Recovering Threatened and Endangered Species

FY 2021–2022
Report to Congress

NOAA FISHERIES

ESA 50

Recovering Threatened and Endangered Species

FY 2021–2022

Report to Congress

National Marine Fisheries Service Mission

NMFS is responsible for the stewardship of the nation's ocean resources and their habitat. We provide vital services for the nation: productive and sustainable fisheries, safe sources of seafood, the recovery and conservation of protected resources, and healthy ecosystems—all backed by sound science and an ecosystem-based approach to management.

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Front cover: Hawaiian monk seal, Coho salmon, and Pacific leatherback sea turtle. Credit: NMFS

Back cover: A Rice's whale (*Balaenoptera ricei*) surfaces in the Gulf of Mexico. Credit: NMFS (Permit #21938)

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List of Acronyms

ADF&G	Alaska Department of Fish and Game
AKBMP	Alaska Beluga Monitoring Program
ASF	Atlantic Salmon Federation
ASTER³	Advanced Sampling and Technology for Extinction Risk Reduction and Recovery
AWA	Alaska Wildlife Alliance
BCRP	Battle Creek Salmon and Steelhead Restoration Project
BIL	Bipartisan Infrastructure Law
BML	Bodega Marine Laboratory
BOEM	Bureau of Ocean Energy Management
CCC	Central California Coast
CDFW	California Department of Fish and Wildlife
COVID-19	Coronavirus Disease 2019
CSAMP	Collaborative Science and Adaptive Management Program
CZU	San Mateo–Santa Cruz Unit
DFO	Fisheries and Oceans Canada
DLNR	Department of Land and Natural Resources
DMA	Dynamic Management Area
DPS	Distinct Population Segment
Dtag	Digital Acoustic Recording Tag
DWR	Department of Water Resources
ECHO	Enhancing Cetacean Habitat and Observation
eDNA	Environmental DNA
EEZ	Exclusive Economic Zone
ePTM	Enhanced Particle Tracking Model
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FR	Federal Register
FY	Fiscal Year
HMAR	Hawai'i Marine Animal Response
HMSRP	Hawaiian Monk Seal Research Program
IATTC	Inter-American Tropical Tuna Commission
ICES	International Council for the Exploration of the Sea
KPC	Kenai Peninsula College
MADMF	Commonwealth of Massachusetts' Division of Marine Fisheries
MMPA	Marine Mammal Protection Act
MPA	Marine Protected Area
NASCO	North Atlantic Salmon Conservation Organization
NCCP	North Coast Coho Project
NEFSC	Northeast Fisheries Science Center
NEIT	Northeast Implementation Team
NFWF	National Fish and Wildlife Foundation
NGO	Non-Governmental Organization
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NWFSC	Northwest Fisheries Science Center
NWHI	Northwestern Hawaiian Islands
PET	Population Evaluation Tool
PG&E	Pacific Gas and Electric Company
PIFSC	Pacific Islands Fisheries Science Center
PIRO	Pacific Islands Regional Office
PMRG	Paua Marine Research Group
PSAT	Pop-up Satellite Archival Tag
Reclamation	U.S. Bureau of Reclamation
RFMO	Regional Fisheries Management Organization
ROV	Remotely Operated Vehicle
SCUBA	Self-Contained Underwater Breathing Apparatus
SEIT	Southeast Implementation Team
SHA	Safe Harbor Agreement
SHARE	Salmon Habitat and River Enhancement
SHaRP	Salmonid Habitat Restoration Priorities
SMA	Seasonal Management Areas
SWFSC	Southwest Fisheries Science Center
TBF	The Bay Foundation
TCAF	The Cultured Abalone Farm
TLC	Time Lapse Camera
TMMC	The Marine Mammal Center
TNC	The Nature Conservancy
TU	Trout Unlimited
UCSB	University of California Santa Barbara
UME	Unusual Mortality Event
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USMCA	U.S. Mexico Canada Agreement
WCPFC	Western and Central Pacific Fisheries Commission
WCR	West Coast Region
WRLCM	Winter Run Life Cycle Model
WWF	World Wildlife Fund for Nature

Letter from the Assistant Administrator

December 28, 2023, marks the 50th anniversary of the Endangered Species Act. As we celebrate this milestone anniversary throughout this year, I have had many opportunities to reflect on how powerful and effective the ESA has been for conserving species and their habitats. The world is a much different place now than it was when the Act was signed in 1973, and the landscape of threats and challenges facing threatened and endangered species has become increasingly more complex. The ESA has been remarkably effective at preventing the extinction of species and putting many species on the road to recovery. Many of the 160+ marine and anadromous species listed under the ESA would not be here today had it not been for the protections of the Act. I am proud of the work NMFS and our partners do every day to implement this landmark piece of legislation that conserves a diverse array of species such as North Atlantic right whales, salmon, sea turtles, corals, smalltooth sawfish, sturgeon, white abalone, giant manta rays, chambered nautiluses, and many others. All ESA-listed species play integral roles in their ecosystems. Extinction is forever—once species are gone, their ecological, economic, and intrinsic values are lost. I want to express my sincere gratitude to Congress, NMFS staff, and all of our partners for 50 years of dedication to the ESA.

This milestone anniversary is also an opportunity to look ahead to the next 50 years and beyond to prepare for the challenges we will face as we work to secure the future of these species. Climate change is changing our oceans, and will continue to impact ecosystems and species. There is much we still do not know about how these effects will impact protected species conservation and recovery. In 2021, we developed the Protected Resources Climate Change Strategic Framework, which identifies the highest priority management and science needs that will enable us to promote strategies to ensure protected species populations are more adaptable and resilient to climate change. This framework guides the planning and coordination of protected resources management and science activities at the national level, as well as the necessary investments at both the national and regional levels. With this strategic framework guiding our efforts, we can be more effective at coordinating high-priority actions, sustaining momentum to address long-term challenges, and measuring our progress along the way. The framework also allows us to communicate the scope of the challenges facing protected species to both internal and external audiences. In 2022, we established a Protected Resources Climate Change Steering Committee to help move this framework forward and guide the planning and coordination of protected resources climate change activities across the agency.

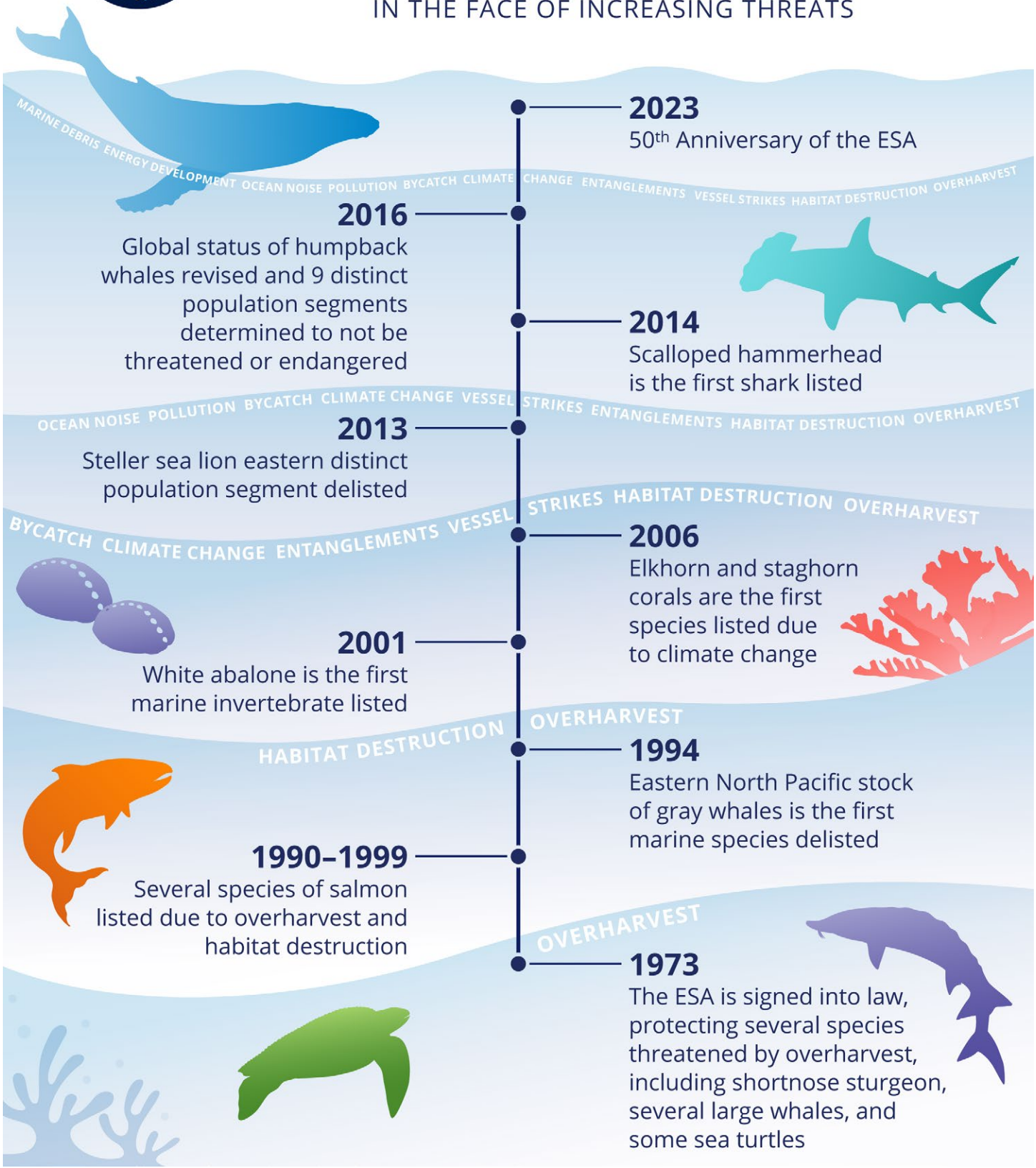
While the threats and challenges facing our species are becoming more complex, technology is also advancing at an unprecedented pace. I am excited about the potential for science-based innovations to expand our toolbox for effectively tackling conservation challenges. In 2023, we launched a new initiative—Advanced Sampling and Technology for Extinction Risk Reduction and Recovery (ASTER[3])—focused on reducing extinction risk and supporting recovery of protected species through technological innovation. New technologies have the potential to minimize some of the threats to species, provide new tools to fill in data gaps, and mitigate our carbon footprint through the use of innovative data collection methods. Artificial intelligence and machine learning can help us process acoustic and visual data to reliably detect the presence of species in near-real-time and inform dynamic management decisions. Uncrewed aircraft systems (also known as drones) can greatly expand our capacity to conduct aerial surveys and capture photos that can help us assess abundance as well as health and body condition of marine species. Multi-spectral and high-resolution satellite imagery can help us identify ice seals in the Arctic and detect whales in the ocean from space. The use of these technologies improves our understanding of how species use their habitats and how those habitats are shifting due to climate change. Additionally, advanced statistical methods, new molecular methods for sampling and analyzing environmental DNA, and new advancements in tagging open the door to more efficient, effective, and better-informed management strategies to recover threatened and endangered species. Through long-term investments in data and technology, we can develop innovative management tools to allow marine species to coexist with human activities in an increasingly complex ocean environment.

In the last biennial report, we highlighted the listing of the Gulf of Mexico Bryde's whale subspecies as endangered under the ESA in 2019, which was subsequently identified in 2021 as a new species, Rice's whale (*Balaenoptera ricei*). With fewer than 100 individuals remaining, Rice's whale is one of the most endangered whales in the world. Since the species was listed, we have learned much more about the threats impacting them, including the chronic effects of acute oil exposure from the *Deepwater Horizon* oil spill in 2010. Since 2010, few calves have been sighted, and there are frequent observations of individual whales in poor body condition. It is likely that the population has been declining since at least 2010. In addition to the long-term effects of oil exposure, we have documented vessel strikes on Rice's whales and we know the species is impacted by marine debris and anthropogenic noise. These threats acting on a very small population with limited distribution increases the Rice's whale's extinction risk. We believe immediate, concerted action can help stabilize this species. Thus, I am announcing its inclusion as a *Species in the Spotlight*. We will develop a 5-year Priority Action Plan for the Rice's whale and report on progress on those priority actions in the next biennial report.

In the face of immense challenges for species such as the Rice's whale, as well as seemingly intractable problems like global climate change, it's important to remember that our actions can make a difference. Our *Species in the Spotlight* profiles later in this report highlight the progress we have made toward stabilizing these endangered species, including how we are planning for climate change impacts and how we are applying advanced technologies to solve management challenges. For example, we have conducted climate change scenario planning for Atlantic salmon, and have started implementing actions to identify climate-resilient habitat for the species. We have also tested the use of environmental DNA to detect the presence of Central California Coast coho salmon and Cook Inlet beluga whale prey species in waters that would otherwise be difficult and costly to survey. Through strategic, coordinated, and innovative management efforts rooted in sound science, we can safeguard the nation's valuable marine resources for another 50 years and beyond.

50 YEARS OF THE ENDANGERED SPECIES ACT

CONSERVING AND PROTECTING SPECIES IN THE FACE OF INCREASING THREATS



2023
50th Anniversary of the ESA

2016
Global status of humpback whales revised and 9 distinct population segments determined to not be threatened or endangered

2014
Scalloped hammerhead is the first shark listed

2013
Steller sea lion eastern distinct population segment delisted

2006
Elkhorn and staghorn corals are the first species listed due to climate change

2001
White abalone is the first marine invertebrate listed

1994
Eastern North Pacific stock of gray whales is the first marine species delisted

1990–1999
Several species of salmon listed due to overharvest and habitat destruction

1973
The ESA is signed into law, protecting several species threatened by overharvest, including shortnose sturgeon, several large whales, and some sea turtles

Giant manta ray. Credit: Joshua Stewart

Background

The primary purpose of the Endangered Species Act (ESA) as amended (16 USC sections 1531–1544) is the conservation of endangered and threatened species and the ecosystems on which they depend. Conservation is defined, in part, as "…the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this [Act] are no longer necessary." As one means of achieving recovery, the ESA requires the development of recovery plans for listed endangered or threatened species (except those species for which it is determined that such a plan will not promote the conservation of the species). Recovery plans organize and guide the recovery process, but are not regulatory documents.

The ESA requires that we monitor recovery progress by conducting a review of the species' status at least once every 5 years to determine, on the basis of such review, whether the species should be reclassified or removed from the List of Threatened and Endangered Species (ESA section 4(c)(2)).

The ESA amendments of 1988 added a requirement that the Secretaries of Commerce and the Interior report to Congress every 2 years on the status of efforts to develop and implement recovery plans, and on the status of all species for which recovery plans have been developed (ESA section 4(f)(3)). The Secretary of Commerce has delegated responsibility for endangered and threatened species recovery to the National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration (NOAA). This is NMFS' 17th Report to Congress on the status of the recovery program for species under its jurisdiction.

Overview

Recovery is the process of restoring listed species to the point they no longer require the protections of the ESA. A recovery plan serves as a road map for species recovery—it lays out where to go and how to get there. Without a plan to organize, coordinate, and prioritize recovery actions, the efforts by so many federal agencies, states, non-governmental organizations (NGOs), tribal entities, stakeholders, and citizens may be inefficient, ineffective, or misdirected. The ESA envisions recovery plans as the central organizing tool guiding each species' progress toward recovery.

This report summarizes efforts to recover all domestic and transnational species[1] under NMFS' jurisdiction in FY 2021–2022 (from October 1, 2020, through September 30, 2022). It includes a summary table (Table 1) providing information such as the status of each species, the status of the recovery plan, and the date the last 5-year review was completed or initiated.

With this report, NMFS also is updating progress made on the *Species in the Spotlight* initiative launched in 2015. The initiative is a strategic approach to endangered species recovery that focuses on species for which immediate, targeted efforts can be taken to stabilize their populations and prevent extinction.

During the 2 years covered in this report, we managed 99 domestic and transnational and 66 foreign marine and anadromous species—including salmon, sturgeon, sawfish, sharks, rays, mollusks, sea turtles, corals, and marine mammals.

During this period, we delisted two species based on new information indicating they do not meet the definition of a species[2] under the ESA and do not qualify for listing:

- The coral species *Siderastrea glynni* listed as endangered on November 6, 2015 (80 FR 60560); delisted on January 31, 2022 (86 FR 74378).[3]
- Johnson's seagrass (*Halophila johnsonii*) listed as threatened on October 14, 1998 (63 FR 49035); delisted on May 16, 2022 (87 FR 22137).[4]

In this report, we address the 99 species for which a recovery plan would promote their conservation.

Between October 1, 2020, and September 30, 2022, of the 99 domestic or transnational listed species for which a recovery plan would promote its conservation, 58 had final recovery plans, 35 plans were in development, and six species recovery plans had not been started.

During this period, the status of the 99 endangered or threatened species for which recovery plans have or will be developed was:

- 23 (23.2%) were stabilized or increasing.
- 13 (13.1%) were declining.
- 22 (22.2%) were mixed, with their status varying by population location.
- 41 (41.4%) were unknown, because we lacked sufficient trend data to make a determination (i.e., the species has fewer than 3 data points over a 10-year period or all available data years to estimate trends).

1 Transnational species are those ESA-listed species with current and/or historical geographical ranges both within the United States, the U.S. exclusive economic zone (EEZ), and/or the high seas, and within the waters or the EEZ of one or more foreign country.
2 The ESA defines a species to include any subspecies of fish or wildlife or plants, and any distinct population segment (DPS) of any species of vertebrate fish or wildlife which interbreeds when mature.
3 *S. glynni* is synonymous with *S. siderea* and is not a separate taxonomic species or subspecies.
4 Johnson's seagrass is not a unique taxon but rather a clone of an Indo-Pacific species, *Halophila ovalis*.

Green sea turtle. Credit: NMFS/Paula Ayotte

A list of the domestic and transnational species managed by NMFS and for which recovery plans would provide a conservation benefit (99 species) is provided in Table 1. For each species/subspecies/evolutionarily significant unit (ESU)[5]/DPS, the table lists the population trend (unknown, decreasing, mixed, stable, or increasing), the recovery priority number,[6] the status of the recovery plan, and the date the last 5-year review was completed or initiated. Additional information on these species is available online at: http://www.fisheries.noaa.gov/species-directory/threatened-endangered.

Recovery plans are available online at: http://www.fisheries.noaa.gov/resources/documents?title=&field_category_document_value%5Brecovery_plan%5D=recovery_plan&sort_by=created

This report is available online via the NMFS Office of Protected Resources website at: https://www.fisheries.noaa.gov/resource/document/recovering-threatened-and-endangered-species-report-congress-fy-2021-2022

5 An ESU is a listable entity under the ESA that is (1) substantially reproductively isolated from other conspecific units and (2) represents an important component of the evolutionary legacy of the species; this is a designation used only for Pacific salmonids (November 20, 1991; 56 FR 58612).

6 The recovery priority number is used to prioritize limited agency resources for recovery plan development and implementation and is assigned based on the application of the Endangered and Threatened Species Listing and Recovery Priority Guidelines (April 30, 2019; 84 FR 18243).

Table 1. ESA-listed Species Under NMFS Jurisdiction

ESA-listed species under NMFS jurisdiction through September 30, 2022, where recovery plans are either complete, in progress, or planned. Information includes the ESA listing status, population trend, recovery priority number, recovery plan status, and date of the most recent 5-year review completion or initiation. (ESA status: T = Threatened; E = Endangered).

Species/Subspecies ESU/DPS	Date Listed/ Reclassified	ESA Status	Trend	Recovery Priority Number[7]	Status of Recovery Plan	Date 5-Year or Status Review Completed/ Initiated[8]
SEA TURTLES						
Hawksbill Sea Turtle	06/1970	E	Mixed	3C	Completed 01/1998 (Pacific); 12/1993 (Atlantic)	Initiated 03/2020
Kemp's Ridley Sea Turtle	12/1970	E	Unknown	1C	Completed 08/1992; Revision Completed 09/2011	Initiated 05/2021
Leatherback Sea Turtle	06/1970	E	Decreasing	3C	Completed 01/1998 (Pacific); 04/1992 (Atlantic)	08/2020
GREEN SEA TURTLE						
Central North Pacific DPS	07/1978; 04/2016	T	Unknown	3C	1978 Listing: Completed 01/1998 (Pacific); 10/1991 (Atlantic); 2016 Listing: Not Started	03/2015
Central West Pacific DPS	07/1978; 04/2016	E	Unknown	3C	1978 Listing: Completed 01/1998 (Pacific); 10/1991 (Atlantic); 2016 Listing: Not Started	03/2015
Central South Pacific DPS	07/1978; 04/2016	E	Unknown	3C	1978 Listing: Completed 01/1998 (Pacific); 10/1991 (Atlantic); 2016 Listing: Not Started	03/2015
South Atlantic DPS	07/1978; 04/2016	T	Mixed	5C	1978 Listing: Completed 01/1998 (Pacific); 10/1991 (Atlantic); 2016 Listing: Not Started	03/2015
East Pacific DPS	07/1978; 04/2016	T	Mixed	5C	1978 Listing: Completed 01/1998 (Pacific); 10/1991 (Atlantic); 2016 Listing: Not Started	03/2015
North Atlantic DPS	07/1978; 04/2016	T	Stable	5C	1978 Listing: Completed 01/1998 (Pacific); 10/1991 (Atlantic); 2016 Listing: Not Started	03/2015

Species/Subspecies ESU/DPS	Date Listed/ Reclassified	ESA Status	Trend	Recovery Priority Number[7]	Status of Recovery Plan	Date 5-Year or Status Review Completed/ Initiated[8]
LOGGERHEAD SEA TURTLE						
Northwest Atlantic Ocean DPS	07/1978; 09/2011	T	Stable	5C	Completed 12/1991; Revision Completed 01/2009	3/2023
North Pacific Ocean DPS	07/1978; 09/2011	E	Unknown	3C	Completed 01/1998; Revision Under Development	04/2020
OLIVE RIDLEY SEA TURTLE						
Breeding colony populations of Pacific coast Mexico	07/1978	E	Stable	5C	Completed 01/1998	06/2014
Rangewide	07/1978	T	Mixed	5C	Completed 01/1998	06/2014
PACIFIC SALMON						
CHINOOK						
Chinook, Puget Sound ESU	03/1999; 06/2005[9]	T	Stable	3C	Completed 01/2007	Initiated 10/2019
Chinook, Lower Columbia River ESU	06/2005[9]	T	Stable	3C	Completed 07/2013	10/2022
Chinook, Upper Columbia River, Spring-run ESU	03/1999; 06/2005[9]	E	Stable	1C	Completed 10/2007	08/2022
Chinook, Snake River Fall-run ESU	04/1992; 06/2005[9]	T	Increasing	5C	Completed 12/2017	08/2022
Chinook, Snake River Spring/ Summer-run ESU	04/1992; 06/2005[9]	T	Stable	3C	Completed 12/2017	08/2022
Chinook, Upper Willamette River ESU	03/1999; 06/2005[9]	T	Decreasing	3C	Completed 08/2011	Initiated 10/2019
Chinook, California Coastal ESU	09/1999; 06/2005[9]	T	Mixed	3C	Completed 10/2016	Initiated 10/2019
Chinook, Central Valley Spring-run ESU	09/1999; 06/2005[9]	T	Decreasing	3C	Completed 07/2014	Initiated 10/2019
Chinook, Sacramento River Winter-run ESU	11/1990; 1/1994[10], 06/2005[9]	E	Decreasing	1C	Completed 07/2014	Initiated 10/2019
CHUM						
Chum, Hood Canal Summer-run ESU	03/1999; 06/2005[9]	T	Increasing	3C	Completed 05/2007	Initiated 10/2019
Chum, Columbia River ESU	03/1999; 06/2005[9]	T	Stable	3C	Completed 07/2013	10/2022

Species/Subspecies ESU/DPS	Date Listed/ Reclassified	ESA Status	Trend	Recovery Priority Number[7]	Status of Recovery Plan	Date 5-Year or Status Review Completed/ Initiated[8]
COHO						
Coho, Lower Columbia River ESU	03/1999; 06/2005[9]	T	Stable	3C	Completed 07/2013	10/2022
Coho, Oregon Coast ESU	08/1998[9], 02/2008	T	Increasing	5C	Completed 12/2016	10/2022
Coho, Southern Oregon/ Northern California Coast ESU	05/1997; 06/2005[9]	T	Unknown	3C	Completed 09/2014	Initiated 10/2019
Coho, Central California Coast ESU	10/1996; 06/2005[9]	E	Mixed	1C	Completed 09/2012	Initiated 10/2019
SOCKEYE						
Sockeye, Ozette Lake ESU	03/1999; 06/2005[9]	T	Stable	7C	Completed 05/2009	10/2022
Sockeye, Snake River ESU	11/1991; 06/2005[9]	E	Decreasing	1C	Completed 06/2015	08/2022
STEELHEAD						
Steelhead, Puget Sound DPS	05/2007	T	Increasing	4C	Completed 12/2019	Initiated 10/2019
Steelhead, Lower Columbia River DPS	03/1998; 01/2006[9]	T	Stable	3C	Completed 07/2013	10/2022
Steelhead, Upper Columbia River DPS	08/1997; 01/2006[9]	T	Increasing	3C	Completed 10/2007	08/2022
Steelhead, Middle Columbia River DPS	03/1999; 01/2006[9]	T	Stable	3C	Completed 09/2009	08/2022
Steelhead, Upper Willamette River DPS	03/1999; 01/2006[9]	T	Decreasing	3C	Completed 08/2011	Initiated 10/2019
STEELHEAD						
Steelhead, Snake River Basin DPS	08/1997; 01/2006[9]	T	Stable	3C	Completed 12/2017	08/2022
Steelhead, Northern California DPS	06/2000; 01/2006[9]	T	Mixed	3C	Completed 10/2016	Initiated 10/2019
Steelhead, Central California Coast DPS	08/1997; 01/2006[9]	T	Unknown	3C	Completed 10/2016	Initiated 10/2019
Steelhead, South-Central California Coast DPS	08/1997; 01/2006[9]	T	Mixed	3C	Completed 12/2013	12/2022
Steelhead, Southern California Coast DPS	08/1997; 05/2002[11]; 01/2006[9]	E	Mixed	1C	Completed 01/2012	12/2022
Steelhead, California Central Valley DPS	03/1998; 01/2006[9]	T	Stable	3C	Completed 07/2014	Initiated 10/2019

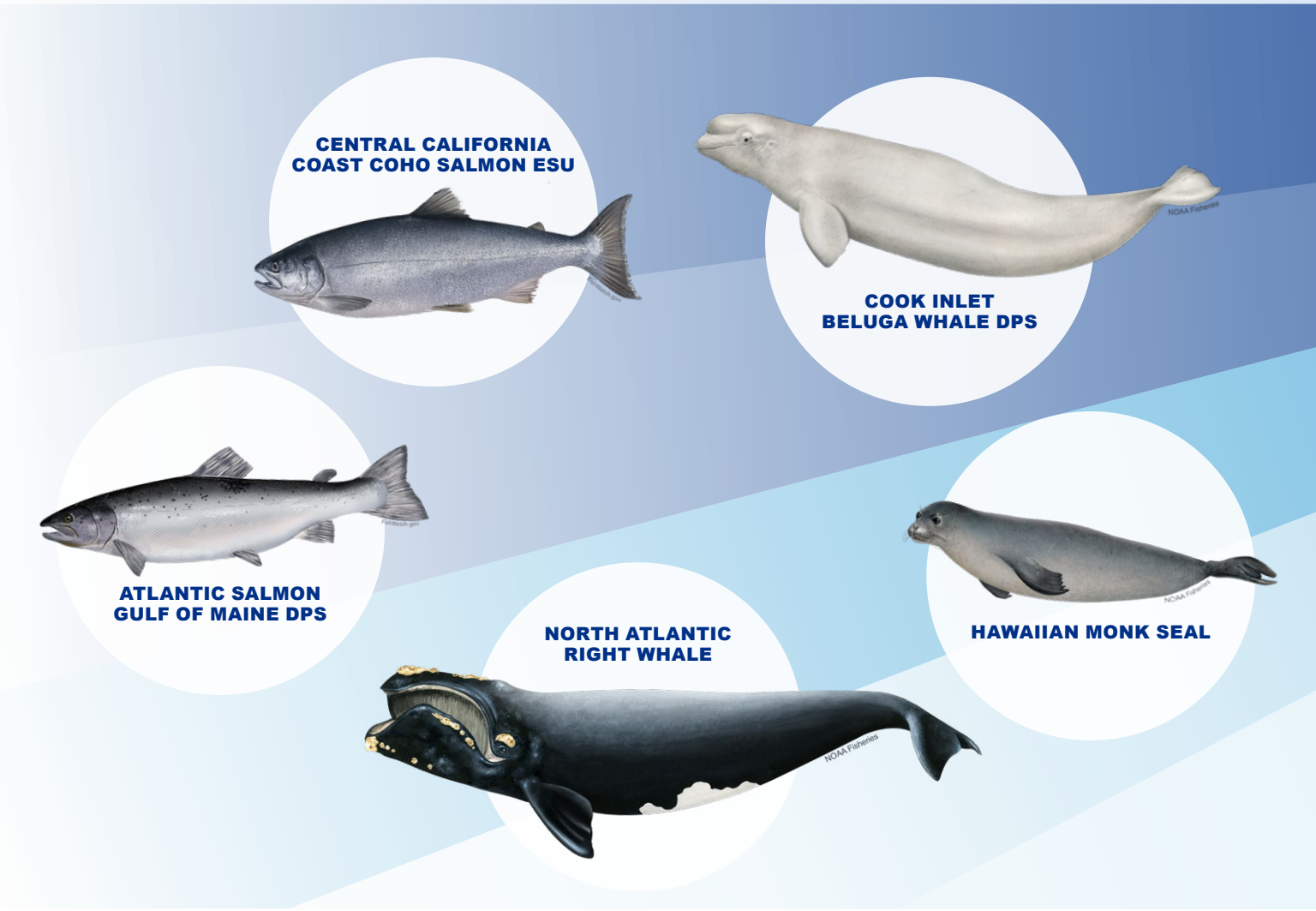
Species/Subspecies ESU/DPS	Date Listed/ Reclassified	ESA Status	Trend	Recovery Priority Number[7]	Status of Recovery Plan	Date 5-Year or Status Review Completed/ Initiated[8]
ATLANTIC SALMON						
Gulf of Maine DPS	11/2000; 06/2009[12]	E	Mixed	1C	Completed 02/2019	11/2020
NON-SALMONID FISH						
Bocaccio—Puget Sound/ Georgia Basin DPS	04/2010; 01/2017[13]	E	Unknown	7C	Completed 10/2017	Initiated 3/2020
Eulachon, Southern DPS	03/2010	T	Mixed	9C	Completed 09/2017	07/2022
Giant Manta Ray	01/2018	T	Unknown	6C	Under Development	Not started
Green Sturgeon, Southern DPS	04/2006	T	Unknown	6C	Completed 08/2018	10/2021
Gulf Sturgeon	09/1991	T	Mixed	7C	Completed 09/1995	05/2022
Nassau Grouper	06/2016	T	Decreasing	3C	Under Development	Not started
Oceanic Whitetip Shark	01/2018	T	Mixed	6C	Under Development	Not started
Shortnose Sturgeon	03/1967	E	Mixed	1C	Completed 12/1998	Not Started
Smalltooth Sawfish—U.S. DPS	04/2003	E	Increasing	1C	Completed 01/2009	09/2018
Yelloweye rockfish—Puget Sound/Georgia Basin DPS	04/2010; 01/2017[13]	T	Unknown	9C	Completed 10/2017	Initiated 3/2020
ATLANTIC STURGEON						
Gulf of Maine DPS	02/2012	T	Unknown	3C	Under Development	02/2022
New York Bight DPS	02/2012	E	Unknown	1C	Under Development	02/2022
Chesapeake Bay DPS	02/2012	E	Unknown	1C	Under Development	02/2022
Carolina DPS	02/2012	E	Increasing	1C	Under Development	Initiated 03/2018
South Atlantic DPS	02/2012	E	Mixed	1C	Under Development	Initiated 03/2018

Species/Subspecies ESU/DPS	Date Listed/ Reclassified	ESA Status	Trend	Recovery Priority Number[7]	Status of Recovery Plan	Date 5-Year or Status Review Completed/ Initiated[8]
PLANTS						
Johnson's Seagrass	09/1998 Delisted 04/2022	T	Stable	N/A	Completed 09/2002	11/2007
INVERTEBRATES						
Black Abalone	01/2009	E	Mixed	2C	Completed 11/2020	07/2018
White Abalone	05/2001	E	Unknown	1C	Completed 10/2008	07/2018
Lobed Star Coral	09/2014	T	Mixed	3C	Under Development	08/2022
Mountainous Star Coral	09/2014	T	Mixed	3C	Under Development	08/2022
Boulder Star Coral	09/2014	T	Mixed	3C	Under Development	08/2022
Pillar Coral	09/2014	T	Decreasing	3C	Under Development	08/2022
Rough Cactus Coral	09/2014	T	Decreasing	3C	Under Development	08/2022
15 Indo-Pacific Corals[14]	09/2014	T	Unknown	3C	Under Development	Initiated 1/2021
Elkhorn Coral	05/2006	T	Mixed	3C	Completed 03/2015	08/2022
Staghorn Coral	05/2006	T	Mixed	3C	Completed 03/2015	08/2022
SEALS AND SEA LIONS						
Bearded Seal—Beringia DPS	12/2012	T	Unknown	9C	Under Development	Initiated 1/2021
Ringed Seal—Arctic Subspecies	12/2012	T	Unknown	9C	Under Development	Initiated 11/2020
Hawaiian Monk Seal	11/1976	E	Increasing	1C	Completed 03/1983; Revision Completed 08/2007; Amended with Main Hawaiian Island Management Plan 01/2016; Revision Under Development 01/2023	08/2007
Steller Sea Lion—Western DPS	04/1990; 11/1990; 05/1997	E	Mixed	5C	Completed 12/1992; Revision Completed 03/2008	2/2020

Species/Subspecies ESU/DPS	Date Listed/ Reclassified	ESA Status	Trend	Recovery Priority Number[7]	Status of Recovery Plan	Date 5-Year or Status Review Completed/ Initiated[8]
WHALES						
Beluga Whale—Cook Inlet DPS	10/2008	E	Decreasing	2C	Completed 01/2017	09/2022
Blue Whale	06/1970	E	Unknown	6C	Completed 07/1998; Revision Completed 11/2020	11/2020
False Killer Whale—Main Hawaiian Islands Insular DPS	11/2012	E	Unknown	1C	Completed 10/2021	04/2022
Fin Whale	06/1970	E	Unknown	8C	Completed 07/2010	02/2019
Killer Whale—Southern Resident DPS	11/2005	E	Decreasing	1C	Completed 01/2008	01/2022
Rice's Whale (formerly Bryde's Whale, Gulf of Mexico)	04/2019	E	Decreasing		Under Development	N/A
North Atlantic Right Whale	03/2008	E	Decreasing	1C	Completed 05/2005	12/2022
North Pacific Right Whale	03/2008	E	Unknown	5C	Completed 06/2013	Initiated 03/2022
Sei Whale	06/1970	E	Unknown	6C	Completed 12/2011	08/2021
Sperm Whale	06/1970	E	Unknown	7C	Completed 12/2010	Initiated 05/2021
HUMPBACK WHALE						
Central America DPS	06/1970; 09/2016	E	Unknown	2C	1970 Listing Completed 11/1991; 2016 Listing Under Development	Initiated 3/13/2023
Mexico DPS	06/1970; 09/2016	T	Unknown	4C	1970 Listing Completed 11/1991; 2016 Listing Under Development	Initiated 3/13/2023
Western North Pacific DPS	06/1970; 09/2016	E	Unknown	7C	1970 Listing Completed 11/1991; 2016 Listing Under Development	Initiated 3/13/2023

Smalltooth sawfish. Credit: Tonya Wiley

7 Recovery Priority Guidelines (April 30, 2019; 84 FR 18243).
8 For species listed within 5 years, a N/A (Not Applicable) is applied to the status of the 5-Year Review.
9 In *Alsea Valley Alliance v. Evans*, 161 F. Supp. 2d 1154 (D. Or. 2001) (*Alsea*), the U.S. District Court in Eugene, Oregon, ruled that NMFS could not exclude hatchery fish within the ESU when listing. Although the *Alsea* ruling affected only one ESU, subsequent to the ruling, NMFS initiated new status reviews for 27 ESUs and, in 2005, re-listed 15 ESUs of salmon with revised definitions of the populations to be included in the ESU, delisted one ESU (Oregon Coast coho) and listed one ESU (Lower Columbia River coho); and in 2006, re-listed 10 ESUs of steelhead (and categorized them as DPSs).
10 This ESU was first emergency-listed as threatened on 8/4/1989, then officially listed as threatened on 11/5/1990, then reclassified as endangered on 1/4/1994.
11 This ESU was first listed on 8/18/1997; the southern range extension to the U.S.-Mexico border was added to the listing for this ESU via a final rule on 5/1/2002.
12 The Gulf of Maine Atlantic Salmon DPS was originally listed on November 17, 2000 (65 FR 69469) and was revised to include the Androscoggin, Kennebec, and Penobscot River basins in 2009 (74 FR 29344, June 19, 2009).
13 The species listing was amended based on a geographic description and to include fish within specified boundaries (January 23, 2017; 82 FR 7711).
14 This includes seven species of threatened Indo-Pacific reef corals known to occur in U.S. waters, as well as eight threatened species known to occur in foreign waters. We have included all 15 species here because NMFS intends to develop a recovery plan for listed Indo-Pacific corals that includes all 15 species.



SPECIES *in the* SPOTLIGHT

In 2015, NMFS launched the *Species in the Spotlight* initiative, a strategic approach to endangered species recovery that focuses on species for which immediate, targeted actions can be taken to stabilize the population and prevent extinction. For some of these species, their numbers are so low that they need to be bred in captivity; others are facing anthropogenic threats that must be addressed to prevent their extinction. In most cases, we understand the threats to these species, and we know that the necessary management actions are likely to be effective. In some cases, we are prioritizing research to better understand the threats so we can fine-tune our actions for the maximum effect. We know we cannot do this alone. A major part of the *Species in the Spotlight* initiative is to expand partnerships and motivate individuals to work with us to get these species on the road to recovery.

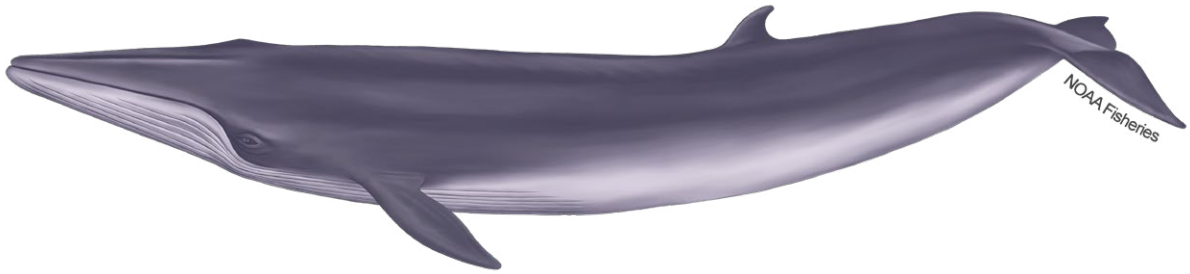
In 2016, NMFS developed 5-year Priority Action Plans for the *Species in the Spotlight* in order to focus recovery efforts on high-priority actions that we and our partners can take in the near term to address the most urgent threats to the species. In the first 5 years of the initiative, we added around 90 new partners, channeled more than $75 million in NOAA grants and discretionary funding, and achieved some important milestones toward stopping the decline of these species. Due to these successes, we renewed the initiative in 2021 and developed new 2021–2025 Priority Action Plans, including the first Priority Action Plan for the North Atlantic right whale, which was added to the initiative in 2019. In 2023, we also added Rice's whales to the *Species in the Spotlight*

initiative due to their critically low abundance, declining population, and exposure to anthropogenic threats in the Gulf of Mexico, their only known home.

The stories in this section highlight the progress made in FY 2021–2022 toward implementing high-priority recovery actions for our *Species in the Spotlight*. In these stories, we also feature our 2023 Partners in the Spotlight, whose exceptional efforts have made a profound difference for the species and have been a critical part of the initiative's success. Their dedication motivates and inspires further conservation efforts and collaboration, and they deserve special recognition for their work. We appreciate all of our current partners and collaborators, as the steps we need to take to stabilize these species would not be possible without them.

While we have made significant progress toward recovering threatened and endangered species, more must be done, locally and globally, to reverse declining populations and address the complex threats facing imperiled species. We will continue to conserve and recover all of the ESA species we are responsible for in collaboration with our partners.

50TH ANNIVERSARY ENDANGERED SPECIES ACT



NEW SPECIES *in the* SPOTLIGHT

RICE'S WHALE

Rice's whales (*Balaenoptera ricei*) are a new addition to the *Species in the Spotlight* due to their critically low abundance, declining population and exposure to anthropogenic threats in the Gulf of Mexico, their only known home. The species likely numbers fewer than 100 individuals—perhaps as few as 50—making it one of the most endangered whales in the world. Initially believed to be a subspecies of the widely distributed Bryde's whale, they were listed as a unique, endangered subspecies under the Endangered Species Act (ESA) in 2019. In 2021, Rice's whales were determined to be an entirely separate species, based on new research showing they are genetically and morphologically distinct from Bryde's whales that inhabit the tropical Atlantic and other ocean basins.

Most sightings of Rice's whales have been concentrated in the northeastern Gulf of Mexico, offshore of Florida and Alabama, along the continental shelf break in waters 100 to 400 meters deep. Recent passive acoustic monitoring studies and visual surveys have shown that Rice's whales also occupy shelf-break habitat in the north-central and northwestern Gulf of Mexico, offshore of Louisiana and Texas. Habitat modeling suggests suitable habitat also exists in the southern Gulf of Mexico, but their existence in Mexican waters is currently unknown. Whaling records and unconfirmed sightings suggest that Rice's whales occurred more broadly throughout the Gulf of Mexico historically.

The species' small population size and limited distribution increase their risk of extinction and vulnerability to threats, which include energy exploration and development, oil spills and spill response, vessel strikes, ocean noise, ocean debris, climate change, and entanglement in fishing gear. Several lines of evidence indicate Rice's whales have likely been declining since the 2010 *Deepwater Horizon* (DWH) oil spill. The DWH Natural Resources Damage Assessment determined Rice's whales were more heavily impacted by the spill than any other shelf or oceanic stock of marine mammal in the Gulf of Mexico. The injury assessment estimated that 48 percent of the Rice's whale population was exposed to oil, 17 percent of the population was likely killed, 22 percent of females experienced reproductive failure and 18 percent of the population experienced adverse health effects. The injury assessment applied a population model and estimated a maximum reduction in population size of 22 percent. The same study estimated it could take up to 69 years for the population to recover from these impacts, because of both acute oil exposure and chronic impacts to the population since 2010. Also, few calves have been sighted during surveys since 2010, and there have been frequent observations of individual whales in poor body condition. These data and observations, the small population size, their restricted range, and comparisons with other large whale species with similar demography, all suggest the species has likely been declining since at least that time. Recovering the Rice's whale will require a combination of science to better understand the species' biology, demographics and threats, and actions to reduce anthropogenic stressors in the Gulf of Mexico.

Rice's whales documented during a research mission in the Gulf of Mexico aboard the NOAA Ship Gordon Gunter. Credit NMFS NEFSC and SEFSC (Permit #21938)

Recovery Progress

Since 2014, when genetic evidence began to reveal Rice's whales are a unique species or subspecies, NMFS has completed a number of conservation and recovery actions, including: (1) publishing a status review, (2) listing them as endangered under the ESA, (3) completing a recovery outline, (4) revising their taxonomy and status to recognize them as a unique species, the Rice's whale, (5) conducting a virtual recovery workshop, and (6) publishing a proposed rule to designate critical habitat. During that same time, NMFS scientists and our partners have made significant strides in our understanding of the species, producing four technical reports and eight peer-reviewed articles on Rice's whale biology, distribution, habitat use, prey, acoustics, threats, and other information critical to conservation. Still, many challenges stand in the way of Rice's whale recovery, including fundamental gaps in our scientific knowledge of the species, how to mitigate threats in their highly industrialized habitat, limited public awareness of the species, and lack of dedicated funds for species recovery.

Looking Ahead

In collaboration with our partners, we are undertaking additional conservation and recovery actions to support the recovery of Rice's whales, including: (1) finalizing the critical habitat designation, (2) developing a Species in the Spotlight Priority Action Plan, (3) writing an ESA recovery plan based on the previously held recovery workshop, (4) developing and implementing conservation measures through the ESA section 7 consultation process with other Federal agencies, and (5) conducting outreach and education with Gulf-coast stakeholders, including fishermen, vessel operators, marine industries, NGOs, and the public. Additionally, NOAA is at the very early stages of implementing two voluntary-based DWH restoration projects to reduce vessel strike risk and impacts from anthropogenic noise to restore for oceanic cetaceans injured as a result of the *Deepwater Horizon* oil spill. Together, these actions will help us identify threats, prioritize recovery actions, and implement recovery with our partners in a holistic manner.

Rice's whales have three prominent ridges in front of their blowhole. Credit: NMFS (Permit #14450)

50TH ANNIVERSARY ENDANGERED SPECIES ACT

SPECIES *in the* SPOTLIGHT

ATLANTIC SALMON GULF OF MAINE DPS

The Gulf of Maine distinct population segment (DPS) of Atlantic salmon (*Salmo salar*) was selected as one of the *Species in the Spotlight* because of its critically low abundance and continuing decline in the population. Atlantic salmon spend the first few years of their life in freshwater rivers and streams, mature in the ocean, and return to the freshwater rivers from which they originated to spawn. The freshwater range of the Gulf of Maine DPS includes all watersheds from the Androscoggin River in central Maine to the Dennys River in Eastern Maine. The marine range is vast: from the Gulf of Maine itself to the Labrador Sea, the coast of Greenland, and as far east as the Faroe Islands. There are three recovery units in the DPS—Downeast Coastal, Penobscot Bay, and Merrymeeting Bay. In the United States, Atlantic salmon populations historically extended as far south as Long Island Sound. Before 1900, southern populations were eradicated due to habitat loss, hydropower development, freshwater habitat impairment, and overharvest.

Today, the only remaining Atlantic salmon populations in U.S. waters exist in a few rivers and streams in central and eastern Maine. These remaining populations are adapted to specific conditions in their home rivers (often referred to as "river-specific stocks"). Since the endangered listing in 2000, one of these river-specific populations has been extirpated; another is now on the brink of being lost. While the conservation hatcheries operated by the U.S. Fish and Wildlife Service (USFWS) have substantially reduced the short-term extinction risks, there is growing concern about the status of the Gulf of Maine DPS as a whole. River-specific populations still persist in central and eastern Maine, and restoring the rivers that support them is a top priority. In addition, there are rivers in the freshwater range of the Gulf of Maine DPS that lack river-specific stocks, yet still contain abundant high-quality spawning and rearing habitat that is essential to supporting a recovered population. An example is the Kennebec River, which currently supports a small run of Atlantic salmon with the help of ongoing management interventions. Achieving our recovery goals requires restoration of self-sustaining wild Atlantic salmon in all three recovery units.

Atlantic salmon. Credit: Nick Hawkins

In 2022, the Atlantic Salmon Federation removed the Walton's Mills Dam on Temple Stream in the Sandy River watershed, which improved access to 40 miles of juvenile salmon rearing habitat. Credit: Atlantic Salmon Federation

Recovery Progress

In FY 2021–2022, we made progress on the key actions[15] identified in the 2021–2025 Priority Action Plan for the Gulf of Maine DPS of Atlantic salmon: (a) reconnect the Gulf of Maine with headwater streams, (b) improve habitat productivity to increase the number of juvenile salmon (smolts) successfully entering the marine environment, and (c) increase our understanding and ability to improve survival in the marine environment.

Reconnect the Gulf of Maine with Headwater Streams

In 2021 and 2022, at least 65 aquatic connectivity projects, such as dam removals and the installation of accessible culverts and fishways, were completed within the freshwater range of endangered salmon. These projects have improved access to approximately 200 miles of stream and river habitat. By helping to restore connectivity and ecological stream processes, these projects enhance adult access to spawning grounds and increase the number of fish that are successfully entering the marine environment. Of particular note, the Atlantic Salmon Federation (ASF) removed the dam on Temple Stream in the Sandy River watershed, which reconnected 40 miles of juvenile rearing habitat. The Sandy River has high restoration value, as it contains abundant cool-water Atlantic salmon rearing habitats that will be increasingly important in a warming climate.

We continue to improve upstream and downstream fish passage and reduce the impact of hydroelectric dams on Atlantic salmon by working through the Federal Power Act and the ESA. In 2021 and 2022, we worked with hydroelectric dam owners and the Federal Energy Regulatory Commission to improve fish passage and habitat conditions at more than a dozen dams within the range of the Gulf of Maine DPS. Although no new fishways were constructed at hydroelectric dams in 2021 or 2022, progress was made on planning for new fishways and/or operational changes over the next several years for projects on the Androscoggin, Kennebec, and Penobscot rivers that will considerably improve fish passage. Notably, in 2022 Brookfield Renewable committed to implementing significant fish passage improvements at their four dams on the lower Kennebec River. These measures include the construction of new upstream and downstream fishways as well as an adaptive management strategy to achieve high (>96%) passage and survival rates.

Fish passage improvements also benefit other species of sea-run fish, including alewives and blueback herring (collectively referred to as river herring) as well as American eel and American shad. These species shared the rivers with salmon historically, but many of the same factors that led to the decline of salmon also severely diminished their populations. When we designated critical habitat for Atlantic salmon in 2009, we emphasized the importance of freshwater and

15 Note: Throughout this report, the order of key actions as they are listed does not imply their relative priority for implementation.

These images depict the same reach of habitat in the Narraguagus River without complexity elements (left) and with complexity elements added (right). Credit: Project SHARE

estuary migration sites with abundant, diverse, native fish communities. Abundant populations of sea-run fish provide benefits to Atlantic salmon, such as reducing predation of smolts from species such as seals, cormorants, and striped bass that would otherwise prey on the significantly less common Atlantic salmon. Abundant populations of these fish species also provide other ecosystem services, as they are a food source for fish, birds, and other wildlife.

Recent fish passage improvement projects within the freshwater range of the Gulf of Maine DPS can lead to substantial increases in populations of these other species of sea-run fish. For example, following the removal of Great Works and Veazie dams on the Penobscot River (and improved passage at other upstream dams), river herring returns increased from 2,000 in 2011 to nearly 3 million in 2022. Similarly, following the removal of the Edwards and Fort Halifax dams on the Kennebec River in 1999 and 2008, river herring returns increased from 47,000 to well over 5 million in 2018. In 2021 and 2022, fish passage projects were implemented by our partners in the State of Maine that will benefit the full suite of sea-run species. Of particular note, Maine Rivers restored access to China Lake in the lower Kennebec River by removing dams and constructing fishways in Outlet Stream, and the Downeast Salmon Federation removed the dam at the outlet to Meddybemps Lake on the Dennys River. We expect these projects to result in more river herring returning to the rivers of Maine. Although such increases have yet to be observed in listed salmon, increasing abundance and distribution of river herring and other sea-run fish continues to improve the habitat features in our salmon rivers and delivery of ecosystem services.

Improve habitat productivity to increase the number of fish successfully entering the marine environment

Historical practices such as log drives, poor forestry and agriculture practices, pollution, and construction of road networks have damaged rivers and tributaries, greatly altering the complex habitat that once successfully supported Atlantic salmon production. Supporting recovery of the DPS includes increasing smolt production in freshwater habitats, and ensuring these juvenile salmon successfully enter the marine environment.

Increasing the production of salmon smolts in freshwater remains a key strategy to mitigate the risk to the DPS given low marine survival. There are numerous threats that affect the number of smolts entering the marine environment, and we are collaborating with partners to better understand and mitigate these threats. Examples of these efforts over the past 2 years include:

- *Increasing Habitat Complexity*—Project SHARE (a non-profit organization based in Downeast Maine) is installing large wood and boulder structures in degraded habitat in the Narraguagus River to evaluate the hypothesis that the existing habitat is simplified and less productive. Evaluations are

underway to see if increased habitat complexity will improve habitat conditions for Atlantic salmon.

- *Preparing for Climate Change*—The Gulf of Maine DPS was ranked highly vulnerable to climate change in a 2016 climate vulnerability analysis.[16] Using climate scenario planning, we identified a number of science and management actions that will support Atlantic salmon resilience across a range of plausible but uncertain future scenarios. One of these actions was to identify climate-resilient freshwater habitats. Stream baseflow (composed primarily of groundwater discharge) influences both water quantity and water temperature, both of which are important limiting factors to Atlantic salmon. In 2021, the U.S. Geological Survey developed a baseflow model for Atlantic salmon watersheds in Maine to help us identify stream reaches that may be more climate-resilient.[17] The model identifies stream reaches that have a relatively high proportion of baseflow during summer low flow periods. This will help inform conservation efforts by identifying areas that will likely be best suited for salmon survival in a warming climate.

Increase our understanding and ability to improve survival in the marine environment

In order to successfully reproduce and contribute to future generations, adult Atlantic salmon must return from feeding migrations in the Atlantic Ocean to their home rivers. Marine survival rates remain very low and are a major impediment to the recovery of the Gulf of Maine DPS. The marine habitat of U.S.-origin salmon extends from the Maine coast though Canada to Greenland. We work with domestic and international partners to document catch in international fisheries and to better understand what factors are affecting salmon return rates. NMFS has helped to identify important climate drivers and changes in ocean food webs, and has also clarified migration timing and routes to ocean feeding areas and return migrations. Better understanding of the links between marine growth and marine survival and how they have changed provides insights into future change. This information helps us better understand salmon resiliency in dynamic ocean conditions.

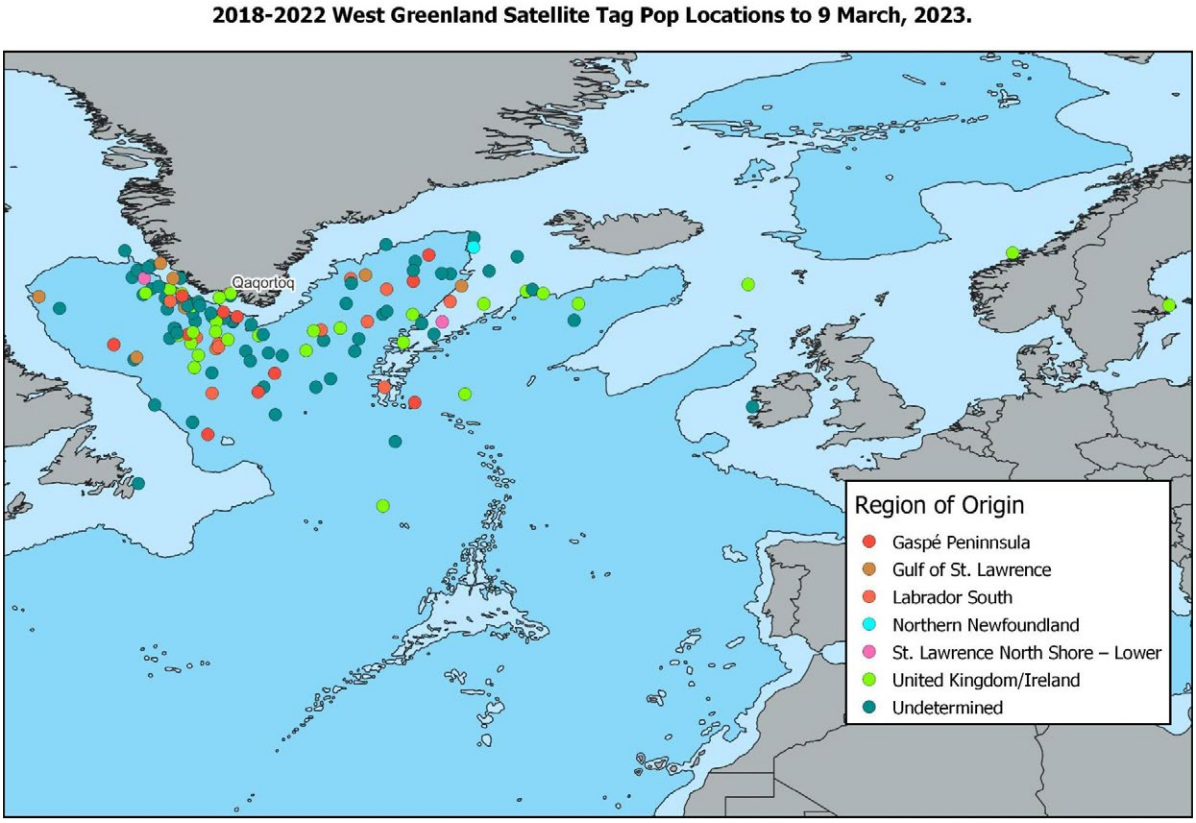
Since 2018, we have partnered with ASF (Canada), Fisheries and Oceans Canada, and the Association of Fishers and Hunters (Greenland) to increase knowledge of ocean habitat use by satellite tagging and releasing Atlantic salmon captured at Greenland. This study is improving our understanding of Atlantic salmon migrations by providing insights into habitat preferences and predation of Atlantic salmon as they migrate from Greenland to natal rivers to spawn. NMFS continues to work with the Woods Hole Oceanographic Institution, ASF, and tag manufacturers to develop novel methods to improve monitoring of marine migration of a wide variety of marine animals. Ongoing research has also provided insights into the interdependencies of salmon and the community of 11 other sea-run fish, including blueback herring, alewives, and American shad. Examining community responses to habitat restoration is informing an ecosystem-based approach to understanding their combined abundance, interactions with marine mammals and other predators, and lingering impacts of dams in estuaries for migratory populations.

The West Greenland fishery for Atlantic salmon continues to harvest fish of U.S. origin. Through its West Greenland Commission, the North Atlantic Salmon Conservation Organization (NASCO) facilitates negotiation of a regulatory measure for the fishery. The International Council for the Exploration of the Sea (ICES) provides science-based catch advice for the West Greenland fishery based on the status of the stocks that make up that fishery. The United States supports long-standing advice from ICES that there should be no fishery for Atlantic salmon at West Greenland. Denmark (in respect of the Faroe Islands and Greenland) maintains that the salmon fishery is both culturally and economically important to its people.

In 2022, the United States worked cooperatively through NASCO's West Greenland Commission to develop a multi-year regulatory measure for the fishery (2022–2025). While it did not contain all of the provisions the United States considers necessary

16 Hare, J.A., Morrison, W.E., Nelson, M.W., Stachura, M.M., Teeters, E.J., Griffis, R.B., et al. 2016. A Vulnerability Assessment of Fish and Invertebrates to Climate Change on the Northeast U.S. Continental Shelf. PLoS ONE 11(2): e0146756.

17 Lombard, P.J., Dudley, R.W., Collins, M.J., Saunders, R., and Atkinson, E. 2021. Model estimated baseflow for streams with endangered Atlantic Salmon in Maine, USA. River Research and Applications, 37(9), 1254-1264.



Pop-off locations of all PSAT tags released at West Greenland from 2018–2022 by region of origin. A number of tags released in 2022 may still be active and additional tagging is planned for 2023. Credit: NOAA NEFSC

to ensure appropriate management of the fishery, the measure includes a number of important elements designed to improve the management of the fishery. These include limiting harvest to 27 metric tons and implementing continued monitoring and control measures. Additionally, in 2022 the parties reached agreement on a new measure that closes the fishery when the registered catch has reached no more than 49 percent of the overall total allowable catch. Modeling indicates that stopping the harvest at that point will limit the potential for the quota to be exceeded. This measure was developed in response to situations in prior years where the fishery would be closed when the full quota was reported to have been met but late reporting by fishermen continued well after the fishery closed. As a result, the harvest often exceeded the quota by as much as 10 metric tons. Preliminary results from the 2022 harvest are encouraging.

Looking Ahead

The 2021 Bipartisan Infrastructure Law (BIL), as well as other grant programs managed by NOAA's Restoration Center, provided significant funding to address connectivity issues in the Gulf of Maine DPS in FY 2021–2022. These opportunities will provide more than $10 million to our tribal, state, and NGO partners to remove dams, install fishways, and upgrade road-stream crossings. We expect approximately 35 barrier projects will be implemented by our partners using funds provided in FY 2022. Of particular note, over the next 2 years, ASF will use BIL funding to remove the Guilford Dam on the Piscataquis River, a major tributary to the Penobscot River, which will improve access to more than 200 miles of modeled salmon rearing habitat. They will also construct an upstream fishway at a dam on Baskahegan Stream, which flows into the Mattawamkeag River, a major tributary to the Penobscot River. This project will provide access to 16,000 acres of alewife spawning habitat, which will result in a further boost to alewife populations in the Penobscot River. As noted above, alewives and other sea-run fish provide important ecosystem services. We expect that these and other projects implemented over the next 2 years will improve access to hundreds of stream miles containing high-quality Atlantic salmon habitat throughout the Gulf of Maine DPS.

PARTNER *in the* SPOTLIGHT: Joan Trial

Joan Trial passed away on March 5, 2023, after a short battle with cancer. Joan was a keen scientist, an incredible mentor, and a good friend to many throughout her career. In 2000, Joan was promoted into the Senior Biologist position with the Maine Atlantic Salmon Commission, which later became the Bureau of Sea-run Fisheries and Habitat within the Maine Department of Marine Resources. In this capacity, Joan supervised the assessment, research, and management activities surrounding endangered populations of Atlantic salmon in Maine. In her role, she represented Maine nationally on the U.S. Atlantic Salmon Assessment Committee and internationally on the ICES Working Group on North Atlantic Salmon and the International Joint Commission's St. Croix River Board. Joan Trial retired from the Maine Department of Marine Resources in July of 2013. Even after departing her role in state government, she continued to make important contributions by co-authoring several peer-reviewed publications, serving on graduate committees, and working with Project SHARE to lead the assessment work related to habitat rehabilitation in the Narraguagus River.

Joan valued service and professionalism throughout her life. She was an active member of the American Fisheries Society, holding several positions in both the Atlantic International Chapter and the Northeast Division. Joan was awarded the Dwight A. Webster Memorial award in 2013—the most prestigious recognition given by the Northeast Division of the American Fisheries Society.

Her intellect, enthusiasm, and gusto will not be replaced, but will be remembered fondly by many throughout northern New England and beyond.

SPECIES *in the* SPOTLIGHT

CENTRAL CALIFORNIA COAST COHO SALMON ESU

The Central California Coast (CCC) coho salmon ESU was first listed under the ESA as threatened in 1996, and reclassified as endangered in 2005. At the southern extent of the coho salmon species' range, this ESU is at very high risk of extinction. Populations within the ESU reached extremely low levels during the height of California's recent extended drought. As such, all populations remain depressed and well below recovery targets—particularly those in the southern portion of the ESU, which are highly vulnerable to extinction and dependent on ongoing conservation hatchery programs.[18]

A critical emerging challenge to CCC coho salmon survival and recovery is the increased frequency, magnitude, and intensity of adverse environmental conditions resulting from climate change. Habitat conditions have significantly diverged from historical conditions. California now routinely experiences extreme weather patterns that include above-average temperatures and extreme variations in precipitation. Severe wildfires throughout the species' range have become a significant habitat concern. Recent fires caused substantial damage to riparian habitat and instream wood shelter, increasing the threat of landslides and sediment inputs to many streams. Restoration and increased monitoring of species and habitat response to these events are necessary to repair and re-evaluate how climate-driven processes influence CCC coho salmon's survival and recovery.

Despite substantial restoration efforts, habitat challenges for CCC coho salmon still exist at the regional and basin level. As the human population grows, urbanization, rural residential growth, and water supply demands will continue to threaten CCC coho salmon and their habitat. The pace and scale of habitat restoration needs to increase to keep up with disturbance patterns due to human impacts and the changing climate.

Juvenile CCC coho salmon. Credit: NMFS/Morgan Bond

18 Southwest Fisheries Science Center. 2022. Viability assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest. 11 July 2022. Report to NMFS West Coast Region from Southwest Fisheries Science Center, Fisheries Ecology Division.

Recovery Progress

In 2021–2022, we made substantial progress on the key actions identified in our 2021–2025 Priority Action Plan for the CCC coho salmon: (a) Summit to Sea—restoration at a watershed scale; (b) improving instream flow; (c) continue and expand captive broodstock programs; (d) partnering and outreach, and (e) monitoring and research.

Summit to Sea—Restoration at a watershed scale

In 2022, The Nature Conservancy (TNC) implemented the Garcia River Estuary Enhancement Project. This ecosystem-scale estuarine habitat restoration project is working to improve the complexity of the estuary. The project enhances instream, floodplain, and off-channel habitat by adding large wood complex structures and creating off-channel ponds. The project will provide salmon and steelhead refugia and rearing habitat as they transition to the ocean. Funding from the NOAA Restoration Center and California Department of Fish and Wildlife (CDFW) helped make this project possible.

Improving instream flow

Drought Initiative

NMFS, in collaboration with the CDFW, launched a community program called the Voluntary Drought Initiative. This program recognizes the severe constraints that drought places on agriculture and fish in California and is targeted to work with water users in high-priority areas throughout the State. Specifically, the program seeks to develop voluntary water conservation and in-stream flow agreements with participant water users in high-priority rivers and streams. NMFS considers participation in the program as an important mitigating factor when a participant unintentionally takes an ESA-listed fish while withdrawing water (or other actions that affect fish passage) while complying with an Individual Agreement. This is a strictly voluntary program with the objective to improve the likelihood of ESA-listed fish survival through droughts.

Safe Harbor Agreements

Safe Harbor Agreements (SHA) provide an avenue to garner private landowners' support and commitment for species conservation on their lands. During the drought conditions in 2022, NMFS and the E&J Gallo Ranch signed an SHA, whereby the ranch released water from an off-stream reservoir into a critical Russian River tributary to enhance CCC coho salmon rearing conditions. The net conservation benefit realized from this SHA includes the enhancement of salmonid habitat from improved flow during spring and summer outmigration, and agency access for studies that have increased our understanding of how instream flows affect fish behavior and feeding ecology. This landowner has embraced their important role in the recovery of the species and has committed to continue these activities pursuant to terms and assurances set forth in the SHA, which protect both the landowner and the salmon.

Restoring the Garcia River Estuary with large wood structures and off-channel wetland ponds (left) and a close-up (right). Credit: The Nature Conservancy

California Sea Grant and Civilian Conservation Corps staff assist NMFS with monitoring CCC coho salmon being reared in a Remote Site Incubator in the Russian River watershed. Credit: California Sea Grant.

Continue and expand captive broodstock programs

Russian River

The CCC coho salmon captive broodstock program at the Don Clausen Fish Hatchery continues to capture natural-origin juveniles from the Russian River and adjacent watersheds in Marin County to diversify its conservation hatchery spawning broodstock. While recent drought years provided challenging conditions, both in the natural environment (requiring numerous rescue operations) and in the hatchery environment (requiring temporary rearing in a local high school hatchery with better water quality), the broodstock program continues to serve as the lifeboat for Russian River CCC coho salmon. Adaptations have been made to ensure program and population resiliency, including adjusting release size and timing. Remote Streamside Incubators have continued to be evaluated for their ability to improve juvenile stream imprinting. The broodstock program partnership includes NMFS West Coast Region (WCR), NOAA Southwest Fisheries Science Center (SWFSC), the U.S. Army Corps of Engineers (USACE), CDFW, California Sea Grant, Sonoma Water, the United Anglers of Casa Grande High School, and Jackson Family Wines.

Santa Cruz

The Southern Coho Salmon Captive Broodstock Program has continued its efforts to conserve and restore nearly extirpated populations of coho salmon in the Santa Cruz Mountains, south of San Francisco. Following the catastrophic CZU[19] Lightning Complex Fire of August 2020 and extreme drought conditions in 2020–2022, the program spent significant effort looking for alternative safe hatchery space for spawning, egg incubation, and rearing of coho salmon, as facilities typically used were destroyed by fire or compromised by extreme weather. Generous grants to program partners from the Wildlife Conservation Board and NMFS WCR allowed for repairs of Kingfisher Flat Hatchery.

Adaptively managing program operations at the damaged hatchery facilities forced some tough decisions that ultimately led to positive outcomes, including the release of more than 200 unspawned adult coho salmon broodstock into the Pescadero Creek watershed during the winter of 2021–2022. This effort was facilitated by the San Mateo Resource Conservation District with support from San Mateo County Parks and private landowners. The adult release was the first of its kind in the Pescadero Creek watershed. This release coincided with record returns of adults observed in many populations of the ESU, including the counting station in Scott Creek. Snorkel surveys conducted by CDFW and NMFS during the summer of 2022 revealed juvenile coho salmon at multiple sites in the Pescadero Creek Watershed. The success of this action, coupled with the somewhat unexpected high return of coho salmon throughout the ESU, illustrates that these populations can exhibit resiliency under certain conditions despite continued deficiencies in program infrastructure and research and monitoring that need to be reversed to elevate program performance and avoid extinction.

19 CZU refers to the Cal Fire designation for its San Mateo–Santa Cruz Unit, the administrative division for San Mateo, Santa Cruz, and San Francisco counties.

Partnering and outreach

Salmonid Habitat Restoration Priorities (SHaRP) Partnership

A prioritized planning effort called SHaRP has been implemented in the Mendocino Coast, the Lower Russian River Tributaries, and Lagunitas Creek. The Lagunitas Creek SHaRP is complete and an action plan was published in August 2022, identifying priority restoration actions to recover CCC coho salmon and CCC steelhead in the watershed. The Mendocino Coast and the Lower Russian River Tributaries SHaRP watershed meetings were completed in 2021–2022 and action plans are being finalized.

A New Hatchery South of San Francisco

Despite funding for temporary hatchery repairs at Kingfisher Flat Hatchery, the recent fires and extreme periods of drought have highlighted the need to build a safer and larger hatchery facility for the program, as well as the need to establish captive rearing refugia for CCC coho salmon throughout the ESU. NMFS WCR awarded $300,000 to CDFW for the development of a feasibility study for a new state-of-the-art hatchery facility south of San Francisco for CCC coho salmon. Throughout 2022, CDFW worked with NMFS to refine the biological and technical scope for the new hatchery facility and to prepare its request for proposals.

Mendocino Broodstock Partnership

CCC coho salmon in the Navarro and Garcia Rivers have experienced historically low abundances. In 2018, the Mendocino Broodstock Partnership began collecting juvenile CCC coho salmon from the Navarro and Garcia rivers and rearing them to adults at the Don Clausen Fish Hatchery. Since then, three year-classes of CCC coho salmon have been captured, raised to adulthood, and released to improve spawner diversity. Partners for this effort included USACE, CDFW, SWFSC, North Coast Regional Water Quality Control Board, TNC, The Conservation Fund, and the Mendocino Redwood Company. This partnership made funding, land access, outreach, technical assistance, and collection and rearing of CCC coho salmon possible. Monitoring of returned spawners and the makeup of their genetics will be evaluated by CDFW and the SWFSC, respectively.

Monitoring and research

Assessing the effects of wildfire on coho salmon and their habitats in the Santa Cruz Mountains region

Scientists at the SWFSC are leading collaborative research to understand how climate-related disturbance events affect the conservation and recovery of CCC coho salmon at the southern end of their range. In August 2020, the CZU Lightning Complex Fire burned more than 350 km^2 (86,500 acres) of coastal forests in the Santa Cruz Mountains region. Among the watersheds severely affected by the CZU Fire was Scott Creek, a basin where the SWFSC has been conducting comprehensive salmonid life-cycle monitoring since 2002. Scott Creek is also home to the Southern Coho Salmon Captive Broodstock Program, making it a pivotal recovery watershed in the region.

Researchers are leveraging more than two decades of physical, chemical, and biological information collected at Scott Creek to rigorously assess the consequences of wildfire on CCC coho salmon production. Initial results highlight substantial changes in riparian and riverine habitat following the fire, chiefly due

CCC coho salmon egg (left) and alevin (right) being raised in a conservation broodstock hatchery. Credit: NMFS

to the loss of vegetation and major landslide events during winter storms. Annual habitat mapping and monitoring has revealed an overall loss in juvenile coho salmon rearing habitat in Scott Creek due to the filling of pools with fine sediment. Moreover, post-fire hydrologic and water temperature regimes appear to be increasingly dynamic, and may be contributing to reduced spawning success and juvenile survival. Continued research and monitoring will improve our understanding of the various pathways through which wildfire affects salmonid populations, and provide important insight into ecosystem recovery following a major disturbance event.

Juvenile CCC coho salmon. Credit: NMFS/Morgan Bond

Efficacy of eDNA methods for detecting coho salmon in the Santa Cruz Mountains

Funding for regional monitoring of adult CCC coho salmon in the Santa Cruz Mountain Diversity Stratum was discontinued after the 2018–2019 spawning season, in part because the expense of conducting season-long adult spawning ground surveys was difficult to justify given the extremely low numbers of returning adults. Scientists at the SWFSC recently published a study evaluating the efficacy of using environmental DNA (eDNA) methods for detecting the presence of juvenile coho salmon in streams in the region.[20]

Experiments were conducted where known numbers of juvenile coho salmon were held in cages in an otherwise CCC coho salmon–free stream during late summer and early fall to assess how the probability of detecting eDNA changes with density of fish and distance from the eDNA source. Results indicated that, under low flow conditions, eDNA was occasionally detected as far as 1,000 meters from the source population; however, the likelihood of eDNA detection typically dropped to very low levels more than 200 meters from the source. Despite the rapid attenuation of the eDNA signal in streams, a study comparing coho salmon detection using snorkel surveys and eDNA sampling across the Santa Cruz Mountains found that reach-level detection probabilities were identical for the two methods. While eDNA methods do not allow enumeration of fish, in locations where coho salmon are extremely scarce and where the primary management question is whether coho salmon are still present, eDNA sampling can provide reliable information on coho salmon occurrence at a much lower cost compared to conventional adult spawner surveys.

Looking Ahead

Improving conditions for CCC coho salmon, particularly in consideration of climate change, requires adequate seasonal streamflow with improved passage and habitat diversity to improve and maintain population viability. Flow protections and improvements are needed to protect all life stages, habitat, and habitat processes. Passage improvements are needed to remedy both partial and complete barriers to migration and reach-scale movement of adults and juveniles. Habitat improvements should include attention to instream, floodplain, and estuarine habitat complexity, and the geomorphic and watershed processes that support habitat function. Improved population monitoring is needed to better understand the status of populations and the ESU. With the passage of the Bipartisan Infrastructure Law, an unprecedented amount of grant funding is available to fund and implement passage and restoration projects at a greater scale than previously possible. Partnership efforts between state and federal agencies and outreach to NGOs and private landowners are critical to recovery and more important than ever.

20 Spence, B.C, Rundio, D.E., Demetras, N.J., and Sedoryk, M. 2021. Efficacy of environmental DNA sampling to detect the occurrence of coho salmon (*Oncorhynchus kisutch*) in Mediterranean-climate streams of California's central coast. Environmental DNA 2021(3): 727-744.

PARTNER *in the* SPOTLIGHT: Trout Unlimited's North Coast Coho Project

Upper Noyo before (top left) and after (top right). Credit (below): Anna Halligan

Trout Unlimited's North Coast Coho Project (NCCP) was started in 1998 with the establishment of a new public-private partnership with the Mendocino Redwood Company in the Garcia River watershed. In this initial partnership, Trout Unlimited, Mendocino Redwood Company, and Pacific Watershed Associates worked with resource agencies to develop and fund restoration efforts on the South Fork of the Garcia River, important habitat for CCC coho salmon. This partnership and their initial efforts prevented 70 percent of estimated road-related sediment from reaching the river, equivalent to 3,500 full dump trucks.

NCCP is a conservation initiative on a large spatial scale. In partnership with timber and gravel companies, wine industry leaders, private landowners, and state and federal agencies, the NCCP is working cooperatively to restore CCC coho salmon habitat. The NCCP's efforts include: assessing watershed conditions, developing and implementing projects to reduce sediment delivery to streams, installing large wood to provide cover and diversify instream habitat, and removing fish passage barriers. NCCP also significantly benefits local economies by creating jobs via focused watershed assessments, restoration construction, and fisheries population monitoring. NCCP's ability to foster new and strengthen existing partnerships with public and private landowners in Mendocino, Sonoma, and Marin counties has accelerated progress on key actions identified in the 2021–2025 Priority Action Plan and CCC Coho Salmon Recovery Plan.

Since 2008, the NCCP has raised and leveraged nearly $25 million for habitat restoration for more than 75 individual projects. NCCP was also a key participant in the SHaRP efforts. The NCCP team attended every watershed meeting, served on expert panels, and provided technical knowledge and insight, resulting in priority restoration actions identified by reach to address the most limiting factors. NCCP has received more than $6 million in grant funding through the Bipartisan Infrastructure Law, Restoring Fish Passage through Barrier Removal funding opportunity. This funding will support the removal of nine partial or total barriers in Mendocino County by constructing seven projects and designing two additional projects. The NCCP team has been instrumental in moving habitat restoration forward, and their ability to form diverse partnerships has been key in CCC coho salmon recovery efforts.

50TH ANNIVERSARY ENDANGERED SPECIES ACT

SPECIES *in the* SPOTLIGHT

COOK INLET BELUGA WHALE DPS

The endangered Cook Inlet beluga whale (*Delphinapterus leucas*) has been in decline since 1979. Where once there were an estimated 1,300 of these white whales adjacent to Alaska's most populous region, only an estimated 331 remain. The rapid decline and dire status of the Cook Inlet beluga whale population makes it a priority for NMFS and our partners to prevent extinction and promote recovery of this iconic population. The majority of the decline likely resulted from unregulated subsistence hunting but, almost 20 years after the hunting ceased, the population has failed to increase in numbers. We have yet to fully understand the reasons why this beluga whale population is not recovering. Key threats identified in the 2016 Recovery Plan are: noise, catastrophic events, cumulative effects of multiple stressors, disease agents, habitat loss or degradation, reduction in prey, unauthorized take, pollution, predation, and subsistence hunting.

Recovery Progress

In 2021–2022, we made substantial progress on the key actions identified in the 2021–2025 Priority Action Plan for the Cook Inlet beluga whale: (a) continue to improve understanding of why Cook Inlet beluga whales are not recovering by enhancing the stranding response program, (b) reduce the threat of anthropogenic noise in Cook Inlet beluga whale habitat, (c) protect habitats that support foraging or reproduction of Cook Inlet beluga whales, (d) gain a better understanding of population characteristics of Cook Inlet beluga whales to ensure effective management actions result in recovery, and (e) ensure healthy and plentiful prey are available.

Tail fluke of a Cook Inlet beluga whale. Credit: NMFS/Paul Wade (Permit #20465)

Continue to improve understanding of why Cook Inlet beluga whales are not recovering by enhancing the stranding response program

It is important to determine causes of death (mortality), the extent to which diseases (morbidity) may limit the Cook Inlet beluga population's ability to recover, and how mortality and morbidity may be changing over time. This information is obtained by Alaska Marine Mammal Stranding Network members and scientists, who perform necropsies of dead stranded Cook Inlet beluga whales. Recent studies from this work indicate that common causes of death include impacts from live stranding, trauma, malnutrition, and perinatal mortality, as well as a variety of diseases. In order to obtain this biological information, we need to find and respond to dead whales before the process of decay has become too advanced. To this end, NMFS continues to redouble its efforts to inform local pilots and members of the public to quickly report sightings of dead (or live-stranded) animals so members of our stranding network can respond rapidly.

NMFS continues to distribute stranding response kits to specially trained and authorized partners, giving them the tools to conduct thorough field examinations of beluga carcasses when strandings occur. We updated and revised the stranding response plan to include sample collection protocols and we are currently updating the Cook Inlet beluga whale stranding response plan. NMFS also continues to work to improve service agreements for stranding response, including flight support, veterinarians, and pathologists. We improved coordination with our partners in stranding response to encourage reporting of dead and live beluga whales, with a 10-year average response rate of 81 percent. We continue to improve awareness of the stranding hotline via NMFS websites and partner websites, media stories, public service announcements, outreach events, and internet search engines. We have also continued our social media presence and our partners have several Facebook and Instagram pages specifically for Cook Inlet belugas that have a large followership who have been active in reporting sightings. We promote timely reporting of strandings at public events, including an annual beluga workshop at the Alaska Marine Science Symposium, numerous in-school presentations, outreach booths at large public events (e.g., boat, plane, and sportsman's shows), the annual Belugas Count! celebration, and community science monitoring sessions. We continue to develop new educational materials with the stranding hotline number and install signs at pullouts along public roadways adjacent to Cook Inlet, Alaska.

A Cook Inlet beluga calf swims in the Inlet waters. Credit: The Cook Inlet Beluga Whale Photo-ID Project/Tamara McGuire

Reduce the threat of anthropogenic noise in Cook Inlet beluga whale habitat

Cook Inlet beluga whales are a very difficult species to study. The extraordinarily silty water they live in makes them impossible to see except for the portions of their bodies that break the surface of the water. Thirty-foot tides (the highest in the United States) and miles-wide mudflats make boating extremely dangerous. For a third of the year, belugas dwell among large chunks of ice that swift tides wash back and forth. While the harsh conditions may help protect Cook Inlet belugas from predatory killer whales, this dynamic environment severely hinders our ability to understand what may be limiting their recovery. The turbid waters also limit the whales' ability to see their food and each other. They see their world through echolocation, which makes noise pollution in Cook Inlet a potentially serious problem. Cook Inlet is a naturally noisy environment at times, given the hiss of glacial silt in the water, the rushing tides moving rubble on the bottom, and the cracks and rumbles of shifting ice during much of the year. Although belugas in Cook Inlet live in an area where visibility is severely limited and the habitat is naturally noisy, they have managed to adapt to these conditions. What they have perhaps not adapted to as well is human-caused noise from activities such as pile driving, seismic exploration, oil and gas rigs, ship traffic, and military operations.

Manolo Castellote (NOAA Affiliate, University of Washington CICOES) and Chris Garner (DoD, Joint Base Elendorf-Richardson) retrieve acoustic recording equipment from the shore of Knik Arm in upper Cook Inlet. Credit: NMFS

A partnership of scientists from NMFS and the Alaska Department of Fish & Game (ADF&G) has been deploying passive acoustic monitors around key locations in Cook Inlet to identify beluga seasonal feeding grounds and to better understand noise in these waters and its potential effects on belugas. Since 2020, 13 locations in Cook Inlet have been acoustically monitored seasonally or year-round to identify seasonal feeding grounds and to capture data on anthropogenic noise levels, with a goal of characterizing how noise may affect foraging.

With support from the Bureau of Ocean Energy Management (BOEM), NMFS has also deployed Cetacean and Porpoise Detectors, which detect the echolocation clicks of toothed whales (like belugas), dolphins, and porpoises, at four key river mouths in lower Cook Inlet. These detectors classify groups of potential echolocation signals based on the intensity, duration, frequency content, and variation in inter-click intervals. These efforts provide temporal data on beluga activity such as presence, feeding behavior, or habitat usage.

NMFS is finalizing a Population Consequences of Disturbance model, which will assess the degree to which anthropogenic disturbance, and in particular noise, may impact survival and reproduction of Cook Inlet belugas during different life stages, and will evaluate the impacts of hypothetical noise-producing anthropogenic activities that are representative of the actions anticipated in the near future in Cook Inlet.

NMFS works with applicant agencies and industries to develop and implement measures to mitigate the impact of noise in Cook Inlet, including operational windows that reduce noise in seasonally important foraging and calving habitat, and marine mammal monitoring to prevent injurious noise exposure to the whales. In addition, NMFS conducts public education and outreach to encourage "beluga friendly" watercraft to reduce the impact of noise and disturbance from such activities.

Protect habitats that support foraging or reproduction of Cook Inlet beluga whales

Directly across Cook Inlet from Anchorage lies the Susitna River Delta, which appears to function as the very core of essential habitat for these whales in the summer months with its plentiful salmon and eulachon runs. At times, a very large proportion of the population has been sighted congregating there. The Susitna River Delta has also been identified by surveys as an important calving area. This information about foraging and reproduction has led NMFS to give special consideration to protecting the habitat in this area during ESA section 7 consultations.

Although we now have a good understanding of areas important to Cook Inlet belugas in the summer, we have historically known little about their winter habits. In an attempt to better document beluga distribution and habitat during non-summer months, NMFS partnered with BOEM to implement winter aerial

Cook Inlet beluga mother and calf pair. Credit: The Cook Inlet Beluga Whale Photo-ID Project/Tamara McGuire

surveys from 2018 to 2022. The effort has provided valuable information on important wintering areas such as the upper inlet, Kenai River, Tuxedni Bay, and around Kalgin Island, which is being used to inform management decisions and development of mitigation measures.

Gain a better understanding of population characteristics of Cook Inlet beluga whales to ensure effective management actions result in recovery

Our best range-wide population monitoring information for Cook Inlet belugas comes from aerial surveys conducted by NMFS in the summer since 1993. These surveys help estimate the abundance of Cook Inlet belugas throughout their range. The most recent survey was completed in June 2022, producing a median abundance estimate of 331 individuals. This recent estimate is an increase from the previous (2018) median estimate of 279, providing hope that the population may be stabilizing and/or increasing; however, wildlife population numbers commonly fluctuate inter-annually, and additional years of survey data will be needed before conclusions can be drawn.

Since 2005, NMFS has also supported the Cook Inlet Beluga Whale Photo ID project, which tracks individual beluga whales in Cook Inlet via oblique photographs taken from shore and small boats. Sighting histories are compiled for each known individual in a Cook Inlet beluga photo-ID catalog, providing information on distribution, habitat use, social structure, and reproduction. Since 2017, NMFS has also been employing small unmanned aircraft to collect aerial imagery of belugas to estimate calf production and add to the existing photo-ID catalog. We have been partnering with entities specializing in artificial intelligence photo recognition to develop an automated photo-matching process, allowing for faster processing of photographic data.

Since 2016, NMFS has collected data on individual whales by obtaining biopsy samples from Cook Inlet belugas to provide data on genotypes to identify individuals, maternal/paternal relationships, the age of whales using epigenetic methods, health indicators from gene expression and skin microbiomes, pregnant females and sexually mature males, hormone stress levels, contaminant loads, and other important parameters.

An Alaska Wildlife Conservation Center employee monitors for Cook Inlet beluga whales in upper Turnagain Arm, Cook Inlet. Credit: Alaska Beluga Monitoring Partnership

In 2019, NMFS initiated the Alaska Beluga Monitoring Program. This NMFS community science program, supported by multiple partners, trains volunteers to collect data on beluga distribution and habitat and coordinates their shore-based beluga monitoring at five sites throughout Cook Inlet. The data collected are shared with biologists to inform ongoing marine mammal research and management activities and are displayed in the Cook Inlet Beluga Whale Sightings Portal. This publically accessible portal is the result of a partnership between NMFS, Axiom, and the Alaska Ocean Observing System.

Ensure healthy and plentiful prey are available

The Cook Inlet beluga population remains suppressed either because they are not reproducing fast enough or their survival rates are too low, or both. The availability of sufficient food could affect either or both of these factors. In order to understand if there is sufficient prey for Cook Inlet belugas, we need to understand the whale's nutritional needs for healthy growth and reproduction.

In 2018, NMFS partnered with the Georgia Aquarium and University of California Santa Cruz for an ongoing study to determine the energetic requirements and metabolic needs of belugas. Data on oxygen consumption of resting and diving whales housed at Georgia Aquarium were correlated with their overall body condition and daily caloric food intake. This will allow metabolic demands of the whales to be matched

Cook Inlet beluga whale. Credit: NMFS/Paul Wade (Permit #20465)

to potential prey resource needs and applied to the wild Cook Inlet beluga population. Data from Phase 1 of this study have been incorporated into the previously described Population Consequences of Disturbance model to address whether sufficient prey resources are available in the Cook Inlet ecosystem to support the beluga population and to assess the impact various sources of disturbance may have on beluga physiology.

In addition, NMFS is working to identify year-round distribution and abundance of beluga prey in rivers and streams throughout Cook Inlet. In 2020 and 2021, we conducted a pilot project using eDNA to identify fish species present in the Twentymile and Kenai rivers during months when belugas are using the area. This tool is greatly expanding our understanding of what is available for belugas to eat, particularly during the winter months, which has not been well documented previously, and a collaborative effort aimed at expanding eDNA sampling efforts across the population's range is now underway.

Other Recovery Progress

In addition to addressing the actions identified in the 2021–2025 Priority Action Plan, NMFS continues to pursue a diversity of activities supporting conservation and recovery of the Cook Inlet beluga whale.

Federal and Cook Inlet beluga recovery work is guided and informed by the multi-partner Cook Inlet Beluga Whale Recovery Implementation Task Force, coordinated by NMFS and ADF&G. The primary role of the Task Force is to engage the expertise of researchers, managers, communicators, and various other stakeholders to advise NMFS and ADF&G on specific topics or issues relating to Cook Inlet beluga recovery. During 2021–2022, the Task Force committees accomplished multiple goals, including the initiation of subcommittees focused on evaluating and addressing contaminant, prey, and habitat restoration issues (Habitat and Threats Committee); development of virtual and printed educational outreach materials (Outreach Committee); and coordination and tracking of research projects and fieldwork (Research Committee).

After a 2-year pandemic pause, September 2022 heralded the return of Belugas Count!, Alaska's largest 1-day marine mammal outreach event. The event is hosted by NMFS with support from more than 20 partners from government agencies, universities, NGOs, tribes, industry, zoos, and aquaria across the country. The 2022 event, which featured 30 beluga observation stations, was attended by more than 1,000 members of the public, with another 32,000 people engaging virtually.

Also in September 2022, NMFS released the new 5-year review on the status of the Cook Inlet beluga whale. Five-year reviews are periodic analyses of a species' status conducted to ensure that the listing classification of a species as threatened or endangered is accurate. Based on the best available scientific and commercial information, NMFS determined that the Cook Inlet beluga whale DPS should remain listed as endangered.

In addition to community science efforts such as Alaska Beluga Monitoring Program, Belugas Count!, and other outreach described above, during 2021–2022 NMFS encouraged media coverage and produced public service announcements regarding Cook Inlet belugas. In fall 2022, Public Broadcasting Service aired an episode of Molly of Denali, an award-winning children's cartoon dedicated to Belugas Count! and Cook Inlet beluga whales.

Looking Ahead

In collaboration with our partners, we are continuing to improve our knowledge of Cook Inlet beluga whales and their habitat needs. The most recent abundance estimate indicates slight growth of the population, which is heartening; however, we have not yet definitively identified the root cause(s) for the population's lack of sustained growth to date. Research efforts will continue to focus on that task, which is key to the successful recovery and long-term conservation of the Cook Inlet beluga whale.

PARTNER *in the* SPOTLIGHT: Teresa Becher, Intern/Volunteer, University of Alaska Anchorage, Kenai Peninsula College & Alaska Wildlife Alliance

Credit: Allison Gardell, Kenai Peninsula College

In 2013, Teresa Becher retired from 25 years of service as a peace officer for the California Highway Patrol and moved to Soldotna/Kenai, Alaska, where she returned to school and earned her undergraduate degree in Natural Science from the University of Alaska, Anchorage, with a focus on pre-veterinary medicine. Teresa became intrigued by Cook Inlet beluga whales and, through the NMFS Alaska Beluga Monitoring Program (AKBMP), Alaska Wildlife Alliance, and University of Alaska's Kenai Peninsula College, began monitoring them in the Kenai Peninsula area. In 2019, she became the Kenai and Kasilof Beluga Monitoring Coordinator for the Alaska Wildlife Alliance and Kenai Peninsula College.

As of the beginning of 2023, Teresa has logged 378 hours of monitoring with AKBMP. As a result of her efforts and contributions by other volunteers and community members, the Kenai monitoring site consistently has the longest number of days monitored in a row during both the spring and fall monitoring seasons. This total does not include a substantial amount of monitoring that she conducts outside of that program; she is often seen in Kenai and Kasilof collecting opportunistic sighting data and providing support for newer beluga monitors. Teresa is well known in the Kenai Peninsula community and has trained many of the AKBMP volunteers who monitor in the Kenai area. She also dedicates tremendous time and energy to engaging with the local community to educate on the endangered beluga population, promote AKBMP, and recruit new volunteers. In her role with the Alaska Wildlife Alliance, Teresa runs the organization's beluga text alert system, which sends texts to the public when belugas are sighted in the Kenai River. This system both bolsters public enthusiasm for Cook Inlet belugas and alerts fishermen and other recreators on the river of the presence of the imperiled whales so that they can keep an eye out and avoid the whales.

Teresa has also supported NMFS' Cook Inlet beluga eDNA research since its inception, working with Kenai Peninsula College professors to collect samples at the Kenai River through every month of the year, and training students on sample collection. This eDNA work is invaluable in providing information about the seasonal presence of both belugas and their prey in the Kenai area. In addition, she is a key contact for AKBMP partner organizations, graduate students, and other researchers engaged in Cook Inlet beluga recovery efforts on the Kenai Peninsula.

A true team player, Teresa credits all of her mentors and collaborators for the success of her work. However, it is Teresa's passion and dedication to Cook Inlet belugas that inspire recovery partners, students, and the public, and her contributions continue to have a lasting impact on Cook Inlet beluga conservation across the Kenai Peninsula region.

50TH ANNIVERSARY ENDANGERED SPECIES ACT

SPECIES *in the* SPOTLIGHT

HAWAIIAN MONK SEAL

The Hawaiian monk seal (*Neomonachus schauinslandi*) is the world's only surviving tropical seal species. Hawaiian monk seals are endemic to the Hawaiian Archipelago, which stretches 1,500 miles from Hawai'i Island to Kure Atoll. While the predominant trend has been a steep population decline since the 1950s, the past 10 years of population assessments, recovery interventions, partnership growth, and time as a NMFS *Species in the Spotlight* have yielded some encouraging results.

The 2022 annual population assessment showed that Hawaiian monk seals have increased in numbers by about 2 percent annually since 2013, reversing at least six decades of steep population decline. The population is now estimated to be around 1,600, with roughly 1,200 of those seals in the Northwestern Hawaiian Islands and approximately 400 in the main Hawaiian Islands. This recent growth trend is due to increased juvenile survival and stability or growth of those six subpopulations in the Northwestern Hawaiian Islands. Simultaneously, there is population growth in the main Hawaiian Islands. Although this recent trend is encouraging, monk seal numbers are still at one-third of historical population levels, and there is still much work to be done to address threats to their recovery.

Recovery Progress

In 2021–2022, we made substantial progress on the key actions identified in the 2021–2025 Priority Action Plan for the Hawaiian monk seal: (a) improve survival of juvenile and adult female seals in the Northwestern Hawaiian Islands; (b) mitigate human-seal interactions to ensure natural population growth and minimize conflict; (c) address diseases with population level impacts; and (d) foster community support for monk seal recovery.

Hawaiian monk seal. Credit: NMFS

Juvenile Hawaiian monk seals rest on the beach at French Frigate Shoals in the Northwestern Hawaiian Islands. Credit: NMFS/Mark Sullivan (Permit #22677)

Improve survival of juvenile and adult female seals in the Northwestern Hawaiian Islands

Following a 1-year break in presence of our Hawaiian Monk Seal Research Program (HMSRP) in the Northwestern Hawaiian Islands due to the COVID-19 pandemic in 2020, the program began to reestablish camps again in 2021. During our absence, partners such as the State of Hawai'i and U.S. Fish and Wildlife Service (USFWS) contributed to surveys, interventions, and tagging efforts. Additionally the Papahānaumokuākea Marine Debris Project removed entrapment hazards at Tern Island in 2020, creating an enhanced habitat for seals in the area in 2021–2022. A slowed rate of decline leading up to the recent population increase described above is due in many ways to the recovery efforts of NMFS and our partners. A study from 2014 estimated that 30 percent of monk seals were alive at that time because they directly benefited from a lifesaving intervention performed by NMFS with the aid of our partners, such as disentanglement or dehooking, or are the descendant of a female that benefited from an intervention. This gives us confidence that the cumulative efforts of direct, hands-on interventions for individual seals are making a positive impact on the population.

In 2021–2022, we performed 78 interventions in the Northwestern Hawaiian Islands to improve individual seals' survival prospects (30 interventions in 2021 and 48 interventions in 2022). These included translocating pups from high shark predation risk areas to lower risk sites within French Frigate Shoals (Lalo), releasing nine seals entangled in marine debris and one seal trapped behind the Tern Island sea wall, and additional miscellaneous interventions, including administering antibiotics and reuniting separated mothers and pups. Additionally, in 2022, six underweight juvenile seals (five female, one male) were transported from the Northwestern Hawaiian Islands to The Marine Mammal Center's monk seal hospital, Ke Kai Ola, in Kona. One was released via NOAA ship at the end of the 2022 field season, three were released via a U.S. Coast Guard flight at Midway Atoll (Kuaihelani) in March 2023, and the remaining two were released in May 2023 at French Frigate Shoals (Lalo).

Mitigate human-seal interactions to ensure natural population growth and minimize conflict

Monk seals were essentially extirpated from the main Hawaiian Islands for several hundred years, although in the past few decades they have successfully reestablished a small but thriving population. While this is a hopeful sign of recovery for the species, they were not universally greeted with a warm reception at first. Additionally, close proximity to a growing human

NMFS team carefully prepares to transport an underweight Hawaiian monk seal pup for rehabilitation. Credit: NMFS (Permit #18786-06)

population has resulted in human-seal interactions such as harassment of seals hauled out on beaches, fisheries interactions, intentional killings, habituation, and more. A study released in 2020 evaluated causes of death in monk seals in the main Hawaiian Islands from 1992 to 2019, and found that 57 percent of deaths during this period were human-caused. However, there has been a noticeable positive shift in public attitude in the past 5 to 10 years, partially because seals have now been in the main islands long enough that younger residents have grown up seeing monk seals their whole lives and view them as an integral part of the marine ecosystem. The shift is also due in part to the work of NMFS, our partners, and community members sharing information, educating the public, engaging with communities, and encouraging peaceful human-seal coexistence.

In order to maximize our effectiveness, we administered several grants during 2021–2022, including providing funds for an ongoing Species Recovery Grant issued under Section 6 of the ESA to the Hawai'i Department of Land and Natural Resources (DLNR), which focused primarily on promoting recovery in the main Hawaiian Islands through public outreach and education. We also awarded grants to NGOs to help address a variety of human-seal interactions in multiple ways, including reducing disturbance of hauled-out seals and conducting outreach at locations with heavy fishing pressure where seals are known to take bait or catch off of active lines. These grants improve the efficiency of our statewide marine wildlife emergency response program, which includes responding to hooked and entangled seals. With the help of our grantees, we were able to successfully de-hook six seals in 2021–2022. We were also able to trim the fishing line and gear from six additional hooked seals so that the hooks came out on their own. Nevertheless, the human-seal interaction of hookings and entanglements in state-managed nearshore fisheries continue to pose a significant recovery threat. We will continue to work with federal, state, and NGO partners to monitor fisheries interactions and explore strategies to reduce injury and mortality, while ensuring that fishing catch and gear remain protected.

Address diseases with population level impacts

Our program remains focused on morbillivirus and toxoplasmosis—two diseases that are very different but carry serious potential consequences for monk seals. Morbilliviruses are widespread, and outbreaks of the disease have caused the deaths of tens of thousands of marine mammals around the world. This family of viruses includes measles, which human children are immunized against, and distemper, for which vaccines are standard in pet dogs and provide important protection for terrestrial carnivores such as the endangered black-footed ferret. The disease has not yet been documented in Hawaiian monk seals, but could potentially be spread by unvaccinated dogs or from other marine mammals such as cetaceans or other pinniped species that make it to our coastlines on rare occasions. Once introduced into the small population of monk seals, without an intervention like NOAA's Vaccination Program, an outbreak could set back recovery for decades, or eliminate hope for the species altogether. In 2022, a total of 95 seals received at least two full doses of morbillivirus vaccine and are considered fully vaccinated. Since its inception in 2015, this program is the first-ever effort to vaccinate a wild marine mammal species, and we continue to share knowledge about our program's development to help inform future efforts to vaccinate marine wildlife against preventable diseases and safeguard populations against potentially devastating losses.

Since the mid-2010s, it has become apparent that toxoplasmosis poses a major threat to the endangered Hawaiian monk seal. Because of its disproportionate

impact on females, a study published in 2020 concluded that this disease is limiting population growth in the main Hawaiian Islands. Cats are the sole definitive hosts of the protozoal parasite Toxoplasma gondii, which spreads when the cat sheds the oocysts in their feces. Without cats the parasite cannot persist. On the island of O'ahu alone, coarse estimates of feral cats are in the tens to hundreds of thousands. This means that fecal contamination of the environment is widespread, and it only takes ingestion of one oocyst to cause infection. This disease is often rapidly lethal in Hawaiian monk seals and has also affected other wildlife in Hawai'i. It is considered a One Health threat, meaning it impacts the health of humans, pets, livestock, and wildlife. Feral, abandoned, and other outdoor cats (also called "at-large" cats) have substantial, documented negative impacts on other wildlife as well, and are responsible for numerous mammal, reptile, and bird species extinctions around the world.

The 15 known Hawaiian monk seal deaths from toxoplasmosis to date are likely a significant underestimate, as NMFS is unable to recover every monk seal carcass. Of those we do recover, some have decomposed beyond the point where identification of diseases like toxoplasmosis is possible. Thus, our ability to mitigate this threat is complicated not only by a paucity of preventive or curative measures but also because NMFS has no jurisdiction over cats or the terrestrial ecosystems they inhabit. Furthermore, many policy and management actions enacted or proposed in an attempt to manage at-large cats are frequently opposed by some vocal constituencies.

An interagency working group, the Toxoplasmosis and At-large Cat Technical Working Group, was co-founded by NMFS and DLNR in May 2016. This working group, consisting of county, state, and federal agency representatives, continues to grow and develop, reaching out to potential partner agencies, engaging with stakeholders, discussing community outreach messaging, forming collaborative partnerships with cat welfare organizations, and organizing symposia at local and national conservation conferences, among other actions. Through this partnership and a growing number of coalitions—including local, national, and multi-stakeholder partnerships with agencies, universities, NGOs, and cat welfare organizations—we have greatly increased our capacity to address this issue. In 2021–2022, the working group began to develop the Pono Cat Parent Partnership. This partnership provides resources for anyone to contribute to a healthy system for humans, pets, and Hawaiian wildlife. Cat owners can take responsibility for protecting Hawaiian monk seals by taking a Pono Cat Parent Pledge, which includes pet owners keeping their cats indoors to protect the natural resources of Hawai'i, among other actions. Efforts to change the behavior of pet owners and educate them about the impacts cats have on the landscape in Hawai'i continue to gain momentum.

Hawaiian monk seal nurses a pup (left) and a weaned pup on the beach at Kalaupapa on Moloka'i (right). Credit: NMFS

Foster community support for monk seal recovery

Hawaiian monk seal pup. Credit: NMFS

Community support and engagement are cornerstones of our recovery program, and they dovetail in the form of a dedicated network of volunteers. Volunteers across the islands work with various partner agencies and organizations to report seal sightings and observe seals on local beaches. Volunteers also spend many hours answering questions and educating visitors and community members about Hawaiian monk seal biology and conservation, as well as proper conduct around seals. The COVID-19 pandemic was a challenging obstacle to fostering volunteer and community engagement. By relying on our partners, implementing best practice safety measures like social distancing, and working within the boundaries of the local emergency proclamations, efforts were adapted to keep boots on the ground. We continue to support the volunteer network through grants to partner agencies and NGOs such as The Marine Mammal Center and Hawai'i Marine Animal Response, who are essentially our eyes and ears on the beach on several islands.

Citizen science is an incredibly useful tool, since we cannot track all seals at all times. Seal sightings called into our statewide hotline were incorporated into a recent research effort that used this citizen science data to account for unobserved pupping events (e.g., a sightings gap combined with timing of molt might indicate that a female had a pup and we just did not observe it), which helps give us a better picture of the health and growth trends of the main Hawaiian Islands population.

Looking Ahead

At the time this report is published, we will be about midway through the performance period of our 2021–2025 Priority Action Plan for the Hawaiian monk seal. Our efforts have already resulted in increasing population trends in some parts of the species' range, bolstering the overall growth trend, which is increasing for the first time in decades. We continue to monitor the implications of climate change across the management units of monk seals. Habitat loss due to sea level rise in the Northwestern Hawaiian Islands is a primary threat, as approximately 70 percent of the population are located in these remote areas. The exact impacts of climate change on monk seals in the main Hawaiian Islands are complex and include the effects of rising water temperatures, impaired water quality, and increased invasive species. We continue to build program capacity through coordination and partnerships, support sustainable fishery management, sustainable coastal development, and control of non-native and invasive species, and play a role in climate change planning and response. Although much more work remains before the species fully recovers, NMFS and our partners have made significant headway in reducing the extinction risk of Hawaiian monk seals through implementation of the four priority actions listed in our 5-year action plan.

Emerging from the challenges of the COVID-19 pandemic, we are excited to combine our newly enhanced virtual collaboration abilities with reinvigorated in-person efforts to more effectively promote recovery and empower our partners and stakeholders. In addition to continuing work on the actions listed in the 5-year action plan, we intend to complete a revision of the Hawaiian monk seal recovery plan and to roll out a toxoplasmosis threat reduction plan in close coordination with our government and non-government partners. With the continued support of Congress, our partners, and our stakeholders, we are hopeful that we will be able to share more good news about community-based Hawaiian monk seal recovery in our next report.

PARTNER *in the* SPOTLIGHT: Hawai'i Marine Animal Response

In 2023, we recognized Hawai'i Marine Animal Response (HMAR) as a Partner in the Spotlight for expanding and enhancing recovery of Hawaiian monk seals—one of our most imperiled marine species.

HMAR operates on the islands of O'ahu and Moloka'i working with Hawaiian monk seals and other marine protected species. Since partnering with NOAA in 2016, their 80+ volunteers, interns, and staff have spent countless hours conducting field responses for Hawaiian monk seals on shore and have deployed team members to the field to provide support activity. HMAR has responded to stranded seals and newborn pups, monitored injured and compromised individuals, helped collect important health and stranding response data, and developed unique education projects for community members.

"We feel honored to be able to take an active role in the recovery of the Hawaiian monk seal population and to be a key NOAA partner in this endeavor," states founder and president Jon Gelman.

Credit: Hawai'i Marine Animal Response

Outreach and education are key to HMAR's work. Their efforts to educate the public in the field are complemented by their work in schools and local events around the islands. Educational programs in schools include the naming of monk seal pups using protocols developed by Hawaiian educators, which creates a strong sense of *kuleana* (responsibility) within students and teachers for the stewardship of monk seals.

"HMAR has been a wonderful partner for many years. The dedication of HMAR's staff and volunteers is an inspiration for us at NMFS. With all their hard work and long hours watching over seals and working in our communities, HMAR has played a big role in the significant increase we've seen in public awareness and support for Hawaiian monk seal conservation," said Sarah Malloy, Acting Regional Administrator for the NMFS Pacific Islands Regional Office.

In 2017, we all got a big surprise when RH58 "Rocky" gave birth to RJ58 "Kaimana" (Diamond), the first pup ever born in busy Waikīkī. This was the beginning of adaptive management for Waikīkī pupping. Volunteers and staff of HMAR continue to rise to the challenge of being the boots on the ground, working alongside NOAA and other entities to create a safe environment in this highly trafficked beach area.

"Our team works incredibly hard 12 hours a day, 7 days a week—and it's worth every ounce of effort we put in because we're all so committed to the recovery of this species," reflects Jon Gelman. "Hawaiian monk seals are special biologically and culturally, and it's a happy day any time we're able to help even one seal."

50TH ANNIVERSARY ENDANGERED SPECIES ACT

SPECIES *in the* SPOTLIGHT

NORTH ATLANTIC RIGHT WHALE

The North Atlantic right whale (*Eubalaena glacialis*) is one of the world's most endangered large whale species, with fewer than 350 individuals remaining. North Atlantic right whales (also referred to as "right whales" in this section) have been listed as endangered under the ESA since it was enacted in 1973 and are also protected under the Marine Mammal Protection Act (MMPA). Commercial whaling decimated right whales, bringing them to the brink of extinction. Despite protections put in place, recovery continues to be challenging. After a period of growth, a new population decline began in 2010.

Right whales face a number of complex factors limiting their recovery due to their near constant overlap with human activities along the East Coast, which is further complicated by climate change. Vessel strikes and entanglements in fishing gear are the leading causes of right whale mortality. Emerging threats are associated with industries like offshore wind and aquaculture and rising levels of ocean noise. Since 2017, right whales have experienced an Unusual Mortality Event (UME), which includes dead, seriously injured, and sublethally injured/ill (morbidity) individuals. Partnerships, including transboundary collaborations, are critical for right whale recovery.

Recovery Progress

In 2021–2022, we made substantial progress on the key actions identified in the 2021–2025 Priority Action Plan for the North Atlantic right whale: (a) protect North Atlantic right whales from entanglement in fishing gear; (b) protect North Atlantic right whales from vessel strikes; (c) investigate North Atlantic right whale population abundance, status, distribution, and health; (d) collaborate with Canada on North Atlantic right whale recovery; and (e) improve our knowledge of additional factors limiting right whale recovery.

North Atlantic right whale Viola (#2029) and her calf off the coast of Georgia. Credit: Florida Fish and Wildlife Research Institute (Permit #20556)

Captain Robert Martin prepares a lobster trap with on-demand gear on a training trip aboard a Northeast commercial lobster boat, while NOAA Gear Researchers Eric Matzen and Brian Galvez record operational timing data. Credit: NMFS/Henry Milliken

Protect North Atlantic right whales from entanglement in fishing gear

NMFS continued to work with the Atlantic Large Whale Take Reduction Team to further reduce mortality and serious injury of right whales due to entanglement in U.S. commercial fishing gear. NMFS published a rule to modify the Atlantic Large Whale Take Reduction Plan (September 17, 2021) based on team recommendations, stakeholder input, and conservation equivalencies recommended by state resource agencies. The amendment provides measures to reduce entanglement risk in Northeast lobster and Jonah crab trap/pot fisheries, which represent about 94 percent of the risk from all fisheries covered by the plan. The 2021 rule reduces the number of buoy lines in the water and restricts the use of buoy lines in some areas to decrease the chance of a right whale encountering the lines, and adds weak links or rope that would break at 1,700 lb or below so that, if entangled, a whale has a better chance of breaking free before a serious injury occurs. Together, these measures are expected to reduce risk of death or serious injuries in U.S. fixed-gear fisheries covered by the plan by about 47 percent. The rule also requires state-specific gear marks to identify where entanglements occur, which could influence future plan modifications.

To assist with compliance, we conducted trainings with enforcement agencies and with industry in New England states. As new weak ropes and inserts have been developed by manufacturers, the Regional Administrator has approved them for use by industry, expanding the options available to fishermen substantially.

To address entanglements in the other fisheries under the plan, NMFS held 20 informational webinars and 19 days of team meetings in 2021 and 2022 to discuss additional risk reduction measures. In late 2022, the team provided input regarding substantial measures to reduce mortality and serious injury from all fisheries under the plan, as mandated by the MMPA.[21]

NMFS continues to work closely with state fishery managers, gear specialists, and fishermen to develop and test on-demand (or "ropeless") fishing gear for trap/pot and gillnet fisheries to further reduce the use of buoy lines. We have purchased ropeless gear from a variety of manufacturers for use by fishermen trialing ropeless systems under commercial fishing conditions. In 2021 and 2022, fishermen tested ropeless gear in the lobster and black sea bass trap/pot fisheries, as well as gillnets. To develop and test geolocation technology necessary for wide-scale adoption of ropeless systems, we are collaborating with fishermen, gear manufacturers, and organizations such as Woods Hole Oceanographic Institution, the Allen Institute for Artificial Intelligence, and SeaWorld of Florida.

NMFS publicly shared our vision regarding development and implementation of ropeless fishing in a draft Ropeless Roadmap, which we released for public input in July 2022. The Roadmap outlines a path for increasing adoption of ropeless and gear location technology in East Coast commercial fisheries, including the mobile gear fisheries that need to avoid fixed gear.

21 The Consolidated Appropriations Act, 2023, established that NMFS' 2021 rule amending the Plan (86 FR 51970; Sept. 17, 2021), "shall be deemed sufficient to ensure that the continued Federal and State authorizations of the American lobster and Jonah crab fisheries are in full compliance" with the MMPA and ESA through December 31, 2028. H.R. 2617-1631–H.R. 2617-1632 (Division JJ–North Atlantic Right Whales, Title I–North Atlantic Right Whales and Regulations). This has resulted in a change in the commitments made in the Conservation Framework and under the Plan.

Protect North Atlantic right whales from vessel strikes

In light of findings from a 2020 Right Whale Speed Rule Assessment of NMFS' current speed regulation and the continued deaths of right whales due to vessel strikes, NMFS published a proposed rule in August 2022 to modify the North Atlantic Right Whale Vessel Strike Reduction Rule. The proposed rule would: 1) modify the spatial and temporal boundaries of current speed restriction areas, currently referred to as Seasonal Management Areas (SMAs); 2) include most vessels between 35 ft (10.7 m) and 65 ft (19.8 m) in length in the vessel size class subject to speed restriction; 3) create a Dynamic Speed Zone framework to implement mandatory speed restrictions when whales are known to be present outside active SMAs; and 4) update the current speed rule safety deviation provision.

These proposed changes are based on a NMFS coastwide collision mortality risk assessment, and updated information on right whale distribution, vessel traffic patterns, and vessel strike mortality and serious injury events. Changes to the existing vessel speed regulations are essential to stabilize the ongoing right whale population decline and prevent the species' extinction. We received approximately 90,000 public comments on the proposed rule.

While the rulemaking process is underway, the current speed regulations remain in effect, and we use outreach and education to encourage mariners to slow down voluntarily even when not required. In 2021–2022, we continued the Dynamic Management Area (DMA) program throughout the United States and the "Right Whale Slow Zones (Slow Zone)" campaign in the Northeast United States, asking all vessel operators to slow down or avoid areas for 15-day periods when right whale detections meet a visual or acoustic detection threshold. For each new Slow Zone and DMA, information is distributed through U.S. Coast Guard and NOAA weather radio broadcasts, and emails to maritime distribution lists. The Slow Zone campaign followed a recommendation from the Northeast Implementation Team (NEIT) for right whale recovery to use passive acoustic detections (e.g., as a criteria to trigger dynamic speed restrictions) in vessel strike management, which has subsequently been incorporated into the proposed vessel strike reduction rule.

In the past 2 years, we have continued to work closely with our partners, like the Southeast Implementation Team (SEIT), NEIT, state wildlife agencies, U.S. Coast Guard, NOAA weather radio, and the maritime and whale watching industries, to coordinate messaging about the lethal risk of vessel strikes. This included email and social media reminders about minimum distance regulations (500 yards), a web story about the need for boaters to reduce speeds where whales may be, distribution of "See a Spout? Watch Out!" brochures to boaters during safety inspections and training courses, and sharing the proposed rule widely (e.g., at the 2022 conference for the National Association of State Boating Law Administrators).

Investigate North Atlantic right whale population abundance, status, distribution and health

Over the past 2 years, NMFS and the Working Group on Marine Mammal UMEs have continued to work closely with a team of U.S. and Canadian experts to investigate and monitor the right whale UME. On October 14, 2022, we implemented a new morbidity protocol to evaluate and include morbidity (sublethal injury/illness) cases in the UME, alongside serious injury and mortality.

We supported the efforts of the North Atlantic Right Whale Implementation Team's Right Whale Population Evaluation Tool (PET) Subgroup to develop a population viability analysis to determine right whale extinction risk and help guide recovery efforts. Key to this analysis is the unobserved or "cryptic" mortalities identified by Pace et al.,[22] as the total estimated mortality far exceeds the number of recovered carcasses.

NMFS also continues to prioritize and fund a combination of passive acoustic, aerial, and vessel surveys for right whales from Florida to Canada, working with federal and state agencies, and research organizations (e.g., Florida, Georgia, Maine, Massachusetts, New York, Clearwater Marine Aquarium Research Institute, New England Aquarium, Center for Coastal Studies, and the U.S. Coast Guard, U.S. Navy, and U.S. Army Corps of Engineers). We

22 Pace, R.M. III, Williams, R., Kraus, S.D., Knowlton, A.R., and Pettis, H.M. Cryptic mortality of North Atlantic right whales. 2021. Conservation Science and Practice; 3:e346.

Two adult female North Atlantic right whales, Chianti (#3430) and Derecha (#2360), cooperatively skim feeding. Credit: NMFS/Peter Duley (Permit #17355)

also continued to collaborate with the New England Aquarium on curating the photo-ID catalog, and with Wild Me to improve artificial intelligence techniques for semi-automated photo-identification.[23] In 2021, we launched the Passive Acoustic Cetacean Map to help analyze and share acoustic data. NMFS and our partners continue to collaborate on right whale tagging efforts, and we have started to explore the use of very high resolution satellite imagery to document whale distribution.[24] Drones have also been used for right whale photogrammetry and exhalation sample collection to assess right whale health and physiological state.

NMFS completed the 2022 North Atlantic Right Whale Five-Year Review in December 2022, as required by the ESA. The review concludes that right whales should remain listed as endangered, and provides recommendations for NMFS to promote recovery until the next review in 2027. These recommendations focus recovery efforts on increasing the understanding of threats facing right whales and gaining insight into the best approaches to mitigate them.

Collaborate with Canada on North Atlantic right whale recovery

The United States and Canada actively collaborate on the recovery of right whales through ongoing bilateral discussions. In 2021 and 2022, this included regular meetings at the staff and leadership levels, both nationally and regionally, to share information and coordinate on science and management. For example, the United States-Canada Bilateral North Atlantic Right Whale Working Group (NMFS, Fisheries and Oceans Canada (DFO), and Transport Canada) shares lessons learned, explores research collaborations, and coordinates between meetings.

At the June 2021 meeting, the working group discussed fishing and vessel regulations, joint scientific activities (e.g., aerial surveys), and additional collaborations across all right whale efforts (e.g., UME, NEIT, etc.). This included the U.S. Mexico Canada Agreement (USMCA) North Atlantic Right Whale Project, which began in 2021 and provides $3.1 million for right whale recovery. Through this collaborative initiative, NMFS and the Government of Canada are working

23 Khan, C., Blount, D., Parham, J., et al. 2022. Artificial intelligence for right whale photo identification: from data science competition to worldwide collaboration. Mammalian Biology; 102, 1025–1042.

24 Khan, C.B., Goetz, K.T., Cubaynes, H.C., Robinson, C., Murnane, E., Aldrich, T., Sackett, M., Clarke, P.J., LaRue, M.A., White, T., et al. 2023. A Biologist's Guide to the Galaxy: Leveraging Artificial Intelligence and Very High-Resolution Satellite Imagery to Monitor Marine Mammals from Space. Journal of Marine Science and Engineering; 11(3):595.

Adult male North Atlantic right whale #1328, unknown age, first sighted in 1983. Credit: NMFS/Peter Duley (Permit #17355)

together to improve transboundary understanding of right whale distribution, including filling data gaps; enhancing transboundary efforts to monitor and assess right whale health; and furthering the development of innovative fishing gear technologies to reduce the risk of entanglement. These efforts relate to USMCA articles 24.8 (Multilateral Environmental Agreements), 24.12 (Marine Litter), 24.18 (Sustainable Fisheries Management), and 24.19 (Conservation of Marine Species), and provide funding to complement the extensive right whale protection measures and programs in place in the United States and Canada. This initiative complements other coordination efforts between NMFS and the Government of Canada on science and management needs for the conservation and protection of right whales in both Canadian and U.S. waters. Building off of the USMCA project, from December 4–7, 2022, a workshop was held in Montreal to initiate a transboundary collaboration between the United States and Canada, including but not limited to key experts from government agencies, to develop a species distribution model (or set of models) for right whales across their North American range.

In 2021–2022, we benefited from cross-collaboration with Canada on the NEIT, PET Subgroup, and the North Atlantic Right Whale UME Core Team. We will continue collaborations with DFO and Transport Canada on both management and science.

Improve our knowledge of additional factors limiting North Atlantic right whale recovery

In 2021–2022, we worked with partners to understand the effects of several emerging threats that may affect right whale recovery going forward, such as rising levels of ocean noise, offshore wind development, and aquaculture. These threats may also exacerbate the known threats of vessel strikes and entanglement. Climate change presents an ongoing and emerging threat.

- *Climate*: NOAA released a 5-year progress report in 2021 on the Climate Regional Action Plans developed as part of NMFS' Climate Science Strategy to better understand the climate-related information needed to fulfill the agency's mandate. In 2022, we solicited input on draft Climate Regional Action Plans to address climate science needs over the next 3 years; the draft Northeast Regional Action Plan highlights the need to maintain right whale surveys and prey sampling.

- *Wind energy*: We are working with the Bureau of Ocean Energy Management (BOEM) to develop a science and management strategy to promote right whale recovery while responsibly developing offshore wind energy. NOAA and BOEM also collaborated to establish systems for passive acoustic monitoring of offshore wind development.[25] In 2022, NMFS convened a workshop to explore the hydrodynamic and atmospheric alterations caused by offshore wind to the ecosystems that right whales depend on. We also continue to identify best management practices to avoid, minimize, and monitor effects of offshore wind development on right whales, which will help inform project siting and mitigation measures. Additionally, the Regional Wildlife Science Collaborative and Marine Technology Society, in partnership with DOE National Laboratories, with support from DOE and contributions from NOAA and BOEM, is working to host a collaborative workshop series to assess the state of the science regarding technologies, tools, and methods for monitoring marine mammals around offshore wind construction activities.

25 Van Parijs, S.M., Baker, K., Carduner, J., Daly, J., Davis, G.E., Esch, C., Guan, S., Scholik-Schlomer, A., Sisson, N.B., and Staaterman, E. 2021. NOAA and BOEM Minimum Recommendations for Use of Passive Acoustic Listening Systems in Offshore Wind Energy Development Monitoring and Mitigation Programs. Frontiers in Marine Science, 8:760840.

- *Aquaculture*: In 2021, NMFS published a framework for assessing the effects of aquaculture projects in the Greater Atlantic Region through ESA Section 7 consultations. The framework describes the stressors and risks (e.g., entanglement, habitat modification, vessel interaction) to endangered species, including right whales, that should be evaluated. NMFS co-chairs the interagency Subcommittee on Aquaculture, which released a National Strategic Plan for Aquaculture Research in 2022. Research goals include considerations for reducing risk to endangered species from construction and operation.

- *Noise*: In 2022, NMFS released a Summary of Marine Mammal Protection Act Acoustic Thresholds (Summary)[26] to help action agencies and project proponents better assess how marine mammals respond to sound exposure. The summary will support ESA consultations and MMPA incidental take authorizations.

Other Recovery Progress

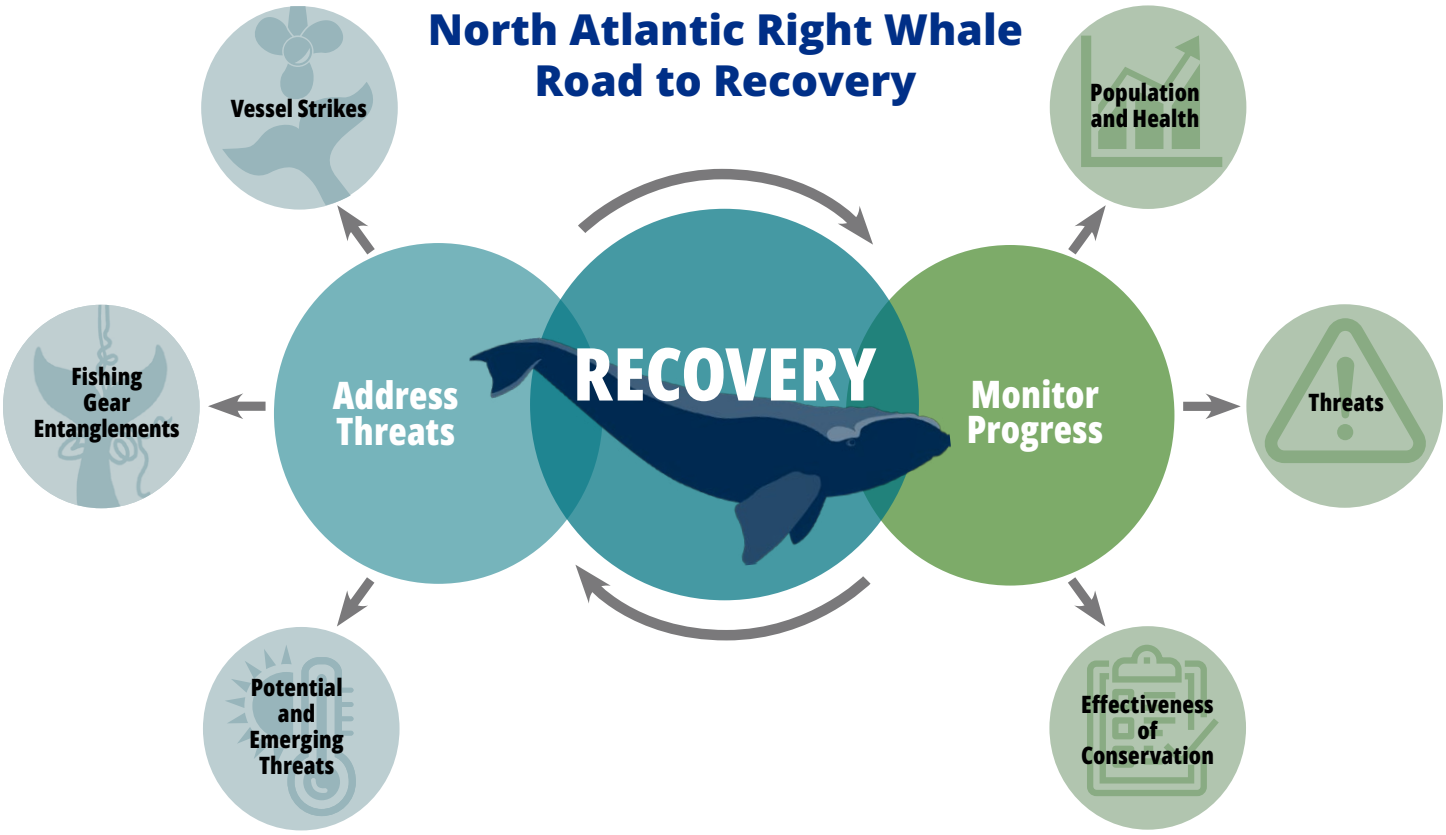
Right whales hold significant cultural value for many indigenous communities and tribes; we are working with them to better understand and incorporate their perspectives and indigenous knowledge as we address a number of the *Species in the Spotlight* Priority Actions. Additional partnerships are described in our *Species in the Spotlight* Priority Action Plan.

Looking Ahead

There is meaningful activity underway on all five priority actions. To reduce entanglements, we are collaborating with states and the Atlantic States Marine Fisheries Commission to apply $26M in FY 2023 Congressional appropriations help New England fishermen implement 2021 regulations to reduce entanglement related mortalities and serious injuries to right whales. Additionally, we are working with the National Fish and Wildlife Foundation to implement an $18M New England Gear Innovation program to support On-Demand gear development that would allow fishermen to continue to harvest lobster in seasonal areas closed to buoy lines. These innovations may also aid fishermen that may be impacted by further measures under development that would affect gillnet and other trap/pot fisheries. We also anticipate finalizing a rule that would close a gap in protections by extending the boundary of the Massachusetts Restricted Area for the period of February 1 to April 30. We are beginning to work with the South Atlantic Fishery Management Council to fully authorize the Southeast black sea bass trap/pot fishery to use ropeless gear in closed areas. To reduce vessel strikes, we are reviewing the comments on the proposed vessel strike reduction rule and intend to take final action on it in 2023. Numerous research projects are underway to better understand the factors impeding recovery, and bilateral cooperation on both research and policy continues to be a cornerstone of our progress. Additionally, the Consolidated Appropriations Act of 2023 passed in December of 2022 prescribes and provides increased appropriations that support further development and implementation of innovative gear technologies and monitoring in the Gulf of Maine. Funds authorized for right whale research will also be used to inform our understanding of right whale distribution, habitat use, health, threats, and other factors that will improve the models used to describe, predict, and analyze the changing risk landscape facing the North Atlantic right whale.

In addition, a historic $82 million in funding from the Inflation Reduction Act will complement NMFS' annual appropriations and further support our overarching Road to Recovery strategy. With this funding, we aim to increase our near real-time understanding of the North Atlantic right whale's ocean presence using new technologies and improved distribution models. We will also invest in technologies to reduce the risk of vessel strikes, such as whale detection and avoidance technology, including an upcoming North Atlantic Right Whale Vessel Strike Risk Reduction Technology workshop in early 2024. Finally, we aim to increase the use of on-demand fishing gear and improve enforcement of existing federal regulations. This historic funding provides a once-in-a-lifetime opportunity to address the North Atlantic right whale crisis and the primary threats to their survival: entanglements and vessel strikes.

26 Document was later updated in 2023; acoustic thresholds to be updated in the near future.



North Atlantic Right Whale Road To Recovery

NMFS launched the *North Atlantic Right Whale Road to Recovery* in 2022 which complements the *North Atlantic right whale 2021–2025 Priority Action Plan* developed under the *Species in the Spotlight* initiative. It describes NMFS' efforts to halt the current population decline and recover the species, and spotlights activities such as those included in this biennial report. Similar to the Action Plan, it is built on the foundation of the statutory requirements that we are charged with implementing under the ESA and the MMPA. It shows how our collective actions, in collaboration with partners, fit together to save this iconic species. The strategy complements the *North Atlantic right whale 2021–2025 Priority Action Plan* by identifying our goals and related objectives, and by tracking and communicating progress on major activities and associated milestones. The Road to Recovery is a living information resource and will be updated regularly.

PARTNER *in the* SPOTLIGHT: Commonwealth of Massachusetts' Division of Marine Fisheries

As described in the *Species in the Spotlight* Priority Action Plan for the right whale, NMFS encourages states to use their existing regulatory mechanisms to reduce risks from entanglement in fishing gear and vessel strikes. The Commonwealth of Massachusetts' Division of Marine Fisheries (MADMF) has led the way in implementing regulations to reduce both entanglement and vessel strike risk for right whales in state waters.

MADMF's mandatory fishing gear restrictions in state waters seasonally limit participation in commercial fixed gear fisheries that may entangle right whales. They have a number of requirements such as prohibiting setting commercial trap gear in all state waters north and east of Cape Cod, including Cape Cod Bay, from February 1 to May 15; a seasonal gillnet closure in all state waters from January 1 to May 15; modifying fixed gear at times when right whales are rarely present to reduce risk of entanglement; and requiring extensive gear marking to ensure gear is identifiable to Massachusetts fisheries. MADMF is also planning future solutions to further regulate and reduce entanglement risk.

In 2022, in partnership with NMFS and others, MADMF released a report that comprehensively characterizes the issues and challenges associated with the implementation of on-demand fishing gear in New England lobster fisheries. MADMF also implements mandatory speed limits in Cape Cod Bay (state waters) for most vessels less than 65 feet in length during March and April to protect right whales foraging in the Bay. MADMF has also extended (six out of the nine closure years; e.g., 2021 and 2022) the mandatory protections into the month of May based on the continued presence of right whales in the area.

The regulatory efforts in Massachusetts to reduce the two major threats to right whales are an important complement to NMFS' regulations. We are happy to acknowledge MADMF's leadership in right whale recovery efforts by recognizing MADMF as our Partner in the Spotlight.

50TH ANNIVERSARY ENDANGERED SPECIES ACT

SPECIES *in the* SPOTLIGHT

PACIFIC LEATHERBACK SEA TURTLE

Leatherback sea turtles (*Dermochelys coriacea*) in the Pacific Ocean are split into Western and Eastern Pacific populations based on their distribution, biology, and genetic characteristics, and are considered at risk because of the drastic decrease in their abundance since the 1980s. Western Pacific leatherbacks have declined more than 80 percent and Eastern Pacific leatherbacks by more than 97 percent since the early 1980s. Eastern Pacific leatherbacks nest along the Pacific coast of the Americas, primarily in Mexico and Costa Rica, and forage throughout coastal and pelagic habitats of the southeastern Pacific. Western Pacific leatherbacks nest seasonally during the winter and summer months, primarily in Indonesia, Papua New Guinea, and the Solomon Islands. This seasonal nesting behavior influences their migratory behavior and marine habitat use. The summer-nesting portion of the western subpopulation migrates throughout the waters of Southeast Asia or across the North Pacific past Hawai'i to feeding areas off the Pacific coast of North America. The winter-nesting segment of the western subpopulation migrates into the southern hemisphere through the Coral Sea, into waters of the western South Pacific Ocean. Both populations face significant threats from bycatch in fisheries (entanglement and/or hooking), direct harvest of eggs and turtles, coastal development, and the effects of climate change (habitat loss due to sea level rise, alteration of hatchling sex ratios, and decreased nest success). Additional threats include vessel strikes, ingestion of plastics, and entanglement in marine debris, including lost or discarded fishing gear.

Bycatch of Pacific leatherbacks in U.S. and international fisheries continues to be a significant threat. We strive to reduce leatherback bycatch in commercial fisheries by developing and implementing bycatch minimization

Female leatherback turtle sighted in Monterey Bay, California one year after being captured and satellite tagged by NOAA researchers. Credit: Kate Cummings (Permit #21111)

strategies, including fishing gear modifications, bycatch limits, and, where necessary, fisheries closures. Because many threats to leatherback populations occur in areas outside of U.S. jurisdiction, it is also imperative to work with international partners to help develop in-country capacity, expertise, and sustained governance to reverse this downward population trajectory.

Recovery Progress

We made substantial progress over the past 2 years on the key actions identified in the 2021–2025 Priority Action Plan for the Pacific leatherback turtle, including efforts to: (a) reduce fisheries bycatch and in-water harvest; (b) improve protection on nesting beaches; (c) support in-water research and monitoring to inform conservation actions; (d) foster cooperation with international partners; and (e) encourage public engagement.

Reduce fisheries bycatch and in-water harvest

Collaborative efforts are underway to assess fisheries impacts and reduce bycatch in high seas and coastal waters, particularly near nesting beaches. The United States works closely with other countries, NGOs, and tuna Regional Fisheries Management Organizations (RFMOs) to reduce bycatch and encourage the adoption of mitigation measures. We continue efforts in the Western and Central Pacific Fisheries Commission (WCPFC) and the Inter-American Tropical Tuna Commission (IATTC) to enact resolutions to protect leatherback turtles from fishery-related threats. This work includes resolutions to mitigate impacts on sea turtles in the Eastern Tropical Pacific and expand mitigation measures to all shallow-set longline fisheries in the WCPFC Area. We continue our efforts to reduce fisheries threats to leatherback turtles and as we work to encourage the adoption of bycatch reduction measures with communities and the fishing industries, as well as countries in multinational agreements. Additionally, we focused efforts on reducing the direct harvest of immature and adult western Pacific leatherback sea turtles in their coastal Indonesian foraging habitats.

Improve protection on nesting beaches

Nest protection efforts promote successful hatching by minimizing threats through a science-based management approach. These activities include strategies to prevent egg depredation by feral pigs and dogs, and measures to reduce other threats that lower hatching success, such as relocation of nests laid in erosion-prone areas. In the Eastern Pacific, the U.S. Fish and Wildlife Service (USFWS) continues to support our partners' efforts in Mexico, Nicaragua, and Costa Rica to protect critical leatherback nesting beaches. In the Western Pacific, NMFS and USFWS continue to support population monitoring and leatherback turtle conservation in Indonesia through funding, technical support, and engaging in community-based projects. These efforts are focused on fostering community involvement to monitor nesting activity while promoting culturally focused community-based educational outreach, with a focus on alternative livelihood programs where relevant. Importantly, we continued to support nesting beach monitoring activities at the primary Western Pacific index nesting beaches at Papua Barat, Indonesia, in collaboration with local University of Papua researchers. Maintaining this long-term nesting dataset is critical for ESA recovery planning and understanding population trends and abundance.

Community-based ranger inventories a leatherback turtle nest on Buru Island, Indonesia to gather data on the number of eggs laid and hatchling emergence. Credit: Yayasan WWF-Indonesia/Idham Farsha

At Buru Island within the Maluku Province of Indonesia, the multi-year action plan, developed with the involvement of local government agencies, local village elders, and community members continues to be implemented. This plan included local and village government roles in encouraging protection activities at the provincial government and village levels. When

A birds-eye view of NOAA researchers preparing to capture a leatherback turtle offshore San Francisco, California. Credit: Joel Schumacher (Permit #15634)

the project was first implemented in 2017, more than 60 percent of nests were being poached or predated with nesting females also taken. But by 2022, less than 1 percent of nests were being poached with no nesting females taken, with benefits continuing into the present. This project is an important component of leatherback turtle conservation as it provides additional life history information on a portion of the population that was previously unknown, and over time data will complement status assessment and recovery efforts by adding to the Western Pacific population's baseline.

USFWS and NMFS also support a number of projects in the Solomon Islands to monitor nesting activity and improve leatherback nesting conservation, including developing conservation action plans with the local communities. This ensures that nest protection and anti-poaching efforts continue, as every hatchling and nesting female is vital for the survival of these nesting populations. Isabel Island is the epicenter for leatherback turtle nesting in the Solomon Islands, yet nearly all nests are poached with nesting females regularly killed and consumed. With technical support provided by NMFS, The Nature Conservancy has been working to reinitiate monitoring and sampling efforts, working with local communities to understand and reduce poaching pressure, and building capacity within the provincial government toward securing long-term conservation goals.

Support in-water research and monitoring to inform conservation efforts

Information on migration, foraging areas, and threats in marine habitats is an essential component to inform development of conservation measures. We continued to engage with partners to support telemetry studies, aerial and in-water surveys, and population assessments in marine habitats to understand habitat use, abundance, and threats. We plan to continue building on partnerships aimed at monitoring, assessing, and reducing direct harvest of leatherback turtles in coastal foraging habitats, while also advancing genetic sample collection and analysis of samples from Indonesia, Philippines, Papua New Guinea, and Solomon Islands to understand connectivity of foraging turtles and the threats to the population. This has included building in-country capacity to store and analyze samples in Indonesia and the Philippines. We are also working to develop modified satellite tag attachment methodology for

leatherbacks to expand opportunities for studying movement, habitat use, and post-interaction mortality.

In partnership with NOAA's Pacific Islands Fisheries Science Center (PIFSC) and the Pacific Islands Regional Office (PIRO), World Wildlife Fund for Nature (WWF) Indonesia actively works to monitor and reduce the poaching of leatherback turtles in the Kei islands, Maluku province of Indonesia. In this area, more than 100 leatherback turtles were harvested annually—a significant threat to the population. Over the past 4 seasons (2017–2022), the project has documented a reduction of leatherback takes by 86 percent. A coalition of government agencies, officials, church leaders, and village leaders have worked together to strengthen a growing leatherback conservation ethic in the Kei Islands. Leatherback turtle conservation goals and foraging grounds have also been incorporated into the management plan of a newly formed Marine Protected Area. Currently conservation benefits are program-dependent and efforts to achieve long-term sustained reduction of leatherback takes is pending. This project also provides a unique research platform to study in-water populations of leatherback turtles in Indonesia to understand coastal habitat use and connectivity.

Continuing collection and analysis of genetic samples from nesting females, fishery bycatch, and stranded turtles allows us to understand regional connectivity and the threats to populations. Genetic analysis helps us identify the origins of bycaught turtles to help inform management measures. Because a number of countries will not allow the export of tissue samples for DNA analysis, we continue to develop partnerships in the western Pacific to build in-country technical capacity to conduct future genetic analyses with standardized markers developed by NOAA's Southwest Fisheries Science Center.

We continue to expand telemetry studies in order to determine overlap between fisheries and leatherback marine habitats. Defining seasonal foraging and migratory areas within the South China, Sulu, Celebes, Molucca, Halmahera, Philippine, and Banda seas as well as off the U.S. West Coast will help guide conservation and management strategies (e.g., real-time data that can be used by the State of California to inform the opening and closing of the Dungeness crab fishery season).

Trained community-based rangers attach a satellite tag on a nesting leatherback turtle on Isabel Island, Solomon Islands. Credit: The Nature Conservancy

Foster cooperation with international partners

Because Pacific leatherbacks originate from and migrate outside of U.S. territorial waters during much of their life cycle, effective recovery and conservation efforts must engage international partners to address the various threats facing leatherbacks on land and sea. Partnerships are the cornerstone of our Pacific leatherback conservation efforts. The United States continues to work on a Memorandum of Understanding on leatherback conservation with the Government of Indonesia. Furthermore, we have been actively engaged with many environmental NGOs around the Pacific. In the Western Pacific, we are working closely with WWF to monitor nesting activity and engage with indigenous communities to reduce poaching of leatherbacks. We also work with Tetepare Descendants' Association and The Nature Conservancy to support on-the-ground efforts to protect leatherbacks and their nests in the Solomon Islands. We have initiated efforts and renewed relationships with international partners to re-establish a nesting beach monitoring program along the Huon coast of Papua New Guinea. In the Eastern Pacific, NOAA has worked with the Mexican NGO Kutzari, aiding their efforts to monitor and protect leatherbacks at several of the primary nesting beaches. The conservation network LaudOPO (Spanish for "Eastern Pacific leatherback initiative") is also a key partner in the region, and serves as a platform for information and data sharing across

Leatherback turtle hatchling on the beach. Credit: NMFS

multiple countries along the Pacific Rim of Central and South America. Finally, throughout the Pacific we have been promoting leatherback conservation measures in multilateral instruments that provide opportunities to work collaboratively to conserve and recover the species, such as the Inter-American Convention for the Protection and Conservation of Sea Turtles and the Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia. We will continue our international efforts to promote cooperation and share best practices in conservation, support programs to protect nesting beaches, and reduce bycatch and harvest of leatherback turtles.

Encourage public engagement

Increasing the public's awareness and capacity to make responsible seafood choices by supporting sustainably managed fisheries that work to reduce sea turtle bycatch is an effective, market-based approach to support leatherback conservation. Online resources allow consumers to find out where their seafood is from and buy products sourced from fisheries that incorporate bycatch reduction measures.

Leatherbacks can become entangled in marine debris such as derelict fishing gear or plastic debris, which can interfere with their ability to swim, submerge, feed, avoid predators, and/or surface to breathe, resulting in injury or death. Leatherbacks can also ingest debris such as plastic bags, balloons, latex products, and other refuse, which they mistake for their prey. NOAA's Marine Debris Program continued efforts to reduce the amount of debris in the marine environment and facilitated beach and marine cleanup events throughout Hawai'i and along the U.S. Pacific coast.

Looking Ahead

Because Pacific leatherbacks are a slow-growing, late-maturing species, long-term and sustained programmatic commitment is critical to its conservation success. In 2021, we released an updated Priority Action Plan for Pacific leatherbacks that builds on the progress we have made thus far but also maintains momentum of the five priority actions described above over the next 5 years through 2025.

In addition to the five priority actions needed to conserve Pacific leatherback turtles, NOAA has developed clear criteria for determining the susceptibility of sea turtle populations to the array of climate change–driven impacts. These criteria have been applied to Pacific leatherbacks and it is clear that the well-being of this population is extremely vulnerable to the myriad of threats brought about by climate change (in prep for publication).

PARTNER *in the* SPOTLIGHT: Andreas Hero Ohoiulun, WWF Indonesia

Given the precipitous decline of Pacific leatherback sea turtle populations over the past few decades, we take this opportunity to highlight a special partner whose dedicated efforts are working to protect Western Pacific leatherbacks from vanishing.

The Maluku Province in Indonesia hosts two key Pacific leatherback conservation projects. Through the recent efforts of WWF-Indonesia and, in particular, the leadership of Andreas Hero Ohoiulun (WWF-Indonesia Project Leader, Inner Banda Arc Sub-Seascape), extraordinary conservation gains for Western Pacific leatherbacks have been achieved.

In the Kei Islands, villages traditionally engage in an annual harvest of adult and juvenile leatherback turtles foraging in nearshore habitats. Despite previous attempts to monitor and mitigate this harvest, a sustained program to do so had not been established. Beginning in 2016, WWF-Indonesia, through the nuanced persistence of Hero Ohoiulun, reached out to the 11 villages of the Kei Islands that participate in the hunt, established collaborations with key village leadership, generated interest and support from Catholic and Protestant church leaders, and ensured cooperation from the district and provincial fisheries agencies, to initiate a robust monitoring program that documented 104 leatherbacks harvested during 2017. Recognizing that this level of take is unsustainable, Hero led WWF-Indonesia in developing and initiating a multi-faceted strategy to reduce hunting efforts, which in subsequent years reduced leatherback harvest by approximately 86 percent. Looking toward the future, Hero helped establish the Kei Island Marine Protected Area (MPA) as a major driver for leatherback conservation through a management plan that has local, district, and provincial government commitments. By securing a functioning MPA in Kei, Hero and WWF-Indonesia are ensuring that Indonesian agencies are able to carry on the conservation work that NOAA helped initiate. Reducing the take of leatherbacks and establishing a plan to solidify these initial conservation gains are key components and important successes in the ongoing conservation of this *Species in the Spotlight*.

Parallel to these efforts, in 2017 Hero and WWF-Indonesia also initiated a local monitoring program on newly identified leatherback nesting beaches on Buru Island. These beaches receive an average of 160 nests per year, but more than 60 percent of nests were either being poached by villagers or eaten by predators, while three to five nesting females were also being taken each year for local consumption. Village elders report that Buru Island was once a significant nesting area, so much so that historically approximately 150 leatherbacks were harvested annually, which suggests amazing recovery potential exists for the site. Once again, through Hero Ohoiulun's leadership, WWF-Indonesia coordinated a collaboration between key village leaders and the district and provincial agencies that resulted in the reduction of poached nests to less than 1 percent, and eliminated the harvest of nesting females completely. This work also involved passing village-level laws prohibiting the take of leatherback eggs and nesting females, the creation of a community-based conservation group (*Pokmaswas*), and the initial steps toward creating an MPA to protect nesting leatherbacks.

These combined efforts at two key projects have formed an important foundation for the continued conservation and recovery of leatherback sea turtles in the Maluku Province, in Indonesia, and in the United States. Many thanks to our *Species in the Spotlight* hero, aptly named Hero.

SPECIES *in the* SPOTLIGHT

SACRAMENTO RIVER WINTER-RUN CHINOOK SALMON ESU

The Sacramento River winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha*) is at risk of extinction because it is composed of just one small population that is blocked from much of its historical spawning habitat, it is a mere fraction of its historical abundance, and it faces a number of ongoing and emerging threats to its survival. Historically, spawning populations of winter-run Chinook salmon occurred in the Sacramento, McCloud, and Pit rivers, and in Battle Creek—all cold-water, spring-fed rivers draining the southern Cascade Mountains in northern California.

The earliest abundance data for winter-run Chinook salmon are from the late 1960s, when the spawning population size was estimated at up to 117,000 adults. The population crashed in the 1970s, and the ESU was subsequently listed as threatened under the ESA in 1989, and reclassified as endangered in 1994. Over the most recent 10-year period from 2013 to 2022, the combined annual abundance of natural- and hatchery-origin winter-run Chinook salmon adults spawning in the Sacramento River ranged from a low of 797 in 2017 to a high of 9,971 in 2021, with an average of 4,870.

The species has persisted in large part due to managed cold-water releases into the Sacramento River from Shasta Reservoir, and artificial propagation from the USFWS Livingston Stone National Fish Hatchery's winter-run Chinook salmon conservation program. Shasta Dam, constructed in 1945, blocks winter-run Chinook salmon from returning to the headwaters of the Sacramento, McCloud, and Pit rivers. Since the dam was constructed, winter-run Chinook salmon have been dependent on sufficient cold water originating from those headwaters to be released from Shasta Reservoir from spring through fall to protect the spawning, egg incubation, and early juvenile rearing

Chinook salmon. Credit: NMFS/Morgan Bond

life stages. It has long been recognized that a prolonged drought could have devastating impacts, possibly leading to the species' extinction. As climate change results in increased temperatures and drought frequency and severity in the Central Valley, it becomes increasingly difficult to manage winter-run Chinook salmon on the valley floor, highlighting the need to reintroduce the species into higher elevation historical habitat in the McCloud River and Battle Creek.

Recovery Progress

In 2021–2022, we made substantial progress on the key actions identified in the 2021–2025 Priority Action Plan for winter-run Chinook salmon: (a) improve management of Shasta Reservoir cold water storage, (b) restore Battle Creek and reintroduce winter-run Chinook salmon, (c) reintroduce winter-run into historical habitats above Shasta Dam, (d) improve Yolo Bypass fish habitat and passage, (e) manage winter and early spring Delta conditions to improve juvenile survival, and (f) collaborative science and fostering partnerships.

Improve management of Shasta Reservoir cold-water storage

The objective of this action is for the U.S. Bureau of Reclamation, NMFS, and California state agencies to use and improve water management tools to ensure that cold water from Shasta Reservoir is available for release into the Sacramento River throughout the spring, summer, and early fall to support the spawning, egg incubation, and fry rearing life stages. Unfortunately, 2021 was one of the warmest and driest years on record in California. The availability of cold water in Shasta Reservoir was limited and the summer of 2021 was a grim one for winter-run Chinook salmon in the Sacramento River. Close to 10,000 adult salmon returned to the river to spawn below Shasta and Keswick dams, the most since 2006. However, approximately 75 percent of their roughly 31 million eggs died from warm water temperatures driven by the historic drought that shrank reservoirs across California. Scientists believe that other factors, including a deficiency of thiamine (Vitamin B1) in returning adult salmon, reduced survival of fry that successfully hatched.

Water temperature management for the protection of winter-run Chinook salmon was much more successful in 2022, despite it being the third consecutive year of extreme drought. The Sacramento River Settlement Contractors reduced their water diversions, leaving more cool water in the reservoir to help keep winter-run eggs alive through the summer. NMFS estimates that more than 80 percent of winter-run eggs survived temperatures in the river, much improved from the conditions in 2021, and well above the temperature survival rates for past critically dry water years. Despite the water temperature management success in 2022, high levels of thiamine deficiency that year contributed to the lowest production and survival of juvenile winter-run Chinook salmon in the Sacramento River on record.

Also in 2022, NMFS and the Sacramento River Science Partnership made progress lining up annual cohort evaluations to help understand the factors affecting winter-run Chinook salmon production. Planning work led to a contract between the Sacramento River Science Partnership and Anchor QEA to expand the assessment of brood year 2019 to include conditions in the Delta, and complete assessments for brood years 2020, 2021, and 2022.

Restore Battle Creek and reintroduce winter-run Chinook salmon

The Battle Creek Salmon and Steelhead Restoration Project (BCRP)—located near the town of Manton, California, in Shasta and Tehama Counties—will restore and provide access to approximately 42 miles of prime salmon and steelhead habitat on Battle Creek, plus an additional 6 miles in its tributaries. Restoration of Battle Creek is being accomplished by the modification of hydroelectric project facilities and operations, including instream flow releases. Phase 1 of the project has been completed with fish passage provided at several locations.

In 2021 and 2022, planning work among Pacific Gas and Electric Company (PG&E), Reclamation, the Federal Energy Regulatory Commission, the State Water Resources Control Board, NMFS, and other restoration project partners occurred, setting the stage for Phase 2 construction starting in 2024. Once Phase 2 is completed, the BCRP will restore suitable winter-run Chinook salmon habitat and set the stage for reintroduction.

Children from the Winnemem Wintu Tribe return winter-run Chinook salmon juveniles to their ancestral home in the McCloud River for the first time in more than 80 years. Credit: California Department of Fish and Wildlife/Matt Johnson

In 2021 and 2022, juvenile winter-run Chinook salmon were released into Battle Creek as part of the jumpstart reintroduction effort that began in 2018. In 2020, 2021, and 2022, adults returned to spawn in Battle Creek. Also in 2022, adult winter-run Chinook salmon were transported to the upper reaches of North Fork Battle Creek, which marked the first time in more than 100 years that fish were provided access to that area of coldest habitat. The jumpstart effort, along with the BCRP, is setting the stage for implementing the long-term Reintroduction Plan in Battle Creek.

Reintroduce winter-run Chinook salmon into historical habitats above Shasta Dam

In 2022, NMFS, the Winnemem Wintu Tribe, the California Department of Fish and Wildlife (CDFW), and USFWS planned, implemented, and celebrated the return of endangered winter-run Chinook salmon to the McCloud River upstream of Shasta Reservoir for the first time since the construction of the Shasta Dam in the 1940s. The historic return of winter-run Chinook salmon eggs to the mountains upstream of Shasta Reservoir was an urgent response to reduce the extinction risk during the third consecutive year of extreme drought, after near-year-class failures occurred in 2020 and 2021. The fertilized eggs were delivered to the McCloud River from the USFWS' Livingston Stone National Fish Hatchery near Redding in two batches of 20,000—the first by truck and the second by helicopter. The eggs were placed into specialized incubators alongside the McCloud River's cold waters where the species once spawned.

In a riverside welcoming ceremony on July 11, 2022, Winnemem Wintu Chief and Spiritual Leader Caleen Sisk led the Tribe in song, dance, and prayer for the salmon eggs that had been brought to the McCloud River. "We are asking that the river receive these eggs. We are asking that the old-time ways continue and that they grow in that way," she said. "We put down that song so they have a fighting chance."

After the eggs hatched and the fry were able to swim, the Winnemem Wintu Tribe and CDFW released the fish into the river, marking the first time that winter-run Chinook salmon have swum in the McCloud River in more than 80 years. Approximately 1,600 juveniles were collected at fish traps set 20 miles downstream from the egg incubation site. These fish were then transported to the Sacramento River downstream of Shasta and Keswick dams to allow them to continue their journey to the Pacific Ocean.

The successful project was the start, or restart, of two relationships: one among the Winnemem Wintu Tribe, NMFS, and CDFW; and, more broadly, among people, salmon, and the McCloud River. On May 1, 2023, the Tribe and agencies signed a co-stewardship agreement formalizing a shared commitment to restore traditional cultural fisheries including state and federally listed winter-run Chinook salmon to historical spawning grounds above Shasta Reservoir.

Improve Yolo Bypass fish habitat and passage

The 2021–2025 winter-run Chinook salmon action plan included the Yolo Bypass Salmonid Habitat Restoration Project, commonly referred to as the Big Notch Project. This project will become the single largest floodplain salmon rearing habitat restoration in California history. In 2022, the California Department of Water Resources (DWR) and Reclamation broke ground on the Big Notch Project, a 30,000-acre floodplain habitat restoration and fish passage project in the Yolo Bypass in Yolo County.

The project will expand floodplain rearing habitat for juvenile salmon and improve access through the bypass for salmon and sturgeon, which is pivotal to the recovery of these threatened and endangered fish species. The project includes the removal of a section of the Fremont Weir, the installation of three gates in the weir, the excavation of 180,000 cubic yards of earth to carve a new path for salmon, and construction of a control building and pedestrian bridge.

The ceremonial first shovel at the Big Notch Groundbreaking ceremony on June 23, 2022 at the Fremont Weir Wildlife area in Yolo County. Credit: California Department of Water Resources

When the project is finished (expected late 2023), the gated passage, or notch, will be opened when the Sacramento River is high enough to flow into the Yolo Bypass floodplain. The water will enter the bypass through the notch at Fremont Weir and create shallow-water habitat for fish to easily migrate through the area. Juvenile salmon will be able to feed in a food-rich area for a longer time, allowing them to grow more rapidly in size, improving their chances of survival as they travel to the Pacific Ocean. Adult salmon and sturgeon will benefit from improvements that will reduce stranding and migratory delays due to passage barriers.

Manage winter and early spring Delta conditions to improve juvenile survival

In 2021 and 2022, progress was made on two actions intended to understand, manage, and reduce the exposure of juvenile winter-run Chinook salmon to negative flows and increased predation in the central and south Delta. The first action related to the installation of barriers at Georgiana Slough and other key junctions to keep juvenile salmon from entering areas known to have poor survival. In 2022, NMFS completed a formal ESA Section 7 consultation on the construction and operation of a non-physical barrier at Georgiana Slough for implementation in February 2023 until September 2030, to be operated in the winter and spring periods.

The second action is real-time salmon monitoring in the Delta. Knowing when winter-run Chinook salmon may be present is based on historical distribution data and current monitoring data from rotary screw traps, beach seines, Sacramento River trawl surveys, and tracking acoustically tagged fish. During 2021 and 2022, about 500 winter-run Chinook salmon juveniles were implanted with acoustic transmitters and released along with the Livingston Stone National Fish Hatchery production. Arrays of receivers indicated in real time when fish arrived at the start of the Delta at the city of Sacramento and the end of the Delta at Benicia Bridge. Valuable information about fish transit times and survival rates are provided by these studies. For instance, in the drought years of 2021 and 2022, it was found that fewer than 15 percent of fish survived to enter the Delta, and fewer than 6 percent further survived to enter the ocean. This information can be coupled with operational decisions and hydrologic conditions to inform management actions.

Collaborative science and fostering partnerships

Collaborative Science and Adaptive Management Program

NMFS West Coast Region and the Southwest Fisheries Science Center continue to engage with the Collaborative Science and Adaptive Management Program (CSAMP) through participation in CSAMP's Collaborative Adaptive Management Team and the CSAMP-sponsored Reorienting to Recovery project. Reorienting to Recovery brought together interested parties to define broad-sense recovery goals for Central Valley salmonids, including winter-run Chinook salmon, that include but exceed goals defined in the ESA recovery plan. Using the SWFSC's Winter Run Life Cycle Model (WRLCM) and other models, the project will develop and evaluate suites of management actions to identify pathways to achieving these broad recovery goals.

SWFSC Winter-run Chinook Salmon Science Program

During 2021 and 2022, the Southwest Fisheries Science Center advanced their winter-run Chinook salmon research in three areas identified in the 2021–2025 action plan: (1) continuing development of the WRLCM and its enhanced particle tracking model component (ePTM); (2) thiamine study; and (3) pathogen exposure study.

1. WRLCM and ePTM: The WRLCM is under continuous development to tailor it to specific management applications, and now can include growth processes and reintroductions. One of its components, an agent-based model of juvenile salmon migration, referred to as the ePTM, has been calibrated with acoustic tagging data, and published in a peer-reviewed journal. This has helped to apply novel science and modeling capabilities to evaluation of fish survival while migrating out of the Central Valley.

2. Thiamine Study: A large interdisciplinary research team of scientists funded by CDFW have been conducting surveillance of thiamine deficiency in California salmonids, assessing ocean food web causes, and developing mitigation strategies. We continue to assess the impact of thiamine deficiency on winter-run Chinook salmon by analyzing the concentration of thiamine in their eggs and relate those concentrations to survival thresholds for their progeny developed in laboratory studies. We found thiamine-dependent mortality has worsened over time with 33 percent (2020), 45 percent (2021), and 47-54 percent (2022) of winter run eggs not having enough vitamin B1 to support proper embryo development. Mitigation strategies to inject winter-run females at the Livingston Stone National Fish Hatchery with thiamine have been successful and continue to be administered annually for hatchery broodstock. Pelagic forage surveys along the West Coast suggest that anchovies that contain a thiamine-degrading enzyme continue to be unusually abundant and dominant in salmon diets. Thiamine status of California stocks is regularly updated here: https://oceanview.pfeg.noaa.gov/projects/salmon_thiamine/intro

3. Pathogen Exposure: During 2021 to 2022, team members at the Southwest Fisheries Science Center, along with collaborators at the University of California Santa Cruz, University of California Davis, and Oregon State University, continued collecting data on salmon pathogen exposure as a part of a CDFW-funded grant. This work included collecting environmental water samples biweekly across 10 sites along the Sacramento River, as well as conducting sentinel exposure studies using hatchery-raised fall-run Chinook salmon. With this information, an inventory of pathogens detected frequently and an improved understanding of their potential impact to salmon population health is being developed. Additionally, these data are being used with other sources of information to develop a disease transmission model for outmigrating juvenile salmon. The model will integrate the stressor of pathogen exposure with other environmental stressors (i.e., temperature) to predict health outcomes of juveniles outmigrating from the Sacramento River.

Winter-run Chinook salmon juveniles from the McCloud River (top) and the Livingston Stone National Fish Hatchery (bottom). The fish are the same age, demonstrating fast growth within the McCloud River. Credit: University of California, Davis/Eric Holmes

Looking Ahead

We look forward to our continued partnership with the Winnemem Wintu Tribe and CDFW to advance the restoration and reintroduction of winter-run Chinook salmon and the Tribe's Nur to the McCloud River. We also hope to take advantage of once-in-a-lifetime restoration funding opportunities, with the federal Bipartisan Infrastructure Law and the Inflation Reduction Act providing more than $1.3 billion for new Pacific salmon recovery and restoration projects, as well as California's new effort to support critical restoration statewide with $200 million in new funding for multi-benefit ecosystem restoration and protection projects under Drought, Climate and Nature Based Solutions Initiatives.

PARTNER *in the* SPOTLIGHT: Matt Johnson, California Department of Fish and Wildlife

Credit: California Department of Fish and Wildlife/ Travis VanZant

In 2022, winter-run Chinook salmon were reintroduced to the McCloud River for the first time in more than 80 years, largely due to the efforts of Matt Johnson and his California Department of Fish and Wildlife colleagues. Matt's passion for this project and genuine and respectful demeanor helped foster a trustful and effective partnership with the Winnemem Wintu Tribe, NMFS, and other project partners including the USFWS, U.S. Forest Service, and California Department of Water Resources.

Matt and his team worked tirelessly to turn initial ideas into on-the-ground actions. This involved sacrificing the creature comforts of home to camp along the McCloud River throughout the summer and fall so that the remote incubators containing 40,000 endangered winter-run Chinook salmon eggs were safe from fires, bears, humans, mud, and algae. Some of the feats that Matt and his team accomplished to successfully return winter-run Chinook salmon to the McCloud River include:

- Assembling and installing remote site egg incubators without a source of power.
- Siting the project components and tending to the fish in ways that were understanding of and sensitive to the cultural and spiritual recommendations of Tribal co-managers.
- Running gravity-fed water lines upstream in the McCloud River for great distances to ensure the incubators had adequate flow to keep the eggs clean and oxygenated.
- Delivering eggs from the hatchery to the McCloud River, once by truck many miles on a poorly maintained logging road, and once by helicopter.
- Adapting to unforeseen circumstances including mud flows and high densities of rock snot algae (didymo) that inhibited the supply of clean water necessary to keep salmon eggs alive.
- Working around the clock to gently clean sediment from the eggs with a turkey feather and scare off bears from the incubation site while doing so.
- Installing, cleaning, and maintaining rotary screw traps and fyke nets to capture juvenile winter-run Chinook salmon and transport them downstream to the Sacramento River.

Quite simply, 2022 was a historic year in the conservation of winter-run Chinook salmon because of Matt's efforts to protect and recover this species. NMFS is very pleased to recognize Matt Johnson as a winter-run Chinook salmon Partner in the Spotlight.

50TH ANNIVERSARY ENDANGERED SPECIES ACT

SPECIES *in the* SPOTLIGHT

SOUTHERN RESIDENT KILLER WHALE DPS

Southern Resident killer whales (*Orcinus orca*) are one of the most endangered whales, with only 73 whales in the population at the end of 2022. The continued population decline over the past decade highlights their challenges with survival and reproduction, and the population's risk of extinction. However, as a small ray of hope, 2022 saw two new calves born, including the first new calf in K pod in over a decade. In 2021 and 2022, we worked with new organizations joining the recovery effort and implementing actions to improve conditions for Southern Residents. We participated in an emergency response to a sunken vessel leaking fuel in a prime foraging area and expanded our efforts as new partners heard the call to action. The recommendations from the Washington State Orca Task Force are being implemented, many of which are complementary to the 2021–2025 *Species in the Spotlight* Priority Action Plan as well as the Recovery Plan for Southern Residents.

Recovery Progress

In FY 2021–2022, we made substantial progress on the four key actions in the 2021–2025 Priority Action Plan for Southern Resident killer whales: (a) protect killer whales from harmful vessel impacts through enforcement, education, and evaluation; (b) target conservation of critical prey; (c) improve our knowledge of Southern Resident killer whale health to advance recovery and support emergency response; and (d) raise awareness about the recovery needs of Southern Resident killer whales, and inspire stewardship through outreach and education.

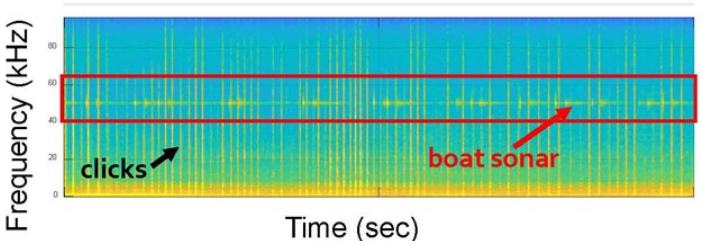
Southern Resident killer whale and calf near downtown Seattle. Credit: Maya Sears (Permit #781-1824/16163)

Southern Resident killer whale with Dtag attached by suction cup. Credit: NMFS (Permit #781-1824/16163)

Protect killer whales from harmful vessel impacts through enforcement, education, and evaluation

Southern Resident killer whales rely on echolocation and communication to support their critical foraging and social needs; however, physical and acoustic disturbance from vessels can impair these functions. Since NMFS finalized regulations to protect Southern Resident killer whales from vessel impacts in 2011, we have reviewed their effectiveness, and have been working with outreach, enforcement, and industry partners to educate boaters to achieve high rates of compliance to minimize impacts from sound and vessel disturbance. In 2021–2022, we continued to work with Canada, Washington State, and San Juan County as they updated or developed additional protective regulations and voluntary guidelines to help protect Southern Resident killer whales. We continued to participate in the intergovernmental working group as Washington State implemented their new licensing program for commercial whale watching established in 2020 and continued engagement in Canada's technical working group for vessels.

Ongoing research projects, like NOAA's Northwest Fisheries Science Center (NWFSC) digital acoustic recording tag (Dtag) project in partnership with Fisheries and Oceans Canada (DFO), provided results to inform protective measures, including new insights into foraging behavior and interference from vessels and sound. In 2021–2022, the NWFSC published multiple papers analyzing the Dtag data collected over several years. The studies found that the whales descended more slowly, and took longer dives to capture prey, when nearby boats had navigational sonar switched on. The sonar from private and commercial vessels directly overlaps the main sound frequencies the whales use to hunt. This may mask the whales' signals and force them to expend more energy to catch prey. In addition, they found a relationship between vessel speed and the odds of the whales capturing prey. The greater the speed of nearby vessels, which introduces more underwater noise, the lower the chances the whales captured prey. Another key finding indicated that vessels affect whale foraging when boats approach within 400 yards, on average. These results have already informed recommendations and new legislation in Washington and will guide updates to regulations and guidelines into the future. Analysis of the Dtag data continues, with efforts underway to uncover the mysteries surrounding nighttime behavior and make comparisons between the foraging behavior of declining Southern Residents and the neighboring Northern Resident killer whale population, which has increased over the past decade.



A spectrogram illustrating Southern Resident killer whale echolocation clicks (black arrow) and 50 kHz navigation sonar emitted by boats (indicated by the red rectangle and arrow) that were recorded by the Dtag. Adapted from Fig. 1 of Holt et al. 2021

Southern Resident killer whales with the Seattle waterfront in the distance. Credit: Maya Sears (Permit #781-1824/16163)

Our efforts to focus on potential impacts from large ships transiting through our waters resulted in establishing Quiet Sound, a program similar to the Canadian ECHO (Enhancing Cetacean Habitat and Observation) Program, as recommended by the Washington State Orca Task Force. Both programs are industry-led, with NOAA engaging on the Leadership Committee and working groups, and work to understand and manage the impacts of shipping activities. Quiet Sound moved quickly from announcing a new framework to implementing their first voluntary slowdown (see Partner in the Spotlight story). ECHO continued voluntary measures in 2021 and 2022 to slow down and shift vessel operations to reduce sound in important foraging areas. We continued collaboration with transboundary and local partners on specific projects, like broader application of the Whale Report Alert System in U.S. waters to enhance awareness of whale movements, and fostering implementation of responsible vessel operations.

Target conservation of critical prey

Southern Resident killer whales are fish-eating whales that rely on Pacific salmon as their most important prey. Research indicates that a single species—Chinook salmon—makes up most of their summer diet, and challenging research in coastal waters has shown that it remains an important component throughout the year. Sufficient salmon prey is essential to recover the Southern Resident population. Knowing where and when the whales are most food-limited, and which salmon stocks they eat and overlap with throughout their range, helps target conservation of salmon stocks that will most benefit the whales. In 2021–2022, we continued to use the Prey Priority Report developed by NMFS and Washington Department of Fish and Wildlife. The list of priority Chinook salmon stocks has been incorporated into grant programs, including the National Fish and Wildlife Foundation's (NFWF) Killer Whale Research and Conservation Program and the Pacific Coastal Salmon Recovery Fund, to help identify projects that support salmon and killer whale recovery. The priority prey report also informed implementation of initiatives funded in 2021 and 2022 under the Pacific Salmon Treaty to support salmon habitat restoration and hatchery production to benefit the Southern Residents. Efforts are underway to use the latest science on whale and Chinook salmon movements to refine and improve the priority prey list.

To evaluate potential impacts of coastal salmon fisheries, the Pacific Fishery Management Council formed a workgroup including the NMFS West Coast Region, the NWFSC, and the Southwest Fisheries Science Center (SWFSC), along with state, tribal, and industry members. The workgroup completed a risk assessment in 2020 to describe relationships between killer whale population metrics (such as reproduction and body condition) and the abundance of Chinook salmon, which served as the basis for an Amendment to the fishery management plan (Amendment 21).

The workgroup recommendations and Pacific Council actions were also informed by extensive public reviews and numerous comments. The framework under Amendment 21 limits Chinook salmon fishing in certain areas on the West Coast when the number of Chinook salmon along the northern Oregon and Washington coast falls below a certain threshold. The goal of Amendment 21 is to reduce fishery impacts on Chinook salmon when abundance is low in order to meet the prey needs of Southern Resident killer whales, while still providing fishing opportunities.

Improve our knowledge of Southern Resident killer whale health to advance recovery and support emergency response

Understanding killer whale health is essential to identifying the cause of reduced survival and reproduction in the declining Southern Resident population compared to other increasing or stable populations of killer whales.

Ongoing research on the health of Southern Residents has provided baseline information for comparison with compromised individuals and other killer whale populations. Ongoing health sample collection and analysis has given us a clearer picture of pathogens and the composition of microbiomes (i.e., microorganisms in the digestive or respiratory systems) in Southern Resident killer whales, and will also give us the capacity to identify any emerging infectious diseases or at-risk individuals. With support from a NFWF grant, a focused field effort resulted in collection of health samples, as well as insight into new technologies in development (e.g., using infrared cameras to evaluate respiration), and contributed to our growing database of health information.

In 2021–2022, researchers from Sealife Response, Rehabilitation, and Research; Oregon State University; and the SWFSC have continued to draw on the long-term data set of photogrammetric monitoring (taking measurements from aerial photos) to develop models to relate body condition to population dynamics and examine trends in body condition in relation to environmental variables, such as Chinook salmon abundance. For example, a paper published in 2021 found there was a higher probability of a decline in body condition in J pod when salmon abundance was low and an overall elevated mortality for whales in the poorest body condition. This data also facilitated identification of vulnerable whales based on poor body condition or pregnancies, so that Washington State could implement additional protections as part of their commercial whale watching program.

In 2021–2022, we drew on our protocols to guide emergency response for medically treatable whales with compromised health, as well as our wildlife response plans for oil spills. We continued our work with veterinarians, researchers, and other experts to review any reports of animals that are in poor condition or appear to be particularly vulnerable based on their behavior or health. In August of 2022, a 58-foot fishing vessel, the Aleutian Isle, sank in deep waters off the west side of San Juan Island. From the very beginning of the incident response, the Unified Command identified the protection of the Southern Residents as one of the top priorities. The Wildlife Branch quickly established two marine mammal management components: real-time monitoring of marine mammal sightings and a Whale Deterrence Team. Many local partners reported sightings and participated in drills and deterrence activities until the vessel and risk of further spill could be removed. The Whale Deterrence Team was on standby for more than a month. It was activated on several days when it appeared that killer whales were headed toward an area with visible sheen. The Deterrence Team created sound by banging pipes to change the movements of transient killer whales, resulting in long deep dives and whales not surfacing in the sheen. The response was an excellent example of collaboration across many agencies and partners, including Canada, to protect key habitats and species. Building on our recent experiences, past cases, and input from experts around the world, we are continuing to improve response plans for strandings, entanglements, oil spills, and other circumstances so we can continue to learn about and protect the whales and build our response capacity.

Raise awareness about the recovery needs of Southern Resident killer whales and inspire stewardship through outreach and education

Public awareness of the status of the whales and the threats they face is essential to the conservation of the species. The *Species in the Spotlight* initiative has inspired a growing campaign to spread messages about the whales through social media, videos, and web

pages. In 2021–2022, we participated in 36 Southern Resident killer whale *Species in the Spotlight* events, with approximately 1,845 participants, and reached many more people through websites, social media, podcasts, distribution of materials, and supporting our partners through educational grants to reach new and expanding audiences. Southern Residents are a popular topic on the West Coast Region's and Science Center's social media channels, which reached 1.4 million people in 2021–2022. Our most popular Southern Residents Connections blog post—a post about coastal critical habitat, which was finalized in 2021—reached more than 3,000 people. About 4,600 listserv subscribers received nine newsletters with Southern Resident updates in 2021–2022. During the COVID-19 pandemic, many of our events were virtual and we had to adapt our outreach efforts. In some ways this brought us access to new audiences. NMFS has long-standing partnerships with education and outreach experts at institutions in the region, such as The Whale Museum and Seattle Aquarium. In 2021–2022, outreach events and visits to exhibits continued to be hindered by the COVID-19 pandemic, but started to rebound, with some in-person events and visits resuming in 2022.

Southern Resident killer whale. Credit: NMFS

Long-term and new partnerships have helped expand the reach of several education programs. Reaching students and their families is an important way to ensure Southern Residents will have stewards into the future, and 2021–2022 included transitions back into the classroom. NMFS' Southern Resident killer whale curriculum, fin matching activity, and materials to support taking actions were downloaded about 4,500 times for use in classrooms, including materials translated into Spanish. Our partners at Killer Whale Tales combined virtual and in-person classroom experiences. They ran a thriving program dedicated to educating kids about Southern Resident killer whales and what they can do to help the pods, reaching more than 4,600 students from 91 schools ranging from California into Canada. As schools reopened, about half of the students had an in-person classroom experience. Having a robust virtual program also allowed for virtual follow-up visits for about 2,500 students, enriching their experience. The Whale Trail, a series of shore-based viewing sites to build awareness about killer whales and other whales and dolphins, provided a safe outdoor experience, including social distancing. As of 2022, the Whale Trail identifies more than 100 shoreside whale watching sites, from San Diego to north of Vancouver Island, and includes the Washington State Ferries as another platform for responsibly viewing whales. The creativity and flexibility shown throughout 2021–2022 will make these programs even stronger into the future.

The Priority Action Plan for 2021–2025 highlights ongoing key education partnerships and collaborative initiatives, such as Orca Month every June and Orca Recovery habitat restoration events in October. Even more importantly, we are developing partnerships that raise awareness about the whales to support conservation efforts with new audiences. Many organizations and education experts inspire stewardship of the whales and their habitats by educating concerned citizens about actions they can take to help recover the whales. New children's books written by our partners, which highlight NOAA science and our role in Springer's rescue (see page 70), are just one example of efforts to reach a new audience of young readers.

Other Recovery Progress

Local, state, federal, tribal, and international partners continued to support recovery in 2021 and 2022, implementing actions from NMFS' 2008 Southern Resident killer whale recovery plan, our *Species in the Spotlight* Priority Action Plan, the Washington Executive Order, the Washington State Orca Task Force reports, and Canada's Oceans Protection Plan. These plans are complementary, coordinated, and cover a broad suite of actions addressing the key known threats and increasing our scientific knowledge. The Task Force drew on existing plans for Southern Residents, NMFS' ESA recovery plans for Pacific salmon species, and Puget Sound clean-up efforts to guide development of recommendations to support recovery. We made significant progress on habitat protection by publishing a final rule designating critical habitat in coastal waters in 2021. The final rule maintains the previously designated critical habitat in inland waters of Washington and expands it to include coastal waters off Washington, Oregon, and California. The revision adds to critical habitat approximately 15,910 square miles of marine waters between the 6.1-meter and 200-meter depth contours from the U.S.-Canada border to Point Sur, California. Additionally, over the past 2 years we have made progress by developing new partnerships such as Quiet Sound, building external funding resources through our partnership with NFWF, and implementing a variety of ongoing research and conservation activities in the United States and across the border in coordination with Canada.

Looking Ahead

Over the past 2 years, we have continued to improve our understanding of and ability to protect this unique population of whales. Despite the progress made by our scientists and regional partners on the key actions identified in the Southern Resident killer whale Priority Action Plan, the population has not grown; in fact the population has declined in abundance since it was first listed under the ESA. In 2021 we completed an ESA 5-year review of the Southern Resident killer whale DPS, reviewing scientific and management progress over the previous 5 years and recommending that the DPS remain listed as endangered. We clearly still have important work to do locally, with our federal capabilities and internationally to bring Southern Resident killer whales back from the brink of extinction. With increased public awareness and momentum through implementation of recommendations by the Washington State Orca Task Force and in Canada, there are many positive and collaborative initiatives underway to identify resources, make commitments, and follow through on strong actions that will benefit the whales, their prey, and the ecosystem.

Southern Resident killer whale and calf. Credit: NMFS and Vancouver Aquarium (Permit #16163)

Celebrating Springer's Rescue 20 Years Later

On January 14, 2002, a member of the public sighted an orphaned juvenile Northern Resident killer whale in Puget Sound. She was identified as A73, also known as Springer, and was the first killer whale calf to be rescued, rehabilitated, and released. Springer was reunited with her family in British Columbia on July 15, 2002. Almost 20 years to the day after her release, Springer was resighted, much to the delight of those who gathered at a reunion celebration in Canada.

On July 21, 2022, Dr. John Ford, a retired Canadian Department of Fisheries and Oceans scientist, photographed Springer, who is now a mother. She was seen with her two calves, Spirit (A104) and Storm (A116). He noted they looked to be doing well. Dr. Ford saw the whales on his way to Telegraph Cove, British Columbia, to attend a celebration of the 20th anniversary of Springer's rescue operation.

Members of the team that rescued Springer gathered at the Whale Interpretive Centre on July 23 to tell Springer's story and answer questions from the public. Joe Scordino, now retired from NMFS, highlighted the challenging decision-making process involved. He acknowledged the crucial roles played by all of the partners and the public. Dr. Brad Hanson, the lead for NOAA's Northwest Fisheries Science Center research program for endangered Southern Resident killer whales, emphasized what we learned from the rescue. "The techniques and expertise developed for Springer's rescue have helped us respond to other ailing whales, such as the emergency response we did for J50 a few years ago," he said. "While we weren't able to save J50, we continue to learn about the whales' health to inform our recovery program and it all started with Springer."

"Springer's success story continues to be an inspiration for all of us working on conservation in the Salish Sea," said Lynne Barre, the lead for orca recovery at NMFS' West Coast Regional Office in Seattle. "The partnerships created during Springer's rescue provide a strong foundation for international cooperation as well as coordination between government, state, tribal, and non-profit groups to benefit both Northern and Southern Resident killer whales."

From left, Donna Sandstrom, John Ford, Joe Olson, Joe Scordino, Lynne Barre, and Brad Hanson answer questions from the public at the Whale Interpretive Centre in Telegraph Cove, British Columbia. Credit: Ken Weiner

PARTNER *in the* SPOTLIGHT: Quiet Sound, a Program of Washington Maritime Blue

A new program called Quiet Sound aims to better understand and reduce the effects of large commercial vessels on the whales in Washington State. Human-caused underwater noise that affects endangered Southern Resident killer whales comes from a variety of sources. These include recreational boaters, whale watch vessels, and large commercial vessels that transit Puget Sound and the Salish Sea every day. Quiet Sound was developed over several years to help fulfill recommendations of the Southern Resident Orca Task Force assembled by Washington Governor Jay Inslee. Recommendation #22 from their report encouraged collaboration with strategic federal and Washington State partners to support "parallel and adaptive implementation of ECHO and related shipping noise-reduction initiatives while promoting safe, sustainable shipping practices." ECHO, or Enhancing Cetacean Habitat and Observation, is a similar but more established program led by the Port of Vancouver in British Columbia. Results of noise monitoring studies from the ECHO program have found that reducing the speed of commercial shipping vessels through voluntary slowdown programs can significantly reduce the amount of noise produced by commercial shipping traffic in the surrounding marine environment.

December 2021 marked the official launch of Quiet Sound with Rachel Aronson announced as the Program Director. Initial funding for the program was provided by NOAA, the Environmental Protection Agency, and the Ports of Seattle and Tacoma. NMFS participated in development of the program and holds a position on the Leadership Committee. With the framework in place and several active workgroups bringing in many partners, Quiet Sound moved quickly to take action to reduce effects on the whales. They launched five projects in their first year, tackling challenges and data gaps around sighting networks, hydrophone and whale sensing technology, and sound levels in Puget Sound, culminating in a voluntary slowdown for commercial vessels.

After review by stakeholders and tribal partners, Quiet Sound finalized guidelines for a trial Seasonal, Voluntary Slowdown Area in Southern Resident critical habitat in Admiralty Inlet and Puget Sound. The slowdown trial was in effect from October 24, 2022, through January 12, 2023, and overlapped with multiple Southern Resident visits to the area. Slowdown areas were designated zones on the water that covered parts of the shipping lanes in which large commercial vessels were asked to reduce their speed while the trial was underway.

Grace Ferrara (NMFS) on right, presents Partner in the Spotlight Award to Rachel Aronson, Quiet Sound Program Director (center), and Caitlin O'Morchoe, Quiet Sound Program Manager (left). Credit: NMFS.

"We've been encouraged by the support from the commercial shipping industry, who are interested in seeing whales rebound from current low population levels and are dedicated to being part of the solution," said Quiet Sound Program Director Rachel Aronson. "Shippers came to the table very early on to help us craft a slowdown recommendation that is safe and compatible with the realities of the maritime industry."

The program included educating commercial shipping pilots about the slowdown. The program collected baseline data on sound levels when killer whales were present in Puget Sound, both with and without a slowdown. Initial data showed a 60 percent participation rate with the voluntary slowdown measures during the trial period. As a result, preliminary acoustic data collected from hydrophones in the slowdown area found that conditions were 45 percent quieter during the trial period. Quiet Sound plans to use these data from the trial to evaluate and improve the design of future slowdowns in 2023.

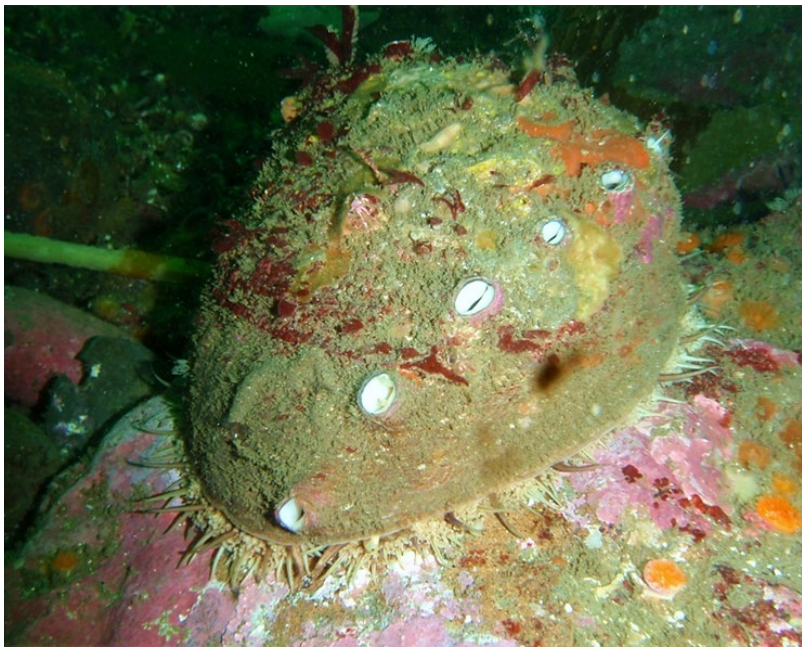
"Environmental stewardship efforts are becoming the norm for ocean carriers and that will include broad participation in the Quiet Sound slowdown," said Pacific Merchant Shipping Association Vice President, Captain Mike Moore. "Quiet Sound's focus on data-driven efforts that truly benefit the Southern Residents will create credibility and enhance participation. We look forward to the results of this first trial and how that will inform future efforts."

50TH ANNIVERSARY ENDANGERED SPECIES ACT

SPECIES *in the* SPOTLIGHT

WHITE ABALONE

The white abalone (*Haliotis sorenseni*), an herbivorous marine snail, was selected as a *Species in the Spotlight* because it was brought to the brink of extinction by a combination of factors, most notably a brief but intense commercial fishery in southern California prior to 1980. Fragmented, low-density populations, a consequence of overfishing, are likely experiencing reproductive failure and have not recovered despite the fishery closure in 1997. White abalone's role as a keystone grazer in subtidal kelp forests contributes to sustaining higher species diversity and stability in the ecosystem. NMFS and its partners can prevent the extinction of this endangered kelp forest architect by continuing to restore populations until they reach sustainable levels through a captive propagation, enhancement, research, and monitoring program.



A white abalone in its native Southern California kelp forest habitat. Credit: NMFS/David Witting

Recovery Progress

In 2021–2022, we made substantial progress on the key actions identified in the 2021–2025 Priority Action Plan for the white abalone (*H. sorenseni*): (a) improve reproductive output and maximize survival of captive-bred animals, (b) expand conservation aquaculture for the purpose of population enhancement through outplanting in the wild, (c) increase outplanting and monitoring in order to enhance white abalone populations in the wild (d) improve data access for recovery partners, and (e) improve outreach and communications to build support and foster partnerships.

Our progress would not be possible without a growing list of partners, all of whom are supported in part by NOAA grants and contracts, especially the ESA Section 6 Species Recovery Grant Program. Our partners include (in alphabetical order): Aquarium of the Pacific, The Bay Foundation (TBF), Cabrillo Marine Aquarium, California Department of Fish and Wildlife (CDFW), California Science Center, Creeklands Conservation, Centro de Investigación Científica y de Educación Superior de Ensenada, The Cultured Abalone Farm (TCAF), Moss Landing Marine Laboratory, Paua Marine Research Group (PMRG), Southern California Marine Institute, The Santa Barbara Natural History Museum Sea Center, SubAqua Imaging, Universidad Autónoma de Baja California, the University of California Davis Bodega Marine Laboratory (BML), and the University of California Santa Barbara (UCSB).

Improve reproductive output and maximize survival of captive-bred animals

Captive propagation is white abalone's best hope for quickly boosting numbers in the wild through outplanting (also known as reseeding, restocking, reintroduction, or enhancement; a method whereby captive-bred abalone are introduced into their native kelp forest habitat where they will grow and become a part of a healthy wild population over time). The ability to spawn broodstock and produce large numbers of newly settled white abalone in a captive setting has

White abalone. Credit: NMFS/David Witting

been developed and improved as a direct result of captive breeding efforts and research. Production of 1-year-old white abalone has soared from handfuls to tens of thousands of animals over the past several years, but ensuring that these animals survive to outplanting size (~2 years of age and ~25 mm shell length) has remained a challenge. We are developing the tools necessary to reliably produce an order of magnitude more white abalone of the desired outplanting size in order to meet enhancement goals. A key to ensuring that we meet this goal is to design applied research programs (preferably non-lethal ones) that identify the factors that improve the reproductive output of broodstock, improve juvenile survival, future-proof white abalone for a changing climate, and maximize the long-term health and survival of captive-bred white abalone in the laboratory and the field.

Our captive breeding program led by BML collected more than 17 million eggs during planned and spontaneous spawning events and created approximately 15,000, 8-month-old juveniles in 2021 and 2022. The program is primed to produce more than 2,000 settled juveniles that will be ready for outplanting to restoration sites beginning in the spring of 2023. Research focused on how to improve reproductive success of broodstock taught us that understanding reproductive physiology is important for improving captive production; males and females may require different reproductive conditioning treatments; young males spawn more reliably than older males so distributing these "teenager" males to all partners with large female broodstock will increase our likelihood of successful spawning attempts; and diet and lineage play an important role in juvenile survival in the face of climate change. Studies centered on the health and survival of captive-bred white abalone conducted by CDFW's Shellfish Health Laboratory are teaching us how to better mitigate disease and pest impacts on captive animals. Results from these research topics were presented at the International Abalone Symposium (February 2023, Auckland, New Zealand) and the Western Society of Naturalists (November 2022, Oxnard, California).

At the NOAA Southwest Fisheries Science Center, scientists have been examining the tolerance of juvenile white abalone to increased water temperature, hypoxia and low pH conditions that seasonally occur throughout the historic range of white abalone.[27] These experiments focus on understanding how captive white abalone survival, growth, and metabolism are impacted under challenging climate conditions so that their chances of contributing to future generations once outplanted to the wild are maximized. So far, it appears that white abalone fitness is directly impacted by low dissolved oxygen conditions, which are exacerbated by warmer temperatures. Acclimating abalone to low oxygen and pH conditions does not appear to affect their overall fitness or sensitivity to these conditions. However, there is high variation in abalone metabolic demands and sensitivity to hypoxia, indicating differences in animal fitness depending on how an individual's genes and environment interact. This result highlights the need to investigate the overall fitness of different crosses and cohorts in order to enhance long-term outplanting success.

27 Fan, Stephanie. 2021. The effects of temperature and body size on the metabolism and hypoxia tolerance of white abalone (*Haliotis sorenseni*) and red abalone (*H. rufescens*). Theses. 47. https://digital.sandiego.edu/theses/47

More than 6,000 white abalone raised in our conservation aquaculture network were individually tagged and outplanted to native subtidal rocky reefs between 2021–2022. Credit: The Bay Foundation/Jill Demeter

Expand conservation aquaculture for the purpose of population enhancement through outplanting in the wild

In order to meet or exceed our enhancement goals, the survival and growth of captive-bred white abalone between ages 1 and 2 must improve. One way to achieve this has been to improve the program's grow-out capacity over the past 2 years. As a result, juveniles are held at 10+ partner grow-out facilities at any given time and broodstock are currently at a subset of these facilities. By adding the expertise of commercial abalone growers to our network, we have improved the quality of care that our juvenile abalone receive and by expanding our partnership we have provided captive abalone with the additional space they need to reach the targeted outplanting size more quickly. The knowledge and resources we are using to help save white abalone, in turn, enhances the sustainability and security of aquaculture practice. We are getting closer to meeting our production targets, even with the challenges that the COVID-19 pandemic presented to our programs. During the previous biennial reporting period, we produced ~4,200 white abalone for outplanting, and from 2021–2022 we produced ~6,000 white abalone for outplanting, a 43 percent increase in production. Across the network, coordinated partner spawns occurred for the first time in years, leading to the first successful multi-facility spawn in early 2023. Partner coordination between UCSB and a commercial aquaculture facility, TCAF, led to one of three successful rearings of spontaneously spawned gametes, resulting in thousands of newly settled juveniles.

We anticipate getting to our production target of 10,000 to 25,000 white abalone outplanted annually soon because: 1) our operations will be fully functioning now that COVID-19 restrictions have been lifted across the network; 2) intra-agency funding sources have been stable and we hope future funding opportunities will grow; and 3) we are continuing to improve and expand spawning and reproductive conditioning methods for white abalone while improving their chances of survival and growth, both in the laboratory and once outplanted to natural habitats.

Increase outplanting and monitoring in order to enhance white abalone populations in the wild

In order to establish multiple self-sustaining populations of white abalone and reinforce the health of the kelp forest ecosystems upon which they depend, repeated enhancement efforts in current outplant sites, the addition of new outplant sites, and the continued monitoring of abalone and their habitats must occur. Monitoring wild and outplanted white abalone using multiple tools such as remotely operated vehicles (ROVs), self-contained underwater apparatus (SCUBA), in situ time lapse cameras (TLCs) developed by SubAqua Imaging, abalone recruitment modules, genetics, and environmental data loggers is necessary to support research efforts, determine whether our restoration efforts are effective, and highlight methodologies that need revision.

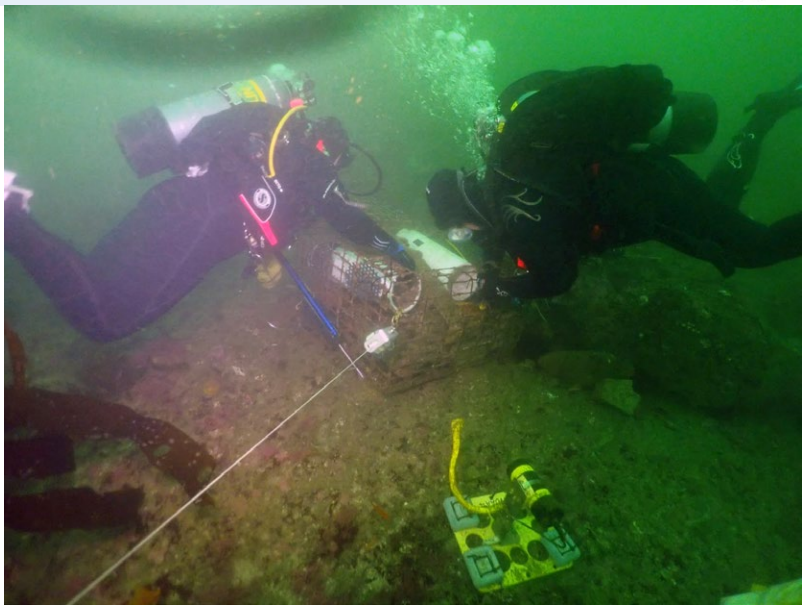
NOAA is leading efforts with partners (CDFW, TBF, and PMRG) to improve methods for outplanting abalone in kelp forests, which culminated in four additional successful white abalone outplanting efforts in the spring and fall of 2021 and 2022. The selection of new sites involved analyzing habitat information that has been collected since 2018 across the Southern California Bight. Low-relief reef, a diversity of substrate types, consistent kelp canopy and understory algae abundance, cool bottom temperatures, and the presence of wild abalone spanning a range of sizes were important factors that led us to selecting two additional outplant sites. Using SCUBA band transect

survey methods, we have estimated an average ~30-33 percent mortality rate of outplanted white abalone regardless of outplant location or season when using semi-enclosed outplanting modules. These modules protect the abalone from most predators and allow them to acclimate to the natural environment prior to release onto the reef. TLC data analyzed by PMRG has confirmed that the modules themselves, stocking to the modules, and release from the modules do not appear to attract an unusual number of predators to our outplant sites. Estimated mortality rates at a 3-month post-outplant reference point have consistently decreased with each successive outplanting event, giving us confidence that our methods are improving over time.

NOAA continues to lead the development of a genetic toolbox to guide outplanting design and monitoring. This has included gathering full genome information from wild white abalone to understand diversity and examine genetic connectivity between regions. A high-quality reference genome has been produced for white abalone, and a sex-determining region has been identified that will allow better monitoring and tracking of wild and captive populations. Environmental DNA sampling is being developed to help improve our ability to locate wild white abalone populations. ROV monitoring efforts at deeper depths resulted in the discovery of a previously unknown aggregation of white abalone at an offshore bank. We aim to collect genetic samples from these wild white abalone this year to determine the degree of relatedness between them and nearer-shore populations.

Improve data access for recovery partners

The development of a shared database that contains high-quality data is essential for our program to communicate the outcomes of our efforts in a consistent and coordinated manner. High-quality, accessible data for all partners are necessary to determine how well recovery actions are performing and to know where and how to adaptively manage activities to increase our chances of meeting recovery goals. During this biennial reporting period, a series of trainings were led by our National Research Council post-doctoral fellow to train our partners in organizing and uploading data and running protocols to identify data errors and make corrections on a shared Google



California Department of Fish and Wildlife scientific divers outplant captive-bred white abalone to modules that help keep the animals safe while they acclimate to their natural habitat. Credit: CDFW/Mohammad Sedarat

platform. A Shiny web application was developed and launched in 2021 to communicate information as interactive data explorations instead of static documents. Data have been accessed and vetted in a timely fashion to communicate our results at local, national, and international meetings, in peer-reviewed journals, internally within NOAA, and at public outreach events.

Improve outreach and communications to build support and foster partnerships

Our program has established consistent themes and unified messaging to highlight why white abalone were listed as endangered, why it is important to recover the species, and what needs to be done to improve the status of populations so they can be removed from the endangered species list. Using traditional media outlets, social media, and outreach events, our partners have reached millions of listeners. We have partnered with artists, authors, and tribal leaders to showcase the white abalone recovery story (e.g., Oriana Poindexter Photography, Michael Ready Photography, Ann Vileisis Author, Beatie Wolfe Artist).

Efforts to secure funding for the program by creating a list of unified priorities that are featured in the NOAA abalone outreach and education grant program and in proposals written for external grant opportunities have proved successful. For example, our partners

NOAA scientific divers descend with captive-bred white abalone to the subtidal kelp forests of Southern California in the hopes of restoring the species. Credit: Michael Ready Photography

in Mexico have embarked on efforts to improve conservation and research hatchery facilities in Ensenada and establish new and efficient methods for grow-out of young abalone on native reefs. We also plan to select two new outplant sites on Catalina Island due to external interest and support for expanding our partnership to the island. Our outreach and communication campaign has attracted new partners to the program and new sources of funding that ultimately bring greater geographic coverage for recovery activities. This expansion is necessary to re-establish wild populations throughout the range of the species from Point Conception, California, to Central Baja California, Mexico.

Looking Ahead

The future of the white abalone recovery program hinges on overcoming several challenges. Laboratory and field work will undoubtedly experience higher operational costs. If funding levels do not keep up with the rising costs of the recovery program, we will not recover the species. We expect that initial signs of recovery will take years to realize and maintaining the momentum of the program over a long time frame will be difficult. Climate change has introduced stressors (e.g., disease, food limitation, large storm events, and harmful algal blooms) that work counter to restoration activities and add another layer of obstacles to recovery. The impacts of these stressors on captive production have been studied, but continuous research is needed to ensure that recovery keeps pace with a changing ocean.

We see opportunities to meet these challenges by securing long-term funding, maintaining a strong and unified communication network, and producing high-quality data. This will enable our program to share intermediate accomplishments in a timely manner and attract new partners that may be able to bring additional resources and greater efficiencies to the table. For example, international cooperation efforts to build a captive breeding and restoration program in Baja California, Mexico, will help expand the program's geographic reach, explore methodologies that are not feasible to use in other areas, and partner with fishing communities that have specific knowledge and skill sets that can help improve efficiencies and chances of success. In addition, ongoing research aimed to improve spawning output from wild broodstock and increase the genetic diversity of captive populations can help the program overcome climate-induced hurdles.

PARTNER *in the* SPOTLIGHT: The Bay Foundation

Pictured left to right are Brian Cohn, Tom Ford, Rilee Sanders, Heather Burdick, Olivia Carmack, and Ben Grime. Credit: The Bay Foundation/Heather Burdick

The Bay Foundation (TBF), led by Chief Executive Officer Tom Ford, has been partnering with NOAA on kelp and abalone restoration for nearly two decades in the Southern California Bight, especially Santa Monica Bay. TBF has made major contributions to the white abalone recovery program from 2021–2022. We were particularly lucky to have them as a partner during the pandemic because they were able to establish safe protocols for continued field and laboratory operations in a timely manner. Skilled TBF staff have transported, cared for, tagged, fed, and prepared thousands of white abalone in a well-maintained laboratory environment during the months preceding outplanting of white abalone to native Southern California habitats. TBF's well-maintained boat and proficient dive team have proven indispensable for monitoring abalone habitat and populations throughout the Southern California Bight, especially along the Palos Verdes Peninsula and California Channel Islands. This accomplishment has led to the selection of new outplant sites, monitoring the status of wild populations of white abalone and collecting genetic samples from them, and assessing wild white abalone as candidates for our broodstock program.

In the same vein, outplanting thousands of captive-bred white abalone and tracking their survival would not have been possible without the adept TBF scientists and staff. Finally, TBF spent extensive time re-organizing, re-cataloguing, and performing intensive quality control on a substantial portion of the data collected for this project. Through the guidance of the data manager and other partners, a comprehensive new database structure was created that met NOAA's needs and standards. While field operations were initially limited due to the pandemic, TBF made significant progress to increase the efficacy of data usability and comprehension. For all of these reasons and more, TBF is the recipient of the Partner in the Spotlight award in 2023.

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