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Electromagnetic Fields (EMF) and Environmental Risk

Studies Supported by BOEM

California Ocean Renewable Energy Conference

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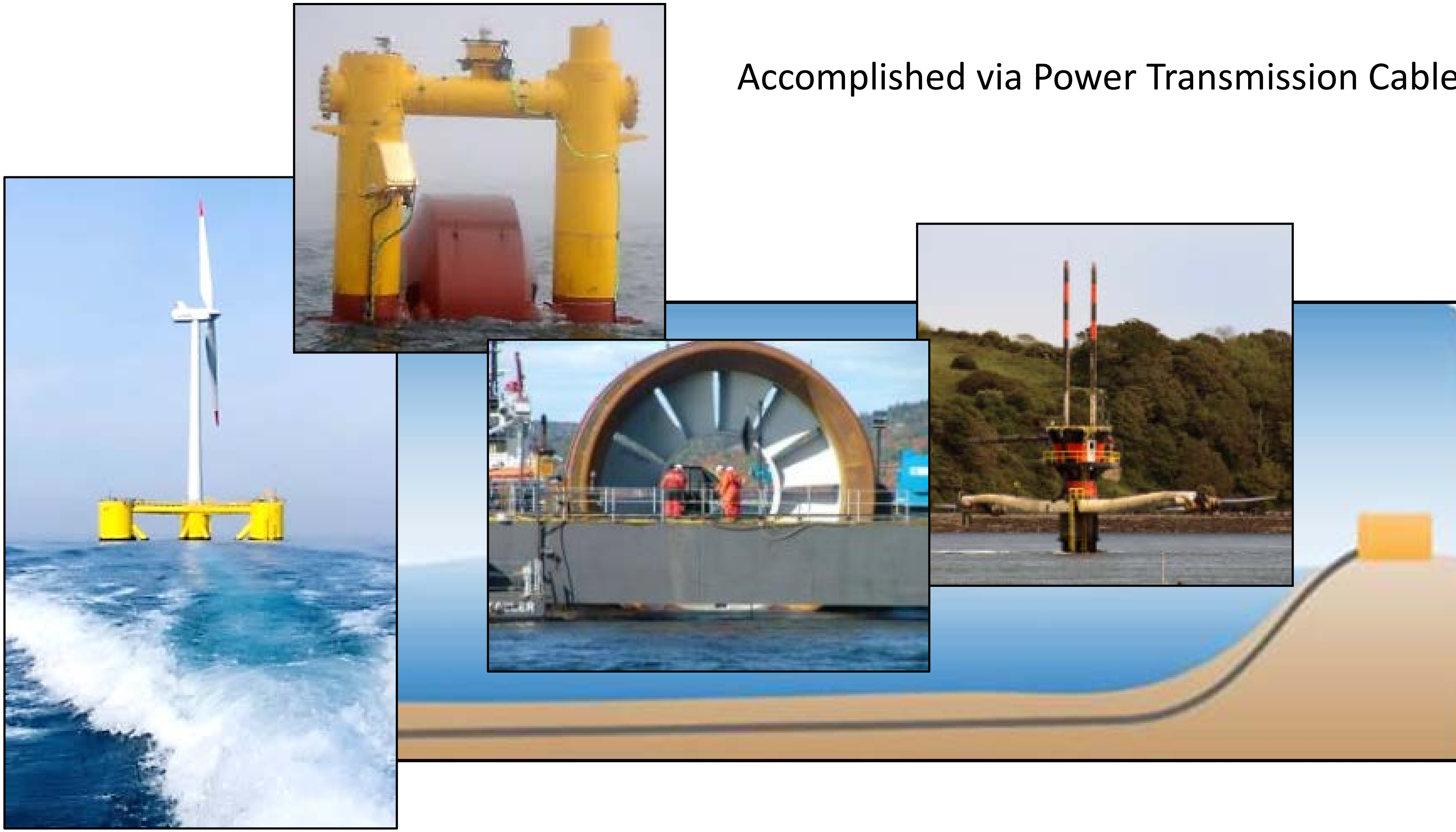
U.S. Department of the Interior
March 3, 1849

Moving Electricity from Offshore to Onshore is a Common Global Technology

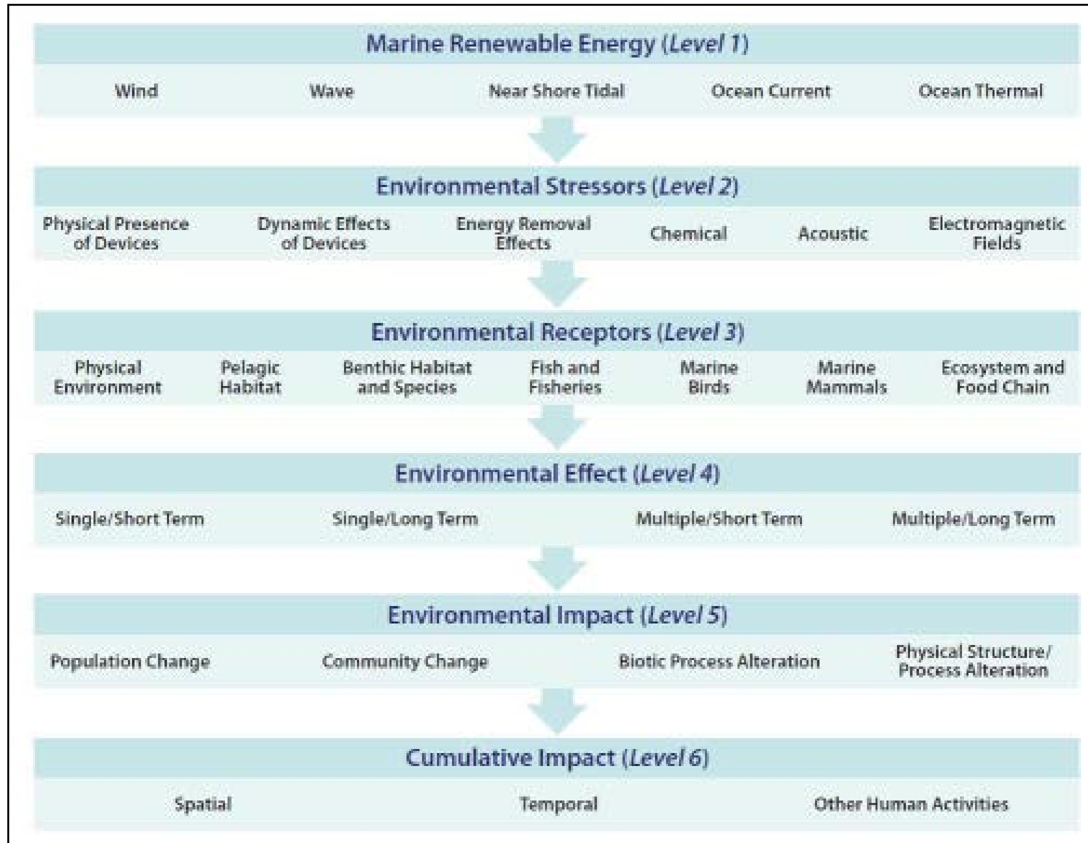
Accomplished via Power Transmission Cables



Uncertainty about Environmental Effects Increases Regulatory and Industry Risk

Confidence about Environmental Effects Stabilizes Risk and Expectations

- Framework for consideration of environmental effects of marine renewable energy encompasses different scales.
- The reaction of an individual animal at level four does not indicate that the animal is adversely affected.
- Level five makes the key distinction between biological response of an animal (level four) and environmental impact.

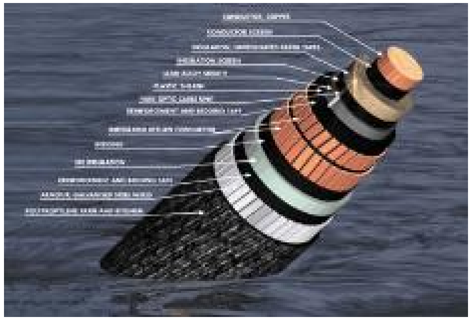


Boehlert and Gill 2010

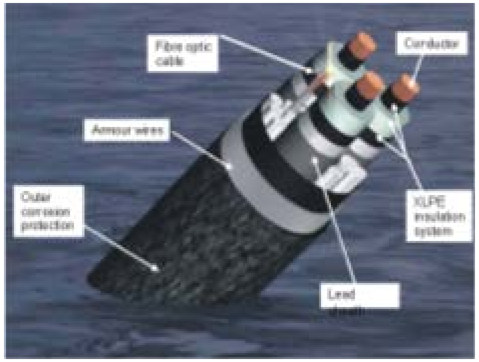
What is EMF?

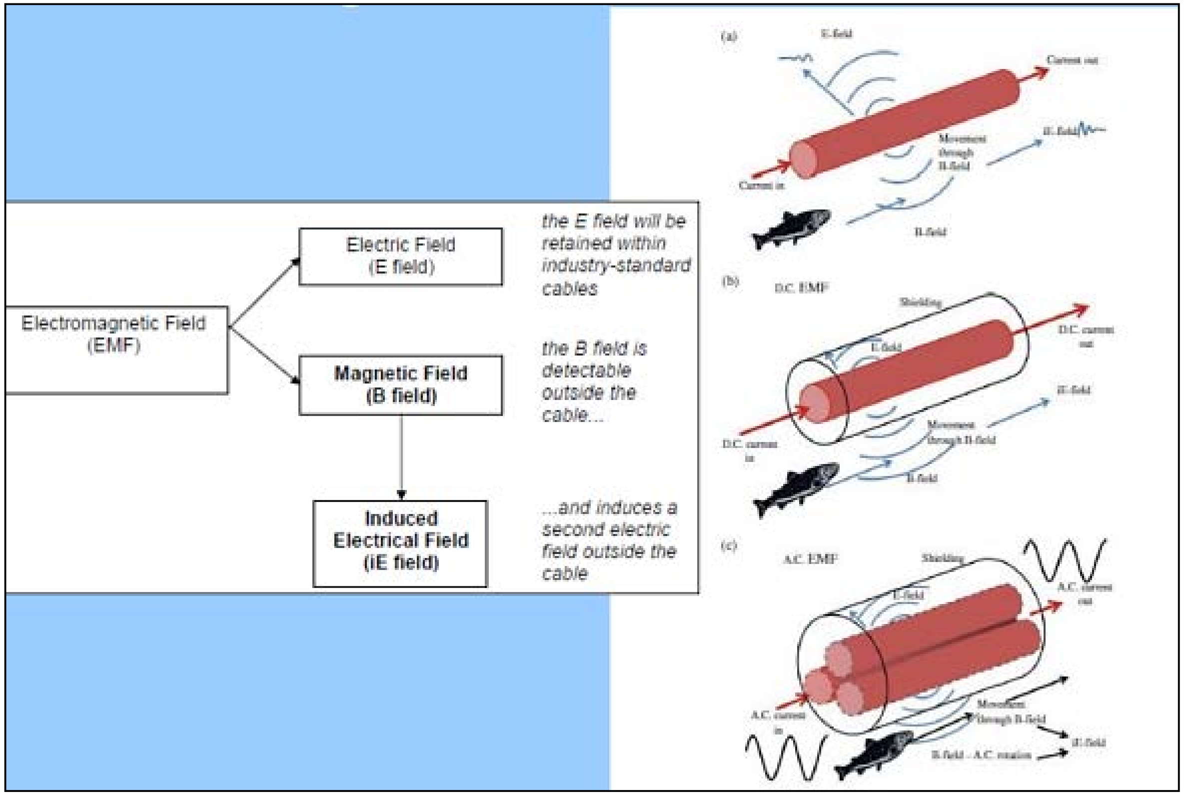
Defining Electromagnetic Fields for AC and DC Power Cables

DC Cable



AC Cable





DC

AC

Gill et al. 2009

3 BOEM-Funded Pacific Studies Related to EMF

- #1 Completed — Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species
  www.data.boem.gov/PI/PDFImages/ESPIS/4/5115.pdf
- #2 Completed — Renewable Energy *in situ* Power Cable Observation
  http://www.boem.gov/2016-008/
- #3 Ongoing — Potential Impacts of Submarine Power Cables on Crab Harvest
  www.boem.gov/pc-14-02/

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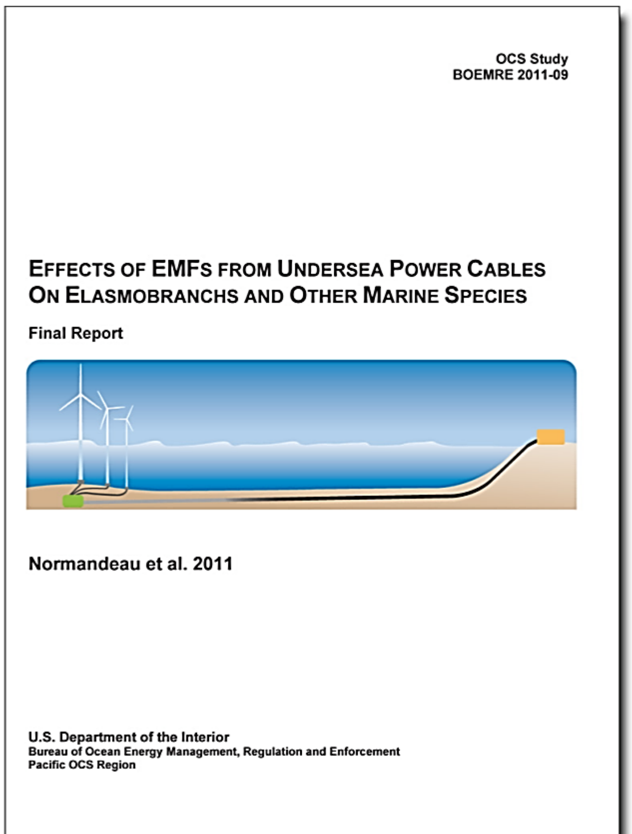
EMF Study #1

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

What does the literature tell us?


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

Objectives:

- Describe and quantify predicted EMF from power cables connected to offshore renewable energy projects.
- Compile information on sensitive marine species that have the potential for exposure effects.
- Understand sensitive marine species and the potential effects of exposure to EMFs from offshore power cables.

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EMF Study #1

Appendix Table B-1. Summary of information on existing and proposed undersea power cables.

Existing and proposed undersea power cables.

Year	Name	Country	Landfalls	Waterway	Length (km)	Frequency (Hz)	Voltage (KV)	Maximum Capacity (MW)	Calcs[a]	Marine Assess[b]
Existing Power Cables										
1969	1385 Line Cable System (NU/LIPA	US	Norwalk, CT Northport, NY	Norwalk Harbor/Long Island Sound	11.7	60	138	300	-	-
1996	Nantucket Cable #1	US	Harwich, MA Nantucket Is, MA	Nantucket Sound (Horseshoe Shoal)	26	60	46	35	Y	N
1998	Haines Scagway Submarine Cable Intertie Project	US	Haines, AK Skagway, AK	Taiya Inlet	24.2	60	35	15	-	-
2000	SwePol Link	SW/POL	Karlshamm, Sweden Slupsk, Poland	Baltic Sea	245 km	0	±450	600 Max	Y	-
2001	?	US	Galeveston, TX Galeveston Island, TX	?	?	60	138	200	?	?
2002	Replacement of 138kV Submarine Electric Transmission Cable System	US	Norwalk, CT Northport, NY	Norwalk Harbor/Long Island Sound	17.7	60	138	300	Y	Y
2002	Cross Sound Cable	US	New Haven, CT Brookhaven, NY	Long Island Sound	38.6	0	± 150	330	Y	Y
2002	San Juan Cable Project	US	Fidalgo Island Lopez Island	Puget Sound	13.5	60	69		-	-
2003	Nysted Offshore Wind Farm	DE	Baltic Sea Nysted, Denmark	Baltic Sea	48 km	50	33 to 132	165.6	-	Y

Normandeau et al. 2011

Some Findings from Literature Study

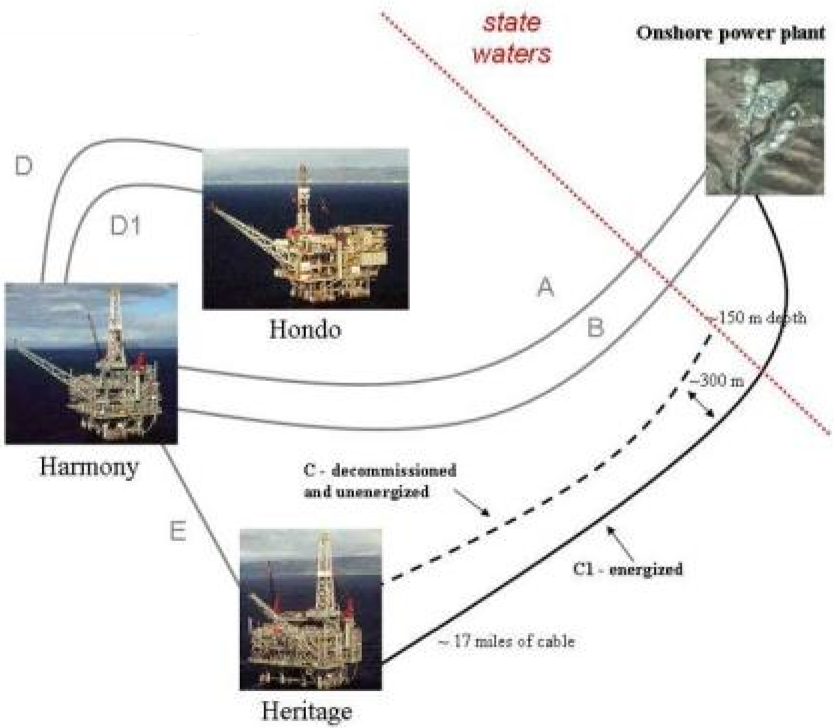
- Anticipated EMFs from power cables can be modeled easily <u>if</u> specific information is available:
  - Cable design
  - Burial depth and layout
  - Magnetic permeability of the sheathing
  - Loading

- Behavioral responses to and some effects from electro- or magnetic fields are known for a few species; extrapolation to many other species or to population impacts is speculative.



Renewable Energy *in situ* Power Cable Observation

What does an observational study tell us?



Identical 35 kV AC power cables carrying a usual load of 17-18 MW and occasionally as high as 26 MW

Objectives:

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

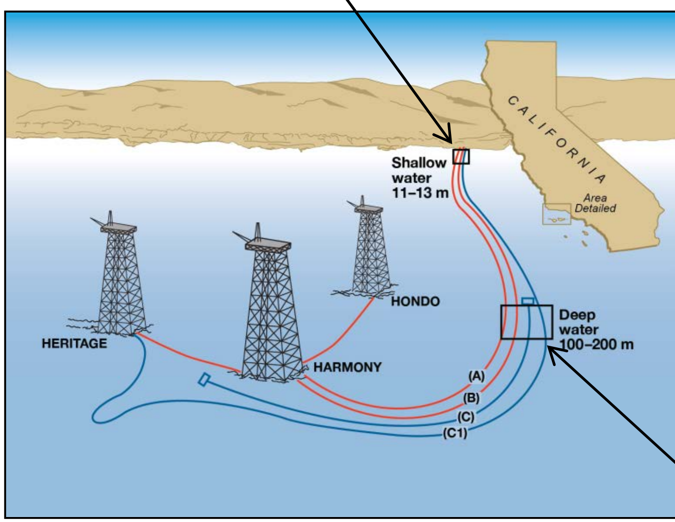
Love et al. 2016

EMF Study #2

Methods:

Video Surveys using SCUBA

11-13 m depth



30-150 m depth

Video Surveys using Sub

Some Findings from the *in situ* Observation Study

- No response (attraction/repulsion) from fish or macroinvertebrates to EMF from a 35 kV AC *in situ* power transmission cable.
- At a usual electricity load of 17-18 MW, and occasionally as high as 26 MW, the EMF measured 109-120 µT directly on the 35 kV energized cable.
- Carrying no electricity load, the mean value EMF was 0.5 µT directly on the unenergized cable.
- The scalar magnitude of the magnetic field diminishes toward background levels (~0.05 µT) at a distance of 1 m from the energized cable.
- Actual EMF measured on and away from the cables closely fits the model results found in Study #1.
- Apparent lack of response to EMF generated from 17-26 MW 35 kV cables indicates burial of such cables is not essential for biological reasons.

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EMF Study #3

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 environmental assessment and planning.

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.
- Measure the *in situ* EMF at AC cables.
- Expose rock crabs to 35 kV AC power cable with response choice in Santa Barbara Channel.
- Expose dungeness crabs to 69 kV AC power cable with response choice in Puget Sound.

EMF Study #3

Crab Experimental Design

Give crabs a choice to decide if they will cross an energized power cable in response to a baited commercial fishing trap

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EMF Study #3

Crab Experimental Design

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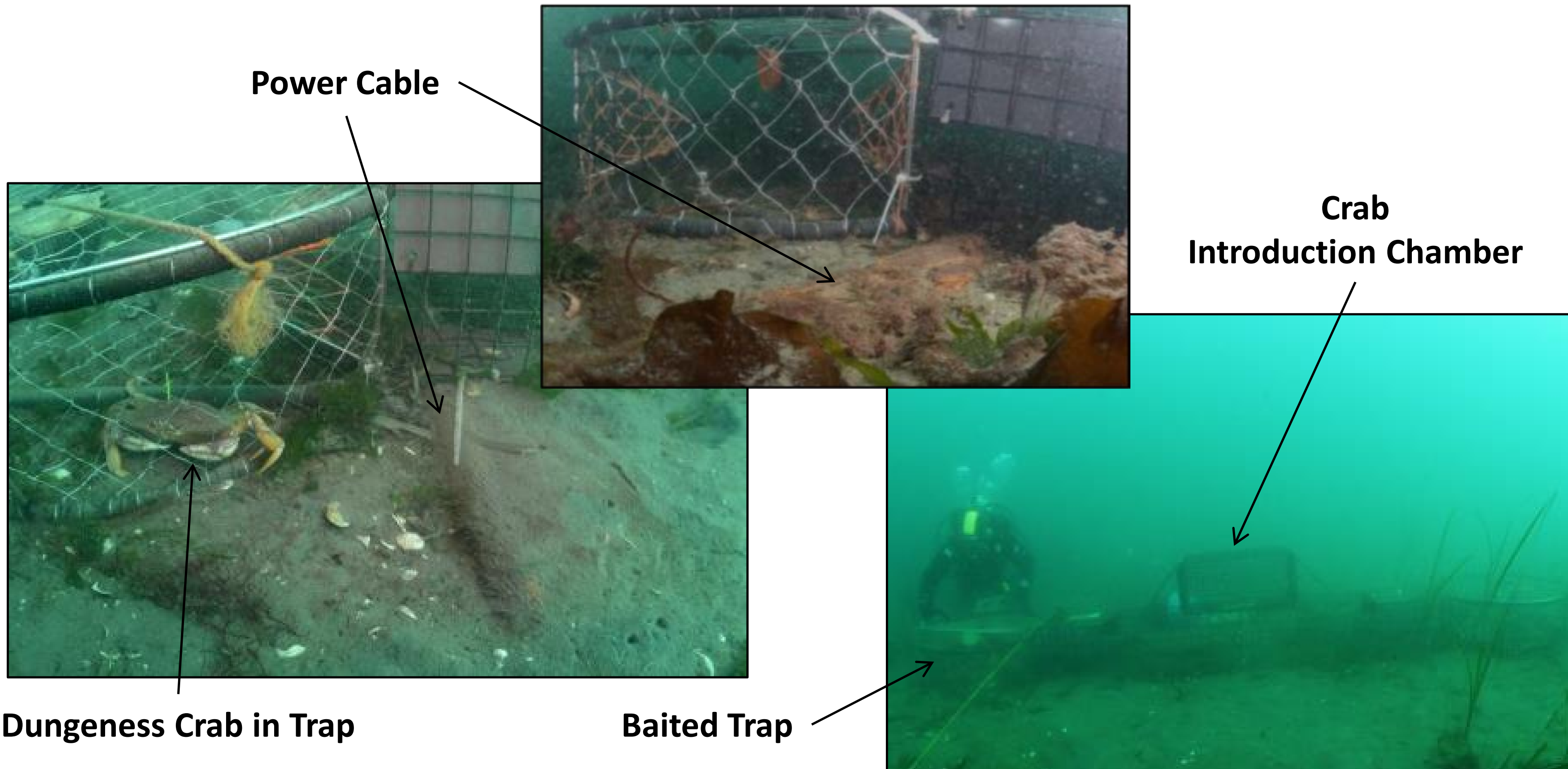

Preliminary Findings from Crab Harvest Study

Unpublished Results from Rock and Dungeness Crab Experiments

- Rock crabs will cross an energized unburied 35 kV AC power cable and Dungeness crabs will cross an energized unburied 69 kV AC power cable to enter baited commercial traps.
- Crabs tend to move into the current.
- Chemosensory response to bait in commercial traps is not impeded by the energized power cables.

Contact Information

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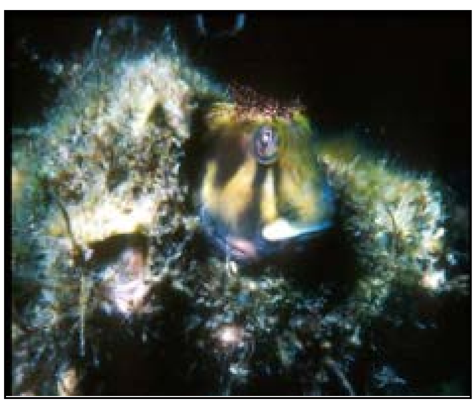

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