



Searching for the FishOASIS: Using passive acoustics and optical imaging to identify a chorusing species of fish

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Point Conception

- Legend
- Island Special Closure
 - SMCA
 - SMCA (No-Take)
 - SMR

Los Angeles

San
Diego

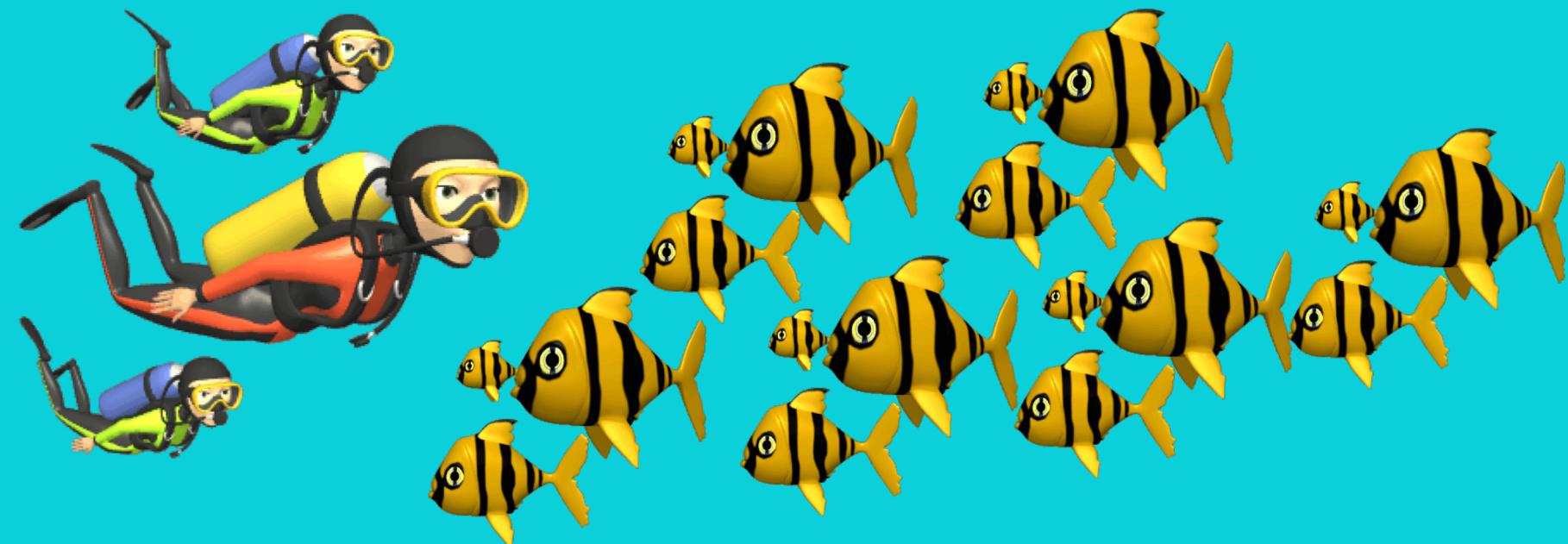
Southern California Marine Protected Areas (MPAs)

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data: APHIS
Image: Google
Data: LDEO-Columbia, NSF, NOAA

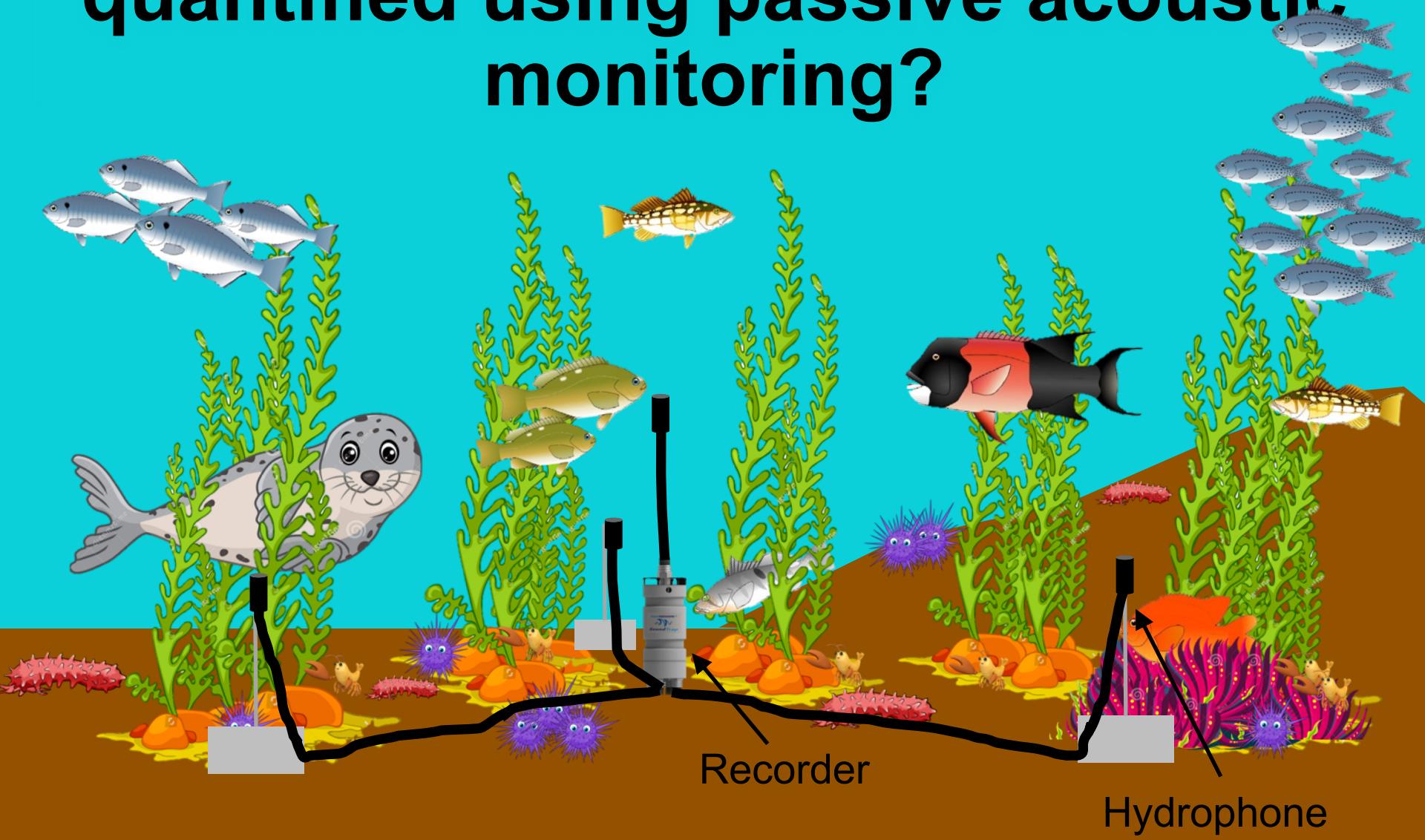
The background image shows an underwater environment with a dense forest of kelp. The water is a clear teal color, and the sunlight filters down through it, illuminating the long, thin blades of kelp. The plants are anchored to a rocky or sandy bottom.

How do we assess the impact of MPAs?

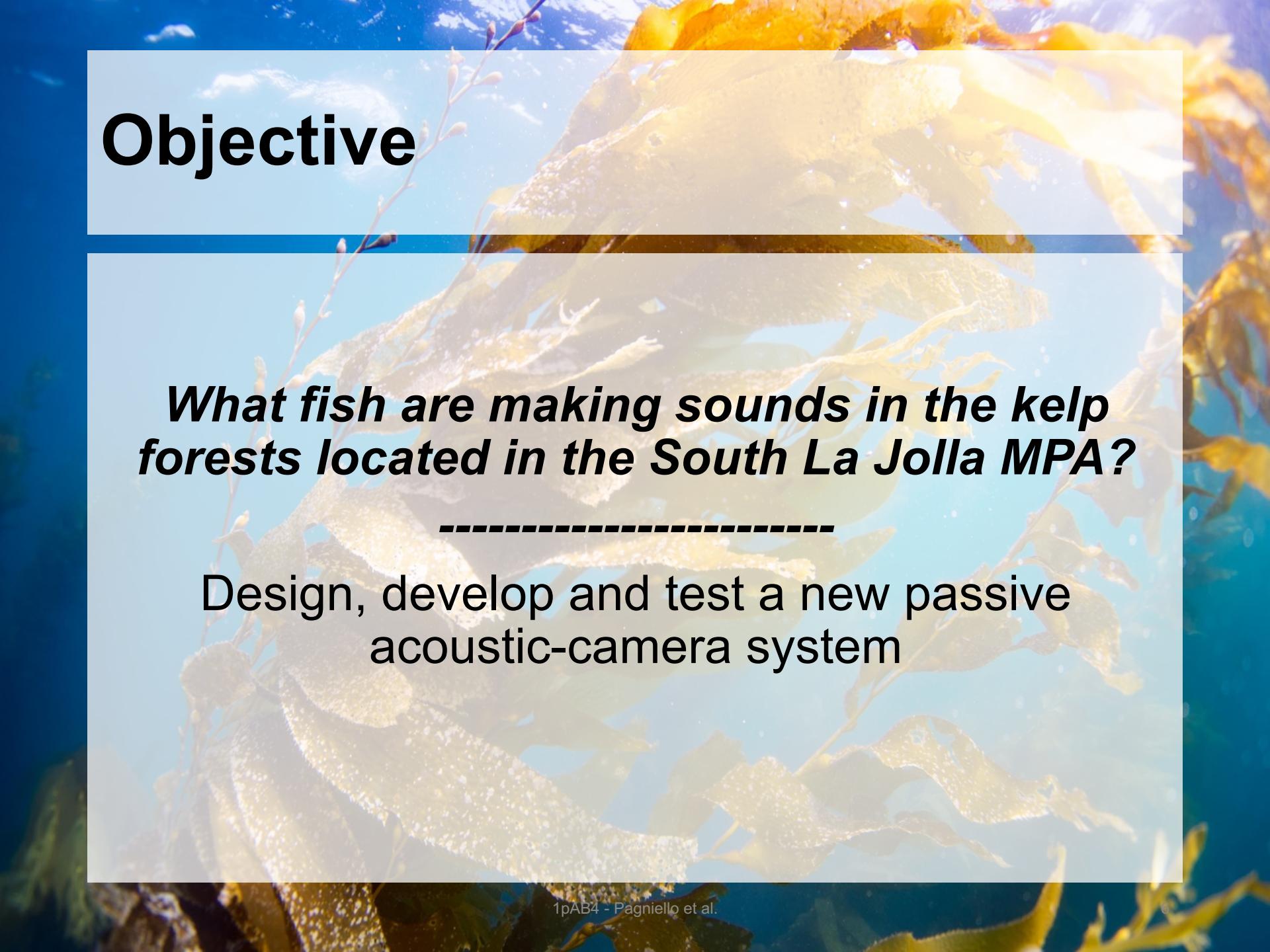
Methods to evaluate effectiveness of MPAs



Can community structure be quantified using passive acoustic monitoring?



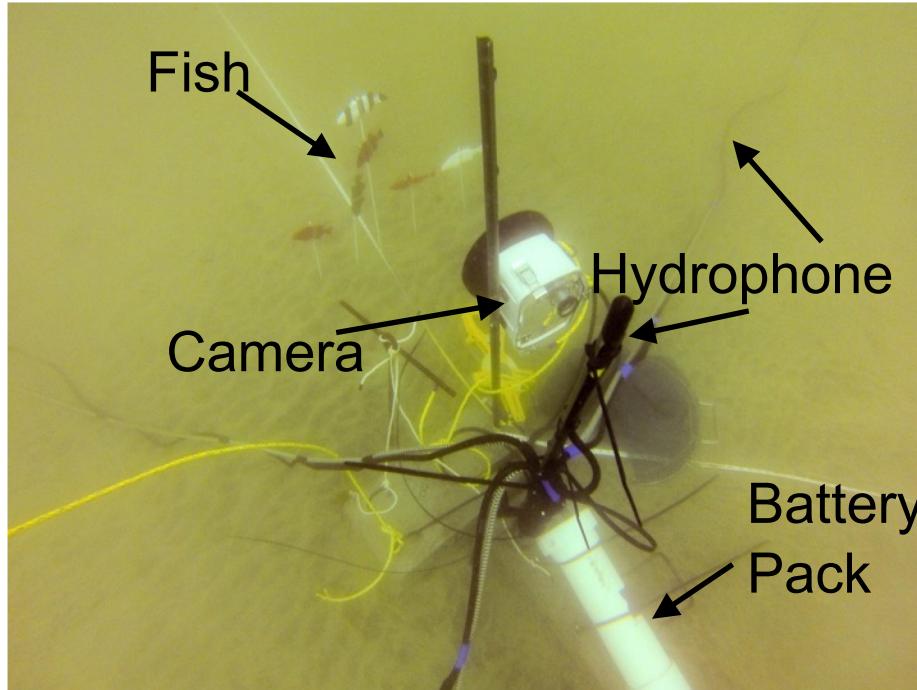
Objective

A close-up, underwater photograph of a kelp forest. The frame is filled with large, yellowish-brown kelp fronds swaying in the current. Sunlight filters down from the surface in bright rays, creating a dappled light effect on the leaves and the dark, textured stems. Some small, thin plants with tiny flowers are visible in the upper left corner.

What fish are making sounds in the kelp forests located in the South La Jolla MPA?

Design, develop and test a new passive acoustic-camera system

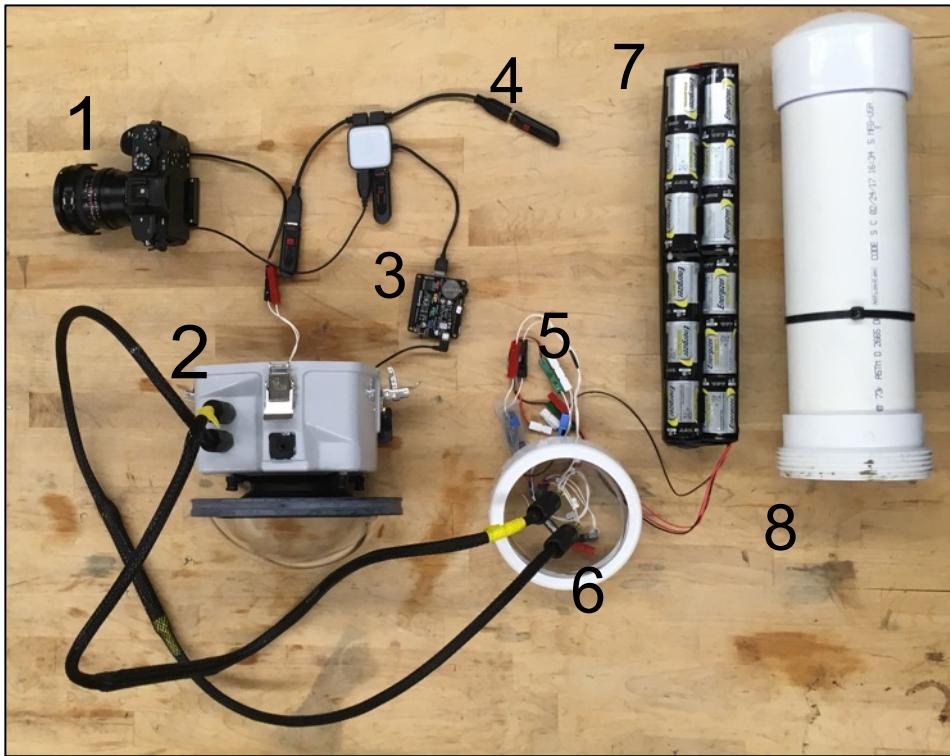
FishOASIS: Fish Optical and passive Acoustic Sensor Identification System



Capabilities:

- optically identify soniferous species of fish
- capture good images in poor light conditions
- deployment length capable of capturing episodic and long-duration events
- inter-calibration of the camera and passive acoustic systems
- user-defined sampling protocol

Camera system

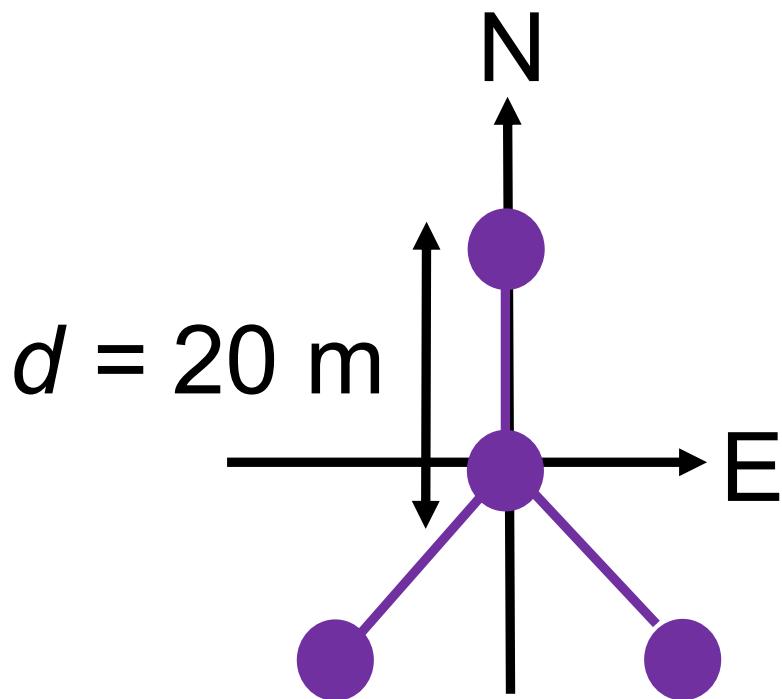


Components:

- 1) Sony a7s II camera with fisheye lens
- 2) custom-built Ikelite camera housing
- 3) Raspberry Pi A+ with witty Pi real-time clock and power management board
- 4) USB flash data storage
- 5) step-down converters
- 6) wet-mateable bulkhead connectors
- 7) battery bank
- 8) PVC battery housing

(not pictured) HOBO light and temperature logger, mini speaker

Passive acoustic system



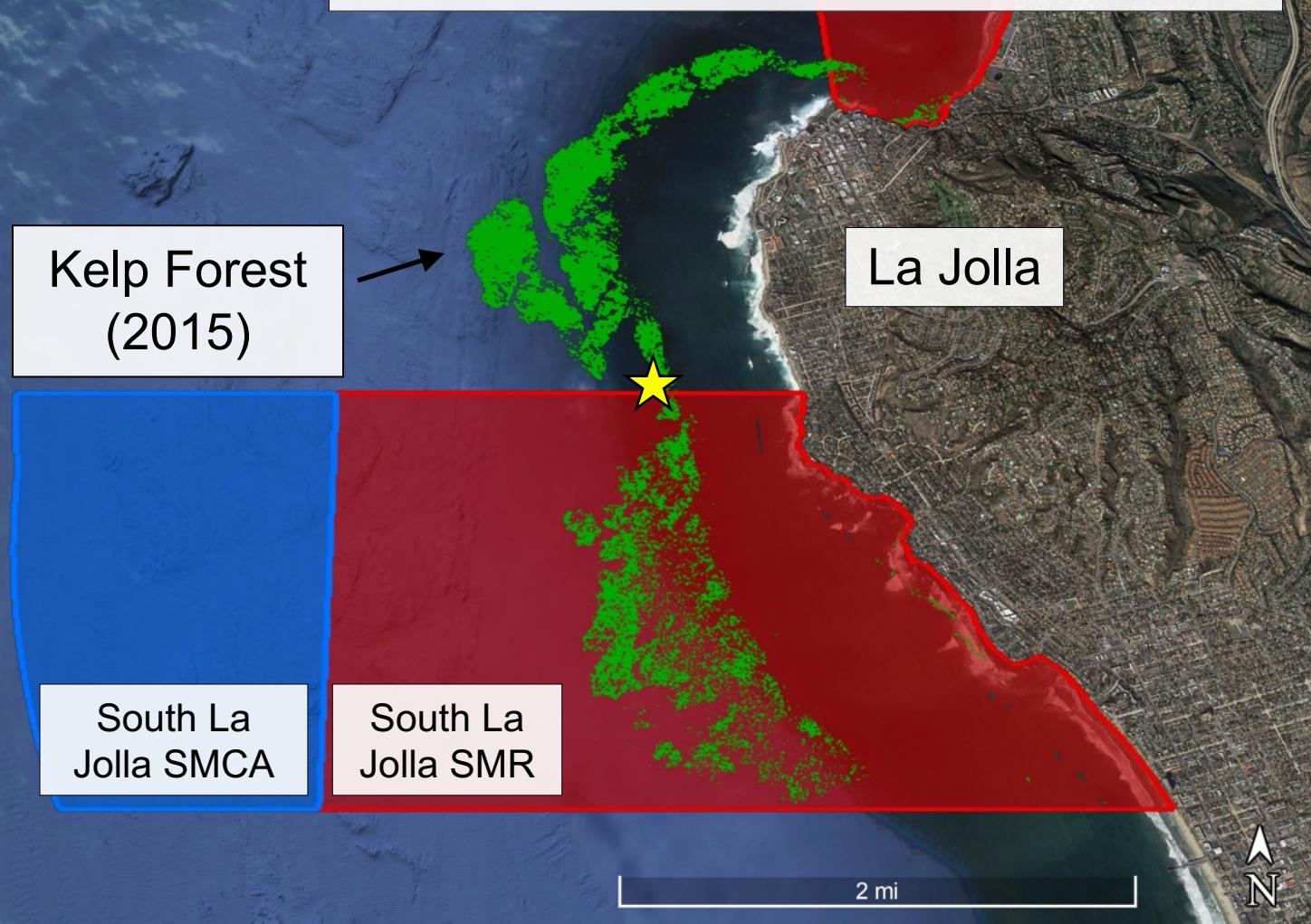
Components:

- SoundTrap ST4300 256 GB acoustic recorder
- four HTI-96-MIN hydrophones

Capabilities:

- sampling at 48-288 kHz
- up to 14 days continuous recording at 48 kHz

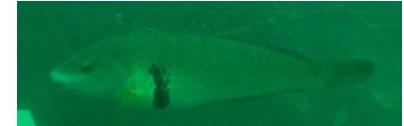
San Diego MPAs



SMR: prohibits damage or take of all marine resources

SMCA: allows some recreational and/or commercial take of marine resources

Diversity of fish species



Garibaldi
(*Hypsypops rubicundus*)

Halfmoon
(*Medialuna californiensis*)

Opaleye
(*Girella nigricans*)

Sargo
(*Anisotremus davidsonii*)

Rock Wrasse
(*Halichoeres semicinctus*)



Señorita
(*Oxyjulis californica*)

Adult Terminal

Juvenile

Blacksmith
(*Chromis punctipinnis*)



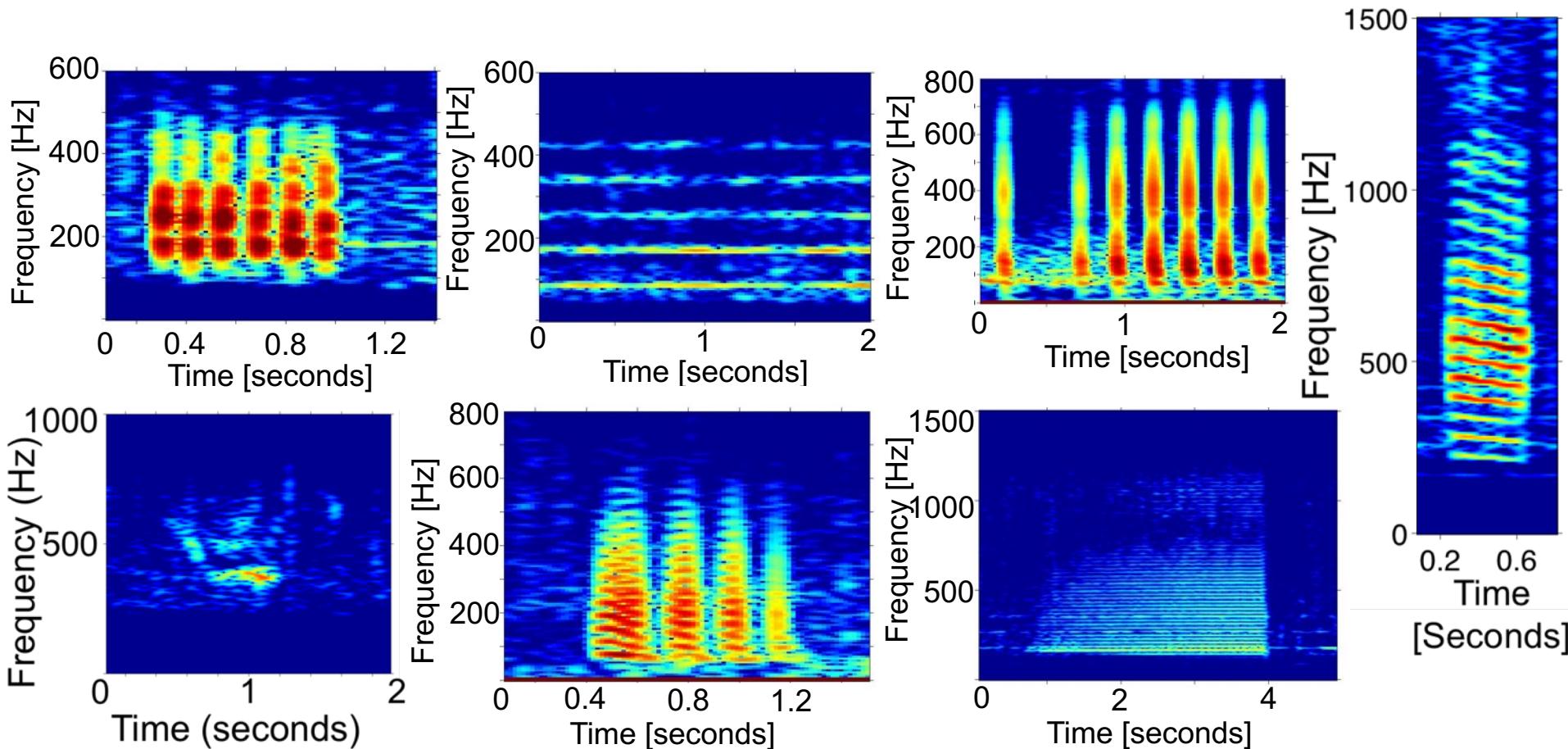
California yellowtail
(*Seriola lalandi*)

California Sheephead
(*Semicossyphus pulcher*)

Kelp Bass
(*Paralabrax clathratus*)

Pacific Barracuda
(*Sphyraena argentea*)

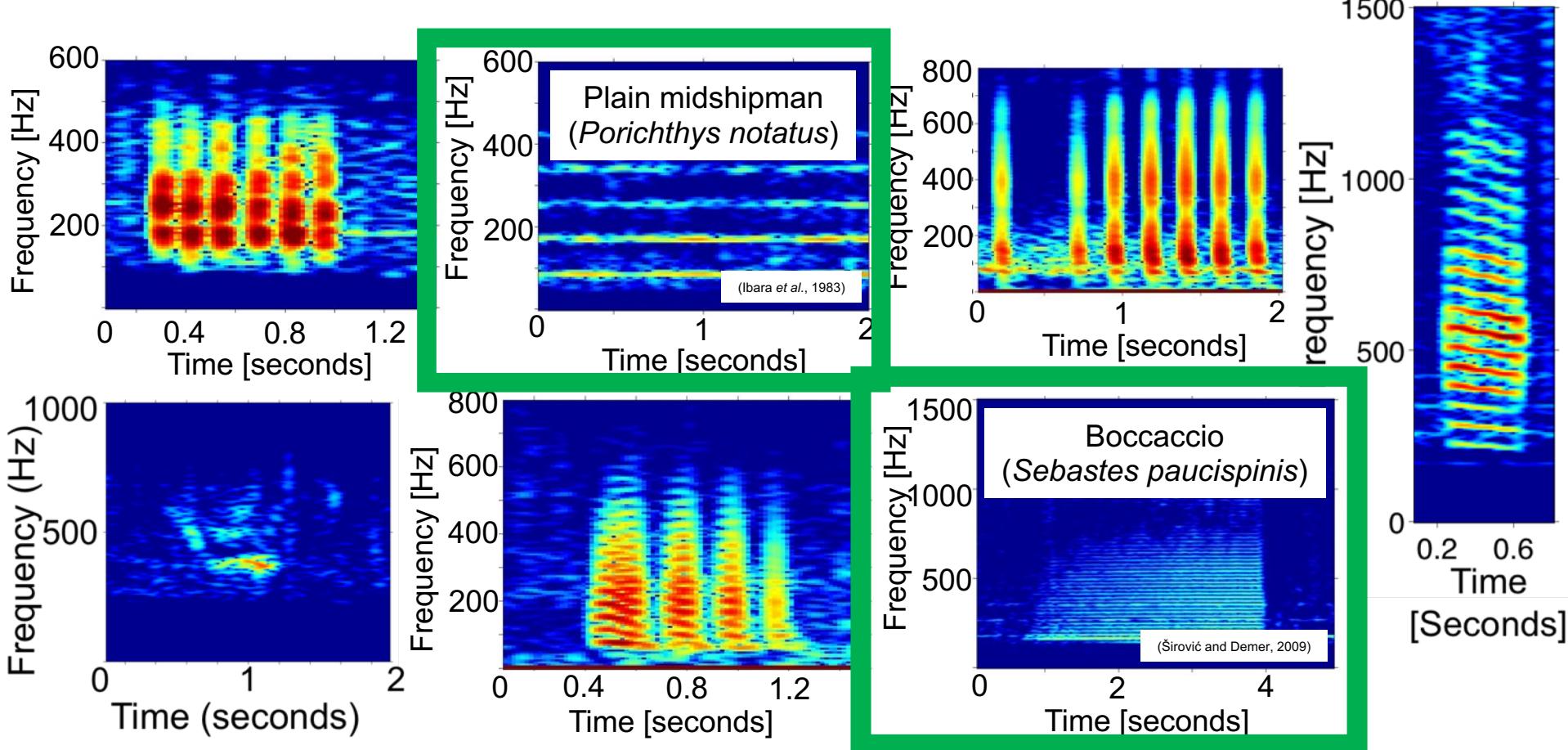
Diversity of “fishy” sounds



Hanning window, $F_s = 48 \text{ kHz}$, NFFT = 8192, overlap = 90%.

Color represents spectrum level, with red indicating highest intensity.

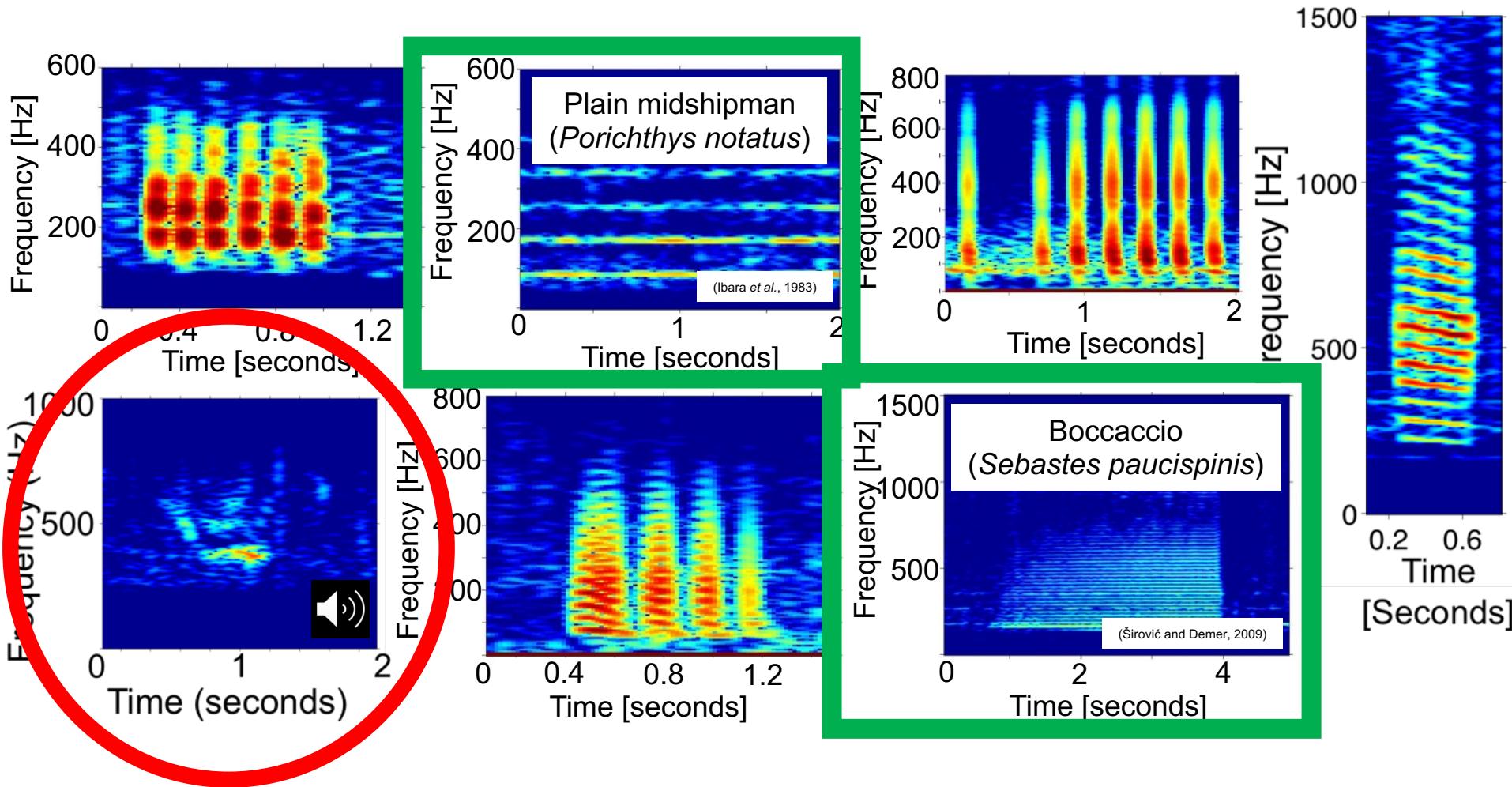
Diversity of “fishy” sounds



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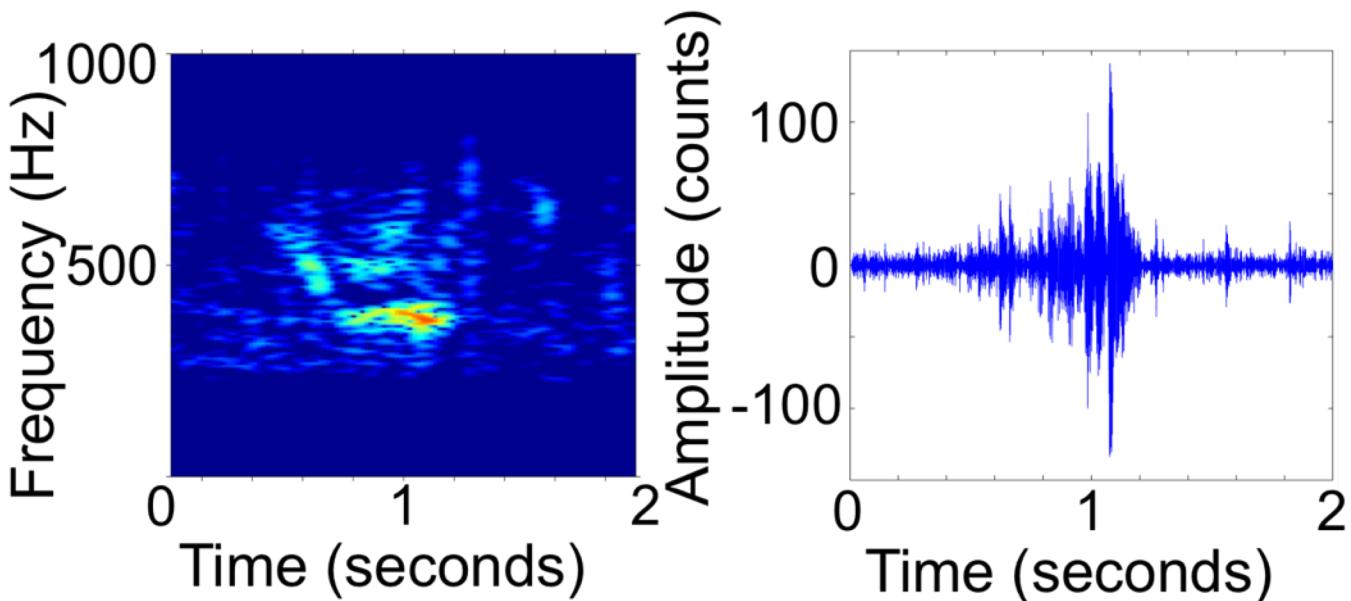
Diversity of “fishy” sounds



Hanning window, $F_s = 48$ kHz, NFFT = 8192, overlap = 90%.

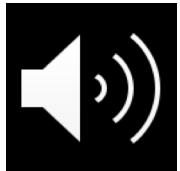
Color represents spectrum level, with red indicating highest intensity.

Barred sand bass (*Paralabrax nebulifer*)

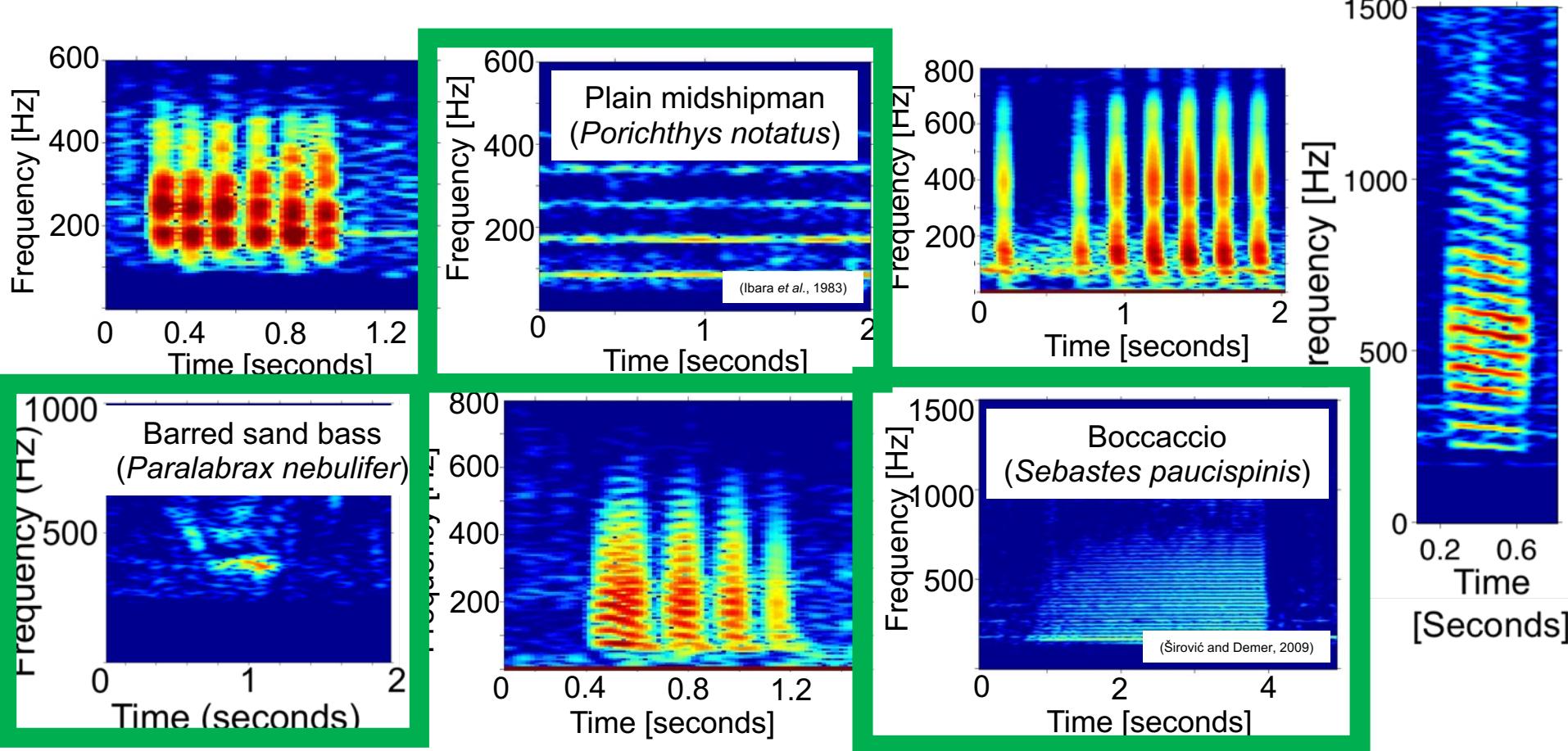


Hanning window, $F_s = 48$ kHz, NFFT = 8192,
overlap = 90%; band pass filter = 250-700 Hz.

Color represents spectrum level, with red indicating highest intensity.



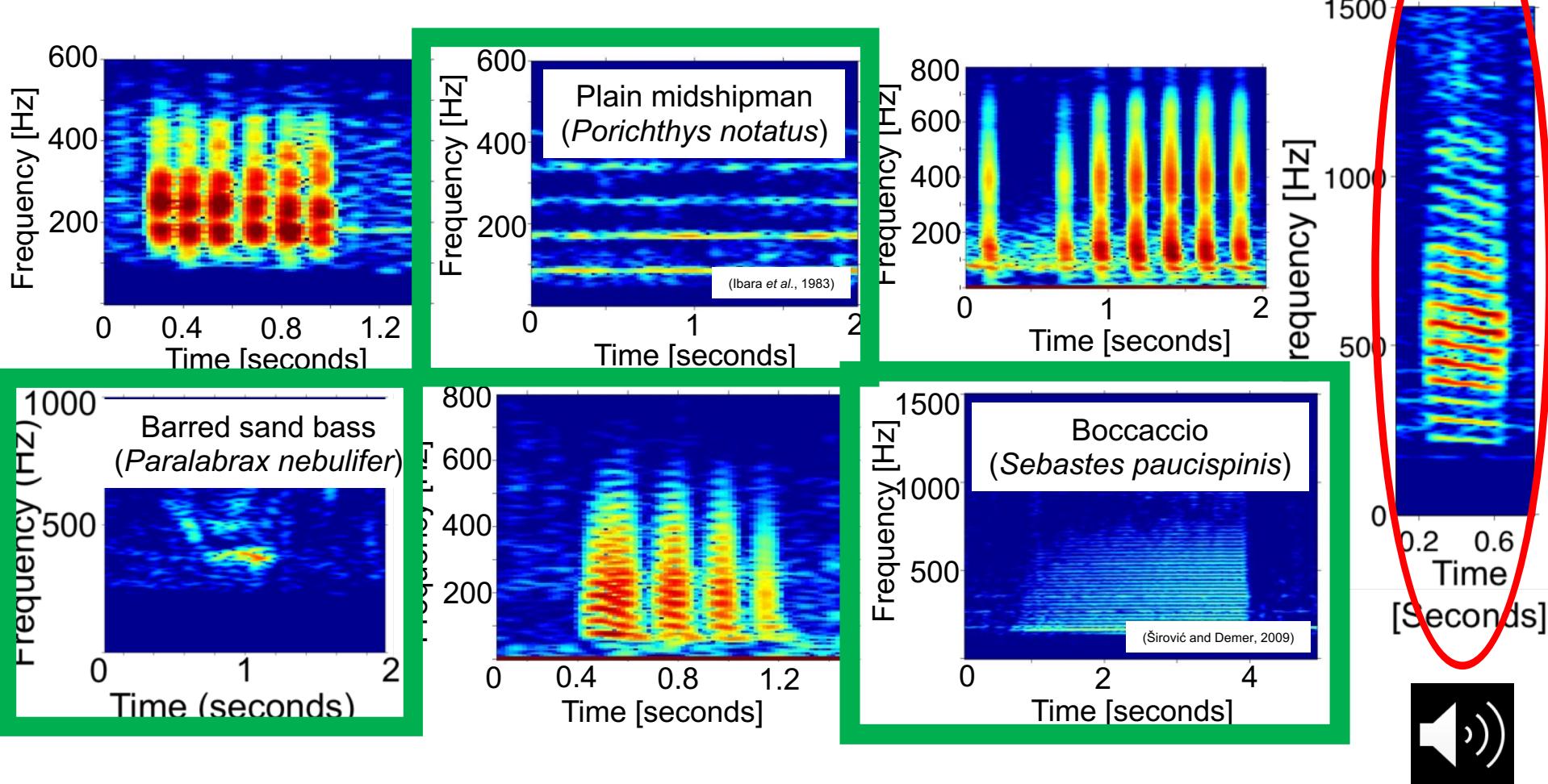
Diversity of “fishy” sounds



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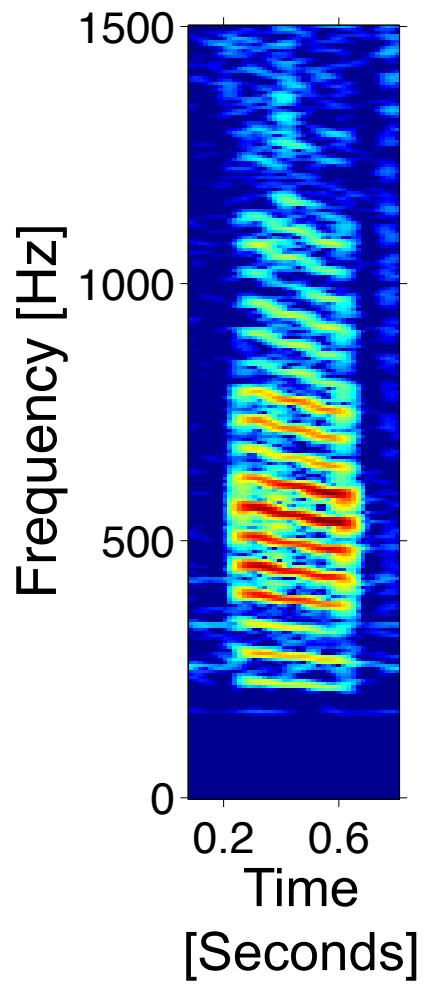
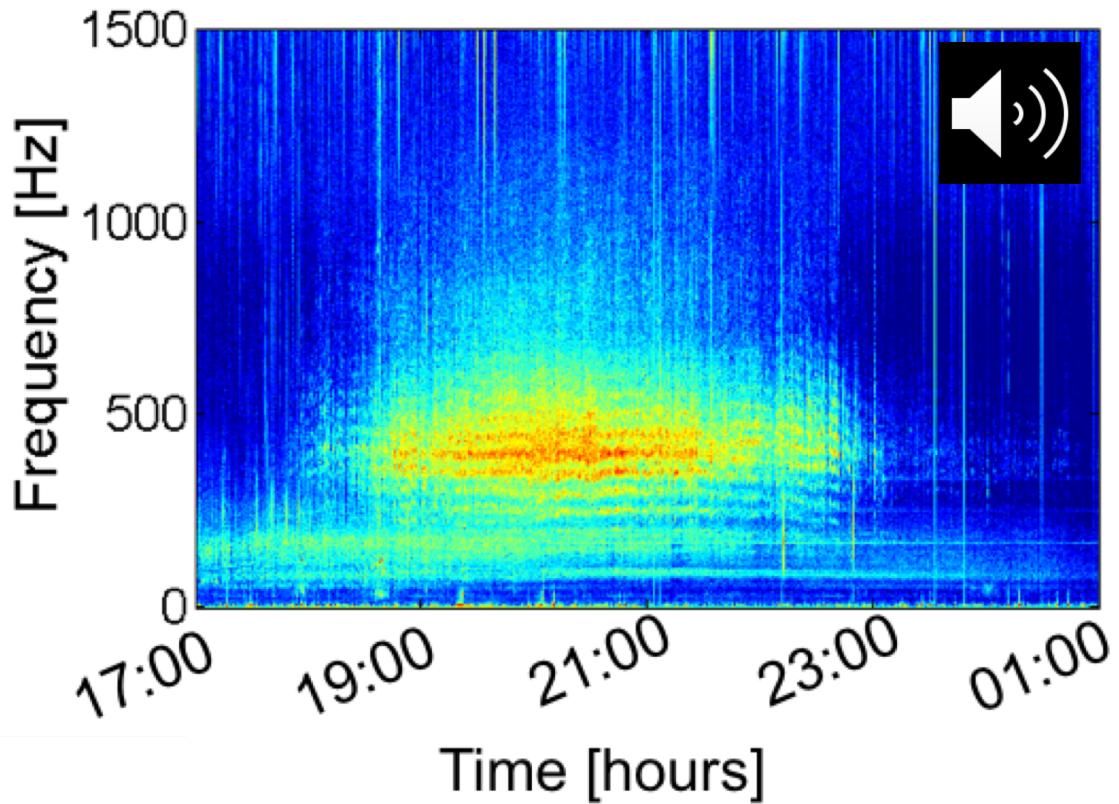
Diversity of “fishy” sounds



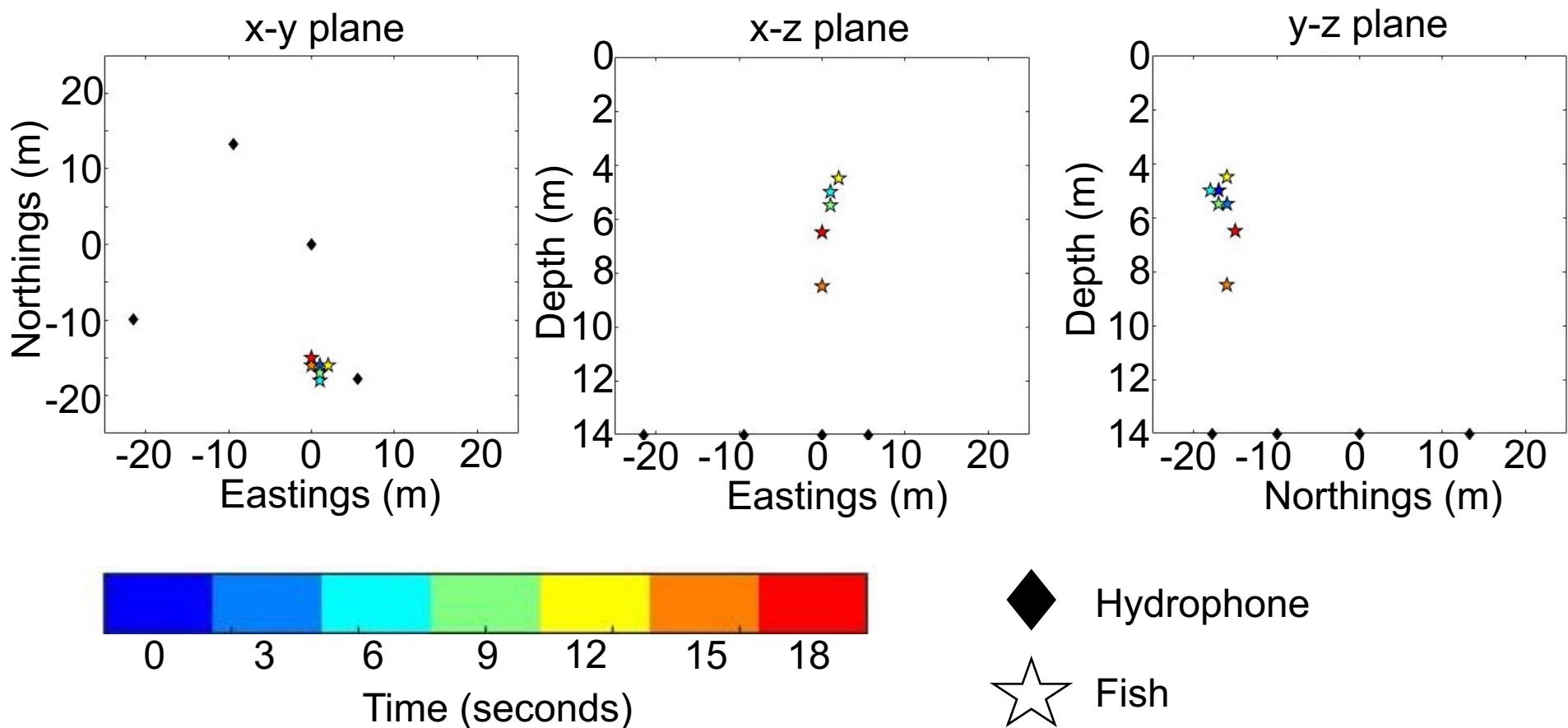
Hanning window, $F_s = 48$ kHz, NFFT = 8192, overlap = 90%.

Color represents spectrum level, with red indicating highest intensity.

A low-frequency fish chorus!

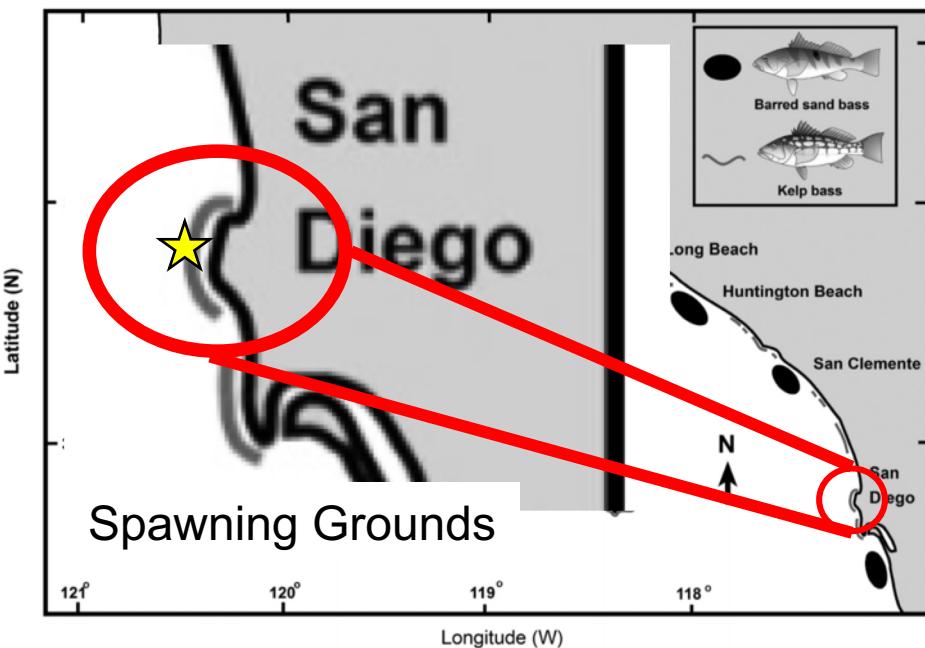


Tracking an individual chorusing fish



Potential Chorusing Species

Kelp bass (*Paralabrax clatharus*)

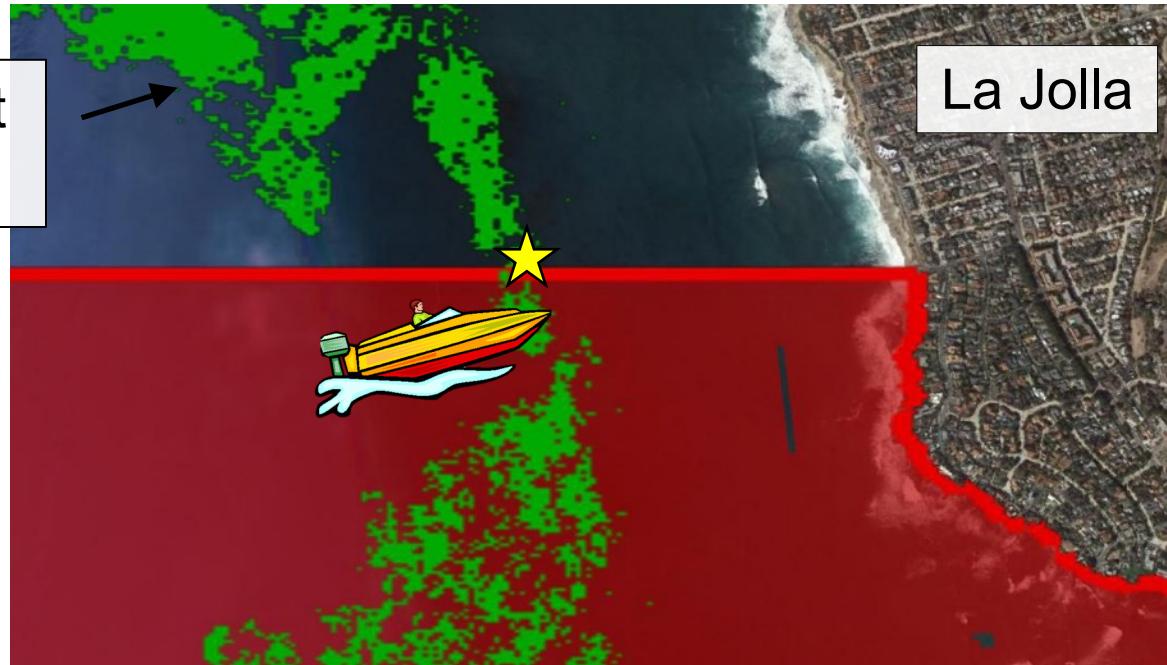


Erisman *et al.*, 2011



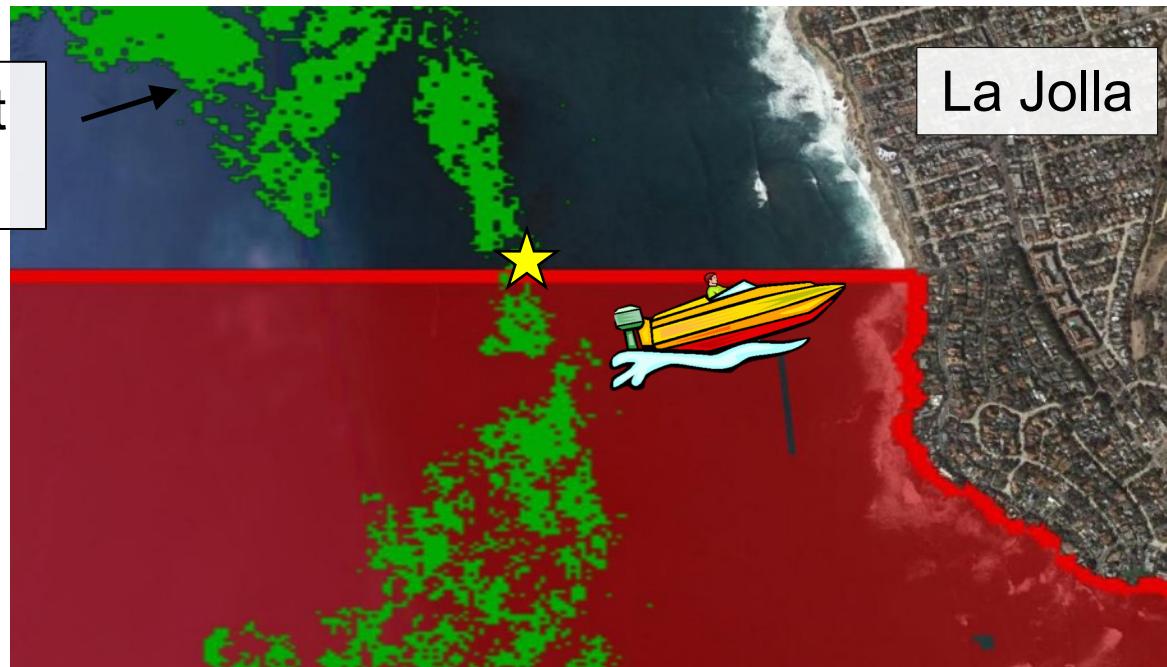
We can hear the chorus from the surface when in the kelp forest...

Kelp Forest
(2015)



We can't hear the chorus from the surface when inshore of the kelp forest!

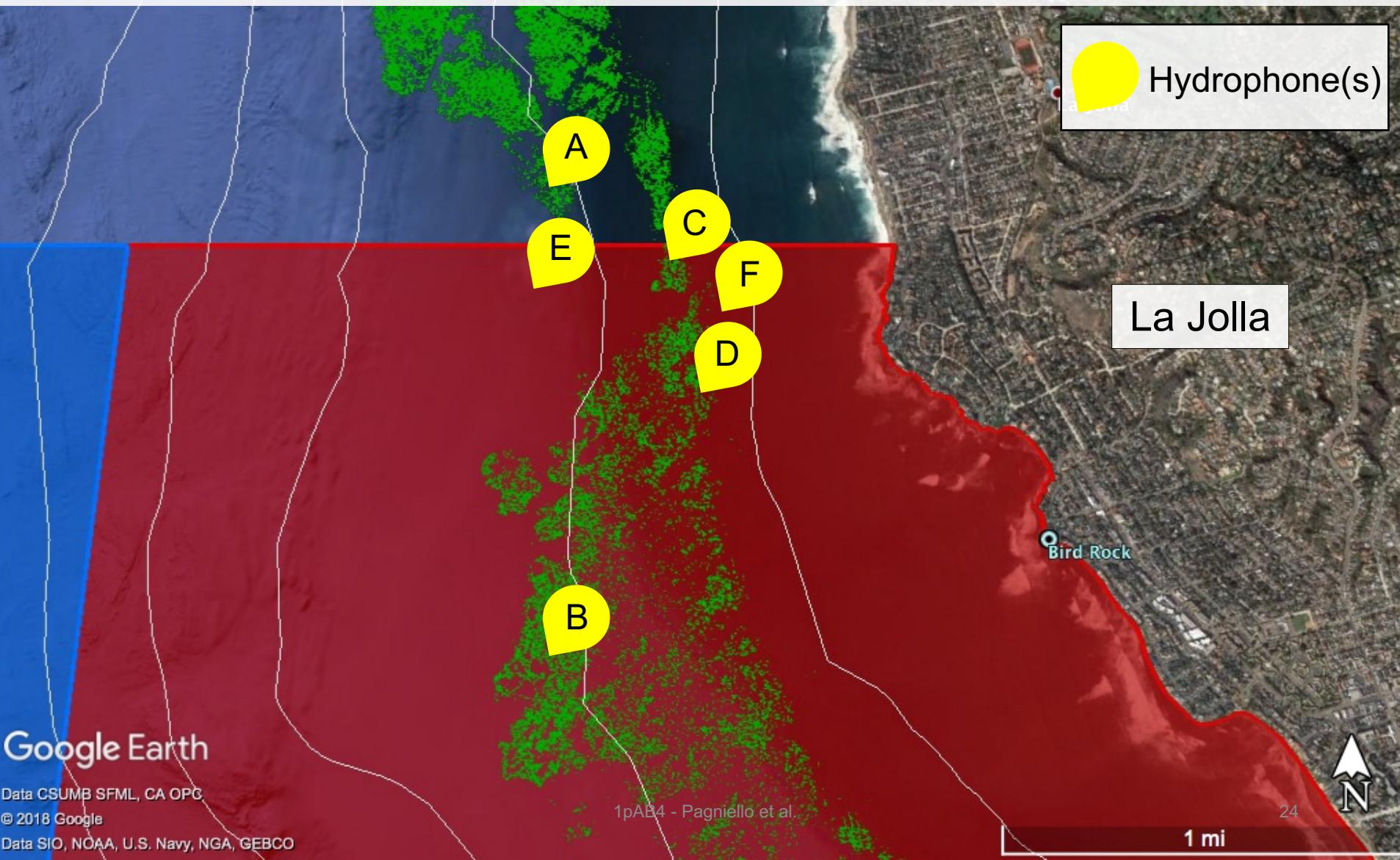
Kelp Forest
(2015)



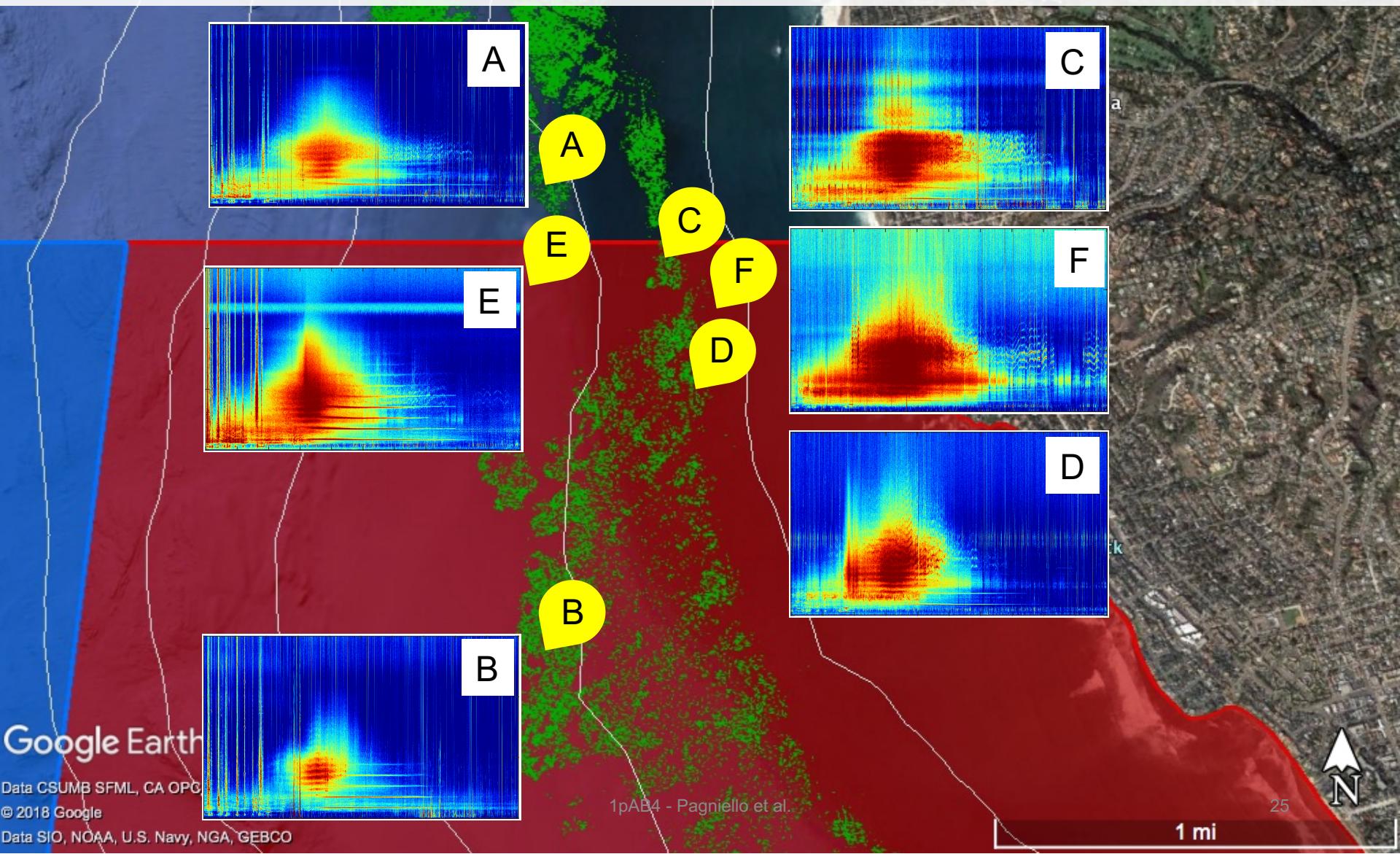
The background of the slide features an underwater scene of a kelp forest. Large, bright green kelp plants with long, thin blades grow vertically. The water is a clear, pale blue-green color, allowing light to penetrate the dense canopy.

Are kelp forests an acoustic refuge for soniferous fish?

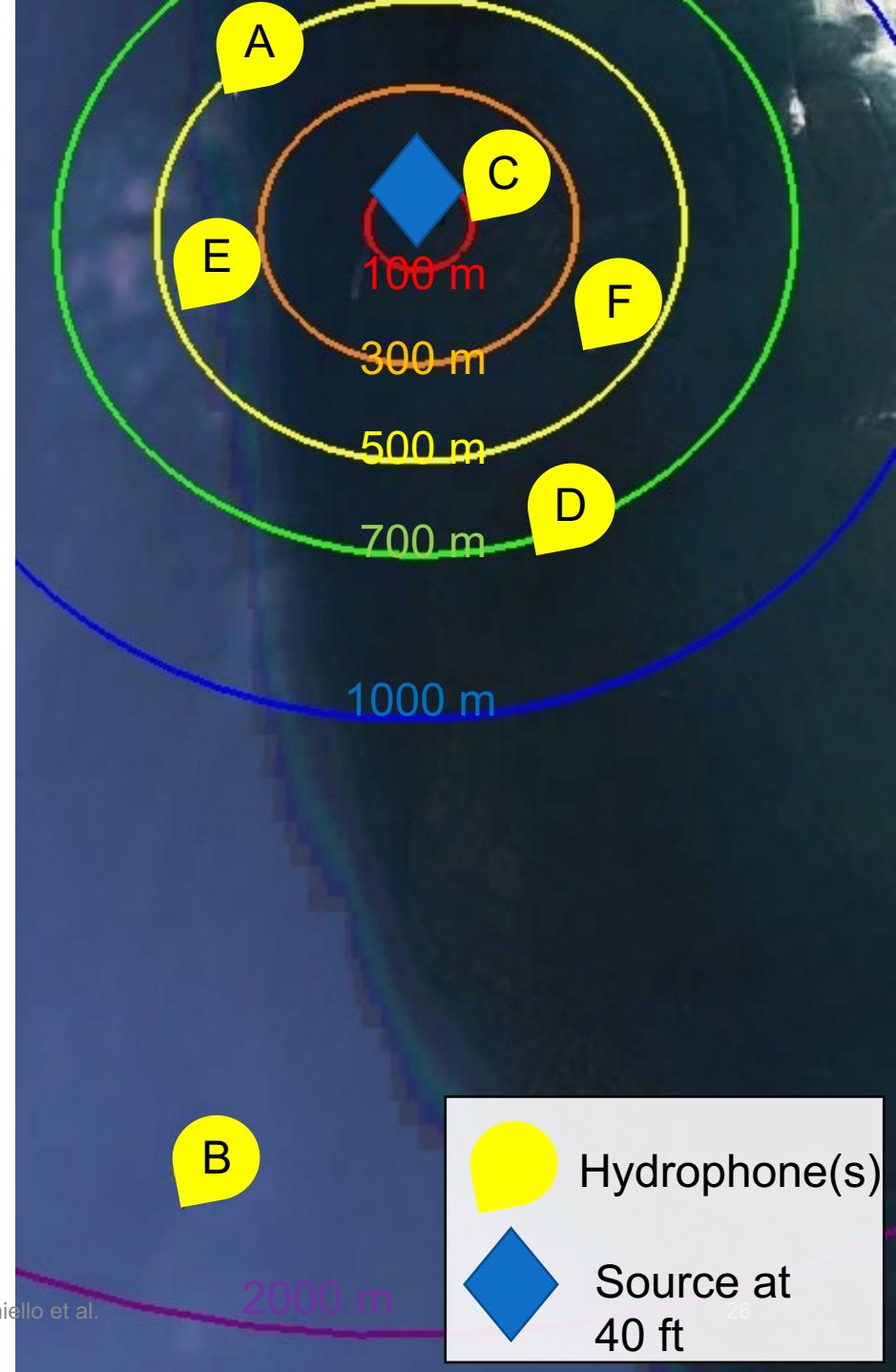
Kelp Acoustic Propagation Experiment



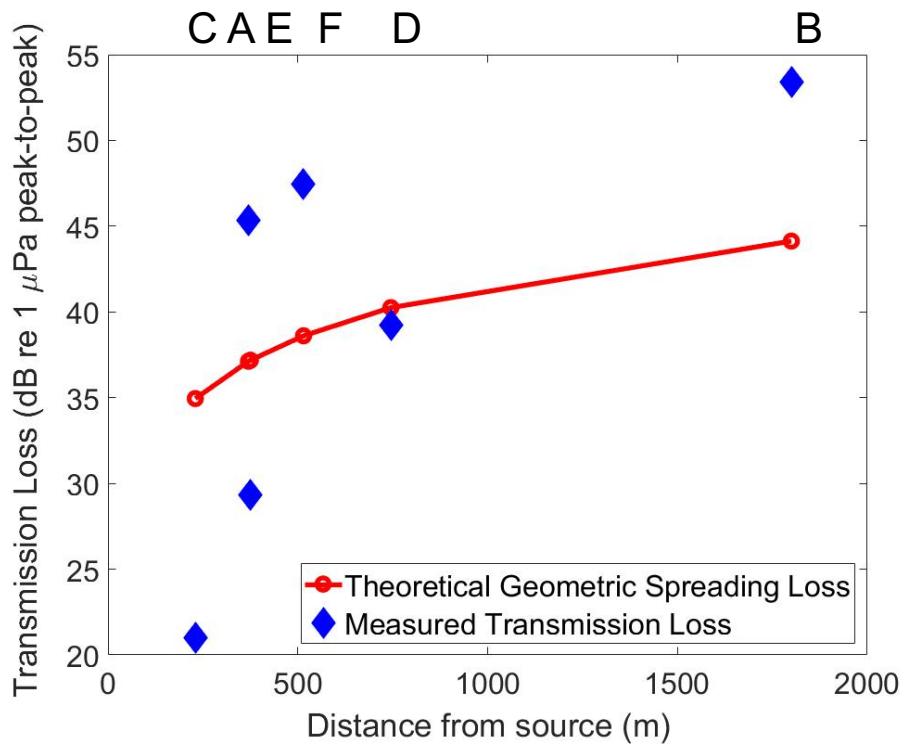
Kelp Acoustic Propagation Experiment



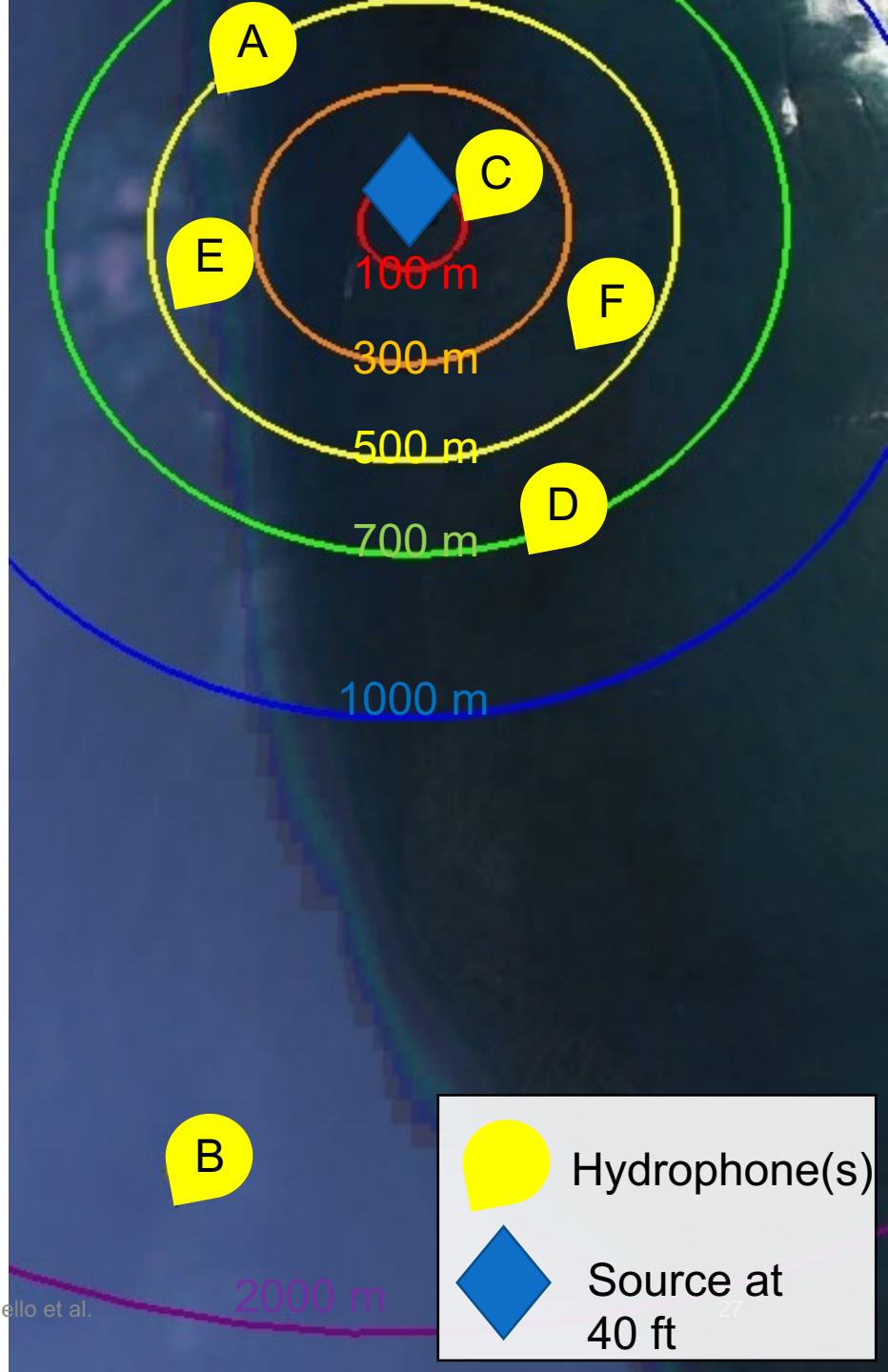
Kelp APE



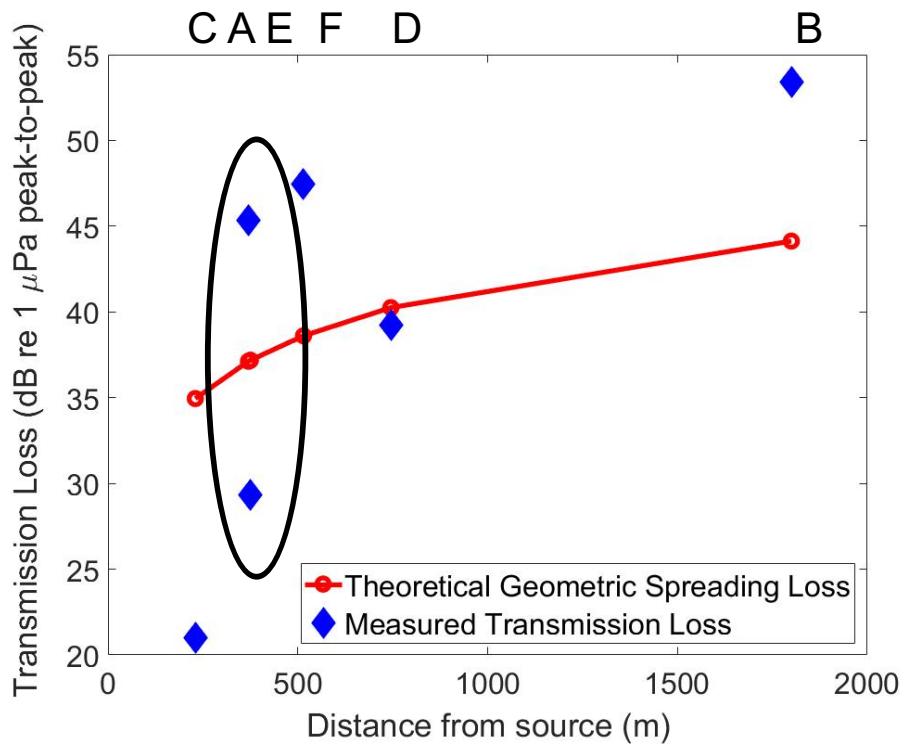
Kelp APE



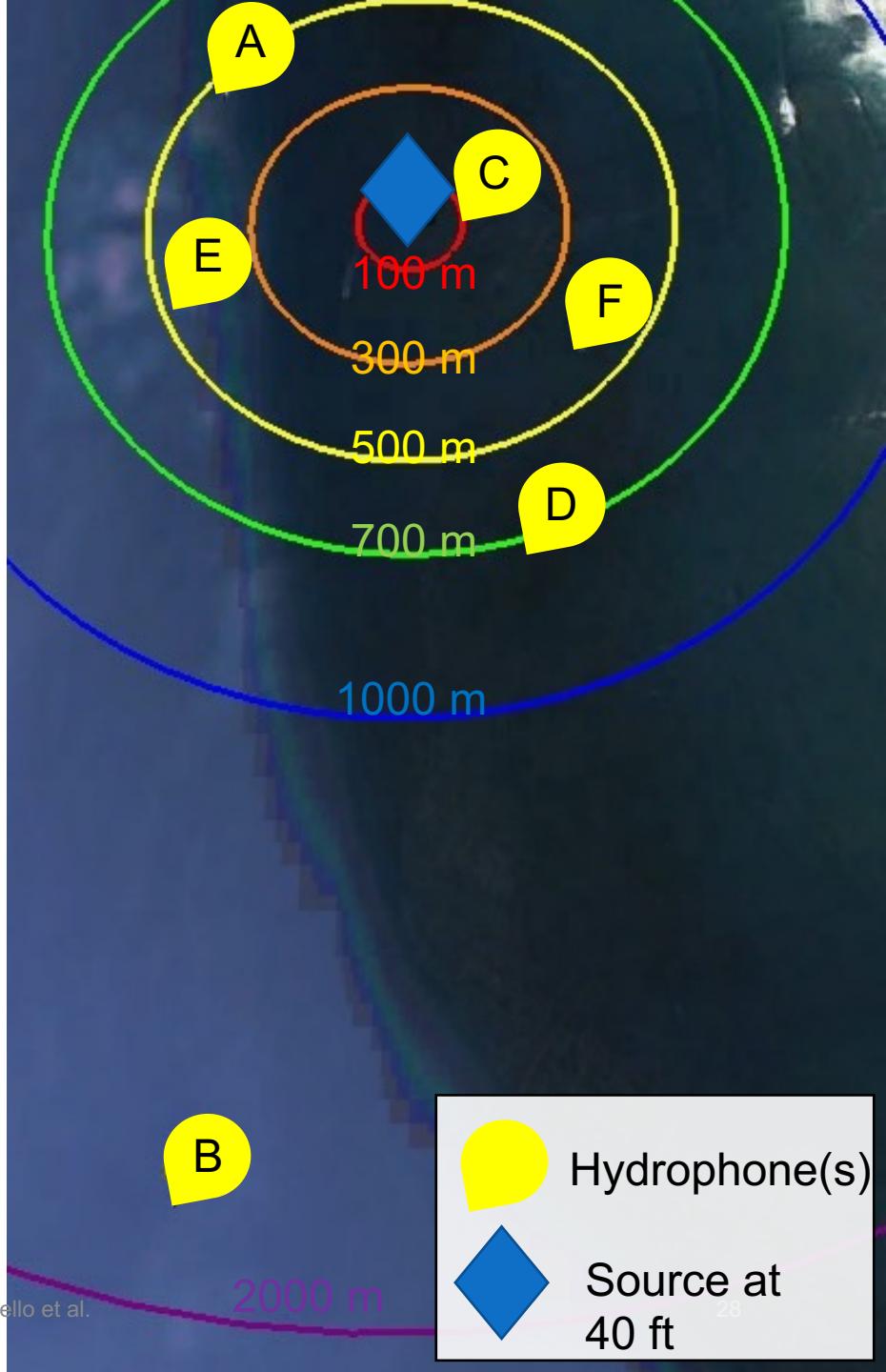
$$SL_{500 \text{ Hz tone}} = 162 \text{ dB re } 1 \mu\text{Pa peak-to-peak}$$



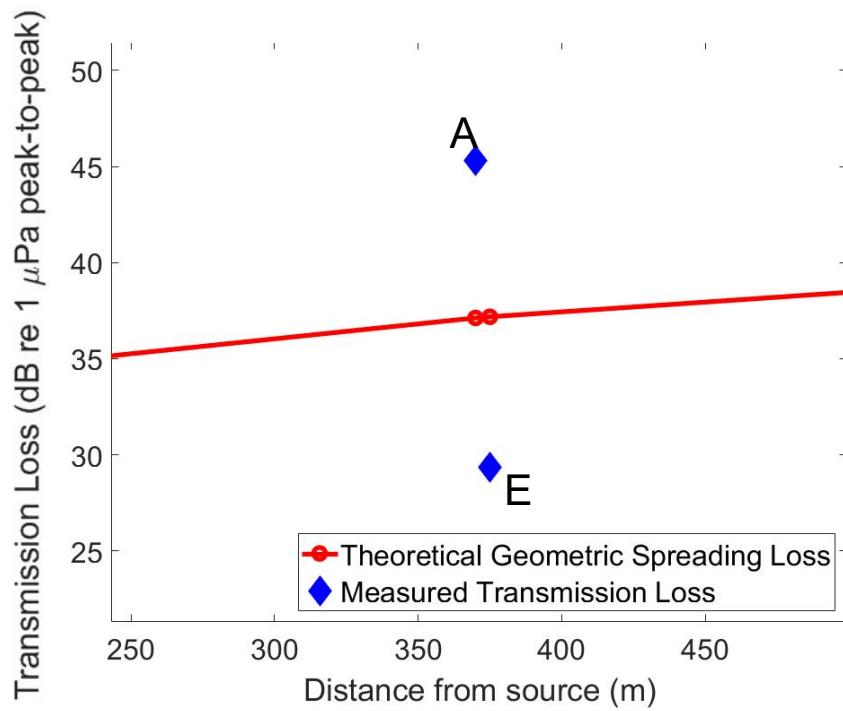
Kelp APE



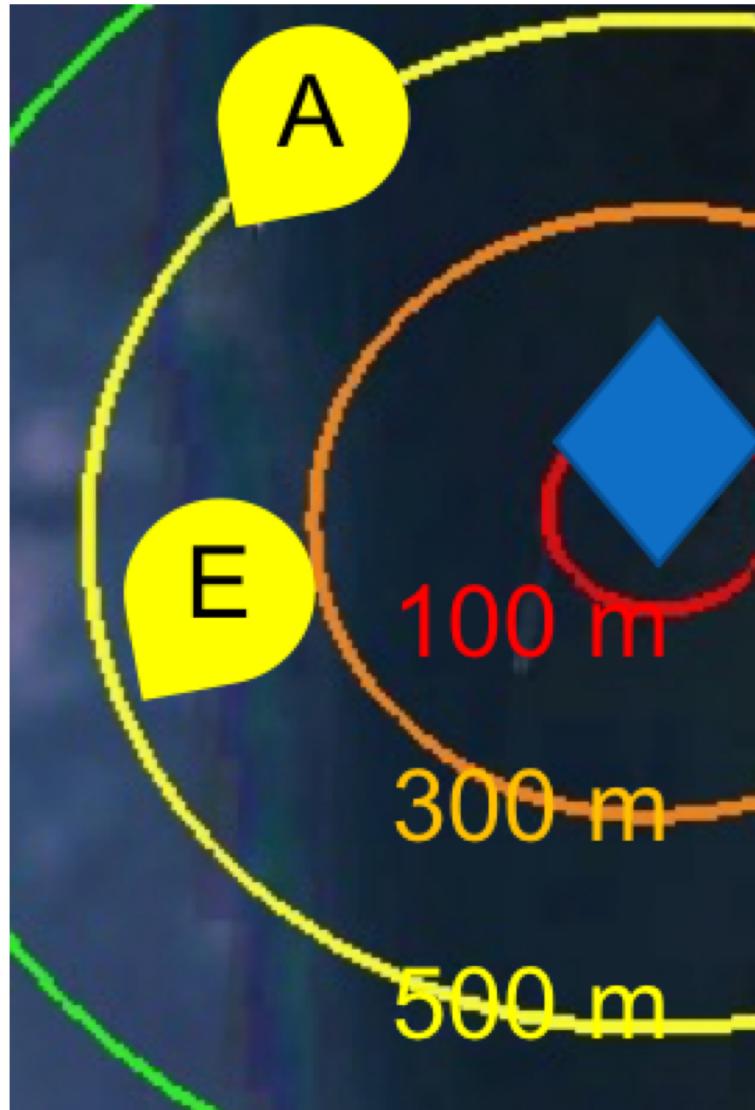
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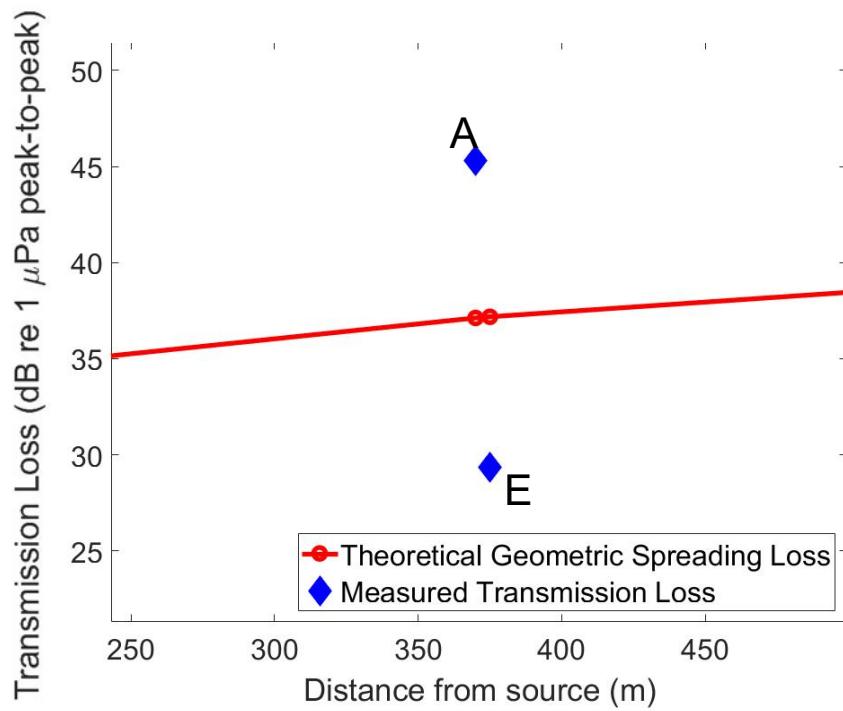
Kelp APE



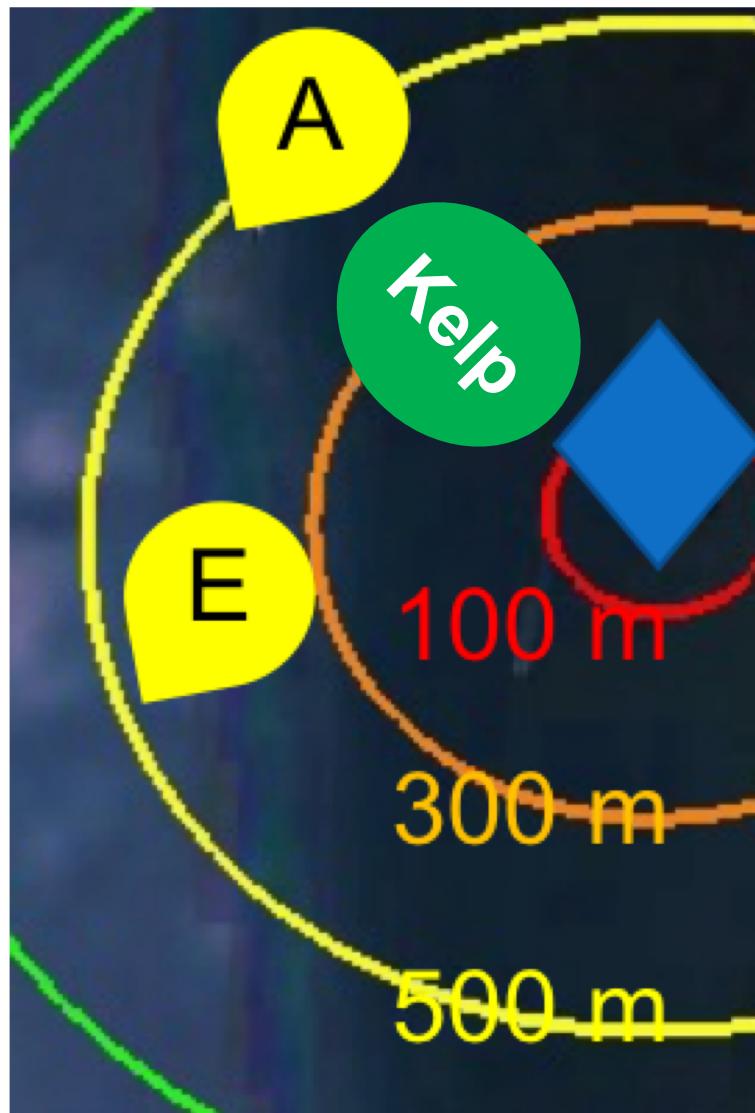
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Kelp APE



$$\text{SL}_{500 \text{ Hz tone}} = 162 \text{ dB re } 1 \mu\text{Pa peak-to-peak}$$



Conclusions and Future Work

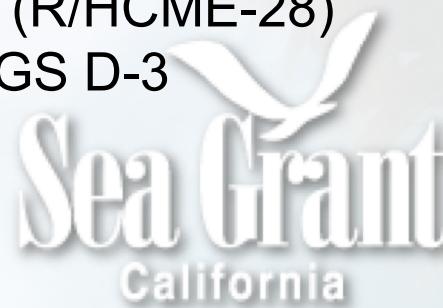
- developed cost-effective, long-lasting acoustic-camera system to optically identify soniferous species of fish in low-light conditions
 - viable, non-invasive technique for monitoring MPAs
 - barred sand bass are a soniferous fish
-
- establish species-sound associations for other kelp forest fish
- develop a unified ocean/seabed acoustic propagation model including scattering from kelp for low- and mid-frequency sounds in shallow water

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Thank you!



Questions?