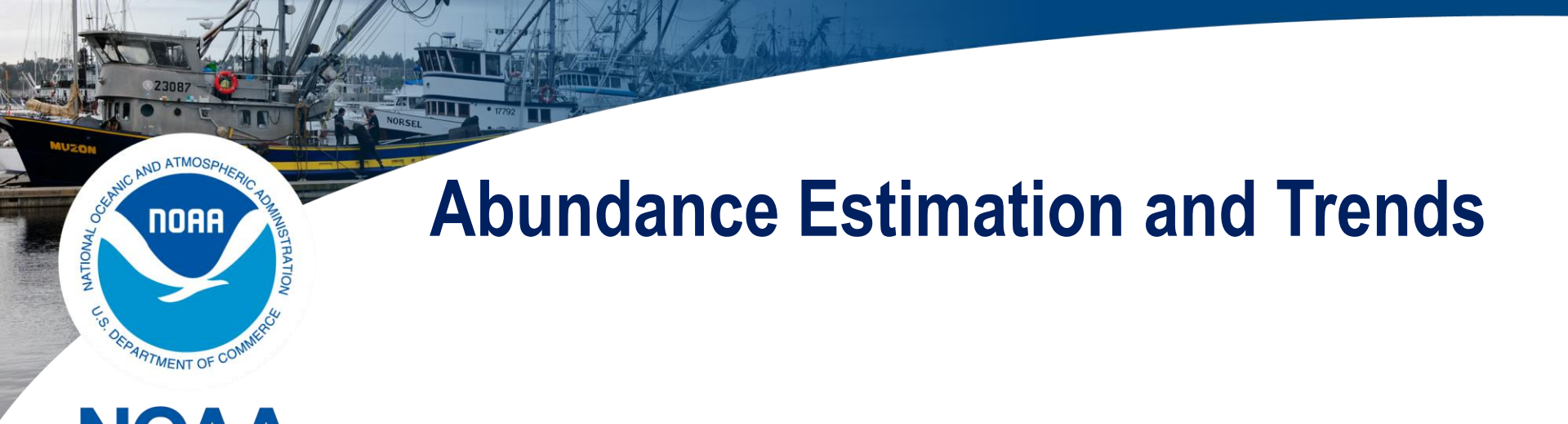


Abundance Estimation and Trends

NOAA FISHERIES

Jeffrey Moore

EEZ Mammals and Acoustics Program Leader,

Mammal & Turtle Research Division

NOAA Fisheries, Southwest Fisheries Science Center

Review of NOAA Fisheries' Science on Marine Mammals & Turtles

Southwest and Northwest Fisheries Science Centers

27-31 July 2015

La Jolla, CA

Links with Mandates, Regulatory Partner Needs

- MMPA Stock Assessments
  - Stock structure, Abundance, Trends, Bycatch Estimates
- MMPA Pacific Scientific Review Group (SRG)
- MMPA Take Reduction Team Process
  - Pacific Offshore Cetaceans, False killer whale
- ESA Status Reviews
  - Humpback whale
- ESA Recovery Planning
- Responding to WCR needs on diverse regional issues
- International commitments

Stock Assessment Reports (SARs)

- MMPA requires stock assessment reports for all U.S. stocks
  - 42 US West Coast EEZ (WCEEZ)
    - 9 pinnipeds, 31 cetaceans, 2 sea otters
  - 44 Pacific Islands Region stocks
- Basis for identifying strategic stocks & evaluating fisheries
- Multi-disciplinary inputs required
  - e.g., Stock structure, abundance/trends, human-caused mortality and serious injury estimates
- Reviewed annually by Scientific Review Groups (SRG)

Marine mammal survey efforts in the U.S. West Coast EEZ – Overview

- CA Current vessel line-transect cruises (for most WCEEZ species)
- Aerial surveys for pinnipeds and harbor porpoise
- Small-boat surveys for coastal bottlenose dolphins
- Shore-based surveys for gray whales

Vessel line-transect surveys for cetaceans

Survey years: 1991, 1993, 1996, 2001, 2005, 2008, 2014

2 – 3 yr intervals

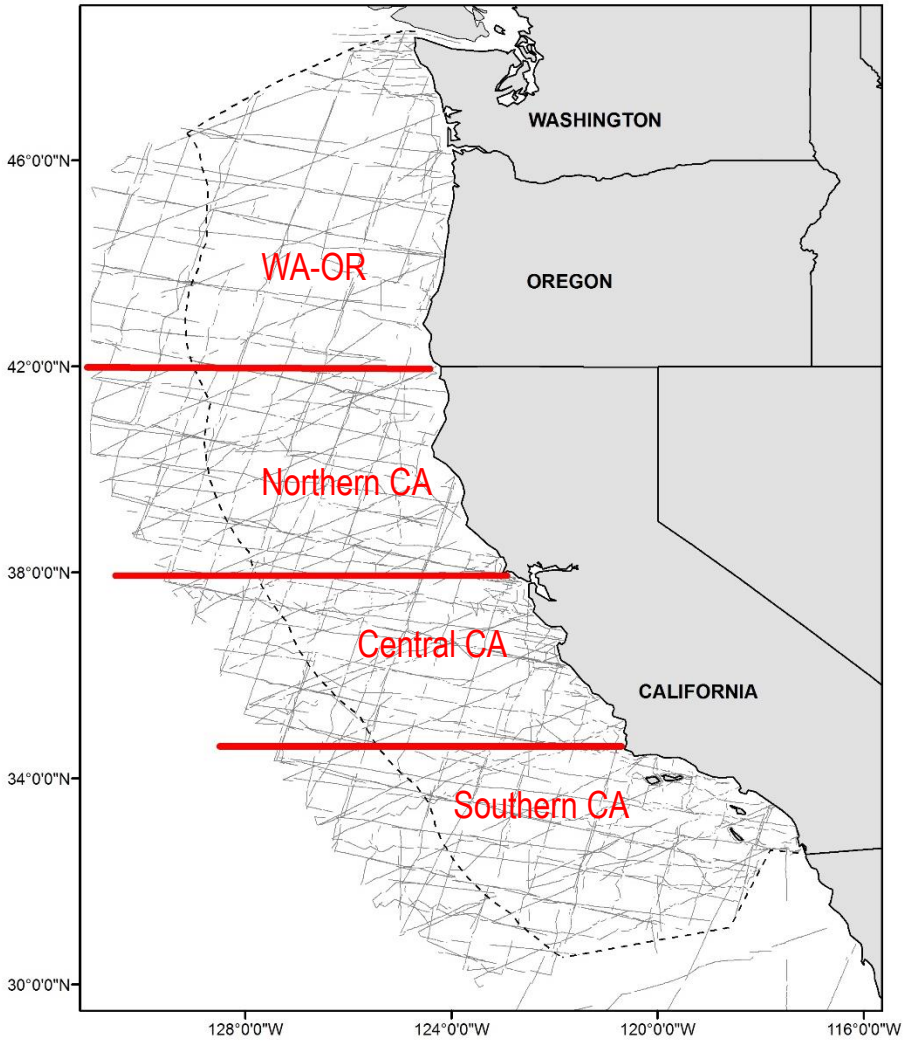
3 – 5 yr intervals

6 yr interval;

2014 survey external-funding dependent (U.S. Navy and BOEHM)

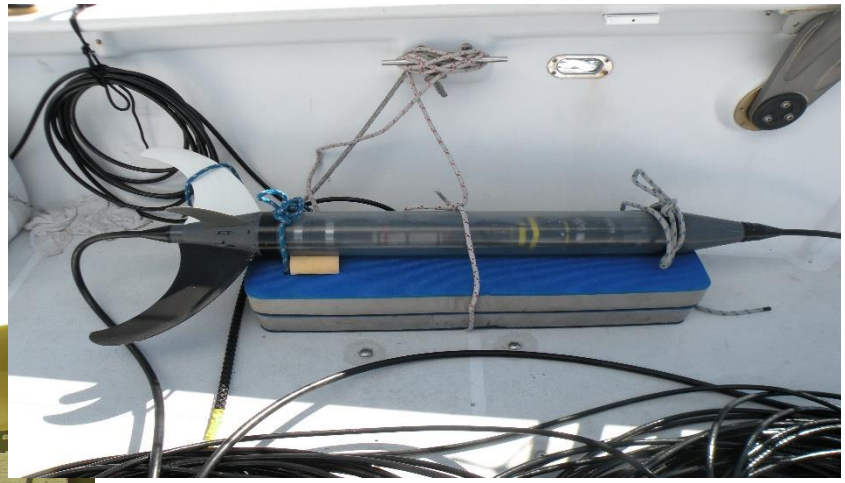
Vessel line-transect surveys for cetaceans

- Study area: 1.14 million km^2
- Effort: 72,214 km
  - Avg. 10,300 km per survey
- No. Species detected: 23+
- Roughly 70,000 groups detected



Vessel line-transect surveys for cetaceans

- Acoustic monitoring (esp for visually cryptic species)

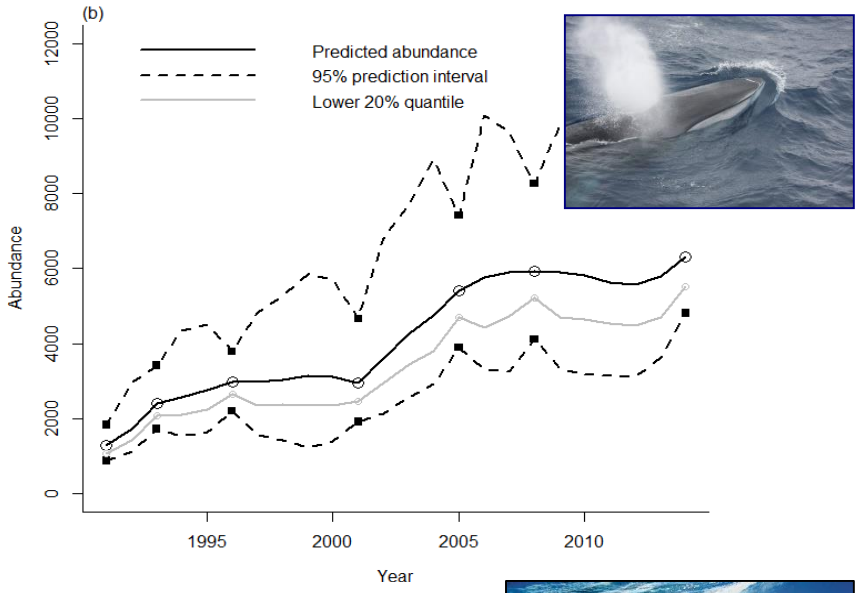


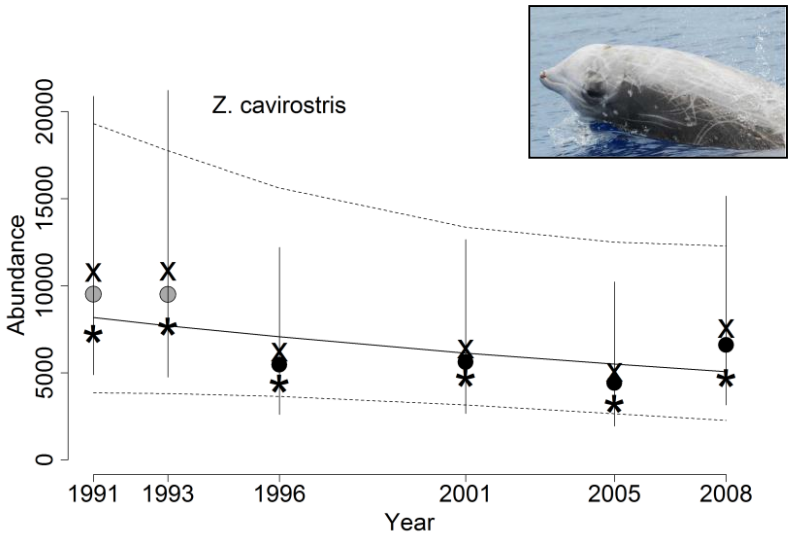
Case study speaker: Jay Barlow

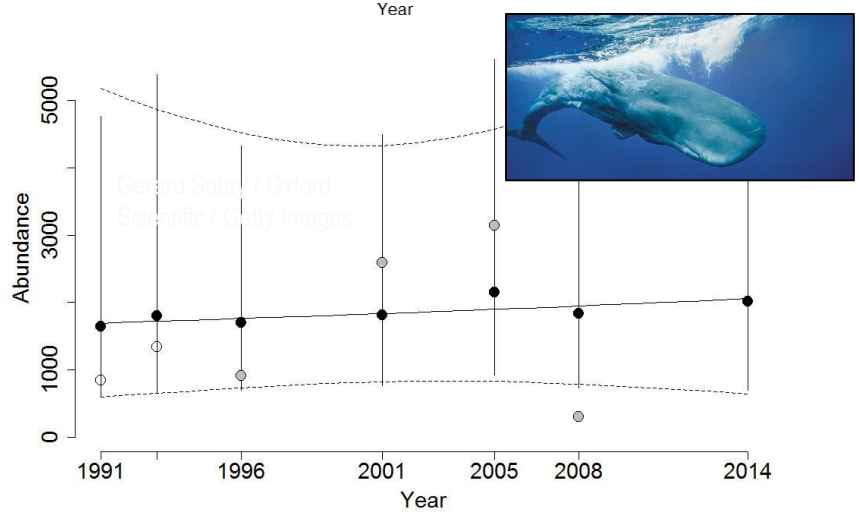
Vessel line-transect surveys for cetaceans

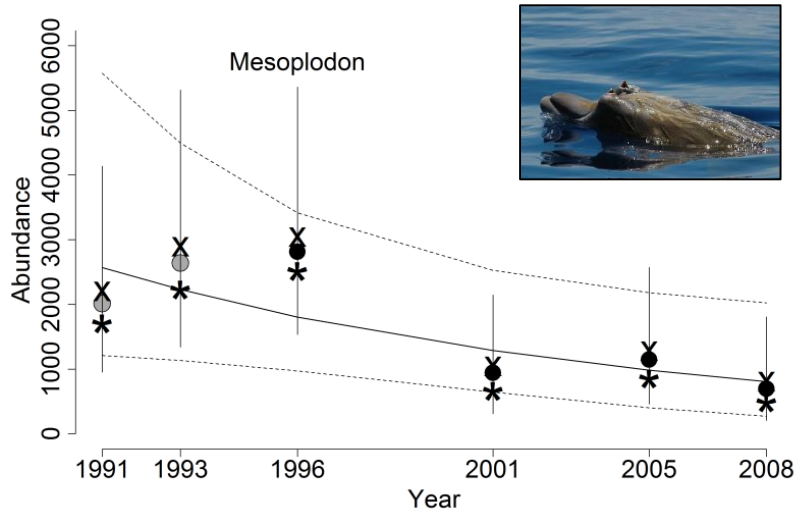
- Toward hierarchical Bayesian trend and abundance estimation (Moore and Barlow 2011, 2013, 2015)
  - Makes more efficient use of all information in the time series
  - Improves precision and reduces volatility of individual abundance estimates
  - Can be used to make inference about future (projected) abundance
  - Incorporates Beaufort-specific g(0) estimates (Barlow 2015)

Vessel line-transect surveys for cetaceans



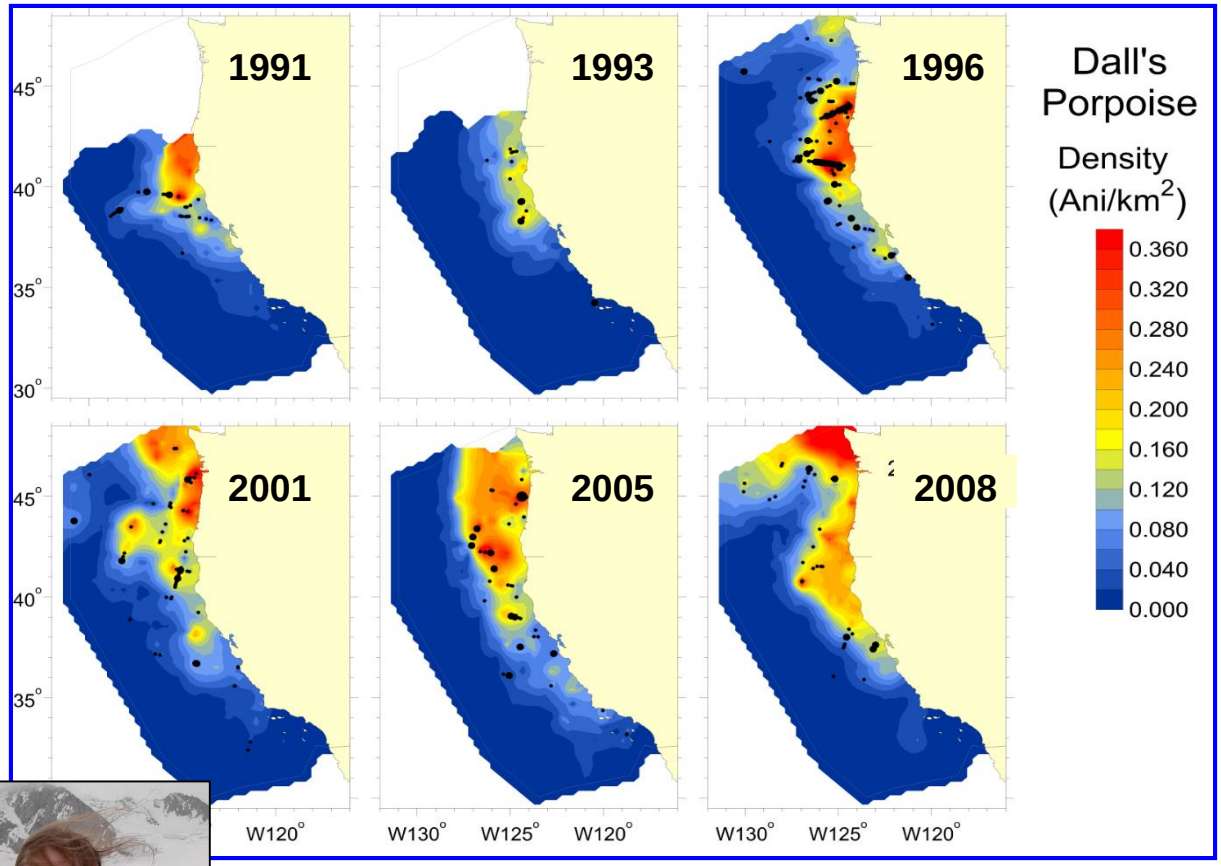






Vessel line-transect surveys for cetaceans

- Habitat-based density models from line-transect data
  - Alternative to design-based abundance estimation
  - Can help explain trends & provide inference at finer spatial scales

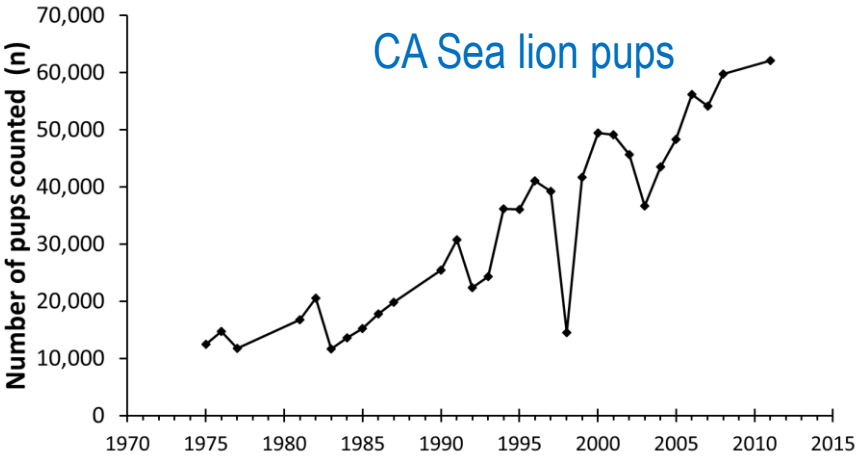


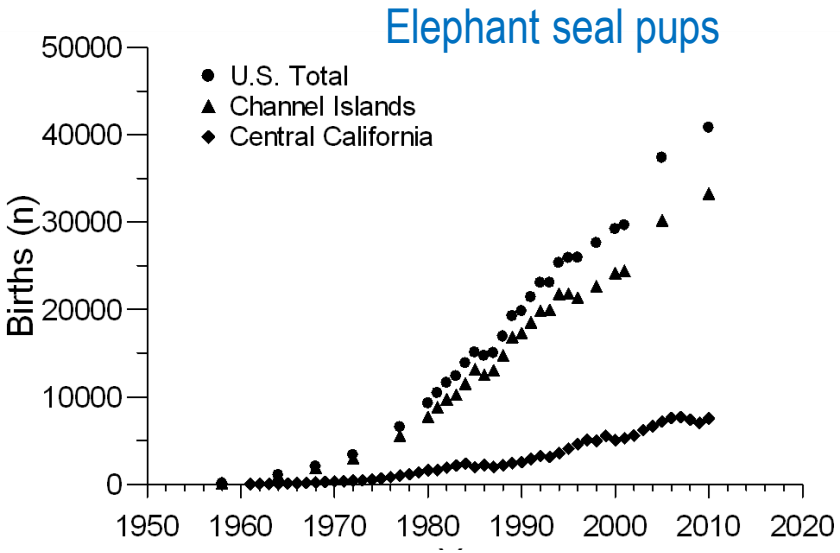
Case study speaker: Karin Forney

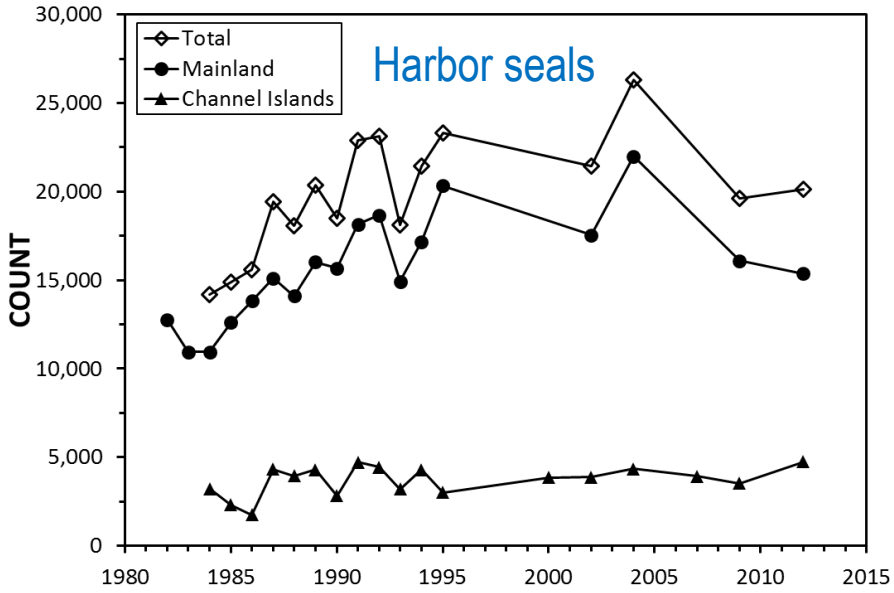
Aerial pinniped surveys

- Surveys consistently conducted since 1980s
- Current funding largely from U.S. Navy and National Park Service

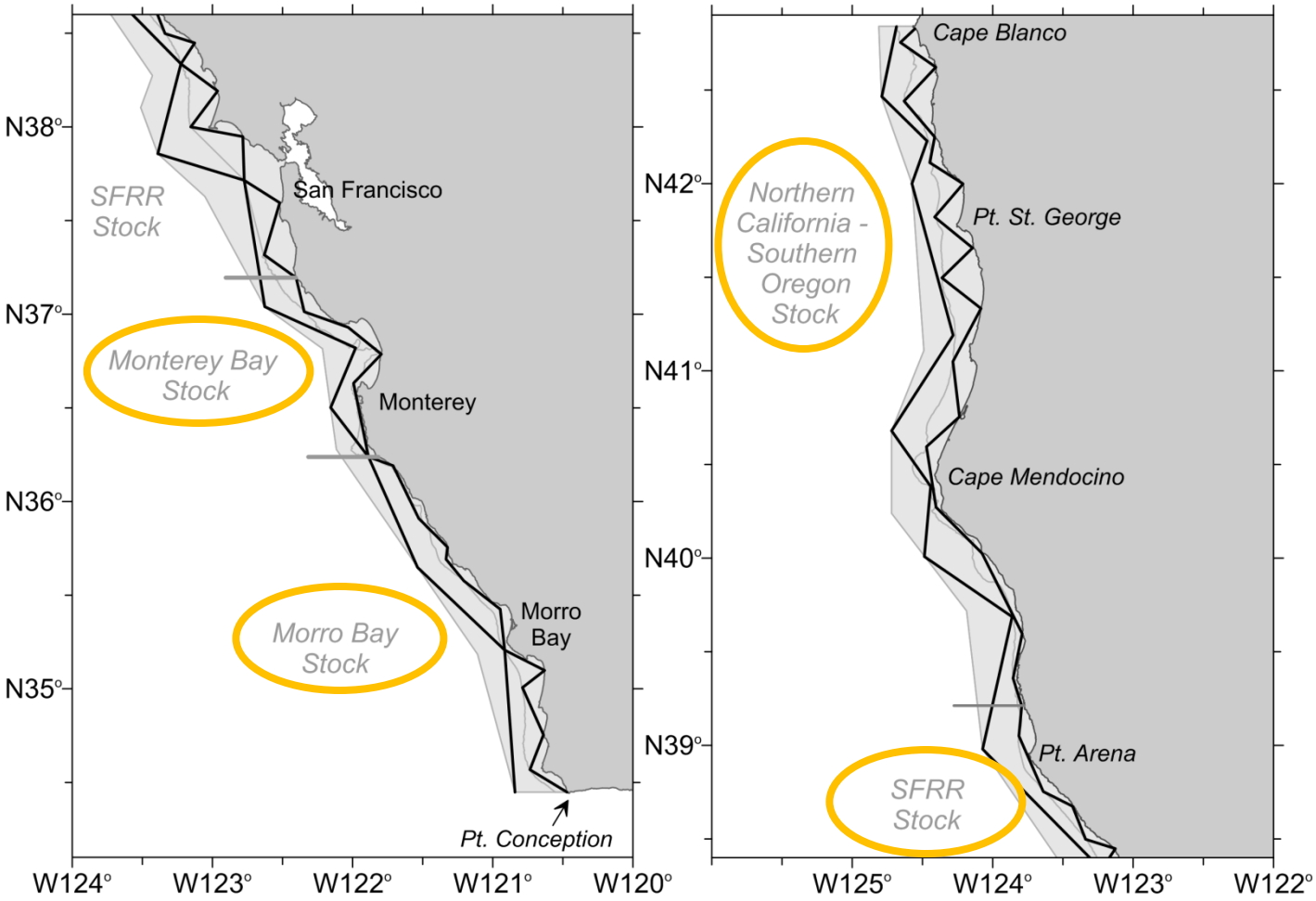
Aerial pinniped surveys







Harbor porpoise surveys



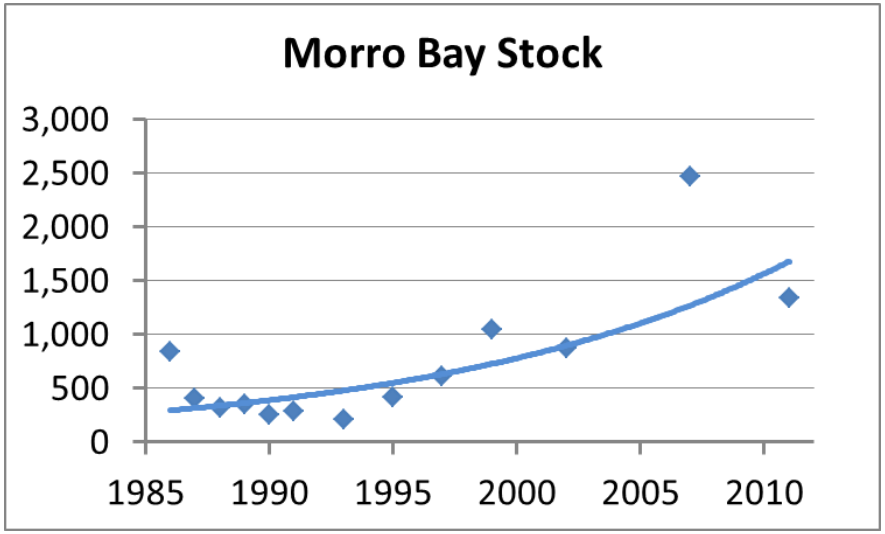
Survey years

1986 - 1991,

1993, 1995, 1997, 1999,

2002, 2007, 2011

Harbor porpoise surveys



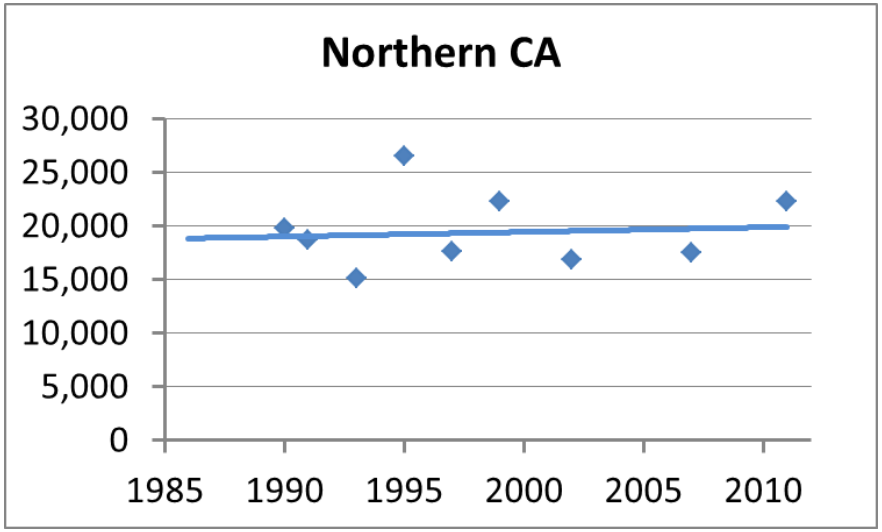


Photo ID surveys for coastal bottlenose dolphins

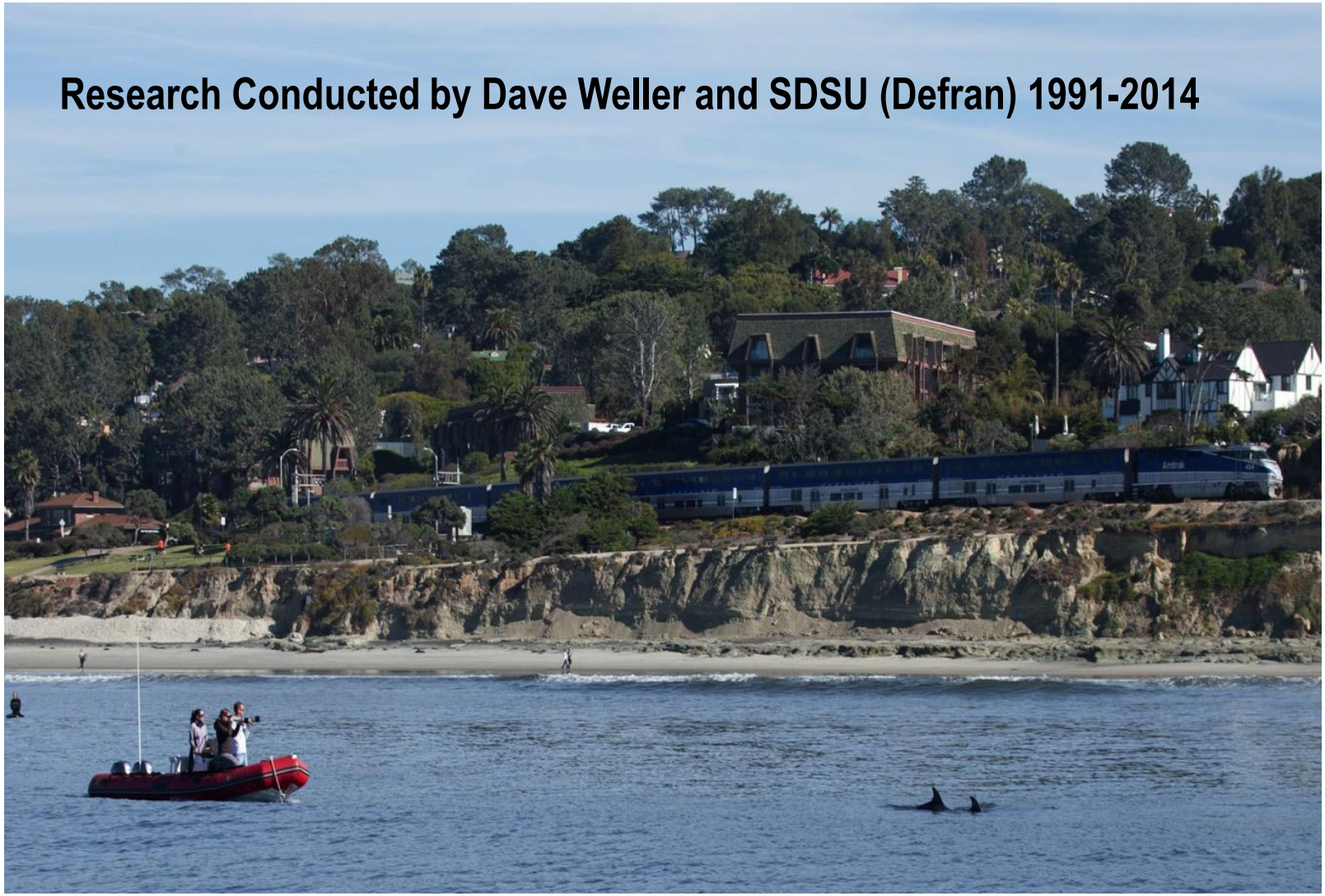


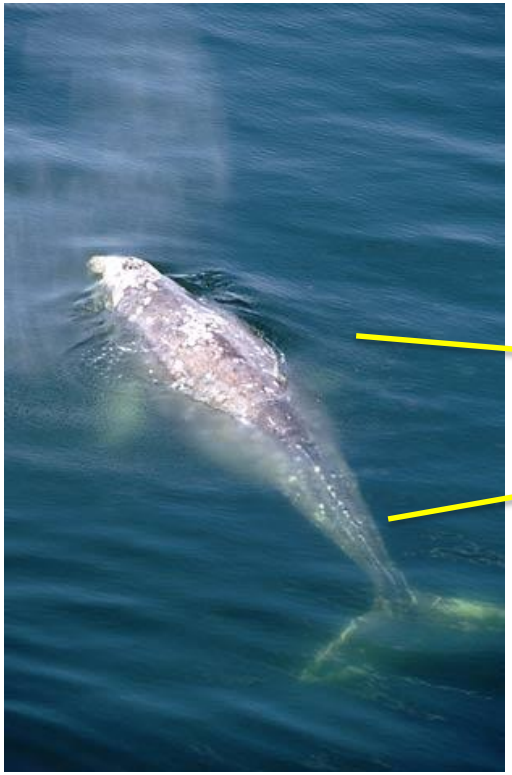
Photo ID surveys for coastal bottlenose dolphins

Mark-Recapture Abundance Estimates (M_{th} Chao's Model)

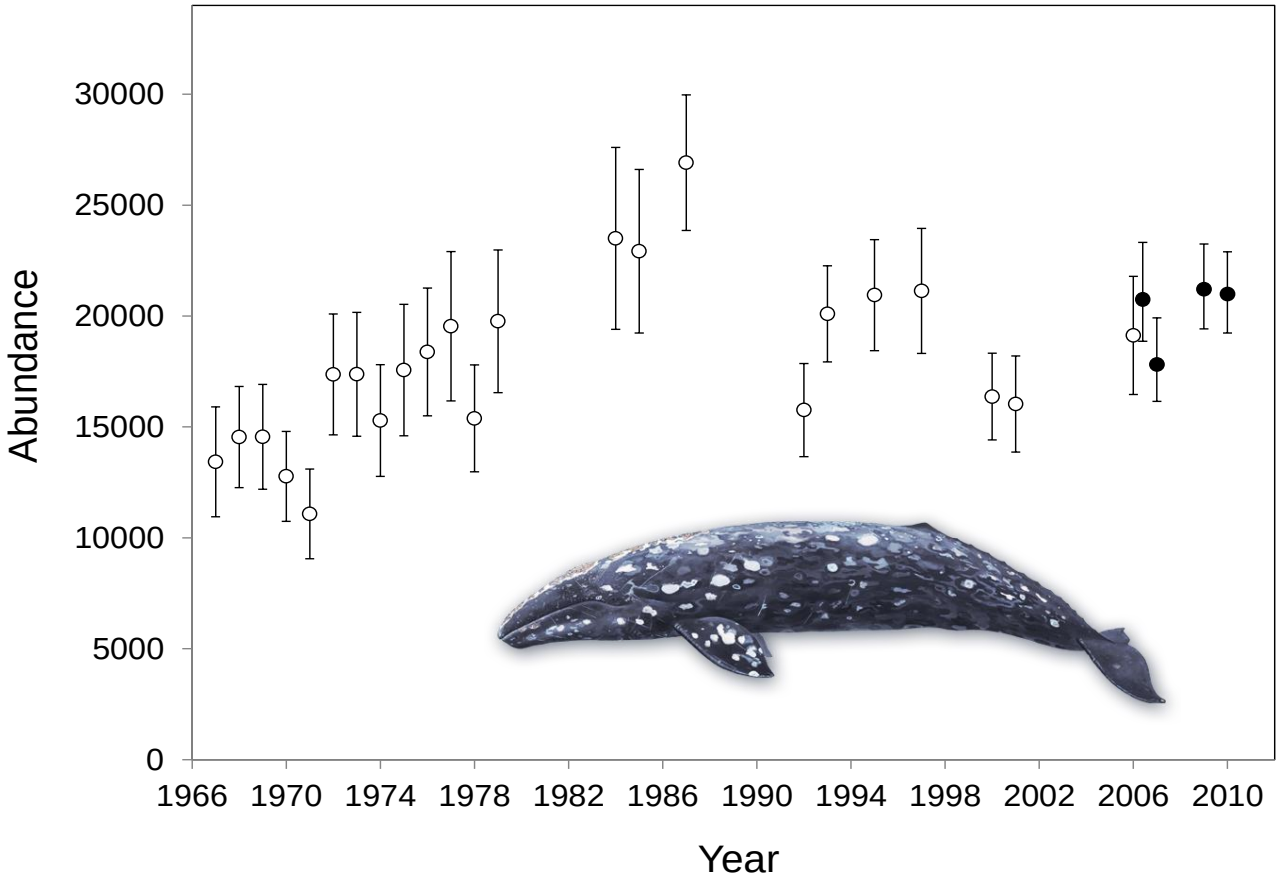
Study Period	Abundance	Lower 95% CI	Upper 95% CI
1984-1986	289	230	398
1987-1989	354	330	390
1996-1998	356	306	437
2004-2005	323	259	430
2009-2011	465	430	517

Shore-based surveys for gray whales

- Southbound (abundance surveys) @ Granite Canyon



Shore-based surveys for gray whales



Case study speaker: John Durban

Shore-based surveys for gray whales

- Northbound (calf counts) @ Piedras Blancas

Common themes of MMTD abundance/trends research

- Innovation
  - Methodological (survey design, acoustics)
  - Analytical (mark-recapture abundance estimation, distance sampling, trend & habitat modeling, Bayesian and machine-learning approaches)

Common themes of MMTD abundance/trends research

- Research and collaborations serving a broader scientific and conservation community
  - IWC Scientific Committee contributions
  - IUCN Red List status assessments
  - Involvement in national and international initiatives
  - Capacity sharing nationally and internationally
  - International example: vaquita

Case study speaker:
Tim Gerrodette

Strengths

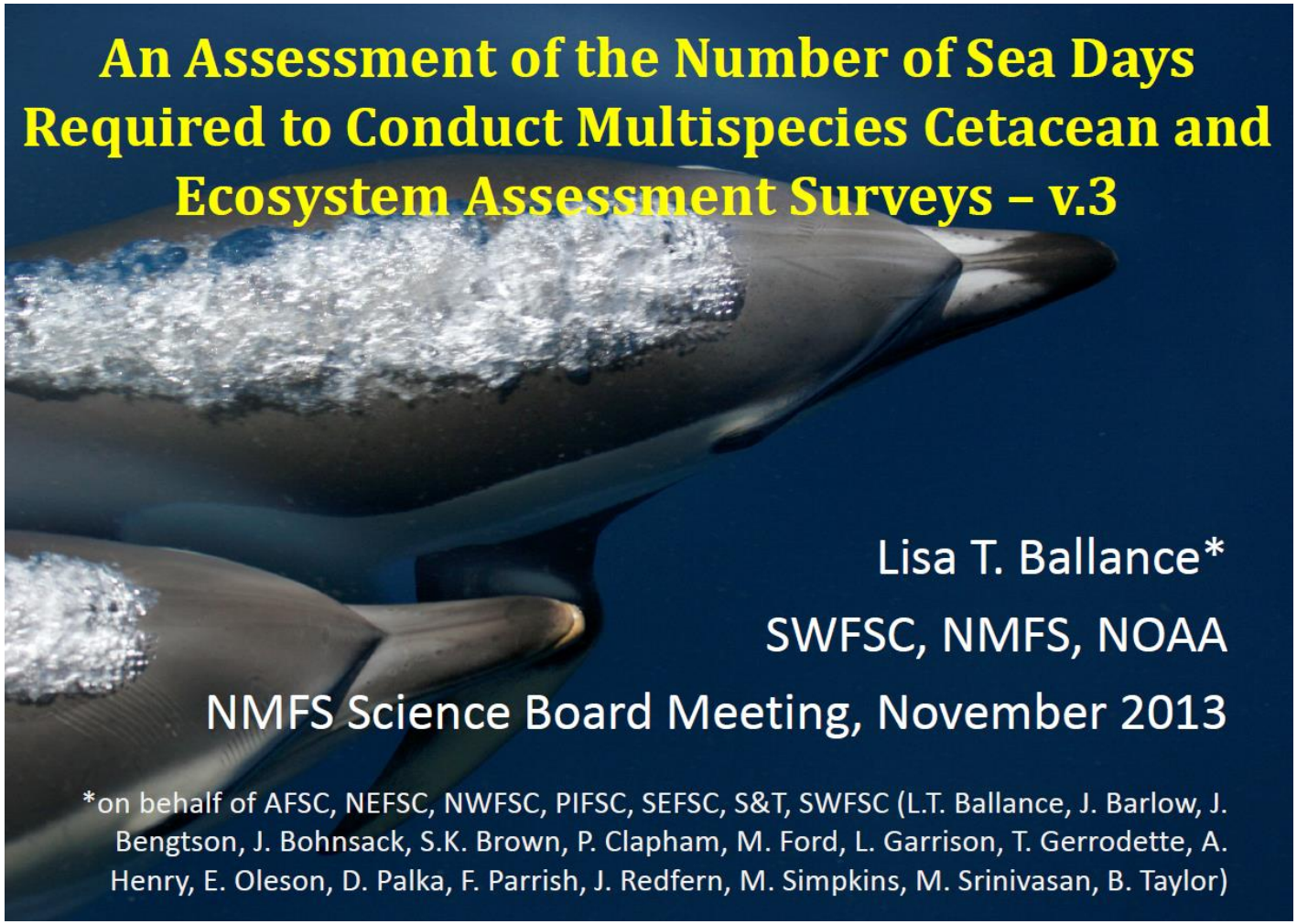
- Long-term time series data
- Expertise
  - Survey design
  - Quantitative analysis
  - Acoustics
- Constructive relationships with regulatory partners (regional office, headquarters) and constituents (e.g., US Navy, BOEM, fishing groups)
- High-performing and dedicated staff

Challenges

- Developing capability to acoustically estimate abundance & trends for visually cryptic species
- Developing expertise in ocean noise issues
- Understanding impacts of environmental change on population abundance and trends
- Replacing key expertise in near future (e.g., pinniped surveys & acoustics)
- Meeting our MMPA requirements (e.g., maintaining survey schedules, improving survey methods) without dedicated funding

Strategies

- Developing acoustics monitoring methodology to survey for cryptic species (and incorporate ocean noise portfolio)
- Recruit necessary new expertise
- Continue seeking external funding opportunities to support problem-specific R&D efforts
- Strategically press for increased base funding to support regular MMPA requirements
- Prioritizing research within our acoustics program
- Identify new collaborative partnerships
- Collect fewer survey and environmental data?



Proposal for rotating survey schedule and funding strategy to help secure future of NOAA large ship cetacean/ecosystem surveys

Strategies

- Developing acoustics monitoring methodology to survey for cryptic species (and incorporate ocean noise portfolio)
- Recruit necessary new expertise
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