COASTAL PELAGIC SPECIES ADVISORY SUBPANEL RECOMMENDATIONS FOR NOAA OFFICE OF LAW ENFORCEMENT PRIORITIES

The Coastal Pelagic Species Advisory Subpanel (CPSAS) received a report from National Oceanic and Atmospheric Administration (NOAA) Counsel Phillip Ortiz, requesting input on establishing annual enforcement priorities. The CPSAS notes that there are overlapping jurisdictions involved in the management of West Coast pelagic fisheries. Therefore, the CPSAS recommends that NOAA law enforcement emphasize coordination with state enforcement officials to provide uniformity from the fishing grounds to the point of delivery and subsequent distribution. Promoting a policy of federal and state cooperation in the areas of patrol and data sharing is the most cost effective means to improve compliance and deterrence.

ENFORCEMENT CONSULTANTS REPORT 2

The Enforcement Consultants (EC) reviewed the letter to the Council from National Oceanic and Atmospheric Administration (NOAA) Office of Law Enforcement (OLE) Director Bruce Buckson, dated October 12, 2011 concerning NOAA Enforcement priorities. We sincerely appreciate the acknowledgment from the Director that Council and advisory body input is important to the evaluation process.

NOAA OLE is seeking Council input with respect to (1) "setting annual priorities at the national and regional level," and (2) "how the agency can develop national and regional priorities that reflect:

- The potential effective and or threat of non-compliance to the resource
- The status of the resource
- Efforts to improve compliance
- Opportunities for deterrence
- Catch share programs
- Efforts on cases outside specific priorities
- Available resources
- Other considerations as warranted"

Our understanding is that we are tasked with (1) considering and recommending a process or a road map that prioritizes living marine resource protection issues, and (2) actually identifying regional priorities so that they can be compared nationally in an effort to set direction. Given that NOAA OLE is the requester, the following statement is offered as the state partner perspective only. The planning model used on the west coast normally results in a consistent set of living marine resource enforcement priorities between the state and Federal enforcement programs

IDENTIFYING A PROCESS

Our experience on the West Coast demonstrates that the processes associated with the Council and Joint Enforcement Agreements (JEAs) maximize the effectiveness of law enforcement by defining Pacific Coast and the nations marine fisheries protection priorities, support comprehensive cooperative planning efforts, and enabling inter-jurisdictional fisheries enforcement operations. An active Enforcement Consultant Committee assigned to a Council process has the ability to advise the Council on regulations and outcomes associated with implementation. It is our experience that the Council takes our enforcement concerns seriously when making regulatory decisions. This connectivity is central to success in identifying priorities and carrying them out in a manner that results in real protection for the resource.

Our view is that, at least in the broad sense, national priorities should mirror regional priorities, and vice versa. Priorities should be set at the regional fisheries council level and cascade down in the form of direct patrol and investigative operations. Council protection priorities are heavily considered when developing the operational portion of JEAs. Field operations are then led by

state enforcement personnel that can leverage patrol resources when there is limited Federal presence, complement the investigative role of NOAA Agents, determine compliance, identify and report on regulatory deficiencies, and bridge jurisdictional gaps.

REGIONAL ENFORCEMENT PRIORITIES

We believe that one of the highest priorities should be effective and efficient enforcement of the Council's enforcement priorities and Federal regulations protecting endangered species. When it comes to enforcing Federal regulations, uniformed state officers, wardens, and troopers have a role, and NOAA OLE agents have a role. Federal and state operations must be complimentary of one another in a way that addresses the considerations Director Buckson notes in his letter to the Council; e.g. status of the resource, opportunities for deterrence, available resources, etc. In our view, the enforcement priority-setting mission cannot be accomplished without analyzing the roles of Federal and state officers at the same time.

NOAA is considering a change in enforcement strategy that places uniformed NOAA Officers in the field at the expense of filling vacant Special Agent positions. The West Coast States have developed and implemented an enforcement model that capitalizes on the strengths of the Federal and state JEA partnership to address Federal and Council enforcement priorities. The West Coast model has the ability to leverage over 600 general authority officers that are already present and engaged in the community-based resource protection effort. The model takes advantage of the State partners' infrastructure in place, as well as trained, equipped and supervised personnel, already deployed to meet uniformed patrol needs. An important part of the time-tested West Coast model is the important role current NOAA Special Agents fulfill - as the necessary corresponding "detective force" with state and USCG partners.

NOAA does not have the infrastructure in place to properly support a uniformed contingent, as is currently proposed. This approach is duplicative of the state's ability to perform uniformed Federal fishery patrol functions. Investing in a "new" program versus using existing cost-efficient and available state resources does not make good sense in a time of increased fiscal challenges at the Federal and state levels.

Effective enforcement of complex enforcement issues/priorities requires both patrol and detective or investigative functions. The patrol and detective/ investigative functions are fundamentally different from each other. One aspect of enforcement requires call-for-service patrol officers focused on the responsibilities of day-to-day and emphasis patrols. The other aspect requires an investigative agent that is not consumed with the responsibilities that come with day-to-day patrols and instead can focus and commit the time required to investigate large, complex cases. While many investigations are often a result of an initial uniformed officer, and investment in an Agent / Detective force is necessary if violations discovered at the field level are elevated.

Someone needs to have the time and latitude to focus on egregious offenses such as large-scale fraud. The expertise needed to be competent and successful in detecting, investigating, and eventually taking action on major fisheries cases necessitates a well-trained work force. It is

critical to hire and train NOAA investigators with the requisite skill set to perform these complex fisheries investigations and ensure their effectiveness.

Given the above as a backdrop, we offer the following marine resource priorities:

PRIORITY ONE

ESA listed fish / Overfished species: The land area affected by Endangered Species Act (ESA) listed species is significant (WA-61 percent, OR-55 percent, CA-32 percent). Given that virtually every West Coast marine and associated freshwater tributary is occupied by ESA-listed or overfished species, providing access to healthy populations while avoiding impacts to recovering species is a typical challenge for the Council. As a result, commercial and recreational opportunities are tied to some of the most complex management strategies in the nation. Trawl rationalization involving over 90 species of groundfish is but one example. Adequate enforcement of related measures is the key to being able to successfully prosecute fisheries without negative effects on stock rebuilding efforts.

For anadromous species, adequate enforcement means providing a law enforcement presence throughout the range of migrating fish, not just saltwater areas. Pacific salmon, steelhead, and Eulachon rely on thousands of miles of fresh water spawning and rearing habitats far inland from the Pacific Coast. If illegal take of sensitive species and habitat destruction goes unchecked when they occupy this environment, the repercussions will be felt in fisheries that occur elsewhere.

Unfortunately, West Coast ESA listings are not limited to just fish. Several marine mammals have this distinction, and require law enforcement presence to monitor and control human interactions.

Related State Activities

- ESA-listed fish protection in marine / freshwater: patrolling closed seasons and take prohibitions, enforcing selective fishery regulations, detecting and enforcing hydraulic and other habitat laws.

- ESA-listed marine mammals: Enforcing vessel interactions with Southern Resident Orca Whales, human interactions with other listed marine mammal species along the coast.

- Overfished groundfish stocks: patrolling marine protected areas and conservation lines, enforcing laws related to Trawl Rationalization, monitoring catch accounting.

Related Federal Activities

- Coordinate cooperative compliance programs in watersheds with a history of water diversion, barriers to fish passage, and screening.
- Assisting in and coordinating investigations involving egregious hydraulics violations and habitat damage.

- Investigate large scale ESA take case referrals.

PRIORITY TWO

Protection of Healthy Stocks: At-sea and dockside law enforcement presence during commercial and recreational fisheries under a federal management plan is important to both a fair playing field for participants and fishery sustainability.

Related State Activities:

- Patrolling the Exclusive Economic Zone (EEZ) by vessel to ensure compliance with limits, gear requirements, area closures and seasons
- Patrolling dockside to ensure compliance with limits and seasons. Particular focus should be on species, daily, trip, weekly, monthly and cap limits and total catch accounting

Related Federal Activities:

- Investigate field referrals involving significant catch accounting violations and fraud

PRIORITY THREE

Lacey Act Enforcement / Domestic Undocumented fish: In general, when fish and shellfish resources have been taken in violation of state, Federal or tribal law, have a nexus with commerce, and are transported across a state or an international border, a violation of the Federal Lacey Act has occurred. Expanding patrol and inspection activities beyond fishing grounds and typical fish delivery sites is critical to taking the profit out of poaching, protecting the integrity of legitimate commercial industry, and determining whether catch was fully accounted for. Successfully tracing products through a highly mobile market is reliant on an investment of time conducting inspections at border crossings with Canada, Mexico and adjoining states, as well as cold storage facilities, shippers, and retail markets.

State Officers / Troopers have the broad inspection authority over commercial businesses engaged in dealing, shipping, transporting, storing, selling, or buying natural resources that is necessary to detect large-scale abuses.

Related State Activities:

- Border inspections on inbound and outbound commercial fisheries products to ensure compliance with harvest and catch accounting regulations
- Ground and air shipper inspections
- Market place inspections that detect undocumented fish, illegal commercialization, and misbranding or mislabeling events that undermine commercial fishing business and defraud consumers

Related Federal Activities:

- Focus on large scale violations involving the movement of illegally taken or marketed fish with interstate or international nexus
- Lead and coordinate multi-jurisdictional approach to investigations

PRIORITY FOUR

Illegal Foreign Fishing Incursions: Obviously the presence of vessels fishing illegally disadvantages our fishermen and industry through competition for limited resources. But just as important, it compromises fishery management plans. Other ancillary impacts occur through unreported catch and failing to follow strategies that were designed for fishery sustainability. Given how tightly resources are managed today, a small number of non-compliance events can have profound impacts on legitimate U.S. commercial fishing operations.

Related State Activities:

- On the water patrol presence
- Collaborating with other law enforcement entities with joint border concerns

Related Federal Activities:

- Coordinate the cross jurisdictional investigative response.
- Investigate large scale illegal harvests

USCG COMMENTS

The United States Coast Guard (USCG) appreciates the opportunity to work with NOAA in setting annual enforcement priorities, both nationally and regionally. USCG Headquarters is working on this initiative through our USCG liaison at NOAA Headquarters and will provide written comments to NOAA at the national level. In addition, USCG D13 and D11 enjoy a close working relationship regionally with NOAA Northwest Region and Southwest Region, respectively. We have already started discussions on priorities with our local NOAA counterparts through our quarterly planning meeting process. We will continue to refine priorities during our routine interactions with our local NOAA partners and will ensure our collaborative priorities are in alignment with the USCG's annual strategic operational planning process. Per the USCG Commandant's strategic plan for fisheries enforcement, our number one fisheries priority is illegal, unregulated, and unreported/EEZ enforcement. Additional domestic fisheries enforcement priorities are heavily dependent on specific regional issues, which we will work with our partners to identify. Although the USCG's enforcement efforts will primarily remain focused on at-sea boardings, we want to be able to complement the priorities of NOAA by utilizing partnerships and information sharing to most optimally employ our assets."

PFMC
11/6/11

A Bilateral Scientific Workshop Process to Evaluate Effects of Salmon Fisheries on Southern Resident Killer Whales

NOAA Fisheries

Southern Resident killer whales (*Orcinus orca*) are listed as an endangered species under both the U.S. Endangered Species Act (ESA) and Canada's Species at Risk Act (SARA). The National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) and Fisheries and Oceans Canada (DFO) have developed and adopted recovery plans as required by the ESA and SARA. The plans are substantially similar; both describe the biological status of the population and specific threats and factors potentially limiting recovery. The plans establish interim recovery objectives, identify critical uncertainties and data gaps, and call for research to address the uncertainties and data gaps.

Several threats to killer whales have been identified: environmental contaminants, insufficient abundance of prey, physical disturbances by vessels, noise pollution, oil spills, diseases, climate change, small population size, and cumulative effects. Due to information gaps, the recovery plans generally do not characterize the absolute or relative importance of these threats. The multi-faceted nature of the threats to the whales requires an ecosystem approach to recovery. NOAA Fisheries and DFO have continued existing research and undertaken or supported new research to better understand threats to their recovery. They have initiated and continue to support a wide range of management actions to address identified threats. For example, they utilize their authorities and resources to support efforts to protect and restore salmon habitat to improve the abundance of salmon. They have adopted regulations designed to limit physical disturbance of whales by vessels and to limit noise pollution in areas frequented by the whales. The agencies review proposed actions within their respective jurisdictions for potential negative effects on killer whales and use their authorities to prescribe measures to mitigate such effects. The workshop process described herein is a response to one such proposed action – the adoption of a Chinook salmon fishing plan for Puget Sound, and is intended to evaluate the effects of salmon fisheries on the whales. This workshop process is not intended or designed to undertake a comprehensive review of all threats to killer whales; its focus on fishing is intended to be one component of a broader ecosystem approach to their conservation and recovery.

In addition to the development of recovery plans, the listing of a species under the ESA or SARA requires the applicable U.S. or Canadian federal agency to consider the potential effects of various management actions on that listed species. In the case of the ESA, the purpose of NOAA Fisheries' evaluation – set forth in a "biological opinion" – is to determine whether the proposed action will jeopardize a listed species or result in the adverse modification or destruction of its critical habitat. Because the Southern Resident killer whales are known to rely heavily on Chinook salmon as their preferred prey, NOAA Fisheries must consider whether the reduction in available prey resulting from the fishery will jeopardize the survival and recovery of the whales.

Pursuant to requirements of the ESA, NOAA Fisheries conducted an evaluation of new fishing regimes recommended in 2008 by the Pacific Salmon Commission for U.S. and Canadian fisheries covered by the Pacific Salmon Treaty. That consultation examined the estimated reduction in Chinook salmon available to the whales from the proposed fisheries in relation to the whales' estimated prey requirements. Using the best scientific information then available, NOAA Fisheries concluded that the proposed regimes would reduce prey available to the killer whales, but would not jeopardize their survival and recovery or adversely modify their critical habitat. It was noted that new scientific information would continue to emerge to help inform future consultations.

In 2010, the Washington Department of Fish and Wildlife and the Puget Sound treaty Indian tribes submitted a proposed new fishing plan that would govern their Chinook salmon fisheries in Puget Sound for the next several years. NOAA Fisheries again evaluated the effects of fishing on the abundance of prey available to the killer whales using a similar approach to the 2008 analysis, but incorporating new scientific information available since 2008. This newer analysis suggests that the amount of Chinook available to the whales in comparison to their metabolic requirements may be less than what was estimated in 2008. This change results from several factors, including but not limited to revised estimates of the metabolic requirements of the whales, their selective preference for larger Chinook salmon and inclusion of a broader range of years to represent expected variations in the annual abundance of Chinook salmon. In addition, NOAA Fisheries developed new analyses regarding the relationship between Chinook salmon abundance and Southern Resident killer whale population growth.

NOAA Fisheries and DFO are mindful of the potential significance of this new information to fisheries and other activities that affect the abundance of Chinook salmon available to the killer whales. For this reason, NOAA Fisheries and DFO want to ensure that the scientific data and analyses are carefully reviewed in an open and scientifically rigorous process. The bilateral workshop process described here was conceived and designed with these purposes in mind. It will provide a structured and focused scientific forum wherein NOAA and DFO scientists and other invited experts can interact with an independent science panel to review the best available scientific information on the effects that salmon fisheries may have on Southern Resident Killer Whales by reducing their prey. The panel and workshop participants will review the ecology of the whales and their feeding preferences and energy requirements. They will examine the extent to which various salmon fisheries may reduce prey available to the whales, and the potential consequences to their survival and recovery. This focus on the effect of fisheries does not suggest that fisheries are believed to be the primary cause of the whale population's depleted status or that fisheries are the only actions affecting salmon abundance. Rather, it is intended to shed light on the extent to which prey scarcity may be limiting recovery of the whales and the role that salmon fisheries may have in contributing to that scarcity.

By addressing one of the identified threats to killer whale recovery, this process will contribute to the broader recovery programs for Southern Resident killer whales. A rigorous scientific investigation of the effects of fishing on the whales when placed in the broader context of all the factors affecting the whales will better inform future fishery management decisions by NOAA and DFO. Note that this workshop process and the resulting report of the panel are not intended to establish policy or make management recommendations or decisions.

Key question: To what extent are salmon fisheries affecting recovery of Southern Resident killer whales by reducing the abundance of their prey, and what are the consequences of this reduction to their survival and recovery?

Overall approach: NOAA and DFO have established an independent science panel to oversee the scientific deliberations and produce a report at the conclusion of the process. Three workshops will be convened to present, discuss, and refine scientific information relevant to the key question. The first workshop occurred on September 21-23, 2011 in Seattle. The second will be March 13-15, 2012, in British Columbia, and the third will be September 18-20, 2012 in the Seattle area. The specific objectives of each of the workshops are detailed below. To keep the workshops to a manageable size and foster productive scientific discussion, attendance will be limited to the science panel, scientific presenters and other experts invited to engage in the discussions and help perform a scientific peer review function. A limited number of observers representing the public and stakeholders also will be invited, but generally will not participate in the scientific discussions.

Independent Science Panel: A seven-member science panel has been established to oversee the workshop proceedings, participate in workshop discussions, challenge and critique presentations and analyses, and provide expert feedback. The members of the panel were selected based on their expertise in salmon management, marine mammals (killer whales) and predator-prey dynamics. Through a structured process and iterative dialog with invited experts, the panel will help sharpen scientific understanding of the effects of fishing on southern resident killer whales. At the conclusion of the process, the panel will produce a report that:

- identifies the extent to which salmon fisheries in specific locations and times, in combination or in the aggregate, or as a function of annual prey abundance, may be affecting the well-being of Southern Resident Killer Whales by reducing their prey;
- describes the nature of those effects (e.g., through a reduction in whale survival, growth rates, fecundity, or some other mechanism);
- discusses the consequences to survival and recovery of the killer whales; and,
- identifies assumptions, critical uncertainties and data gaps and potential research to reduce uncertainties.

Members of the Independent Science Panel: The panel consists of the following individuals:

Dr. Ray Hilborn (Chair), School of Aquatic and Fishery Science, University of Washington, Seattle, WA;

Dr. Sean Cox, School of Resource & Environmental Management – Simon Fraser University; Vancouver, BC;

Dr. Francis Gulland, Marine Mammal Commission; Marine Mammal Center, Sausalito, CA;

Dr. David Hankin, Department of Fisheries Biology, Humboldt State University, Arcata, CA;

Dr. Tom Hobbs, Natural Resource Ecology Lab., Colorado State University, Fort Collins, CO;

Dr. Daniel Schindler, School of Aquatic and Fishery Science, University of Washington; and

Dr. Andrew Trites, Marine Mammal Research Unit, University of British Columbia, Vancouver, BC.

Science Facilitator. A scientific consulting firm with demonstrated experience in resource management problem-solving processes, ESSA Technologies, Ltd. has been retained to provide facilitation services. Its president, David Marmorek will help plan and conduct the workshops and assist the panel in producing its report.

Presentations. Most of the workshop presentations will be by NOAA and DFO scientists who conduct research on killer whales, manage salmon fisheries or have performed analyses in connection with the agencies' management of listed species. Additional speakers will be invited based on their expertise and/or research on matters pertinent to the workshop purposes.

Public Input. NOAA will establish a web site where workshop and other relevant materials will be posted for access by the public. Between the second and third workshops, a draft of the scientific panel report will be made available for public review and comment. The comments will be considered by the panel as it develops its final report.

The Workshop process and schedule:

Workshop 1: September 21-23, 2011 (Crowne Plaza Hotel, Seattle, WA)

Process. The first workshop took much time and advance preparation because all attendees were asked to come to the process familiar with recovery plans, biological opinions, and scientific publications relevant to proceedings as appropriate to the nature of their participation. To facilitate informed discussion at the workshop, presenters made their study results, data and/or analysis available prior to the workshop.

Purposes. Workshop 1 was designed to serve these four primary purposes:

1. Identify what we know about Southern Resident killer whales, their feeding habits, and prey abundance.
2. Present and discuss NOAA, DFO and others' research and analyses relating salmon abundance and fishing to killer whales.
3. Identify and discuss key assumptions and uncertainties and the potentials for reducing them.
4. Begin formulating specific follow-up tasks for completion and presentation at Workshop 2.

Time period between Workshops 1 and 2

1. Soon after the first workshop, the science panel began deliberating on the presentations and analyses to identify alternative or additional analysis that should occur.
2. Workshop 1 presenters will refine their analyses based on workshop discussions and feedback received from the science panel subsequent to Workshop 1.
3. Other scientists may prepare analyses in response to Workshop 1 proceedings for presentation at Workshop 2.
4. Additional information will be compiled for presentation to the workshop process (e.g., biological performance criteria applicable to salmon and marine mammals) for consideration by the science panel.
5. The science panel and facilitator begin to outline the draft report (sans conclusions for matters still under consideration)
6. The Chair and facilitator will prepare and distribute an agenda for Workshop 2.

Workshop 2: March 13-15, 2012 (at a place TBD in British Columbia)

Purposes. The primary purposes of Workshop 2 are as follows:

1. Workshop 1 presenters will summarize the results of their updated/refined analyses prepared in response to discussion and feedback from Workshop 1 and the science panel.
2. Other scientists (e.g., state, tribal, NGO) may make presentations in response to matters presented at Workshop 1.
3. The science panel and participants will discuss the new information, ideas and analysis identified in Workshop 2.
4. The science panel begins to formulate tentative conclusions and identify key uncertainties in discussions with workshop participants.
5. The science panel and facilitator may meet at the conclusion of the workshop to begin synthesizing the information and assign writing responsibilities for sections of a draft report.

Time period between W2 and W3.

1. The science panel writes its draft report.
2. The science panel's draft report is circulated for public review and comment.
3. The agencies receive and collate public comments on the report for consideration at Workshop 3.
4. The Chair and facilitator prepare and distribute an agenda for Workshop 3.

Workshop 3: September 18-20, 2012 (at a place TBD in Washington State)

1. Workshop participants meet to review and discuss:
   a. the scientific findings and conclusions of the science panel's draft report;
   b. public comments received on the draft report;
   c. the methods employed to estimate effects of alternative fishery scenarios on prey availability;
   d. major findings and conclusions that can be reached based on workshop proceedings;
2. The science panel identifies additional information it needs to inform its final report and how to obtain it.

Following Workshop 3, the science panel and facilitator will produce its final report by November 30, 2012. NOAA Fisheries and DFO will consider the report of the science panel as they conduct future consultations on fisheries and other actions affecting prey available to killer whales. Additionally, the panel's findings regarding additional research will be considered and likely given substantial weight as the agencies develop their research priorities.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

October 12, 2011

Donald McIsaac
Executive Director Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 101
Portland, Oregon 98220-1384

Dear Director McIsaac:

The NOAA Fisheries Office of Law Enforcement (OLE) and the NOAA Office of General Counsel for Enforcement and Litigation (GCEL) are seeking comment from the public and other interested stakeholders on setting annual priorities at the national and regional level.

The priorities adopted will support NOAA's statutory mandates to manage marine resources and Department of Commerce and NOAA strategic goals. We intend to utilize stakeholder recommendations, emphasize partnerships with State and Federal partners, work to increase compliance and implement the priorities in a manner that will result in effective and fair enforcement programs.

Regional enforcement proposals will be reviewed annually and national priorities every two years.

NOAA is particularly interested in recommendations from all interested parties on how the agency can develop national and regional priorities that reflect:

- The potential effective and/or threat of non-compliance to the resource (high, medium, low);
- The status of the resource (e.g. endangered, threatened, depleted, overfished, overfishing occurring, etc.)
- Efforts to improve compliance;
- Opportunities for deterrence;
- Catch share programs;
- Efforts on cases outside specific priorities;
- Available resources, and
- Other considerations as warranted.

I request that this letter be included in the November 2011 briefing book for the upcoming Council meeting. Special Agents in Charge Vicki Nomura and Don Masters will be in attendance at the Costa Mesa Council meeting and they will be available to schedule meeting with interested parties. As well, if the Council or any interested party wishes to provide recommendations after the Council meeting, comments can be forwarded to the Regional NOAA

OLE Special Agents in Charge (contact information listed below) no later than December 15, 2011.

Thank you for your assistance in this matter,

Sincerely,

for Tracy A. Dunn

Bruce Buckson
Director
Office of Law Enforcement

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cc: Vicki Nomura
Don Masters

ENFORCEMENT CONSULTANT OPEN COMMENT

The Enforcement Consultants (EC) are in the process of reviewing the letter submitted by NOAA-OLE Director Buckson. We respectfully ask that the Council leave this agenda item open and provide time on Saturday, November 5, or thereafter for the EC to provide formal comment.

PFMC
11/02/11

GROUNDFISH MANAGEMENT TEAM REPORT ON ENFORCEMENT PRIORITIES

The Groundfish Management Team (GMT) had opportunity for a brief discussion with Don Masters, Paul Ortiz, and Dayna Matthews—representatives from National Oceanic and Atmospheric Administration's (NOAA) Office of Law Enforcement and Office of General Counsel for Litigation and Enforcement—on Open Comment 2 letter from NOAA Office of Law Enforcement Director Bruce Buckson ("Regarding NMFS Office of Law Enforcement Seeking Comments on Setting Annual Enforcement Priorities"). We thank them for seeking out the GMT's input. Given our schedule at this meeting and the timing of this agenda item, we had little time for discussion.

The Open Comment 2 letter expresses NOAA's intent to gather input on regional enforcement priorities from various groups, including stakeholders, the Council, and advisory groups such as the GMT. One piece of this input, as we understand it, relates to the views of the various groups on enforcement's role in the fisheries management system. NOAA is seeking this input no later than December 15, 2011.

The GMT understands that our input must be provided at this Council meeting rather than through a supplemental letter at a later date. Given the GMT's schedule at this meeting we were not able to dedicate time for a detailed discussion on specific enforcement priorities and are only able to provide our general comments relative to the key role that enforcement plays in groundfish management. We stress that state and Federal enforcement efforts are vital to the effectiveness of the Groundfish Fishery Management Plan (FMP) and we think that this importance should be captured. Enforcement activities underpin key pieces of the groundfish management structure including the Rockfish Conservation Areas, fish tickets, logbooks, the at sea observer program, trip limits, and more.

PFMC
11/7/11

SALMON ADVISORY SUBPANEL REPORT ONPRIORITY ENFORCEMENT ISSUES

The Salmon Advisory Subpanel (SAS) reviewed priority enforcement issues with members of NOAA Fisheries Office of Law Enforcement NOAA General Counsel, recommend enforcement of violations affecting Critical Habitat for Endangered Species Act (ESA) listed salmon stocks should be a high priority.

Consideration of existing state law enforcement as an asset to facilitate adequate presence in the field is important. State resources already strategically located across ESA listed habitat areas provide a ready protection tool for ESA listed fish. This consideration should also be linked to funding available through joint enforcement agreements between NOAA office of law inforcement and the states.

PFMC
11/02/11

October 21, 2011

Mr. Eric Schwaab
Assistant Administrator for Fisheries
National Marine Fisheries Service
1315 East West Highway
Silver Spring, MD 20910

RE: West Coast Swordfish Fishery

Dear Mr. Schwaab:

We are disappointed that the National Marine Fisheries Service (NMFS) is once again pushing to increase domestic Pacific swordfish landings and fishing effort with gears known to have high levels of bycatch. In this time when our country is seeking to promote sustainable industries and ecosystem-based approaches to management that protect and maintain the health and biodiversity of our oceans, it is unreasonable that NMFS continues to allow the California drift gillnet swordfish fishery to kill dolphins and sea lions, and to toss back, dead and damaged, 20 to 30 percent of its catch of fish. Further, it would be unreasonable to continue to invest in and promote efforts to develop a pelagic longline fishery for swordfish when the State of California and the Pacific Fishery Management Council have already taken actions to prohibit it due to the high levels of bycatch associated with this fishery and the take of endangered and threatened species.

We are writing to request that NMFS end this current effort to expand a west coast based drift gillnet or pelagic longline fishery for swordfish. If, however, NMFS is going to spend valuable time and taxpayer money investigating approaches to expand commercial fishing for swordfish on the west coast, you can expect serious challenges by conservation organizations and others if those efforts are 1) not associated with the phase out and prohibition of drift gillnet gear, and 2) associated with any experimental gear that is not significantly different from the drift gillnet or pelagic longline gear that NMFS has already tried, but failed to advance in recent years.

At the September 2011 meeting of the Pacific Fishery Management Council (PFMC), NMFS gave a report on the California-based driftnet fishery for swordfish and made the argument that NMFS and the PFMC must explore how to allow for greater catch levels of swordfish in U.S. waters in order to fulfill the local demand for swordfish. NMFS staff suggested in their report, without providing any supporting evidence, that if we increase domestic swordfish catch this will decrease the take of endangered leatherback sea turtles by other Pacific nations targeting swordfish. In response to the NMFS request, the PFMC directed its Highly Migratory Species (HMS) Management Team and Advisory Subpanel to provide information to inform a decision on whether to change the current driftnet swordfish fishery, scheduled for the March 2012 PFMC meeting.

If the agency's primary goal continues to be to increase domestic regional production of swordfish with a west coast fishery using drift gillnets and/or pelagic longlines, the result will be the increased take and mortality of endangered sea turtles, marine mammals, sharks, tunas, and many other fishes. We suggest, however, the primary goal ought to be a comprehensive international plan to protect marine mammals and recover endangered Pacific leatherback and loggerhead sea turtles from nesting beaches, across migratory pathways and in foraging hotspots. NMFS could work towards this goal by demanding changes to fisheries through international fisheries organizations to which the United States is a member, such as the Inter-American Tropical Tuna Commission (IATTC) and the Western and Central Pacific Fishery Commission (WCPFC), and also by using legal tools under the Magnuson-Stevens Fishery Conservation and Management Act and Marine Mammal Protection Act to restrict swordfish imports by Nations not meeting U.S. conservation standards.[1]

In particular, we urge NMFS to immediately finalize and publish a rulemaking to implement provisions of the Marine Mammal Protection Act that require foreign fisheries to meet the same levels of protections as domestic fishers for marine mammals. NMFS published an advanced notice of proposed rulemaking in April 2010 to develop regulations to implement these provisions and additional measures to ensure that foreign fleets protect all protected species including sea turtles under the Endangered Species Act.

Since the public comment period closed more than a year ago, NMFS has not moved forward on these important regulations. Doing so would help level the playing field for swordfish fishers in the U.S., and would likely be a far more effective option for providing sustainable seafood to the U.S. market than expanding the west coast swordfish fishery.

The PFMC, California legislators, the California Coastal Commission, conservation organizations, and thousands of members of the public have engaged in the debate over the west coast swordfish fishery now for decades. One thing is abundantly clear: these groups do not want to see an unselective west coast swordfish fishery that is going to kill marine mammals, endangered sea turtles and result in the annual bycatch of thousands of iconic fish and sharks. In 1992 the California Department of Fish and Game banned all pelagic longline fishing in the EEZ off the California Coast. Since 2004, longline gear used to target swordfish has been prohibited on the high seas off the U.S. west coast following NMFS' determination that the bycatch of North Pacific loggerhead sea turtles would violate the Endangered Species Act. In response to bycatch concerns, the State of Washington prohibits drift gillnet gear for swordfish and the State of Oregon revoked all of its drift gillnet permits for swordfish and thresher sharks in 2009. What is more, due to the projected high catch levels of non-target fish, marine mammals and sea turtles, the PFMC voted in April 2009 for the 'no action alternative' in a Draft Environmental Impact Statement that would have allowed for a west coast based high seas shallow-set longline

[1] 16 U.S.C. 1862i §608 'Actions to Strengthen International Fishery Management Organizations' and 16 U.S.C. 1826k §610 'Equivalent Conservation Measures' and 16 U.S.C. § 1371(a)(2) 'The Secretary of the Treasury shall ban the importation of commercial fish or products from fish which have been caught with commercial fishing technology which results in the incidental kill or incidental serious injury of ocean mammals in excess of United States standards.'

fishery for swordfish.[2] This high seas fishery proposal followed multiple failed Experimental Fishing Permit proposals to expand the geographic and temporal scope of the drift gillnet fishery into the Pacific Leatherback Conservation Area, and to allow for a single vessel to fish swordfish in the EEZ off California using pelagic longline gear.

In July 2008, the California Legislature passed AJR 62 with the resolution,

> That the Legislature of the State of California requests that the National Marine Fisheries Service defer consideration of any efforts to introduce shallow-set longline fishing off the California coast, both inside and outside the EEZ, until Pacific leatherback sea turtle critical habitat is established, the federal status of the North Pacific loggerhead sea turtle is clarified, and *critical habitat is designated for the North Pacific loggerhead sea turtle, if it is designated as "endangered". [emphasis added]*

As you know, on September 22, 2011, NMFS issued a final rule determining that North Pacific loggerhead sea turtles are a distinct population segment and that they are endangered with extinction, thus uplisting them from "threatened" to "endangered".[3] Given this resolution, however, NMFS should not pursue any efforts to expand pelagic longline fishing for swordfish until critical habitat is designated for both loggerheads and leatherbacks. While we expect a final rule designating critical habitat for leatherback sea turtles by November 15, 2011, NMFS has not yet issued a proposed rule to designate critical habitat for North Pacific loggerheads meaning that any effort by NMFS to expand a longline fishery would be contrary to the expressed resolution of the California Legislature.

Meanwhile, the California drift gillnet fishery targeting swordfish and thresher shark has a high level of indiscriminate and wasteful bycatch that includes many species of fish plus the lethal take of marine mammals (~138 marine mammals per year) ,[4] and at times, threatened and endangered sea turtles. Given this fishery's track record with bycatch, it is baffling that less than 14% of fishing effort was observed in the 2008-09 fishery and less than 13% in 2009-2010 fishery,[5] making it extremely difficult to accurately account for the bycatch of rare and endangered species known to be caught and killed by this gear. This is far under the 20%

[2] The proposed shallow-set longline fishery would have caught as bycatch, 3-9 leatherback sea turtles/ year, 4-27 loggerhead sea turtles/ year, 5-10 marine mammals per year, 5,900 – 30,900 sharks/ year, and 1,600-5,500 tuna/ year. NMFS 2009. Amednement 2 to the HMS FMP to authorize a shallow-set longline fishery seaward of the EEZ, PDSEIS, at 107, 72, and 99. PFMC Agenda Item D.2.a, Attachment 1, April 2009.
[3] 76 Fed Reg. 58868 (September 22, 2011)
[4] NMFS. 2011. National Bycatch Report, at 362
[5] NMFS California/Oregon Drift Gillnet Observer Program. Observed Catch-2009/2010 Fishing Season. http://swr.nmfs.noaa.gov/fmd/observer/catch0910.htm

observer coverage required by the 2004 Biological Opinion (BI-OP)[6] and the 30% coverage recommended by NMFS in the recently published National Bycatch Report.[7]

The NMFS National Bycatch Report finds that the bycatch of three marine mammal stocks in this fishery – the long-beaked common dolphin, short-finned pilot whale, and Northern right whale dolphin – exceed Potential Biological Removal levels defined in the Marine Mammal Protection Act and/ or the Zero Mortality Rate Goal.[8] Even with such low observer coverage, the bycatch of loggerhead sea turtles was observed in 2006, the bycatch of a leatherback turtle was observed in 2009, and the fishery is known to take prohibited species such as white shark, basking shark and megamouth shark.

NOAA's National Bycatch Strategy and bycatch reduction efforts define bycatch as "discarded catch of any living marine resource plus retained incidental catch and unobserved mortality due to a direct encounter with fishing gear."[9] This definition does not distinguish between live or dead discards; rather it includes all discards. In 2009, observers documented over 6 common molas discarded for every swordfish caught and an overall discard rate of 65% (number of animals discarded divided by total number of animals caught).[10] Using NMFS' bycatch definition, this is a bycatch rate of 91% (number of animals discarded or incidentally caught divided by total catch). Furthermore, from May 1, 2008 to January 31, 2009 there were 1,060 drift gillnet sets with approximately 25% of the catch returned to the sea dead or damaged (over 4,800 fish), including over a thousand sharks of various species, tunas and others fishes.[11]

We ask that you work with the Southwest Regional office of NMFS to end these repeated efforts to expand the west coast based drift gillnet fishery or pelagic longline fishery for swordfish. If anything, NMFS should be working to phase out and eventually close the California driftnet swordfish and thresher shark fishery once and for all, and in the meantime increase observer coverage to adequately monitor and account for all bycatch and discards, plus implement hard bycatch caps on all marine life taken including fish, marine mammals and sea turtles. We could envision exploration of other fishing gears that are substantially different from gillnets or longlines as part of a comprehensive strategy to develop a clean swordfish fishery, including potential expansion and/or marketing efforts focused on the harpoon fishery.

We also ask that NMFS develop and advance an international plan to protect and conserve marine mammals and sea turtles in fisheries from which the U.S. imports swordfish as described above. Clearly it is time to put an end to the indiscriminate killing and waste of marine life that has been occurring for decades in this driftnet fishery off the coast of California. Now is not the

---

[6] National Marine Fisheries Service, Southwest Region, Sustainable Fisheries Division and Protected Resources Division, Endangered Species Act Section 7 Consultation – Biological Opinion, Highly Migratory Species Fishery Management Plan, U.S. West Coast Fisheries. February 4, 2004. Page 38: "A vessel is required to carry an observer about 20 percent of the time."
[7] NMFS. 2011. National Bycatch Report, at 359
[8] NMFS. 2011. National Bycatch Report, at 359
[9] http://www.nmfs.noaa.gov/by_catch/bycatch_whatis.htm
[10] NMFS California/Oregon Drift Gillnet Observer Program. Observed Catch-2009/2010 Fishing Season. http://swr.nmfs.noaa.gov/fmd/observer/catch0910.htm
[11] NMFS, at http://swr.nmfs.noaa.gov/fmd/observer/catch0809.htm

time to take steps to expand this driftnet fishery or a pelagic longline fishery that will have similar, destructive impacts.

Sincerely,

Ben Enticknap
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Enclosure: Table and Figure - Bycatch of marine mammals and fish species in the drift gillnet fishery

cc. Dan Wolford, Chair, Pacific Fishery Management Council
Rodney McInnis, Regional Administrator, NMFS SW Region
Mr. Jim Kellogg, President, California Fish and Game Commission

Table. Catch of marine mammals in the Drift Gillnet fishery after the Take Reduction Team requirement of acoustic "pingers" on nets was implemented. While observed takes declined after pingers were required, this fishery still catches and kills many marine mammals each year. From: PFMC and NMFS. March 2006. Draft EA, DGN EFP. PFMC Agenda Item J.3.a, Attachment 1, March 2006.

Dolphin, short-beaked common	**112**
Dolphin, long-beaked common	**6**
Dolphin, northern right whale	**22**
Dolphin, Pacific white-sided	**7**
Dolphin, Risso's	**9**
Dalls Poropoise	**1**
Sea lion, California	**84**
Seal, Northern Elephant	**17**
Whale, Fin	**1**
Whale, Gray	**3**
Whale, Humpback	**2**
Whale, Minke	**1**
Whale, short-finned pilot	**1**
Whale, Sperm	**2**

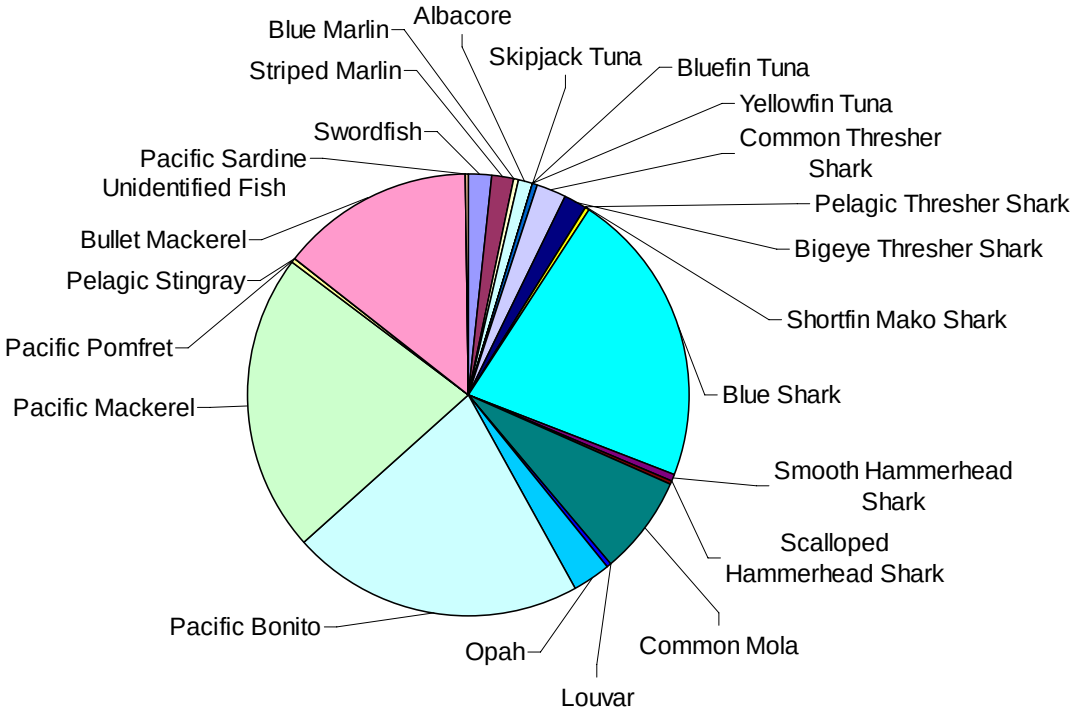

Figure. Discard mortality in the 2008-09 CA/OR Drift Gillnet Fishery. An estimated 3,595 fish were released dead based on observed rates from 146 sets and 1,060 total sets.

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PFMC

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Quileute Tribe
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LaPush, WA 98350

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Taholah, WA 98587

October 11, 2011

Mr. Dan Basta
Director
Office of National Marine Sanctuaries
1305 East-West Highway
Silver Spring, MD 20910

Dear Director Basta:

Recently, while in attendance at the September Pacific Fisheries Management Council, the Hoh, Makah, Quileute Tribes and the Quinault Nation (Coastal Treaty Tribes) became aware of initiatives under development in at least two Sanctuaries that cause us great concern. It appears there is a planned effort within the National Marine Sanctuary system to close areas to fishing and or multiple uses under the pretext of ecosystem-based management (EBM) or ecological research areas. Each of these current initiatives has cited the respective "updated management plans" as a reason for justifying these proposed management areas or access closures. It is also our understanding that these sanctuaries are utilizing the Fishery Management Councils' requirement under the Magnuson-Stevens Act (MSA) for developing essential fish habitat data as further justification to modify access to these areas. To be clear, the Coastal Treaty Tribes contributions to the modification of the Olympic Coast National Marine Sanctuary's (OCNMS) current Draft Management Plan as well as our direct dialogue with you cannot be interpreted as our endorsement for the Office of National Marine Sanctuaries (ONMS) to develop proposals limiting access to areas within the sanctuary system at this time.

The new National Ocean Policy is meant to harmonize agencies with management authority in the ocean, yet initiatives such as these appear to be prime examples of inconsistency and lack of harmony within NOAA's ocean management goals. Currently, within the Pacific Fisheries Management Council (PFMC) processes there are several examples of strategies that are committed to incorporate EBM in future management strategies. Fisheries Management Plans will integrate ecosystem components utilizing tools being developed by the Northwest Fisheries Science Center. Another example is the Essential Fish Habitat review process and updating the data and information relative to PFMC managed species. Having Sanctuaries develop their own EBM initiatives on parallel tracks rather than incorporating the findings and tools developed within the larger NMFS wide process is not only duplicative, but confusing and contradictory. We have commented in the past on the unnecessary duplication of efforts between NMFS and ONMS regarding regulation of fisheries within Sanctuary boundaries, and the need for each of the Sanctuaries to honor their commitment not to regulate fishing activities, particularly within OCNMS.

The proposals being developed by Stellwagen Bank National Marine Sanctuary (SBNMS) to designate an ecological closure area and Monterey Bay National Marine Sanctuary (MBNMS) to develop an EBM Initiative, both with potential fishery management aspects, are troubling for several reasons. First, we believe that NMFS is the federal agency responsible for regulating fishing and houses not only the scientific expertise necessary for this function but also has a well-developed and transparent process for the inclusion of data to inform management measures. The regional fishery management councils are the proper place to identify fisheries issues and concerns and recommend action to the Secretary of Commerce through NMFS. The Sanctuaries do not have the infrastructure, expertise, transparency or the engagement of potentially affected public to effectively identify and manage fishery practices. Here in the northwest, the Tribes as co-managers of resources in our respective Usual and Accustomed Area's (U&A's) recognize NMFS as the proper office within NOAA to discuss management measures specific to our shared fishery resources.

Indeed we continue to work with NOAA as resource trustees for our treaty resources both locally and nationally. For example the Coastal Treaty Tribes continue to have representatives serving on several Federal Advisory Committees. We remain actively committed to working with state and federal partners to help enact the National Ocean Policy and ensure that ocean governance is coordinated both nationally and in our region to secure sustainability for our communities. Closer to home we have developed our Ocean Ecosystem Initiative with both state and federal partners such as NOAA, including NMFS. This Initiative highlights our approach to collective research needs in order to better inform management by our individual governments and as outlined within the broader PFMC context rather than proposing to craft a management regime to aid ecosystem understanding.

Finally, OCNMS lies entirely within the U&A's of the Hoh, Makah, and Quileute Tribes and the Quinault Indian Nation. The fishing rights retained in our treaties are protected under the U.S. Constitution as the supreme law of the land. Further, the sovereignty of the tribes requires that any federal action be developed in consultation with each of us and at the earliest stages. To date we have not heard of such an action being proposed for OCNMS but, similar to the trend in the 1990's to develop Marine Protected Areas, we remain aware and cautious of proposals to restrict access in other sanctuaries in the national system. In our view, closing access to areas of the ocean as experiments for their own sake without full regard to potentially impacted communities is a solution looking for a problem.

Sincerely,

Dave Hudson
Hoh Tribe

Micah McCarty
Makah Tribe

Ed Johnstone
Quinault Indian Nation

Lonnie Foster
Quileute Tribe

Cc:
Don McIsaac, Executive Director, Pacific Fishery Management Council
Nancy Sutley and Dr. John P. Holdren, Co-Chairs, National Ocean Council

Supplemental Open Comment 5
November 2011

FORAGE FISH

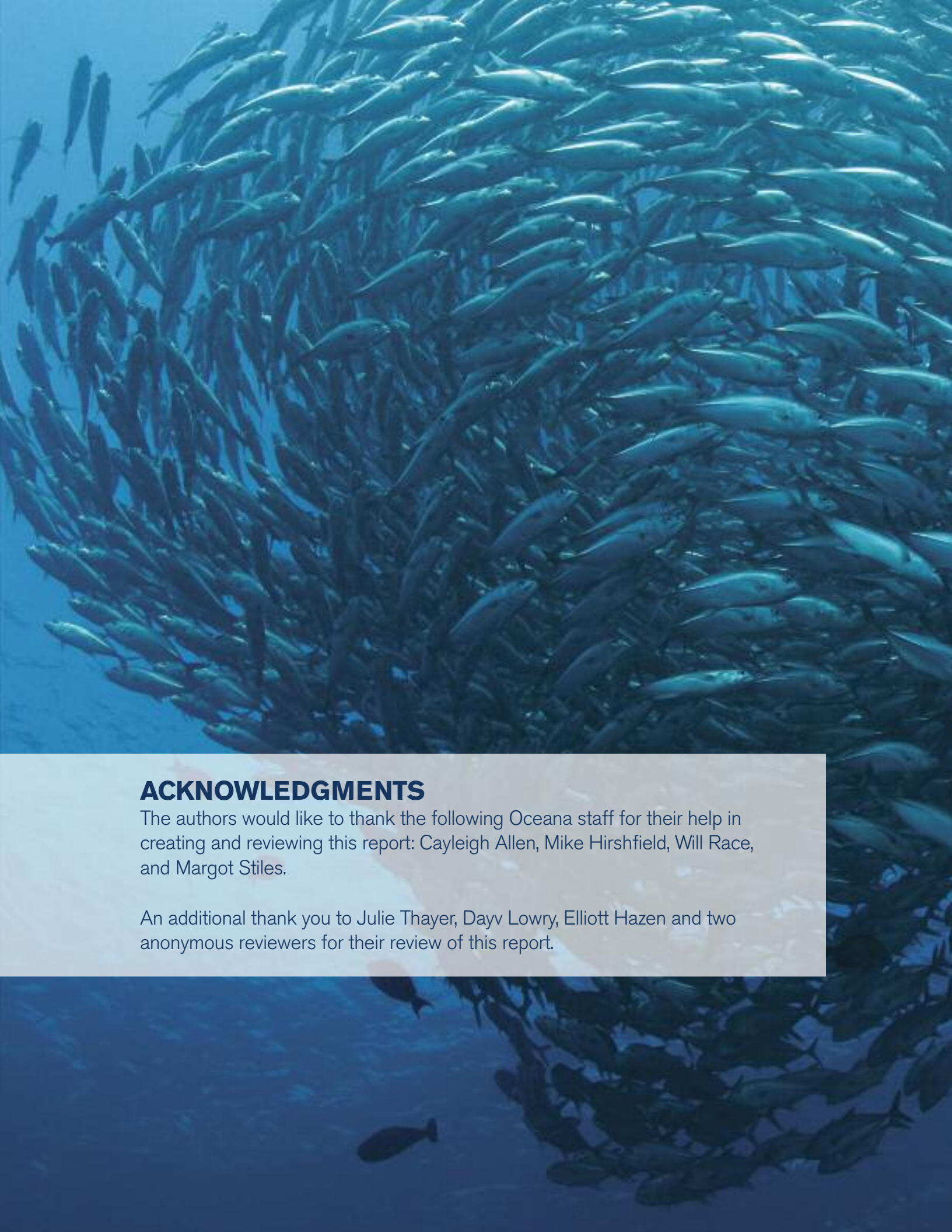
Feeding the California Current Large Marine Ecosystem

Marine Forage Species Management off the U.S. West Coast

By Ben Enticknap, Ashley Blacow, Geoff Shester, Whit Sheard, Jon Warrenchuk, Mike LeVine, and Susan Murray

October 2011

OCEANA



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Cover Photo – Brandon Cole – A 40 foot long Bryde's whale and California sea lions feed on a school of Pacific mackerel

Inset Photo – Brandon Cole – School of Pacific mackerel

Back Cover Photo – Brandon Cole – School of Pacific sardines

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Executive Summary

In this report we examine the role of forage species in the California Current marine ecosystem, the threats to forage species populations, and the management structures currently in place. At the multiple levels of state, federal, and international management, we identify major gaps in the conservation of the overall forage base that provides the food supply in this ecosystem. We document numerous cases of mismanagement and ample reason for concern, including overly aggressive harvest rates, forage species declines, and a failure by fishery managers to account for existing information on the prey consumption needs of larger animals when making management decisions.

In any ecosystem – on land or sea – food availability is a critical factor directly affecting the health and biodiversity of the system. This is especially true for the California Current Large Marine Ecosystem, spanning from British Columbia to Baja California. This wild ocean ecosystem supports a phenomenal diversity of life. It also contributes to the regulation of our climate and supports a major part of the U.S. and world economy. Unfortunately, individual and cumulative threats to the health of this ocean ecosystem continue to grow, making the path towards sustainable living an ever pressing issue.

The term "forage species" means any fish or invertebrate species that contributes significantly to the diets of other fish, birds, mammals, or sea turtles, or otherwise contributes disproportionately to ecosystem function and resilience due to its role as prey.

One pillar to the long-term sustainability of this ocean ecosystem is healthy populations of forage species that provide the food supply for larger animals. Forage species, such as Pacific herring, Pacific sardine, Northern anchovy, smelts, squid, and krill, are the critical prey for whales, dolphins, sea lions, many types of fish, and millions of seabirds. The abundance and availability of these small schooling fish and invertebrates are key to a vibrant food web and a healthy ecosystem.

Given the increasing global demand for seafood, and in particular wild-caught fish used as feed for the growing aquaculture industry, it is imperative to take action today to avert a crisis tomorrow. The first step is to manage forage species differently than other commercial fish species. There has been some progress. West Coast states, regional fishery managers, and the federal government have already prevented directed fisheries for krill off the U.S. West Coast, citing the importance of these species as a keystone prey in the California Current marine ecosystem food web. Many other important forage species, however, are unmanaged and fisheries could develop at any time and with little warning.

Bryde's whale inhales a mouthful of Pacific sardine

As fisheries for larger species have declined off the U.S. West Coast (e.g., tunas, salmon, and rockfish), the relative contribution of the smaller forage species to commercial landings and value has increased. Yet the value of some forage species to recreational and commercial fisheries, tourism, wildlife viewing, and healthy ecosystems will be much greater if we choose to leave more in the ocean. Tourism, recreation, and fishing reliant on healthy forage species brought in over $23 billion in Gross Domestic Product to California, Oregon, and Washington combined in 2004 alone.[1]

As a society we face a difficult choice about the future of our oceans. Forage species have value if they are caught, but they are also valuable if we leave them in the ocean, as they increase the value of other commercial and recreational fisheries, provide more abundant wildlife and associated tourism, and lead to a more healthy, resilient marine ecosystem. By way of laws and regulations, we directly determine which species should be fully protected and which species can be harvested in a way that sustains the most value to the ecosystem and humans. Those decisions are becoming more complicated as we now must determine if we leave more fish in the oceans where they can contribute to healthy food webs, or whether we remove them for use as industrial feeds for farmed fish and open ocean fish pens. Properly conserving and managing forage species, however, will not only benefit the health of the ecosystem; but will also enhance the cultural, environmental and economic benefits of ocean resources, for both present and future generations.

Role of Forage Species in the California Current Large Marine Ecosystem

One of ten major Large Marine Ecosystems in the United States, the California Current Large Marine Ecosystem is considered globally important for its high productivity and the large number of species it supports.[2] According to the Census of Marine Life, the California Current ecosystem has among the highest number of species of fish, seabirds and marine mammals of all 11 large marine ecosystems in the North Pacific Ocean. The California Current extends 1,900 miles from the northern end of Vancouver Island to Baja California Sur, and includes the Pacific Ocean waters off Washington, Oregon, and California from shore to the 200-mile Exclusive Economic Zone.

California Current Large Marine Ecosystem

The California Current ecosystem is influenced by a series of four currents and is one of five[3] large marine ecosystems in the world that is characterized by productive upwelling. When strong winds blow alongshore towards the equator, warm surface waters are carried offshore and are replaced by deep, cold, nutrient-rich waters.[4] This upwelling fuels phytoplankton blooms and in turn, zooplankton like krill (euphausiids) flourish. These tiny plants and animals create a solid foundation for a food web that supports marine mammals including blue and humpback whales, elephant seals and orcas. Additionally, this food web supports millions of seabirds, endangered sea turtles, slow-growing fragile deep sea corals, crabs, and fish such as salmon, halibut, rockfish and tuna that are vitally important for commercial, recreational, and subsistence harvest.

The California Current is integral to the economy, culture, and well-being of the U.S. West Coast. These waters provide recreational activities, commercial fishing, critical commerce supply links, subsistence and personal use, and a variety of economic activities, including tourism opportunities, for millions of Americans. In 2004, industries dependent on the ocean contributed over $57 billion to the combined Gross Domestic Product of California, Oregon, and Washington.[5] The ocean sector includes marine construction, living resources, minerals, ship and boat building, transportation, tourism and recreation.

Importance of Forage Species

Forage species of the California Current ecosystem are of great cultural, economic and ecological importance. Massive schools of eulachon smelt once pushed up into the rivers of the Pacific Northwest to spawn and were integral to Native American subsistence and trade, and local economies. In the 1930s and 1940s Pacific sardine supported the largest fishery in the western hemisphere. The iconic "Cannery Row" in Monterey, California was built around this ballooning fishery. In 1936 the Pacific sardine fishery peaked at 700,000 metric tons, followed by a dramatic fishery collapse just a few years later. Today Pacific sardine are once again an important part of West Coast fisheries, as are market squid, mackerel, anchovy and others.

Healthy, abundant and diverse forage populations are also critical to the sustainability of invertebrates, fish, marine mammals, and seabirds. The Pacific Fishery Management Council lists 19 species of marine mammals, 33 species of marine birds, and over 40 species of marine fish that rely on forage species.[6] Among these predators are endangered salmon stocks, endangered birds, depleted rockfish populations, and eight species of whales. An insufficient ocean food supply has been linked to the loss of Sacramento River fall Chinook salmon[7], substantial declines of Coho salmon off Oregon[8], major bird reproductive failures and population declines[9], and marine mammal mortality events[10] in California waters over the last decade. In addition, there has been a 75% drop in top predatory fish populations in the California Current since 2003.[11]

Abundant forage species populations are vital to the sustainability and recovery of economically important commercial and recreational fisheries like Chinook salmon, albacore tuna, yelloweye rockfish, white seabass, barred sand bass, kelp bass, and California halibut.[12,13,14] Forage species are also critical to supporting marine wildlife including humpback whales, sea lions, dolphins, porpoises, seabirds and associated tourism.[15,16,17]

In recent years U.S. West Coast states have seen major seabird die-offs and poor salmon returns to many river systems. Considerable overlap exists in the diet of salmon and seabirds, and they may be responding similarly to fluctuations in a common prey base. Seabird populations tend to parallel the populations of forage prey[19], largely because newborn survival is highly dependent on the parents being able to catch enough high-energy food.[20] For example, the breeding success of the brown pelican has been linked with the abundance and availability of northern anchovy.[21] Therefore, it is important to recognize that top predators require prey abundances that are many times that of their consumption levels alone, since the density of schools and availability of forage species can be a limiting factor to foraging success.[22]

"Forage species such as krill are vital links in the food chain and play an essential role in maintaining ecosystem health. Precautionary measures should be taken to ensure their protection."

- West Coast Governors' Agreement On Ocean Health, 2008

Krill are consumed by both rockfish and humpback whales

Humpback whale

Canary rockfish

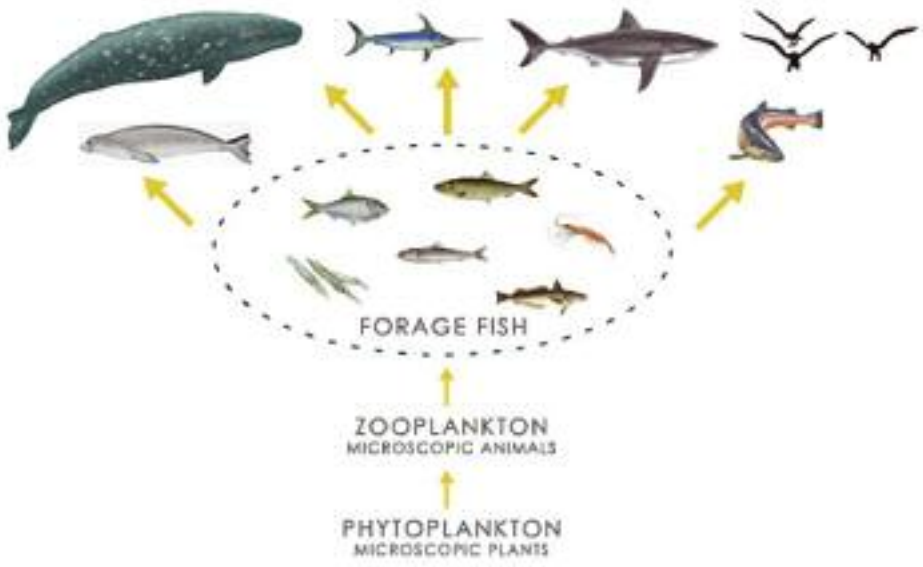
When preferred forage species are absent or depleted, marine predators are forced to switch to less nutritionally desirable prey. Preying on species with lower energy content (fat content) may directly adversely affect the health of the predators' populations. The elegant tern is a seabird whose limited geographic range and specialized diet make its population particularly vulnerable to changes in prey abundance. Northern anchovy and Pacific sardine are the bird's preferred prey, but changes in the abundance or distribution of these species in California led to terns relying on lower-energy forage species (such as topsmelt).[23] Over the long term, such dietary changes may decrease survival and reproductive success of this seabird.[24] When alternate prey species are not available due to depletion or seasonal unavailability, reproductive failure and or death may ensue. As another example, when alternate prey species are available, juvenile salmon are more likely to survive since predators have alternate prey upon which to feed.[25]

Elegant tern

"Decreased prey resources have caused murrelets to fish further down on the food web, appear partly responsible for poor murrelet reproduction, and may have contributed to its listing under the U.S. Endangered Species Act."

– Becker and Beissinger 2006[109]

Forage Fish: The Vital Link of the Ocean Food Web



Courtesy MFCN

Forage species play an integral role in marine food webs by transferring energy and nutrients from zooplankton to larger animals at the top of the food web like whales, sharks and seabirds

Threats to Forage Species

Forage species face a multitude of threats and stressors, including climate change, ocean acidification, habitat loss, fishing pressure, pollution, and increased demand for forage fish-based feed for aquaculture and agriculture. It is often the synergy of multiple and simultaneous stressors that can lead to the collapse of forage fish populations.[26] A prime example of this is the collapse of the Pacific sardine population in the 1940s due to both extensive fishing pressure and changing oceanographic conditions, which had ramifications throughout the food web[27] and fishing communities like Monterey, California's Cannery Row.

Climate Change

Climate change impacts the survival, growth, reproduction, and distribution of forage fish through gradual warming, changes in oceanographic conditions, and the frequency, intensity, and location of extreme events. Due to their known sensitivity to temperature and oceanographic conditions, forage species are particularly vulnerable to climate change. The impacts of climate change on forage species depend on changes to primary productivity (phytoplankton blooms), transfer of nutrients through the food chain, and the effects on oceanographic conditions that determine reproductive potential and survival. Some studies have predicted significant changes in fishery production based on the effects of climate change on species distribution.[28] Fishing makes fish populations more sensitive to the stresses of climate change.[29] Fishing reduces the age, size and geographic distributions of fish populations, and the biodiversity of marine ecosystems, and these effects are magnified by climate change impacts to species and ecosystems.[30] To increase the resilience of ocean ecosystems to the effects of climate change, the Food and Agriculture Organization of the United Nations recommends taking an ecosystem-based approach to fisheries.[31] In this context, that means considering the impacts of climate change when managing fisheries and incorporating buffers for climate-driven losses in prey populations.

Ocean Acidification

The emerging literature on ocean acidification has highlighted human-caused carbon dioxide emissions as a threat to forage species. In particular, the shells of microscopic organisms like pteropods (a planktonic snail-like animal), which are consumed by krill, herring, and other species, are at risk of dissolving. As ocean pH drops, pteropods may be unable to form calcium carbonate shells, thus threatening their ability to survive.[32] Without pteropods, krill, herring, and other species lose an important food source. Ocean acidification may also have unexpected impacts on forage species physiology. For example, increased ocean acidity is likely to inhibit a squid's ability to transport large amounts of oxygen, thus inhibiting important activities like hunting and avoiding predators, and ultimately imperil their populations.[33] Increased carbon dioxide levels have been shown to have direct lethal effects on krill embryos.[34]

Pteropod shells dissolve as ocean acidification increases

Habitat Loss

Many important forage species depend on suitable spawning habitat along coastal beaches, rivers, estuaries and bays. Loss of spawning habitat due to coastal development, shoreline armoring, aquaculture, dredging, dams and other hydroelectric projects, threaten forage fish populations through the degradation or complete loss of their essential reproductive habitat.

Fishing Pressure

Because of their relative short lifespan and reproductive strategies, many forage species populations fluctuate more widely due to changing environmental conditions than populations of other fish species.[35] This relationship to environmental change has led to a flawed perception that fishing has a small effect on forage species populations or the availability of forage. In fact, scientists have recently concluded that forage species are just as likely, if not more likely, to experience fishery collapses than larger fish.[36] Throughout the world, fishing on small pelagic fish and invertebrates has been linked to declines in their predators.[37,38,39]

On the U.S. West Coast, simulations of Pacific sardine populations show that slight changes in fishing pressure result in drastic changes in the number of years of low fish abundance, as well as changes to the average sardine biomass.[40] In particular, the effects of fishing forage species are more severe in times of low natural productivity. For example, some forage species are less productive during El Niño conditions when ocean water is warmer than usual.[41] Furthermore, the schooling behavior of forage species often means that exploitation rates do not decrease directly as populations decline. Schooling forage fish are easier to catch, even at low population levels. While forage species are affected by many stresses beyond our immediate control, fishing is the greatest factor that we can control. In the end, it is the compounding effect of low natural productivity and fishing pressure that determines the rate of collapse and the speed of recovery of forage species populations.[42] Fishing can lower forage biomass to a point where the effects of unfavorable ocean conditions are strongly magnified throughout the ecosystem, including other fisheries. Therefore managing forage fisheries relative to natural forage species population fluctuations is critical to maintaining the resilience of ocean food webs in the face of the many pressures on forage species.

Purse seiners off the coast of Monterey, CA

Pollution

Pollution, such as oil spills, can have catastrophic effects on forage species through direct developmental effects and acute toxicity.[43] The *Exxon Valdez* oil spill caused the collapse of the Prince William Sound Pacific herring population, which has still not recovered over twenty years later. The loss of Pacific herring has likely affected the recovery of seabirds and marine mammals in this area.[44,45] On November 7, 2007, the container ship, *Cosco Busan* ran into a tower supporting the San Francisco Bay Bridge, spilling 54,000 gallons of bunker fuel oil into the bay. This heavy bunker oil contaminated the shoreline in areas important to herring spawning in months following the spill. Following the spill and subsequent herring spawning, researchers documented reduced herring survival, reduced hatching success and high rates of herring birth defects at the oiled sites.[46]

Images from a study performed by government scientists contrast normal herring embryos raised in clean water (left) with fatally deformed embryos exposed to the type of oil used by the Cosco Busan

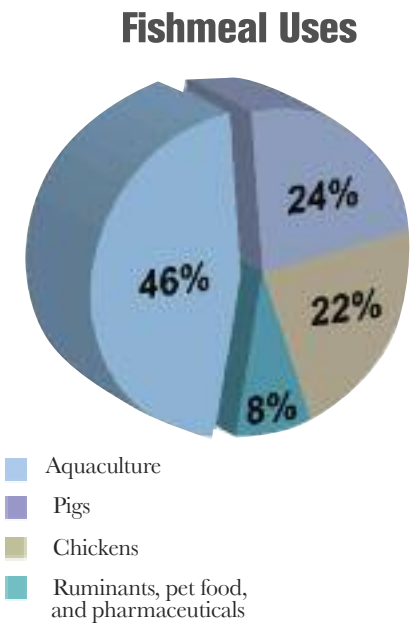
Aquaculture

Despite marked increases in feed efficiency, aquaculture's share of global fishmeal and fish oil consumption has more than doubled over the past decade to 68% and 88%, respectively.[48] Total production of farmed fish and shellfish increased threefold from 1995 to 2007. Furthermore, a greater percentage of fish farms now use compound feeds that are derived from wild fish. While feed conversion ratios (amount of fish feed required per quantity of farmed fished produced) are improving, growth in the industry has resulted in an overall increase in the quantity of fish feed used. This growth in the aquaculture sector will likely drive prices of forage fish higher, creating incentives for higher catch rates in existing fisheries and making once uneconomical fisheries feasible.[49]

For several decades, 20 million to 30 million metric tons of fish (1/4 to 1/3 of the global fish catch) have been removed from the marine food web each year to produce fishmeal and fish oil for animal feeds and other industrial purposes.[50] Since the 1960's humans have consumed 10-20% of the total forage fish catch per year.[51] Another 5-9 million metric tons of "low value/trash fish" and other forage fish are used for non-pelleted (farm-made) Aquafeeds.

In 2002, 46% of fishmeal and fish oil produced globally was used for aquaculture, followed by 24% for pigs, and 22% for poultry.[53] Despite improvements in feed efficiency, overall demand, particularly for fish oil, is increasing due to the expansion of aquaculture production. In 2008, 27.2 million tons of the 89.7 million tons of fish caught in the world's oceans went to non-food uses. Of this, 20.8 million tons went to fishmeal and fish oil. The remainder went as a combination of bait, pharmaceuticals, and direct feeding in the aquaculture and the livestock industries.

Pacific sardines being fed to penned bluefin tuna



Data from Campbell and Alder, 2008

The Economic Value of Forage Species

Like many other forage fish fisheries around the world, forage fish caught off the U.S. West Coast are sold as relatively high volume/low value products. Pacific mackerel is canned for pet food, Pacific sardine is frozen and shipped to Australia to feed penned tuna, and northern anchovy is reduced to meal and oil. Larger Pacific sardine taken off Oregon and Washington are typically sold as bait for Asian longline tuna fisheries. Other vessels target northern anchovy and other forage fish for local live and dead bait markets. A relatively small amount of Pacific mackerel, sardine and anchovy is sold for human consumption.[57]

The same species of wild fish that are used as feed for fish farming or animal farming are also a source of food for marine fish that are captured and used for human consumption, and are food for animals that are in demand for non-consumptive reasons (marine mammals or sea birds). Therefore, it is highly likely that the capture of feed fish is at the expense of other wild fish or animals that mankind values and utilizes, directly or indirectly.

" ...the opportunity cost of sardines as prey for other fish and animals has not been explicitly considered in setting catch quotas for sardines."

– Hannesson and Herrick. 2010.[58]

The economic value of forage species cannot be measured by simply summing the landings values of commercial fisheries targeting forage fish. It is highly likely that the capture of forage fish to feed farmed fish will be at the expense of other wildlife like salmon, tuna, whales, and seabirds. Forage species left in the ocean are valuable for two reasons. First, they contribute directly to the size of the forage population in future years. Second, forage fish contribute to the overall abundance of their predators. More forage means more predators. It is those very predators such as salmon and whales that also drive other important sectors of coastal cultures and economies.

Economists would refer to the tradeoff between harvest and the ecosystem as the "opportunity cost" of removing forage fish from the sea. Depending on the value of sardine predators, for example, and the transfer efficiency of sardine biomass into predator biomass, sardines may be more valuable to the coastal economy if left in the water unfished. The trade-offs between healthy ecosystems, tourism, other fisheries, and industrial feeds need to be examined. Specifically, when calculating optimum harvest levels, including the overall benefit to society, managers must consider the other ecological services forage species provide, including their benefit as prey for other commercially important species.

© Ocena

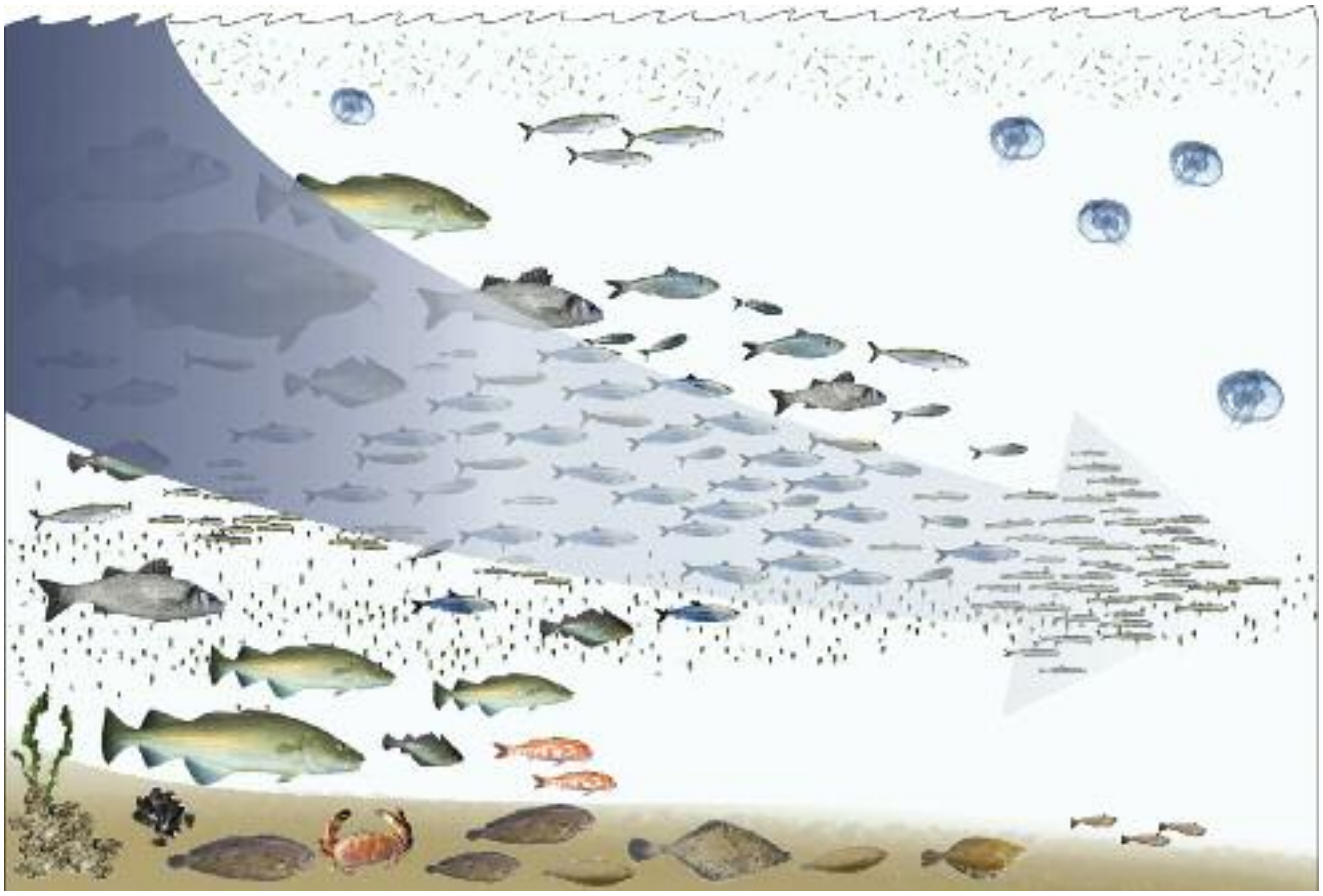
Whale watching provides major revenue on the west coast

Shifting the Management Paradigm

Fishery managers typically do not consider how much prey needs to be left in the ocean to support valuable fisheries and wildlife. Instead, managers use the traditional single-species approach to managing forage species, evaluating each fish species in isolation and determining what catch levels most likely would allow humans to continue to catch that same amount of fish or more in future years. Every major report on ocean management in recent years came to the same conclusion: we need to move away from this single-species "money fish" model to an ecosystem approach that accounts for the needs of other components of the ecosystem, like predators, when setting catch levels.

Although there has been some progress at the state and federal levels of fishery management, there is currently an inadequate accounting for the needs of top predators. To address this gap, an explicit recognition of the dual value forage species play both as prey and as fishery landings is needed, and this must be accounted for in the management process. Similarly, from a scientific perspective, the focus of data collection needs to expand beyond assessing the populations of forage species themselves and include their interactions with oceanographic conditions and predators.

The traditional single-species management approach emphasizes maximizing the catch of individual fish stocks, as opposed to maintaining a healthy ocean ecosystem. Whether managed by individual states, federal entities or international agreement, the underlying principle for determining how much fish can be taken from the ocean is embedded in the philosophy of Maximum Sustainable Yield (MSY). MSY is considered to be the largest long-term average catch or yield that can be taken from a stock, year after year, under prevailing conditions.[59]



Ecosystem-based management is needed to prevent fishing down the food web, which is when fisheries target lower and lower trophic level fish stocks as species in higher trophic levels are sequentially overfished
© Hans Hillewaert / CC-BY-SA-3.0

Based on the concept of MSY, fishery managers seek to maintain high fishery catches by regulating the number or weight of fish caught, the size of the fish caught, and/or the time and space where fishing is allowed to take place.[60]

The single-species MSY approach, however, threatens the sustainability of forage species, and hence the overall ecosystem. This focus on maximizing yield, or fish catch, based on a single-species model that assumes constant relationships between population density and productivity can lead to overfishing in years of unfavorable environmental conditions, poor recruitment, and low productivity.[61] Hypothetically there may be a maximum sustainable yield, but in reality management is dealing with fisheries targeting real fish populations in a dynamic ocean ecosystem with much uncertainty. In practice, the MSY approach is unsuccessful, as evidenced by the global trend of fishing down marine food webs.[62]

Fishing down the food web (see page 13) occurs as fisheries target lower and lower trophic level fish stocks as species in higher trophic levels are sequentially overfished. Despite scientific studies depicting strong forage species-predator relationships, and fisheries policies calling for ecosystem-based management, current management of forage species does not adequately consider their importance in maintaining a healthy ocean. These factors, combined with a fragmented management system, a lack of fundamental biological information, information on stock status, and historic catch records, can have devastating consequences for forage species and their predators.

In order to protect the food web of the California Current Large Marine Ecosystem, fishery management must shift the paradigm to manage for ecologically sustainable populations of forage species. This means moving away from traditional single-species management to Ecosystem-Based Management (EBM) by explicitly considering scientific uncertainty in stock assessments, predator-prey relationships, and bycatch (taking of untargeted species) when determining catch levels. Fishery managers need to shift the focus from the MSY to Ecologically Sustainable Yield (ESY) where the full impacts of fishing on the ecosystem are evaluated and considered.[63] ESY is an estimate of the amount, rate, distribution and time period of fishing that can occur without diminishing the ecological role of fish and invertebrate species. Fishery scientists and ecologists agree that a wide range of exploitation rates can result in catch levels nearly as high as maximum levels. Yet setting exploitation at the lower end of this range reduces ecosystem impacts, rebuilds total biomass, prevents species collapse, reduces the costs of fishing, and increases profit margins over the long term.[64,65] Specific to forage species, a recent study found widespread impacts of harvesting forage species across five different ecosystems, including the California Current. The study's authors recommended maintaining forage biomass levels much greater than MSY biomass levels (over 75% of their unfished levels) and fishing rates less than half of MSY rates.[66]

Sockeye salmon

Management Overview

FEDERAL GOVERNMENT

The National Marine Fisheries Service (NMFS) is the lead federal agency responsible for the stewardship of the nation's offshore living marine resources and their habitat. NMFS works closely with the Pacific Fishery Management Council (PFMC), which advises the agency on all federal fisheries management occurring off the U.S. West Coast. In addition to federal managers, the PFMC includes representatives from the States of Washington, Oregon, California, Idaho; Native American Tribes; and appointed members of the public who generally represent various commercial and recreational fishing interests. NMFS and the PFMC manage fisheries that directly target key forage species like Pacific sardine, Pacific mackerel, and market squid. Additionally they manage some important forage species that have no directed fishery, like shortbelly rockfish and krill. A directed fishery is one that targets a specific species of fish. Fisheries for forage species are generally managed by NMFS in one of two federal plans: the Coastal Pelagic Species Fishery Management Plan (FMP) and the Groundfish FMP.

What's working

The PFMC and NMFS have taken some precautionary actions to protect forage species and their role in the marine ecosystem. In 2006, recognizing the importance of krill as a key prey for blue whales, salmon, seabirds and many other species, the PFMC unanimously voted to recommend that NMFS prohibit krill harvest off the U.S. West Coast. After much delay, in July 2009, NOAA officially adopted the ban on krill harvest throughout the U.S. West Coast Exclusive Economic Zone (EEZ).

In 2010, the PFMC, recognizing the value of shortbelly rockfish as forage, voted to set the 2011-2012 catch levels for this species at less than 1% of the allowable biological catch. This is another example where fishery managers have recognized the role of an important forage species as prey in the ecosystem and taken action to protect that ecological role.

NOAA vessels like the Pisces offer fisheries scientists the ability to collect valuable data to monitor and manage fish populations

What's not working

Lack of Management

There are many important forage species like whitebait smelt, Pacific sandlance, and lanternfishes (myctophids) that receive no management by NMFS and the PFMC. There are presently no plans in place that recognize the important role these species play in the California Current ecosystem, or to protect them from any potential or future fishing effects. The PFMC and NMFS have the authority to take proactive measures, like they did with krill, to prevent the development of new fisheries for these and other key forage species.

Overfishing

Pacific jack mackerel

Federal law requires that fishery managers prevent overfishing and inlcude in fishery management plans objective and measurable criteria for determining when a fish stock is overfished.[68] Having these management thresholds in place is critical for triggering plans to rebuild depleted populations to healthy levels and to prevent further declines. To date, the PFMC and NMFS have failed to identify overfished thresholds for market squid, northern anchovy and jack mackerel. This failure to designate legally required thresholds risks jeopardizing these populations and the marine life that depends on them.

The overfished thresholds identified for other targeted forage species, like Pacific sardine and Pacific mackerel, are too low, making the chances of overfishing more likely. Furthermore, the overfished level for Pacific sardine is currently set at 50,000 metric tons, less than 4% of their biomass at maximum sustainable yield (Bmsy). NMFS guidelines on preventing overfishing state that the overfished threshold should be 50% of the biomass that produces MSY, or a reasonable proxy, but certainly not as low as 4%. These thresholds clearly do not account for ecosystem needs and are far too low to protect Pacific sardine populations. Furthermore, the 2010 Pacific sardine assessment found that the 2010 sardine biomass is at the lowest level in the past 23 years and that the combined fishing pressure from the U.S., Mexico, and Canada exceeded the total overfishing limit in 2009, the most recent year for which coast-wide fishing levels are available.[69]

Failing to account for ecosystem needs

Rosy rockfish

The Magnuson-Stevens Fishery Conservation and Management Act mandates that fish catch levels be set in a manner that protects marine ecosystems. Fisheries are to be managed at "Optimum Yield", defined as the amount of fish which "will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems."[70] Optimum Yield is described as Maximum Sustainable Yield "as reduced by any relevant economic, social, or ecological factor."[71] While the federal law requires Optimum Yield and NMFS has agreed that ecological conditions and ecosystem factors should be taken into account, they have failed to do so in any of the Pacific fishery management plans.

Currently a wealth of existing data and analytical methods are available to address ecological factors relevant to the harvest strategy of forage species. Diet information, which indicates the existence and strength of predator-prey relationships, has been published by NOAA for U.S. West Coast species.[72] In addition, food web models of the California Current have been published.[73,74] These models provide the ability to qualitatively and quantitatively describe the impacts of removing forage species on other marine species, and to evaluate food web resilience and biodiversity. This existing ecological data must be incorporated into the setting of Optimum Yield.

Failure to adequately address uncertainty

Fishery scientists use a complex set of tools and methods for estimating the abundance of fish populations in the ocean. Unfortunately, these estimates come with a great deal of uncertainty. Managers must set buffers to account for scientific and management uncertainty; not doing so puts the fish population at risk. The current fishery management process fails to address or even acknowledge many major uncertainties in overfishing limits and allowable catch levels, including uncertainty in the optimal harvest rate, the effects of climate change, and ecosystem interactions.

Unfortunately, the results of operating large scale commercial fisheries based on uncertain stock assessments and aggressive management decisions has proven to be overfishing, with likely ecosystem-wide impacts. In January 2000, following intensive fishing pressure, a risky fishery management strategy and highly uncertain scientific advice, the West Coast groundfish fishery was declared a commercial fishery disaster, as seven species of groundfish were overfished. As of June 30, 2011 seven stocks of West Coast fish species, including rockfish, flatfish, and salmon, are considered to be overfished.

STATE GOVERNMENT

Washington

The Washington Department of Fish and Wildlife (WDFW) is responsible for state-managed fisheries off Washington. Among West Coast states, Washington became a leader in forage fish management in 1998 when it adopted a Forage Fish Management Plan.[79] The Forage Fish Management Plan provides a strong conservation framework that emphasizes maintaining the role of forage species in the ecosystem over commercial and recreational harvest. The Forage Fish Management Plan includes important policy statements such as "maintain[ing] healthy populations of forage fish species and individual stocks of forage fish while assuring the integrity of the ecosystem and habitat upon which marine resources depend" and "consider[ing] the role of forage fish in the marine ecosystem and the need to supply sufficient quantities of forage fish for ecosystem needs."

Beginning in the early 1970s, the State of Washington started to address forage fish issues in the Puget Sound Basin as the state began work to identify critical spawning habitats. The State of Washington has since adopted a "no net loss" approach to documented herring, surf smelt, and Pacific sand lance spawning habitats and has listed these habitats as "marine habitats of special concern."[80] State laws now control the timing and extent of development on and near these spawning grounds. Efforts are ongoing to document currently unknown holding and spawning areas. A lack of sufficient biological data, including documentation of distribution and abundance, for other forage fish species (e.g., whitebait smelt, night smelt, longfin smelt) has led to a lack of protection for the spawning and holding areas of these species.

While the State of Washington has acted as a leader with regard to forage fish conservation and management, more work is needed to identify forage fish spawning habitats on Washington's outer coast and to eliminate activities that are destructive to forage fish spawning areas in Puget Sound. With continued human population growth in the Puget Sound Basin, there will likely be increasing pressures for development in the marine nearshore zone with impacts to both known and undocumented spawning sites. Washington can continue to improve its forage fish management by committing to population surveys, continuing to identify spawning habitats both in Puget Sound and along the outer Washington coast, dedicating effort to assessment of the lesser known forage species of the state, and working with the public to increase awareness about forage fish and their critical habitats. The State of Washington also plays a key role on the Pacific Fishery Management Council where they can help advance an ecosystem-based approach to fisheries management, including ecologically sustainable catch levels, along with other West Coast states and the federal government.

Threatened Forage Species:

Eulachon

In March 2010, the National Marine Fisheries Service (NMFS) listed the southern distinct population of Pacific eulachon (a.k.a. hooligan or Columbia River smelt) as threatened under the Endangered Species Act. NMFS identified climate change, habitat loss and bycatch in commercial fisheries as some of the greatest threats to the recovery of this ecologically and culturally important fish species.[86] In January 2011, NMFS issued a proposal to designate critical habitat for eulachon in some Pacific Northwest rivers, creeks and estuaries where eulachon spawn, but failed to propose designation of any marine waters, where eulachon spend 95-98% of their life.[87]

NMFS also failed to adequately address the issue of the bycatch of eulachon in other fisheries. In 2007 the state managed California, Oregon and Washington pink shrimp fishery caught approximately 10,360 pounds of eulachon as bycatch.[88] The fishery took over 26,600 pounds in 2008 and over 23,800 pounds in 2009.[89, 90] The 2009 bycatch of eulachon represents over 800,000 individual fish. State managers are exploring gear modifications to try to limit the amount of eulachon bycatch in the shrimp fishery, but other mechanisms must be considered as well, such as time and area closures and an overall hard cap on the amount of eulachon bycatch that can be taken. The Canadian pink shrimp fishery off British Columbia also takes this population of threatened eulachon as bycatch.

In 1956 Kelso, Washington was dubbed the "Smelt Capital of the World"

Northern anchovy

Oregon

Severe declines of eulachon, now listed as threatened under the Endangered Species Act (ESA), have prompted recent action by Oregon to close all recreational smelt fishing in estuaries, bays and rivers. In 2010, all commercial fisheries for smelt (family Osmeridae) were closed by the State of Oregon, including ocean fisheries and the Columbia River smelt fishery.[82] State rules allow for the bycatch of smelt in commercial fisheries, like the Oregon pink shrimp fishery that takes thousands of endangered eulachon each year (see eulachon text box on page 17).

Unlike Washington, the State of Oregon does not have a comprehensive forage fish plan. Oregon-based fisheries for forage species, like Pacific sardine and northern anchovy, are managed primarily by the National Marine Fisheries Service. Fisheries for Columbia River eulachon are managed jointly with the State of Washington.

Surf smelt were also once abundant off the Oregon coast. In fact, the coastal town of Yachats, Oregon has long held an annual smelt festival. The local surf smelt population began to decline in the early 1980s and smelt ceased to return to the area almost entirely by 2000.[83] Despite the declining numbers of surf smelt, they are not listed as threatened or endangered. In fact, state management allows all recreational anglers to take 25 pounds a day in marine waters.

The State of Oregon manages fisheries for other important forage fish – Pacific saury, Pacific herring, California market squid, jack mackerel, Pacific mackerel, shortbelly rockfish and northern anchovy – as open access fisheries. As a result, there is no incentive for individuals to conserve fish stocks.[84] Globally, open access fisheries have been demonstrated to be a poor way to conserve fish stocks or ecosystem health because there is no way to exclude newcomers from the fishery and limited ability to control the exploitation level. Oregon's open access management regime allows any person or company with an Oregon commercial fishing permit to target these species. Some of these species have limited controls at the federal level, in the Coastal Pelagic Species FMP, but little is done at the state level to manage these species other than to monitor landings.

Oregon has taken proactive measures to prohibit the comercial harvest of smelts and krill. In 2003 Oregon passed a law banning the commercial harvest of all species of krill.[85] This state action helped convince the federal government to take parallel action to prohibit the harvest of krill in federally managed waters. The recent

prohibition on the commercial harvest of all smelt species was driven largely in response to the listing of eulachon as threatened under the federal Endangered Species Act and by a lack of funding for Oregon's "developmental fisheries program" where smelt species were formerly managed.

The State of Oregon needs to fully develop forage species conservation and management by moving toward an ecosystem-based approach. This plan must include actions to identify and protect forage fish spawning habitats and account for ecosystem needs when setting catch levels.

What is more, the State of Oregon must implement an ecologically significant network of marine protected areas and reserves throughout the state's ocean waters. In November 2010 three coastal Oregon community teams recommended marine reserves and protected areas for the northern Oregon coast. These community recommendations include specific provisions to protect forage species, including one marine protected area off Heceta Head which would specifically prohibit fishing for forage species for the protection of seabirds feeding in the area.

A comprehensive forage fish plan for Oregon is needed to help focus on long-term conservation of all important forage species.

Pacific bluefin tuna

California

The California Department of Fish and Game (CDFG) is responsible for state-managed fisheries off California with the California Fish and Game Commission (CFGC) as the decision-making body. Fisheries are managed under the state's Marine Life Management Act (MLMA). The State of California does not have a comprehensive forage fish management plan, nor does it have any formal recognition of forage species in the MLMA or in state policy.

Under the MLMA, Fishery Management Plans (FMPs) were envisioned to be the primary tool for fishery management. Due to chronic underfunding and the comprehensive requirements of FMPs, however, only three FMPs have been completed in the last decade. While the three FMPs stated an intention to move toward "ecosystem-based management", neither the MLMA nor the FMPs define what "ecosystem-based management" means in the context of the managed species or provide a framework for evaluating whether management is ecosystem-based.[92] While FMPs are required to summarize existing information on the ecological role of target species, the effect of the fishery on their ecological role, and the influence of oceanographic conditions on the target species, the CFGC is not required in any way to account for these factors in management decisions.

The State of California does not have a comprehensive forage fish management plan, nor does it have any formal recognition of forage species in the MLMA or in state policy.

Blue whale

Market squid

Some California-based fisheries for forage species, such as Pacific sardine and northern anchovy, are managed primarily by the National Marine Fisheries Service. The State of California enforces those management decisions for the component of the fishery that occurs in state waters and monitors landings. Market squid and Pacific herring are the two main forage species currently managed by the CDFG. Market squid is managed through the Market Squid Fishery Management Plan, while Pacific herring is managed through an annual Supplemental Environmental Document by CDFG and the CFGC. In addition, some regulations exist on fishing gear and monitoring of landings for smelts and silversides.

The MLMA contains provisions for the development of new fisheries that do not currently exist, termed "Emerging Fisheries." The state's current policy is to promote the development of such fisheries and not to regulate them until they have emerged (e.g., landings and participation have increased).[93] However, until a new fishery has been officially declared an "Emerging Fishery" by CDFG, the state does not have authority to regulate it. Therefore, it is unclear whether California can prevent new fisheries from developing on forage species under current law.

California is now completing its implementation of the Marine Life Protection Act by creating a new, improved network of marine protected areas (including several no-take marine reserves) in state waters. Unfortunately, protecting forage species and key foraging areas were not specific objectives of the scientific guidelines used in developing the network. The marine protected areas, however, do a little of both by protecting some key nearshore spawning areas for market squid and other forage species, and protecting several areas in the vicinities of seabird colonies and marine mammal haul-outs.

Reliance of key predators on forage species

CHINOOK SALMON
(Oncorhynchus tshawytscha)

The Chinook salmon is the largest of the Pacific Ocean salmon species and has great cultural, economic and ecological value. These fish are renowned for their great migrations from the streams where they are hatched, across vast stretches of the Pacific Ocean, and back as adults to spawn in their streams of origin. In the California Current ecosystem, juvenile and adult Chinook salmon prey heavily on Pacific sardine, herring, northern anchovy, krill and juvenile rockfish. Pacific herring, Pacific sardine and northern anchovy make up 48% of the diet of Chinook salmon by weight.[94] Nine evolutionary significant units of Chinook salmon in Washington, Oregon and California, comprising dozens of independent stocks, are listed as threatened or endangered under the U.S. Endangered Species Act.[95]

CALIFORNIA SEA LIONS
(Zalophus californicus)

California sea lions have increased in number since the end of directed hunting in the 1940s.[103] In the United States, the major breeding areas are located in the Channel Islands off Southern California. However, in 2010, as a result of shifts in their prey, a record number of yearling sea lions were stranded on California beaches, while adults from Southern California migrated north to Monterey and Oregon in search of food. The top five prey items for California sea lions are northern anchovy, market squid, Pacific hake, jack mackerel, and shortbelly rockfish.[104]

YELLOWEYE ROCKFISH
(Sebastes ruberrimus)

Yelloweye rockfish are an exceptionally long-lived and slow growing rockfish species that has been overfished. Living up to 118 years old, this is one of the longest lived rockfishes.[96] The current low population size is a result of overfishing and the species is now managed by NMFS under a rebuilding plan. The primary food source of yelloweye rockfish are small planktivores (fish that eat plankton) like northern anchovy and Pacific sardine, which make up 32% of their diet.[97] Other rockfish like black rockfish and blue rockfish also prey heavily on these forage species.[98] The population of yelloweye rockfish is not estimated to recover until the year 2074.

ALBACORE TUNA
(Thunnus alalunga)

Albacore tuna is one of the most prized and lucrative fish on the U.S. West Coast, both commercially and recreationally. In 2009, the commercial fishery for albacore tuna was worth over $27 million, about 90% of the total value of highly migratory species (e.g., tunas, swordfish, sharks).[99] Over 80% of albacore tuna diet is composed of small planktivores, primarily northern anchovy and Pacific sardines[100], making it among the species most dependent on these forage fish.

CALIFORNIA BROWN PELICANS

(Pelecanus occidentalis californicus)

Forage fish availability is likely the most important factor influencing brown pelican breeding success.[105] Brown pelican productivity is associated with the abundance and availability of northern anchovy, which in some years makes up over 92% of their diet.[106]

MARBLED MURRELET

(Brachyramphus marmoratus)

Listed as threatened under the Endangered Species Act, the marbled murrelet is a small seabird that nests in coastal old growth forests from central California to Alaska and feeds on forage fish in coastal nearshore waters. In California's Monterey Bay ecosystem, marbled murrelets historically fed on sardine.[107] The collapse of the California sardine fishery in the late 1940s reduced the availability of sardine for the marbled murrelet. Over time, these birds made a fundamental prey switch, from sardine to smaller forage species like krill. This prey switch requires spending more time and energy foraging since it takes 80 krill to match the energy found in a single Pacific sardine.

COMMON MURRE

(Uria aalge)

The common murre is one of the most abundant seabird species in the California Current. During the breeding season, juvenile Pacific hake and northern anchovy constitute the majority of adult murre diets, yet market squid dominate their diet in the wintering season. However, chicks consume primarily (>80%) northern anchovy, Pacific sardine, and juvenile rockfish. In 2004, adult common murres from Cape Blanco, Oregon to Point Conception, California were estimated to consume 225,000 metric tons of prey, rivaling the largest commercial fisheries off the West Coast.

BLUE WHALE

(Balaenoptera musculus)

Endangered blue whales are the largest animals to have ever lived on earth. They feed exclusively on tiny krill at rates of up to two metric tons per day.[101] With their great size (up to 33 meters and 172 metric tons), blue whales have the highest average daily energy requirements of any species.[102] Therefore blue whales feed only in exceptionally productive areas like the northern Channel Islands, Monterey Bay Canyon, and Gulf of the Farallones, around the Farallon Islands off San Francisco.

Pacific sardine

Forage Species Profiles

PACIFIC SARDINE

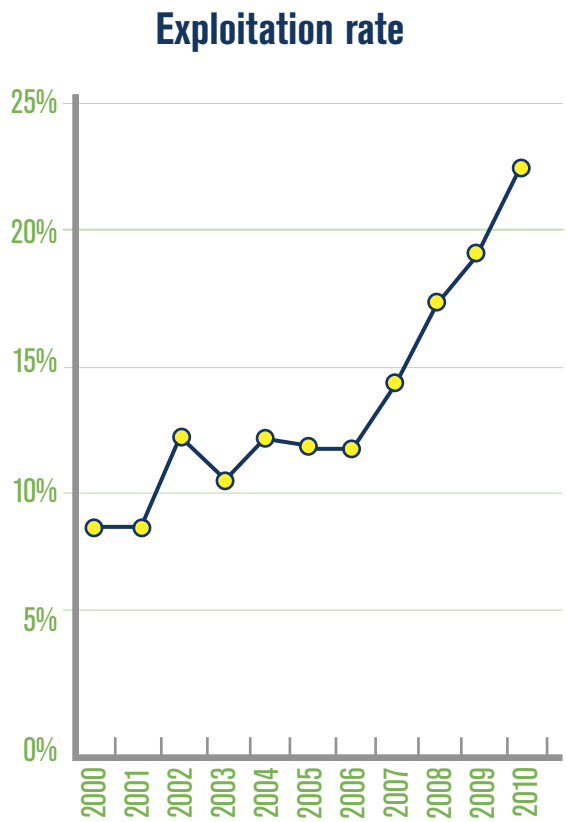
(Sardinops sagax)

Pacific sardine are a major forage species in the California Current. Feeding primarily on plankton, they play a critical role in transferring energy from low to higher trophic levels. Sardine populations are highly variable, as their recruitment depends largely on oceanographic conditions. On the U.S. West Coast, Pacific sardine and northern anchovy populations appear to have an inverse relationship, where periods of low sardine abundance are marked by dramatic increases in anchovy populations and vice versa.[123] These fluctuations are thought to be related to large scale changes in ocean temperature where warmer than average temperatures are more favorable for sardine and cooler than average temperatures are more favorable for anchovy populations.

Pacific sardines are managed by the Pacific Fishery Management Council within the Coastal Pelagic Species (CPS) FMP. Sardine management takes place through an innovative framework that has the potential to serve as a model for ecosystem-based forage species management. In this framework, a minimum cutoff biomass is "set-aside" such that fishing quotas are set on a percentage of the biomass above the cutoff and the fishery is closed if the total population drops below the cutoff. The current cutoff for Pacific sardine is 150,000 metric tons, however, this level was set without considering what is required to provide adequate forage. The percentage of the remaining biomass that can be fished increases (to15%) in warmer ocean conditions when the population is thought to be more productive and decreases (to 5%) in cooler, less favorable conditions. Finally, there is a maximum catch value that cannot be exceeded regardless of how large the population becomes. This prevents overcapitalization and provides a level of precaution when stock assessments are uncertain. The Pacific sardine control rule currently employs a maximum catch threshold of 200,000 metric tons. Other targeted forage species do not have this important control in place.

While these fishery management concepts are steps in the right direction, the implementation has failed to maintain the sardine stock at or above maximum sustainable yield (MSY) levels due to flawed assumptions and the failure of managers to respond to new information. Since implementation of the harvest policy in 2000, coast-wide exploitation rates have increased, the biomass has been maintained below the single-species MSY level (1,408,000 metric tons (Bmsy)), the increasing catch from Canada and Mexico has not been addressed, and the temperature-recruitment relationship used to justify the fraction parameter (allowing higher exploitation under favorable environmental conditions) has been shown to be invalid.[124,125] In 2010, NMFS ignored evidence from its own stock assessment that coast-wide overfishing was occurring (i.e., total catch exceeding overfishing levels). Meanwhile, catch levels continue to be set according to the existing harvest control rule despite clear scientific evidence that its underlying parameters are flawed.

Pacific sardine near kelp forest



Coastwide exploitation rates on Pacific sardine since 2000. Data from Hill, K.T., Lo, N.C.H., Macewicz, B.J., Crone, P.R., and Felix-Uraga, R. Assessment of the Pacific Sardine Resource in 2010 for U.S. Management in 2011. NOAA Technical Memorandum NMFS-SWFSC-469. December 2010.

Pacific hake

PACIFIC HAKE
(*Merluccius productus*)

The fishery for Pacific hake, also known as Pacific whiting, is among the top three fisheries by volume on the U.S. West Coast (along with market squid and sardine).[126] Pacific hake play an important role in shaping the California Current ecosystem, as they are both a major provider and consumer of forage. Because almost 80% of their diet is zooplankton, they transfer significant energy up the food web. However, as they grow larger, they consume other forage species. Making up the other 20% of their diet are other planktivores like sardines and anchovies.[127] Juvenile Pacific hake provide prey for migrating and surface seabirds, demersal sharks (those that live near the seafloor) and rockfish. Pacific hake are major prey for large flatfish (37%), pinnipeds (fin-footed marine mammals) (20%), pelagic sharks (those that live in the upper part of the ocean) and sablefish (black cod). Despite sharing many characteristics to other species managed under the Coastal Pelagic Species FMP (e.g., importance as forage, highly variable recruitment based on oceanographic conditions), they are managed in the Groundfish FMP by the Pacific Fishery Management Council. Regardless of which plan they are in, managers must begin to account for their ecological role in the ecosystem when setting catch levels.

JUVENILE ROCKFISH
(*Sebastes spp.*)

Most people do not consider rockfish to be in the same category of important forage species as other species like squid, sardines, or anchovy. However, the juveniles of some rockfish can be extremely abundant and in fact are a primary food source in the California Current. In particular, shortbelly rockfish are the most abundant juvenile rockfish in the California Current and have been recognized for decades as a primary prey item for marine mammals, seabirds, Chinook salmon, and other commercially important fishes.[134,135,136,137,138,139,140] For many breeding California seabirds, as much as 90% of their diet is composed of pelagic stages of juvenile rockfish during the late spring and early summer breeding seasons, and unexploited species (such as shortbelly) generally account for more than two thirds of the juvenile rockfish identified.[141,142] Shortbelly rockfish are described as important prey for thresher sharks, longnose skate, and jumbo squid. They are also eaten by other rockfish species, including bocaccio and chilipeppers.[143] Furthermore, there is a significant relationship between juvenile rockfish abundance (particularly shortbelly rockfish) and seabird breeding productivity.[144]

Juvenile rockfish and krill

PACIFIC HERRING
(*Clupea pallasii*)

Pacific herring are a critically important forage species off California, Oregon and Washington. Herring are utilized as forage at each stage of their life history from egg to adult, serving as prey for marine mammals and seabirds as well as commercial and recreational fish species. Pacific herring spawning sparks short-term, frenzied feeding at multiple levels of the marine food web. Animals that prey on herring eggs include ctenophores (gelatinous invertebrates), chaetognaths (worms), jellyfish, juvenile salmonids, sturgeon, smelt, surfperches, crabs and at least 20 species of birds.[128] Adult herring are also prey for many seabirds, salmon, seals, California sea lions, porpoises, northern fur seals, killer whales, dogfish, steelhead trout, Pacific cod, sablefish, hake, lingcod, several species of rockfish (black, yelloweye, quillback and tiger rockfish), striped bass, cutthroat trout, sculpin, and sand sole.[129]

Pacific herring are commercially harvested for roe (fish egg) products, bait, pet food, and fresh fish; additionally herring eggs are harvested after herring spawn on kelp. Pacific herring are currently managed by individual states. However this species may soon be added as an Ecosystem Component Species to the federal CPS FMP, primarily to monitor their populations, to recognize the importance of this species as forage, and to monitor herring bycatch in other federally managed fisheries. NMFS established the Ecosystem Component Species management category as a new way for fishery managers to recognize and protect species that are important in the ecosystem yet which are not the focus of major federal commercial fisheries.

While California state managers have aimed to harvest between 0-15% of the spawning biomass, the actual exploitation rate was above 20% in the 1990s.[130] The main herring stock in California, the San Francisco Bay population, recently crashed in 2007. As a result, managers decreased the harvest rate and subsequently closed the fishery in 2009 as the biomass fell to a new historic low. The population has responded to these management decisions and is showing signs of recovery; however, the age structure of the population is still highly skewed, with few older herring that were previously the backbone of the fishery.

Although California fishery managers have recognized the importance of herring as forage and have taken measures to help the stock recover, there is still no explicit accounting for the needs of predators in herring management. A fishery management plan is in its early stages of development, though progress has been stalled by lack of funds. In 2010, CDFG reopened the fishery at a 5% harvest rate, but the long-term management goals and the ability to provide adequate forage for predators remain unclear.

The State of Oregon allows an open access fishery for herring in ocean waters. In 2008, a record 55.8 metric tons of herring were landed as part of the Oregon sardine fishery. The only commercial roe-herring fishery, however, takes place in Yaquina Bay, Oregon. Yet the Yaquina Bay fishery has only opened twice since 1999 due to low herring returns.[131] There are relatively small fisheries in the Umpqua estuary and Columbia River estuary that target herring for bait (~4 metric tons per year), plus recreational fisheries in Oregon's bays and estuaries.

The State of Washington reports that less than half of the Washington herring stocks are healthy, or even 'moderately healthy.'[132] The genetically distinct Cherry Point herring stock used to be Washington's largest herring population from the 1970s to mid-1990s, but it is now considered to be in critical condition after its abundance dropped dramatically. The Northwest San Juan Island herring population is considered to have disappeared, and the Strait of Juan de Fuca herring population is in critical condition. The only current commercial fishery is in Puget Sound and uses lampara seines to target herring, which are sold as bait for recreational salmon and groundfish fisheries. The Puget Sound herring fishery lands, on average, 387 tons of herring per year.[133]

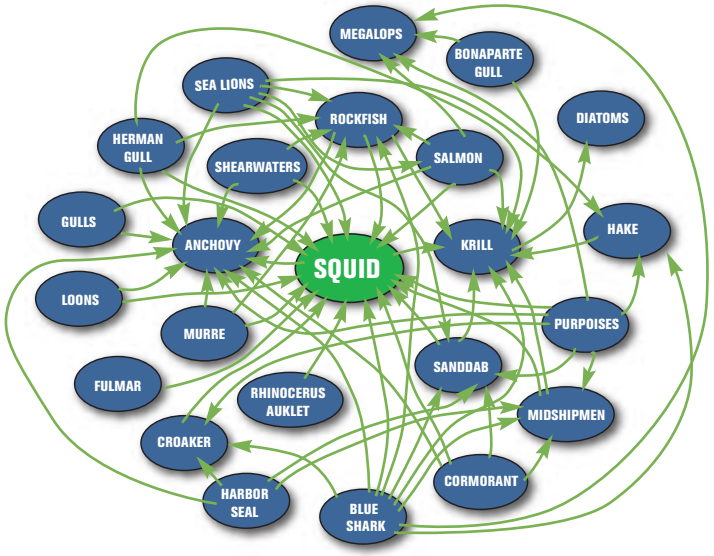
Workers sort Pacific herring

MARKET SQUID

(Doryteuthis opalescens)

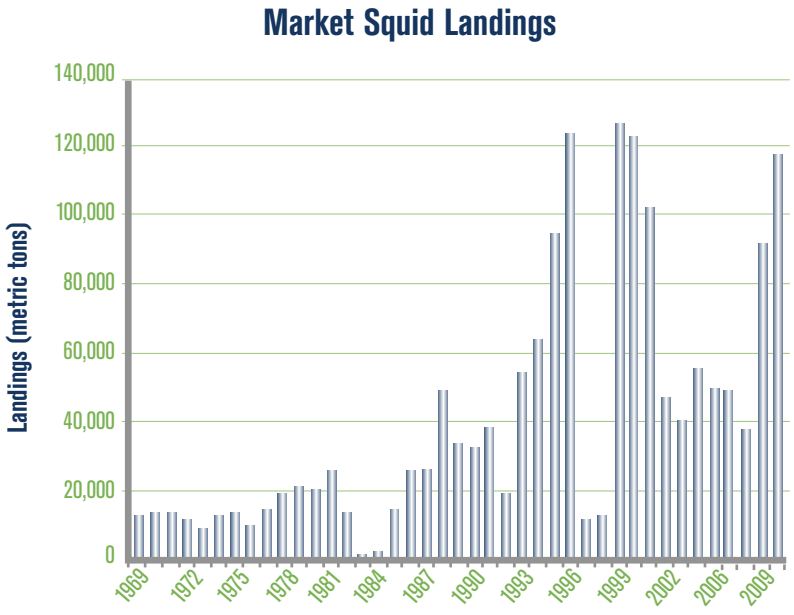
Market squid are an important forage species in the California Current for a long list of predators including pinnipeds (such as sea lions and seals), whales, dolphins, seabirds, and marine fish, over 15 of which are endangered species.[146] Market squid have short life spans (they have been aged to 10 months), and the current population fluctuates massively. In recent years, this fishery has been the largest and most valuable commercial fishery in California.

Some precautionary regulations have been implemented to protect the stock such as weekend fishery closures and marine protected areas that will protect significant spawning grounds. The Market Squid Fishery Management Plan (MSFMP) repeatedly recognizes the importance of squid as forage, but the actual catch levels do not adequately reflect their importance.



Food web for market squid, Doryteuthus opalescens, involving commercially important fish and key birds and marine mammals (adapted from Morejohn et. al. 1978).

Serious concerns remain about the total catch limits established in the MSFMP. Since little data was available on squid biomass to estimate Maximum Sustainable Yield, the MSFMP referred to NMFS' guidance suggesting it is reasonable to use recent average catch from a period when there is no qualitative or quantitative evidence of declining abundance. Catch levels in the late 1990s were by far the highest in history and catch limits were set based on the average of the three highest consecutive catch years on record, despite the fact that it preceded a major decline in abundance. Without any biomass estimates, this catch limit is extremely risky even from a single-species perspective and completely disregards the strong evidence for the important role of squid as forage. Essentially, squid are being removed at historically high levels without knowing the current population size.



Market Squid Landings from MSFMP and the Pacific Fisheries Information Network (PacFIN).

Market squid

Northern anchovy

NORTHERN ANCHOVY

(Engraulis mordax)

Northern anchovy are small, schooling, pelagic forage fish found along the Pacific coast from Baja California to British Columbia. An extensive list of marine fish, birds and mammals in the California Current region depend on anchovy as prey, including tunas, salmon, sharks, seals, whales and dolphins.[147] Northern anchovy make up over 92% of the diet of nesting brown pelicans off southern California.[148] There are three sub-populations divided into the northern, central, and southern sections of their range. The central subpopulation previously supported relatively large commercial fisheries in the U.S. and Mexico. Anchovies move offshore in winter and are abundant nearshore, in bays, and estuaries in the spring, summer and fall. Currently no published estimates of the northern anchovy populations exist. In fact, no stock estimates have been conducted since the mid-1990s, despite the high importance of anchovy to predators (from seabirds to salmon), on-going directed commercial fisheries, bait and recreational fisheries, and bycatch. Commercial fisheries for northern anchovy are managed by NMFS under the CPS FMP in cooperation with individual states. On average, between 2000 and 2009, over 9,600 metric tons of anchovy were landed each year on the West Coast.[149]

Delta smelt

SMELT

(Osmeridae)

Smelt is a general term used to describe a group of small marine, estuarine and anadromous forage fish, in the family Osmeridae.[150] In the California Current, there are two anadromous smelt, eulachon *(Thaleichthys pacificus)* and longfin smelt *(Spirinchus thaleichthys)*, that spend most of their lives in marine waters, but spawn in coastal rivers and streams. In 1956 Kelso, Washington was dubbed the "Smelt Capital of the World" for the large runs of eulachon that once traveled up the Columbia River to spawn.[151] Eulachon populations have since crashed off the U.S. West Coast and are now listed as threatened. Whitebait smelt *(Allosmerus elongates)* and night smelt *(Spirinchus starksi)* are strictly marine smelt species, and surf smelt *(Hypomesus pretiosus)* is a marine/estuarine species. The delta smelt *(Hypomesus transpacificus)* is endemic to the Sacramento-San Joaquin estuary of California and is listed as an endangered species. Capelin *(Mallotus villosus)* mostly live at higher latitudes, but the southern range of this marine smelt extends into the northern California Current system to approximately the Strait of Juan de Fuca, Washington. Arctic rainbow smelt *(Osmerus mordax dentex)* extend as far south as Vancouver Island, British Columbia. All of these smelt species are important prey for many other fish, birds and mammals in the California Current ecosystem, including recreationally and commercially important species like salmon and halibut.

Topsmelt *(Atherinops affinis)* and jacksmelt *(Atherinopsis californiensis)* are also important marine forage fish of the California Current, yet are not true smelt. These fish belong to the family Atherinidae *(silversides)*, which includes California grunion *(Leuresthes tenuis*).

KRILL

(Euphausiidae)

Eighty-five species of krill have been identified throughout the world's oceans, eight of which dominate the krill community in the California Current ecosystem. Many of the fish species that depend on krill directly or indirectly, including salmon, rockfish, hake and flatfish, support important recreational and commercial marine fisheries. The planet's largest animal, the blue whale, feeds almost exclusively on krill. During the peak summer feeding season off California, blue whales concentrate on large krill schools, with individual whales consuming roughly two tons of krill per day.[152] Two West Coast krill species, *Euphausia pacifica* and *Thysanoessa spinifera*, form large, dense aggregations near the surface. The sub-tropical *Nyctiphanes simplex* is abundant in U.S. West Coast waters during strong El Niño years, and also forms large surface swarms. *Nematocelis difficilis* is very abundant in the California Current, but it does not migrate to the surface, preferring deeper habitats. The other known krill species in the California Current are T. *gregaria, E. recurva, E. gibboides*, and *E. eximia.*[153]

Recognizing the importance of krill in the marine ecosystem, NMFS officially adopted a ban on krill harvest throughout the West Coast Exclusive Economic Zone (three to 200 nautical miles offshore) in July 2009. This decision adds upon krill protections already in place in Alaska's state and federal waters, as well as the prohibition on directed harvest of krill in California, Oregon, and Washington state waters (zero to three nautical miles offshore).

Pacific mackerel

PACIFIC AND JACK MACKEREL

(Scomber japonicus and Trachurus symmetricus)

Pacific mackerel and jack mackerel are coastal pelagic fish species that play an important ecological role in the California Current for top predators like bluefin tuna, pelagic sharks, swordfish, marlin, seals and toothed whales. [154,155] Pacific and jack mackerel form large surface schools that are the target of these apex predators, but are also targeted by another top predator - humans. Pacific and jack mackerel fisheries are managed by the National Marine Fisheries Service and Pacific Fishery Management Council as part of the Coastal Pelagic Species Fishery Management Plan. The status of the jack mackerel population off the U.S. West Coast is unknown, and the Pacific mackerel population is at relatively low levels, complicated by uncertainties in estimating the population size. Despite this uncertainty, federal managers allow commercial and recreational fisheries, mostly off central and southern California, to take up to 31,000 metric tons of jack mackerel per year and over 40,000 metric tons of Pacific mackerel.[156]

PACIFIC SAND LANCE

(Ammodytes hexapterus)

The Pacific sand lance range extends across the Pacific Rim from southern California, north to the Aleutian Islands, and west to Japan. They inhabit relatively shallow depths in bays, estuaries and the open ocean from the intertidal zone to approximately 47 meters. At every stage in its life cycle, sand lance are valuable prey for salmon, seabirds, seals, minke whales and other fish and marine mammals. 35% of juvenile salmon diets are composed of sand lance, while juvenile Chinook salmon depend on sand lance for up to 60% of their diet.[157] Pacific sand lance have a highly unusual behavior of burrowing into the seafloor sediment at night for protection from predators. During the day sand lance travel in large schools, feeding on plankton. These large schools are pushed up from below into tight defensive balls by salmon, dog sharks and sea lions. From above, flocks of gulls, cormorants, murres and auklets dive on the balls of sand lance as they approach the surface. Adult sand lance spawn in the upper intertidal zone of sandy-gravel beaches. Some sand lance are taken for recreational purpose and bait off the U.S. West Coast, but presently no commercial fishery exists. In Japan, however, roughly 10,000 tons of sand lance are taken each year by commercial fisheries using trawls and seines.[158,159]

Important Forage Species of the California Current

The list of included species is adapted from the Pacific Fishery Management Council[160] and several studies of predator diets. The composition of the list is ongoing and may be modified as additional analysis and information come forward.

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Seabirds plunge feed on forage fish like sardines, anchovies, mackerel, and squid

Common Name	Scientific Name
California market squid	Doryteuthis opalescens
Northern anchovy	Engraulis mordax
Pacific herring	Clupea pallasi
Pacific sardine	Sardinops sagax
Pacific mackerel	Scomber japonicus
Jack mackerel	Trachurus symmetricus
Pacific hake YOY	Merluccius productus
Rockfishes YOY	Sebastes spp.
Krill	Euphausiidae
Neon flying squid	Ommastrephes bartramii
Boreal clubhook squid	Onychoteuthis borealijaponica
American shad	Alosa sapidissima
Surf smelt	Hypomesus pretiosus
Night smelt	Spirinchus starksi
Longfin smelt	Spirinchus thaleichthys
Eulachon	Thaleichthys pacificus
Whitebait smelt	Allosmerus elongatus
Delta smelt	Hypomesus transpacificus
Capelin	Mallotus villosus
Topsmelt	Atherinops affinis
Jacksmelt	Atherinops californiensis
Lantern fish	Myctophidae
Pacific saury	Cololabis saira
Pacific sandlance	Ammodytes hexapterus
Shortbelly rockfish	Sebastes jordani
Californian grunion	Leuresthes tenuis
Codfishes YOY	Gadidae
Pacific tomcod	Microgadus proximus
Greenlings YOY	Hexagrammos spp.
Pacific sanddab	Citharichthys spp.
Surfperches	Embiotocidae
Sculpins	Cottidae
Midshipmen	Porichthys spp.
White croaker	Genyonemus lineatus
Kelpfish	Clinidae
Gunnels	Pholididae
Pricklebacks	Stichaeidae
Deep-sea smelts	Bathylagidae

* major commercial fishery – A "major fishery" is defined as a commercial fishery with greater than 1,000 metric tons annually landed on average from 1996-2010. Pacific Fisheries Information Network (PacFin) Report #307, 1996-2010, Pacific States Marine Fisheries Commission, Portland Oregon

YOY indicates young of the year.

Management	Major Fishery?*	Population Status
California Market Squid FMP and NMFS CPS FMP	yes	unknown
NMFS: CPS FMP/WA Forage FMP	yes	unknown
Various levels of state management (CA, OR, WA) Washington Forage Fish Management Plan	yes	stocks range from moderately healthy to critically low
NMFS: CPS FMP/WA Forage FMP	yes	stock below sustainble biomass levels (Bmsy)
NMFS: CPS FMP	yes	low
NMFS: CPS FMP	yes	unknown
NMFS: Groundfish FMP	yes	considered healthy/large uncertainty
NMFS Groundfish FMP and states (e.g. CA Nearshore FMP)	yes	some rockfishes overfished, some healthy, some unknown
NMFS: CPS FMP, OR/WA/CA fishery prohibitions	no	unknown
No active management	no	unknown
No active management	no	unknown
No active management	no	unknown, assumed healthy
No active management/WA Forage FMP	no	unknown
No active management/WA Forage FMP	no	unknown
No active management/WA Forage FMP	no	active petition to list CA population as threatened species under federal ESA. CA listed as threatened
NMFS: ESA Threatened as of 2010/WA Forage FMP and OR/WA joint Columbia River Eulachon Management Plan	no	threatened
No active management/WA Forage FMP	no	unknown
California endangered species/ U.S. Fish and Wildlife Service threatened species	no	federal ESA threatened/CA endangered
No active management/WA Forage FMP	no	unknown (southern extent of range is WA)
No active management	no	unknown
NMFS: Proposed EC species in CPS FMP	no	unknown
No active management	no	unknown
No active management	no	unknown
No active management/WA Forage FMP	no	unknown
NMFS: Fishery through 2012 in Groundfish FMP	no	depressed
CDFG - recreational fishery only	no	unknown
NMFS: Groundfish FMP	no	unknown
No active management	no	unknown
NMFS: Groundfish FMP	no	unknown
NMFS: Groundfish FMP	no	unknown
No active management	no	unknown
No active management	no	unknown
No active management	no	unknown
No active management	no	unknown
No active management	no	unknown
No active management	no	unknown
No active management	no	unknown
No active management	no	unknown

RECOMMENDATIONS

THE FOLLOWING RECOMMENDATIONS APPLY TO FORAGE SPECIES MANAGEMENT AT THE STATE, FEDERAL AND INTERNATIONAL LEVEL

1) Establish Ecosystem-based Management Policies Recognizing and Protecting the Role of Forage Species in the Ecosystem

A new general policy must be established that recognizes, accounts for, prioritizes, and protects the important role forage species play in the California Current Large Marine Ecosystem with its top priority the long-term health of the ecosystem.

2) "Freeze the Menu" for Forage Species

Prohibit development of new commercial fisheries for forage species. The most conservative approach to protecting forage species is to ban commercial fishing on these species before it begins. The National Marine Fisheries Service and the Pacific Fishery Management Council demonstrated this to be a successful approach to ensuring the long-term health and productivity of the marine ecosystem when protecting krill off the U.S. West Coast. This approach to protect forage species has also been employed by the North Pacific Fishery Management Council in the Gulf of Alaska, Aleutian Islands, Bering Sea and the Arctic.

Krill harvest was prohibited off the U.S. west coast in 2009

3) Move Existing Fisheries to an Ecologically Sustainable Yield Approach

Each forage species targeted by commercial fisheries must be managed using an Ecologically Sustainable Yield approach where the full impacts of fishing on the ecosystem are evaluated and considered. An ESY approach will ensure sufficient abundance of forage species for the ecosystem including fish, invertebrates, sea birds, marine mammals and other marine life when calculating appropriate catch levels. Depending on the specific context of each fishery, this would include various combinations of the following approaches:

- Establish forage reserves (e.g., cutoff value in Pacific sardine management) based on consumption needs of predators, such that they provide sufficient biomass to support healthy populations of those predators.
- Develop an index of the overall health of the forage base and reduce fishing pressure if the index drops below threshold levels.
- Develop oceanographic triggers for changes to harvest rates (e.g., if El Niño conditions are predicted, set a lower fishing mortality rate).
- Account for climate change and ocean acidification impacts. Managers should leave a buffer for climate-driven losses in prey populations.
- Establish ecosystem-based biomass targets and minimum level limits for forage species harvest control rules.
- Keep fishing mortality rates below the maximum fishing mortality that would maintain the species ability to serve as forage.
- Incorporate predator-prey relationships into stock assessments.[161]
- Set maximum catch thresholds for all actively targeted forage species.

4) Identify and Protect Key Forage Species Habitats and Foraging Grounds

Similar to actions taken by Washington State in Puget Sound, West Coast states must identify and protect forage fish spawning habitats from development. The National Marine Fisheries Service must identify and designate critical habitat for the threatened eulachon smelt in all of its key habitats including rivers, bays and ocean waters. Managers should also identify key foraging grounds for predators and enact time/area closures for fishing gears or other activities that impact forage species during the places and times that the areas are known to serve as key foraging areas, to prevent localized forage depletion.

Sardines congregate off the west coast certain times of the year and attract countless numbers of top predators like marlin

Schooling Pacific sardine

5) Promote Higher Value Products

Most forage species are sold as low value products such as aquafeeds and bait. As a result, the fishing industry currently has an incentive to maximize harvest levels in a "low value, high volume" business model. However, if a shift to ecosystem-based management of forage species were accompanied by an increase in value per pound of landings, the industry could maintain its profitability in a "higher value, lower volume" model. Such a shift would compensate and provide incentives for leaving more forage species biomass in the ocean. Rather than removing forage species from the California Current ecosystem and exporting them to low value international markets, we should leave more in the ocean and promote higher value domestic markets such as those for direct human consumption.

6) Conduct Additional Research and Data Collection

Management of forage species, especially harvest rates, should consider multi-decadal oscillations as well as anthropogenic factors such as climate change and impacts of ocean acidification. For example, what are the key environmental indicators that predict the productivity of forage species stocks and how should harvest rates be altered in accordance with ocean temperature regime shifts? While much information is known, more research should be conducted on predator-prey relationships to help managers account for predator needs when setting catch levels. Additionally, improved monitoring of non-target forage species populations is needed and can be accomplished through existing or future surveys and fishery catches.

CONCLUSION

The health and biodiversity of the California Current Large Marine Ecosystem depends on abundant populations of forage species. Forage species literally feed and sustain our oceans; they are the lifeline for the sea. From whales and seabirds to tuna and salmon, forage species feed wildlife populations that we rely on and cherish for cultural, recreational and economic reasons.

In this review of forage species conservation and management off the U.S. West Coast, Oceana has found that regional managers and state lawmakers have made some important decisions to protect forage species such as the state and federal prohibitions on commercial fishing for krill, and the forward thinking Washington State Forage Fish Management Plan. We have also found, however, major gaps in the species that are managed and protected, and severe flaws in the management of fisheries that target forage species. In this report, we documented numerous cases of mismanagement and ample reason for concern, including overly aggressive harvest rates, species declines, and a failure to account for existing information on the prey consumption needs of larger animals that rely on forage species.

In order to protect the food web of the California Current marine ecosystem, significant improvements must be made to maintain an abundant supply of forage species. These improvements do not require shutting down existing fisheries, but they do require new policies and management change. Policy makers and fishery managers must take on the challenge of moving away from managing one species at a time in isolation and shift towards an ecosystem-based management approach that includes a focus on the conservation of forage species. The full California Current forage base must be recognized, accounted for and protected. The full set of recommendations provided in this report offers a practical and tangible path forward toward an ecosystem-based approach that helps to ensure healthy oceans for everyone.

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Blue rockfish schooling in a giant kelp forest located in Point Lobos State Marine Reserve, California

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Supplemental Open Comment 6
November 2011

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