Proceedings of the Third National Protected Species Assessment Workshop

Hosted by NOAA Fisheries Southeast Fisheries Science Center and sponsored by the Office of Science and Technology

Edited by Erin McMichael, Lesley Stokes, Alexandra Curtis, Genevieve Davis, Chris Jordan, Caroline Good, Nancy Friday, Julie Scheurer, and Matthew Lettrich

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

NOAA Technical Memorandum NMFS-F/SPO-256
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U.S. Department of Commerce
Howard Lutnick, Secretary

National Oceanic and Atmospheric Administration
Laura Grimm, Chief of Staff performing the duties of
Undersecretary of Commerce for Oceans and Atmosphere
and NOAA Administrator

National Marine Fisheries Service
Eugenio Piñeiro Soler, Assistant Administrator for
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Executive Summary

The third national Protected Species Assessment Workshop (PSAW III), organized by NOAA Fisheries' Office of Science and Technology (OST), took place in two stages, virtually and in-person, in 2022 and 2023, respectively. The first phase of the workshop consisted of online training sessions, while the second phase included an in-person student outreach half-day, in-person oral and poster presentations, and panel discussions. Workshop participants included students, federal agency scientists and managers, contractors, researchers from academia, and collaborators and partners from other external agencies and organizations.

The theme for PSAW III was Incorporating Novel Data, New Analytical Approaches, and Increasing Anthropogenic Impacts in Protected Species Assessments, and the workshop was hosted by the Southeast Fisheries Science Center (SEFSC). A steering committee composed of representatives from NOAA Fisheries Science Centers, Regional Offices, and headquarters offices (i.e., OST and Office of Protected Resources (OPR)) were primarily responsible for workshop planning including identification and agreement on thematic areas, keynote speakers, and workshop format.

Although the main workshop was postponed until spring 2023 due to COVID-19 travel restrictions, 10 virtual training sessions covering eight topics were held from January through March 2022, with 319 registrants from NOAA Fisheries, other NOAA Line Offices, and academic as well as other external partner organizations. Training sessions have become an important component of PSAW because they provide critical knowledge exchange regarding methods and techniques used to assess protected species populations and threats.

Recognizing the need to educate and engage the next generation of protected species assessment scientists, PSAW III included an in-person and virtual student outreach half-day on March 28, 2023, at Florida International University (FIU). More than 40 students and NOAA Fisheries scientists and managers attended the outreach. The student outreach session introduced students to protected species and the importance of assessments in formulating successful management actions, informed them of opportunities at NOAA Fisheries and provided a platform for students to engage with agency scientists and managers.

The main workshop occurred on March 29–30, 2023, also at FIU, and included opening and welcome remarks from SEFSC and OST and keynote speaker addresses at the start of

each day, followed by plenary talks, oral presentations, and panel discussions. Poster presentations were on view during the two main workshop days with dedicated time periods for authors to interact with workshop attendees. More than 140 individuals participated in the main workshop either in-person or virtually. Main session topics included (1) novel data collection methods, 'omics and acoustics, (2) climate change impacts on assessments, (3) new analytical methods for abundance and risk assessments, and (4) impacts of new and increasing marine development on protected species assessments. Posters covered any topic related to protected species assessments.

Introduction

In 2015, the NOAA Fisheries Protected Resources Board began supporting a biennial workshop focusing on protected species assessments similar to the National Stock Assessment Workshop and the National Habitat Assessment Workshops. These workshops, hereafter referred to as Protected Species Assessment Workshops (PSAWs), bring scientists together to share data, methods, and technologies and establish best practices in protected species assessment science. PSAWs focus on assessment science related to all protected species including corals, sturgeon, elasmobranchs, marine mammals, sea turtles, sea birds, salmon, and other invertebrate and vertebrate taxa that are protected by law and under NOAA Fisheries' jurisdiction. Although the theme of each PSAW varies, they all provide an opportunity for exchange across disciplines with the goal of fostering collaboration among scientists from different programs within NOAA Fisheries as well as with external collaborators.

PSAW III was hosted by the Office of Science and Technology (OST) and the Southeast Fisheries Science Center (SEFSC) both virtually and at Florida International University (FIU) in Miami, Florida. The SEFSC provided extensive logistic support and assistance with planning for the workshop and during the main workshop as well. As with previous PSAWs, OST provided overall coordination along with a planning team consisting of steering committee members from NOAA Fisheries headquarters (HQ) Office of Protected Resources (OPR), NOAA Fisheries Regional Offices (Regional Offices), and NOAA Fisheries Science Centers (Science Centers). The steering committee convened in early 2021 and was instrumental in identifying workshop themes and overall workshop structure, providing feedback on keynote speaker selections, reviewing abstract submissions, and designing panel discussions and training sessions.

Training sessions have become an important component of PSAW because they provide critical knowledge exchange regarding methods and tools to conduct protected species assessments. Because of travel restrictions during COVID-19, virtual training sessions were held ahead of the main workshop, during January, February, and March 2022. Eight training topics were offered with more than 300 registrants from NOAA Fisheries, other NOAA Line Offices, and academic as well as other external partners. A special thank you to those who volunteered their time and expertise in leading the training sessions.

The eight sessions were as follows:
(1) Introduction to GitHub
(2) Getting Started with RStudio Cloud
(3) Accessing Environmental Data Using ERDDAP
(4) Introduction to Free and Open Source Software for Acoustics, Part 1 and Part 2
(5) Creating a Data R Package
(6) Seabird Bycatch Data Collection, Protocols, Best Practices, and Standards
(7) Introduction to Mapping and Spatial Analysis in R (cancelled)
(8) Fitting Spatial and Spatiotemporal Models with sdmTMB, Part 1 and Part 2

PSAW III and FIU co-hosted a student outreach half-day on March 28, 2023, at FIU. Engaging with the next generation of protected species scientists is critical to ensure that informed, educated, and dedicated scientists continue to enter the field of protected species assessments and make meaningful and impactful contributions. This half-day was designed to introduce students to protected species assessments and opportunities at NOAA Fisheries. More than 40 students and NOAA Fisheries personnel participated either in-person or virtually. The session focused on (1) introducing students to protected species and the importance of assessments in formulating management actions that support the recovery of vulnerable species, (2) sharing student internship and scholarship opportunities with NOAA Fisheries, and (3) providing a platform for students to directly engage with agency scientists and managers, discuss related career options, and receive tips on resume and job application preparation.

The main workshop was held on March 29–30, 2023, at FIU, with the overall theme of Incorporating Novel Data, New Analytical Approaches, and Increasing Anthropogenic Impacts in Protected Species Assessments. Although participation in the main workshop was mostly in-person, remote participants could view the sessions virtually via WebEx. The main workshop began with opening and welcome remarks from SEFSC and OST Leadership. SEFSC leadership reviewed the history of PSAW and highlighted SEFSC contributions to regional and national protected species science. OST Leadership emphasized the extent to which protected species research and management inform the larger NOAA Fisheries' mission. Regional efforts document and comprehend what scientists observe in the field, analyze and assess data collected, and then deliver the information to managers to make science-based decisions that are key to the agency, reinforcing NOAA's mission of stewardship of marine living resources. Opening remarks were followed by a keynote address focused on advanced technologies to assess protected species. The keynote address on day two highlighted differences of behavior and habitat use within species that require more nuanced conservation approaches. The ecological roles of protected species were also highlighted, citing the need to consider these factors when designing conservation approaches. On both days of the main workshop, the keynote

addresses were followed by the main sessions of the workshop: (1) integrating novel data types, 'omics and acoustics, (2) impacts of climate change on assessments, (3) new analytical methods for abundance and risk assessments, and (4) impacts of new and increasing marine development on protected species assessments. The workshop also included two session-themed plenary talks, 26 oral presentations, 13 poster presentations, and two panel discussions. Over 140 attendees participated in PSAW III either in-person or virtually.

Assessments are the core science products used to inform management of protected species. Significant advances are occurring at each NOAA Fisheries Science Center and region, and PSAW III was an exciting opportunity to share these advancements and form collaborations to enhance NOAA Fisheries' ability to adapt and formulate new approaches that ultimately aid in the conservation of protected species.

Training Sessions

Summary

Because PSAWs are designed to share the latest advances, challenges, and solutions in protected species science and highlight methods that improve assessment capabilities, training sessions have become an important part of PSAW. Because of COVID-19 travel restrictions, the PSAW III training sessions were held January–March 2022, ahead of the main workshop. A call went out across Science Centers and HQ offices to solicit topics and instructors. Instructors were either NOAA Fisheries employees or external partners, and all volunteered their time to lead the sessions and share their knowledge on methods and topics applicable to protected species assessment science. The sessions were open to NOAA Fisheries and collaborators with 319 people pre-registering for the sessions. The sessions were recorded and posted on a NOAA Fisheries internal Google site for future access. The following were selected as session topics:

- Introduction to GitHub
- Getting Started with RStudio Cloud
- Accessing Environmental Data Using ERDDAP
- Introduction to Free & Open Source Software for Acoustics
- Creating a Data R Package
- Seabird Bycatch Data Collection, Protocols, Best Practices, and Standards
- Introduction to Mapping and Spatial Analysis in R (cancelled)
- Fitting Spatial and Spatiotemporal Models with sdmTMB

Session Descriptions

Training Session 1: Introduction to GitHub
Date: January 12, 2022
Time: 1–3 p.m. (EDT)
Instructor: *Eli Holmes, NOAA Fisheries NWFSC*

This workshop will introduce you to Git and GitHub for data, coding, and report projects. The focus will be on the project management and tracking features of GitHub: issues for tracking your to-do items, project boards, team collaboration tools, releases, and automation tools for common tasks.

Users will need a GitHub account in order to follow along. The main content will use GitHub in a browser. Interaction with one local computer will be illustrated with RStudio and GitHub Desktop. Attendees can simply watch if they want to have basic familiarity with GitHub's features. In order to follow along and try the demos, attendees will need a GitHub account.

Training Session 2: Getting Started with RStudio Cloud
Date: January 12, 2022
Time: 3–5 p.m. (EDT)
Instructor: *Eli Holmes, NOAA Fisheries NWFSC*

Installing software and packages is often a friction point for participants and instructors for workshops that involve running computer code. In this workshop, I will get you started with RStudio Cloud, a free service (up to 8 hours per month) that allows you to run RStudio in the cloud. You will sign in with a Google account and will be running R in 2 minutes. In the first hour, I will focus on the basics of using RStudio Cloud for individuals. In the second hour, I will focus on how to use RStudio Cloud for teams or workshops. Those taking the later workshops who want to run code but do not want to install anything on their computer can just do the first hour.

Note that all you need is a browser so that you can use RStudio Cloud on your phone or tablet. Those who would like to use RStudio Cloud for a team or for teaching workshops should stay for the second hour, where I will go through tips on how to set that up and how to set up the environment for your participants (or team members).

Users should have access to a computer or tablet where they can use RStudio Cloud and log in with a Google account.

Training Session 3: Accessing Environmental Data Using ERDDAP
Date: January 19, 2022
Time: 1–3 p.m. (EDT)

Instructor: *Cara Wilson, NOAA Fisheries SWFSC*

Are you interested in using oceanographic satellite data (or other environmental data) in your work but do not know where to start? This training session will provide an introduction to ERDDAP, a data server that provides access to thousands of environmental datasets. Participants will learn how to discover data on ERDDAP, easily visualize it, and download it. A brief overview will be given to tools that facilitate accessing data on ERDDAP from R software.

Participants will need access to a computer. Depending on the software participants use, they might need to download some software-specific libraries.

An additional satellite course will be offered January 24–28, 2023, through NOAA Coastwatch West Coast. Additional information and registration forms can be found at https://coastwatch.pfeg.noaa.gov/courses/satellite_course.html.

Training Session 4: Introduction to Free and Open Source Software for Acoustics, Part 1 and Part 2
Date: February 2, 2022 (Part 1), February 9, 2022 (Part 2)
Time: 1–4 p.m. (EDT)
Instructors: *Shannon Rankin, Taiki Sakai, and Eric Archer, NOAA Fisheries SWFSC*

An introduction to using the PAMpal and BANTER R packages, containing tools for post-processing passive acoustic data analyzed in Pamguard (a sound analysis software), and developing a cross-center standardized workflow to initiate larger NOAA-wide collaborations.

All software and sample data (will be provided ahead of time) must be loaded and fully functional prior to the workshop. Basic R programming experience is required. Mid-level or average knowledge is required.

Training Session 5: Creating an R Package
Date: February 16, 2022
Time: 1–3 p.m. (EDT)
Instructor: *Eli Holmes, NOAA Fisheries NWFSC*

Do you struggle with data requests and data documentation and ensuring that users (or your own team) are using the latest version of your data? Data R packages can solve these problems by providing a standard framework for versioning, documenting, and data-loading. If you host your package on GitHub, you will also have a platform for tracking changes and issues. Creating a data package is easy. In this 2-hour workshop, you will get a demo data package assembled and hosted on GitHub.

Attendees will need a computer with R and RStudio installed. This workshop is geared toward R users with basic or beginner knowledge.

Training Session 6: Seabird Bycatch Data Collection, Protocols, Best Practices, and Standards
Date: February 16, 2022
Time: 3–5 p.m. (EDT)
Instructors: *Lee Benaka, NOAA Fisheries OST, Stephanie Depasquale, NOAA Fisheries NEFSC, Jordan Katz, NOAA Fisheries NEFSC, Gina Shield, NOAA Fisheries NEFSC, Jackie Lindsey, University of Washington, Charlie Wright, U.S. Fish and Wildlife Service, Jody Van Niekerk, NOAA Fisheries SWFSC, and Christa Colway, NOAA Fisheries NWFSC*

This course will describe why NMFS collects seabird data and how the data are used; provide an overview of how observers for Greater Atlantic and Alaska fisheries are trained to collect seabird data; and discuss (1) possible minimum standards for seabird bycatch data collection, (2) tools and technologies needed by observers to effectively collect seabird bycatch data, and (3) current data collection challenges.

Attendees should have access to a computer during training.

Training Session 7: Introduction to Mapping and Spatial Analysis in R (Cancelled)
Date: February 23, 2022
Time: 1–5 p.m. (EDT)
Instructor: N/A

This training will introduce users to packages and workflows to conduct Geographical Information System (GIS)-type spatial data analyses using R and RStudio. Familiarity (and ideally some proficiency) with R, RStudio, GIS software (ArcGIS or similar), and the tidyverse programming style would be valuable. Participants will need a computer running recent versions of R and RStudio, an internet connection to download necessary data and packages, and Git to download course materials from Github.

Training Session 8: Fitting Spatial and Spatiotemporal Models with sdmTMB, Part 1 and Part 2
Date: March 2, 2022 (Part 1), March 9, 2022 (Part 2)
Time: 1–4 p.m. (EDT)
Instructors: *Eric Ward, NOAA Fisheries NWFSC, and Sean Anderson, Fisheries and Oceans Canada*

This training course is designed to teach analysts how to fit generalized linear models (GLMs) with spatial components. We will cover models with spatial effects and spatiotemporal effects (e.g., spatial patterns changing by year), in addition to spatially

varying coefficient models that allow the relationships between covariates and responses to change spatially. All materials for the course will be taught using the sdmTMB R package, which has been primarily developed for index standardization (fisheries stock assessment) and species distribution modeling (SDMs).

Attendees should have mid-level or average knowledge of R, ideally some work using mixed effects models in R (lme4, glmmTMB, or similar), basic familiarity with fitting GLMs (using glm, glmmTMB, or similar), and basic familiarity with fitting generative additive models (GAMs; mgcv). Attendees need to have access to a recent installation of R for the training and the ability to install both sdmTMB and TMB.

Student Outreach Half-Day: Introduction to Protected Species Assessments and Opportunities at NOAA Fisheries

Co-Chairs: Lesley Stokes (NOAA Fisheries SEFSC), Erin McMichael (ECS Federal in support of OST), and Dr. Jeremy Kiszka (FIU)

Summary

This student-focused optional half-day event was co-hosted by FIU and included 44 attendees either in-person or virtually. The session included presentations and discussions on various aspects of the NOAA Fisheries' protected species assessment process with undergraduate and graduate students from FIU and other nearby academic institutions. NOAA Fisheries' Program Managers presented overviews of several internship opportunities at NOAA including those available to under-represented groups. Additional student internship and scholarship opportunities at NOAA Fisheries were also discussed. Materials were provided to attendees, outlining student opportunities at NOAA Fisheries, including internships, fellowships, and scholarships, with links to marine-related job websites and listservs. NOAA Fisheries' scientists, managers, interns, and affiliates participated in a round-table discussion on their experiences working in the field of marine fisheries and answered questions on a variety of marine-focused career options, including those at NOAA Fisheries.

Presentations

The session began with opening remarks from Co-Chairs Lesley Stokes (NOAA Fisheries SEFSC) and Dr. Jeremy Kiszka (FIU) and an overview of the day's activities, as well as a review of the student handout from Erin McMichael (ECS Federal in support of NOAA Fisheries OST). This was followed by several presentations:

1. Introduction to Protected Species Assessments at NOAA Fisheries, Eric Patterson, on detail to NOAA Fisheries OST, Assessment and Monitoring Division, Acting Assessment Branch Chief (Permanent Position: NOAA Fisheries, OPR, Marine Mammal and Sea Turtle Conservation Division, Cetacean and Pinniped Conservation Lead)
2. Ernest F. Hollings Undergraduate Scholarship and José E. Serrano Educational Partnership Program with Minority Serving Institutions (EPP/MSI) Undergraduate Scholarship, Natasha White, Program Manager, NOAA Office of Education
3. William M. Lapenta Internship Program, Peter Roohr, Program Manager, NOAA Office of Education
4. Additional Opportunities at NOAA Fisheries and Other Career Resources, Erin McMichael, ECS Federal in support of NOAA Fisheries OST
5. My Experience as a Hollings and Lapenta Scholar, Emily Speciale, Hollings Scholar, NOAA Fisheries NEFSC

Panel Discussion

This session ended with a panel discussion and questions with a variety of NOAA Fisheries experts including Jenny Litz (SEFSC, Marine Mammal and Turtle Division (MMTD), Marine Mammal Branch Chief), Joseph Pfaller (SEFSC, MMTD, Turtle Branch Chief), Kristan Blackhart (OST, National [Fish] Stock Assessment Program Lead), Genevieve Davis (Northeast Fisheries Science Center (NEFSC), Passive Acoustic Research Group, Research Acoustician), Alex Curtis (Southwest Fisheries Science Center (SWFSC), MMTD, Research Biologist), Yvonne Barkley (Pacific Islands Fisheries Science Center, Cetacean Acoustic Researcher with the Cooperative Institute for Marine and Atmospheric Research (CIMAR)), Cullen Hauck (NEFSC - Hollings Scholar), and Emily Speciale (NEFSC - Hollings Scholar).

The panel discussion focused on a variety of topics related to expanding student experiences as undergraduates and graduates, developing the skills needed for employment in marine science, and exploring the different paths that have led to employment as either full-time NOAA Fisheries employees or contractors. Key points included the following:

- As an undergraduate, seek out internship opportunities and other research experience.
- Having varied experiences is helpful, so consider opportunities outside marine systems.
- Networking is key to making connections that will help you throughout your career. Reach out to people that you are interested in speaking with and ask questions about what they do. Talk to professors and attend workshops and conferences like

PSAW. Reach out to graduate students to get their opinion on the laboratory that they work in and the work that they do.

- Ask a lot of questions and keep an open mind; some opportunities may not work out, and that is okay.
- Federal agencies also rely on contract employees. Sometimes, these positions are hard to find. Also look at cooperative institutes (universities) or directly at contract company websites. Contract work can include short-term and long-term positions.
- A wide variety of marine biology positions exist in NOAA Fisheries. Supervisory positions include a lot of administrative duties. Working at NOAA Fisheries HQ is more coordination-related. There are a lot of opportunities to move from one position to another within the agency and learn what is required in different roles that may work with other agencies, fishery management councils, and international partners. Develop an understanding of how the federal government operates.
- Research conducted at NOAA Fisheries is focused on agency priorities.
- A variety of skills are needed when conducting research involving protected species including the following:
    - Analytical skills (e.g., writing code and analyzing data)
    - Proactive science that examines new, different, and increasing impacts on protected species
    - Interpersonal skills
    - Knowledge of natural history
    - Knowledge of regulatory framework
    - Creativity in problem solving
- Favorite reasons for working with protected species include the following:
    - Unexpected challenges arise that keep you on your toes, especially when in the field. Field work is a very rewarding part of the job.
    - Panel members stated that they like doing something that makes a difference, so they are drawn to applied research.
    - Co-workers and the larger professional community that work with protected species are dedicated, inspiring, and inventive.

Main Workshop Day 1, March 29, 2023

Summary: Day 1

The first day of the main workshop began with opening remarks from SEFSC and OST. Remarks summarized the history of PSAW, protected species issues facing the SEFSC, and the importance of protected species data collection, innovation, collaboration, and adaptive

management in relation to achieving agency priorities. These opening remarks set the stage for discussions on innovative data collection and analysis methods. Remarks were followed by a keynote speaker address that focused on the use of advanced technology and ocean sensing to assess protected species, citing advanced fluid lensing techniques to identify, map, and assess corals and marine mammals as examples. Session 1 focused on the use of 'omics and acoustic methods in protected species assessments. Acoustics and eDNA have become important methods in detecting and/or determining the presence, abundance, distribution, and habitat use for protected species. Posters were presented during lunch and were on display for the remainder of the main workshop. In the afternoon, Session 2 focused on integrating impacts from climate change into assessments. Session 2 presentations highlighted important climate-related initiatives and projects at NOAA Fisheries and included a panel discussion on integrating these initiatives and associated tools into assessments and management decisions.

Opening and Welcome Remarks

History of PSAW

Mridula Srinivasan, Director, MMTD, SEFSC

Dr. Srinivasan focused on the evolution of PSAWs as well as the timeliness of SEFSC hosting PSAW III. Prior to PSAW, there were few occasions where NOAA Fisheries' protected species scientists could meet to talk about ongoing regional research activities, identify new research questions, and formulate new approaches and collaborations. It was clear that NOAA Fisheries needed a larger forum that encouraged a broader approach to protected species science, similar to the National Stock Assessment Workshop for fisheries science. With support from OST and external protected species activity reviews, PSAW was formed to provide a single national venue where protected species scientists across NOAA Fisheries could all meet in one place to share, learn, and discuss protected species science research on a national scale. The first PSAW was held in 2017 in Seattle (Alaska Fisheries Science Center (AFSC)), with PSAW II in 2019 in La Jolla, CA (SWFSC). PSAW has since expanded in scope and offers varied topics, talks, and training, making the evolution of PSAW very exciting.

The SEFSC has undergone reorganization, including the creation of the MMTD. Having PSAW in Miami allowed for this newly formed Division to network with others on pressing protected species threats and the science needed to mitigate and monitor these threats. Further, hosting PSAW focused the spotlight on the issues and challenges the SEFSC is facing, including noisy marine environments, warming waters, fishery interactions, lasting

impacts from oil spills, and, more recently, the development of offshore wind and aquaculture. PSAW III allowed SEFSC researchers to expand research linkages, increase scientific curiosity, and expand our protected species portfolio, all to strengthen NOAA Fisheries' overall mission.

The SEFSC was also very excited to host PSAW III with OST and partner with FIU, as it is extremely important to foster collaborations outside of NOAA Fisheries and create partnerships with researchers from academia and other organizations. This also allows NOAA Fisheries to support students from local universities and provide training and insight into the world of marine science. Supporting students from a variety of backgrounds is key to the future of protected species science.

Dr. Srinivasan finished by thanking the steering committee for their hard work and forward-thinking sessions over the next two days. She noted that everyone has busy lives and was encouraged to see so many working together to have a greater impact on protected species issues and communities, as well as the broader society. She also thanked the supportive staff and volunteers behind the scenes who worked so hard to make PSAW III happen, both onsite and online. She hoped that the participants are energized over the next two days and know that their work matters for the protection of marine ecosystems now and in the future.

Welcome to SEFSC

Clay Porch, Director, SEFSC

Dr. Clay Porch welcomed everyone to the vibrant city of Miami for PSAW III. He noted that he was glad to attend his first PSAW meeting with an exciting agenda covering novel data types, new analytical approaches, and climate change. He began his opening remarks with a summary of the Southeast Region. The SEFSC is headquartered in Miami but has facilities from Beaufort, North Carolina, through Galveston, Texas, and is responsible for the Caribbean U.S. territories of Puerto Rico and the U.S. Virgin Islands. The SEFSC also has the second longest coastline after Alaska and a vibrant system of ports, with some of the largest shipping ports in the country, hundreds of oil rigs in the Gulf, offshore wind, and more fishermen and boaters than the rest of the country combined. This presents a lot of threats and challenges for protected resources in the region. The Southeast Region is home to Rice's whales, one of the rarest animals on the planet with only 50 left, the primary calving ground for the North Atlantic right whale (NARW), and home to 90 other stocks of marine mammals, six species of sea turtles, and other protected species like smalltooth sawfish, corals, and manta rays. Like others across the country, the SEFSC is challenged by limited resources and is dependent on external funds, including for flagship surveys such as the

Gulf of Mexico Marine Assessment Program for Protected Species (GoMAPPS) and Atlantic Marine Assessment Program for Protected Species (AMAPPS). The SEFSC has been able to leverage funds from the *Deepwater Horizon* oil spill settlement and other sources.

Dr. Porch highlighted some of the work that occurs at the SEFSC, including the photo-identification of Rice's whales to catalog and track the population, passive acoustics to triangulate positions of individual animals and to better understand where whales are moving, modeling of NARW vessel strikes, PCR eDNA analyses, and sequencing of the genome of Rice's whales. For sea turtles, the SEFSC conducts cutting edge demography work, looking for funding sources to design and conduct in-water surveys and mitigating bycatch in the shrimp fishery with Turtle Excluder Devices. They do a lot of work with elasmobranchs, including population vulnerability analyses with smalltooth sawfish and work with manta rays. With corals, the SEFSC has been able to characterize the major sources of decline of *Acropora palmata* and other corals, as well as finding resistant strains of corals to help repopulate the Florida Keys. The SEFSC also has long-term sea bird surveys with the Southeast pelagic longline fishery. Dr. Porch then thanked the participants for coming and stated that he looked forward to hearing what they had to say.

Regional Efforts Inform National Strategies

Evan Howell, Director, OST

Dr. Howell welcomed all participants to PSAW III and noted that OST is the only science office within NOAA Fisheries HQ and that as such OST has an important role in protected species science. Furthermore, OST has a large science portfolio that includes protected species, an essential part of the larger NOAA Fisheries mission to integrate science and management to conserve species, including avoiding protected species during fisheries activities. In some regions, protected species interactions drive what NOAA Fisheries focuses on during fisheries activities, making protected species science even more important.

Dr. Howell highlighted the need for more information to address how protected species are affected by changing environments and noted how important it is to have an open discussion on these impacts as they affect all parts of NOAA Fisheries' mission. PSAW is a great platform to discuss innovative ways people are working to assess protected species more efficiently, vibrantly, comprehensively, and collaboratively. Dr. Howell acknowledged the rapid pace at which NOAA Fisheries needs to acquire the necessary information, analyze and assess data in order to understand it, and then deliver the information to managers who can quickly absorb this information and make dynamic management decisions. Dynamic management relies on innovation, and PSAW is a great place to begin to

talk about innovation on a national scale. Dr. Howell emphasized that workshop participants represent the advancements within the agency, whether in-person or watching via WebEx. He again stressed the need to increase the pace of discovery and the ability to learn from each other.

Dr. Howell advocated for open science and an open framework for communication and collaboration that allows participants to develop new tools together. He encouraged everyone to reach out and make connections and talk with other participants. NOAA Fisheries' protected species arena is a national program even though some research has regional specificity. Dr. Howell offered that we need to create a culture of open science that will allow us to speed up discovery and provide critical science information to decision-makers in a rapidly changing and highly uncertain world. With innovation and efficiency, Dr. Howell argued that we can increase the speed at which we acquire, analyze, and deliver information without increasing the burden on ourselves. Collaboration, innovation, and efficiency will allow us to be a vibrant community that people want to be a part of.

Dr. Howell closed by stressing that NOAA Fisheries Leadership is still interested in learning and was excited to hear about advancements and efforts from across the nation. It is crucial that Leadership knows what priorities to invest in to promote dynamic decisions. Furthermore, NOAA Fisheries' protected species efforts are one of a community of trust and action.

Keynote Speaker Address

Keynote Speaker: *Dr. Ved Chirayath, Vetlesen Professor of Earth Sciences, Director of the Aircraft Center for Earth Studies (ACES), Rosenstiel School of Marine, Atmospheric and Earth Science, University of Miami*

Bio: Dr. Chirayath is the founder and former director of the Laboratory for Advanced Sensing at NASA Silicon Valley and a National Geographic Explorer. Dr. Chirayath invented NASA MiDAR, fluid lensing, and the first plasma-actuated aircraft and is authoring a new textbook on remote sensing planetary change. Dr. Chirayath was formerly a fashion and celebrity photographer in Moscow and discovered an extra-solar planet in high school. In 2021, Dr. Chirayath was one of 30 finalists selected from over 12,000 applicants for NASA's Astronaut Candidate Class of '21. Dr. Chirayath received his B.Sc., M.Sc., and Ph.D. in Physics, Astrophysics, and Aeronautics & Astronautics from Stanford University after five years studying theoretical physics at Moscow State University in Russia.

Presentation: Dr. Chirayath's presentation focused on advanced technologies for ocean exploration, noting that only 5–6% of the ocean floor is mapped at a high resolution. Dr. Chirayath discussed several technologies that he has invented and applied to mapping habitats and species in the marine environment. Dr. Chirayath started developing these technologies during his Ph.D. at Stanford and continued to develop them later while at NASA. He is also using his technological advances to contribute to the United Nations Sustainable Development Goal (SDG) 14, which calls for the conservation and sustainable use of the oceans, seas, and marine resources for sustainable development.

Dr. Chirayath talked about three advanced technologies that he has developed over the years: FluidCam, MiDAR (Multispectral Imaging Detection and Active Reflectance), and NemoNet. FluidCam is a fluid lensing technique that corrects refractive distortion from ocean waves and has been validated up to a half-centimeter scale through the water as well as breaking waves. This is the first technology that has been able to give a diverse scale view of a shallow habitat with wave action (i.e., large coral reef) and then geo-rectify the image, removing the distortion from waves. FluidCam also allows for monitoring this same reef and compares images over time to detect changes. However, it only works when the sun is shining. While still at NASA, Dr. Chirayath began developing MiDAR, which uses frequencies of light beyond what is visible in sunlight, thus allowing penetrations deeper into the water column. Dr. Chirayath also uses citizen science as a tool to map the ocean floor with another development from his time at NASA, NemoNet. NemoNet is a crowd sourcing video game in which players help classify coral reefs. Currently, the technology he uses allows imaging to 62 feet below the surface, but he has plans to increase this. These technologies use a tremendous amount of data and processing. Although the data processing has previously deleted everything within the water column and focused only on mapping the bottom, one can go back and look at disturbances in the raw data. Some of the more complicated creatures Dr. Chirayath has been asked to image with fluid lensing include sharks and marine mammals. Along with colleagues, he is trying to obtain 3D images of cetaceans to better understand their morphology, which then allows one to evaluate body condition. Imaging marine mammals is more difficult due to the wave refraction associated with a moving organism, but Dr. Chirayath and colleagues are working to address this and hope to apply fluid lensing techniques to larger mobile marine organisms, including protected species.

Session 1: Novel Data Types: 'Omics and Acoustics

Co-Chairs: Genevieve Davis (NEFSC) and Julie Scheurer (AKRO)

Session Summary

Protected species assessments increasingly rely on incorporating novel data types to enhance assessment capabilities, answer key science and management questions, and fill

data gaps. This session focused on integrating data from 'omics and acoustics in assessments, particularly to quantify abundance and distribution and to monitor changes that occur. Contributors presented on the benefits and challenges associated with these methods. Application of eDNA is especially helpful in detecting the presence of a species and can be used in biodiversity assessments, monitoring, tracking migrations, and filling data gaps for protected species assessments. Presentations highlighted recent advances that have contributed to an increasing reliance on acoustic data and highlighted the use of acoustics to detect and identify marine mammal call types, monitor and assess marine mammal behavior, identify important habitats used by marine mammals, detect biogeographical range shifts, and assess impacts of increased underwater noise on species. Acoustic data can also be used in conjunction with visual survey data to model species abundance and distribution. Presentations also highlighted the use of automated acoustic tracking methods that use machine learning to ultimately increase data processing efficiency and acoustic analysis tools created and housed in the protected species drawer of the Fisheries Integrated Toolbox at NOAA Fisheries. Species of focus included smalltooth sawfish, Rice's whales, false killer whales, Pacific sperm whales, Cuvier's beaked whales, and Pacific white-sided dolphins.

Session Talks | Abstracts

1. Integrating environmental DNA tools into protected species management

Nicole Phillips[1], Ryan Lehman[1], Emma Humphreys[1], Annmarie Fearing[1], Jill Hendon[1], John Carlson[2], Ruth Carmichael[3], and Gregg Poulakis[4]

[1]University of Southern Mississippi, [2]NOAA Fisheries SEFSC, [3]University of South Alabama, [4]Florida Fish and Wildlife Conservation Commission

Environmental DNA (eDNA) is a powerful genetic technique with a wide range of applications, including filling data gaps on the distribution, ecology, and population biology of aquatic species and serving as a monitoring and enforcement tool. The greater sensitivity of eDNA approaches, when compared to more traditional methodologies, makes them more cost-effective for studies of threatened and endangered species, which are often difficult to directly observe. Despite the benefits and practical applications of GulfeDNA data, widespread adoption of these techniques as standard practice in studies of protected marine species and the integration of resultant data into conservation planning have been slow. This is partly due to concerns over data validity and interpretation, lack of expertise and access to advanced technology, and uncertainty in how such data should be used in species management. The use of highly sensitive Droplet Digital PCR technology in eDNA studies increases the probability of detecting rare target DNA from water samples and

provides precise quantification estimates, maximizing the utility of these data. When combined with a foundation in basic research, validation studies, and rigorous quality controls, resultant data from eDNA studies are highly robust and reliable. Here, we discuss how highly advanced eDNA approaches are being used to assess the re-occurrence of smalltooth sawfish, *Pristis pectinata*, in historically occupied habitats in U.S. waters and as a tool to monitor the presence and abundance of the West Indian manatee, *Trichechus manatus*, in the northern Gulf. Employing these eDNA tools will enhance species management, particularly for rare marine species.

2. From the common to the rare with environmental DNA: eDNA for marine assessments of hake, whales, and corals

Krista Nichols, Ole Shelton, Kim Parsons, and Meredith Everett

NOAA Fisheries NWFSC

All species inevitably leave genetic traces in their environments, and the resulting environmental DNA (eDNA) reflects the species present in a given space and time. It remains unclear whether eDNA signals can provide quantitative metrics of abundance on which human livelihoods or conservation successes depend. Here, we report the results of a large eDNA ocean survey (spanning 86,000 kilometers^2 to depths of 500 meters) to understand the abundance and distribution of Pacific hake (*Merluccius productus*), the target of the largest finfish fishery along the west coast of the United States. We sampled eDNA in parallel with a traditional acoustic-trawl survey to assess the value of eDNA surveys at a scale relevant to fisheries management. Despite local differences, the two methods yield comparable information about the broad-scale spatial distribution and abundance. Furthermore, we find depth and spatial patterns of eDNA closely correspond to acoustic-trawl estimates for hake. We demonstrate the power and efficacy of eDNA sampling for estimating abundance and distribution and move the analysis of eDNA data beyond sample-to-sample comparisons to management relevant scales. We highlight the value of eDNA for quantitative applications, particularly in data- or resource-limited contexts, and discuss current projects using similar eDNA approaches to understand the distribution of protected species (marine mammals, deep sea corals, and sponges) using both species-specific and metabarcoding methodologies.

3. Acoustic localization of false killer whale (*Pseudorca crassidens*) subgroups in the Hawaiian archipelago

Pina Gruden[1], Eva-Marie Nosal[2], and Erin Oleson[3]

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Information from passive acoustic data can often be useful for complementing visual-based abundance estimation and monitoring efforts, especially with elusive species. This study focuses on false killer whales (*Pseudorca crassidens*) in the Hawai'ian archipelago, where three distinct populations of this species can be found, one of which is at high risk of extinction. These animals have been the focus of extensive research effort over the years, and as part of this effort, ship-based visual and acoustic surveys have been carried out. Because of their elusive behavior, dispersed aggregations of subgroups over large areas, and potential attraction to the research vessel, biases can be introduced to visual-based abundance estimates. Towed hydrophone arrays are used to aid the monitoring efforts and often result in many additional encounters beyond what may be seen by the visual team alone. Efficient signal processing methods are needed to localize subgroups using the towed array data to aid in a joint visual-acoustic density estimate or one based on acoustic detections alone. In this study, we discuss an automated approach developed to localize multiple subgroups of false killer whales using towed hydrophone arrays. The framework provides an efficient and objective way to localize acoustics based on both whistles and clicks among missed and false detections and is applicable to other species. The presented framework can thus aid future cetacean monitoring and assessment efforts.

4. Modeling sperm whale distribution using visual and passive acoustic data

Yvonne Barkley[1], Taiki Sakai[2], Erin Oleson[3], and Erik Franklin[4]

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Sperm whales (*Physeter macrocephalus*) are a deep-diving cetacean species protected in U.S. waters. Generally, sperm whale data collected during line-transect surveys include visual observations of whales at the surface and passive acoustic data of vocalizing whales at depth. Current sperm whale population assessments only use visual observations to estimate abundance and examine distribution. However, passive acoustic data contribute additional data points as well as demographic and behavioral information to improve population assessments. Species distribution models (SDMs) provide an analytical structure to incorporate visual and passive acoustic data and include behavioral information when examining sperm whale distribution patterns. We used a generalized additive modeling framework to develop SDMs using both data types with biologically

relevant environmental variables to model the distribution of foraging and nonforaging whale groups throughout the Hawaiʻian archipelago. The SDMs predicted higher densities of foraging groups in the archipelago's northwestern region and north of the main Hawaiʻian Islands of Maui and Hawaiʻi. Non-foraging groups were predicted to be more uniformly distributed throughout the archipelago. The best variables for predicting foraging whales included location, temperature at 584 m depth, surface chlorophyll, and the standard deviation of sea surface height, while location and depth predicted non-foraging whales. Additionally, work is underway to evaluate sperm whale acoustic cue rates that may be incorporated into a modified version of the SDMs for acoustic density estimates of sperm whales. Overall, this study contributes methods that incorporate visual observations, passive acoustic data, and contextual information to further our understanding of cetacean distribution patterns.

5. Using a deep neural network to classify echolocation clicks and identify biogeographic patterns of Pacific white-sided dolphins

Michaela Alksne, Annebelle Kok, Kaitlin Frasier, and Simone Baumann-Pickering

Scripps Institution of Oceanography, UCSD

Pacific white-sided dolphins are small delphinids whose distribution spans the Northern Pacific Ocean from the Gulf of California to the Sea of Japan. Two genetically distinct stocks overlap along the west coast of North America. However, they are visually indistinguishable, and the degree of spatial overlap remains unknown. Here, we use a deep neural network to show that the stocks are acoustically distinct. Previous studies described two different echolocation click types associated with Pacific white-sided dolphins and hypothesized that they were stock-specific. Our neural network was trained to classify the type A and type B clicks based on spectral and temporal properties as described in previous studies. The neural network enabled us to analyze passive acoustic recordings from sites between the Gulf of California and the Gulf of Alaska over multiple years to investigate possible stock-specific trends. The latitudinal occurrence pattern of the two click types supports the stock-specific hypothesis: type A clicks continue to associate with the northern stock distribution and type B clicks with the southern stock distribution. At long-term monitoring sites in the Southern California Bight, type B clicks were increasingly present during periods of warm water anomalies. This pattern may be an early indicator of future biogeographic shifts in the distribution of Pacific white-sided dolphins and demonstrates the utility of long-term passive acoustic monitoring. The neural network classification method presented here is a novel technique for analyzing passive acoustic data and may be especially useful for studying species that are visually inconspicuous but acoustically distinguishable.

6. Passive acoustic monitoring for stock assessment: Rice's whales in the Gulf of America

Melissa Soldevilla[1], Ashley Cook[2], Amanda Debich[2], Kaitlin Frasier[3], Heloise Frouin-Mouy[4], Adolfo Gracia[5], Lance Garrison[1], John Hildebrand[3], Anthony Martinez[1], Joel Ortega-Ortiz[2], Arturo Serrano[6], and Ludovic Tenorio-Hallé[2]

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The newly recognized Rice's whale (*Balaenoptera ricei*) is one of the most endangered marine mammal species worldwide. This species faces a high risk of extinction due to its very small population size and limited distribution in the highly industrialized Gulf of America waters. Fundamental questions about where, when, how often, and why the whales occupy certain habitats need to be answered to recover this species and protect its habitat. To address these questions, we have developed a multiscale passive acoustic monitoring program throughout the Gulf. These efforts include a focused ship-based Rice's whale ecology study conducted from 2018 to 2019, with directional sonobuoys deployed to validate species' call types, document call rates, and estimate detection distances. Using this information, we have deployed a long-term moored High-frequency Acoustic Recording Package (HARP) in their core habitat for eight years to understand seasonal and interannual occupancy, providing evidence of near-constant year-round occurrence with some seasonal and interannual variability in call detections. During 2021, we deployed a sparse Soundtrap array throughout the core habitat to investigate seasonal movements and spatiotemporal call density patterns. Exploration of their potential broader distribution and frequency of occurrence beyond their core habitat using moored HARPs along the shelf-break shows that they regularly use waters of the Northwestern Gulf and produce different call types in this region. Current studies expand this work to the southern shelf-break and deep waters of the Gulf. Combined, these passive acoustic studies provide crucial and timely information for developing critical habitat and recovery plans to save one of the most endangered whales.

7. An interactive machine learning toolkit for classifying impulsive signals in passive acoustic recordings

Kaitlin Frasier[1], Alba Solsona Berga[1], Danielle Cholewiak[2], and Melissa Soldevilla[3]

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A typical wide-bandwidth passive acoustic seafloor sensor can record tens of millions of impulsive signals produced by biological, anthropogenic, and physical sources each year. Sources include echolocating toothed whales, snapping shrimp, ship propeller cavitation, echosounders, and weather. The volume and variety of detections make manual classification by human analysts unmanageable without in-depth knowledge of the overall acoustic context of each monitoring location. We developed an interactive machine learning toolkit for efficiently detecting and classifying short, highly variable impulsive signals in large passive acoustic datasets. Modules include a configurable event detector, an unsupervised clustering module for identifying dominant signal categories, a deep learning unit for learning and applying event classes, and a graphical user interface for viewing, correcting, and evaluating detectors and classifiers. The goal of the toolkit is to passive acoustic monitoring (PAM) datasets across sensor types and monitoring locations and to improve quantitative assessment of these sources. These tools are discussed and illustrated through a series of recent applications ranging from classification of impulsive signals in a half-petabyte passive acoustic dataset collected in the Gulf to identification of fish choruses in the Channel Islands.

8. Passive acoustic localization and tracking of Rice's whales (*Balaenoptera ricei*) in the northeastern Gulf of America

Ludovic Tenorio-Hallé[1], Pina Gruden[2], Héloïse Frouin-Mouy[3], Melissa Soldevilla[4], Amanda Debich[1], Ashley Cook[1], Lance Garrison[4], Eva-Marie Nosal[5], and Erin Oleson[6]

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In recent years, passive acoustic monitoring has seen substantial advancements as a tool for complementing traditional marine mammal stock assessment methods, benefiting in particular from its ability to cover spatiotemporal scales that would be impractical to achieve using current ship-based or aerial visual surveys. As part of an ongoing project to study the endangered Rice's whale (*Balaenoptera ricei*), moored stations equipped with low-cost passive acoustic recorders have been near-continuously deployed at various sites within the species' core habitat in the northeastern Gulf since May 2021. While detecting Rice's whale calls in these data readily provides valuable insight into the species

spatiotemporal distribution, estimating whale density requires a better understanding of the species' acoustic behavior.

Here, we present a method for 2D localization and tracking of vocalizing whales in this dataset. The two key components of this approach are (1) the use of opportunistic sound sources to time-synchronize data across sites given the high clock-drift of these low-cost recorders and (2) the implementation of automated techniques for tracking multiple animals simultaneously amid clutter and missed detections. Analyses of the first four months of data show promising results for characterizing the Rice's whale's acoustic behavior within the context of density estimation.

9. Diving behavior of beaked whales in the Gulf of America inferred from three-dimensional acoustic tracking using near-seafloor sensors

Héloïse Frouin-Mouy[1], Kaitlin Frasier[2], John Hildebrand[2], Eric Snyder[2], Sean Wiggins[2], Lance Garrison[3], and Melissa Soldevilla[3]

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The Gulf of America is a semi-enclosed large marine ecosystem inhabited by at least 20 cetacean species including several species of beaked whales. Because these long-diving, cryptic species produce high amplitude species-specific echolocation signals regularly throughout their foraging dives, passive acoustic density estimation may be especially effective for them. A critical component of the distance-sampling approach for density is estimating the probability of detecting an acoustic signal given an animal's distance from an acoustic recorder. Accurate detection probability estimation requires detailed population-specific information on the subsurface behavior of both individuals and groups of animals. Passive acoustic tracking, an alternative tool to tagging, can be used to study the diving behavior of beaked whales and provides the ability to characterize key aspects of their echolocation clicks, including source levels and beam widths. In the Gulf, in 2019 one 4-channel High-frequency Acoustic Recording Package (HARP) was deployed at Mississippi Canyon (MC), and in 2020, two 4-channel HARPs were deployed at Green Canyon (GC). Echolocation pulses from Cuvier's and Gervais' beaked whales detected on both sensors at GC were used to localize individuals in three-dimensions to estimate distances, study the diving behavior, and characterize the signals. Horizontal detection range, received level, and estimated source level distributions from localized encounters were compared with a model estimating detection probability using both diving behavior and signal production. At MC (single HARP), detection angles were combined with the distribution of echolocation

depths established at GC, making it possible to infer the distribution of detection distances for both species at this site.

Session 2: Climate Change Impacts on Protected Species Assessments

Co-Chairs: Caroline Good (OPR) and Nancy Friday (AFSC)

Session Summary

Changing ocean and climate conditions are affecting protected species in a variety of ways. Changes in distribution, abundance, and composition have already been reported for some marine species. In addition, impacts from climate change are projected to continue into the future and in many cases are expected to become more extreme. This session included four oral presentations that focused on NOAA Fisheries initiatives to improve the agency's ability to address climate change impacts to protected species including the Protected Resources' Climate Initiative, Climate, Ecosystem, and Fisheries Initiative (CEFI). Tools to identify, prepare for, and tackle climate challenges include enhancing species adaptation and resilience, managing based on sound science, climate vulnerability analyses (CVAs), and scenario planning. Presenters highlighted the need to ask questions, such as what is changing, why is it changing, how will it change, and how do we respond? CEFI was described as an initiative focused on an end-to-end decision support system for climate-informed decision-making to meet critical needs and provided examples of climate-informed advice across a continuum of scales from rapid response to long-term planning: climate-linked real-time species maps and predictive tools, climate-enhanced stock assessment models, and climate smart long-term strategies. Information and tools used to incorporate climate into fish stock assessments were shared. Climate Vulnerability Assessment approaches were also shared as a method to identify populations that are most vulnerable to climate change and what drives that vulnerability, as well as how the process and resulting information fits within the climate-smart conservation cycle. Common themes across presentations included (1) the value of partnerships in developing climate-informed data and the availability, quality, and frequency of data products used as inputs for models and assessments; (2) the importance of placing model and assessment outputs in a context that is usable by management; and (3) the broadening of access, familiarity, and use of decision-making and decision-support tools. A panel discussion followed the presentations. The panel was asked questions, and the panelists and the audience contributed to the discussion. The discussion focused on a range of topics examining the role and effects of climate change on protected species assessments, including philosophical considerations; survey and data collection needs; knowledge gaps that interfere with management's ability to make informed decisions; models and tools that can help to fill key data gaps and considerations associated with their use; cross-discipline

efforts to improve climate impact analyses; and the use of best available science in protected species assessments to inform adaptive conservation and management decisions.

Session Talks | Abstracts

1. Addressing climate change impacts on protected resources: The PR Climate Initiative

Shannon Bettridge and Dori Dick

NOAA Fisheries OPR

Climate change is an ecosystem threat to all species with widespread impacts across all of NMFS' jurisdiction, yet not all species or regions are being impacted or will be impacted similarly. Our best chance of success is to take actions that will ensure that protected species and their habitats remain as integral parts of coastal and ocean ecosystems. We need to be able to adaptively manage our resources in response to climate change, and we require science information at the appropriate space and time scales. To address this need, over the last decade, the Office of Protected Resources prioritized funding and resources to work on climate change related issues via the Protected Resources (PR) Climate Initiative. This initiative uses a "climate-smart" approach through the intentional and deliberate consideration of climate change to promote strategies to enable adaptation and resilience of protected species and their habitats to climate-related changes. This presentation will highlight some of the past work of the Initiative and provide an overview of the Strategic Framework developed to guide on-going and future Protected Resources climate activities. It will also explain how the PR Climate Initiative relates to CEFI and other NOAA efforts.

2. NOAA Climate, Ecosystems and Fisheries Initiative: An end-to-end decision support system for climate ready resource management

Kirstin Holsman[1] and Roger Griffis[2]

[1]NOAA Fisheries AFSC, [2]NOAA Fisheries OST

Climate variability and change are significantly impacting marine and coastal ecosystems and the many people, businesses, and communities that depend upon them. These changes affect every part of NOAA Fisheries' mission from protected resources conservation to fisheries management. To effectively prepare for and respond to these changes, decision-makers need robust information on likely future conditions and the best options for resilience and adaptation. The NOAA Climate, Ecosystems and Fisheries Initiative (CEFI) calls for developing a nation-wide integrated ocean modeling and decision support system to meet these needs. The CEFI System is designed to provide decision-makers at national, regional, and local levels with a consistent flow of actionable information to reduce impacts and increase resilience. The System will use state-of-the-art climate, ocean, and ecosystem modeling to provide robust future scenarios across multiple time frames and actionable advice for climate-informed decision-making. The CEFI System is composed of five interlinked components that ensure operational delivery of information, services, and feedback for sustained performance and innovation: (1) regional ocean modeling that provides state-of-the-art ocean forecasts and projections for use in developing climate-informed management advice; (2) an information hub to provide easy access to model output and other information; (3) decision support teams at each Fisheries Science Center to transform ocean projections into useful products and advice for climate-informed resource management; (4) decision-maker capacity to use climate-informed advice in decision-making; and (5) targeted observations and research for continuous validation, innovation, and improvement of the System.

3. Incorporating climate and ecosystem information into fish stock assessments

Kristan Blackhart

NOAA Fisheries OST

Climate-based impacts can have major impacts on fish populations and their ecosystems, the fisheries that rely on them, and the science and management processes built around them. Understanding these impacts and incorporating them into existing assessment processes is a major challenge. Significant computing and modeling advancements have been made in recent years, but it requires enormous amounts of empirical data input and research investment to take advantage of these and continue to advance our understanding. Despite many challenges, some notable progress has been made in considering climate and ecosystem factors in the fish assessment process. This talk will begin with a "fish stock assessment 101" discussion, pointing out where climate and ecosystem factors can be incorporated to inform the process. Next, a summary of the extent that climate and ecosystem factors are currently being incorporated in fish stock

assessments will be provided. The talk will close with some case studies of how climate and ecosystem factors are being used to inform fish assessments for both data-limited and data-rich stocks.

4. Marine mammal and sea turtle climate vulnerability assessments within research and management frameworks

Matthew Lettrich

ECS Federal in support of NOAA Fisheries OST

NOAA Fisheries led the development and implementation of marine mammal and sea turtle climate vulnerability assessments (CVAs), in addition to CVAs for marine fish, marine invertebrates, and salmon. These CVAs provide a baseline understanding of which National Marine Fisheries Service-managed populations are vulnerable to climate change, and which life history traits and climate factors drive that vulnerability. The CVA frameworks combine sensitivity/adaptive capacity based on life history traits with exposure based on projected climate and ocean conditions to calculate a climate vulnerability score and relative vulnerability index. These assessments provide managers and researchers with information about climate sensitivity, exposure, and vulnerability at the population-level and summarize results at the regional level to highlight species and populations that are most vulnerable to climate change. This information can be used to focus conservation and management decision-making, inform scenario planning exercises to help identify management actions, identify populations that would most benefit from advanced climate change modeling exercises, and present hypotheses for researchers to test for future study. Incorporating CVA results into future conservation and research life cycles will require additional planning and outreach to ensure that the findings are used effectively and appropriately. Here, we explore how CVA results have contributed to conservation and research planning to date (e.g., for marine fishes, invertebrates, and salmon). Marine mammal and sea turtle managers and researchers can find inspiration and guidance on how these other CVAs are being used to support decision-making and spur the advancement of our understanding of how climate change impacts marine populations.

Panel Discussion

The climate session concluded with a panel discussion intermixed with audience questions and answers. Panelists included science and management perspectives from NOAA Fisheries HQ offices and Science Centers: Shannon Bettridge (OPR), Paul Conn (AFSC), Dori

Dick (OPR, virtual), Kirstin Holsman (AFSC, virtual), Evan Howell (OST), Matthew Lettrich (contractor supporting OST, virtual), Brett McClintock (AFSC), and Chris Sasso (SEFSC).

Topics discussed ranged from philosophical questions about the role of climate change in Protected Resources activities to technical questions about model capabilities and inputs.

Philosophy
Questions were asked about how OPR views risk in light of climate change. Panelists replied that climate change will have an impact on how risk is viewed and pointed to the Resist–Accept–Direct framework as an example of how the range of risks can be considered. Relatedly, the objective of OPR relative to climate change can be seen in the PR Climate Initiative taking the approach of making species more resilient and adaptive to climate change. Taking a precautionary approach to management in a changing climate is likely to result in more regulation, which would likely be met with lots of resistance.

Recognizing that climate change is also affecting human populations and human activities will be a key piece of protected species assessment and management. Finally, climate change may come as a shock to the system, much like an earthquake happens quickly and suddenly, and we must be prepared for rapid changes.

Surveys and Data Collection
Traditional methods of assessment were discussed, along with their limitations in a changing climate. Traditional survey approaches, described simply as going into the field and counting animals, have become increasingly challenging with limited budgets. The question was asked about how else the effects of climate change on marine mammals can be assessed. One possible option was examining health conditions as an indicator.

For sea turtles, participants noted a lack of long-term in-water data, resulting in hard to answer questions without basic monitoring data. Given that such a high proportion of surveys take place on nesting beaches, changes in abundance may take decades to observe, effectively needing to wait until the population matures and begins nesting. However, other proxies like cold stun data could be used as intermediate estimates of changes in abundance. For marine mammals, some populations have annual surveys, but others have longer periods of time between surveys. Good surveys were noted as critically important because surveys provide as close to real-time information about what is happening with the populations. Considering climate vulnerability assessment (CVA) results, participants asked for what proportion of highly vulnerable species we have sufficient survey data to detect rapid decline.

Participants noted that the data limitation situation is significant for a large number of protected species and that ecological systems can change a lot in the time between surveys. We need to figure out how to design assessment approaches to compensate for those challenges. There was a general sense that funding will likely not be available to survey with the frequency desired.

Model and Tool Development

Discussions centered around model and tool development spanned a range of topics including model inputs, development approaches, outputs, and performance. Participants asked whether the time series needs sufficient annual contrast in order to include climate change or whether we could use time blocking or regimes.

Models are trained, tested, and ground-truthed on observed past relationships (e.g., abiotic conditions and plankton density). Participants asked how we can adapt models as the underlying environment changes and the relationships we have previously observed change in unknown ways. Panelists noted that the further we go with the models in time or space, the greater the uncertainty. In the near-term, climate-informed advice is valuable. In the longer-term, projections can set up scenario analyses. Where we are in X years is less important than the range of possible values at X years. Continually and iteratively skill testing on shorter-term advice improves the models.

Participants and panelists discussed the Climate, Ecosystems and Fisheries Initiative (CEFI) and noted that having models linking production to climate drivers would be beneficial. Furthermore, understanding the range of possible outcomes with climate change would be a beneficial outcome of CEFI. Panelists noted that there has been exploration into climate indices and that there are big differences in projections based on which parameter gets linked to which climate index.

Trophic studies are a key part of understanding. Many species distribution models (SDMs) are driven by satellite products that are proxies for prey. Participants and panelists noted a lack of SDMs for prey species, which could inform protected species SDMs. Panelists noted that there are bottlenecks to species survival, such as disease, prey, and prey availability and questioned whether we have data on those elements related to mortality events. Additionally, taxonomic resolution is important to consider when designing models and tools.

Assessing model performance is important for determining effectiveness, and the fish stock assessments that incorporated climate change were assessed on their ability to improve diagnostics or decrease uncertainty when climate change is considered.

Potential Biological Removal

Participants and panelists discussed the potential biological removal (PBR) calculation that is presented in marine mammal stock assessments and whether there is a way to consider PBR differently for stocks with high vulnerability to climate change. Compared with fish stock assessments that are focused on the next few years, marine mammal stock assessments are inherently focused on the decadal scale. Further investigation into climate projections can be incorporated into the long-term growth rate, or changes to the underlying model may be warranted. Participants noted that PBR was designed to be calculated without knowing abundance trends.

Incorporating CVAs

For sea turtles, incorporating CVAs is a longer-term prospect. Without a formal mechanism for sea turtle stock assessments, it is difficult to see where CVAs could fit into sea turtle stock assessment. CVAs could be included in management strategy evaluations (MSEs) and scenario planning exercises.

Management Considerations

Traditional management options are place-based. Participants and panelists discussed options to keep ahead of the curve by collecting the correct data for species that are rapidly adapting to changes and preparing adaptive management options. Identifying the critical tipping points in management systems is an important component, and using projections to frame boundaries of how much change can be expected can help define the bounds of the management system. For example, with NARW waiting for the science that will tell us where the whales will be and when, will take too long. There needs to be flexibility in the management and the capability to use measures that are dynamic. This may involve setting up a framework for regulation when specific conditions are met (e.g., if mortalities and serious injury rise to a threshold within an area).

Siting and placement of mitigation measures is a clear protected species interface. Renewable energy is going to be a part of the future. Lease terms for offshore areas can span decades, and questions arose about how to mitigate impacts once we have a change that has occurred. New industries will be entering the same areas into which species are moving.

Additionally, aquaculture opportunity areas may need to be revisited as conditions change. Adaptive management highlights the need to see potential problems before they exist. However, adaptive management can be limited by monitoring the capability to alert management that a threshold or indicator has been reached. Considering the range of possible futures, panelists conveyed that frameworks are more valuable than prescriptions.

Other Topics
Several additional topics were discussed, such as the growing use of other sections of the marine mammal stock assessment reports beyond the population numbers, particularly related to climate change information. The use of advanced technology, such as drones and passive acoustics, was discussed as ways to supplement survey data and provide additional indicators to stock and ecosystem health. Relatedly, the potential for marine mammals to be indicators or sentinels of ecosystem health was discussed.

Main Workshop Day 2: March 30, 2023

Summary: Day 2

The second day of the main workshop began with a keynote speaker address that focused on incorporating species behavior, habitat use, carrying capacity, and ecological roles into planning for and implementing conservation actions, especially for highly mobile apex predators, citing sharks as examples. The keynote address was followed by Session 3, which focused on new analytical approaches to abundance and risk assessments. The session began with a plenary talk on 2023 as the Year of Open Science, followed by nine oral presentations. Poster presentations occurred during lunch. In the afternoon, Session 4 focused on impacts from new and increasing marine development on protected species assessments. A plenary talk highlighted the impacts from the Deepwater Horizon (DWH) oil spill and discussed tools created to help assess impacts and identify effective restoration strategies. Four additional oral presentations followed. The session ended with a panel discussion that highlighted the need for long-term datasets, proactive planning, effective restoration efforts, increased communication, analytical tools, and internal and external collaboration to address protected species data and assessment needs. The day ended with closing remarks from OST and SEFSC. Participants provided initial feedback on the formatting of PSAW III and would be receiving surveys to provide additional comments. The steering committee and volunteers were thanked for all their efforts, and the workshop was adjourned.

Keynote Speaker Address

Keynote Speaker: *Michael Heithaus, Ph.D., Executive Dean of the College of Arts, Sciences, and Education, Professor Department of Biology, Florida International University*

Bio: As a marine ecologist, Heithaus specializes in predator–prey interactions and the ecological importance of sharks and other large marine species. His research leverages a number of cutting-edge technologies, including drones and animal-borne cameras, to unravel the mysterious lives of hard-to-study marine creatures. His work in Shark Bay, Australia, is the most detailed study of the ecological role of sharks in the world. Several prominent non-governmental organizations have used it as the underpinning for affecting positive policy changes. He has authored or co-authored more than 200 peer-reviewed journal articles and book chapters and co-edited five books on the biology of sharks and their relatives. He also has co-written two high school science textbooks and is an author on national K-8 science programs.

Prior to joining FIU, Heithaus was a scientist at Mote Marine Laboratory's Center for Shark Research. He also worked with National Geographic's Remote Imaging Department where he conducted studies using their "Crittercam." Heithaus has been involved in the production of more than a dozen natural history documentaries, including many featured on National Geographic's Shark Fest as well as Shark Week. He also hosted a National Geographic Channel television series. He has dedicated his career to bringing the excitement of scientific exploration and discovery to audiences of all ages. He received a B.A. in Biology from Oberlin College in 1995 and completed his Ph.D. at Simon Fraser University in 2001.

Presentation: Dr. Heithaus began by welcoming everyone to the FIU campus and to Florida. He discussed some of his research in the Florida Everglades where the Shark River meets the Gulf. Dr. Heithaus has long studied predator and prey relationships, including alligators and bull sharks in the Shark River estuary. There is variability in movement within a species as well as among species. In the case of alligators, there are "couch potatoes" that do not move very much, while others are "commuters" that travel hundreds of kilometers and are more mobile in their movement patterns related to foraging. This is also observed in bull sharks, where tissue isotope analyses show that some feed almost exclusively in upstream areas, while others move to the southern end of the Shark River and forage in more marine food webs. Animals are connecting habitats in different ways with very different roles within the ecosystem. Dr. Heithaus' research efforts in the Everglades have shown that movement patterns can affect species vulnerability to natural and man-made environmental changes and that more nuanced conservation strategies are needed that consider these behavioral types and their ecological functions.

He also discussed Global FinPrint, a long-term project that he is involved in along with 120 other collaborators. Beginning in 2015, Global FinPrint, the first survey of its kind, set out to use underwater videos to record animal sightings and the behavior of sharks and rays on

coral reefs worldwide. Data were then used to assess population structure and identify environmental and human drivers of abundance and develop conservation tools based on these drivers. Initial findings indicate that 20% of expected reefs show no shark presence, suggesting ecological extinction of sharks in these habitats. In terms of function, about half of the reefs worldwide had populations lower than expected based on regional averages. However, some areas with high human populations and robust shark populations exist together. There are a few basic levers that are useful in helping maintain at least resident reef shark populations that include decreasing direct take during fishing and large protected areas. Dr. Heithaus discussed the need to set conservation targets based on regional needs and habitat types, which may have different carrying capacities for shark populations. There is a definite need for protected areas to help conserve shark and ray species by acting as no-take zones. He also highlighted the role of fishing regulations in maintaining shark populations and working with local and regional governance systems to implement conservation initiatives. Dr. Heithaus noted that protected zones are only effective if there is also good fisheries management outside those areas, especially for mobile species like sharks. Efforts need to also focus on taxa that are most important ecologically. For sharks, it appears that really large species feed on animals more directly and that this affects macrophyte populations. If we look at apex predators, current Marine Protected Areas (MPAs) are not necessarily protecting larger taxa, and we need to expand the size of MPAs. Fisheries management outside MPAs also becomes even more important in protecting and rebuilding larger taxa.

Dr. Heithaus thanked the workshop participants for the important work they are doing and recognized how challenging it is to protect marine species in light of the obstacles we all face. Dr. Heithaus encouraged communication and collaboration with universities and other organizations so that ocean managers and conservation biologists can make a lasting impact.

Session 3: New Analytical Approaches to Abundance and Risk Assessments

Co-Chairs: Alex Curtis (SWFSC) and Chris Jordan (NWFSC)

Session Summary

Innovation and adaptation of analytical methods are a key avenue for improving estimates of abundance and risk for protected species assessments, particularly given finite resources and capabilities for data collection. Presenters shared analytical advances that integrate multiple data sources or types, support data-limited assessment, reduce bias, better characterize uncertainty, or increase efficiency. The plenary talk highlighted 2023 as the

"Year of Open Science" to address reproducibility challenges in scientific research, citing the implementation of reproducible workflows and the Openscapes program at NOAA Fisheries to train researchers in open science practices. NOAA Fisheries Integrated Toolbox was presented as advancing open science by serving as a resource for software sharing in support of fisheries management and protected species conservation. Additionally, advancements in machine learning for predicting bycatch hotpots and methodological improvements in monitoring seabird bycatch were discussed. MSE, spatial modeling of humpback whale populations using mark–recapture data, and innovative data integration frameworks for population modeling and habitat selection analysis were also highlighted. The session concluded with a discussion about data integration techniques that tie into repeatable science and the need to relay new findings and "better science" so that managers can make more informed decisions. Participants agreed that building trust and integrity are important in key research practices. The group discussed the challenges and benefits of open science practices, reiterating the importance of data accessibility in protected species science and conservation. The group also agreed that a culture shift is needed in the scientific community to embrace open science and reproducibility that normalizes discussions about workflows and the challenges of making scientific practices more transparent and accountable.

Plenary Talk

NOAA Fisheries Open Science and the 2023 Year of Open Science (YOOS23)

Eli Holmes[1], Mari Williams[1], Diana Dishman[2], Katie Barnas[1], and Chris Jordan[1]

[1]NOAA Fisheries NWFSC, [2]NOAA Fisheries WCRO

The White House Office of Science and Technology Policy launched 2023 as the Year of Open Science (YOOS23). The goal of YOOS23 is to "advance national open science policy, provide access to the results of the nation's taxpayer-supported research, accelerate discovery and innovation, promote public trust, and drive more equitable outcomes" funded by new investments at the federal level. YOOS23 is a culmination of efforts by federal agencies with key drivers being NASA's Transform to Open Science Initiative and NOAA's Data Strategic Action Plan. NOAA Fisheries' Open Science supports scientists and decision-makers within NMFS in fulfilling NOAA's Open Science and Open Data mandates and participating in YOOS23. This involves actively supporting staff in adopting reproducible workflows that improve the delivery of timely, transparent, and accessible data-driven science and decision-making. Such transformation calls for both increased collaboration across offices and regions toward shared scientific data science tasks and expanded support of open science, open data, and open-source communities within NMFS.

One of the ways that NMFS Open Science has been doing this over the last two years is Openscapes Champions cohorts, an 8-week series that helps teams document their current project workflows, re-imagine these using modern reproducible and robust processes, and then begin moving forward toward change. We will show an example using a team who work on the Pacific Northwest (PNW) salmonid Viability Reports and Status Reviews. Over the next 3 years, NMFS Open Science will be expanding the Openscapes program but also importantly expanding support for skill development and training opportunities along with expanded technical help and cloud infrastructure access for teams and staff. The core mission of NMFS Open Science is to support staff with empathy, kindness, and inclusion to authentically address the (many) barriers NMFS staff face in adopting Open Data and Open Science.

Session Talks | Abstracts

1. Using the NOAA Fisheries Integrated Toolbox to advance open science for protected species

Kathryn Doering

NOAA Fisheries OST

Software-based tools are a critical component of the scientific work of NOAA Fisheries scientists. Many scientists develop and use code for their own work tasks. However, most of the code is never seen except by the primary author or work group, even though these tools may be applicable to other groups. The NOAA Fisheries Integrated Toolbox (FIT) aims to promote sharing of software solutions within the agency to reduce duplication, enhance workflows, and improve scientific results. This presentation will introduce the latest features of the FIT and highlight what is currently available in the toolbox with a focus on tools relevant to protected species science. In addition, this presentation will cover how to share tools via the toolbox. Through the FIT, we can advance open science at NOAA Fisheries together and improve the quality of our science-based products.

2. Forecasting bycatch hotspots using multivariate random forest machine learning

Kelly Soluri and Elizabeth Babcock

University of Miami

The incidental take of nontargeted species, known as bycatch, has shown to have negative long-term effects on marine ecosystems and their dependent populations by accidentally

catching or killing top predators, fauna with slow reproductive capacity, spawning individuals, and endangered species. Predicting areas of concentrated bycatch rates has the potential for obtaining a better understanding of correlated variables in bycatch as well as informing avoidance strategies to mitigate it. Random Forest (RF) models have been shown to be an exceptional tool in classification and regression for forecasting problems due to their powerful predictive capability in ensemble nonparametric learning and imputing missing data. Whereas single species bycatch analyses usually use generative additive models (GAMs) to model nonlinear relationships, RF is more flexible and powerful for viewing bycatch hotspots as a multispecies problem with a larger range of variables. Using more modern statistical methods to investigate fisheries research, this study identifies bycatch hotspots in the Gulf of America and the taxonomic and trait-based compositions of these areas. It investigates the correlation of biological traits, environmental conditions, and bycatch density as predictor variables to better model where these bycatch hotspots may occur in the Gulf by building a RF to predict catch per unit effort of bycatch to select for hotspots.

3. Life history and climate change matter

Yan Jiao[1], Can Zhou[1], Rujia Bi[1], and Joan Browder[2]

[1]Virginia Polytechnic Institute and State University, [2]NOAA Fisheries SEFSC

Seabird bycatch and mortality are long-time conservation concerns. NOAA/SEFSC's Pelagic Observer Program (POP) has monitored the U.S. Atlantic pelagic longline (PLL) fishery since 1992, providing opportunities to study PLL seabird bycatch in an area of high seabird diversity. A Virginia Tech–SEFSC collaboration assesses bycatch annually and addresses important ecological and fisheries questions such as where and when high bycatch risk (hot spot) occurs. Do they vary over years? How might bycatch risk vary among species? Major challenges included the high percentage of zero observations in POP seabird bycatch, only 50% identified to species level, and the already low abundance of endangered seabirds in this region, reducing the likelihood of documenting rare species captures should they occur. We present our recent study progress and show how we are overcoming obstacles and answering important ecological questions through advanced quantitative methods with methodologies developed by our team that evolved over time. Evolution of methods led to a Bayesian spatial–temporal random effect model to study climate effects and species-specific state space Bayesian models to study the bycatch risk effect from species attributes, space–time variables, and species associations. Our study found that the mid-Atlantic bight and neighboring south Atlantic bight and Northeast coast areas impose high bycatch risk but that hot spots vary among years related to climate changes. Bycatch risk varies among species, and ecological traits can improve bycatch estimation and

provide species-specific risk analysis for all potentially affected seabird species in this region.

4. Management strategy evaluation (MSE) for protected species

Cassidy Peterson[1], Melissa Cook[1], Jennifer Lee[2], Joseph Pfaller[1], Susan Piacenza[3], Paul Richards[1], Christopher Sasso[1], and John Walter III[1]

[1]NOAA Fisheries SEFSC, [2]NOAA Fisheries SERO, [3]Oregon State University

Management strategy evaluation (MSE) is a framework, pioneered by the International Whaling Commission (IWC) beginning in 1974, in which the full management or conservation process is tested through closed-loop simulation. The management or conservation procedures include specification of (1) data collection and quality, (2) species assessment, (3) control rules that dictate how conservation protocols adapt to changing population status, and (4) the implementation of conservation protocols. Conservation procedures are applied to a suite of operating models, each representing a unique hypothesis of the current and future dynamics of the population. Conservation procedure performance is measured based on the conservation objectives of the population, identified by stakeholder input and/or from existing information (e.g., species management plans). Because MSEs thoroughly address each component of the conservation process, MSEs can be used to measure the impact of:

- Data collection protocols, including sampling methods, design, data quality, and development of novel data collection schemes.
- Species assessment methods and specifications, including model and/or non-model-based methods of determining population status.
- Control rules that adjust conservation measures and/or the type of conservation measures (e.g., limit bycatch, implement closed areas).
- Whether conservation procedures are robust to uncertainties in the population, both current (e.g., uncertain life history parameters, level of anthropogenic interactions) and future (e.g., impacts of marine development and climate change).

MSEs can also help us to prioritize future research by identifying which uncertainties have the greatest impact on conservation success. With this presentation, we discuss MSEs and the value they can bring to protected species.

5. A one-dimensional spatial capture–recapture model to estimate abundance of a coastally distributed population

K. Alexandra Curtis[1], John Calambokidis[2], Katherina Audley[3], Melvin Castaneda[4], Joëlle De Weerdt[5], Andrea Jacqueline García Chávez[3], Frank Garita[6], Pamela Martínez-Loustalot[7],

Christian Daniel Ortega Ortiz[8], Jose D. Palacios-Alfaro[6], Betzi Pérez[6], Ester Quintana-Rizzo[9], Raúl Ramírez Barragan[3], Nicola Ransome[4,10], Kristin Rasmussen[6], Jorge Urbán R.[7], Francisco Villegas Zurita[11], Kiirsten Flynn[2], Ted Cheeseman[12], Jay Barlow[1], Debbie Steel[13], and Jeffrey Moore[1]

[1]NOAA Fisheries SWFSC, [2]Cascadia Research Collective, [3]Whales of Guerrero, [4]Proyecto Megaptera El Salvador, [5]Vrije Universiteit Brussel and Association ELI-S, [6]Panacetacea, [7]Universidad Autónoma de Baja California Sur, [8]Universidad de Colima, [9]Simmons University, [10]Murdoch University, [11]Universidad del Mar, and Yubarta Ecoturismo, [12]Southern Cross University and Happywhale, [13]Oregon State University

Many marine mammal populations exhibit some spatial fidelity within their range, leading to individual heterogeneity in capture probability with space that can bias mark–recapture assessment when sampling is uneven in space and time. Humpback whales (*Megaptera novaeangliae*) wintering off Central America and Southern Mexico show evidence of coarse spatial fidelity within this extensive region. Photo-identification effort in this area has been highly variable in time and space. We developed a one-dimensional, closed, spatial capture–recapture (SCR) model to estimate the abundance of this coastally distributed population. We explore population estimates resulting from the application of this model, both with and without an effort covariate, to photo-identification data from recent years, including the 2021–2022 winter seasons, for which effort was greatly amplified as part of the SPLASH-2 project to reassess North Pacific humpback whales. Results are compared to equivalent non-spatial mark–recapture estimates. Given the high anticipated sex heterogeneity in photo-identification rates in wintering areas, we also developed a method to quantify sex heterogeneity from biopsies taken in the summer feeding areas and photo-identification data from the wintering area and estimate a simulation-based correction factor for the population estimates.

6. Incorporating telemetry data into mark–recapture analysis: Case study of false killer whale (*Pseudorca crassidens*) abundance estimation in the Main Hawaiʻian Islands

Janelle Badger[1], Devin Johnson[1], Robin Baird[2], Amanda Bradford[1], Erin Oleson[1], and Michaela Kratofil[2]

[1]NOAA Fisheries PIFSC, [2]Cascadia Research Collective

Sparse and spatially biased data collected from monitoring programs of rare or inaccessible

species may be difficult to model, standardize across years, and incorporate into a management framework. Integrating data types may provide information to adequately estimate parameters of interest. Currently, surveys for the insular population of false killer whales (*Pseudorca crassidens*) around the main Hawaiʻian Islands are opportunistic in nature and almost exclusively conducted on leeward sides of the islands where sea conditions are more workable. This sampling bias limits the ability to assess population abundance and trends of this endangered population. Here, we used 23 years (1999–2021) of a longitudinal photo-identification mark–recapture dataset containing 202 known false killer whale individuals, who preferentially associate in four social clusters, along with satellite telemetry data from 44 individuals to fit a quasi-spatial mark–recapture model that uses the information from the telemetry data to address sampling biases. Utilization distributions (UDs) were estimated from each satellite tag track and then combined into social cluster UDs. The interaction between these UDs and kernel densities of yearly survey efforts was incorporated into a multistate Jolly–Seber open population model. Simulation experiments indicate that cluster-level space use is adequately defined for the majority of individuals and that this method can provide more accurate and precise estimates of abundance than conventional models. Future accommodation of additional data types, such as passive acoustics, into this framework can further the integration of disparate datasets collected in monitoring programs to enhance our understanding of elusive populations.

7. Integrated modeling of bearded seal densities

Paul Conn, Brett McClintock, Josh London, Jay Ver Hoef, and Catherine Berchok

NOAA Fisheries AFSSC

A variety of data sources provide information on bearded seal abundance and distribution in the Bering, Chukchi, and Beaufort (BCB) Seas. For instance, springtime aerial surveys have produced estimates of abundance and spatial distribution; seals fitted with satellite-linked time–depth recorders provide year-round information about location and habitat preferences; close-kin mark–recapture models fitted to genetic data from Alaska Native subsistence harvests provide total abundance estimates; and passive acoustic detections of bearded seals provide continuous, spatially explicit information on the presence/absence of vocalizing seals. In this talk, we describe a modeling framework for combining these data sources to come up with seasonal "best available science" maps of bearded seal density throughout the BCB. In addition to basic scientific interest, such maps should prove useful to managers for calculating takes associated with anthropogenic activities under the Marine Mammal Protection Act (MMPA) and other goals relative to marine spatial planning. Such maps can be constructed using average habitat conditions or with current habitat covariates under a "nowcasting" framework.

8. The multistate Langevin diffusion: Integrating multiple data types for inferring behavior-specific habitat selection and utilization distributions

Brett McClintock and Michelle Lander

NOAA Fisheries AFSC

Animal population studies often use tracking data to quantify space use and habitat selection, but they typically do not account for the different behaviors (e.g., foraging, migrating, nesting) that link life history requirements to particular habitats. Ignoring behavior limits our ability to understand why animals use certain habitats, and this represents a missed opportunity that can result in erroneous inferences and ineffective management decisions. Despite a clear need and desire, current approaches for extracting these types of inferences from tracking data are limited. We develop a habitat-driven Langevin diffusion for animals that exhibit distinct movement behaviors, thereby providing a novel single-stage statistical method for inferring behavior-specific habitat selection and utilization distributions in continuous time. The model can be customized, fitted, assessed, and simulated using R package momentuHMM. Additional data streams (e.g., dive activity) can be readily integrated to help distinguish movement behaviors with similar horizontal trajectories (e.g., "resting" vs. "foraging"). We highlight some of the potential advantages and challenges of the model through a detailed case study where we integrate Steller sea lion (*Eumetopias jubatus*) location and conductivity data collected in the Aleutian Islands of Alaska. Our model identified distinct movement behavior modes typically associated with this marine central place forager and, unlike previous analyses of these data, found foraging-type movements to be associated with steeper offshore slopes characteristic of the continental shelf, submarine canyons, and seamounts that are believed to enhance prey concentrations. As certain behaviors are often more relevant to specific conservation or management objectives, practitioners can use our model to help inform the identification and prioritization of important habitats.

9. A computationally flexible approach to population-level inference and data integration

Devin Johnson[1], Brian Brost[2], and Mevin Hooten[3]

[1]NOAA Fisheries PIFSC, [2]NOAA Fisheries AFSC, [3]University of Texas at Austin

Population-level inference from complex individual models and the integration of disparate datasets have become increasingly challenging in modern ecological investigation. For

example, sophisticated biologging technology has necessitated fitting complex models to individual animals; however, for management and risk assessment we need information at the population level. For other data integration, the individual datasets are also complex, and bespoke code is often necessary for fitting even when individual models for the separate datasets can be fitted with standard software. In both of these situations, the full model can be formulated as a Bayesian Hierarchical Model (BHM). We demonstrate a multistage method for making inference at all levels of a Bayesian hierarchical model (BHM) using natural data partitions to increase efficiency by allowing computations to take place in parallel form using software that is most appropriate for each data partition. In the second stage, the model results are recombined using normal approximations and meta-analytic techniques. The resulting inference approximates the inference obtained from fitting the full BHM at once. We demonstrate this method by making population-level inference for space-use of false killer whales in the main Hawaiʻian Islands.

Session 4: Impacts From New and Increasing Marine Development

Co-Chairs: Lesley Stokes (SEFSC) and Erin McMichael (ECS Federal in support of OST)

Session Summary

Protected species are facing unprecedented impacts from new and increasing marine development activities. Incorporating these impacts (both direct and cascading) is crucial to the conservation and recovery of imperiled species. This session focused on impacts from non-fisheries sectors such as offshore wind development, aquaculture, and oil spill response. This session included a plenary talk, four additional oral presentations, and a panel discussion on protected species data, assessment and management needs in relation to addressing changing habitats and species responses to oil spills, restoration efforts, and increasing marine development. The plenary talk focused on impacts from the DWH oil spill in the Gulf of America. Findings indicate that many species are slow to recover and are still impacted from DWH. Studies have documented changes in species distribution, habitat use, behavior, health, reproduction, and survival. The presentation also highlighted research efforts and analytical tool creation to help assess impacts, direct restoration activities, and monitor their effectiveness. The next four presentations highlighted (1) the importance of marine spatial planning for industries like aquaculture and offshore wind so that conflicts can be avoided in advance rather than after projects are designed; (2) overlapping habitats of offshore wind activities with leatherback sea turtles in the Northwestern Atlantic identified after wind farm placement; (3) the need for a multifaceted approach using a combination of survey and tracking methods, health assessments, toxicological studies, and environmental data to assess impacts of DWH on multiple sea turtle species and life history stages; and (4) diet changes in sperm whales in the Gulf pre- and post-DWH as determined through isotopic analyses. The panel discussion focused on a

variety of topics including the tools available or needed to identify, prepare for, and monitor impacts to protected species from increasing marine development. Long-term monitoring data and understanding baselines are crucial for assessing impacts and effective restoration planning. Models can be useful tools for understanding impacts and restoration needs; however, without baseline data it is challenging to determine the cause and effect of observed changes in populations. The panel also discussed the need for ongoing injury assessments and restorations over time to study long-term impacts to protected species and design effective conservation actions and mitigation strategies. The panel discussion and audience all agreed that increased communication and outreach efforts are needed to demonstrate the value of protected species research to stakeholders and decision-makers. Participants also supported increasing cross-disciplinary collaboration within NOAA Fisheries (e.g., stock assessment community, other NOAA Line Offices that collect environmental data) to leverage data and expertise to further support protected species impact assessments. Additional partnerships with external organizations and agencies will enhance data collection, merge data streams, and increase research capacity. All agreed that scientists and managers need to be proactive instead of reactive to mitigating impacts from increasing marine development. Lastly, many participants noted that increasing the use of advanced technologies across disciplines could also lead to more efficient monitoring and assessment processes.

Plenary Talk

Restoring Marine Mammal Populations under Changing Conditions

Lance Garrison

NOAA Fisheries SEFSC

The Gulf of America is highly industrialized with fishing, oil/gas exploration, shipping, and chronic ocean noise. It is also home to diverse tropical and subtropical dolphins, small whales, resident baleen whales, and sperm whales. In 2010, the Deepwater Horizon oil spill released 134 million gallons, affecting the central, western, and eastern regions. Injury

assessment for marine mammals pulled from multiple tools to evaluate exposure, health effect, survival, and reproduction. Findings show continuing effects and slow recovery for many populations. Restoration projects focus on evaluation and reducing anthropogenic impacts to help restore populations. New industries like aquaculture and offshore wind energy are adding new stressors to the ecosystem. The Gulf of Mexico Marine Assessment Program for Protected Species (GoMAPPS) started in 2017. This is a multi-agency, multi-species study providing information on the abundance, distribution, habitat use, and behavior of cetaceans, sea turtles, and seabirds. Three vessel surveys were conducted in 2017 and 2018, covering 20,000 kilometers of track line, and found significant distribution shifts for sperm whales from the eastern to western Gulf. The study has also documented substantial decline in Pantropical spotted dolphin abundance. Using spatial density models to analyze species–environment relationships has suggested that changes in oceanographic structure are driving variability in density and distribution. Climate change including deep water and surface layer warming will likely continue to affect habitats. In terms of population impacts and modeling, dolphin species abundance has decreased with some dropping from 70,000 to 30–50,000 animals. However, trend analysis is complicated by high uncertainty in abundance estimates. We have implemented a project called Listen GoMEX to establish long-term passive acoustic monitoring across the Gulf. A Population Consequences of Multiple Stressors (PCOMS) model was also developed to integrate impacts. The model framework connects exposure to stressors with physiological and/or behavioral changes and population effects. PCOMS was primarily developed to assess impacts on sperm whales and oceanic dolphins. Models have proven particularly useful in planning restoration activities through understanding potential outcomes and optimizing the scope of projects aimed at restoring the Gulf.

Session Talks | Abstracts

1. Modeling protected species distributions and habitats to inform siting and management of pioneering ocean industries

Nicholas Farmer[1], Jessica Powell[1], Lance Garrison[2], James Morris[3], Jr., Kenneth Riley[4], Melissa Soldevilla[2], Jenny Litz[2], Joel Ortega-Ortiz[5], Gina Rappucci[5], Paul Richards[2], Lisa Wickliffe[6], Jonathan Jossart[6], Jonathan MacKay[6], Alyssa Randall[6], Gretchen Bath[6], Penny Ruvelas[7], Laura Gray[8], Dana Bethea[1], Jennifer Lee[1], Wendy Piniak[8], Robert Hardy[8], Kristen Hart[9], Chris Sasso[2], Lesley Stokes[2], Mariana Steen[10], and Tershara Matthews[10]

[1]NOAA Fisheries SERO, [2]NOAA Fisheries SEFSC, [3]NOS NCCOS, [4]NOAA Fisheries Office of

Aquaculture, [5]CIMAS, University of Miami RSMAS at NOAA Fisheries SEFSC, [6]CSS-NOS NCCOS, [7]NOAA Fisheries WCRO, [8]NOAA Fisheries OPR, [9]USGS, [10]BOEM

Ocean planning provides managers with opportunities to evaluate tradeoffs among environmental, social, economic, cultural, and management considerations in the development of place-based activities. Early integration of mobile protected species considerations into ocean planning reduces the likelihood of future resource conflict. Transparency and problem-solving with potential conflicts in mind in the early planning stages can help minimize contention and increase efficiency during permitting and, hopefully, also minimize litigation challenges during project design and implementation. Case studies are presented for Gulf of America aquaculture and wind energy planning. To support ocean planning for these large-scale activities, a generalized scoring system for protected species status and trends that facilitates relative comparison between species was developed. The cumulative vulnerability for species whose distributions overlap areas under consideration for leasing was calculated as the product of scores within cells and integrated into the broader ocean planning process. This generalized approach proactively reduced siting conflicts, is directly applicable to other areas under consideration within the U.S., and is transferable to a variety of ocean spatial planning applications.

2. Movements of leatherback sea turtles (*Dermochelys coriacea*) suggest new foraging locations and interactions with offshore windfarms along the Atlantic Coast of the United States

Mitchell Rider[1], Heather Haas[2], Larisa Avens[3], and Chris Sasso[3]

[1]University of Miami, RSMAS, [2]NOAA Fisheries NEFSC, [3]NOAA Fisheries SEFSC

Understanding the movement ecology of migratory species is imperative as their large geographic distributions make them susceptible to a myriad anthropogenic threats. This is especially true for leatherback sea turtles (*Dermochelys coriacea*) that face various threats across all stages of their migration cycle. With the increasing number of offshore windfarms along the Atlantic coastline of the U.S., there is a need to understand the potential overlap between leatherback high-use areas and offshore windfarm leases. Satellite telemetry data from 53 leatherbacks tagged between 2017 and 2022 off the coasts of Massachusetts and North Carolina were analyzed with kernel density estimations and

move persistence models to determine space use and behavioral states, respectively, along the U.S. Atlantic coastline. Leatherbacks displayed high use of the Southern New England (SNE) and Mid-Atlantic Bight (MAB) regions during the summer and fall and were observed to move off the continental shelf into the Gulf Stream during the fall and winter. Move persistence models indicated that leatherbacks were displaying foraging-like behavior in SNE between Nantucket and Long Island Sound and in the MAB between Cape Hatteras, North Carolina, and the mouth of the Chesapeake Bay. In addition to highlighting a previously undocumented foraging area in the MAB, our results indicated considerable overlap between offshore windfarm leases and both leatherback high-use and foraging areas. Continued monitoring of this population is critical to understanding if and how leatherbacks may alter their movement patterns in relation to windfarm implementation and operation.

3. Understanding oil spill effects on sea turtles: Lessons learned and persistent challenges

Brian Stacy

NOAA Fisheries OPR

The Deepwater Horizon (DWH) oil spill occurred over a decade ago and spilled an estimated 134 million gallons of oil into the Gulf of America over 3 months. The spill response and subsequent Natural Resource Damage Assessment were the most comprehensive and complex ever conducted for sea turtles. Every life phase of the sea turtle was affected, from eggs, hatchlings, and adult females on oiled nesting beaches, to neritic juveniles and adults in foraging areas on the continental shelf, to surface-pelagic juveniles in offshore habitat. Vessel-based wildlife operations guided by aircraft were used to locate oiled *Sargassum* and convergence zones to rescue and document oiled surface-pelagic juvenile turtles. Aerial surveys were used to sight larger juveniles and adults. All surveys were conducted using methods that allowed extrapolation to estimate the abundance of sea turtles within the spill area. Direct observations, including veterinary assessments and field observations, were used to characterize the effects of the spill on sea turtles and were coupled with environmental information, abundance data, and toxicological risk assessment to estimate the numbers of turtles killed by the spill. For shoreline effects, additional losses were quantified based on the deterrence of nesting females by response operations and required translocation of eggs from nests under threat from the spill. Losses of sea turtles as a result of the DWH spill ultimately were estimated to have been on the order of thousands to tens of thousands, depending on life stage. Although the DWH oil spill was historic in scale, this spill heightened general awareness of the threats posed by these pollution events to sea turtles and other wildlife and the

importance of timely spill response conducted in a manner that supports damage assessment. Spills that can be especially injurious to sea turtles in terms of magnitude of effect include those that impact nesting beaches during periods of reproductive activity, offshore habitats frequented by small juvenile turtles, and high-use foraging areas. Understanding the impacts of oil spills on sea turtles may require a multifaceted approach that uses a combination of animal survey and tracking methods, health assessment, toxicological studies, and environmental data. Assessments benefit from robust baseline information with which to study possible spill effects; however, such information is often limited or unavailable for many areas impacted by oil spills, particularly in the Gulf. There are significant challenges to understanding the effects of oil spills on sea turtles due to their cryptic nature as ocean-going reptiles, complex life histories, long life spans, and slow maturation. Noteworthy examples that would benefit from innovation and additional study include the difficulty in estimating sea turtle abundance within response zones and the limited understanding of chronic or sublethal effects of oil exposure.

4. Diving deeper into the oil spill: Potential shifts in habitat use and foraging ecology of sperm whales after the Deepwater Horizon oil spill

Clarissa Teixeira[1], Bruce Mate[1], Ladd Irvine[1], and Genyffer Troina[2]

[1]Oregon State University, [2]University of British Columbia

The 2010 Deepwater Horizon explosion discharged millions of barrels of oil and chemical dispersants into the Gulf of America. Yet, the long-term consequences on sperm whales (*Physeter macrocephalus*) inhabiting the Gulf remain uncertain. Here, we combine bulk-skin isotopic data obtained from free-ranging sperm whales before (n = 71) and after (n = 30) the oil spill to assess potential shifts in habitat use and diet. Our preliminary analyses suggest that whales foraged in the same areas between these two periods, as indicated by a lack of difference in δ13C values, while there appeared to be a potential shift in trophic level, as indicated by significantly higher δ15N values after the oil spill. Isotopic mixing models are being implemented to identify any dietary changes between periods. We will then combine these data with individual amino acids, as well as satellite tracking and diving data from the same individuals. The outcomes of this study have the potential to reveal how sperm whales responded to the oil spill, thereby improving our capacity to predict changes in habitat use related to future environmental disturbances in the Gulf. Doing so can help sharpen conservation actions and inform the mitigation and recovery efforts for current and future acute and chronic stressors that might affect sperm whales directly or indirectly through components of their food web, thereby safeguarding their ecological role for years to come.

Panel Discussion

The session concluded with a panel discussion intermixed with audience questions and answers. Panelists included science and management perspectives from NOAA Fisheries HQ offices and Science Centers: Mridula Srinivasan (SEFSC), Lance Garrison (SEFSC), Nick Farmer (SERO), Dennis Klemm (SERO), Nick Sisson (GARFO), and Brian Stacy (OPR). Topics discussed ranged from communication challenges between scientists and managers to the need for better external messaging that elevates the profile of protected species assessment needs to various stakeholders. The lively discussion reflected a collective effort to improve the management and conservation of protected species under NOAA Fisheries jurisdiction, especially in the face of increasing marine development and environmental conditions. Some of the main themes during the panel discussion are discussed in more detail below.

Science and Management Communication
The panel discussed challenges in communication between science and management noting that timelines of scientific product delivery are a key challenge when facing regulatory deadlines. The need for long-term datasets and data availability for effective management was also discussed.

Collaboration
The panel also highlighted the value of cross-regional sharing and socialization of the work that different regions are focusing on. Others highlighted the need for increased collaboration with ecosystem level research and management to ensure that protected species are included in broader NOAA Fisheries ecosystem-based science and management efforts. The panel also highlighted the need for better collaboration between the stock assessment community and the protected species community in sharing methodologies and data that could enhance the understanding of species interactions and improve management strategies. Participants noted that collaboration with other NOAA Line Offices and agencies that have common goals and common data needs will leverage resources and expertise and enhance data collection and research capabilities.

Improving Messaging to Encourage Funding
Panelists and audience members all agreed that funding is the greatest limiting factor in most protected species research. Better messaging is needed to relay the importance of protected species research to the broader public, potential partners, and other stakeholders and decision-makers (e.g., Congress). Panelists also noted that cross-disciplinary approaches are needed to address funding limitations. This will ultimately help with the current state funding constraints that limit the ability for researchers and managers to be proactive rather than reactive to data needs.

Integration and Assessing Impacts
Several panel and audience members highlighted the need for better integration between restoration planning, monitoring, and assessments. The discussion also included how to determine cause and effect relationships between development and changes in species abundance, distribution, and behavior. Baseline data prior to development are critical to detecting and assessing if and how species are impacted. This is especially true with long-term datasets as these are crucial for assessing impacts from industries like aquaculture and wind energy. Otherwise, it is sometimes difficult to tease out impacts from DWH versus natural variability. Ongoing assessments are needed to continue to assess injuries from DWH and mitigate impacts well into the future.

Modeling Impacts
Audience members had questions about how to incorporate and communicate uncertainty in assessment and impact models. Models should clearly articulate the levels of uncertainty, which will help those making informed decisions and manage expectations at the same time. Models that integrate multiple stressors affecting protected species are essential for understanding cumulative impacts on species and inform restoration efforts. Participants also discussed the ideal survey periods and integration of multiple studies to develop trend data and populate spatial density models. Marine spatial planning for increased development activities was mentioned as a successful collaborative modeling effort. Panelists encouraged a more proactive approach to marine spatial planning in regions with anticipated industrial development.

Advanced Technology
Many on the panel and in the audience noted that the use of advanced technology, such as video cameras and machine learning, will enhance data collection efforts and could lead to more efficient monitoring and assessment processes.

Main Workshop Poster Session

Chair: *Julie Schuerer (AKRO)*

Session Summary

The poster session was open to presentations on any topic related to protected species assessments, including topics covered during individual sessions. Students were especially encouraged to participate in the poster session, and a number of posters were authored or co-authored by NOAA Fisheries interns and scholars. Posters were displayed throughout the entire main workshop, and designated poster presentation times allowed authors to

interact with and answer questions from other workshop participants. Poster presentations covered a wide variety of protected species research and conservation topics including using passive acoustics to assess protected species locations and behaviors; NOAA Fisheries National Seabird Program 5-Year Strategy; modeling detection of Rice's whale calls; national and international efforts to monitor and restore coral reef populations; using acoustic telemetry to inform smalltooth sawfish ecology and commercial fisheries bycatch risk; foraging ecology of common dolphins determined through bycatch specimens; use of eDNA to measure marine vertebrate diversity and the presence of rare marine mammal species; fine-scale population genetics of common bottlenose dolphins; trends in U.S. commercial fisheries bycatch and solutions to global bycatch problems; and visualizing changes in distributions through the NOAA Fisheries Distribution Mapping and Analysis Portal (DisMAP).

Session Abstracts

Assessing patterns of courtship at suspected grouper spawning aggregations using passive acoustics

Zoie Bright[1] and Tim Rowell[2]

[1]Hollings Scholar at NOAA Fisheries NEFSC, [2]NOAA Fisheries NEFSC

Understanding the spatial and temporal dynamics of grouper spawning aggregations allows for the identification of periods of reproduction, vulnerability, and management priority. Within transient aggregations, regional populations are confined to a small area, which may increase the probability of incidental fishing mortality and disruptions to spawning behaviors and output. As many species of groupers produce courtship-associated sounds when aggregated, passive acoustic data collected from December 2021 to February 2022 at Western Dry Rocks in Florida Keys National Marine Sanctuary were analyzed to identify sounds produced by black (*Mycteroperca bonaci*), Nassau (*Epinephelus striatus*), and red grouper (*E. morio*) and infer potential spawning activity. Spectrograms were manually reviewed, and targeted sounds, for example, courtship, non-courtship, non-target species, and vessels, were noted. Grouper sounds were present throughout the dataset, but there were increases in the prevalence of courtship-associated sounds around the full moon in the months analyzed, suggesting that the site supports multi-species grouper spawning aggregations during these periods. Vessels were present throughout the study, further indicating possible negative interactions between aggregated fishes and fishers despite current regulations that permit fishers to catch and release grouper during spawning periods. Additional work should be conducted to further investigate the entire

spawning season and corroborate reproductive activity at the site with ancillary methods. Given the importance of grouper to the ecological and economic stability in the Florida Keys coupled with overlap in vessel activity, additional management options should be considered to ensure that undisrupted spawning can be maximized to sustain grouper populations in the region.

NOAA Fisheries National Seabird Program: 5-Year Strategic Plan update

Annette Henry[1], Lee Benaka[2], Joan Browder[3], Shannon Fitzgerald[4], Tom Good[5], Trevor Joyce[6], Mi Ae Kim[7], and Ryan Silva[8]

[1]NOAA Fisheries SWFSC, National Seabird Program, [2]NOAA Fisheries OST, [3]NOAA Fisheries SEFSC, [4]NOAA Fisheries AFSC, [5]NOAA Fisheries NWFSC, [6]Ocean Associates-SWFSC, [7]NOAA Fisheries Office of International Affairs, Trade, and Commerce, [8]NOAA Fisheries GARFO

NOAA Fisheries National Seabird Program (NSP) is a cross-cutting group of managers and scientists who work domestically and internationally to protect and conserve seabirds. Our activities are guided by statutes and emerging agency policies and priorities that form the basis for NSP's two overarching goals: (1) monitor and mitigate bycatch and (2) promote seabirds as ecosystem indicators. The NSP produced a 5-year Strategic Plan, covering years 2020–2024 based on input from NSP representatives, as well as NOAA's National Ocean Service, U.S. Fish and Wildlife Service, Bureau of Ocean Energy Management, and regional fishery management councils. The Plan has the following five strategic goals:

1. Monitor and estimate seabird bycatch
2. Mitigate seabird bycatch
3. Strengthen key partnerships
4. Promote seabirds in advancing ecosystem-based fisheries management
5. Elevate awareness of and support for the NSP

A steering committee formed in 2020 to implement the Plan has made significant progress toward defining and implementing actions toward the Plan's goals and milestones. This includes following up on new ideas, tracking current projects, collaborating with Federal and State agencies and nongovernmental organization groups, and maintaining a strong leadership role in international seabird conservation, especially with bycatch. As we complete the third year of the Plan, the steering committee continues to identify issues pertaining to the conservation of seabirds and advancing best practices to minimize seabird bycatch. We are also looking ahead to a new 5-year strategic plan to guide the work of the NSP beyond 2024.

Quantifying detection areas of Rice's whale calls in the Gulf of America using sound

propagation modeling

Ashley Cook[1], Michael Brown[1], Melissa Soldevilla[2], Ludovic Tenorio[1], and Heloise Frouin-Mouy[3]

[1]CIMAS, University of Miami RSMAS at NOAA Fisheries SEFSC, [2]NOAA Fisheries SEFSC, [3]Cooperative Programs for the Advancement of Earth System Science, University Corporation for Atmospheric Research at NOAA Fisheries SEFSC

Rice's whales (*Balaenoptera ricei*) are one of the most endangered species with fewer than 100 individuals in their population and a habitat primarily limited to the northeastern Gulf of America. Understanding how they occupy this core habitat throughout the year is crucial to develop recovery actions for their conservation, and fixed passive acoustic monitoring methods are an ideal way to monitor whale occurrence year-round. In 2021, passive acoustic monitoring was extended from 1 site to 18 sites that nearly cover the animals' core habitat to improve understanding of variability in call occurrence and seasonality throughout this area. Ambient noise levels and sound propagation conditions in the ocean vary over time and space, and this variability in the acoustic environment greatly affects the detectability of marine mammal vocalizations. Therefore, to ensure accurate assessment of Rice's whale call occurrence and seasonality across sites, site-specific and time-varying environmental effects must be quantified to account for varying detection areas over space and time. In this study, the open-source parabolic equation acoustic propagation model is used to model transmission loss of Rice's whale long-moan calls and downsweep pulse sequences as a function of range and depth at 15-degree intervals around each recorder in the 18-element array. Relative detection areas are estimated monthly at each site by combining transmission loss, source level data, and ambient noise levels to account for variability in probability of detection throughout the array from May 2021 to May 2022. This information will enhance assessment capabilities and fill in data gaps for the Rice's whale.

International partnership for the restoration of coral reefs in the Arrecife de Puerto Morelos National Park (APMNP), Mexico

Marina Garmendia[1], Claudia Padilla[2], and David Gilliam[1]

[1]Nova Southeastern University, [2]Mexican National Fishing Institute (INAPESCA)

The Mesoamerican Reef (MAR) is the second largest coral reef track in the world. The Arrecife de Puerto Morelos National Park (APMNP) has been a MAR marine protected area

in Mexico since 1998 and includes over 20 kilometers of coral reef. This study aims to address stony coral decline in APMNP by implementing a coral restoration project using micro-fragmentation techniques. Micro-fragmentation is a recently developed practice consisting of cutting whole coral colonies into ~2 centimeter fragments, which optimizes growth, increases genetic diversity, and facilitates reproduction. Colonies from *Montastraea cavernosa*, *Orbicella faveolata,* and *Orbicella annularis* will be collected in APMNP. These three slow-growing species were greatly impacted by the Stony Coral Tissue Loss Disease (SCTLD) outbreak first reported in the summer of 2018 in the Mexican Caribbean. Collected colonies were micro-fragmented using a diamond band saw and glued onto plugs, for a total of 1440 micro-fragments. Fragments were outplanted into 6 reef sites previously affected by SCTLD using cement bases. Overall survival, growth, and health conditions (predation/disease) will be compared between species and sites. This project is a partnership with Coralisma, a non-profit organization dedicated to the restoration, preservation, and education of coral reefs in the Riviera Maya, the Mexican National Fishing Institute (INAPESCA), and the Coral Reef Restoration Assessment and Monitoring Laboratory (CRRAM) Nova Southeastern University. The goals of this partnership are to promote the exchange of ideas, evaluate the efficacy of micro-fragmentation in the MAR, and to increase the abundance of reef building species as part of restoration efforts.

Using passive acoustics to study endangered baleen whales off the coast of Senegal

Cullen Hauck[1], Danielle Cholewiak[2], and Salvatore Cerchio[3]

[1]Hollings Scholar at NOAA Fisheries NEFSC, [2]NOAA Fisheries NEFSC, [3]African Aquatic Conservation Fund

Marine mammals use vocalization as a primary means of interacting with their environment and engaging in social activities such as foraging, intra-group communication, and courtship. Passive acoustic monitoring enables us to study these behaviors as well as species occurrence and distribution using sound received on stationary receivers. Recently, a new monitoring program was initiated in the eastern North Atlantic off the coast of Senegal, an area that may include humpback whales (*Megaptera novaeangliae*) from the endangered Cape Verde/West Africa distinct population segment. Using six months of recordings taken from receivers deployed at the head of the Dakar Canyon, this study seeks to document the distribution of humpback whales and the other baleen whale species in this ecologically critical habitat. Acoustic data were auditorily and visually analyzed in Raven Pro version 1.6.3 using spectrograms showing frequency (0.0 to 500.0 Hz) and

amplitude on a temporal scale. Characteristic vocalization signals were identified from prior studies and published literature. The cetacean species that were readily identifiable in the first dataset spanning early June to early November 2021 included humpback, sperm (*Physeter macrocephalus*), blue (*Balaenoptera musculus*), and killer whales (*Orcinus orca*). Furthermore, the presence of other cetacean signals, including possible Omura's (*Balaenoptera omurai*) and Bryde's (*Balaenoptera brydei*) whale song, and unidentified small odontocete signals suggest that species diversity exceeds what our current findings reveal. These results stress the importance of West Africa as habitat for large whale species while also emphasizing the need for more exhaustive studies documenting cetacean stock structure and distribution in the region.

Advances in acoustic telemetry informs on habitat use, movement ecology, and commercial fisheries bycatch risk of endangered smalltooth sawfish

Andrea Kroetz[1], Dean Grubbs[2], and John Carlson[3]

[1]CIMAS, University of Miami RSMAS at NOAA Fisheries SEFSC, [2]Florida State University Coastal and Marine Laboratory, [3]NOAA Fisheries SEFSC

At the time of ESA listing in 2003, little was known about smalltooth sawfish ontogenetic shifts in habitat use and movement ecology. Critical Habitat was designated for small juvenile sawfish (<2 meters total length); however, it remains to be identified and is a recovery priority for larger juveniles (>2 meters) and adults (>3.4 meters). Additionally, an accurate assessment of habitat use and any threats associated with the areas they inhabit is needed for all life stages. Acoustic telemetry is a novel way to collect long-term data and has provided fine-scale movement data of small juveniles, indicating that they migrate over greater distances than previously documented. Large-scale migrations up both Florida coasts have been observed in larger sawfish, and high-use habitats have been identified with potential Critical Habitat implications. Additionally, this technology has allowed for the identification of potential bycatch risk in the shrimp trawling commercial fishery, which has management implications. Acoustic telemetry has significantly improved what we know about sawfish movement and habitat use across life stages and has aided in the identification of threats associated with high-use areas of this endangered species. This presentation addresses the session theme that acoustic telemetry is a tool being used to address and fill data gaps in monitoring relative abundance, distribution, and habitat use of smalltooth sawfish that has and will continue to inform on key science, management questions, and recovery of the species.

Monitoring and restoration of ESA-listed coral species on Florida reefs

Mark Ladd[1], Dana Williams[2], Allan Bright[2], Kathryn Grazioso[2], Dylan Orcutt[2], and Sophia Ippolito[2]

[1]NOAA Fisheries SEFSC, [2]CIMAS, University of Miami RSMAS at NOAA Fisheries SEFSC

The Coral Research and Assessment Lab has been monitoring the population of *Acropora palmata* in the Upper Florida Keys since 2004. The main goals of our monitoring program are to (1) quantify changes in the population of *A. palmata*, (2) identify drivers of population trends, and (3) provide information to inform management on relevant timescales. Here, we document declines in the abundance and genotypic diversity of Florida's *Acropora palmata* population captured by our long-term monitoring program in the Upper Florida Keys and the biotic and abiotic drivers behind these dynamics. Next, we focus on our field-based research geared toward supporting the restoration of Endangered Species Act (ESA)-listed and other protected coral species, including results from field experiments testing the role of colony density, arrangement, and genotypic diversity on the growth and survival of outplanted *A. palmata* colonies. Lastly, we showcase our coral spawning work that generates unique genotypes of numerous protected coral species to support population recovery initiatives and allows us to conduct research using our new land-based experimental tank systems.

Foraging ecology of common dolphins (*Delphinus delphis*) in the Northwest Atlantic

Alexander Reulbach[1] and Frederick Wenzel[2]

[1]Hollings Scholar at NOAA Fisheries NEFSC, [2]NOAA Fisheries NEFSC

Despite the protected status and importance of the common dolphin (*Delphinus delphis*) as a marine predator within the Northwest Atlantic, its foraging ecology is still poorly understood. Common dolphins in this region have historically been located in offshore waters, but warmer water temperatures due to climate change have allowed for an expansion of their range into inshore waters. The present study utilized hard part analysis from the contents of 36 bycaught common dolphin stomach samples, collected over 28 years (1993–2021), to obtain a greater understanding of their foraging ecology in the region. Depending on where the stomach samples were obtained, they were categorized as either inshore (n = 20) or offshore (n = 16). This division was essential in understanding how differences in habitat result in differences in foraging ecology. Stomach content analysis indicates that cephalopods and small fish species, including silver hake and Atlantic butterfish, dominate the inshore diet. Myctophids, including Madeira's lanternfish and Bermuda lanternfish, dominate the offshore diet. A wide range of prey species was

found within the stomach samples at both the inshore (n = 17) and offshore (n = 15) locations. The significant difference in foraging ecology between locations and the large variety of prey species consumed at both locations suggests that common dolphins are opportunistic predators. Common dolphin foraging ecology is dictated by variation in the regional composition of abundant prey species. These results allow for targeted management of important prey species to ensure better protection of the common dolphin within the Northwest Atlantic.

Using eDNA to measure marine vertebrate diversity from Cape Cod to Cape Hatteras USA

Emily Speciale[1], Michael Jech[2], Yuan Liu[2], and Richard McBride[2]

[1]Hollings Scholar at NOAA Fisheries NEFSC, [2]NOAA Fisheries NEFSC

Environmental DNA (eDNA) metabarcoding is a novel approach for assessing biodiversity in marine habitats. How much water to collect for eDNA sampling is a fundamental methodological question that may have significant implications for balancing the identification of all taxa in the sample with the cost/time of filtrating and preparing the sample. In this study, we identified an optimal filtration volume for Niskin bottle sampling when filtering seawater for eDNA multiple species detections using common eDNA mitochondrial markers. Samples were collected from the NOAA Research Vessel Gordon Gunter in fall 2019, which surveyed the continental shelf and slope habitats from North Carolina to Massachusetts. eDNA samples of 1, 2, and 3 L were filtered from various locations at multiple depths. Significant differences in species richness (SR) were found between paired samples of 1 and 2 L ($p = 0.00055$) and 2 and 3 L ($p = 0.0095$). Although SR increased with increased sampling volume from 1 to 3 L, average filtration time also increased, leading us to choose 2 L as the optimal sampling volume. Using 2 L samples, we found that SR and species evenness were significantly correlated to relative depth, with higher SR and Shannon–Wiener indices near the seabed ($p = 0.0017$; $p = 0.0025$). SR was also significantly correlated to longitude, with SR decreasing further from the coastline ($p = 0.0055$). Furthermore, several protected marine mammals were detected, including three species of baleen whales, at least six species of toothed whales, and two species of seals.

Examining fine-scale population genetic structure of common bottlenose dolphins (*Tursiops truncatus*) in North Carolina using next-generation RAD-seq data

Nicole Vollmer[1], Lynsey Wilcox[2], Antoinette Gorgone[1], Aleta Hohn[1], Andrew Read[3], Eric Zolman[4], and Patricia Rosel[2]

[1]CIMAS, University of Miami RSMAS at NOAA Fisheries SEFSC, [2]NOAA Fisheries SEFSC, [3]Duke University Marine Laboratory, [4]National Marine Mammal Foundation

In the waters of North Carolina on the U.S. east coast, four management stocks of common bottlenose dolphins (*Tursiops truncatus*) occur, with delineations largely based on photo-identification and satellite telemetry data. Two stocks remain primarily within estuarine habitats throughout the year, and two inhabit coastal waters and are thought to make broadscale migratory movements in and out of state waters. Thus, the spatio-temporal overlap of these four stocks in NC varies seasonally, creating a complicated stock structure where boundaries are difficult to identify, and the demographic independence among populations is not well-understood. Furthermore, incidental mortality and serious injury of dolphins occurs in some fisheries in NC, but the spatio-temporal overlap makes it difficult to assign mortalities and characterize their impact on each stock. Using biopsy samples from 142 individuals, the genetic population structure of dolphins in these waters was investigated using next-generation molecular sequencing techniques and a reference genome-based alignment. Using a highly informative dataset containing over 6,000 single nucleotide polymorphism markers, Bayesian structure analysis identified four significantly differentiated populations (overall Fixation Index (FST) = 0.03, $p < 0.0001$). However, the distributions of these populations do not align well with the currently delineated stocks, and genetic data support the presence of three populations in estuarine waters of NC. An improved understanding of the underlying population structure of common bottlenose dolphins in these waters will provide a better characterization of stock distribution and support more accurate assignment of mortality, which is imperative for successful conservation and management of this species.

Environmental DNA assay for detection of the rare Rice's whale in the Gulf of America

Lynsey Wilcox[1], Nicole Vollmer[2], Laura Aichinger Dias[1], Anthony Martinez[1], and Patricia Rosel[1]

[1]NOAA Fisheries SEFSC, [2]CIMAS, University of Miami, RSMAS

Rice's whales (*Balaenoptera ricei*) are the only resident baleen whale species in the Gulf of America. Most sightings of this whale are in the northeastern Gulf within its core habitat; however, historical whaling records suggest that they may have inhabited the north-central Gulf, and recent acoustic and visual observation data have detected this species' presence in the northwestern Gulf. Noninvasive molecular techniques have been successfully developed to detect the presence/absence of other marine species through the use of environmental DNA (eDNA). We therefore evaluated the use of eDNA to detect this rare

species to better understand its distribution in the Gulf. We developed and validated a quantitative polymerase chain reaction (qPCR) assay targeting the Rice's whale mitochondrial DNA control region to detect eDNA shed by the whales. Seawater samples collected in or near whale "flukeprints" were positive for Rice's whale eDNA, while control water samples were negative, illustrating the efficacy of the new assay. Using this novel assay, we were also able to compare and optimize various eDNA collection methods such as filter pore size and time of collection. These data will help to refine and improve eDNA collection techniques in the laboratory and field for many marine mammal species. Future eDNA work on Rice's whales, including combining the newly developed qPCR assay with seawater sampling outside the Rice's whale core habitat, will improve our understanding of the distribution and habitat use of this endangered and elusive species.

Analyzing trends in U.S. commercial fisheries bycatch and evaluating solutions to global bycatch problems

Andrea Chan[1] and Lee Benaka[2]

[1]ECS Federal in support of NOAA Fisheries OST, [2]NOAA Fisheries OST

Sustainable fisheries management requires that the bycatch of fish and protected species be estimated, tracked, and minimized to the extent practicable. In U.S. commercial fisheries, data on levels of bycatch or the discarded catch of any living marine resource is primarily collected by independent fisheries observers on a portion of total fishing trips. NOAA Fisheries is responsible for ensuring adequate data collection for priority bycatch species and producing bycatch estimates using the best scientific information available. In 2011, NOAA Fisheries published the first edition of the U.S. National Bycatch Report, which contained bycatch estimates for fish and protected species by region (using 2005 data), descriptions of bycatch estimation methods, and quality control metrics. The authors of this report recommended that the agency monitor bycatch trends over time for key fish and protected species groups (which may be stocks, populations, species, or aggregations of multiple species) that have high bycatch levels, of special importance to management, and/or have stock status concerns (e.g., all endangered species). While updated bycatch estimates for some of these key stocks have been published regionally or as part of subsequent editions of the National Bycatch Report (including data collected up until 2015), a bycatch trend analysis to demonstrate how well the agency is currently meeting bycatch reduction goals on a national scale is outstanding. In this analysis, bycatch data time series were designated as increasing, stable, or decreasing for key fish, elasmobranch, marine mammal, sea turtle, and seabird stocks from all regions of the U.S. The effectiveness of bycatch reduction measures is also assessed, where appropriate. Lessons learned from successful reductions in bycatch are discussed, and applicability toward the remaining high

bycatch stocks in the U.S. and internationally is evaluated.

NOAA Fisheries Distribution Mapping and Analysis Portal (DisMAP): Visualizing changing distributions

Melissa A. Karp[1], Roger Griffis[1], Patrick Lynch[1], Tim Haverland[1], John Kennedy[1], Venkat Sunkara[1], Kevin Craig[2], Elliott Hazen[3], Isaac Kaplan[4], Don Kobayashi[5], Scott Large[6], Wendy Morrison[7], Hassan Moustahfid[8], Malin Pinsky[9], Phoebe Woodworth-Jefcoats[5], and Kristan Blackhart[1]

[1]NOAA Fisheries OST, [2]NOAA Fisheries SEFSC, [3]NOAA Fisheries SWFSC, [4]NOAA Fisheries NWFSC, [5]NOAA Fisheries PIFSC, [6]NOAA Fisheries NEFSC, [7]NOAA Fisheries Office of Sustainable Fisheries, [8]NOAA/US Integrated Ocean Observing System, [9]Rutgers University

Marine species are moving in response to climate change, with the impacts reaching far beyond the individual species moving to affect entire ecosystems, fisheries interactions, and coastal economies. Robust information on past, current, and expected future distributions of marine species is critical for effective ecosystem-based management and decision-making in all ocean use sectors. In general, information on species distributions is dispersed across multiple sources and regions and therefore not easily accessible across fisheries governance boundaries. In response to this need, in 2022 NOAA Fisheries launched a new state-of-the-art mapping portal to consolidate information on species distributions into one easily accessible, interactive portal called the Distribution Mapping and Analysis Portal (DisMAP). The current version of the portal displays data from fishery-independent surveys for six U.S. regions (Northeast, Southeast, Gulf of America, West Coast, Hawaii, and Alaska) and includes a map viewer and graphing capabilities to explore the distributions of over 900 marine fish and invertebrate species caught during the surveys. The portal is being developed in phases, with plans for future releases to include additional data types, model outputs, and functionalities. The interactive website will improve data sharing and collaboration, help fisheries managers and the fishing industry better plan for and respond to changes, and increase overall knowledge of species distributions. User-friendly tools like this play a critical role in decision-making for a climate-ready future.

Main Workshop Conclusions

PSAW III ended with closing remarks from Patrick Lynch (OST) and John Walter (SEFSC). Closing remarks highlighted the impressive cutting-edge science presented at the workshop, synergies between stock assessment and protected species researchers, and the

need to better demonstrate the economic value of protected species, especially in advancing Blue Economies and increasing public and congressional interest in protected species. Remarks highlighted the ongoing transition of advanced technologies from research to operations, which will benefit protected species research and management.

The steering committee along with many other volunteers were thanked for their efforts in organizing and running the workshop.

Participants commented on the collegial atmosphere of the in-person workshop that allowed individuals to interact directly with colleagues and peers across Science Centers and regions. Many participants came away with new contacts and potential collaborations.

Because of time constraints, participants were informed that they would receive a post-workshop survey to provide feedback on the workshop themes and organization and make recommendations for future PSAWs. Results from the surveys indicate that attendees had a pleasant experience at PSAW III and were satisfied with the overall format. The virtual training sessions were especially popular since they were easy to attend online. Survey responses also encouraged the continuation of training at future PSAWs. Almost all indicated that they greatly benefited from the knowledge exchanged at PSAW and looked forward to attending another PSAW in the future.

Appendix 1: Steering Committee Members

- Erin McMichael, Lead Workshop Coordinator, ECS Federal supporting OST (Co-Chair Student Outreach Half-Day and Session 4)
- Lesley Stokes, SEFSC (Co-Chair Student Outreach Half-Day and Session 4)
- Genevieve Davis, NEFSC (Chair Session 1)
- Alex Curtis, SWFSC (Co-Chair Session 3)
- Chris Jordan, NWFSC (Co-Chair Session 3)
- Nancy Friday, AFSC (Co-Chair Session 2)
- Caroline Good, OPR (Co-Chair Session 2)
- Julie Scheurer, AKRO (Co-Chair Session 1, Chair Poster Session)

Appendix 2: Workshop Agenda

Tuesday, March 28th - Student Outreach Half-Day
Introduction to Protected Species Assessments and Student Opportunities at NOAA Fisheries

1:00 - 1:20 pm	**Welcome Remarks** *Lesley Stokes (SEFSC, Marine Mammal Turtle Division (MMTD), Research Fisheries Biologist)* *Jeremy Kiszka (FIU, Assistant Professor, Department of Biological Sciences)*
1:20 - 1:40 pm	**Introduction to Protected Species Assessments** *Eric Patterson (on detail to OST, Assessment & Monitoring Division, Acting Assessment Branch Chief, Permanent Position: OPR, Marine Mammal and Sea Turtle Conservation Division, Cetacean and Pinniped Conservation Lead)*
1:40 - 3:15 pm	**Student Opportunities at NOAA Fisheries & Resume Tips**
3:15 - 3:25 pm	**My Experience as a Hollings Scholar** *Emily Speciale (NEFSC)*
3:30 - 3:45 pm	**Break**
3:45 - 4:45 pm	**Panel/Round Table Discussion with NOAA Fisheries Experts** *Jenny Litz (SEFSC, MMTD, Marine Mammal Branch Chief)* *Joe Pfaller (SEFSC, MMTD, Turtle Branch Chief)* *Kristan Blackhart (OST, National [Fish] Stock Assessment Program Lead)* *Genevieve Davis (NEFSC, Passive Acoustic Research Group, Research Acoustician)* *Alex Curtis (NWFSC, MMTD, Research Biologist)* *Cullen Hauck (NEFSC - Hollings Scholar)* *Emily Speciale (NEFSC - Hollings Scholar)* *Yvonne Barkley (CIMAR at PIFSC, Cetacean Research Program, Cetacean Acoustics Researcher)*
4:45 pm	**Closing Remarks**
5:00 pm	**Adjourn**

Wednesday, March 29th - Day 1 (Main Workshop)

8:00 - 8:30 am	**Registration & Poster Set-Up**
8:30 - 8:35 am	**Welcome Remarks, SEFSC** *Mridula Srinivasan (Director, SEFSC MMTD)*
8:35 - 8:45 am	**Opening Remarks - SEFSC** *Clay Porch (Director, SEFSC)*
8:45 - 8:55 am	**Opening Remarks - OST** *Evan Howell (Director, OST)*
8:55 - 9:25 am	**Keynote Speaker** **Ved Chirayath, Ph.D**. *Associate Professor, UM RSMAS, Department of Ocean Sciences, Aircraft Center for Earth Studies*
Session 1: Novel Data Types - 'Omics and Acoustics	
9:25 - 9:30 am	**Session Remarks** *Co-Chairs: Genevieve Davis (NEFSC), Julie Scheurer (ARO)*
9:30 - 9:45 am	Integrating environmental DNA tools into protected species management *Nicole Phillips (University of Southern Mississippi)*
9:45 - 10:00 am	From the common to the rare with environmental DNA: eDNA for marine assessments of hake, whales, and corals *Krista Nichols (NWFSC)*
10:00 - 10:15 am	Acoustic localization of false killer whale (*Pseudorca crassidens*) subgroups in the Hawai'ian archipelago *Pina Gruden (Cooperative Institute for Marine and Atmospheric Research, Research Corporation of the University of Hawai'i)*
10:15 - 10:30 am	Modeling sperm whale distribution using visual and passive acoustic data *Yvonne Barkley (Cooperative Institute for Marine and Atmospheric Research, Research Corporation of the University of Hawai'i at PIFSC)*
10:30 - 10:45 am	**Break**
10:45 - 11:00 am	Using a deep neural network to classify echolocation clicks and identify biogeographic patterns of Pacific white-sided dolphins *Michaela Alksne (Scripps Institution of Oceanography)*
11:00 - 11:15 am	Passive acoustic monitoring for stock assessment: Rice's whales in the Gulf of America

	Melissa Soldevilla (SEFSC)
11:15 - 11:30 am	An interactive machine learning toolkit for classifying impulsive signals in passive acoustic recordings *Melissa Soldevilla (SEFSC)*
11:30 -11:45 am	Passive acoustic localization and tracking of Rice's whales (*Balaenoptera ricei*) in the northeastern Gulf of America *Ludovic Tenorio-Hallé (Cooperative Institute for Marine and Atmospheric Studies, University of Miami RSMAS at SEFSC)*
11:30 -11:45 am	Diving behavior of beaked whales in the Gulf of America inferred from three-dimensional acoustic tracking using near-seafloor sensors *Héloïse Frouin-Mouy (Cooperative Programs for the Advancement of Earth System Science, University Corporation for Atmospheric Research at SEFSC)*
11:45 - 12:15 pm	**Discussion: 'Omics & Acoustics**
12:45 - 2:15 pm	**Lunch** (In-House), **Poster Session** (1:45-2:15pm)
Session 2: Climate Change Impacts on Protected Species Assessments	
2:15 - 2:20 pm	**Session Remarks** *Co-Chairs: Caroline Good (OPR), Nancy Friday (AFSC)*
2:20 - 2:40 pm	Update on the Protected Resources Climate Initiative *Shannon Bettridge (OPR)*
2:40 - 2:55 pm	NOAA Climate, Ecosystems, and Fisheries Initiative (CEFI) Update *Kirsten Holsman (AFSC)*
2:55 - 3:10 pm	Incorporating environmental factors and climate into fish stock assessments *Kristan Blackhart (OST)*
3:10 - 3:25 pm	Marine mammal and sea turtle climate vulnerability assessments within research and management frameworks *Matthew Lettrich (ECS Federal in support of OST)*
3:25 - 3:45 pm	**Break**
3:45 - 5:00 pm	**Panel Discussion** *Shannon Bettridge, Dori Dick (OPR)* *Matthew Lettrich (ECS Federal - OST)* *Kirsten Holsman, Paul Conn, Brett McClintock (AFSC)* *Chris Sasso (SEFSC)* *Evan Howell (OST)*

5:00 -5:30 pm	**Wrap Up - Day 1 & Adjourn**

Thursday, March 30th - Day 2 (Main Workshop)

8:00 - 8:05 am	**Updates & Logistics**
8:05 -8:35 am	**Keynote Speaker** **Michael Heithaus, Ph.D.** *Executive Dean of the College of Arts, Sciences & Education, Professor* *Department of Biology, FIU*
Session 3: New Analytical Approaches to Abundance and Risk Assessment of Marine Protected Species	
8:35 - 8:40 am	**Session Remarks** *Co-Chairs: K. Alexandra Curtis (SWFSC), Chris Jordan (NWFSC)*
8:40 - 9:10 am	**Plenary Speaker** NOAA Fisheries Open Science and the 2023 Year of Open Science (YOOS23) *Eli Holmes (NWFSC)*
9:10 - 9:25 am	Using the NOAA Fisheries Integrated Toolbox to advance open science for protected species *Kathryn Doering (OST)*
9:25 - 9:40 am	Forecasting bycatch hotspots using multivariate random forest machine learning *Kelly Soluri (University of Miami)*
9:40 - 9:55 am	Life history and climate change matter *Joan Browder (SEFSC)*
9:55 - 10:10 am	Management strategy evaluation (MSE) for protected species *Cassidy Peterson (SEFSC)*
10:10 - 10:25 am	A one-dimensional spatial capture–recapture model to estimate abundance of a coastally distributed population *K. Alexandra Curtis (SWFSC)*
10:25 - 10:40 am	**Break**
10:40 - 10:55 am	Incorporating telemetry data into mark–recapture analysis: case study of false killer whale (*Pseudorca crassidens*) abundance estimation in the Main Hawaiʻian Islands *Janelle Badger (PIFSC)*

10:55 - 11:00 am	Series Introduction: Modeling species distributions with diverse data sources: research from AFSC's National Protected Species Toolbox Initiative projects *Paul Conn (AFSC)*
11:00 - 11:15 am	Presentation 1: Integrated modeling of bearded seal densities *Paul Conn (AFSC)*
11:15 - 11:30 am	Presentation 2: The multistate Langevin diffusion: integrating multiple data types for inferring behavior-specific habitat selection and utilization distributions *Brett McClintock (AFSC)*
11:30 -11:45 am	Presentation 3: A computationally flexible approach to population-level inference and data integration *Devin Johnson (PIFSC)*
11:45 am - 12:15 pm	**Discussion: New Analytical Approaches**
12:15 - 1:15 pm	**Lunch** (In-House), **Poster Session** (12:45-1:15pm)
Session 4: Incorporating New and Increasing Impacts from Marine Development	
1:15 - 1:20 pm	**Session Remarks** *Co-Chairs: Lesley Stokes (SEFSC), Erin McMichael (ECS Federal in support of OST)*
1:20 - 1:50 pm	**Plenary Speaker** *Lance Garrison (SEFSC)*
1:50 - 2:10 pm	Modeling protected species distributions and habitats to inform siting and management of pioneering ocean industries *Nicholas Farmer (SERO)*
2:10 - 2:25 pm	Movements of leatherback sea turtles (*Dermochelys coriacea*) suggest new foraging locations and interactions with offshore wind farms along the Atlantic Coast of the United States *Mitchell Rider (University of Miami, RSMAS)*
2:25 - 2:40 pm	Understanding oil spill effects on sea turtles: lessons learned and persistent challenges *Brian Stacy (OPR)*
2:40 - 2:55 pm	Diving deeper into the oil spill: potential shifts in habitat use and foraging ecology of sperm whales after the Deepwater Horizon oil spill *Clarissa Teixeira (Oregon State University)*

2:55 - 3:10 pm	**Break**
3:10 - 4:10 pm	**Panel Discussion** *Mridula Srinivasan, Lance Garrison (SEFSC)* *Nick Farmer, Dennis Klemm (SERO)* *Nick Sisson (GARFO)* *Brian Stacy (OPR)*
4:10 - 5:00 pm	**Wrap Up - Day 2 & PSAW III** **Ideas for PSAW IV in 2025** **Closing Remarks** - *Patrick Lynch (OST), John Walter (SEFSC)* **Adjourn**