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Habitat Impacts of Offshore Wind and Wave Energy Development

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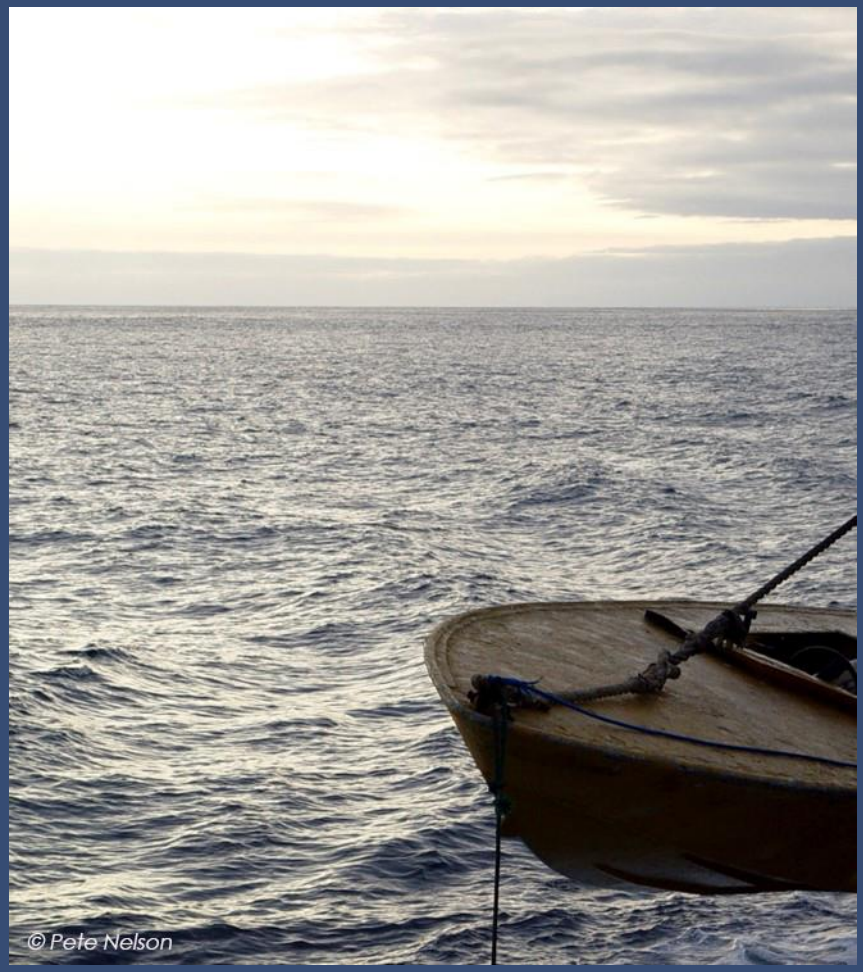
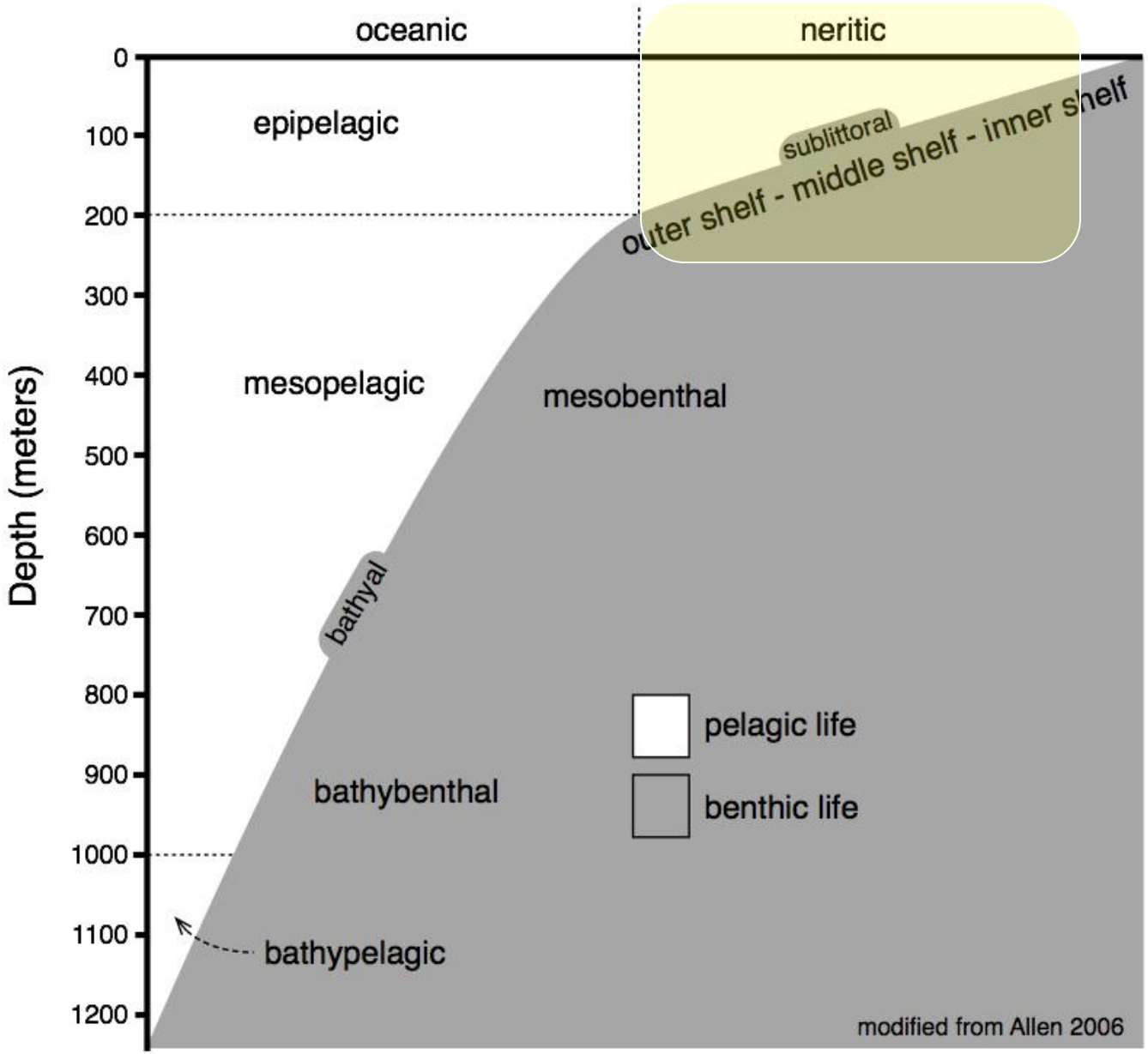
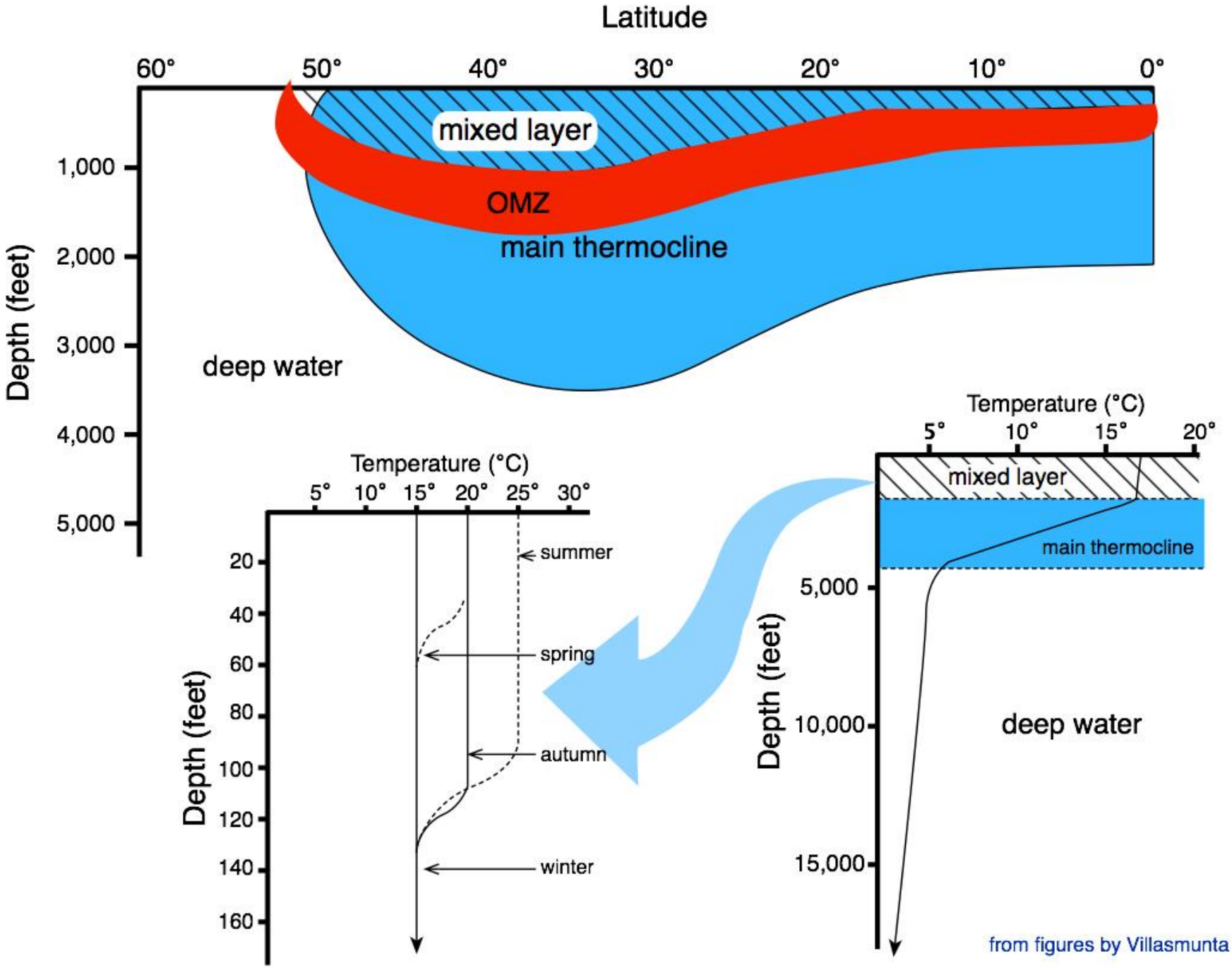
Offshore Marine Environment

- dynamic
- open water—no obstructions
- light gradient
- thermal structure
- variable O_2 content
- substrate: unconsolidated sediments



solid structure historically large wood, currently anthropogenic


oceanic
neritic
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
Depth (meters)
epipelagic
mesopelagic
bathypelagic
sublittoral
outer shelf - middle shelf - inner shelf
mesobenthal
bathyal
bathybenthal
pelagic life
benthic life
modified from Allen 2006


Latitude
60°
50°
40°
30°
20°
10°
0°
mixed layer
OMZ
main thermocline
deep water
Depth (feet)
1,000
2,000
3,000
4,000
5,000
Temperature (°C)
5°
10°
15°
20°
25°
30°
summer
spring
autumn
winter
20
40
60
80
100
120
140
160
Depth (feet)
Temperature (°C)
5°
10°
15°
20°
mixed layer
main thermocline
5,000
10,000
15,000
Depth (feet)
deep water
from figures by Villasmunta

Who Lives Here?

benthos + open water

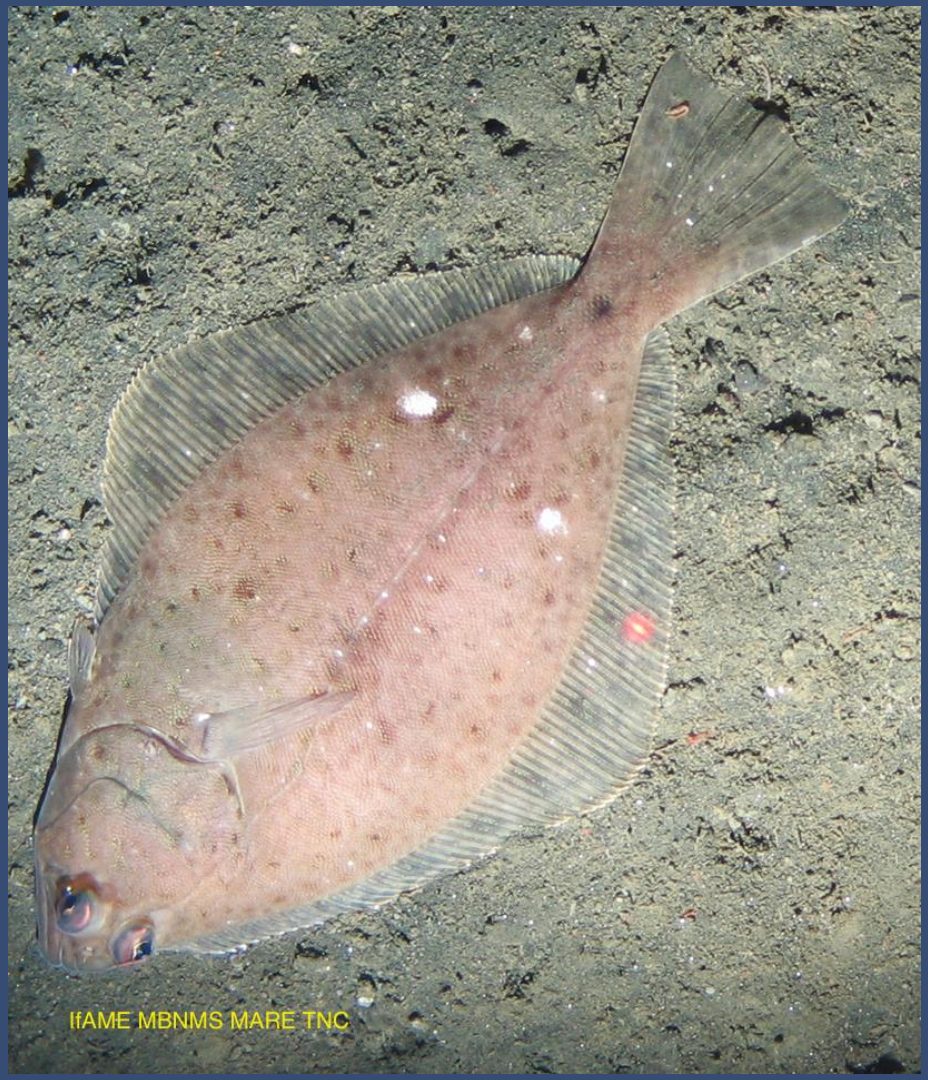
- invertebrates, sessile and motile
- planktonic organisms
- fishes
- marine turtles
- seals and sea lions
- sea otters
- whales, dolphins and porpoises
- seabirds

Two ecological communities affected

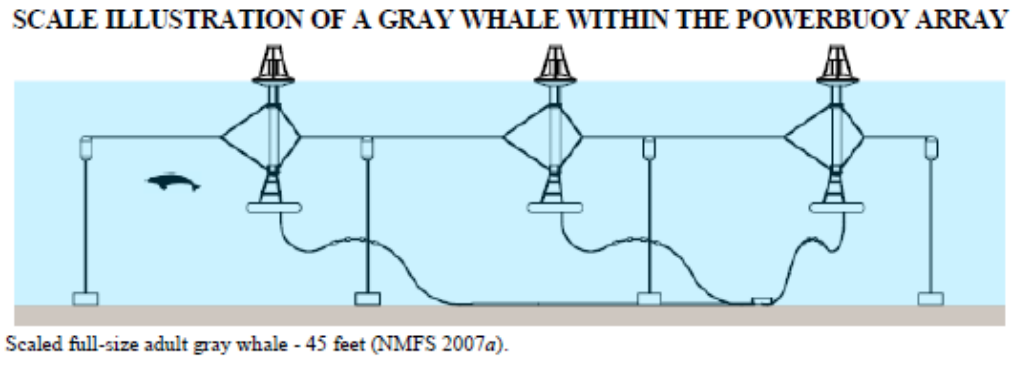
BENTHIC and PELAGIC

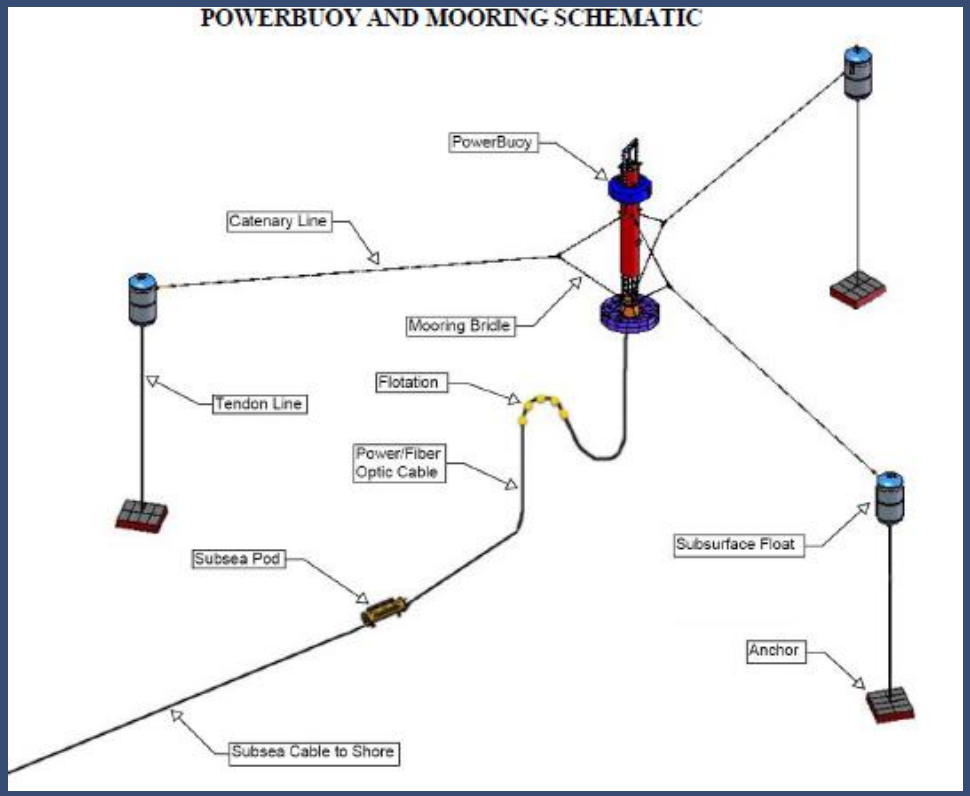
Benthic Impacts

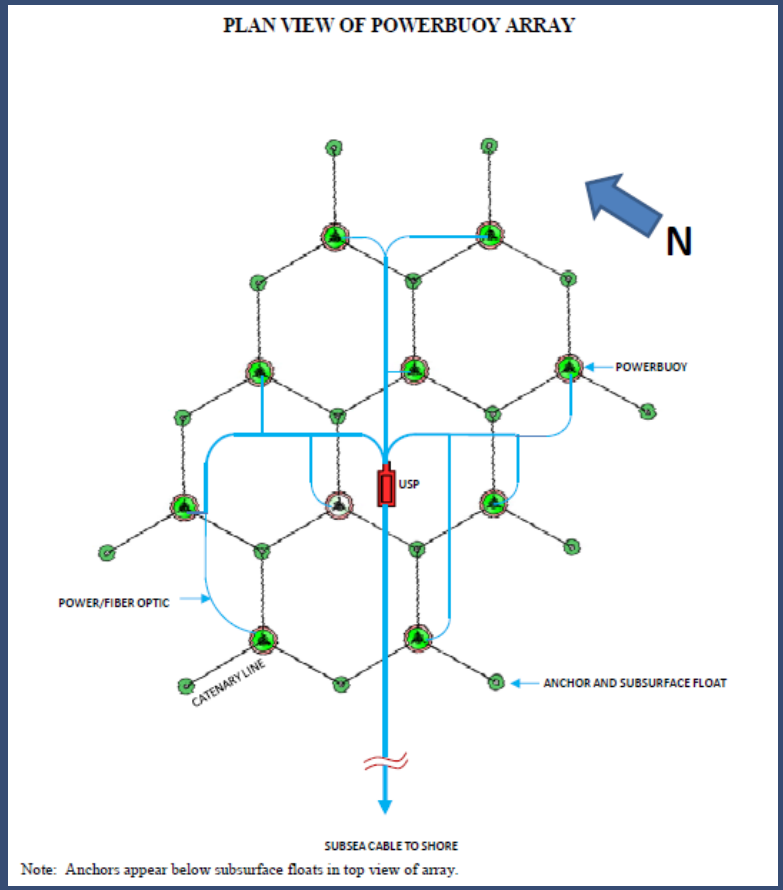
- scour and winnowing
- hard substrate
- relief—artificial reef effect



Installations







Images from Ocean Power Technologies

Artificial Reef Effect

- rapid colonization certain
- species composition comparable to natural reefs
- likely high recruitment rates

Benthic Ecology

- impact footprint small relative to comparable habitat
- localized areas of higher biodiversity
- fishery and conservation enhancement
- stepping stone effect (whale fall)?

Pelagic Impacts

- structure in open water
- fixed visual reference point
- entanglement of fishing gear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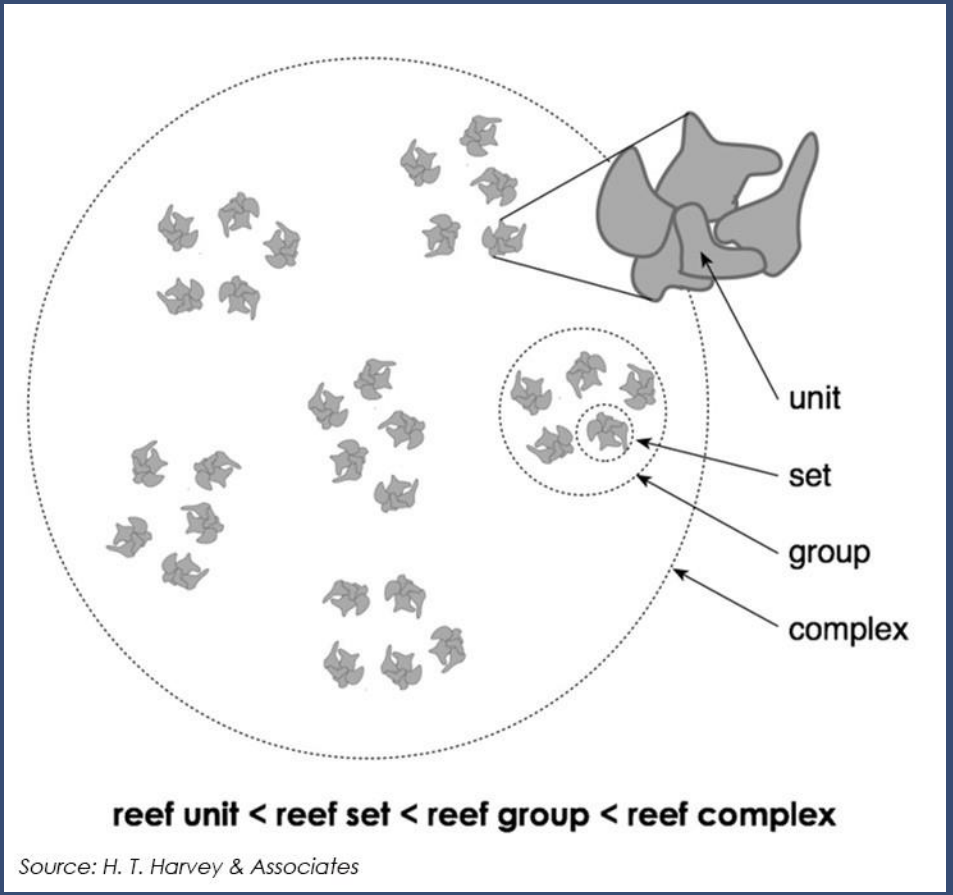
Wind and Wave Energy Conversion Installations as Fish Aggregation Devices (FADs)

Structure

- surface structure
- subsurface mooring gear
- anchors (not shown at left)
- unburied cable?

optimum artificial reef design

- reef set: 400 m^3 minimum for viability
- area of influence: 200-300 m
- max aggregation effect in reef fish w 400 m between groups
- fish biomass 2 orders of magnitude > natural reefs (highly design dependent)

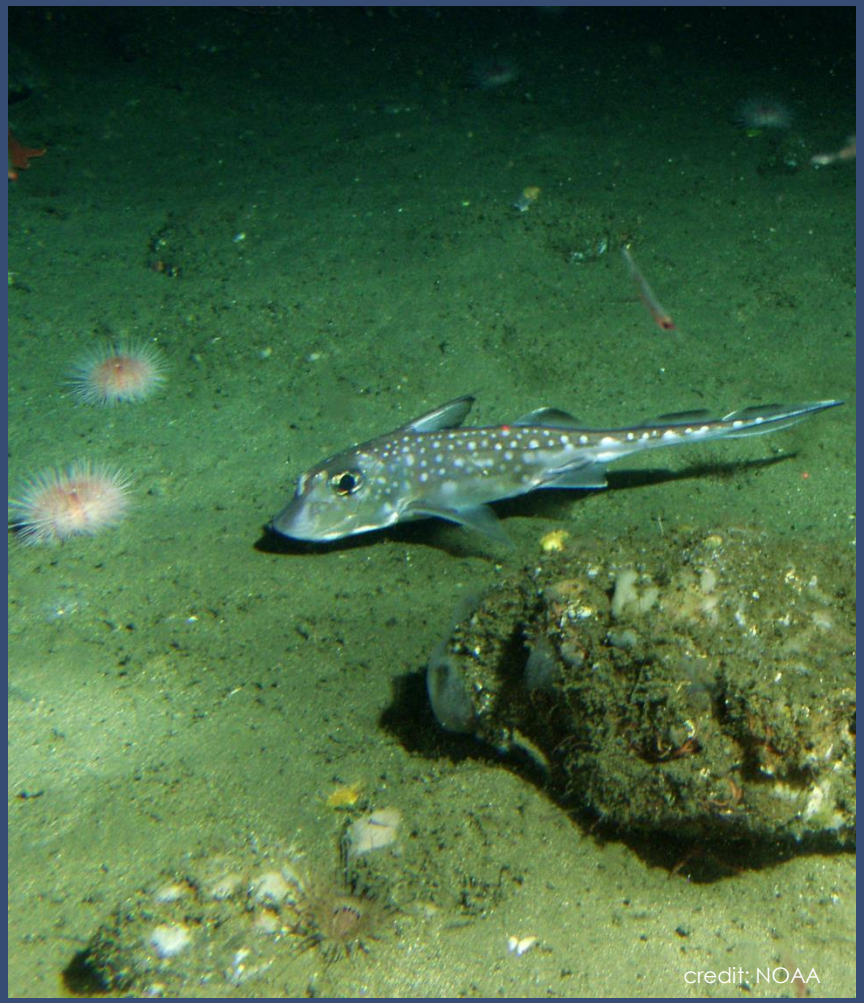


Habitat Concerns

Real	Possible	Unlikely
entanglement **of** lost fishing gear	entanglement **in** lost fishing gear	predation effects on spp of concern
artificial reef effect—high local biodiversity	FAD effects select spp in SCB	FAD effects on forage species
	MPA effect	EMF disturbance
		impacts on plankton
		avoidance by migratory animals
		collision by large whales

Source: H. T. Harvey & Associates

Conclusions



- anchored structures: linking artificial reef to FAD effects
- oceanography probably reduces effects
- lost fishing gear & entanglement
- conservation & fishery management
- otherwise, many concerns appear to be very low risk, based on consideration of surrogates and animal behavior

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