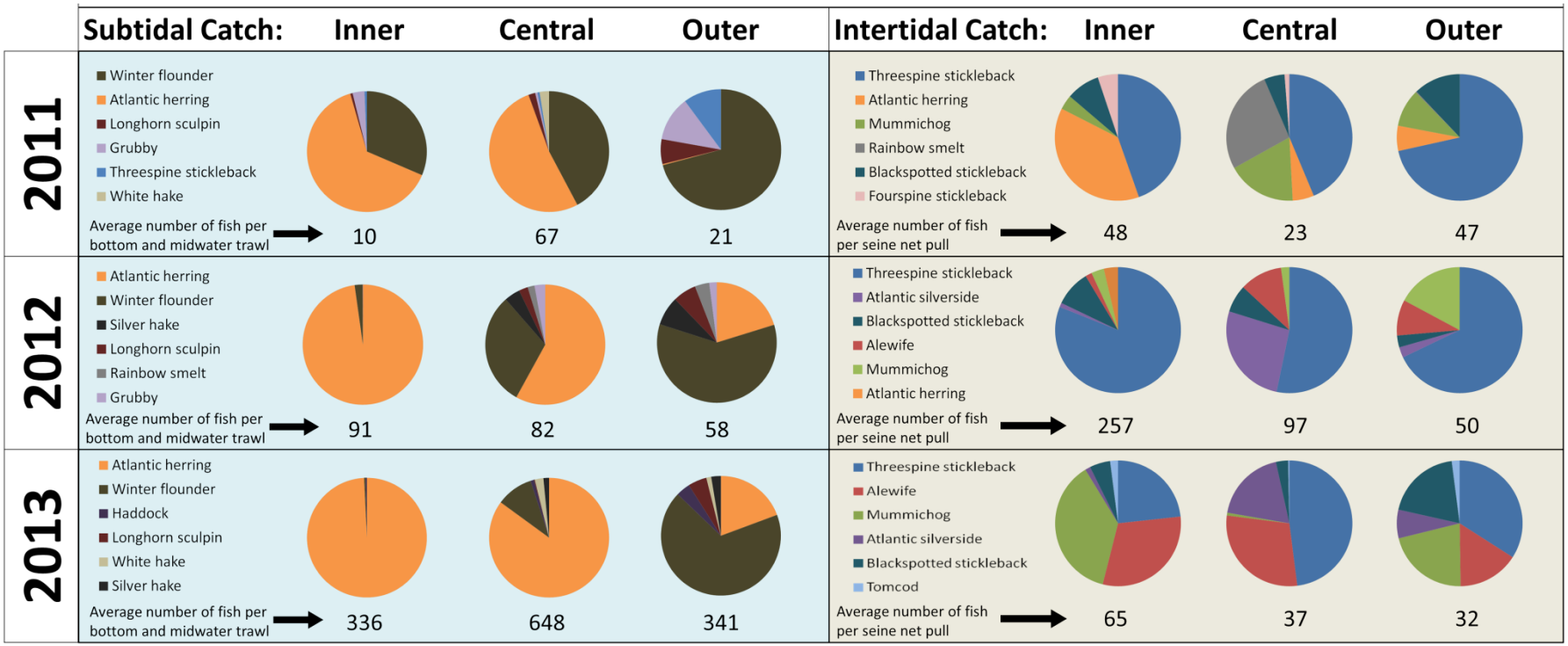
   Limitations: resolution and sampling volume, large amount of data, time required for data processing

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

   Limitations: 24 h surveys representing seasonal data, sampling close enough to device, inability to discriminate species

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

   Limitations: low long-term temporal resolution, inability to discriminate species


Stationary 24-hr surveys
(31° single beam echosounder)
Mobile surveys
(7° split beam echosounder)
Area viewed by DIDSONs
(at the test turbine)
In-line with turbine
Beside turbine
Area viewed by mobile surveys (200 m up- and downstream of turbine)
Flow
Mobile survey data exclusion zone
Flow
Bottom
15 m
60 m
ORPC TidGen®
N
30 m

Natural variation: in Space and Time