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Overview of Completed and Ongoing Studies that Address Electromagnetic Field Effects on Marine Life

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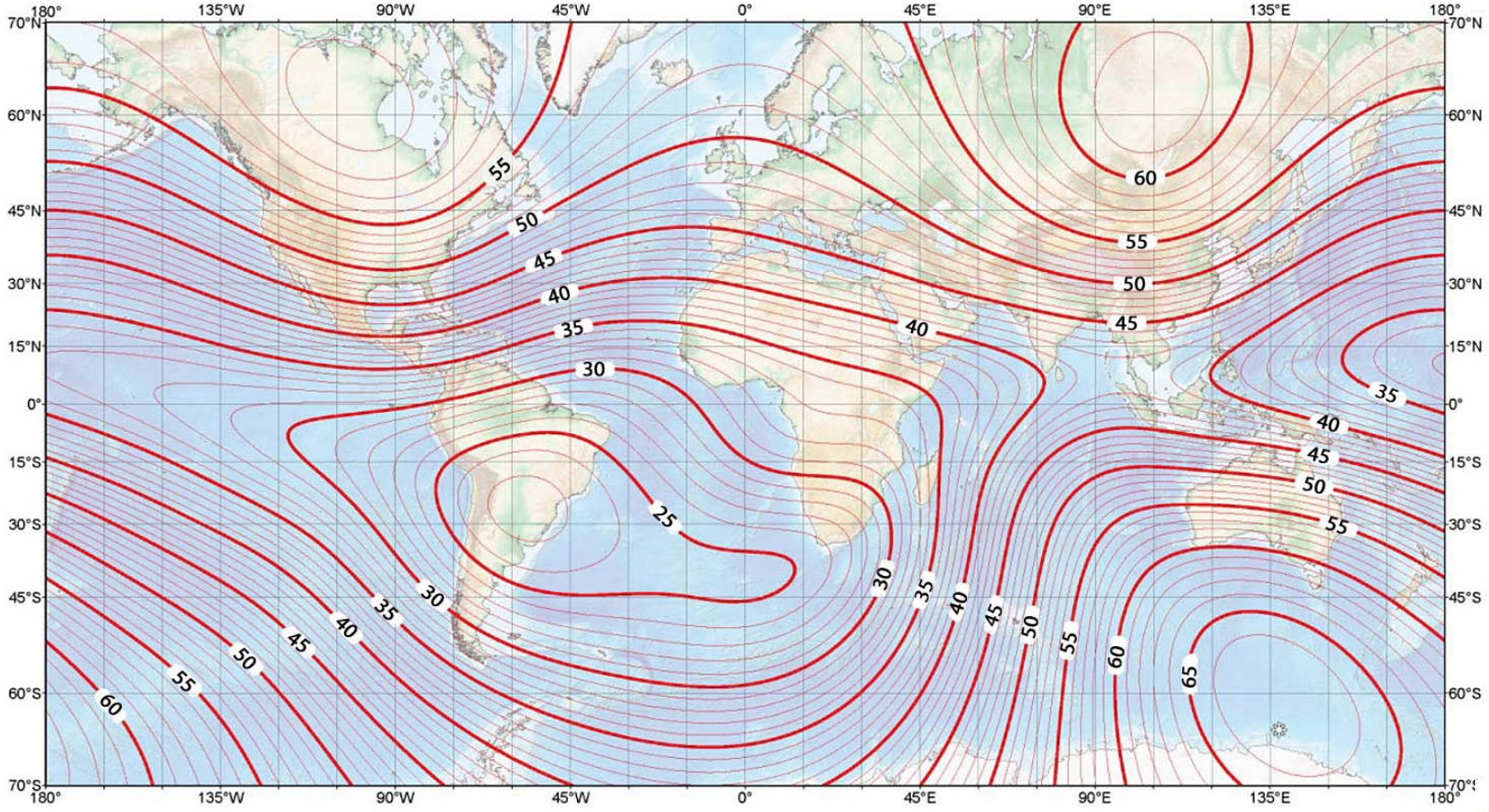
Hawaii OCS Renewable Energy Task Force

December 5, 2012
Honolulu, Hawaii

Map of Total Intensity of Main Geomagnetic Field

(Intervals in Microteslas)



Adapted from Normandeau, et al. (2011)

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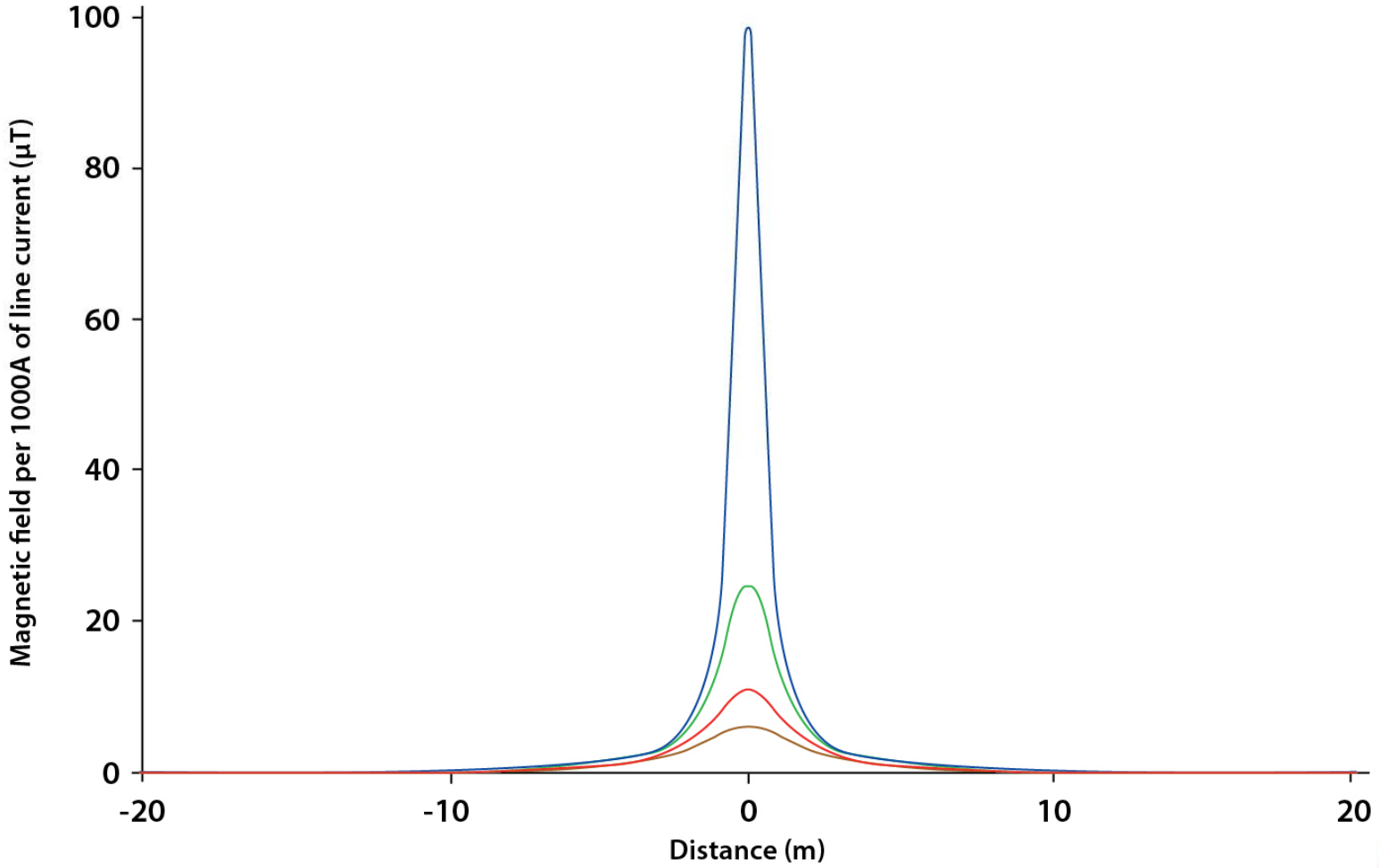

Adapted from Normandeau et al. (2011)

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DOUGLAS CUMMINGS

NOAA

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Effect vs Impact

(Boehlert and Gill 2010)

Effect means that something acts on something else

Example – A cable EMF attracts a fish

Impact deals with the significance of the effect on an organisms, but more particularly on its population or its ecological community.

Example – A cable EMF cause thousands of fishes to halt their migration and thus preventing them from reproducing

Impacts can be positive or negative

To date, almost all studies of EMF and marine organisms have been at the “effect” stage (none or small)

Review of three important field studies:

Westerberg, H. and I. Lagenfelt. 2008. Sub-sea power cables and the migration behaviour of the European eel. Fisheries Management and Ecology 15:369-375.

Gill A. B., Y. Huang, I. Gloyne-Philips, J. Metcalfe, V. Quayle, J. Spencer, and V. Wearmouth. 2009. COWRIE 2.0 Electromagnetic Fields (EMF) Phase 2: EMF-sensitive fish response to EM emissions from sub-sea electricity cables of the type used by the offshore renewable energy industry. COWRIE Ltd. COWRIE-EMF-1-06.

DONG Energy and Vattenfall A/S. 2006. Review report 2005. The Danish offshore wind farm demonstration project: Horns Rev and Nysted offshore wind farms environmental impact assessment and monitoring. Prepared for the Environmental Group of the Danish Offshore Farm Demonstration Projects.

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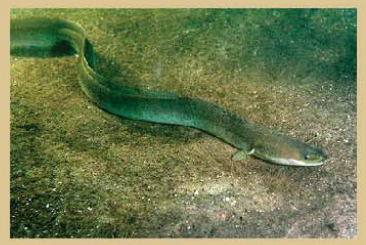
RESULTS:

1. Eel swimming speed was significantly lower around the cable than both north and south of the cable.
2. There was no significant relationship between changes in amperage and swimming speed.
3. From the point of view of environmental impact assessment, the effect of the cable on eels was small.



Migration Route

Release Site

North

Middle

Cable

South

Receiver Buoys

Adapted from
Westerberg and Lagenfelt (2008)

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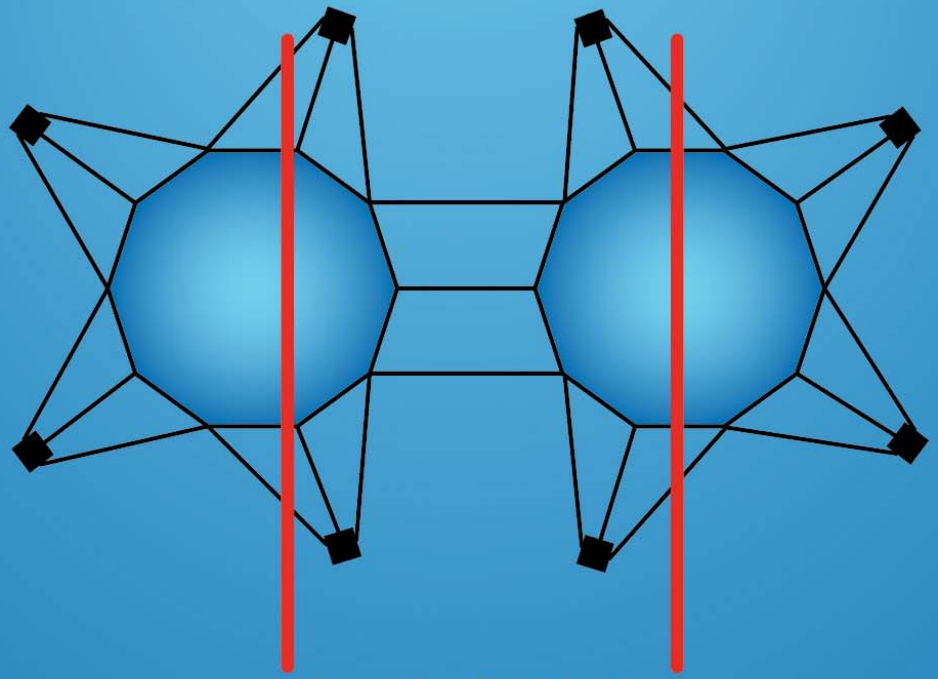
Cage Experiment
Gill et al. (2009)



Location: Scotland
Depth: 10–15 m
Cages: 40 m in diameter

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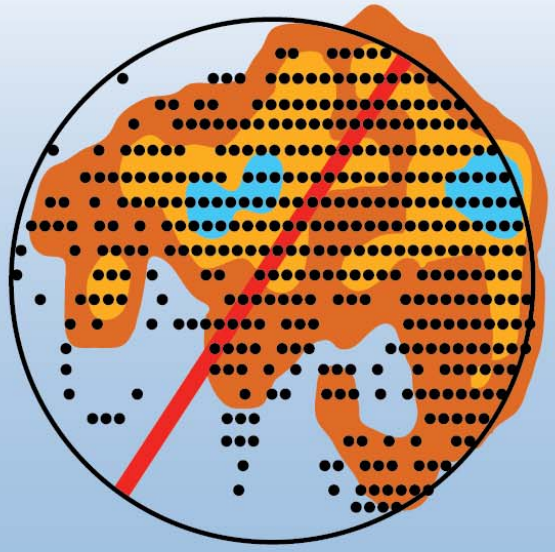
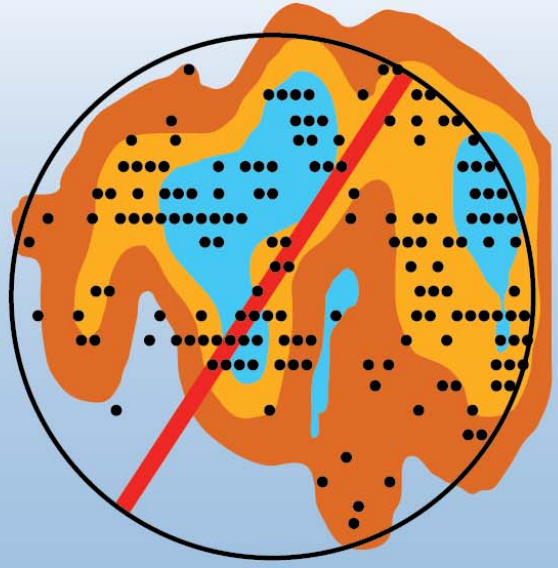
DAY WITH CABLE OFF



DAY WITH CABLE ON



RESULTS

1. For one of two trials – "One species, *S. canicula,* was more likely to be found within the zone of EMF emission during times when the cable was switched on." Thus the other two species were neither attracted nor repelled.
2. The rate of movement of rays and catsharks increased when the EMF was switched on.
3. However, "the response is not predictable and does not always occur; when it does it appears to be species dependent and individual specific."

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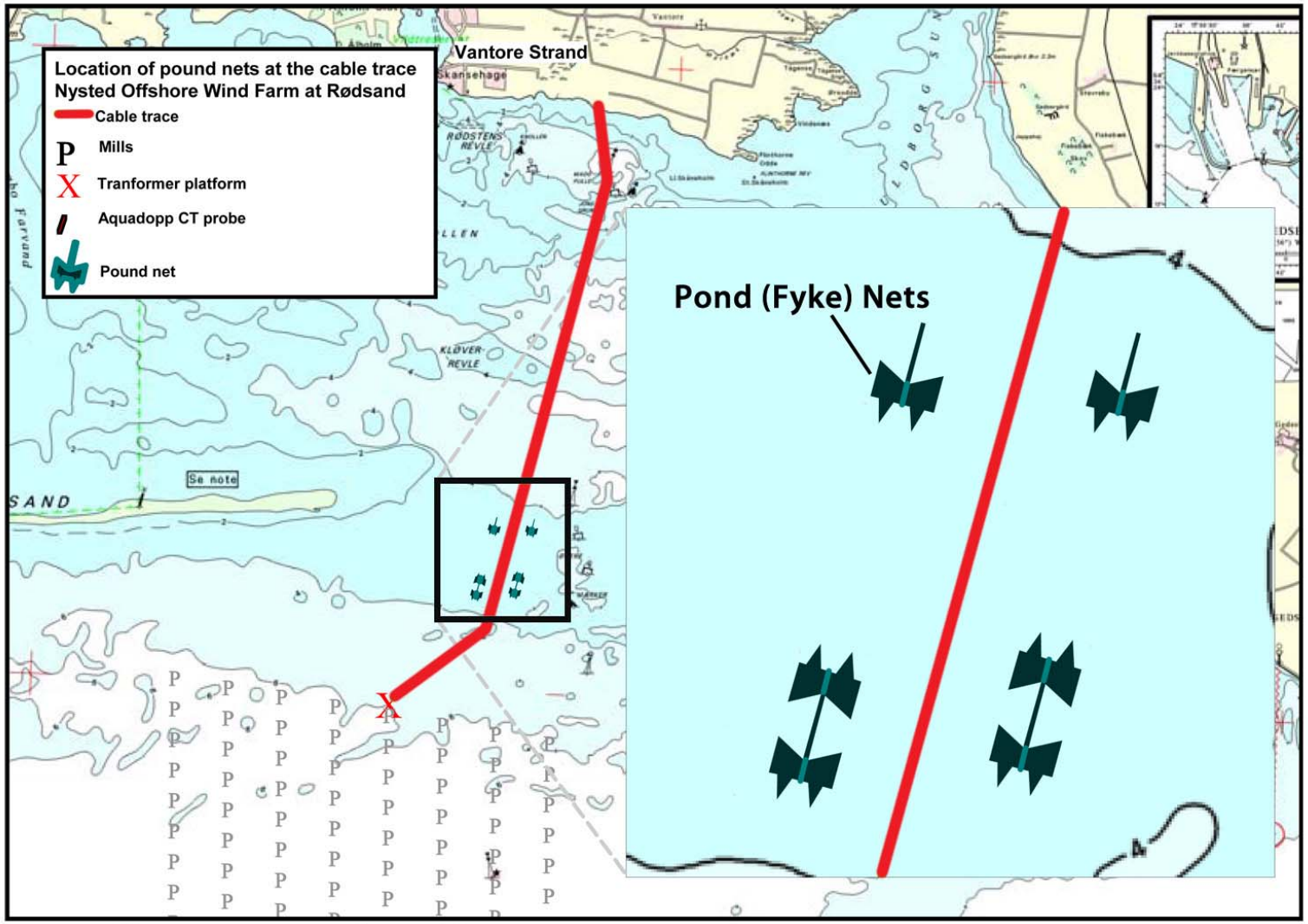

Adapted from DONG Energy and Vattenfall (2006)

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RESULTS:

1. Of all species captured, four species showed asymmetrical catches; Atlantic herring (*Clupea harengus*), European eel (*Anguilla anguilla*), and European flounder (*Platichthys flesus*). This may have been due to partial hindrance of movement across the cable.

2. In addition, some European eels may have left the area near the cable and, in 2003, Atlantic cod accumulated near the cable.

3. The migration direction of eels was not influenced.

4. European flounder primarily crossed the cable when the strength of the electromagnetic field was estimated [but not measured] to be low.

Adapted from DONG Energy and Vattenfall (2006)

SUMMARY of three field studies

Under some circumstances, fishes may detect EMFs from a submarine power cable, as demonstrated by modified behavior

Effects were localized and no impacts to fishes from power cable EMFs were detected

Further studies would be useful

BOEM-supported efforts to date

BRANDON PUCKETT-MARINE PHOTOBANK

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OCS Study
BOEMRE 2011-09

Effects of EMFs from Undersea Power Cables On Elasmobranchs and Other Marine Species

Final Report

Normandeau et al. 2011

U.S. Department of the Interior
Bureau of Ocean Energy Management, Regulation and Enforcement
Pacific OCS Region

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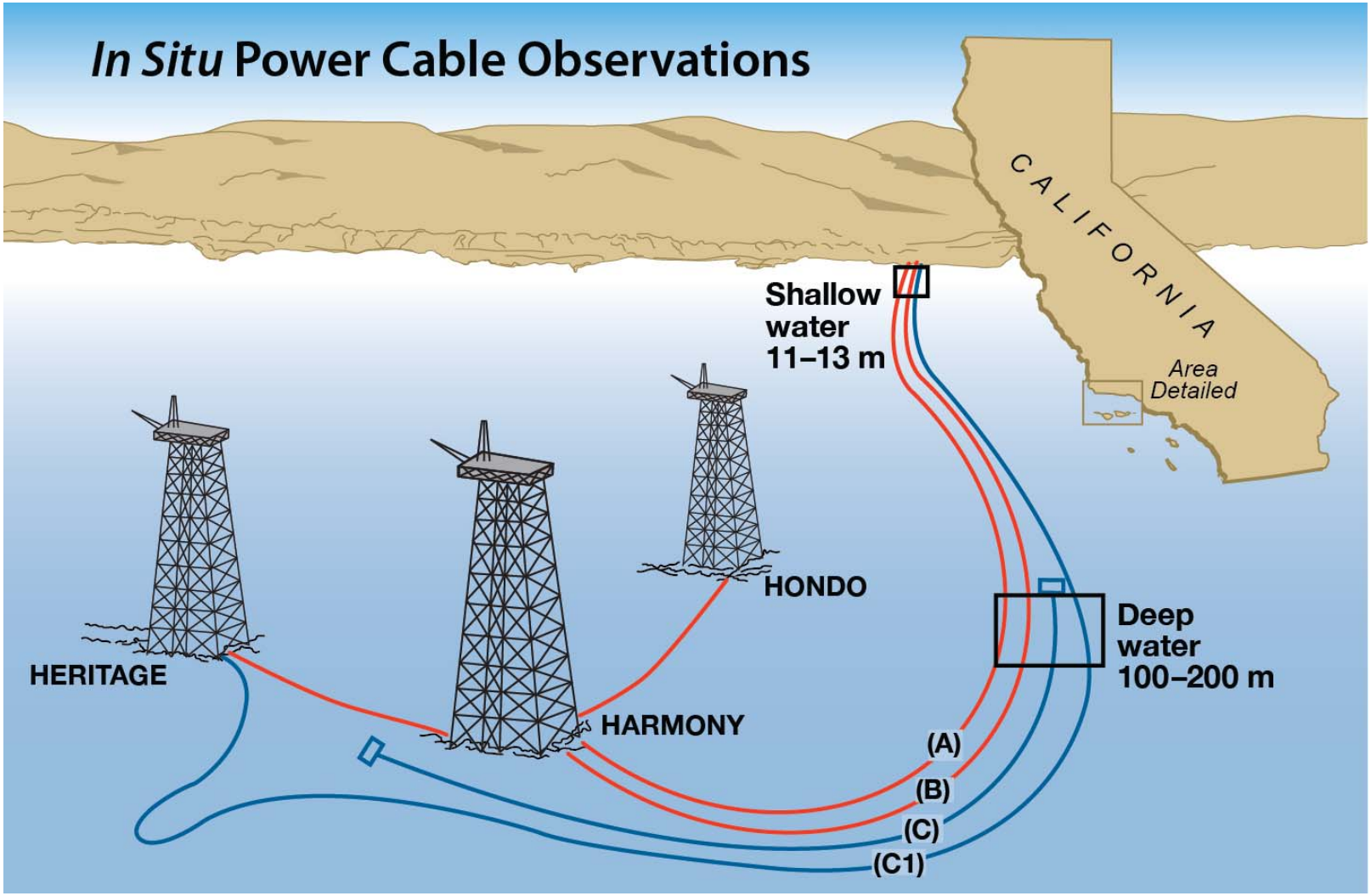

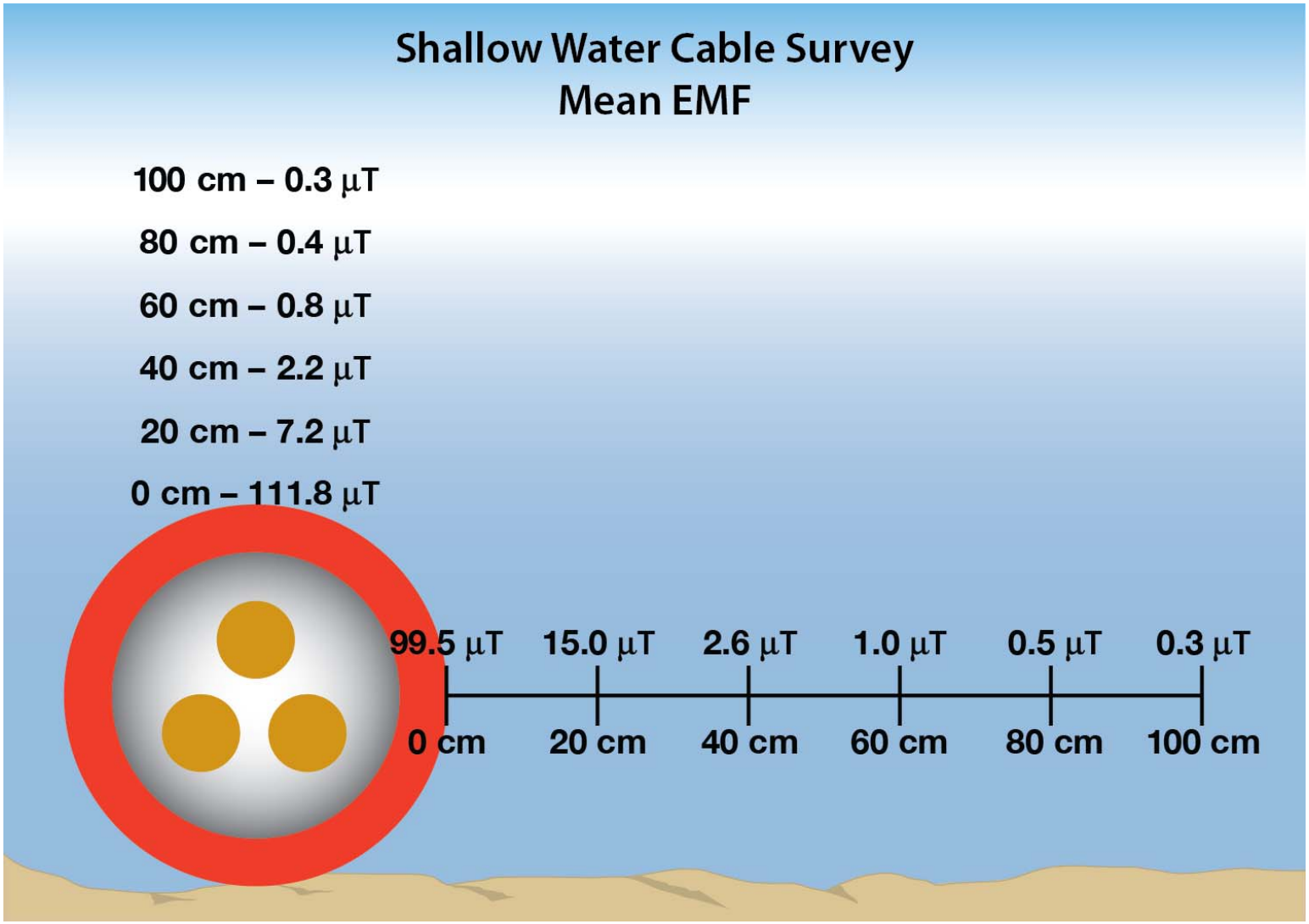
Shallow Water Cable Survey
Mean EMF
100 cm – 0.3 µT
80 cm – 0.4 µT
60 cm – 0.8 µT
40 cm – 2.2 µT
20 cm – 7.2 µT
0 cm – 111.8 µT
99.5 µT
15.0 µT
2.6 µT
1.0 µT
0.5 µT
0.3 µT
0 cm
20 cm
40 cm
60 cm
80 cm
100 cm

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Mean EMF readings in µT

	SCUBA 11-13 m	Submersible 100-200 m
At Cable	112 µT	109 µT
At ~0.5 m	2 µT	3 µT
At ~1m	0.3 µT	0.2 µT

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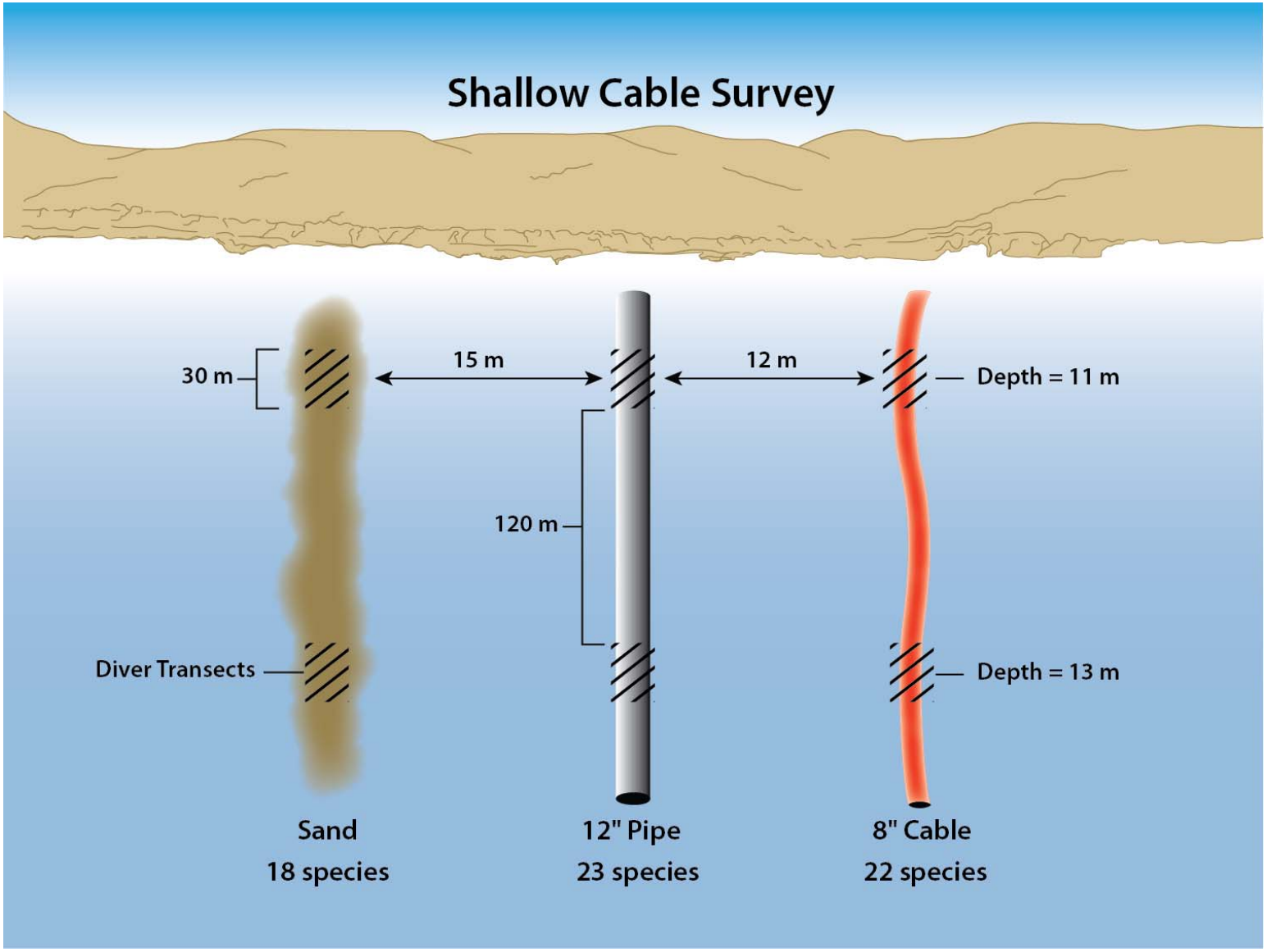
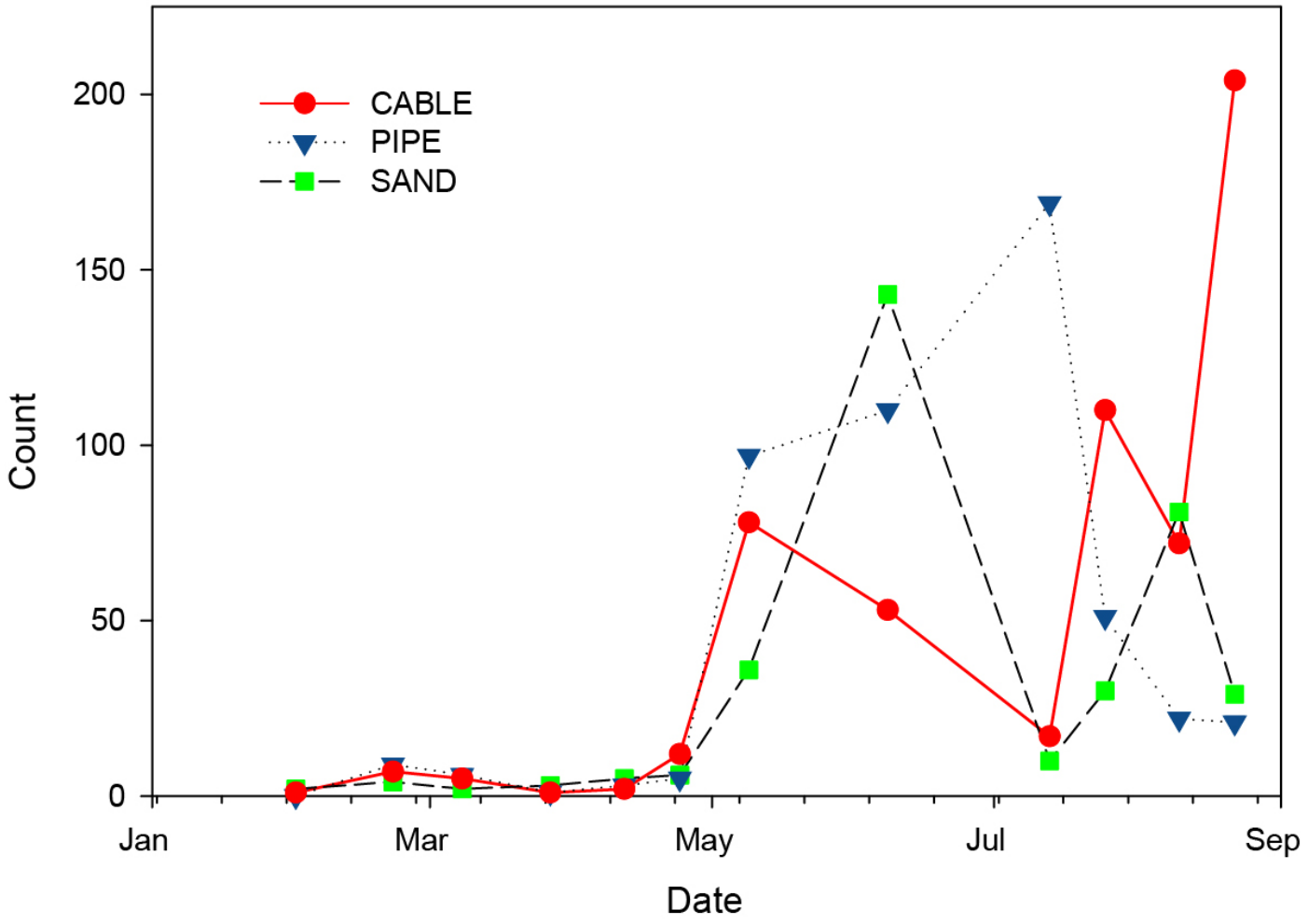
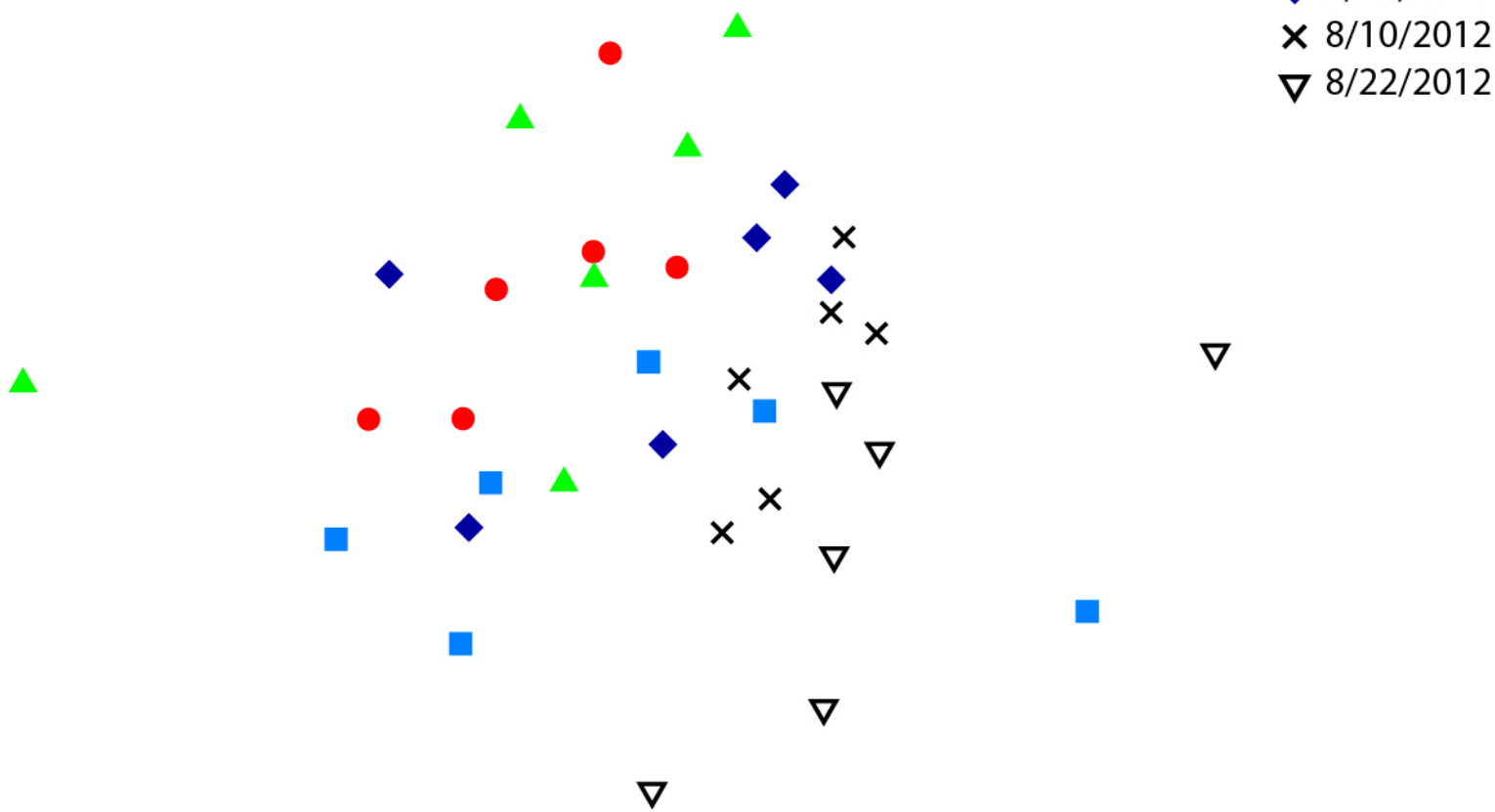


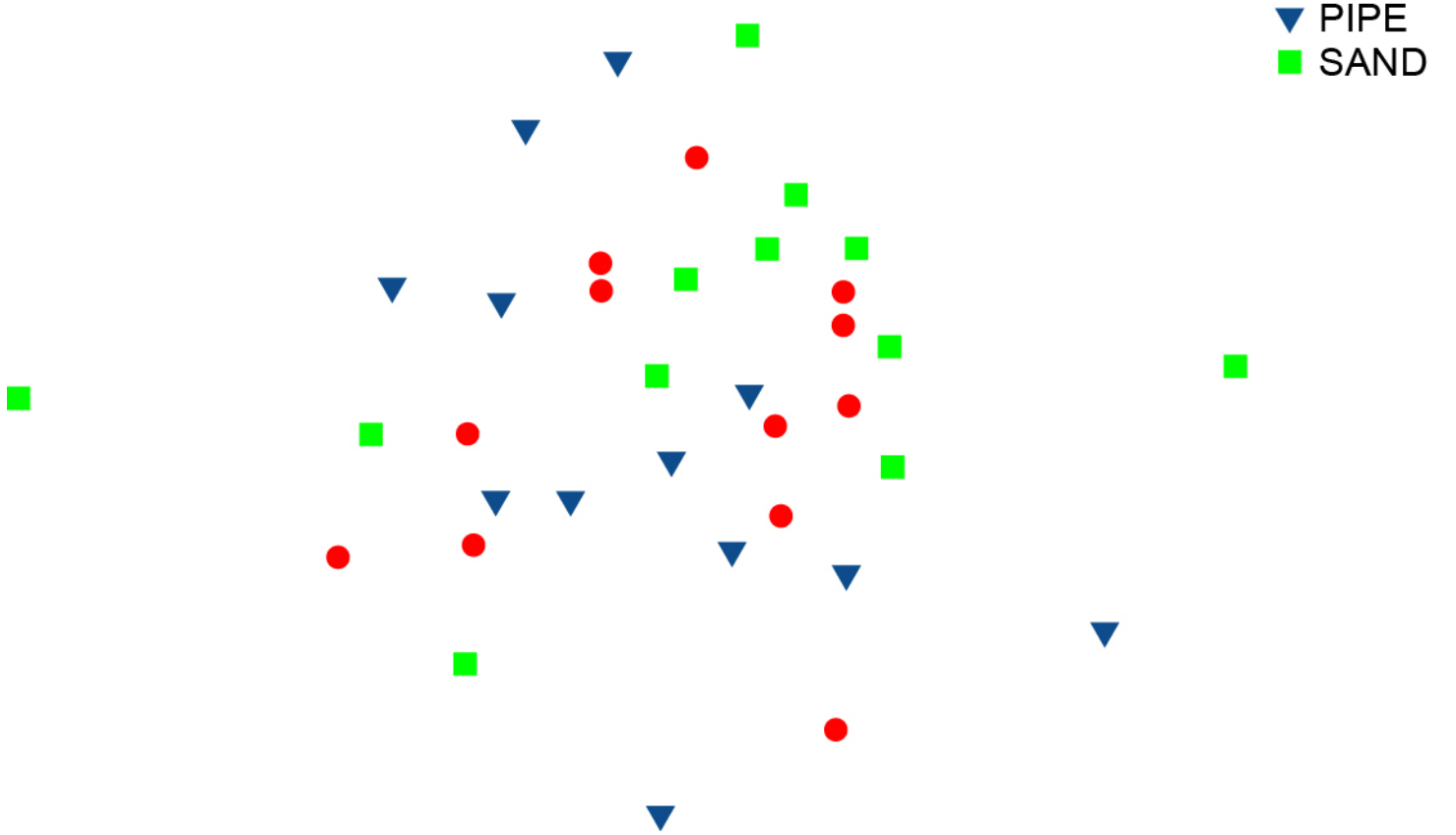
Total Number of Fishes Observed along Cable, Pipe, and Sand (Inshore and Offshore Transects Summed)



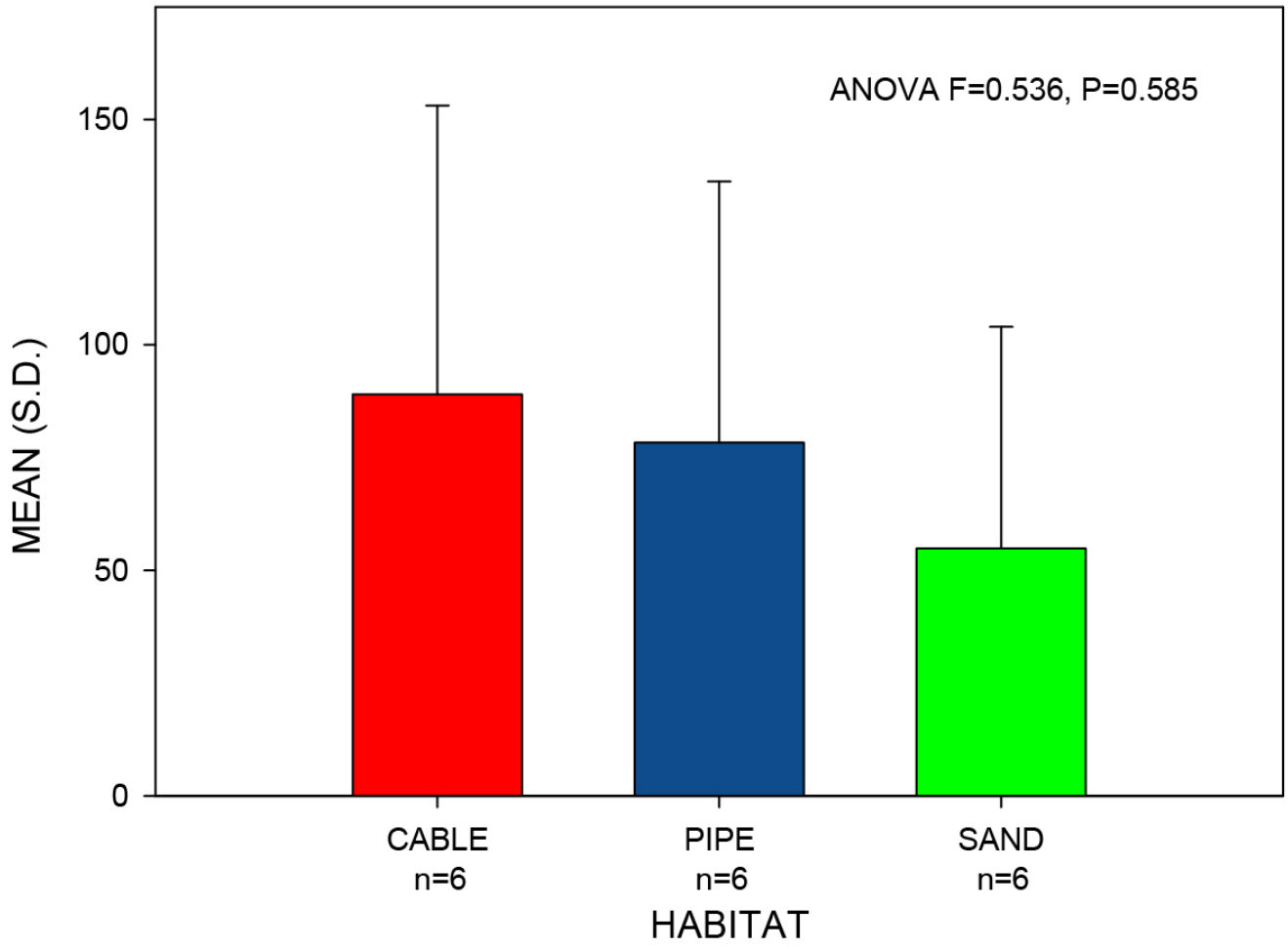
Multidimensional Scaling
All Fish Species – By Date
May–August, 2012



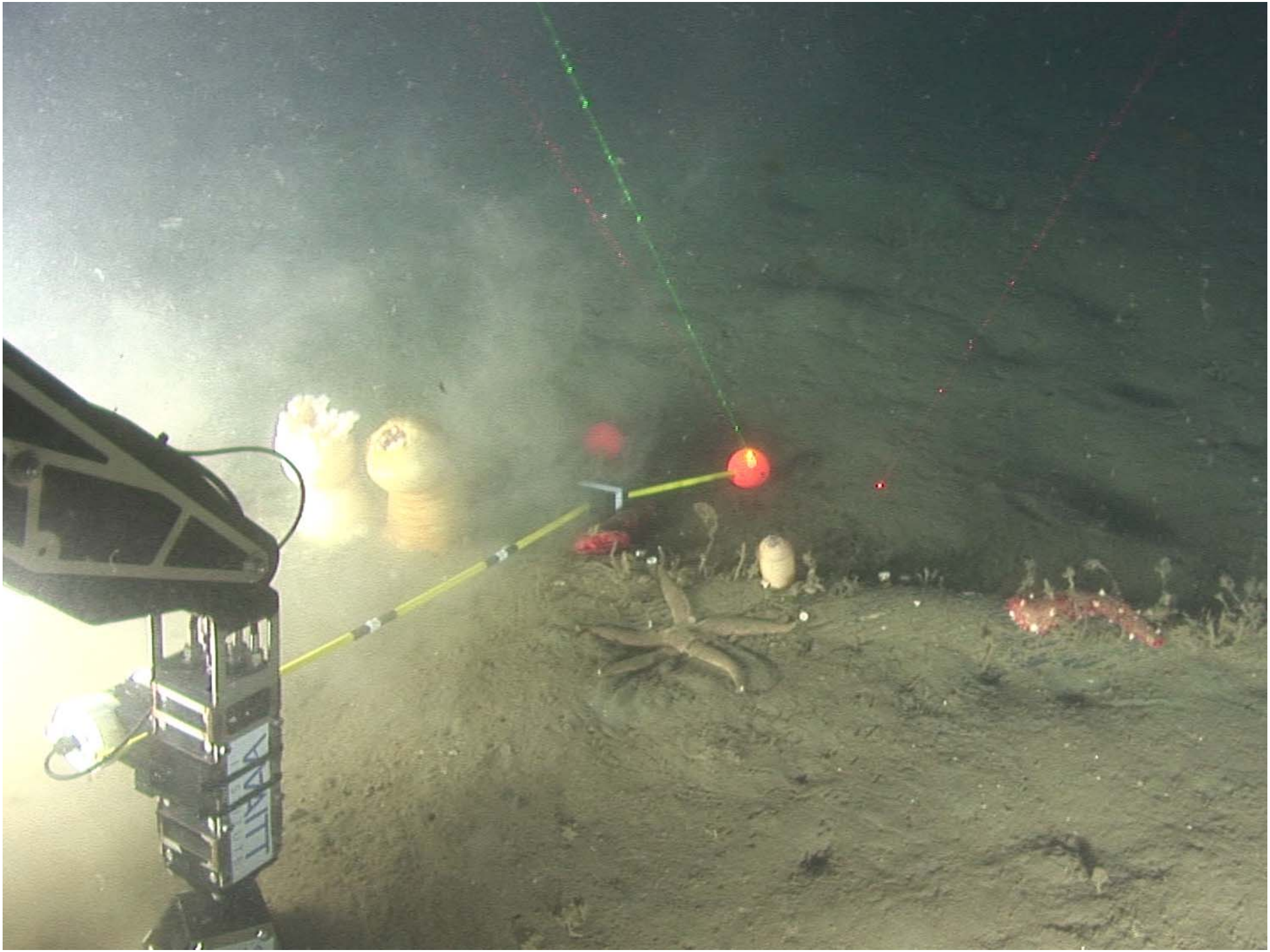
Multidimensional Scaling
All Fish Species – By Habitat
May–August, 2012

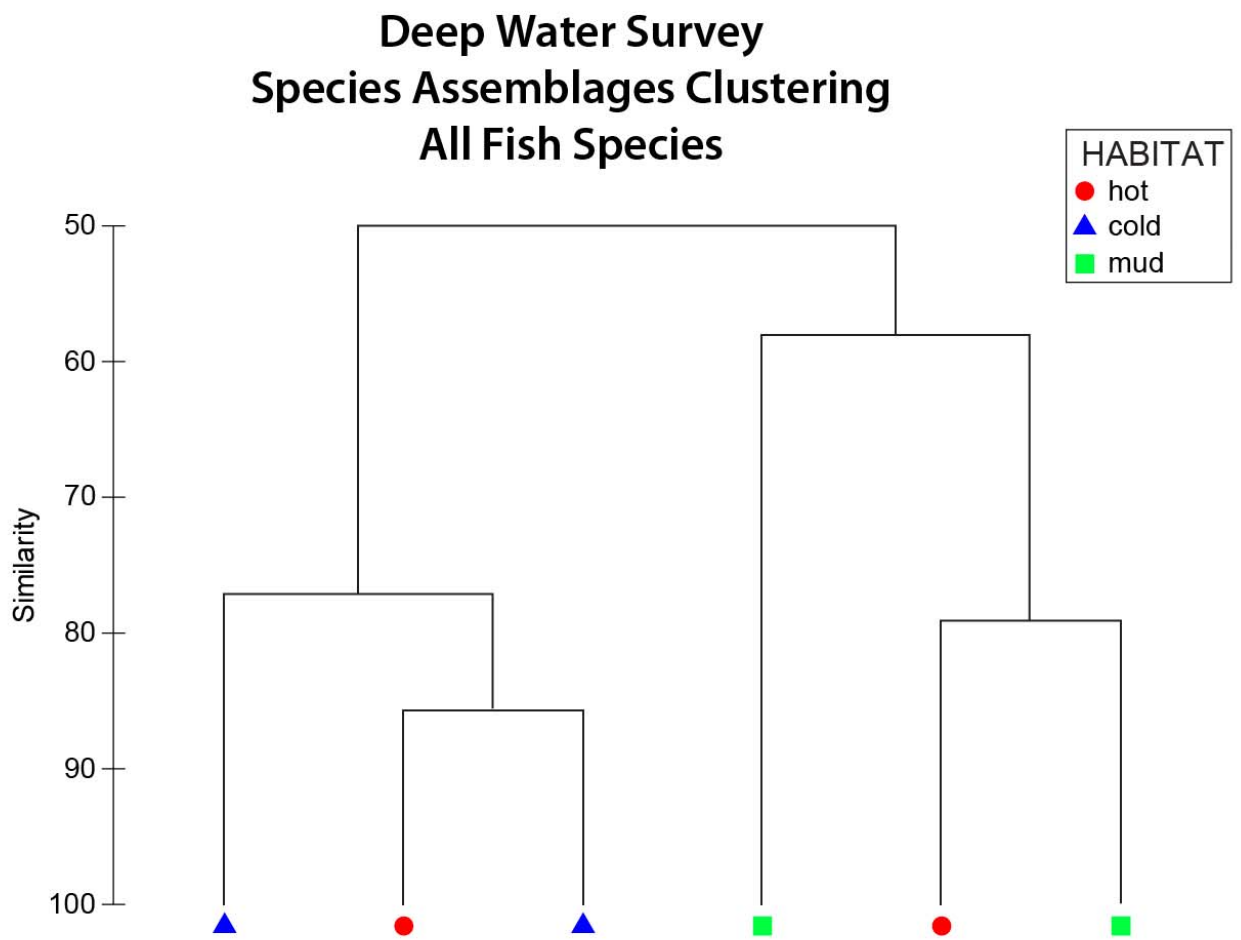


Average Number of Fishes Observed in Cable, Pipe, and Sand Habitats Per Survey Date from May through August 2012 (Inshore and Offshore Transects Summed)



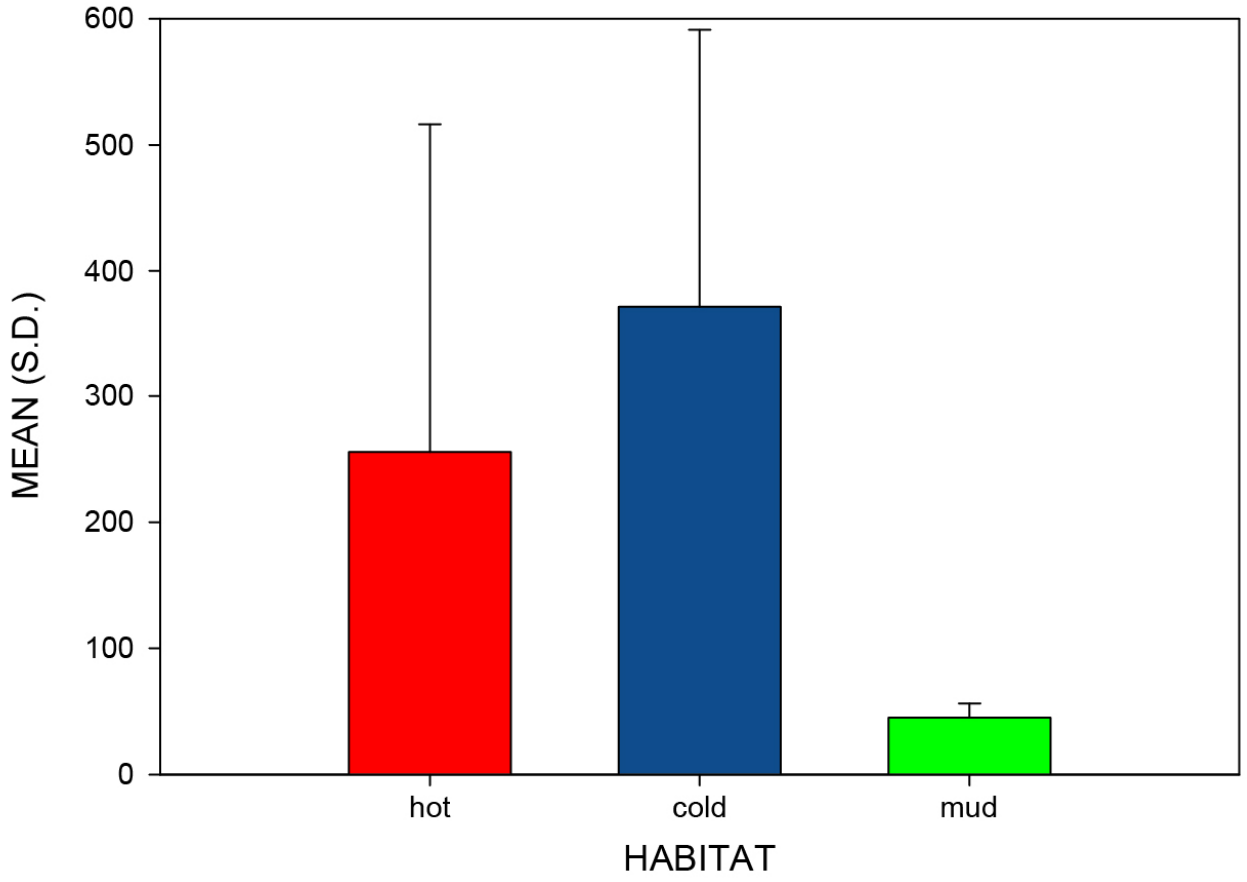

VELERO IV
SEATTLE



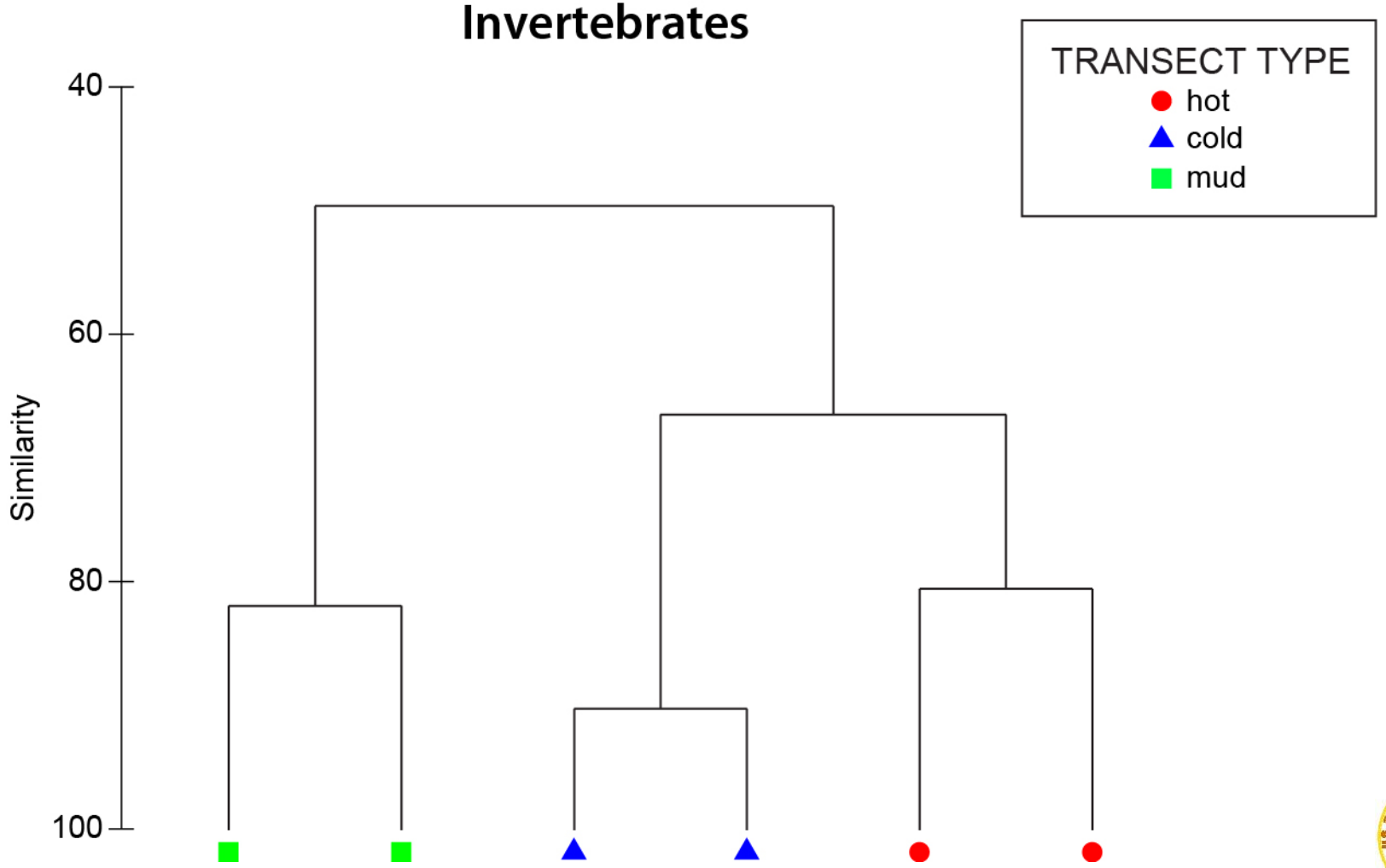

Deep Water Survey
Species Assemblages Clustering
All Fish Species
HABITAT
hot
cold
mud
Similarity
50
60
70
80
90
100

Deep Water Survey

Average number of fishes observed in cable (n=2 transects), pipe (n=2), and sand habitats (n=2)

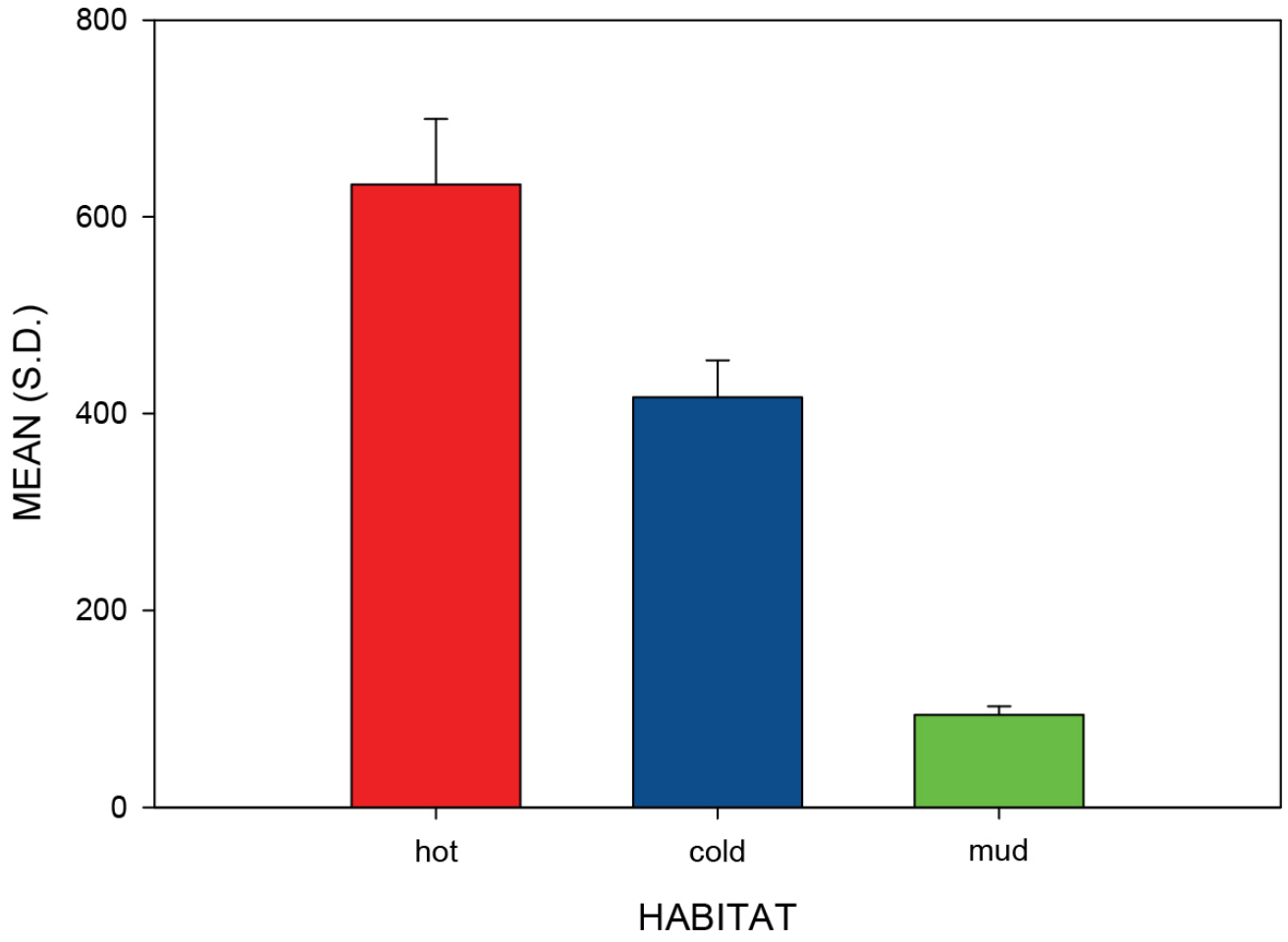


Deep Water Survey
Species Assemblages Clustering
Invertebrates



Deep Water Survey

Average number of invertebrates observed in cable (n=2 transects), pipe (n=2), and sand habitats (n=2)



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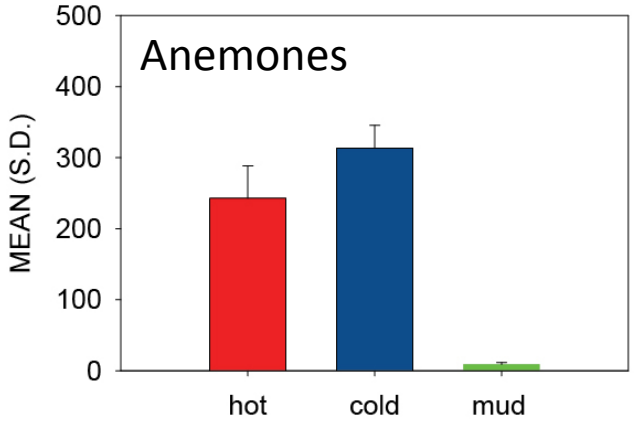

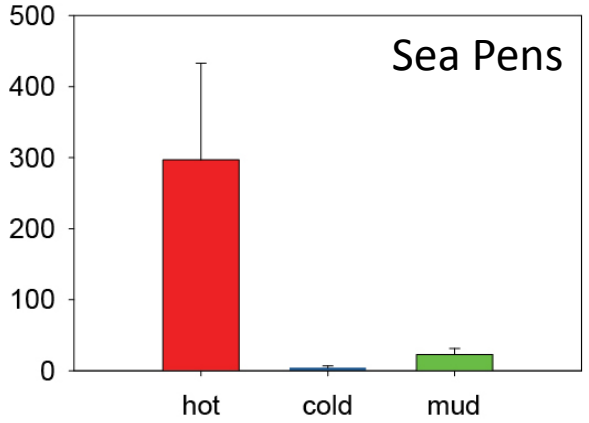

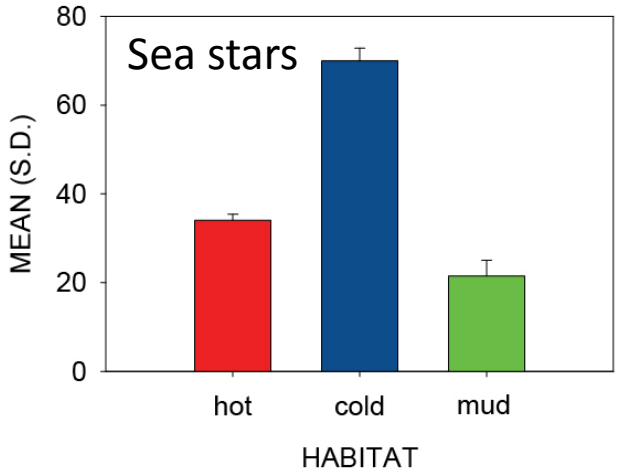

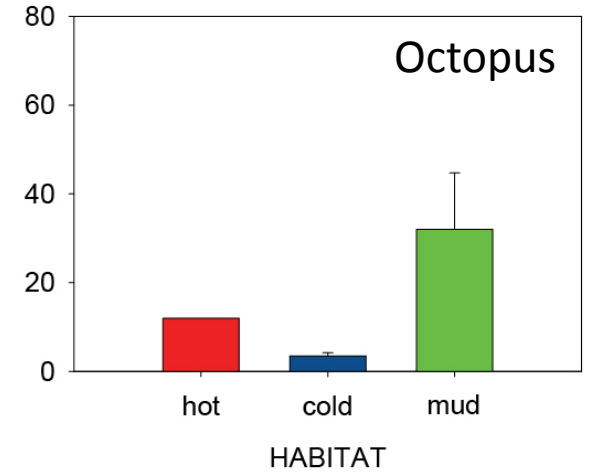

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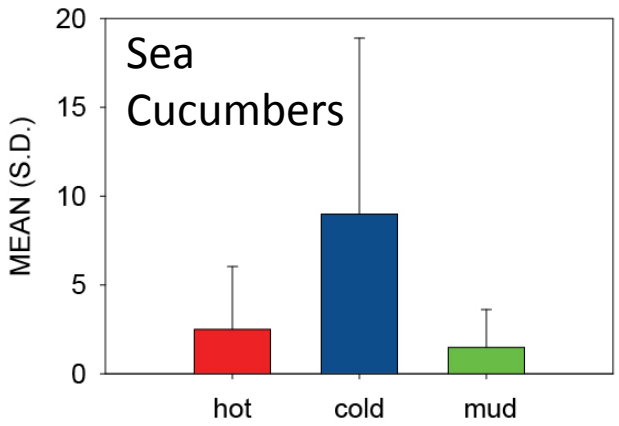

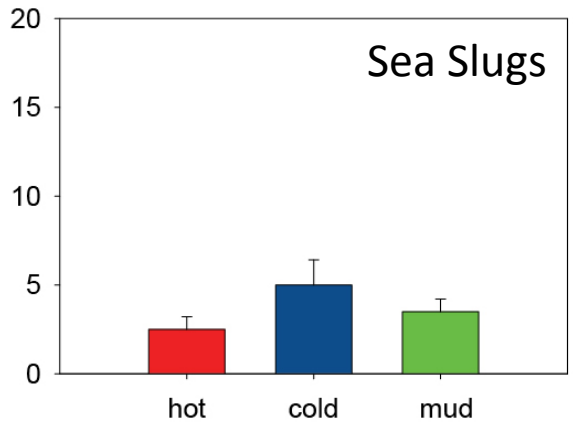

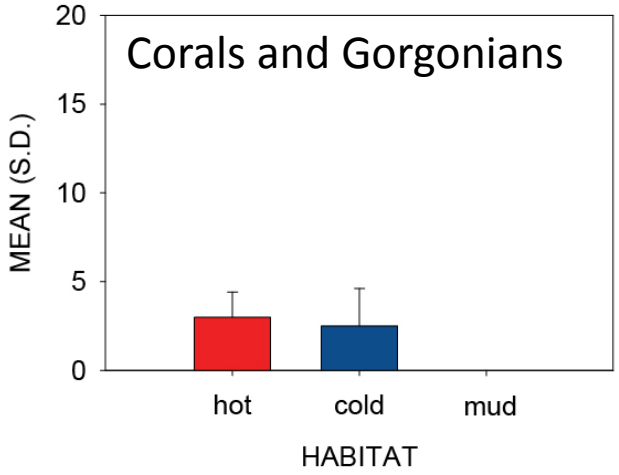

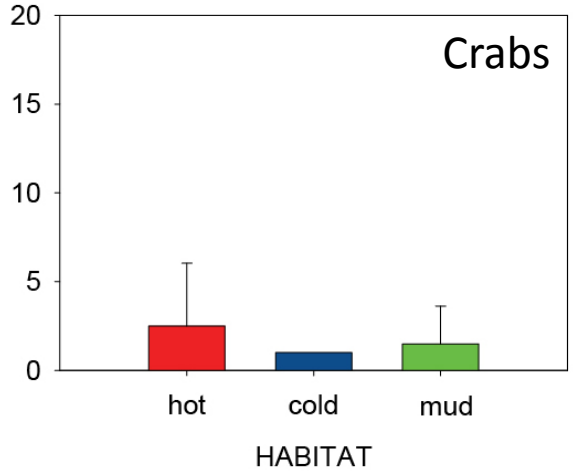

Conclusions from initial surveys in 2012

PRELIMINARY RESULTS suggest that fish assemblages do not differ between energized and non-energized AC submarine power cables.

There may be differences in invertebrate communities with sea pens exhibiting higher densities near energized cables compared to non-energized cables, and sea stars exhibiting lower densities near energized cables.

Further surveys may change or clarify initial patterns observed in 2012.

Potential Future Directions

Further studies on potential EMF impacts from **DC** submarine cables already operating in the marine environment

Additional field measurements of submarine power cable EMFs

Synthesis of information of sensitive species in Hawaiian waters

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Questions?

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