Assessing and Mitigating Impacts of Anthropogenic Sound on Marine Mammals

Presentation to the
Monterey Bay National Marine Sanctuary
Sanctuary Advisory Council
25 April 2014

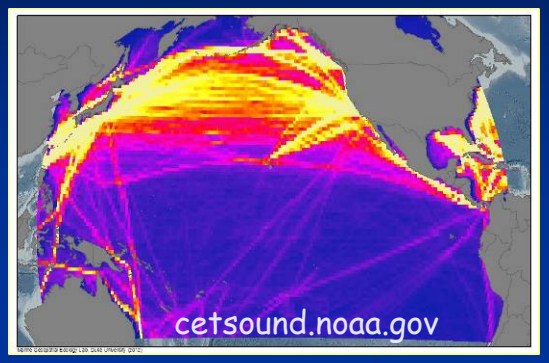
Karin A. Forney
Southwest Fisheries Science Center, NMFS, NOAA
110 Shaffer Rd, Santa Cruz CA 95060
Karin.Forney@noaa.gov

Talk Overview

- Background and defining the issue
- Local case study: Planned (ultimately cancelled) 2012 Diablo Canyon Seismic Survey
  - Assessment, monitoring, and mitigation of impacts to marine mammals
- Give perspective on:
  - Data gaps and important unanswered questions
  - Challenges
  - Designing effective strategies
- Discussion / questions?

Background
Effects of sound on marine mammals

- Marine mammals rely on sound to sense their environment, forage, communicate
- Anthropogenic sound can adversely affect marine mammals in multiple ways:
  - Behavioral disruption
  - Hearing loss
  - Adverse impacts on prey species
  - Stress, injury, death
- Some species known to be more sensitive than others:
  - Beaked whales (navy sonar / seismic surveys)
  - Harbor porpoise (pile driving operations)
  - Melon-headed whales (mass strandings associated with sonar activities)



Common mitigation strategies

Planning:

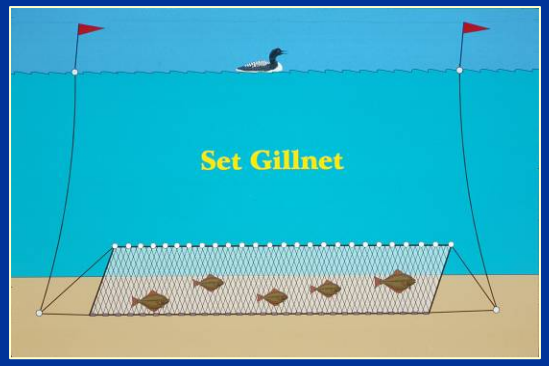
- Adjust seasonal timing to reduce overlap (migratory species)
- Avoid breeding/feeding periods
- Keep duration of activities as short as possible
- Minimize exposure of most sensitive species

Operational:

- Ramp up sound gradually to allow animal to move away before sound is loud enough to cause injury
- Monitor for marine mammals in real-time (ship/air/acoustic)
- Suspend activities if animals are detected nearby (until animals leave area)

Operational Paradigm: Allowing animals to move away from sound source will reduce risk of injury

Failure of Paradigm: For some populations, this paradigm is inadequate, and may indeed cause harm



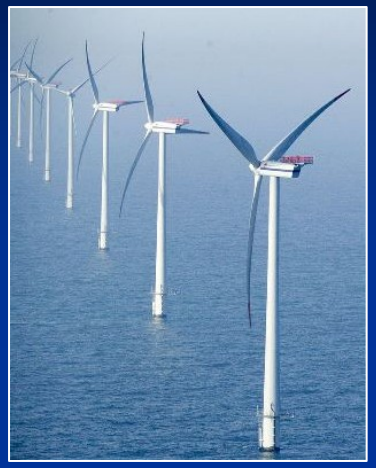
Key considerations

- Are there small populations?
- Do they have suitable habitat outside of impact zone?
- What are risk factors they will be exposed to?
  - Reduced foraging success
  - Bycatch in fisheries
  - Increased stress
  - Mass stranding
  - Inter-specific aggression
  - Increased predation
- Potential population-level consequences, yet we have little or no data to estimate effects

Defining the Issue

What sounds?

- Sonar
- Seismic surveys
- Renewable energy facilities (e.g. pile-driving)
- Vessel traffic, other…

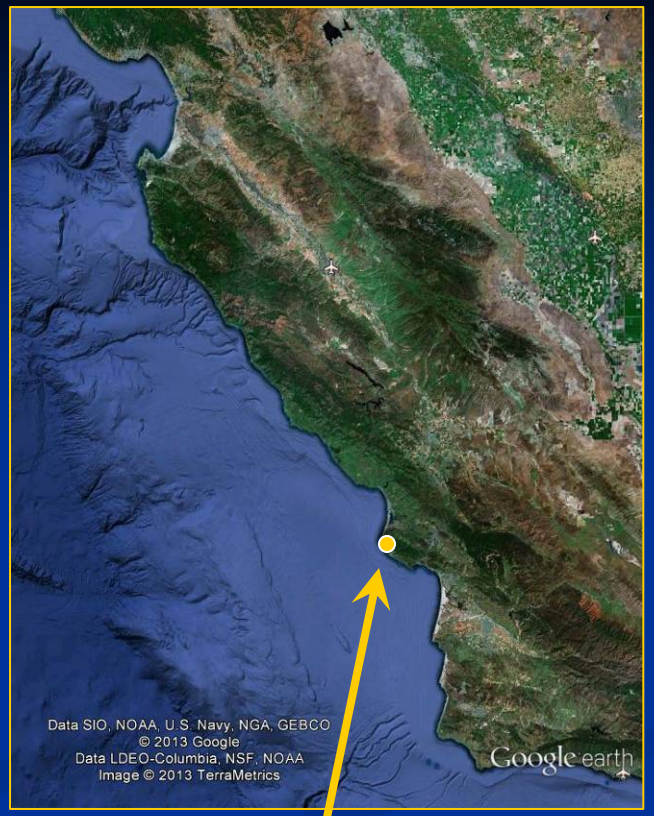


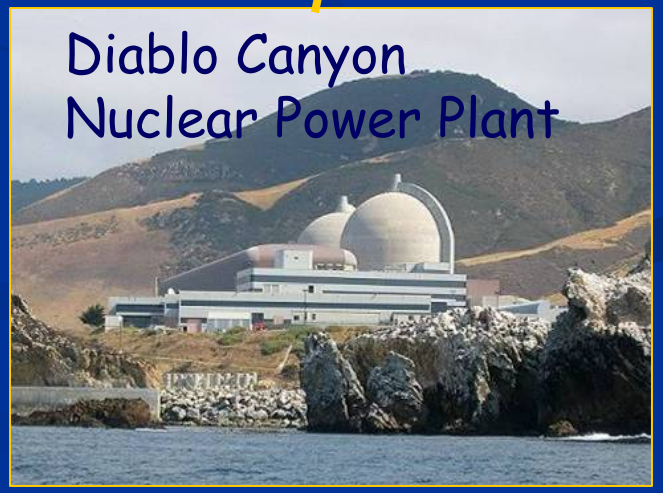
What species?

- Some more sensitive to sound than others
- What other factors are important (e.g. small local populations)?
- What do we know (or not) about impacts? (individual, cumulative, 'Soundscape' concepts)
- How can we address key information needs?

Diablo Canyon Seismic Surveys (Fall 2012)

- PG&E proposed 3-D high energy seismic surveys to assess risks associated with offshore fault zones.
- SWFSC became involved during summer 2012 to ensure adequate monitoring for species protected by the MMPA and ESA.
- Limited time to develop and implement plan
- Monitoring Program Overview
  - Our concerns
  - Key components
  - Lessons learned





Our Primary Concerns

1. Large Whales

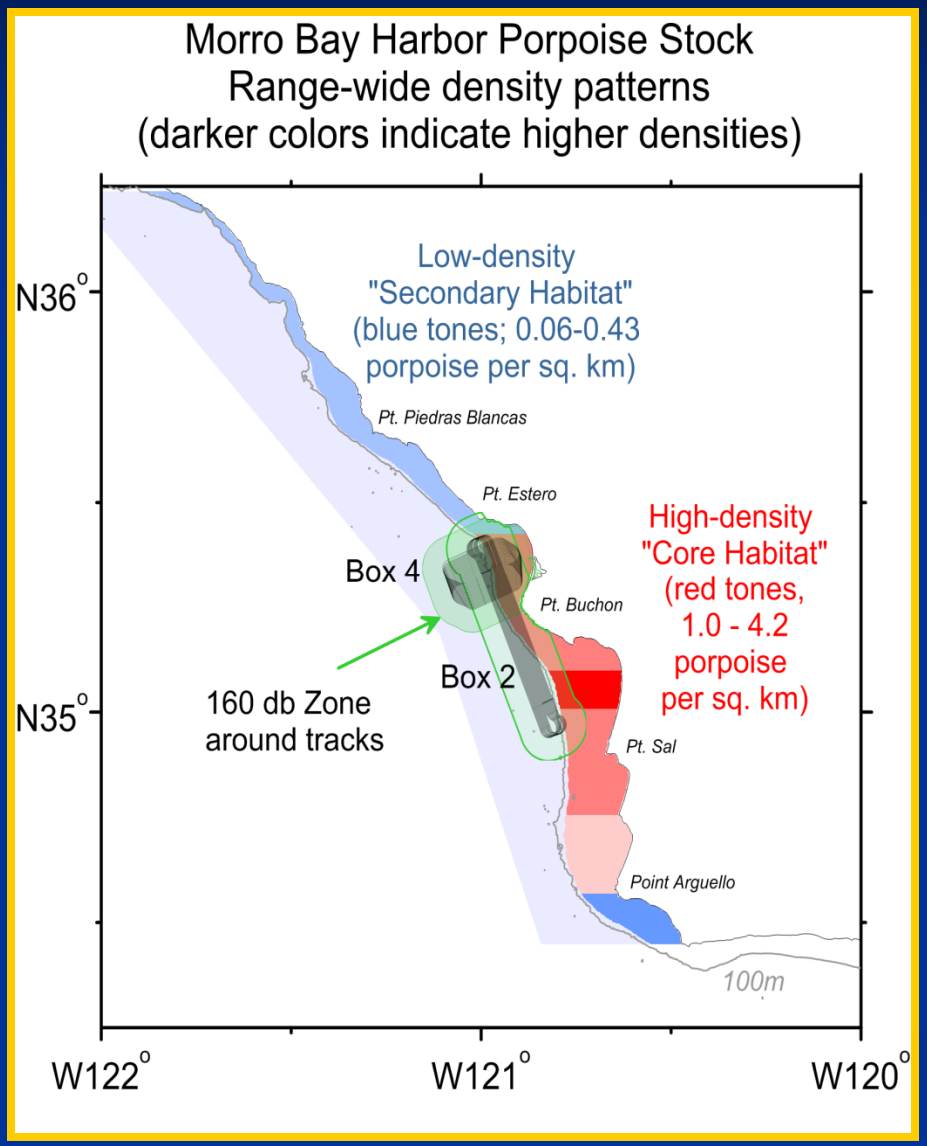
- Foraging habitat for several ESA-listed species
  - Humpback whales
  - Fin whales
  - Blue whales
- Gray whale
  - Migrate through area beginning in December

Our Primary Concerns

2. Harbor Porpoise

- The "Morro Bay Stock" of ~2000 porpoises
- Sensitive to anthropogenic disturbance (e.g. sound, vessels)
- Displacement into secondary habitat for days to weeks
- Adverse impacts on foraging abilities and thus health and survival?

Our Primary Concerns

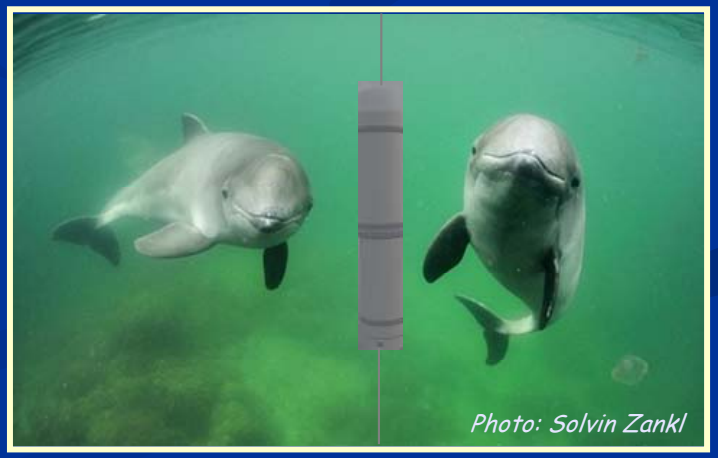


2. Harbor Porpoise

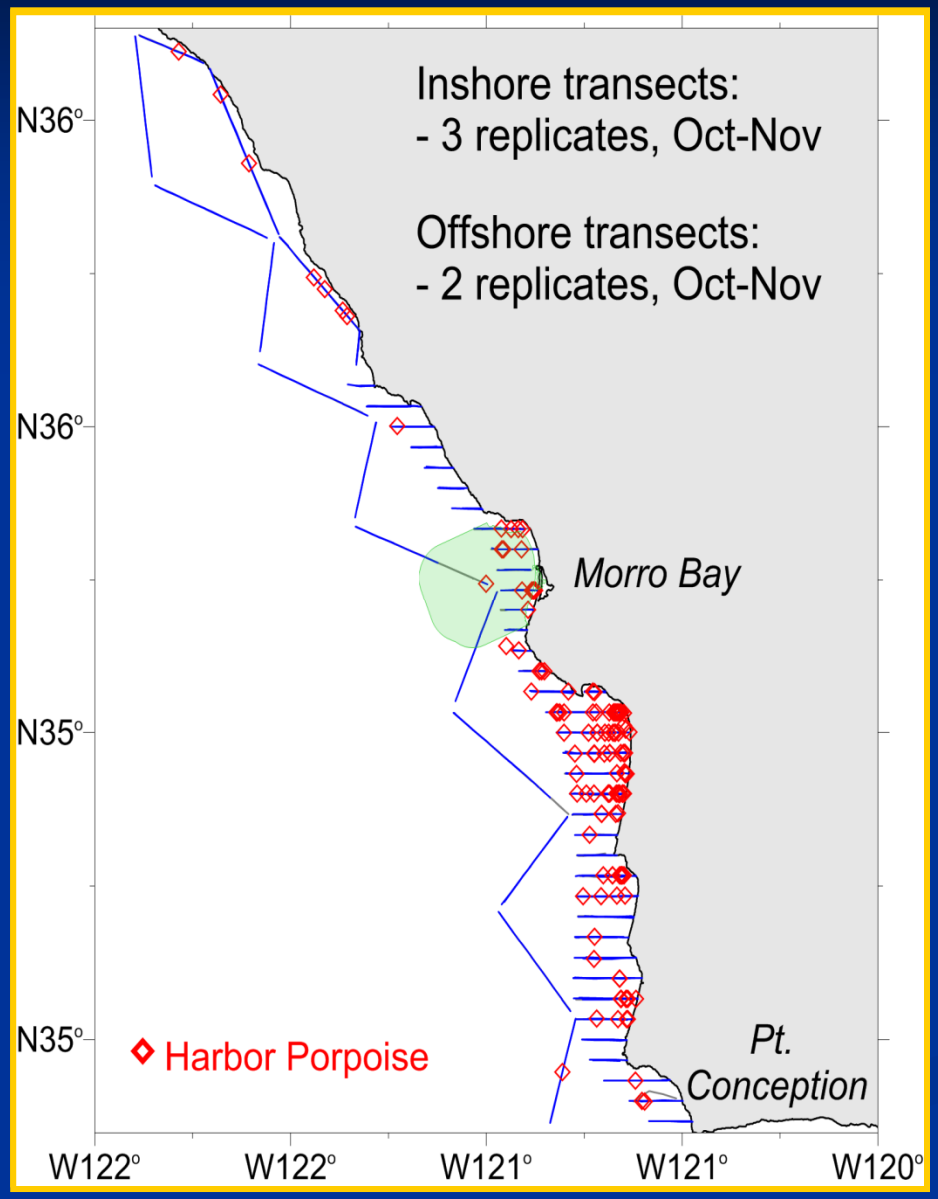
- The "Morro Bay Stock" of ~2000 porpoises
- Sensitive to anthropogenic disturbance (e.g. sound, vessels)
- Displacement into secondary habitat for days to weeks
- Adverse impacts on foraging abilities and thus health and survival?

Diablo Canyon Seismic Survey Monitoring Program Overview

- Objective: to assess potential impacts of seismic surveys
- Methods:
  - 3 Phases: pre-, during, and post-seismic survey data collection
  - 3 Components
    1. Aerial surveys
    2. Passive acoustics
    3. Active beach surveillance and stranding response



1. Aerial Surveys



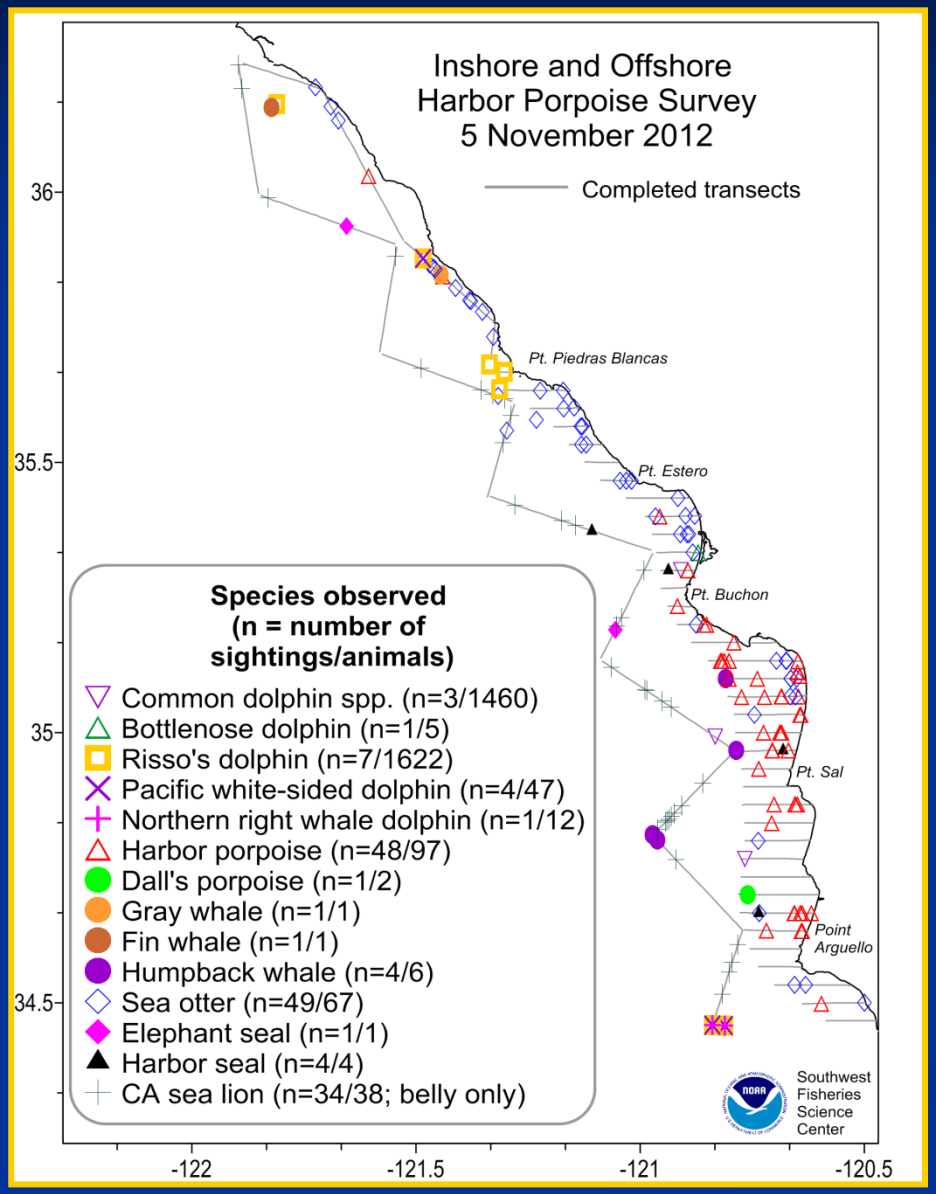
Objectives:

- Detect north/south or inshore/offshore displacement of harbor porpoises
- Assess distribution and abundance of ESA-listed whales and other marine mammals

Pre-survey conditions:

- Provides baseline for comparison to 'during' and 'post' seismic survey.

1. Aerial Surveys



Objectives:

- Detect north/south or inshore/offshore displacement of harbor porpoises
- Assess distribution and abundance of ESA-listed whales and other marine mammals

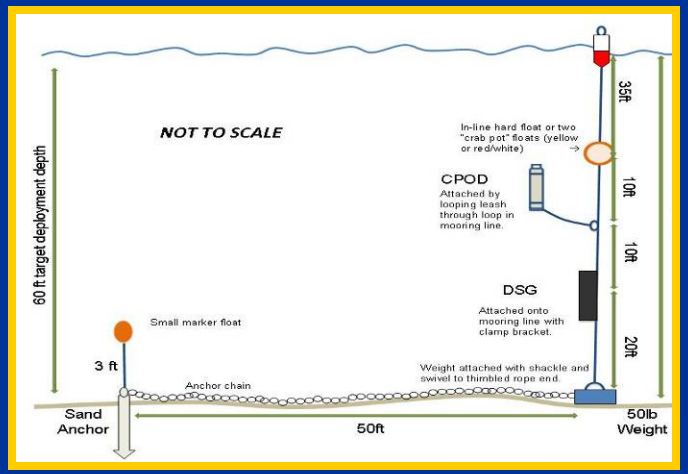
Pre-survey conditions:

- Provides baseline for comparison to 'during' and 'post' seismic survey.

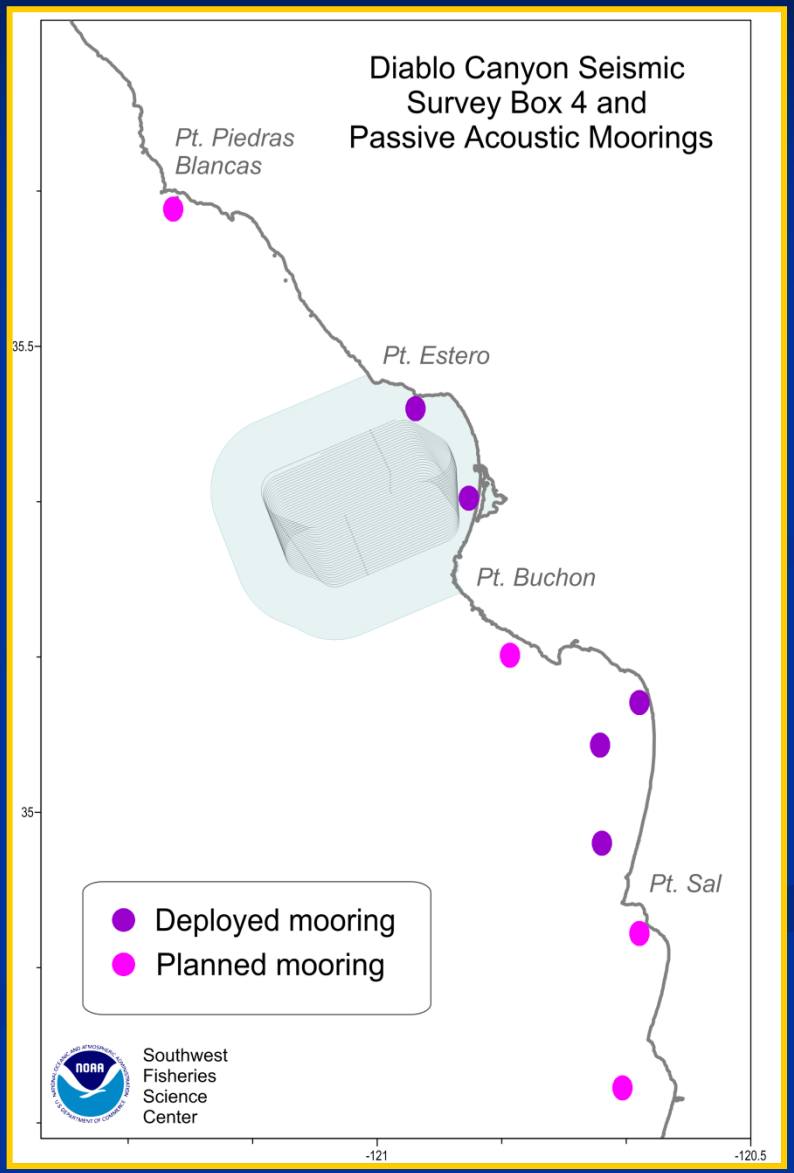
2. Passive acoustics

- Objectives: To assess harbor porpoise distribution and movements, and to document ambient noise
- Deploy porpoise click detectors (CPODs) to monitor north/south occurrence patterns
- Some CPODs deployed with ambient sound recorders (DSG model)

CPOD



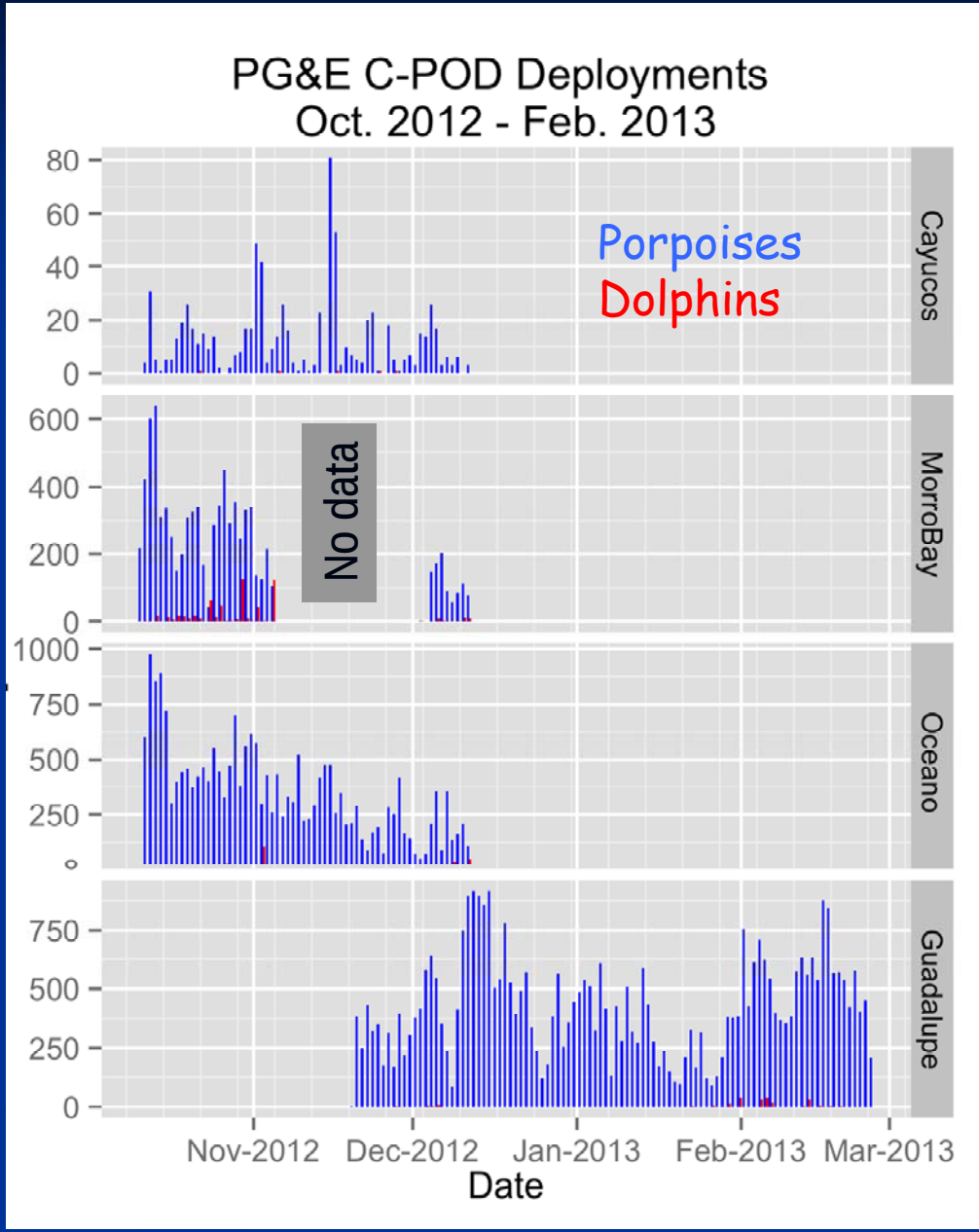
DSG



2. Passive acoustics - CPOD data summaries

- 5 moorings deployed Oct/Nov – Dec/Feb
- Highly variable porpoise detections
- Some dolphins detected
- Analysis after retrieval (not real-time)

- Goal: Identify displacement from seismic survey area to areas north or south, if it occurs?

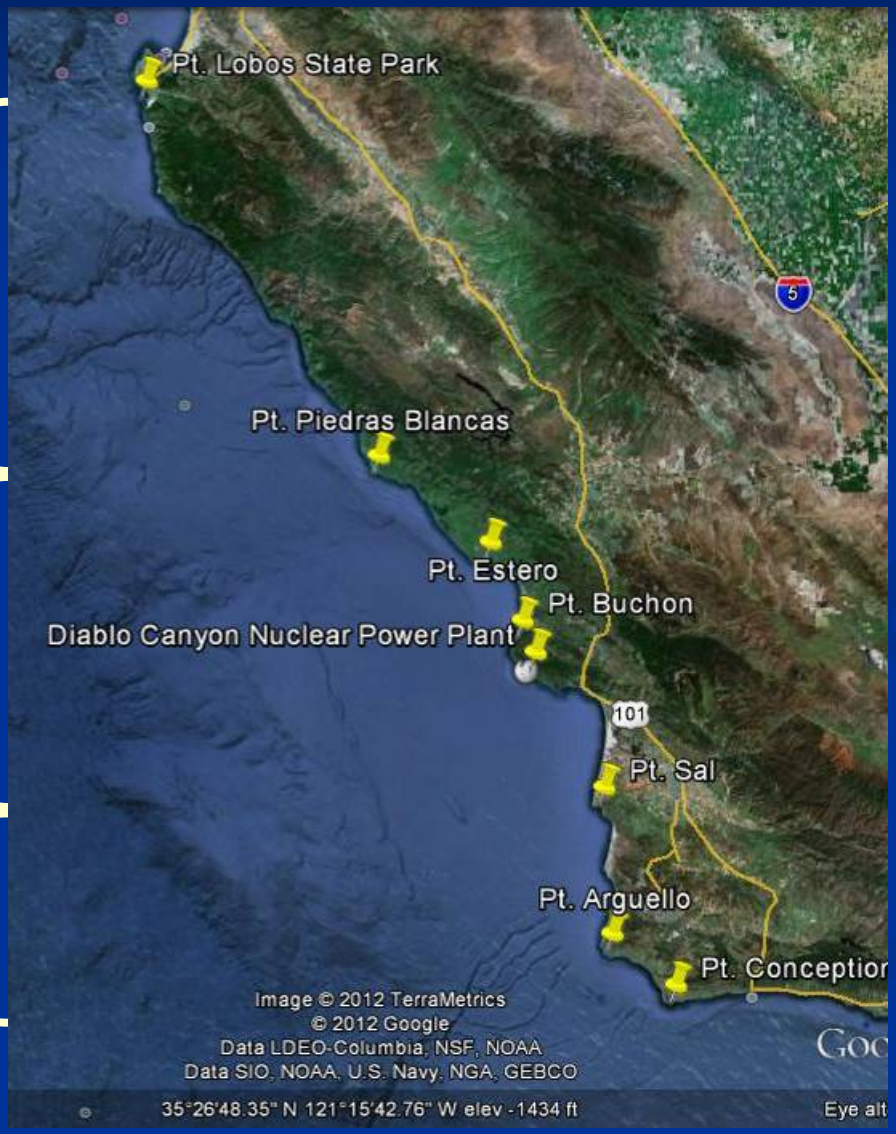


3. Active Beach Surveillance and Stranding Response

Aerial only

Beach Walks

Aerial only



Objectives:

- Detect and efficiently respond to live and dead stranded marine mammals and sea turtles
  - Walk index beaches
  - Fly the study area
- Determine cause of death:
  - Rule out disease
  - Expand knowledge about the impacts of sound

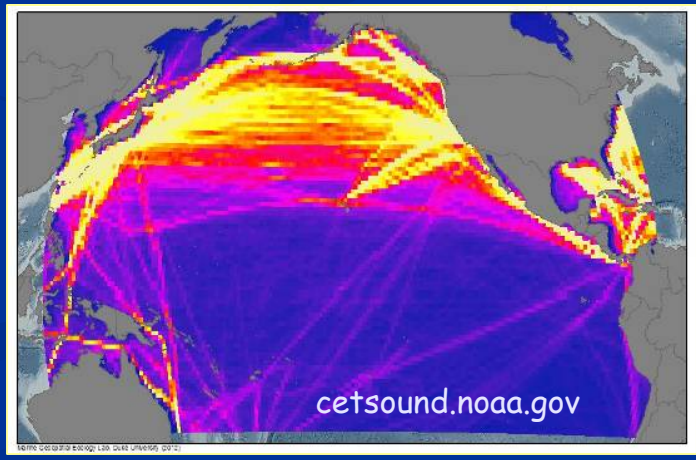
Diablo Canyon Seismic Survey Monitoring Program Conclusions

- The completed pre-seismic survey monitoring indicates plan was *feasible* (but… we got lucky with the weather)
- Was it *effective*? Unclear…
  - Short time window of base-line surveys (weeks)
  - Since seismic survey cancelled, did not learn whether the level of monitoring would have been adequate to detect impacts
  - Monitoring was focused on detecting displacement or strandings of individuals. What about other (more subtle) effects?
- Effective programs require advanced planning & coordination (years, not weeks)

Perspectives on Designing Effective Monitoring Programs

- Data gaps and unanswered questions
  - Species (and population) responses to sound differ
  - Effective mitigation requires some knowledge of these population-level responses
  - Thresholds for 'effects of concern' (e.g. how much displacement is a problem? For how long?)

- Challenges
  - Anthropogenic sound is increasing in the marine environment (globally)
  - Limited understanding of how sound affects individuals, populations, and ecosystem health
  - Small, localized populations present a particular challenge



How do we design effective monitoring/assessment programs?

- Coordinated <u>early</u> planning
- Identify key habitats, species, times of concern
- Evaluate any existing baseline data (e.g. stranding rates, animal distribution and movements, etc)
- Design appropriate monitoring program (e.g. using aerial surveys, passive acoustics, tagging studies, etc)
- Multi-year baseline studies with pre-, during, and post-impact components are essential

Aquatic Mammals 2013, *39*(4), 356-377, DOI 10.1578/AM.39.4.2013.356

Responsible Practices for Minimizing and Monitoring Environmental Impacts of Marine Seismic Surveys with an Emphasis on Marine Mammals

Douglas P. Nowacek,[1*] Koen Bröker,[2] Greg Donovan,[3] Glenn Gailey,[4] Roberto Racca,[5] Randall R. Reeves,[6] Alexander I. Vedenev,[7] David W. Weller,[8] and Brandon L. Southall[9, †]

[1]*Nicholas School of the Environment and [*]Pratt School of Engineering, Duke University Marine Laboratory, 135 Duke Marine Lab Road, Beaufort, NC 28516, USA*
E-mail: dpn3@duke.edu
[2]*Shell Global Solutions, Lange Kleiweg 40, 2288GK Rijswijk, The Netherlands*
[3]*International Whaling Commission, Red House, 135 Station Road, Cambridge, UK CB24 9NP*
[4]*Texas A&M University Galveston, PO Box 1675, Galveston, TX 77553, USA*
[5]*JASCO Applied Sciences Ltd., 2305-4464 Markham Street, Victoria, BC V8Z 7X8, Canada*
[6]*Okapi Wildlife Associates, 27 Chandler Lane, Hudson, Quebec J0P 1H0, Canada*
[7]*P. P. Shirshov Institute of Oceanology of the Russian Academy of Sciences, 36, Nakhimovskiy Prospect, Moscow 117997, Russia*
[8]*Southwest Fisheries Science Center, NMFS, NOAA, 8901 La Jolla Shores Drive, La Jolla, CA 92037, USA*
[9]*Southall Environmental Associates and University of California at Santa Cruz, 9099 Soquel Drive, Suite 8, Aptos, CA 95003, USA*

Abstract

Marine seismic surveys, which use loud, primarily low-frequency sound to penetrate the sea floor, are known to disturb and could harm marine life. The use of these surveys for conventional and alternative offshore energy development as well as research is expanding. Given their proliferation and potential for negative environmental impact, there is a growing need for systematic planning and operational standards to eliminate or at least minimize impacts, especially when surveys occur in sensitive areas. Mitigating immediate impacts is obviously critical, but monitoring for short- as well as long-term effects and impacts is also needed. Regulatory requirements for both mitigation and monitoring vary widely from one country or jurisdiction to another. Historically, most have focused on acute effects but share a common objective of minimizing potential adverse impacts. Specific examples in different areas are given to illustrate general approaches for predicting, minimizing, and measuring impacts for operations in essentially any marine environment. The critical elements of a robust mitigation and monitoring plan for responsibly conducting marine seismic surveys include obtaining baseline ecological data; substantial advance planning, communication, and critical review; integrated acoustic and visual monitoring during operations; and systematic analysis of results to inform future planning and mitigation.

Key Words: seismic, survey, planning, mammal, mitigation, monitoring, marine, Sakhalin

Introduction

As hydrocarbon exploration and extraction continue to expand in the oceans, particularly at higher latitudes, there is a growing need for operational standards to minimize impacts, especially when the activities occur in environmentally sensitive areas. This is particularly true for invasive sensing technologies that use loud sounds to image geophysical properties but incidentally expose large ocean areas to potentially damaging or disturbing noise. Sufficient scientific data exist to conclude that seismic airguns used in geophysical exploration have a low probability of directly harming most marine life, except at close range where physical injury is a real danger. While the use of airguns does not appear to disturb animals in some circumstances, in other conditions it can result in moderate to extreme behavioral responses and/or acoustic masking over large areas (see reviews by Nowacek et al., 2007; Southall et al., 2007; Clark et al., 2009); indeed, recent studies have reported the transmission of sound energy from seismic surveys over vast ranges of nearly 4,000 km (Nieukirk et al., 2012). Most documented responses to seismic exploration or other intermittent human activities involving loud sounds include apparently temporary changes in behavior, but scientific understanding of the prevalence and implications of these effects is limited.

Conclusions

- Great need to understand impacts of anthropogenic sound on marine mammals (and other marine species).
  - Southern California Behavioral Response Study
  - Multi-year studies of porpoises in the North Sea

- Given that many human activities generate sound…
  - Conduct well-designed, advanced studies to understand potential responses to sound stimuli
  - Design real-time monitoring to detect potential effects quickly, and guide immediate mitigation actions.
  - Coordinate with other users of marine environment, e.g. to reduce risk of bycatch in adjacent areas

- New NOAA initiatives that recognize these needs (e.g. Ocean Noise Strategy); working towards understanding and managing impacts more effectively.

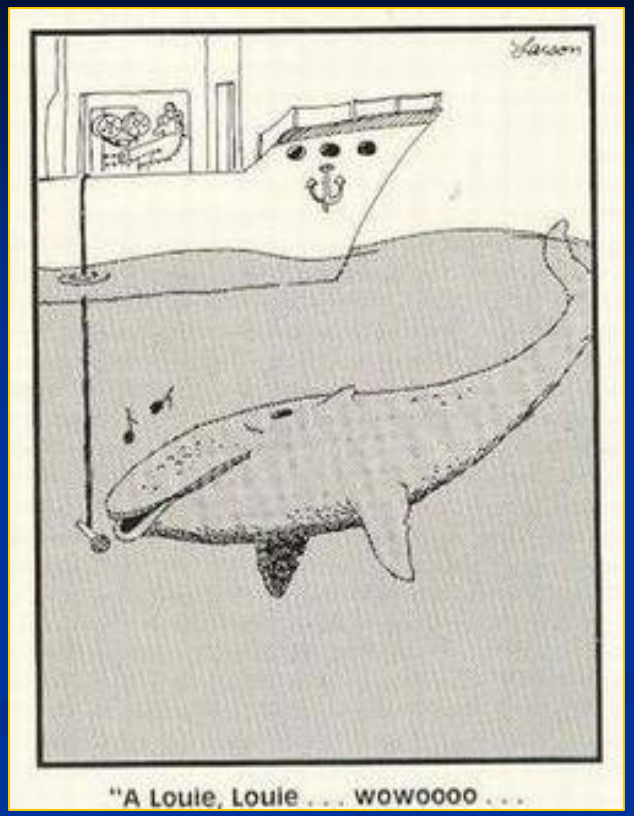
Acknowledgments

Susan J. Chivers, Lisa T. Ballance
Southwest Fisheries Science Center

Sarah M. Wilkin, Southwest Region

Teri K. Rowles, NOAA Office of Protected Resources

Brandon Southall, SEA Inc.



Some sounds may be stranger than others….

Thank you!

Questions? Comments?