Underwater Acoustic Monitoring in US National Parks

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GEER 2017
Greater Everglades Ecosystem Restoration
Advancing Science, Restoring the Everglades

National Parks protect soundscapes as core resources

*"The Service will take action to **prevent or minimize all noise** that adversely affects the natural soundscape or other park resources or values, or that exceeds levels that have been identified as being acceptable to, or appropriate for, visitor uses at the sites being monitored."*

-- NPS Management Policies 2006

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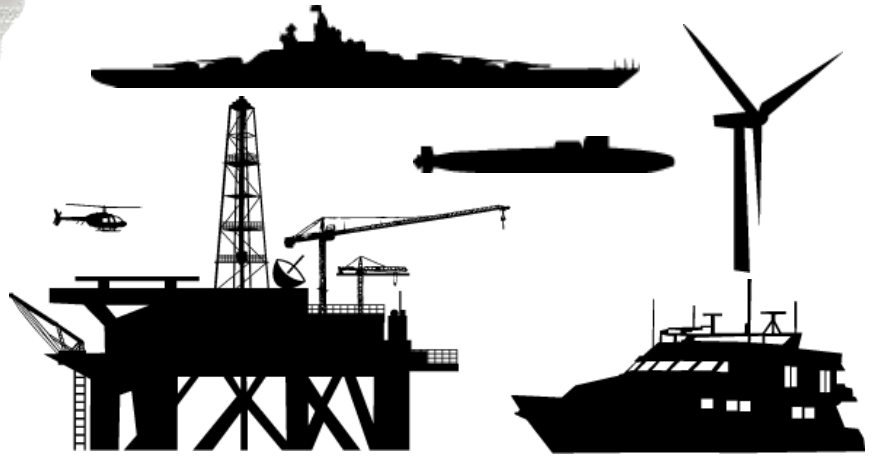
for wildlife that depends on sound and visitor enjoyment

Effects of noise on wildlife

Sound serves an important life history function for many species. For example, finding habitat, finding food, locating mates, avoiding predators.

Humans use and make underwater noise. This noise alters the underwater acoustic environment the animal depend on and effects behavior and physiology.

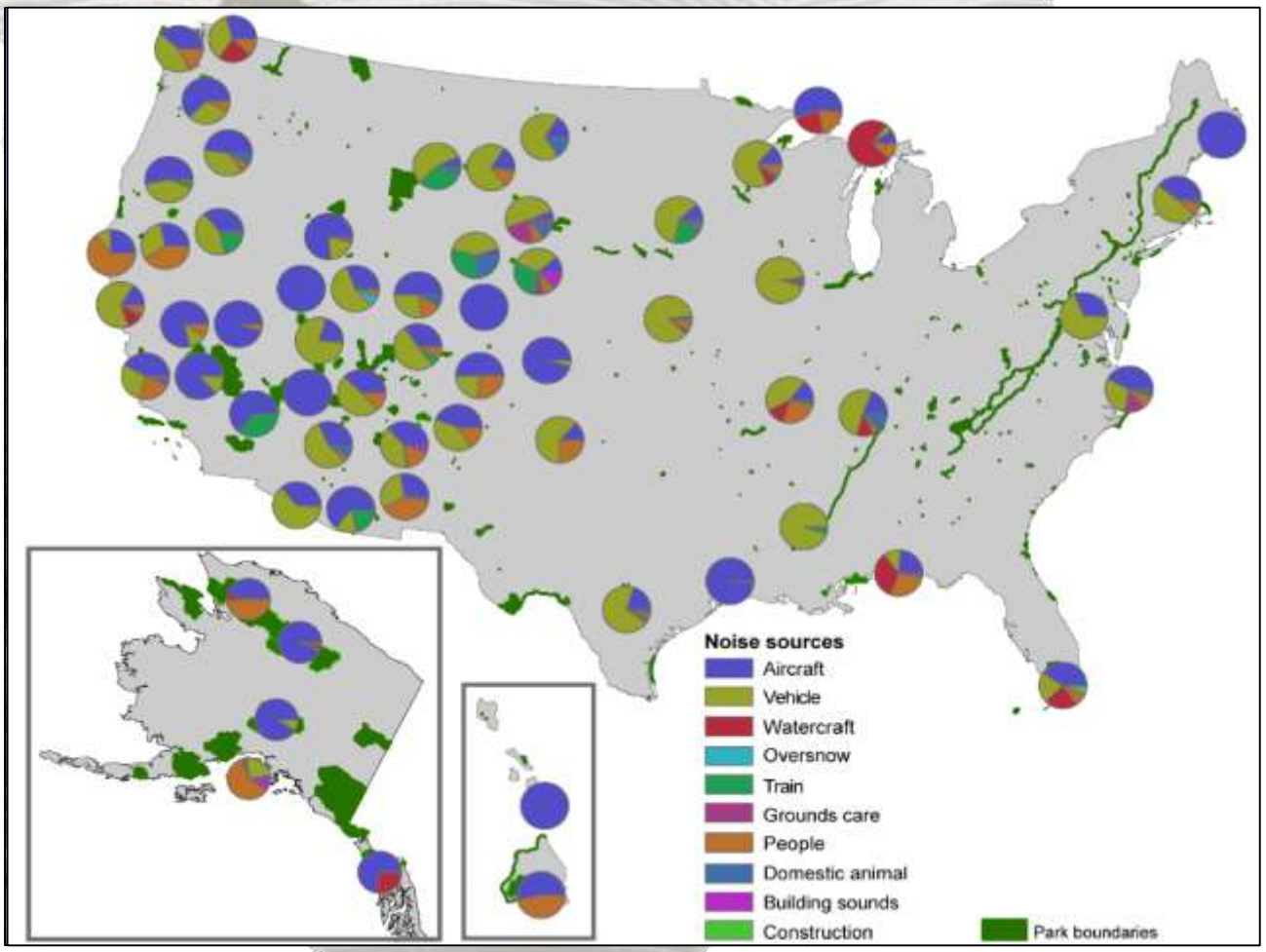


Monitoring acoustic conditions

Yosemite National Park

Over 600,000 hours of terrestrial acoustic data at >800 National Park sites

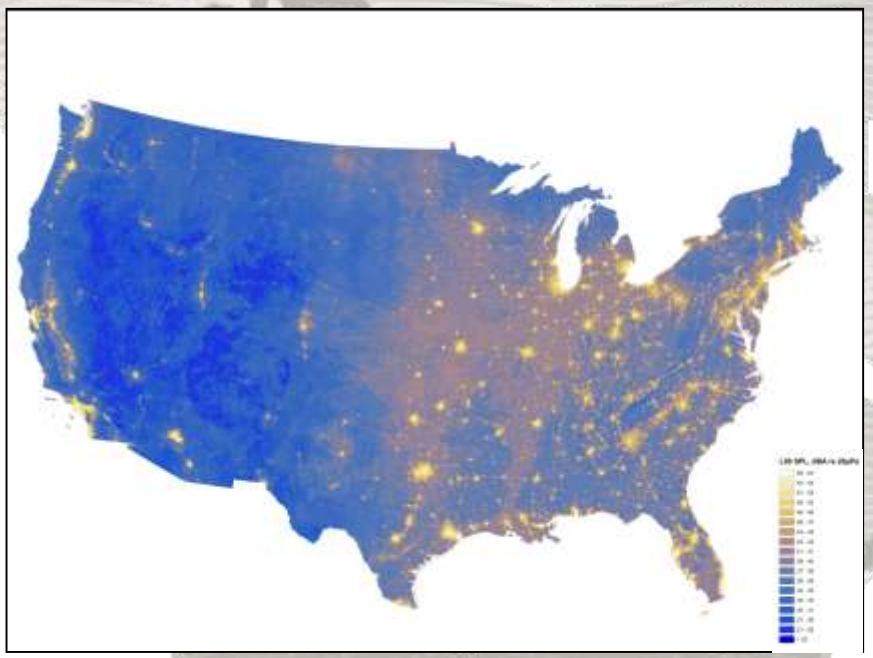
Types of noise sources



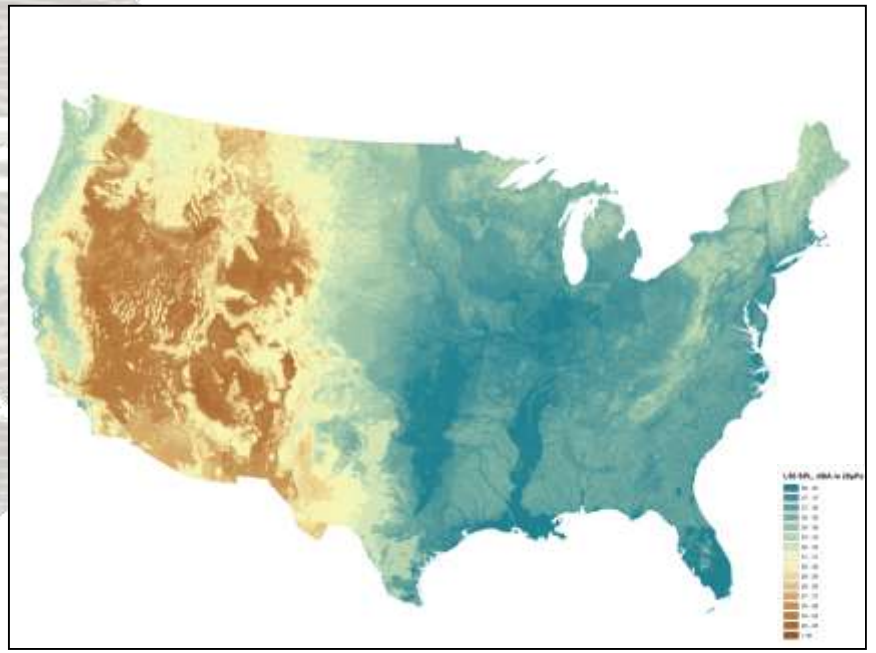
Buxton et al in prep

Identification of common noise sources in National Parks

Predicting noise at large spatial scale



Existing sound levels (summer day)



Natural sound levels (summer day)

Mennitt et al 2016

Underwater acoustic conditions

National Park of American Samoa, 2016

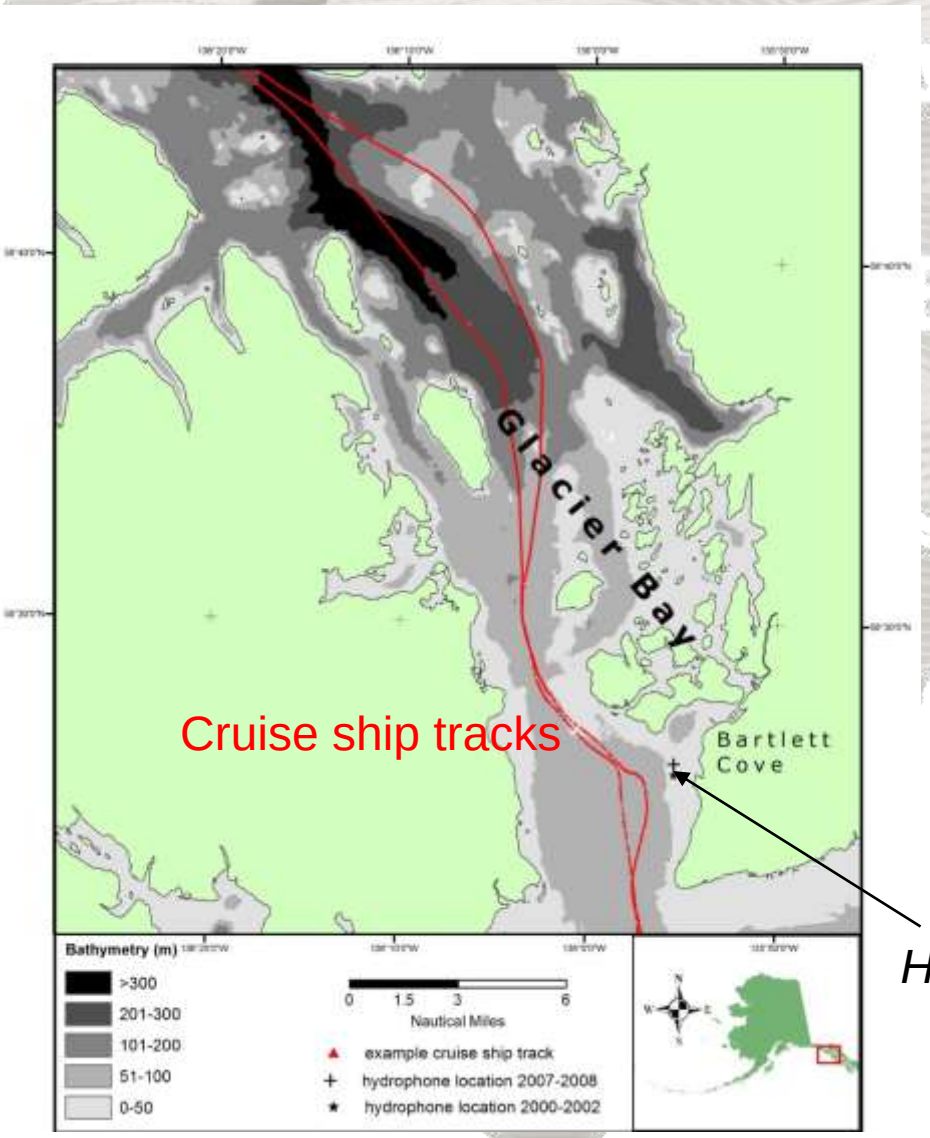
Examples of NPS Projects

- **Reducing Impacts of Vessel Noise,** *Glacier Bay National Park*
- **Monitoring Large-scale Trends in Ocean Noise,** *National Park of American Samoa, Buck Island Reef National Monument*
- **Bio-acoustic Indicators of ecosystem conditions,** *Everglades National Park*

Reducing impacts of vessel noise

Marine vessel traffic, although **essential to visitor use**, produces underwater noise that degrades the acoustic conditions for marine species inhabiting **Glacier Bay National Park and Preserve**.

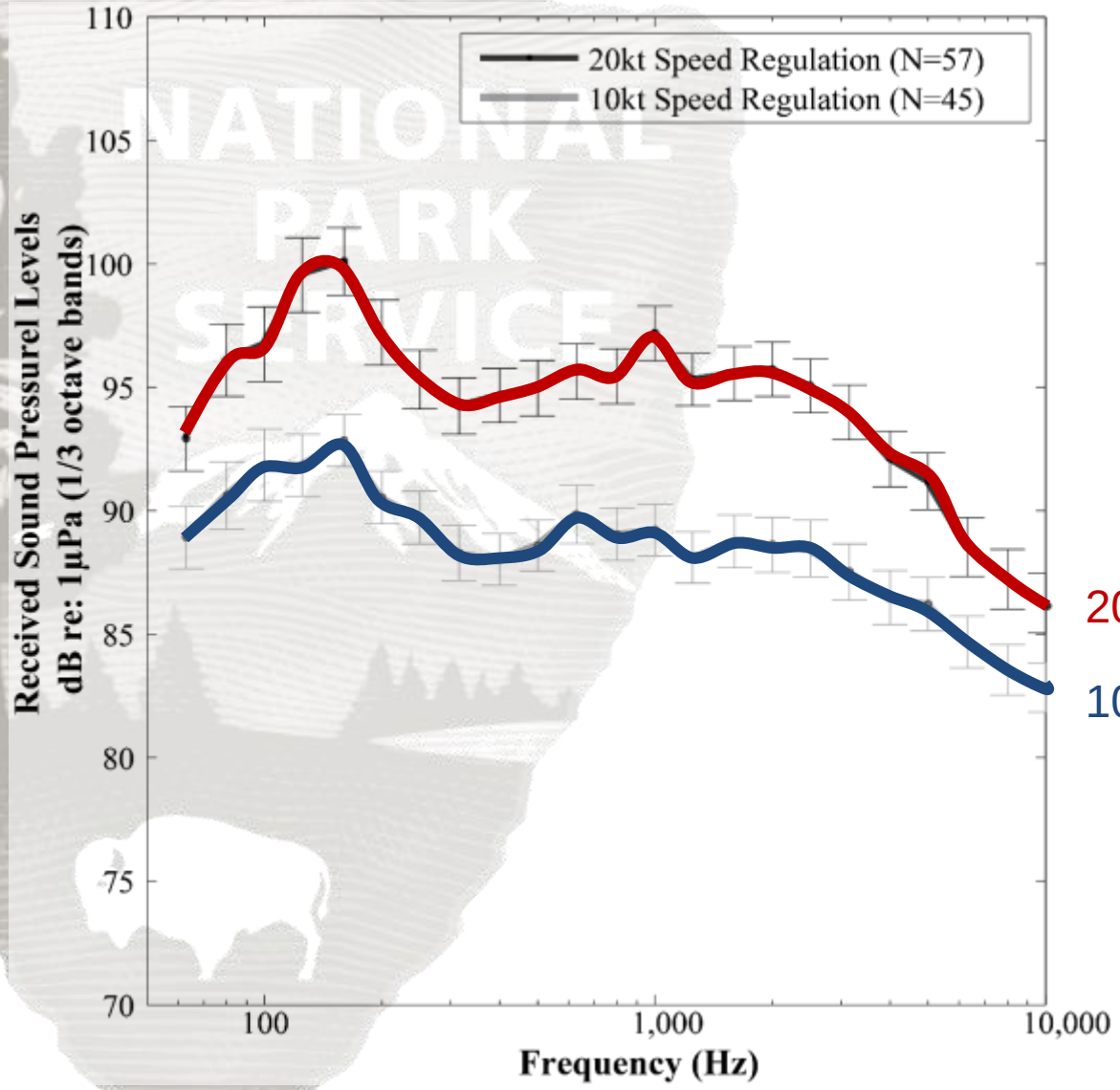
Acoustic monitoring



To protect the underwater acoustic environment and the marine mammals that depend upon it, **implements marine vessel quotas, speed regulations, and routing restrictions** in biologically important areas.

Hydrophone installed May 2000

Slower speeds reduce vessel noise

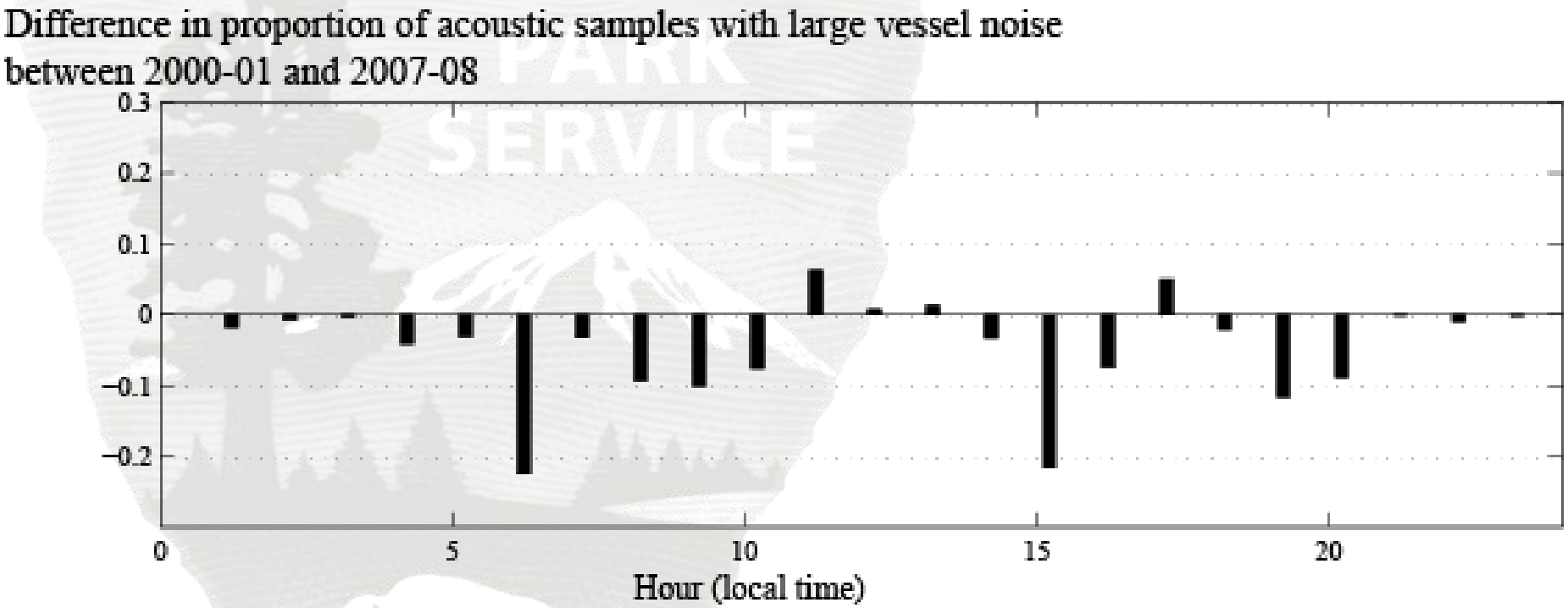


20 knots

10 knots

McKenna et al. 2017

Reduction in time with vessel noise present

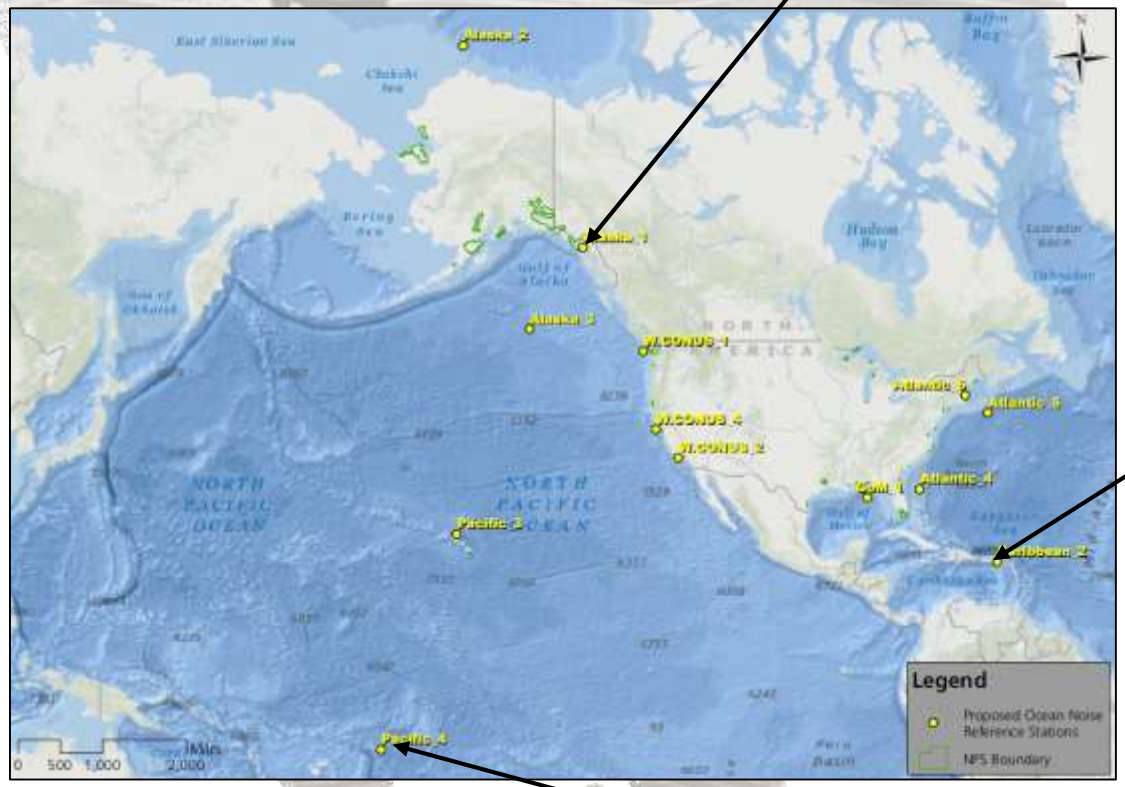


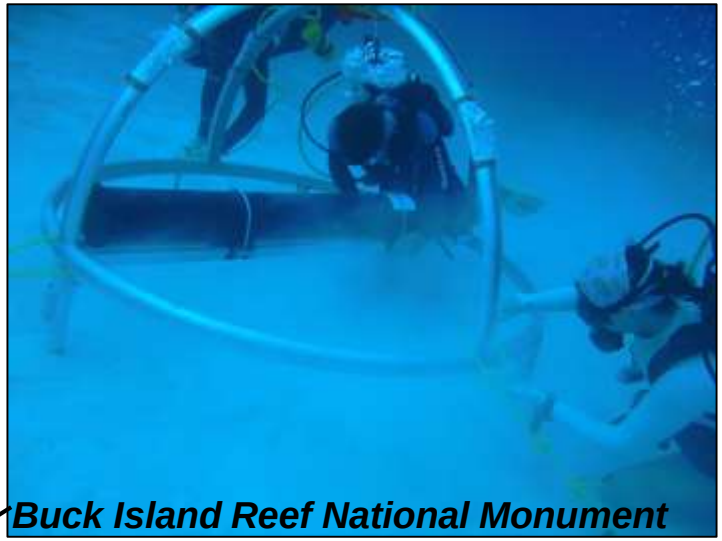
McKenna et al. 2017

Monitoring large-scale trends in ocean noise

Manage Noise

Glacier Bay National Park



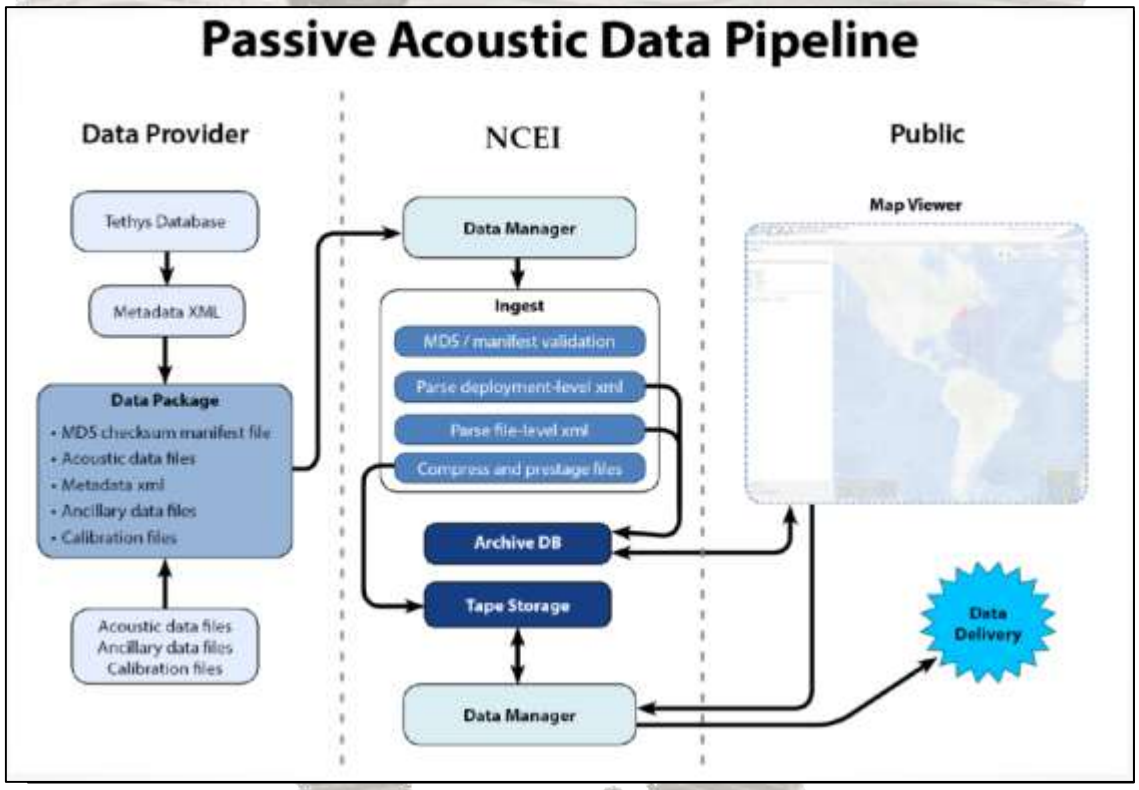


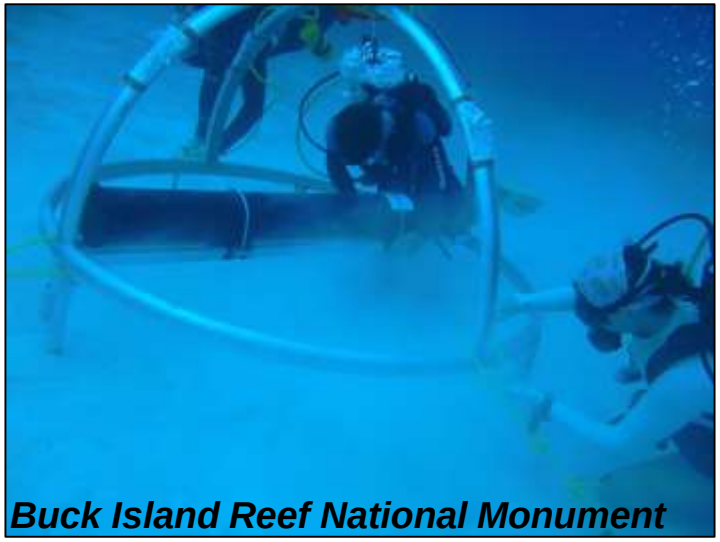
Buck Island Reef National Monument

National Park of American Samoa

Ocean Noise Reference Stations (with NOAA)

Standardized data collection and processing





Buck Island Reef National Monument

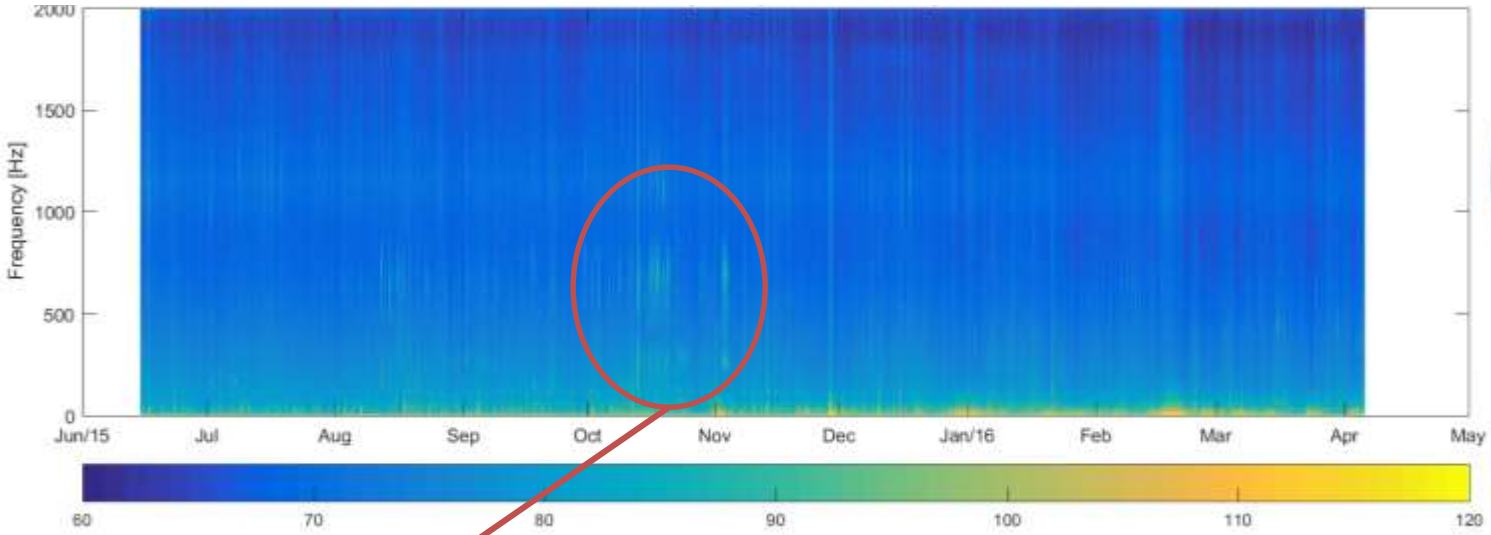
National Park of American Samoa

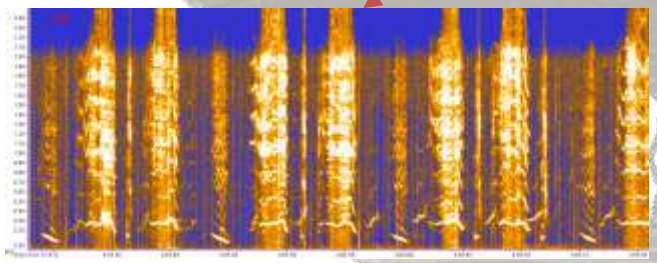
Underwater soundscape

Manage Noise

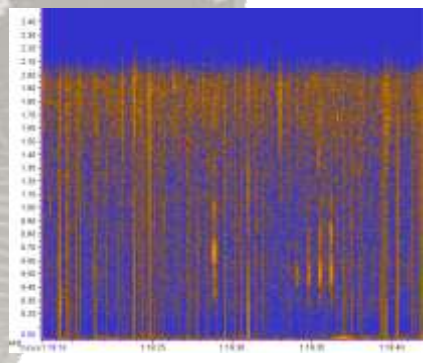
Ecological Monitoring

Summary of Acoustic Data in American Samoa (June-April)

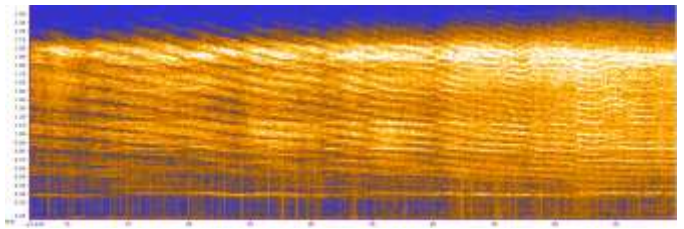




Humpback whale song

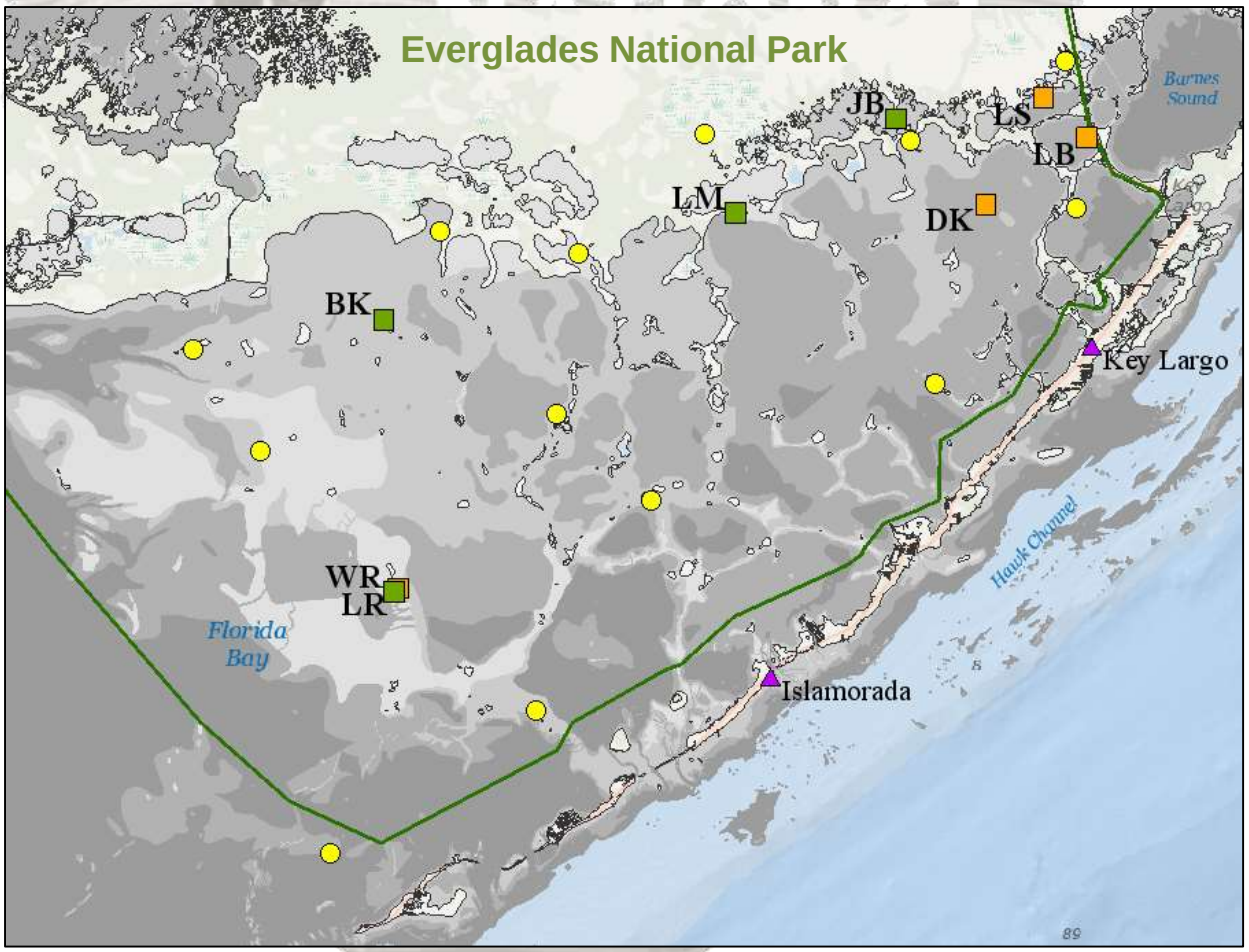


Fish croak (species?)



Ship noise

Bio-acoustic indicators of ecological condition

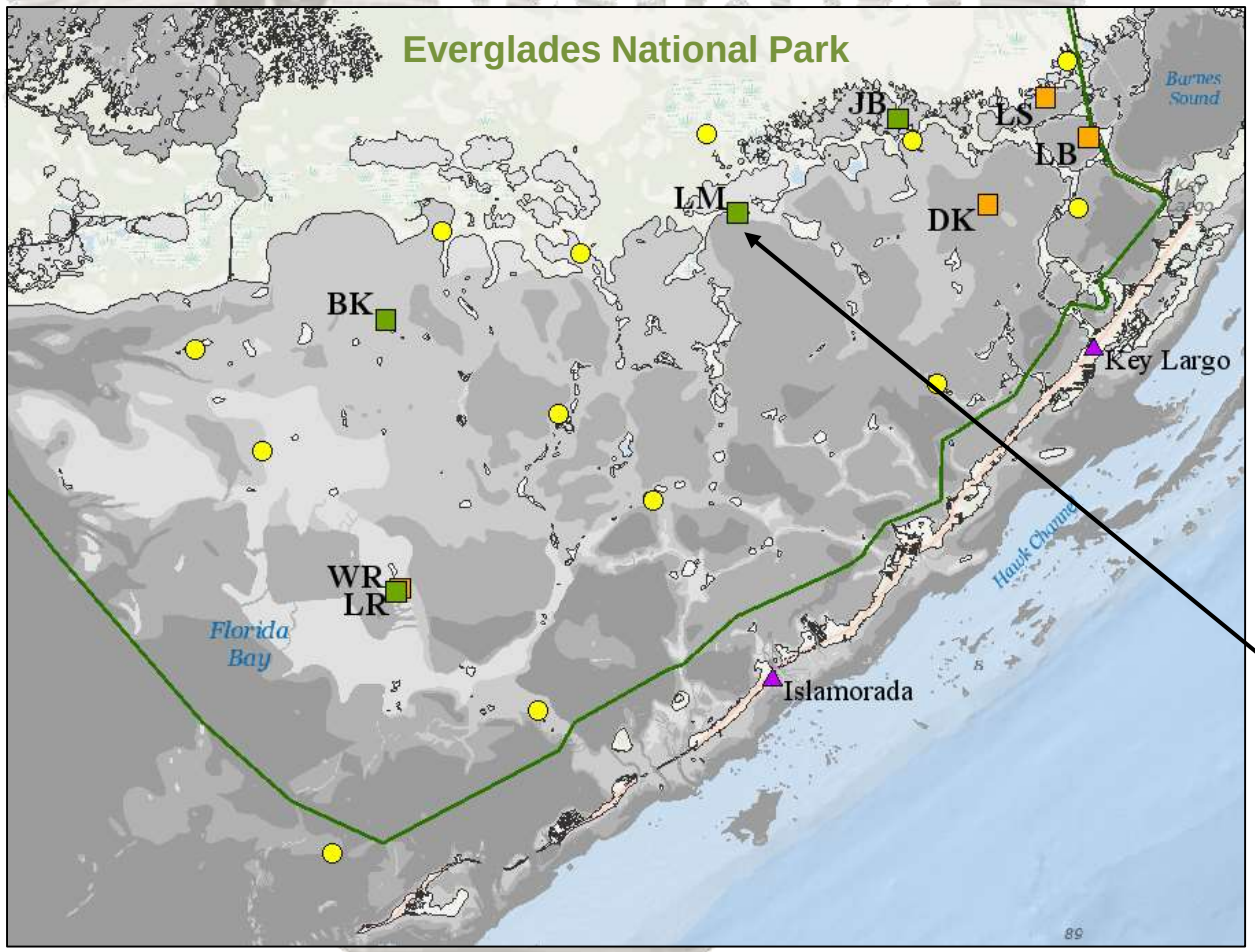


1. Can we predict presence of biological sounds in Florida Bay?

2. Can bio-acoustic indicators predict ecological conditions?

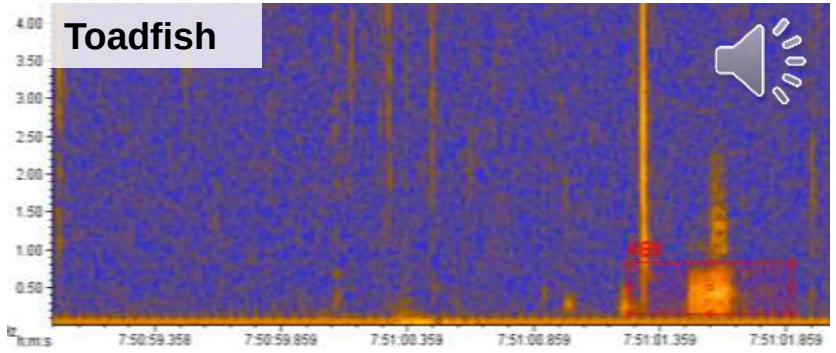
Underwater monitoring in Everglades NP

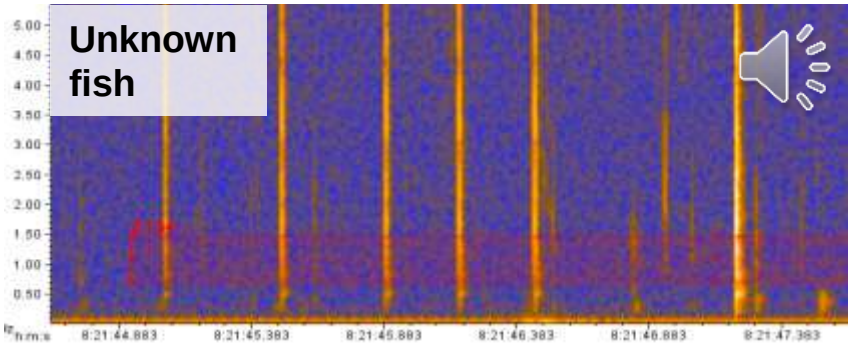
Ecological Monitoring

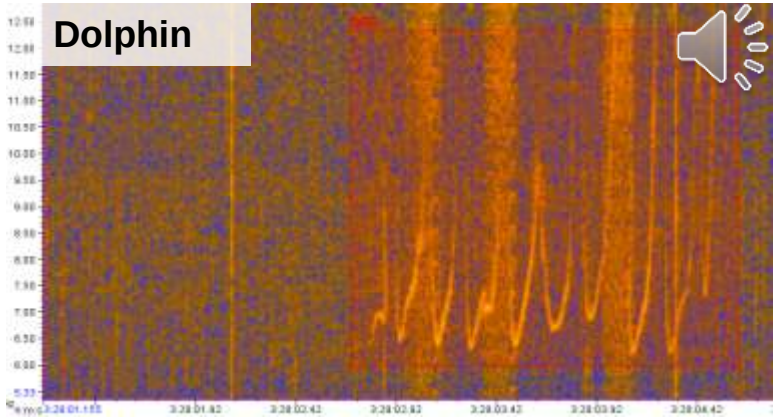


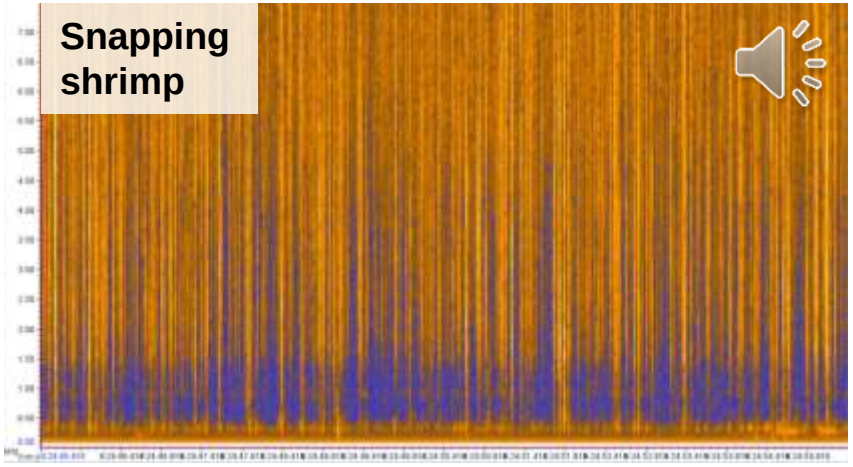
8 sites for 3 days in August & December

Detection of biological sounds





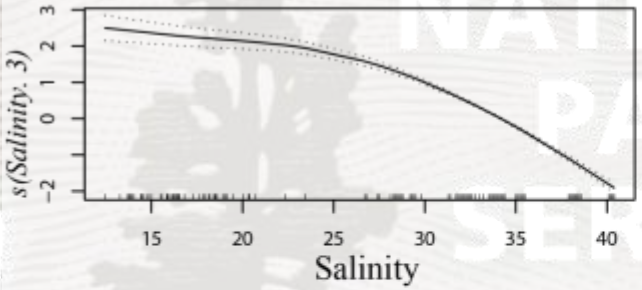


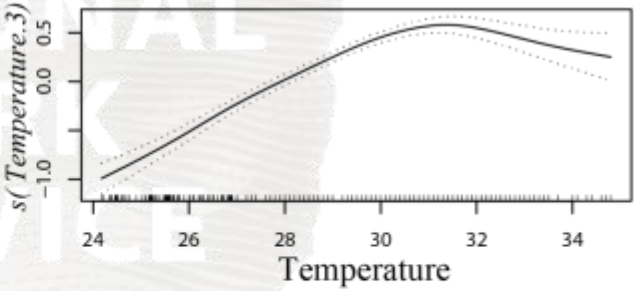


Predicting toadfish calls

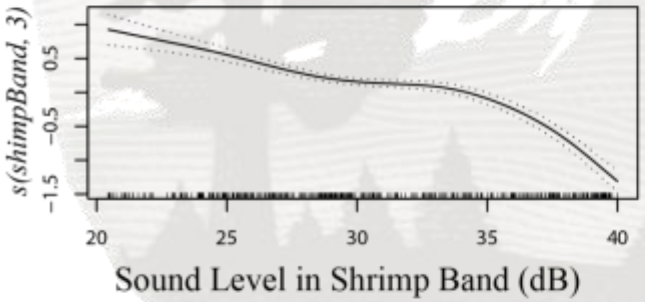
Ecological Monitoring

Physical environment



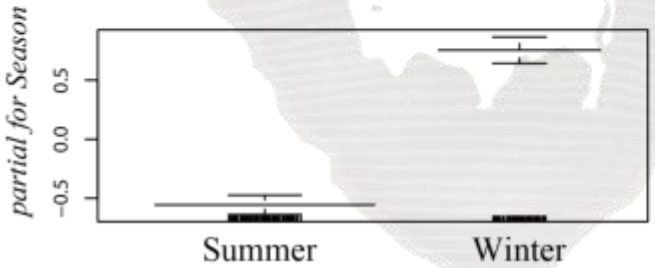


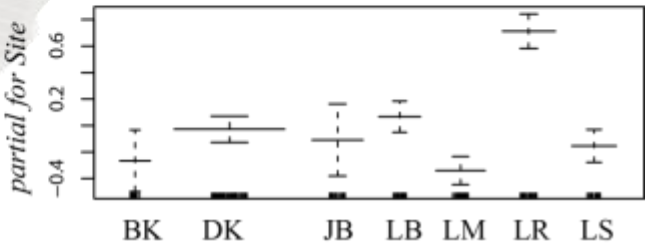
Simple acoustic metrics



Generalized Additive Mixed Model (GAMM) explains 47% of variance

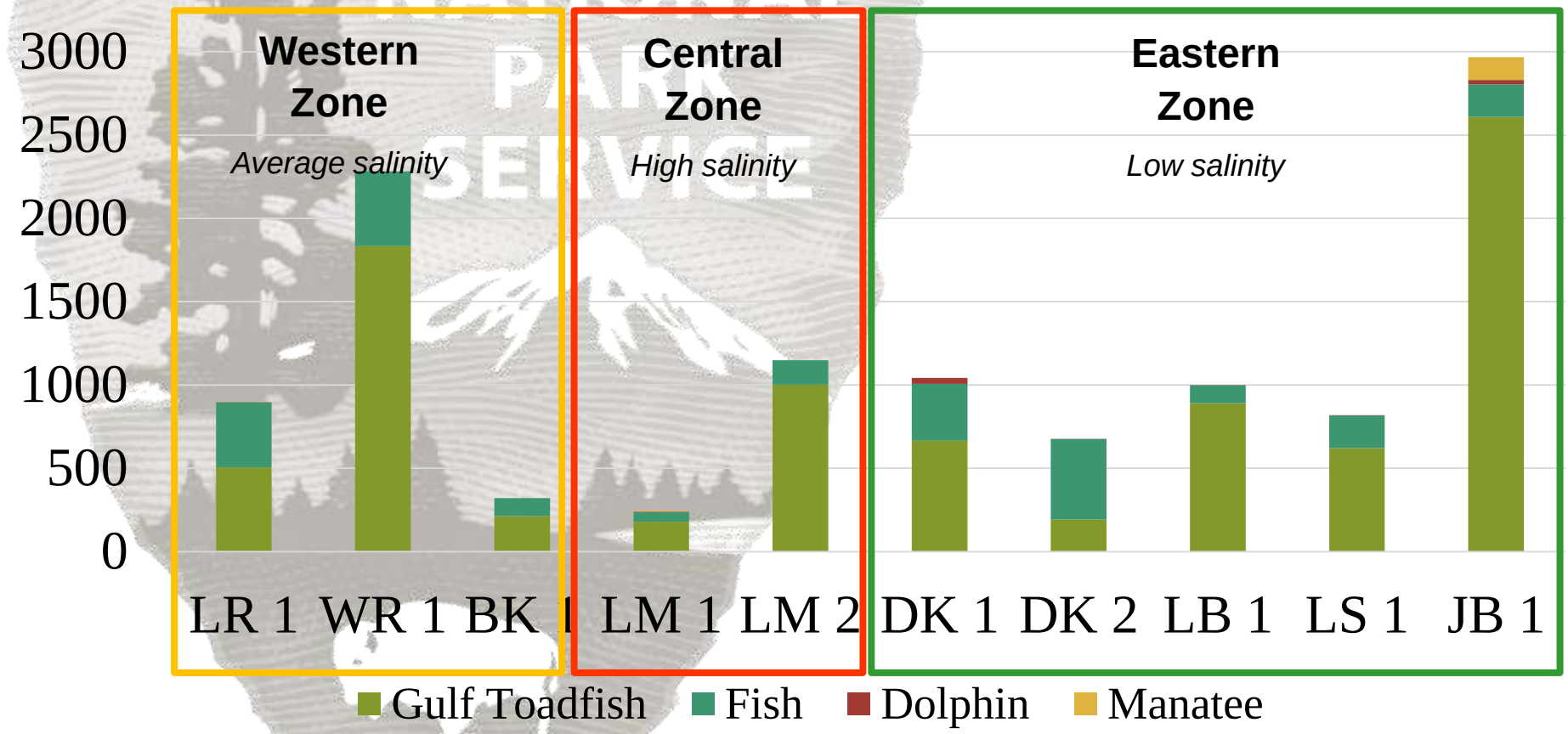
Time and space





Special thanks to K Nuessly

Occurrence of biological sounds



Can we predict presence of biological sounds?

Can bio-acoustic indicators predicts ecological condition?

Longer term acoustic data in collected in Joe Bay

Changes in the bay:

- **Closed to motorized boats**
- **Changes in run off**
- **Changes in use**

Future of underwater acoustic monitoring in National Parks

- **Standardize monitoring to meet the diverse needs of parks**
- **Establish partnerships to expand research on benefits of acoustic ecological monitoring**
- **Create a library of the unique underwater soundscapes in parks and share with visitors and public**

ACKNOWLEDGMENTS

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Oregon State University

Cornell University

THANK YOU

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https://www.nps.gov/nsnsd/

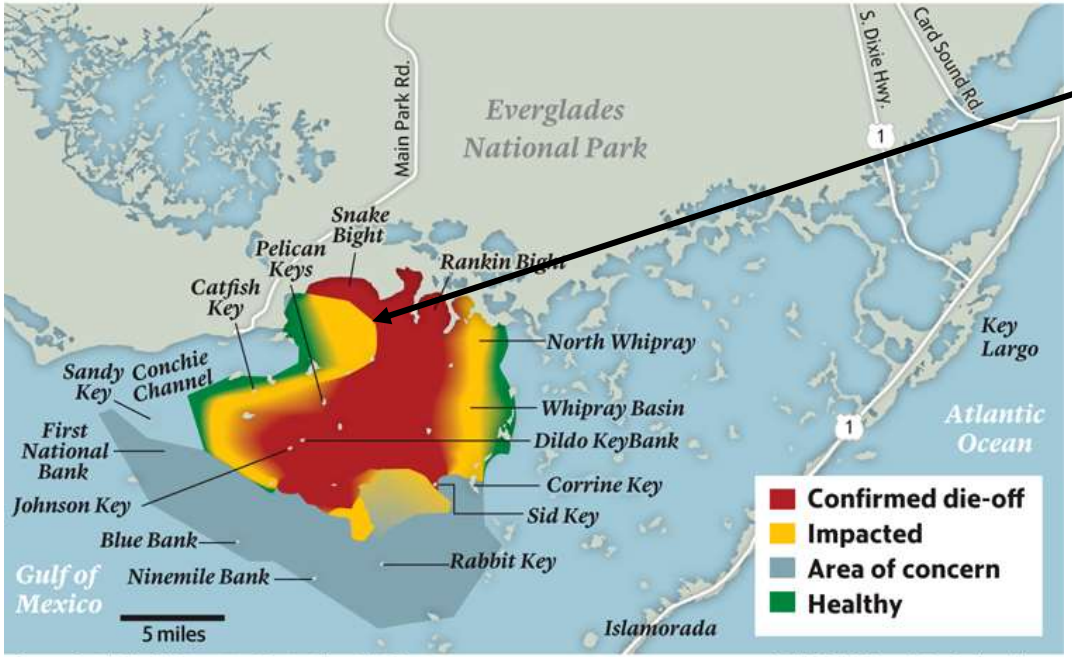
EXTRA SLIDES

Bio-acoustic activity predicts ecological condition

Ecological Monitoring

Seagrass die-off in Florida Bay

Since 2014, scientists say more than 62 square miles of seagrass has died in Florida Bay. While a rainy winter helped stop the trend, summer heat could rekindle the losses or trigger damaging algae blooms. The toll could approach the massive die-off of 1987, when 94 square miles of the bay's ecosystem collapsed.



Source: South Florida Ecosystem Restoration Joint Group.

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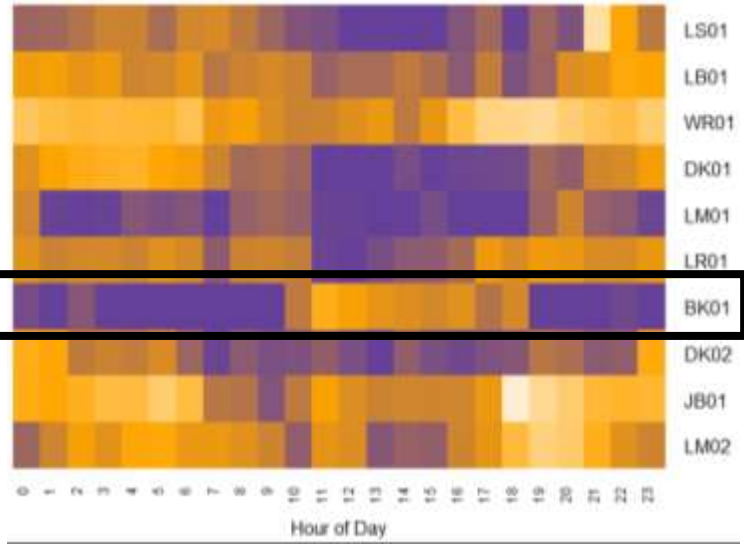

Low levels of biological activity

Abstract

National parks protect unique soundscapes as core resources. Inventorying park sounds and monitoring changing sounds contribute to protecting park soundscapes, cultural landscapes, wilderness, wildlife habitat and communication, and ecological processes— including predator-prey interactions. The first step to protecting the acoustic environment of a park is to characterize it accurately. Monitoring trends in acoustic conditions—including bio-acoustic activity— can then provide evidence of changing conditions that park managers can act upon. An underwater passive acoustic monitoring system in Glacier Bay National Park has been in place for over fifteen years, providing data on the status and trends of underwater noise from motorized vessels and the presence and seasonality of marine species, including humpback whales, killer whales, and harbor seals, as well as baseline data for the Gulf of Alaska region. In 2014, NPS partnered with the National Oceanic and Atmospheric Administration to build and deploy two ocean noise reference stations within NPS waters as part of a larger national network. The network represents the first large-scale effort to monitor long-term changes and trends in underwater sound spanning vast swaths of U.S. waters. The NPS sites at National Park of American Samoa and Buck Island Reef National Monument provide critical baseline information on acoustic conditions to compare across the network and over time. The NPS ocean noise reference stations were also selected to detect the occurrence and seasonality of marine mammals and levels of motorized boat traffic to inform park management. Sitka National Historical Park recently deployed a system as an exploratory study to record sounds in the harbor and serves as a pilot project to build a library of underwater sounds in U.S. national parks. Everglades National Park paired underwater acoustic monitoring with measures of oceanographic conditions (e.g. salinity) in Florida Bay to determine if bio-acoustic activity can provide early indicators of changes in ecosystem conditions and possibly recovery from climatic or anthropogenic events. Collectively, these underwater acoustic monitoring efforts are important steps towards developing relevant methods and reference libraries for monitoring and protecting park soundscapes using passive acoustic sensors.

BIO (50-word maximum): Dr. McKenna is an acoustic biologist and assists parks with acoustic monitoring and soundscape management. She has extensive experience collecting and analyzing passive acoustic data in a variety of aquatic and terrestrial habitats. She has participated in national and international committees to understand and manage acoustic impacts.

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