Welcome to the BOEM-Oregon Science Exchange

December 2 , 2015 10:00 am

Audio: call toll free 1-877-612-1641, passcode: 5729109

We will begin shortly!

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Bureau of Ocean Energy Management

BOEM-Oregon Science Exchange

Renewable Energy *in situ* Power Cable Observations

Ann Scarborough Bull, Ph.D.
Bureau of Ocean Energy Management, Pacific Region
December 2, 2015

Power Cable Observations
EMF and Marine Organisms

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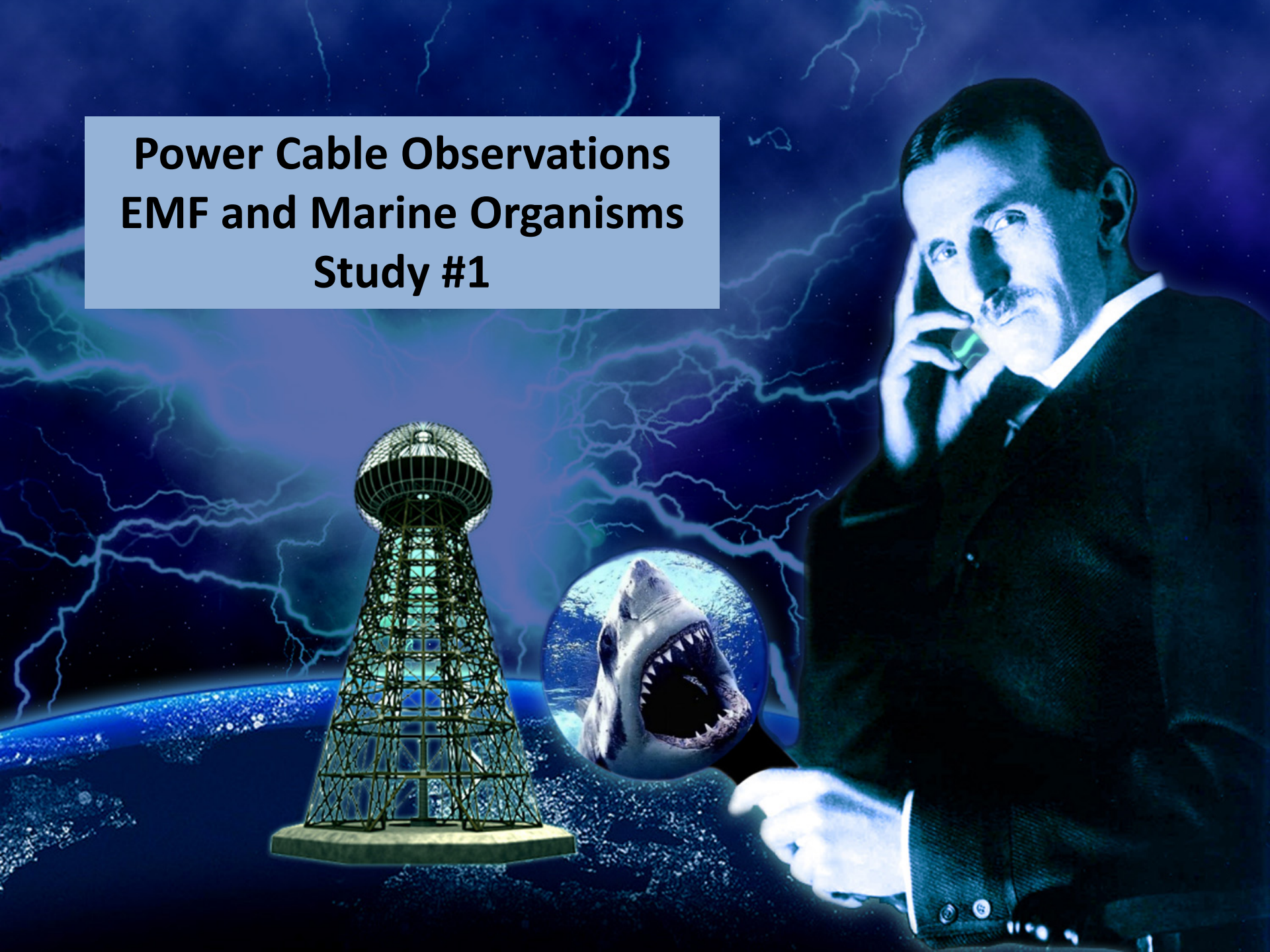
EMF Studies

2 BOEM-Funded Pacific Field Studies Related to EMF

- #1 Spring 2016 Renewable Energy *in situ* Power Cable Observation
  www.boem.gov/pc-11-03/

- #2 Summer 2017 Potential Impacts of Submarine Power Cables on Crab Harvest www.boem.gov/pc-14-02/

Power Cable Observations
EMF and Marine Organisms
Study #1



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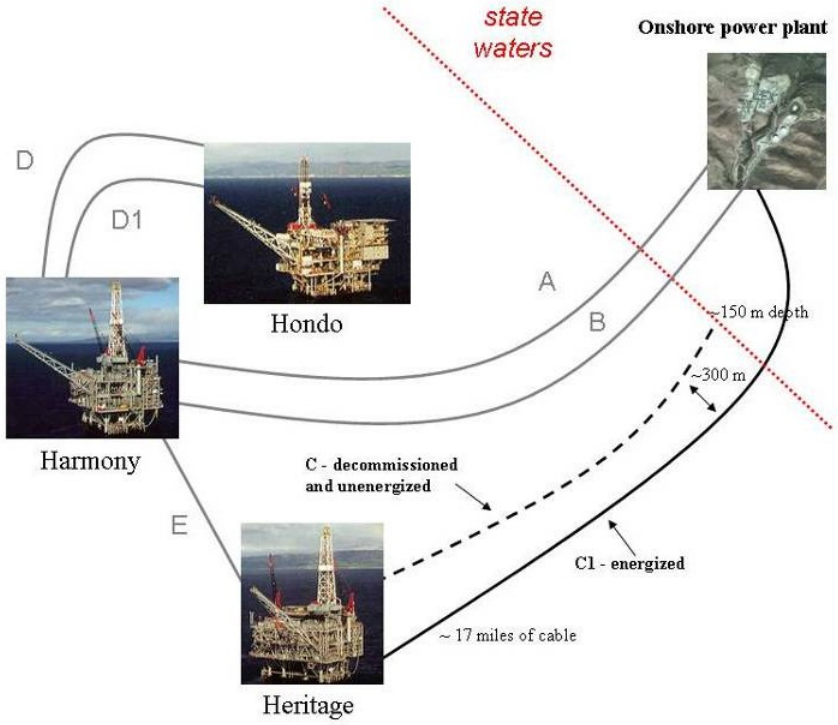
EMF Study #1

Renewable Energy *in situ* Power Cable Observation

Does EMF from a power cable attract/repulse fish or invertebrates?



Identical 35 kV AC Power Cables

Objectives:

- Measure the strength, spatial extent, and variability of EMFs along both energized and unenergized cables.
- Determine attraction/repulsion of fish and macroinvertebrates to the EMF from the power cables.
- Determine the effectiveness of the commonly proposed mitigation of cable burial.

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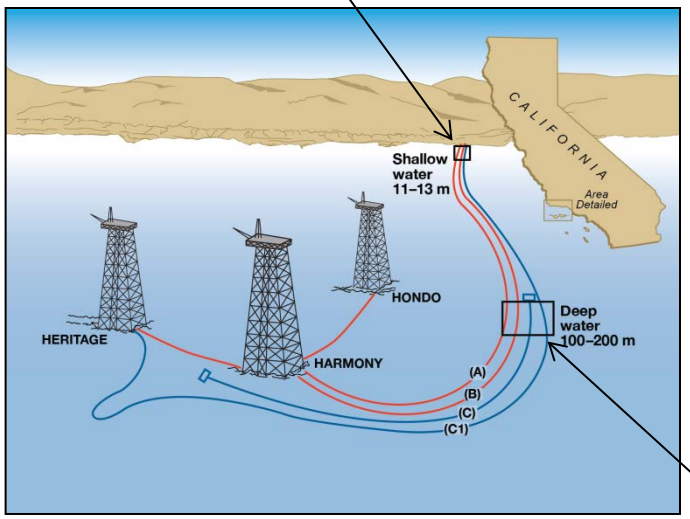
EMF Study #1

Methods:

Video Surveys using SCUBA

11-13 m depth



30-150 m depth

Video Surveys using Sub

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EMF Study #1

Methods:

Integrity Design & Research corp.
182 Browns River Rd.
Essex Jct, VT 05452 USA
Tel: (802) 872 7116
Fax: (802) 872 7115

http://www.integritydesign.com http://www.gaussmeter.info

CALIBRATION REPORT FOR IDR-210

INSTRUMENT:

Make: Integrity Design & Research Corp. (U.S.A.)
Mo/Yr Made: 05/12
Type: 3-Axis ELF AC Milligaussmeter
Serial #: 0202
Probe serial #: 0203
Model: IDR-210
Detector: Very sensitive AC magnetic field detector: (BW: 20-4000 Hz)

This is to certify that the above-described instrument was tested and calibrated on this date to meet or exceeded Integrity Design & Research Corp. published specification, and that the calibration standards used are traceable to the ones described in the "IEEE transactions on Instrumentation and measurement, vol.58, no.1, pp.129-140, Jan. 2009." The error is typically less than 3%. The meter was tested linearly for all the scales, and the readings were found to be accurate within the margins expected.

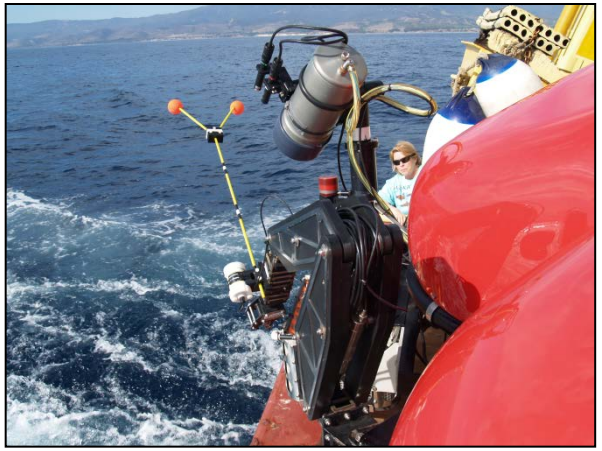
Temperature: $70^0 F$
Relative Humidity: 56%

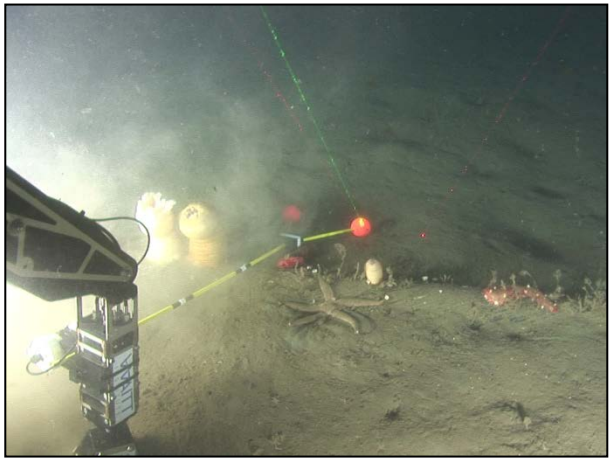
Date of Calibration: **09/01/12** Cal Interval: **12 Months**

This Certificate warrants that the factory calibration is valid up to 12 months from the date placed in service.

Certified By: Saba Hanna

EE, Ph.D





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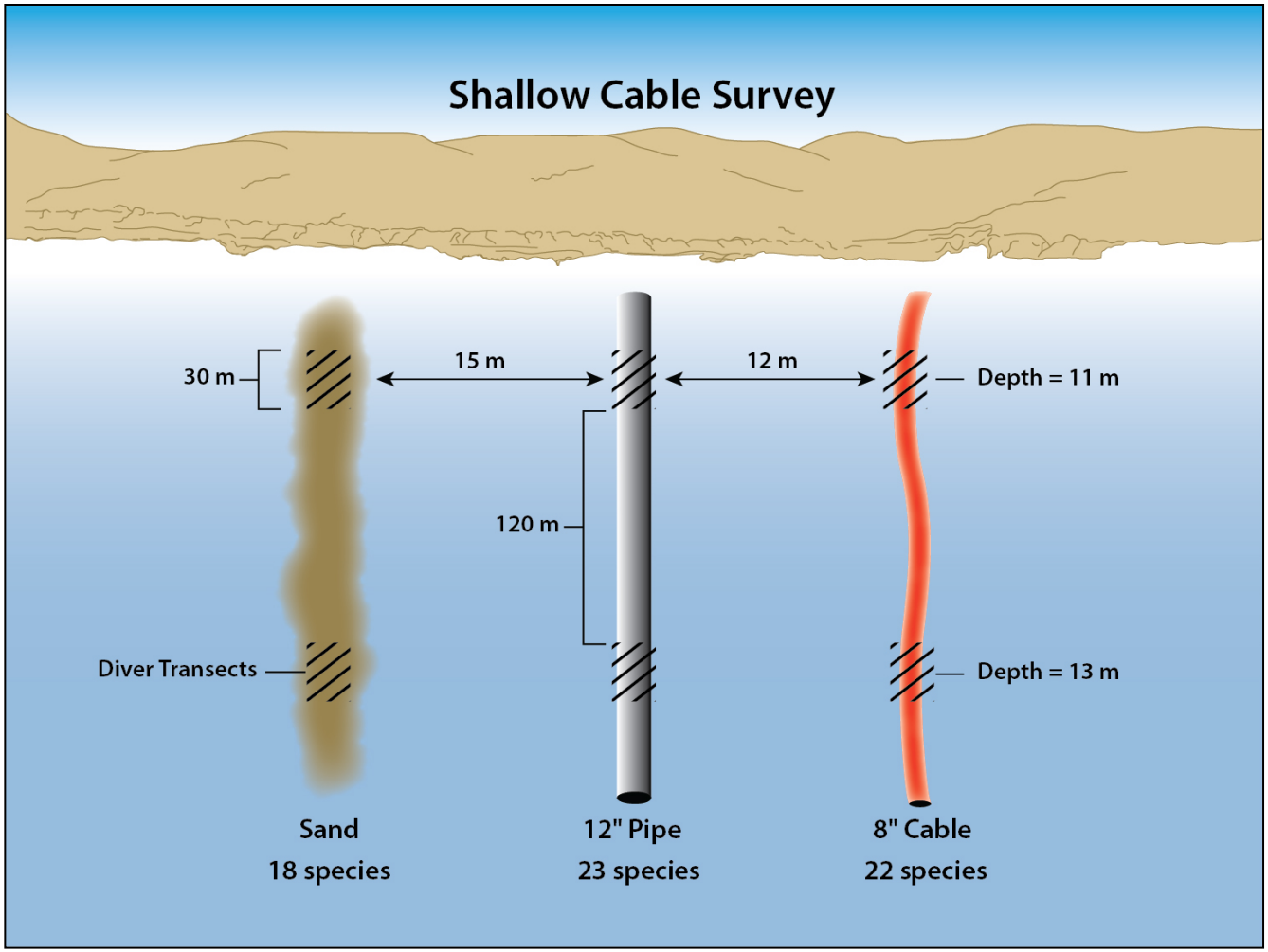
EMF Study #1

Pipeline as Proxy for Unenergized Cable in Shallow Water Surveys



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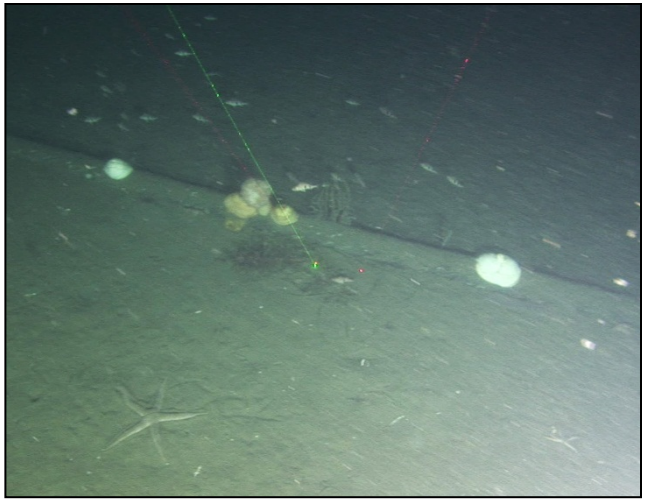
EMF Study #2

Some Findings from *in situ* Study

Mean EMF readings in µT

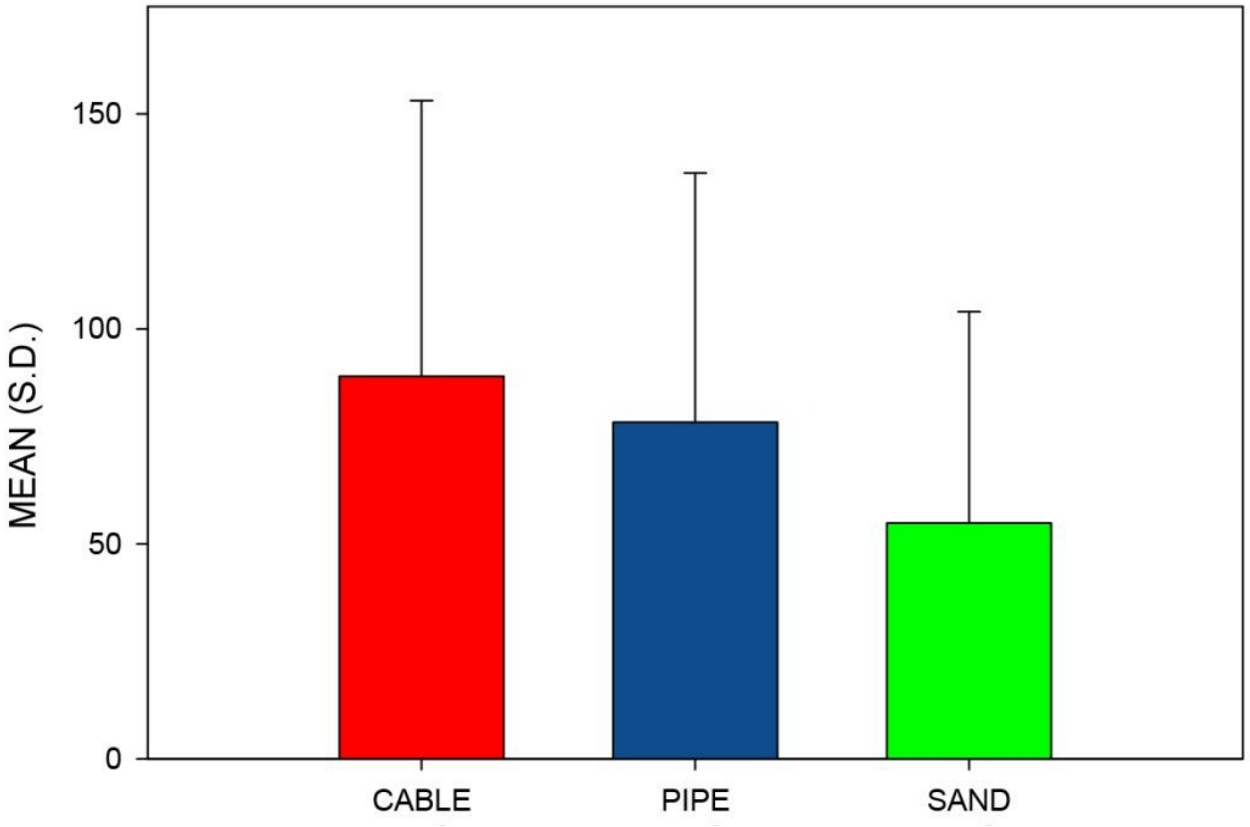
	SCUBA 11-13 m	Submersible 100-200 m
On Pipeline	0.5 µT	NA
On Cable	112 µT	109 µT
At ~0.5 m	2 µT	3 µT
At ~1 m	0.3 µT	0.2 µT
On Mud/Sand	0.0 µT	~0.05 µT



EMF Study #1

Some Findings from *in situ* Study – Shallow Water Depth

Average Number of Fishes Observed in Cable, Pipe, and Sand Habitats Per Survey Date from May through August 2012



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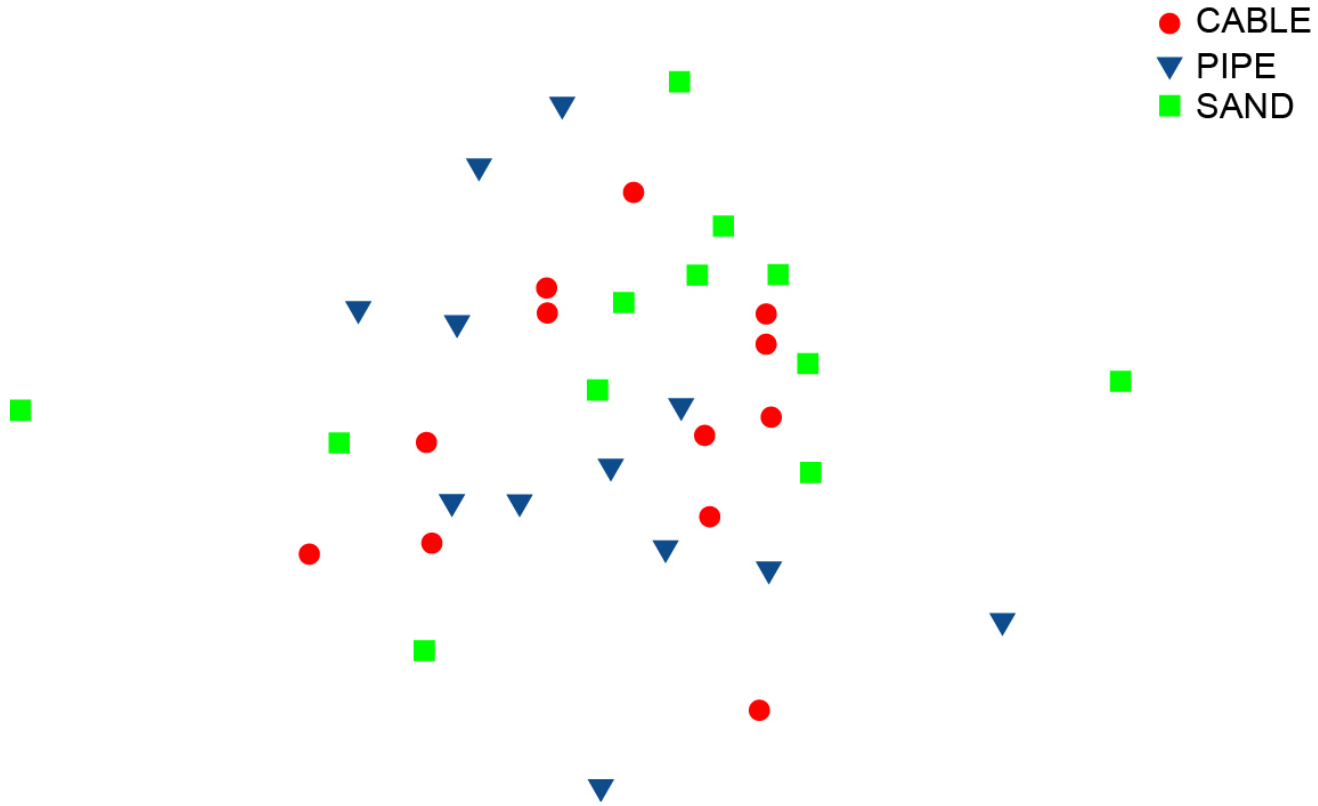
EMF Study #1

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



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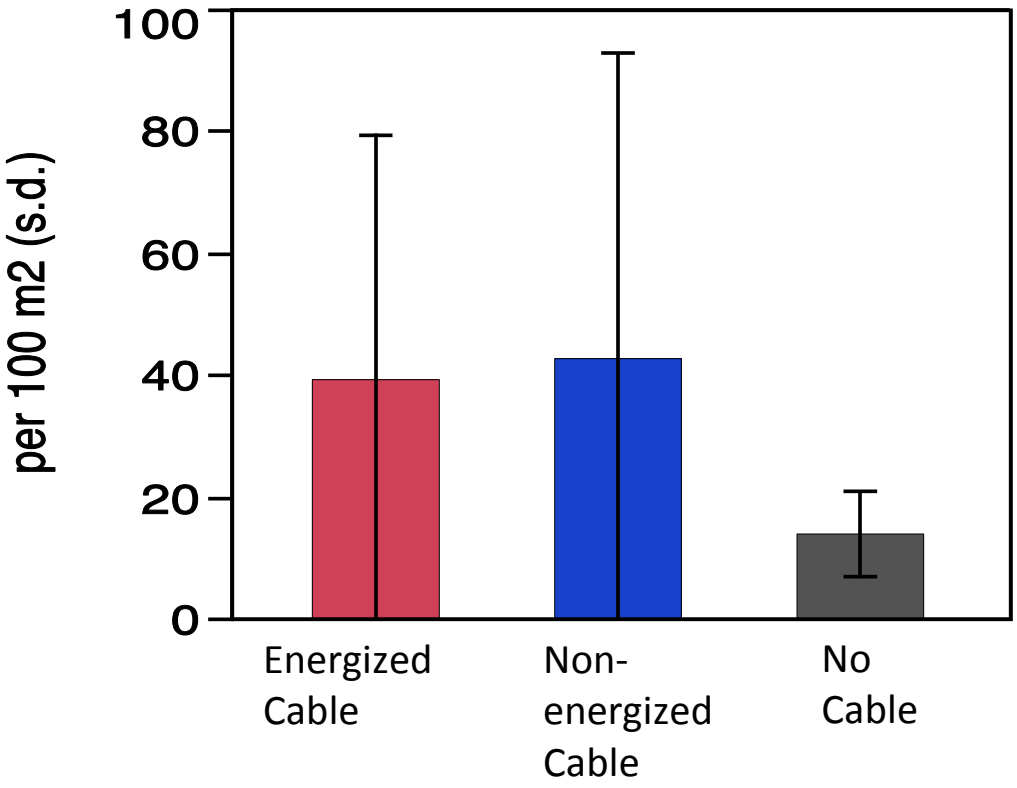
EMF Study #1

Some Findings from *in situ* Study – Deepwater Depth

Fish Density
24 Fish Species



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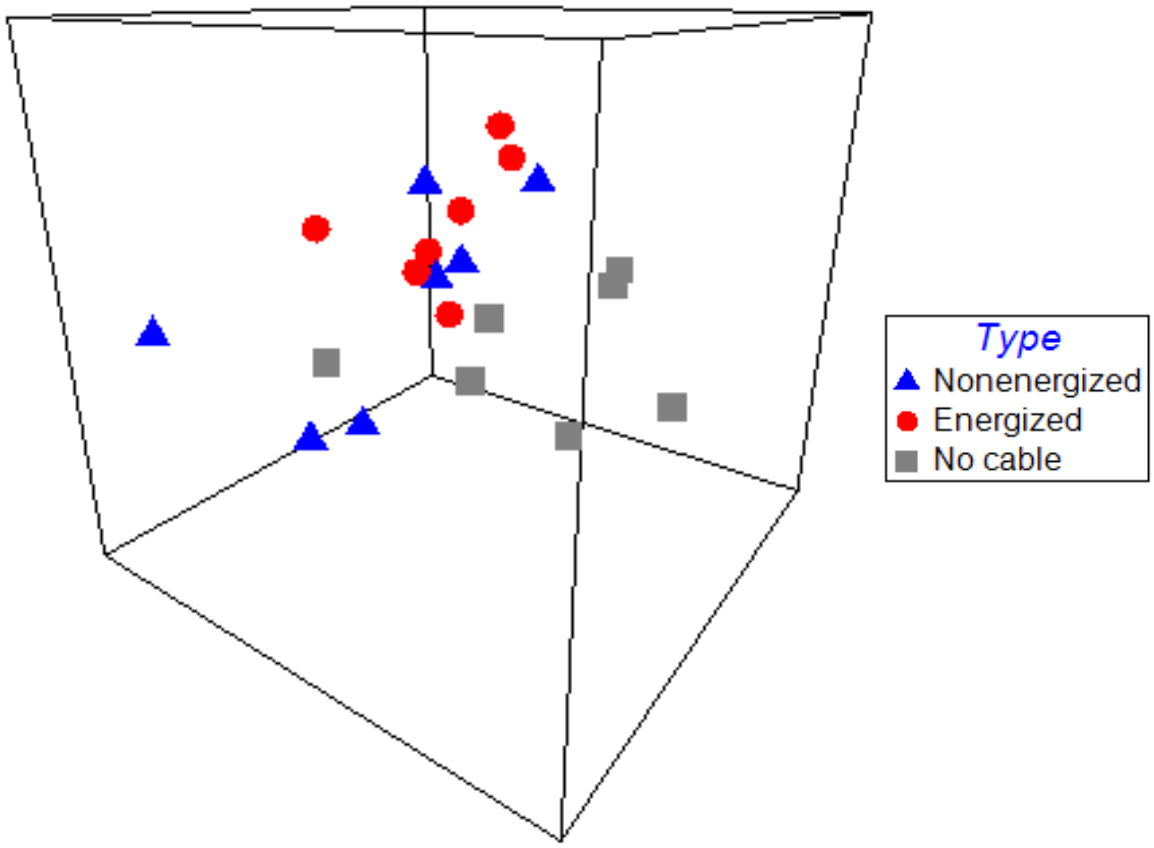
EMF Study #1

Multidimensional Scaling
All Fish Species – By Habitat
From 1-2 Years of Submersible Dives



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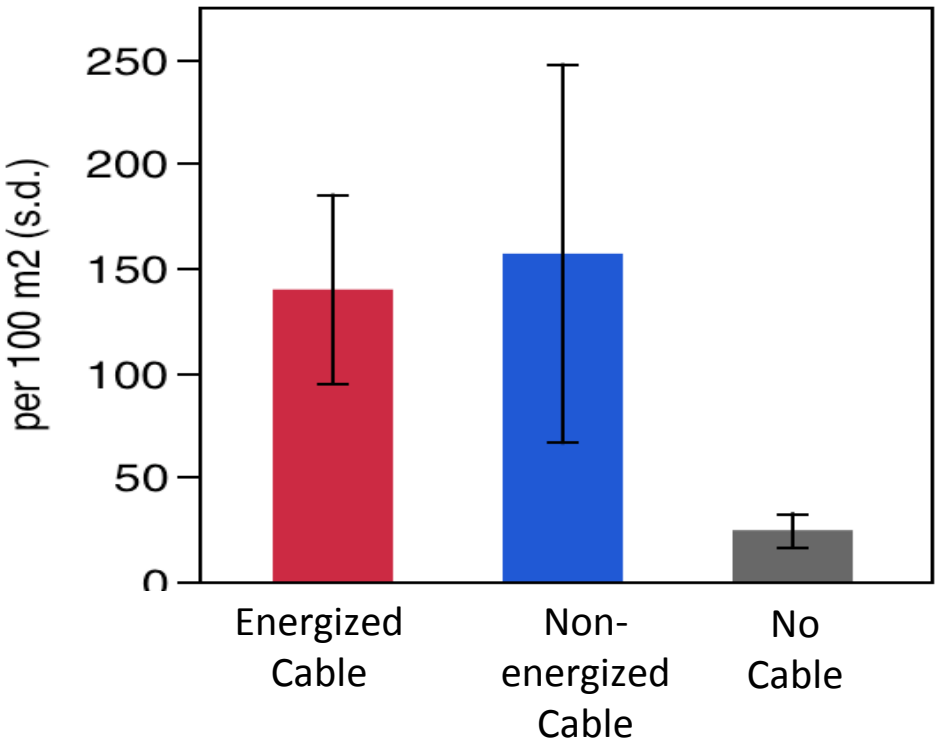
EMF Study #1

Invertebrate Density
16 Species



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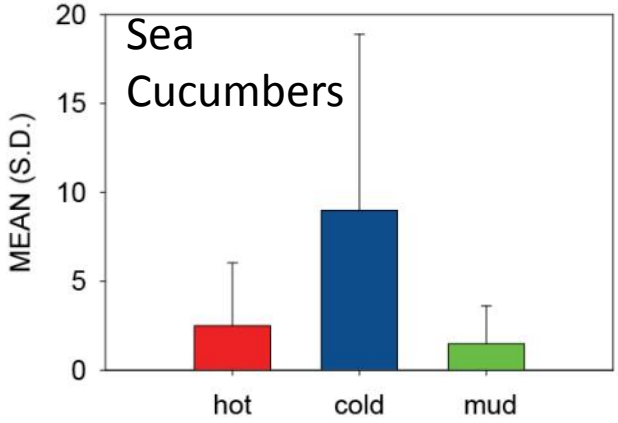

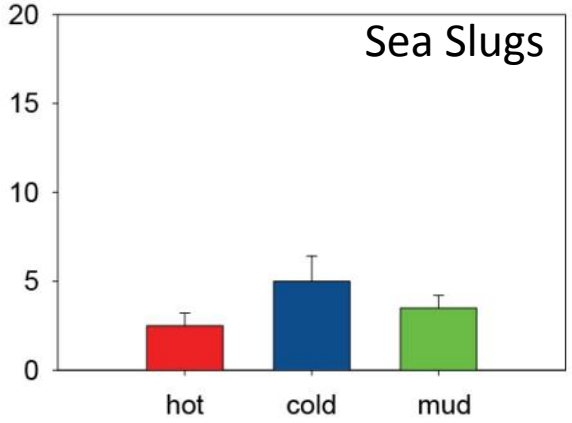

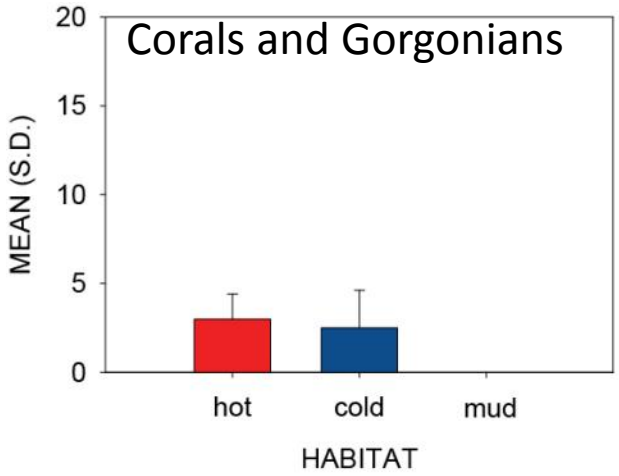

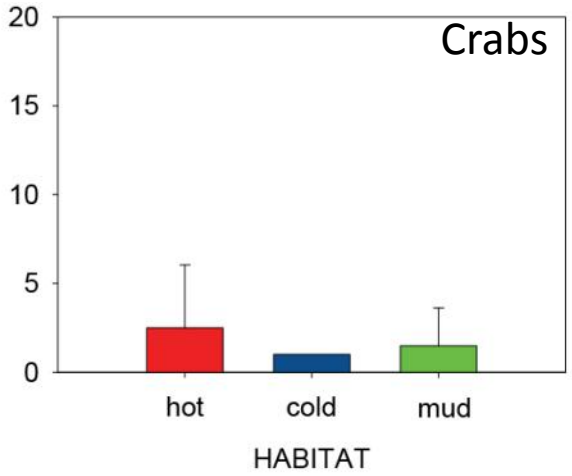

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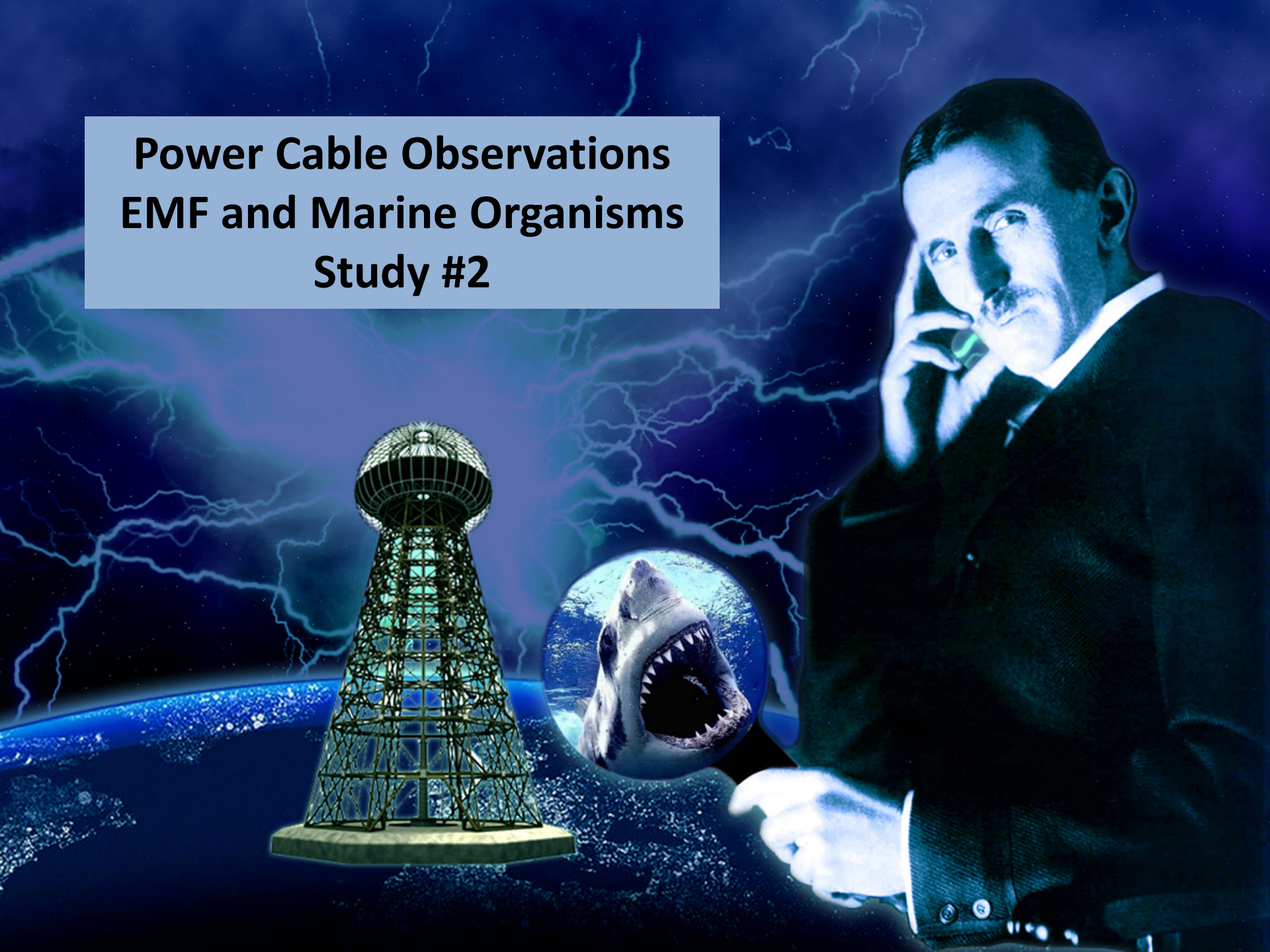
EMF Study #1

Preliminary Findings from *in situ* Study

Unpublished Results from 1-2 Years of Surveys
Final Analyses (from All Years) will Clarify Conclusions

- Results suggest no response (attraction/repulsion) from fish or macroinvertebrates to EMF from a 35 kV AC *in situ* power transmission cable.
- Differences in invertebrate communities may be associated with sediment characteristics close to the cable and their patchy nature of distribution.
- Actual EMF measured on the cables and away from cable output closely fits the model results found in BOEM Normandeau study
- Apparent lack of response would indicate burial is not always essential for biological reasons.
- The results will be published in scientific journals and issued as a 2015 BOEM report.

Power Cable Observations
EMF and Marine Organisms
Study #2



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EMF Study #2

Potential Impacts of Submarine Power Cables on Crab Harvest

Will EMF from a power cable affect commercial crab harvest?

Objectives:

- Determine if rock crab and dungeness crab will cross a power cable and be caught in commercial baited traps.
- Determine likely impact on harvest for assessment documents and planning.

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EMF Study #2

Potential Impacts of Submarine Power Cables on Crab Harvest

Will two crab species cross a power cable into a baited trap?

Methods:

- Use commercial crab fishermen and species.
- Determine the *in situ* EMF at AC and DC submarine cables.
- Expose rock crabs to 35 kV power cable with response choice in Santa Barbara Channel.
- Expose dungeness crabs to HVDC and/or AC power cables with response choice in Puget Sound.

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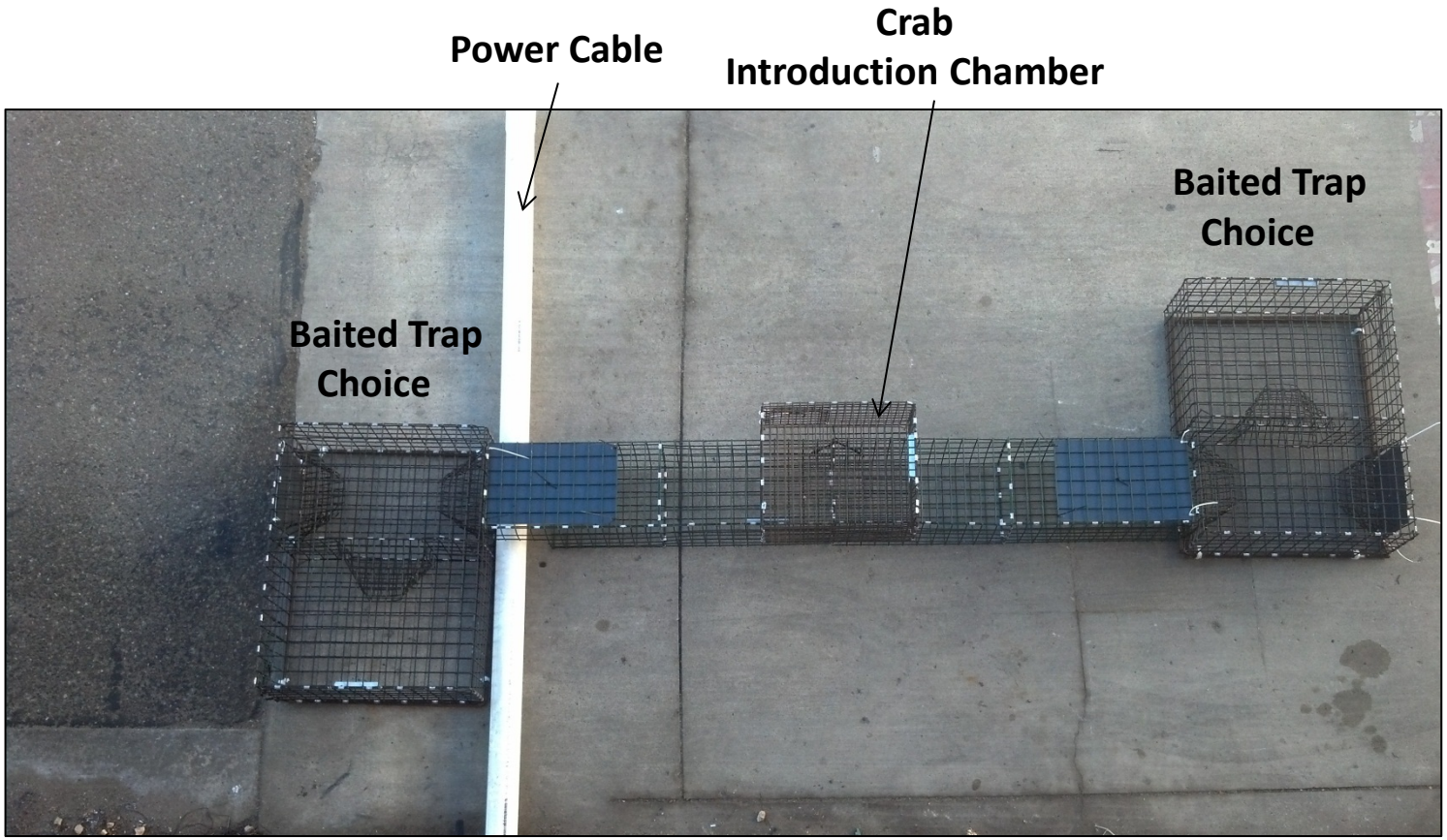
EMF Study #2

Crab Experimental Design

Give Crabs a Choice to Decide if They will Cross a Power Cable
in Response to a Baited Commercial Fishing Trap



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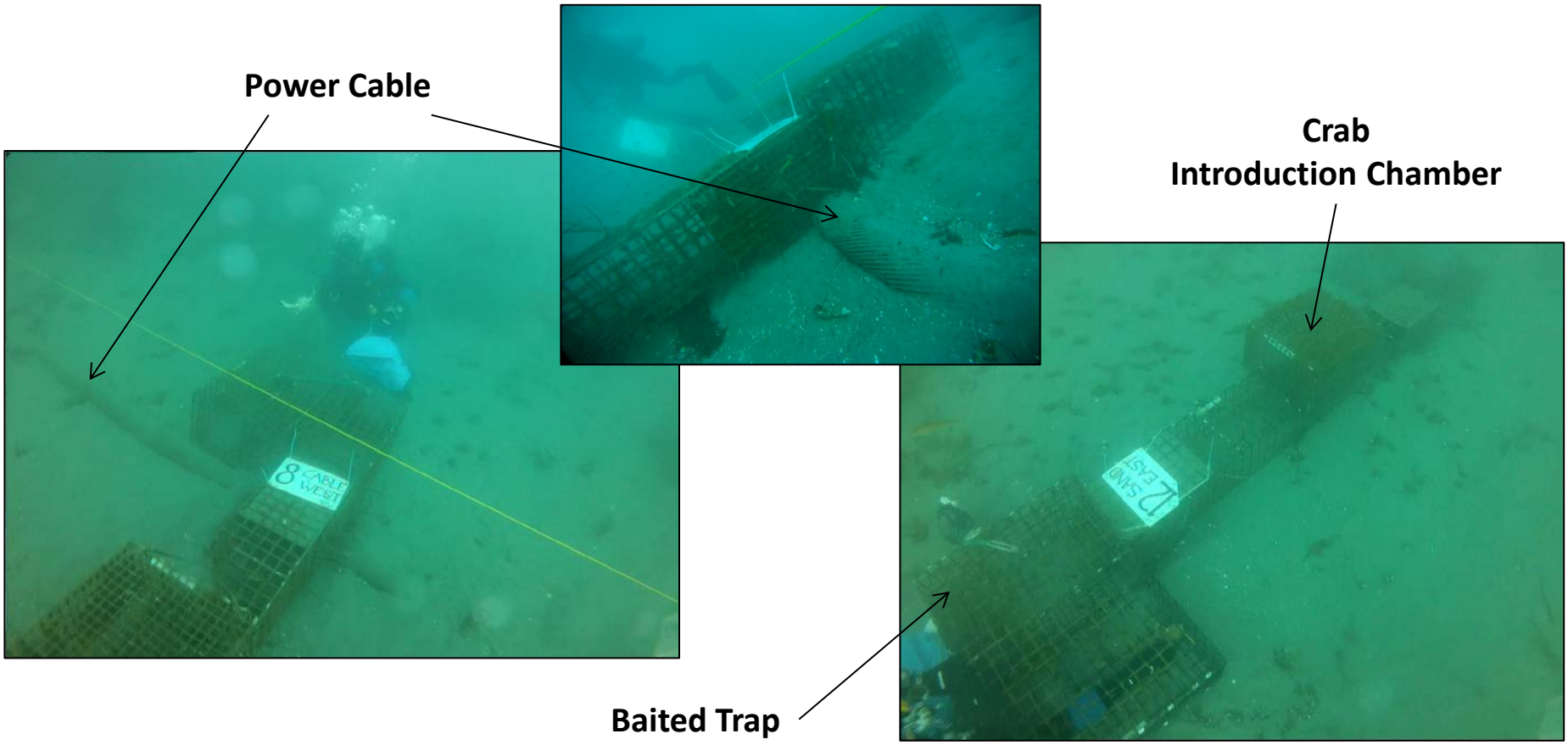
EMF Study #2

Rock Crab Experimental Design for Santa Barbara Channel

Give Crabs a Choice to Decide if They will Cross a Power Cable
in Response to a Baited Commercial Fishing Trap



EMF Study #2

Preliminary Findings from *Potential Effects on Crab Harvest* Study

Unpublished Results from 505 Rock Crab Experiments

Santa Barbara Channel
Rock Crab
Experiment

Frequencies

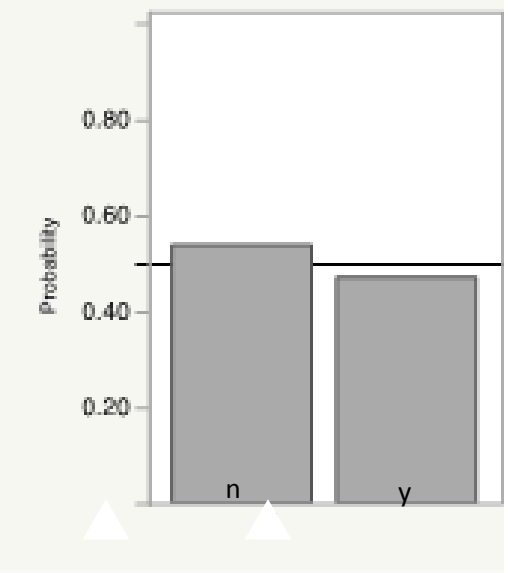
Level	Count	Prob
n	270	0.53465
y	235	0.46535
Total	505	1.00000

539 crabs deployed.
34 crabs did not enter a trap.

Test Probabilities

Level	Estim Prob	Hypoth Prob
n	0.53465	0.50000
y	0.46535	0.50000

Test	ChiSquare	DF	Prob>Chisq
Likelihood Ratio	2.4277	1	0.1192



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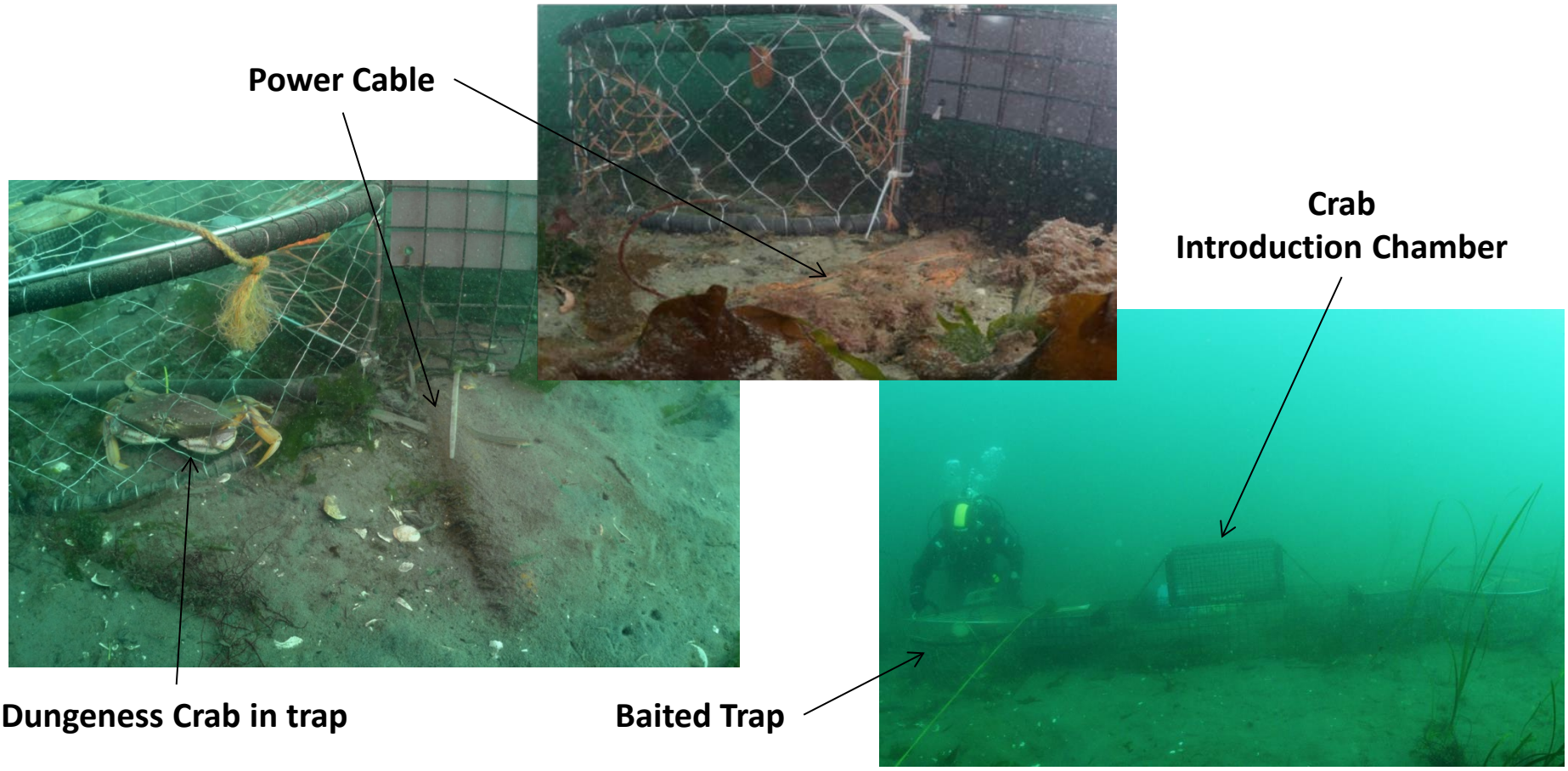
EMF Study #2

Dungeness Crab Experimental Design for Puget Sound

Give Crabs a Choice to Decide if They will Cross a Power Cable
in Response to a Baited Commercial Fishing Trap



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EMF Study #2

Preliminary Findings from *Potential Effects on Crab Harvest* Study

Unpublished Results from 287 Dungeness Crab Experiments

Puget Sound
Dungeness Crab
Experiment

Frequencies

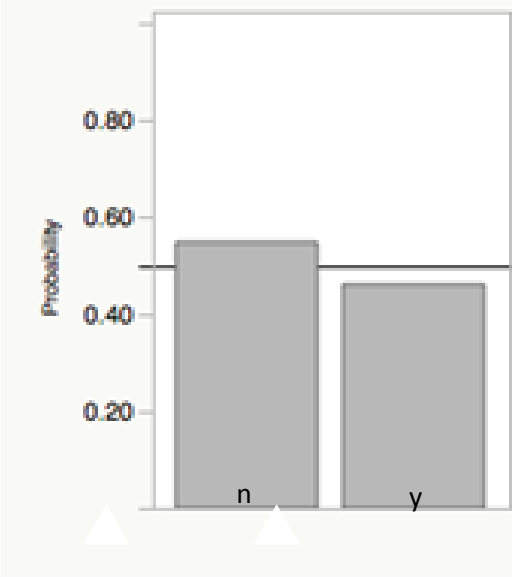
Level	Count	Prob
n	156	0.54355
y	131	0.45645
Total	287	1.00000

310 crabs deployed.
23 crabs did not enter a trap.

Test Probabilities

Level	Estim Prob	Hypoth Prob
n	0.54355	0.50000
y	0.45645	0.50000

Test	ChiSquare	DF	Prob>Chisq
Likelihood Ratio	2.1805	1	0.1398



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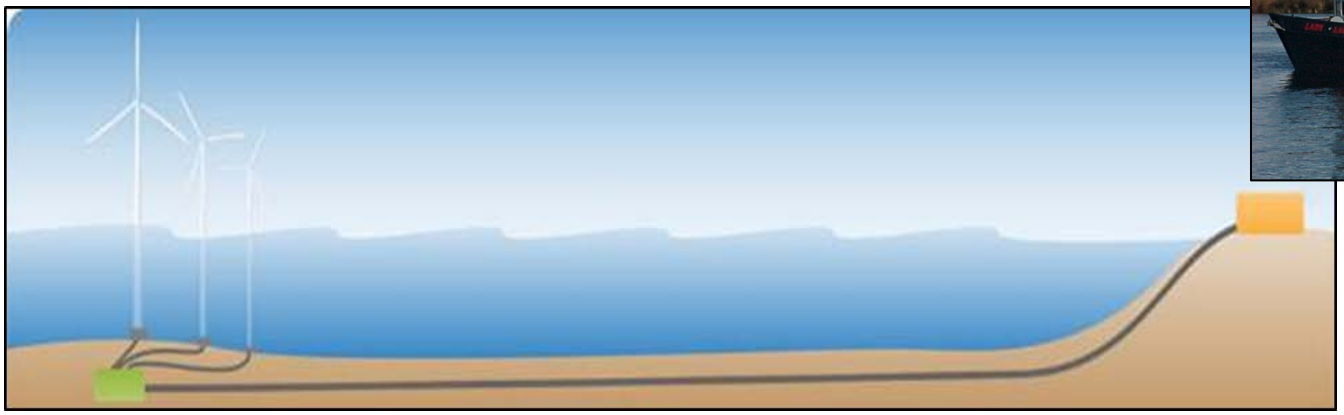
EMF Study #2

Preliminary Findings from *Potential Effects on Crab Harvest* Study

Unpublished Results from Rock and Dungeness Crab Experiments

- Results suggest rock crabs will cross an unburied 35 kV and dungeness crabs will cross an unburied 240 kV AC power cable to enter baited commercial traps.
- Results suggest rock and dungeness crabs will cross an unburied 35 kV and 240 kV AC power cable to enter baited commercial traps.
- The results will be published in scientific journals and issued as a 2017 BOEM report.



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Contact Information

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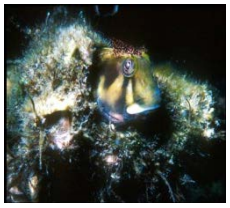

Our thanks to Nikola Tesla