Social & Economic Resilience of the Northern California Commercial Red Sea Urchin Fishery

Final Report

October 2024

About this Report

Led by the California Ocean Science Trust (OST), a team of experts at UC Santa Cruz (UCSC), the California Sea Urchin Commission (CSUC), and the Greater Farallones Association/Greater Farallones and Cordell Bank National Marine Sanctuary assessed the social and economic impacts of the 2016-17 California Sea Urchin fishery disaster and identified strategies to enhance the fishery's resilience to environmental disturbances.

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Disclaimer About Pre-Review

The project results presented in this report have not been peer-reviewed. We expect to draft a manuscript based on some of the work reported here and submit it to a journal for peer review and publication at a later date.

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Executive Summary

Northern California's kelp forests have declined over 90% since 2014, with significant detrimental impacts on the marine ecosystem and the northern California commercial red sea urchin fishery ("the northern fishery") as well as other people and communities that depend on healthy kelp forests for their livelihood and wellbeing. As a result, there were significant economic losses that led the northern fishery to be declared a federal fishery disaster for 2016-2017 and again for 2018-2019. Whereas research to date has focused primarily on the ecological resilience of kelp forest ecosystems, less attention has been directed to the resilience of the people and social systems affected by kelp loss. The overarching goal of this project was to assess the socioeconomic impacts of the fishery disaster and assist resource managers and the commercial sea urchin fishing community with identifying ways to enhance the fishery's resilience to future potential environmental stressors.

The objectives of this project were to: assess the socioeconomic impacts of the 2016-2017 northern fishery disaster; identify and evaluate potential strategies to improve the resilience of the fishery and fishing community; and engage and communicate results with fishery managers, the fishing community and other relevant groups to facilitate their use in local, state, and federal decision-making. To assess the socioeconomic impacts of the fishery disaster, Dr. Pomeroy led analysis of the socioeconomic impacts of the fishery disaster, using California Department of Fish and Wildlife (CDFW) commercial fisheries data, interviews with northern fishery participants and fishing community members, and literature review. To identify and evaluate potential strategies and actions for building resilience to future environmental change, we convened an in-person workshop in Fort Bragg with urchin divers and processors, the fishing community, and key state agency staff. We sought feedback on the workshop report and recommendations from the fishing community, resource managers, legislative staff, and other partners to ensure the project findings and recommendations reflect the needs of the fishery and fishing community.

For the socioeconomic impact assessment we provide an overview of the fishery statewide, a brief comparison of the northern and southern fisheries, and then describe the experiences, impacts and implications of the fishery disaster for the northern fishery and its associated social system. The northern fishery is distinct from the southern fishery in terms of management, participants and practices. Over the northern fishery's more than 50-year history, it has been concentrated along the Mendocino County coast with some activity off of Sonoma County and San Mateo County. The fishery disaster has had profound direct and indirect impacts on fishery participants – divers, crew, buyers and processors – along with ports and fishery-support businesses. Fishery landings (pounds) and ex-vessel value in the five years since the disaster were, on average, down 90% and 84%, respectively, compared to the five years prior to it, with the average number of trips, boats and divers active in the fishery down 73%, 52% and 56%, respectively. In addition to economic losses, which pose immediate and long-term challenges, divers faced increased safety risks as they ventured further from port and into deeper water to find market-quality red urchin. In addition, fishery participants grappled with the uncertainty of the unfolding and persistent fishery disaster. Altogether, these impacts, in turn, have had important implications for them, the industry and associated port communities. At the same time, those who have persisted in the industry have demonstrated significant and diverse capacities for resilience through

their efforts to cope and adapt to the fishery disaster. Maintaining these capacities along with the fishery's physical, social and economic infrastructure are critical to recovery and restoration and the future of the fishery.

We identified several key needs for the fishery including: **fishery-support infrastructure, sustaining industry capacities, fuller engagement in kelp restoration research, fishery management accommodations, and alternative markets or marketing strategies**. We distilled the ideas shared and discussed in the interviews, informal conversations, workshop and other feedback received from resource managers and partners into seven recommendations for addressing these needs (Table 1). As the focus of this project was the northern fishery, consistent with the fishery disaster designation and the primary focus of this project, these recommendations may not address the full suite of needs in the southern or statewide fishery. They are organized by topic and recognizing that some are interdependent and achieving them requires collaboration among multiple entities.

Table 1: Recommendations for increasing the resilience of the northern urchin fishery.

Topic	**Recommendation**
Fishery & Port Infrastructure	1. ***Prioritize support for efforts to repair, renovate, and/or replace and ensure access to fishery-support infrastructure on working waterfronts.*** Access to well maintained, functional port infrastructure is key to commercial fisheries yet is lacking for the northern fishery. Continued and enhanced collaborative efforts between fishery participants, port managers and other harbor users to identify, prioritize and secure funding to address local infrastructure needs is vital.
Collaborative Research & Training	2. ***Facilitate connections to explore and encourage collaborative research and restoration activities among fishery participants, researchers, and managers.*** Combining expertise and ideas from various groups – such as involving urchin divers in the design and implementation of research projects as well as data collection and contributing their experiential knowledge to projects – can lead to better informed and supported work. Creating a mechanism for encouraging and facilitating collaborative research and restoration partnerships among researchers, resource managers, and the fishing community will enable and enhance such work, leading to better social and ecological outcomes. 3. ***Develop programs to attract and train new divers as a way to maintain fishery-related knowledge and skills into the future.*** Developing programs that attract new and/or younger divers will be key to passing on fishery-related knowledge and skills, for example through apprenticeships and collaborative fisheries research. California Sea Grant's Commercial Fishing Apprenticeship Program could be expanded to the northern fishery or new collaborative training programs could be developed to attract and train the next generation of divers.
Fishery Management	4. ***Adjust fishery management measures to increase flexibility of fishing*.** Increasing the number of harvest days or opening selected areas closed to the fishery would increase opportunities as well as flexibility for urchin divers (and buyers) as they seek to operate in particularly challenging conditions. Continued conversations among CDFW, the California Fish and Game Commission and the California Sea Urchin Commission to identify and implement such adjustments are central to increasing flexibility, safety and viability of the fishery.

	5. ***Explore experimental permits for purple urchin collections to expand diver opportunities in kelp restoration.*** Creating an experimental permit for purple urchin collection could increase incentives and opportunities for individuals who do not already hold an urchin dive permit to assist with and thus expand kelp restoration efforts. Continued efforts and collaboration among state agencies, the fishing community, and other relevant stakeholders should explore new permit possibilities.
Risk Mitigation	6. ***Support efforts to minimize or mitigate risk for fishery participants.*** There is growing interest in the potential for fishery insurance – akin to crop insurance – as a tool for mitigating fisheries' vulnerability to climate change. Continued and expanded research, including collaboration among scientists, insurance industry experts, fishing community members, and relevant government decision makers to account for ongoing as well as acute disruptions (as with the urchin fishery) is needed. In addition, expanded grant opportunities to support fishery disaster risk reduction and mitigation is needed.
Markets & Marketing	7. ***Explore additional uses, markets and marketing strategies for purple and red urchins.*** Collaborative projects should continue to explore potential products and market creation for purple urchins – which are abundant but have limited market value. Similarly, additional or alternative marketing strategies to help increase red sea urchin sales are needed. Continued investment in projects that explore, evaluate and implement alternative markets and strategies is needed.

In this report, we also outline the key challenges and considerations affecting the feasibility of each of these recommendations, examples of recent and ongoing efforts, and suggestions for next steps to advance the recommendations. Implementation of these recommendations to increase the resilience of the fishery will require collaboration among resource managers, fishery participants, fishing community members and, in some cases, researchers and other stakeholders. Funding and other forms of support will also be needed to achieve those efforts.

Social & Economic Resilience of the Northern California Commercial Red Sea Urchin Fishery

Background

In California, the red sea urchin (*Mesocentrotus franciscanus*) has been commercially harvested for its roe, called "uni" and primarily used in sushi, since the 1970s. The fishery reached its peak in the mid 1980s (CDFW 2019). The commercial fishery can be divided into two sub-fisheries, split at the Monterey-San Luis Obispo County line. The southern fishery occurs in the Southern California Bight and the northern fishery is concentrated off the Mendocino County coast in Northern California.[1] However, beginning in 2014, a "perfect storm" of environmental events led to a dramatic decline in statewide red sea urchin landings, from 4.2 million pounds in 2013 to 284,000 pounds in calendar year 2022 (Goldenberg 2023). A combination of events—including a marine heatwave known as "the Blob" in 2014, an El Niño in 2015 and the decline of an urchin predator, the sunflower sea star (*Pycnopodia helianthoides*) due to sea star wasting disease—led to the dramatic decline of California's kelp forests (Rogers-Bennett & Catton 2019). Without their main food source of kelp to graze on, red sea urchin mortalities increased and gonad (roe-producing reproductive organs) size decreased, significantly affecting their quality and marketability. Further exacerbating the issue, the smaller and more robust purple sea urchin began feeding voraciously on the remaining kelp, resulting in "urchin barrens."

Not only did the loss of kelp have significant and detrimental impacts on the marine ecosystem and individual species such as red urchin, it also affected the people and communities that depend on healthy kelp forests for their livelihood and well-being, including the northern California commercial red sea urchin fishery. Ultimately, federal fishery disasters were declared for 2016–17 and 2018–19 for the northern fishery based on significant economic losses attributed to the environmental events' impact on urchin availability and quality (see Appendix 2 Workshop Report for detailed background).

There is a need to understand how the fishery and fishing communities were impacted by the fishery's collapse, and identify practical, acceptable and effective strategies that could enhance the fishery and fishing community's resilience to future environmental change. To date, most research has assessed the ecological resilience of kelp forest ecosystems with efforts centered around kelp restoration. However, there has been limited attention to studying the resilience of the people and social systems affected by kelp loss. Climate change can have complex economic, cultural, and social impacts on fisheries and fishing communities (Chavez et al. 2017). Several strategies to mitigate impacts and increase resilience have been proposed and observed for other fisheries, including providing flexibility in timing of fishing activity, identifying new or emerging fisheries, and diversifying fishing portfolios (California Ocean Science Trust 2019; Reimer et al. 2024). For the northern fishery, identifying appropriate resilience strategies to mitigate adverse impacts of kelp loss requires knowledge of the nature, scope, and

[1] Throughout this report, we use "the northern fishery" and "the southern fishery" to refer to these two largely distinct sub-fisheries.

magnitude of those impacts, how fishery participants and communities have responded to them, and their capacities and needs going forward.

Project Overview

The overarching goal of this project was to assist resource managers and the commercial red urchin fishing community to enhance responsiveness and resilience to kelp loss and associated fishery disasters, and other future potential environmental stressors. To accomplish this goal, we were guided by three objectives: 1) assess the socioeconomic impacts of the northern fishery disaster; 2) identify and evaluate potential strategies to improve the resilience of the fishery and fishing community; and 3) engage and communicate results with resource managers and partners throughout the project to help facilitate their use in local, state and federal decision-making.

We used a mixed methods approach to accomplish the project goal and objectives. Pomeroy and her team at UCSC analyzed CDFW commercial fisheries data, conducted and analyzed data from interviews with northern fishery participants, and drew on prior research to assess the socioeconomic impacts of the fishery disaster (see "Socioeconomic Impact Analysis Results"). To identify and evaluate potential strategies and actions for building resilience to future environmental change, we convened an in-person workshop in Fort Bragg in February 2024. Fishery participants including urchin divers, processors, handlers along with other community members and resource managers worked together to identify and evaluate potential resilience strategies. (See Appendix 2 for the full Workshop Report.) Finally, we engaged the fishing community, resource managers, kelp restoration practitioners, and environmental NGO and legislative staff throughout this project. We shared preliminary results and recommendations via a virtual seminar in July 2024 and sought feedback on the workshop report and recommendations from these groups to ensure the project findings and recommendations reflect the needs of the fishery and fishing community. This final report represents the culmination of these efforts.

Workshop Summary

As part of this project, we hosted a half-day, in-person workshop on February 9th, 2024 in Fort Bragg, California. The goal of the workshop was to collaboratively identify and evaluate potential strategies to improve the northern fishery's and the fishing community's resilience to future environmental disturbances. We convened a group of 22 urchin divers and processors, community members, and key state agency staff to brainstorm strategies and ideas and discuss opportunities for implementing them. The workshop included presentations by the project team, state agency staff, and kelp restoration practitioners to provide context for the discussion. Presentations addressed the federal fishery disaster relief process, current efforts for urchin diver-involved kelp restoration, and preliminary findings on the socioeconomic impact assessment. The resulting workshop report outlines a brief history of the urchin fishery and the federal fishery disaster process, discusses the resilience strategies brainstormed by workshop participants, and highlights the opportunities, challenges and needs for advancing those strategies. (See Appendix 2 for the full Workshop Report.) Workshop participants explored ideas such as expanding kelp restoration activities, developing flexible permit systems and fishery insurance, creating markets for purple urchins, and addressing port infrastructure needs. They also highlighted a sense of urgency for ensuring the fishery's future, funding and research needs, and the importance of supporting

the next generation of divers. We shared the report with workshop participants, other fishery participants, agencies, fishery-supporting NGOs, and legislative staff to identify the most actionable resilience strategies and potential next steps, as well as with the broader public.

Socioeconomic Analysis Results

The marine heatwave of 2014–17, associated kelp loss and related events ultimately led to a sharp decline in red sea urchin landings and ex-vessel (dockside) value, prompting a request for a federal fishery disaster declaration and financial assistance.[2] This assessment of the socioeconomic impacts of the 2016-17 Northern California red sea urchin fishery disaster provides: 1) a characterization of the fishery, 2) assessment of the socioeconomic impacts of the fishery disaster, and 3) a summary of fishery participants' needs, concerns and capacities for addressing them. Our findings contribute, in turn, to this report's recommendations for enhancing the resilience of the fishery, as a social-ecological system, to ongoing and future environmental disturbances.

The setting

Our primary focus is the northern fishery, which extends from the Monterey/San Luis Obispo county line to the Oregon border. The northern fishery is centered in Mendocino County, with most activity based at Noyo Harbor (Fort Bragg), followed by Point Arena and Albion. The fishery also has been active, if at a lower level and less consistently, at other ports in the region including, since the mid 2010s, Pillar Point Harbor (San Mateo County) and Bodega Bay (Sonoma County). Appreciating the challenges faced by the southern fishery and the fishery as a whole, as well as the importance of the larger context of the fishery, we provide summary information about these as well.

Methods

We used a mixed-methods approach to characterize the fishery and assess the impacts of the disaster. Data sources and collection included literature, websites, blogs and other materials; commercial fisheries data provided by the California Department of Fish and Wildlife (CDFW); semi-structured interviews and conversations with selected fishery participants and others knowledgeable of the fishery; and participation in and observation of fishery-related meetings and other activities. We conducted thematic analyses of our qualitative data to illustrate the social and economic dimensions of the fishery, impacts and implications of the fishery disaster, and concerns and ideas for the future.

To complement this work, we quantitatively analyzed commercial fisheries landings, license, permit and vessel registration data for commercial fishing years 2010–11 through 2020-21. Commercial fishing years run from April 1 of a given year through March 31 of the following year, and are consistent with CDFW's calendar for the issuance (and validity of) fishing licenses, permits and vessel registrations as well as implementation of most fishery management measures. (One exception is fish business licenses, which are valid for the calendar year.) These data were provided via a data-sharing agreement (DSA)

[2] We do not include purple sea urchin (*Strongylocentrotus purpuratus*), a major competitor of red sea urchin, in this analysis. Purple urchin account for a very small fraction of total commercial urchin landings and ex-vessel value, have a very limited market, and were not the subject of the fishery disaster. (See also CDFW (2019).)

between CDFW and UC Santa Cruz.[3] We analyzed these data to illustrate the spatial and temporal dimensions of the fishery, with a focus on participation, participants and connections to and among ports, and to assess change over time.

Note that the relatively small number of people and businesses involved in the northern red sea urchin fishery in some cases limits the results we can report. In particular, in using the commercial fisheries data provided by CDFW, we are bound by the "rule of three," which requires that we summarize data to represent at least three fishermen, boats and buyers, to ensure the confidentiality of individuals' data. As a result, the CDFW data summaries presented are limited, as for fishing year 2010 when fewer than three fish businesses unloaded or received red sea urchin at northern California ports. Where possible, we draw on other data sources to characterize this activity as it pertains to the project objectives.

Brief history of the fishery

The commercial dive fishery for red sea urchin, *Mesocentrotus franciscanus*, began in earnest in the southern part of the state in 1971 as part of a National Marine Fisheries Service program to develop fisheries for underutilized marine species (CDFW 2019). The northern fishery followed in 1972, initially at a relatively slow pace, then growing significantly from 1985 through 1988 before declining to more moderate levels following the implementation of limited entry and other management measures.

Over time, the fishery as a whole has been affected by a range of environmental, regulatory, social and economic factors (Figure 1). Urchin—and the kelp they feed on—are sensitive to changing ocean conditions, including El Niño events (e.g., 1982–83, 1992–93, 1997–98) as well as larger-scale events such as the 2014-17 marine heatwave. The ebb and flow of the Japanese market demand for California's high quality urchin roe spurred activity in the 1970s and again in the mid 1980s. However, that market crashed in the 1990s and into the 2000s, prompting several buyers to leave the industry and those who remained to focus more on the domestic sushi market (CDFW 2019).

[3] Pomeroy and Kustra worked with the data under the CDFW-UCSC DSA and associated non-disclosure agreements (NDAs). As a non-UCSC collaborator, Goldenberg had parallel but separate agreements for this project with CDFW. In addition, those working on this assessment are included in UCSC's approved Human Subjects Research Protocol.

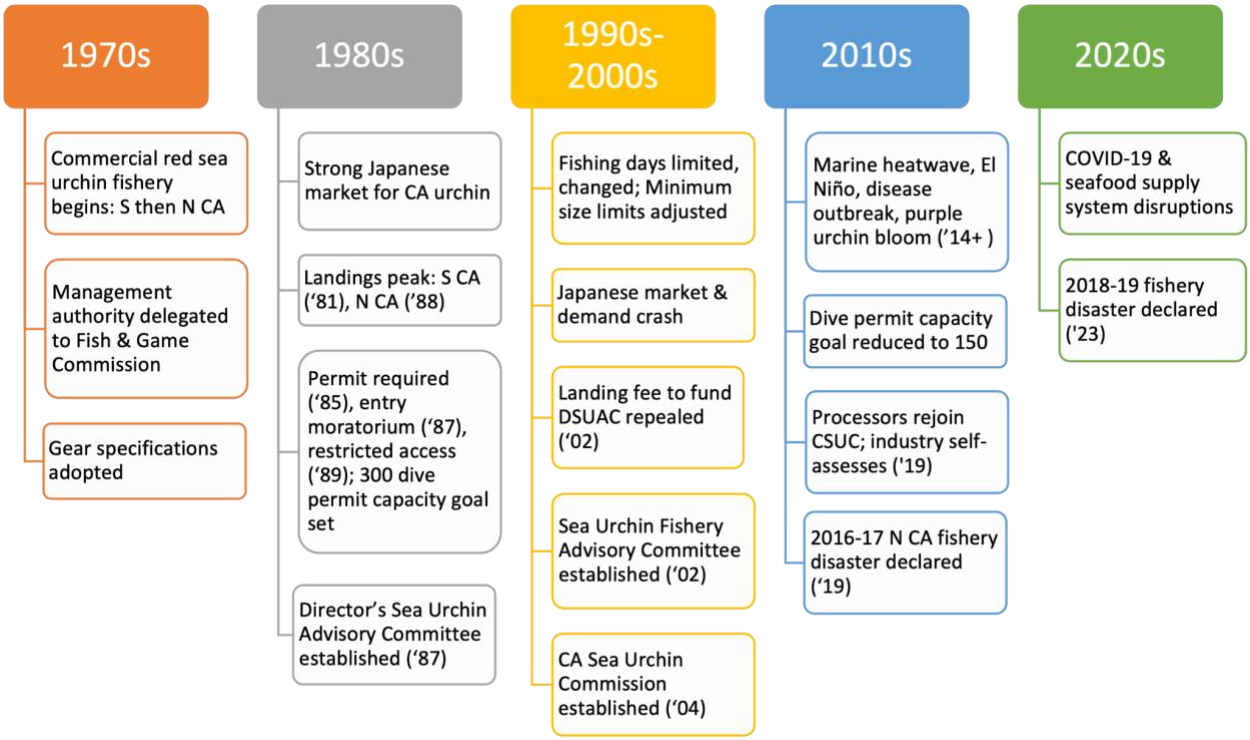

Figure 1. A condensed, selective history of the California commercial sea urchin fishery.

These factors and others have individually and collectively shaped where, when and how the activities of fishing, unloading, processing, distribution and selling urchin products occur as well as who is involved in these activities. They also provide context for assessing the socioeconomic impacts of the recent fishery disaster(s).

The Present-Day Fishery

The commercial fishery for red sea urchin is a dive fishery, with divers typically using surface-supplied air (hookah) systems. They use a hand-rake to collect urchin from the sea floor into a mesh bag before returning to the surface to transfer their catch to the boat. In recent years, especially with nearshore kelp loss, some divers have started to use nitrox (oxygen-enriched) air with SCUBA gear to be able to spend more time on the bottom and reduce the amount of time required between dives (CDFW 2019). Divers may fish alone, in pairs or small groups and/or assisted by a crew member or "tender," on relatively small vessels (mean = 28 ft, median = 26 ft). Whereas some divers own the boat they work from, others are (non-owner) "walk-on" divers who work from a vessel owned by another person. Trips focused on coastal fishing grounds relatively close to port typically last a day, with trips to more distant locations along the coast or out to the islands off southern California lasting two to three days.

At the end of a fishing trip, divers return to port and unload their catch, typically to dockside buyers who process, then package and distribute it, although some of the catch is sold live (Figure 2). As in most other fisheries, trip earnings (revenues) are distributed to the boat, diver(s) and tender using a share system, with allocations specific to each operation and based on a number of factors.

For processed urchin, after the catch is weighed dockside, the urchins are stored in coolers, then processed one to three days later by shoreside workers who crack, clean and pack the urchin for distribution and sale. Historically, the product has gone to both international and domestic markets, reaching customers primarily through restaurants and retail stores that sell a variety of seafood products.[4] With the decline in international markets for California urchin over the past two decades, producers have increasingly focused and relied on domestic markets. In addition, an increasing number (albeit quite small) of divers handle some of their own catch, selling live urchins directly to consumers and high-end restaurants.

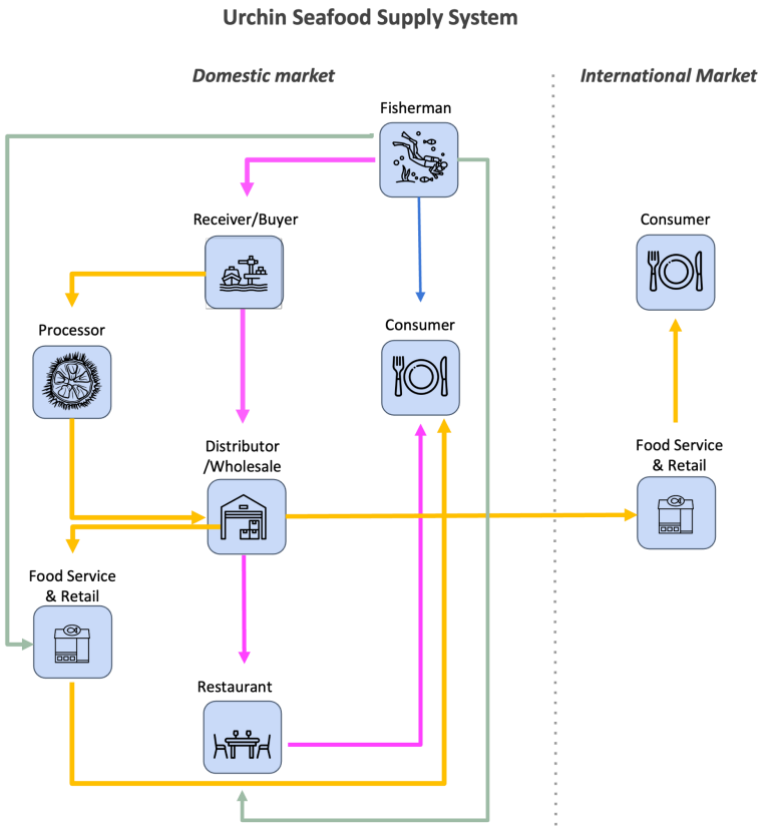

Figure 2. California urchin seafood supply system. The colored lines represent different seafood supply pathways: yellow represents the longest pathways, with processors transforming the urchin to products that are then moved through the seafood supply chain; pink represents a shorter supply chain for handling and distribution of live unprocessed product; gray represents the shortest and most direct supply chain, with fresh live urchin transferred (sold) directly by the diver to restaurants, retailers and/or consumers. (Adapted from McVeigh et al. 2023. Icons sourced from The Noun Project. See credits at the end of this document.)

[4] See the California Sea Urchin Commission website for information about the four main attributes of uni quality - texture, freshness, color and taste - which are used to determine the market grade - California Gold, Premium California and Select California - and the types of products each is typically used for.

The fishery is managed by the California Fish and Game Commission (FGC) and CDFW. It is open year-round, with management measures including statewide gear/method specifications, a logbook requirement for divers, along with minimum size rules and closed days each week specific to the southern and northern fisheries. Following a moratorium on permits in 1987, a restricted access urchin dive permit program was implemented in 1989, along with an unrestricted urchin crewmember permit requirement for those handling the catch on the boat. A capacity goal of 300 dive permits, established in 1989, was reduced to 150 permits in 2017.[5] Urchin dive permits are not transferable and new permits are issued via a lottery when 11 permits are retired or not renewed.

The California sea urchin industry has been substantially involved in guiding the management of the fishery, beginning formally with the establishment of the CDFW Director's Sea Urchin Advisory Committee in 1987. The California Sea Urchin Commission, established in 2004, significantly expanded the scope of industry engagement in management and other relevant activities.[6]

Recent Patterns and Trends in the Fishery Statewide

From 2010–11 through 2020–21, statewide commercial fishery landings at California ports for all species combined averaged more than 270 million pounds, with an ex-vessel (dockside, inflation-adjusted) value of about $248 million per year (Table 2). On average, an estimated 2,089 commercial fishermen, 1,986 vessels and 650 first receivers ("buyers") per year accounted for this activity. During the same period, the statewide urchin fishery accounted for an annual average of 2.9% and 3.8% of pounds landed and ex-vessel value, and active divers, boats and buyers accounted for an annual average of 8.1%, 5.6% and 6.6% of all active California participants, respectively.[7]

Table 2. Comparison of all commercial fishery activity and red sea urchin dive fishery activity in California. Dollar values are for US$, adjusted for inflation using base year 2022. (Source: CDFW data.)

	All fisheries		**Red urchin fishery**	
	2010–20 average	**2020**	**2010–20 average**	**2020**
Landings (pounds)	270,047,273	107,900,000	7,956,364	1,687,022
Ex-vessel value	248,478,182	159,420,000	9,387,273	5,009,915
Price/lb	0.92	1.48	1.57	2.97
Fishermen	2,099	1,959	171	111
Boats	1,986	1,866	112	78
Buyers	650	749	43	26

[5] The state issued more than 900 dive permits under the 1987 moratorium and 644 restricted access permits in 1989. By 2010, that number declined to 308 dive permits. (See CDFW's License Sales Statistics.)

[6] See CDFW (2019), Halmay (2009) and the Urchin Commission's website for more information on its history and work.

[7] Active divers are defined as those permitted divers with at least one urchin landing during that period. While the data we worked with cannot be used to reliably account for permitted crew active in the urchin fishery, the landings data do enable estimation of landings they make in other California fisheries.

Fish tickets	63,392	47,575	9,086	3,674

The number of urchin dive permits sold by CDFW averaged 305 from 2010-11 through 2015-16, then declined to 246 by 2020-21, with the percentage of permitted divers that were active in the fishery peaking at 68% in 2012–13, then declining to 48% by 2019–20 (Figure 3). Urchin crew permit sales increased from 192 in fishing year 2010 to 260 in 2014-15, then declined steadily to 211 in 2020-21; note, however, that the commercial fisheries data do not indicate how many of those permitted crew were active in the fishery.

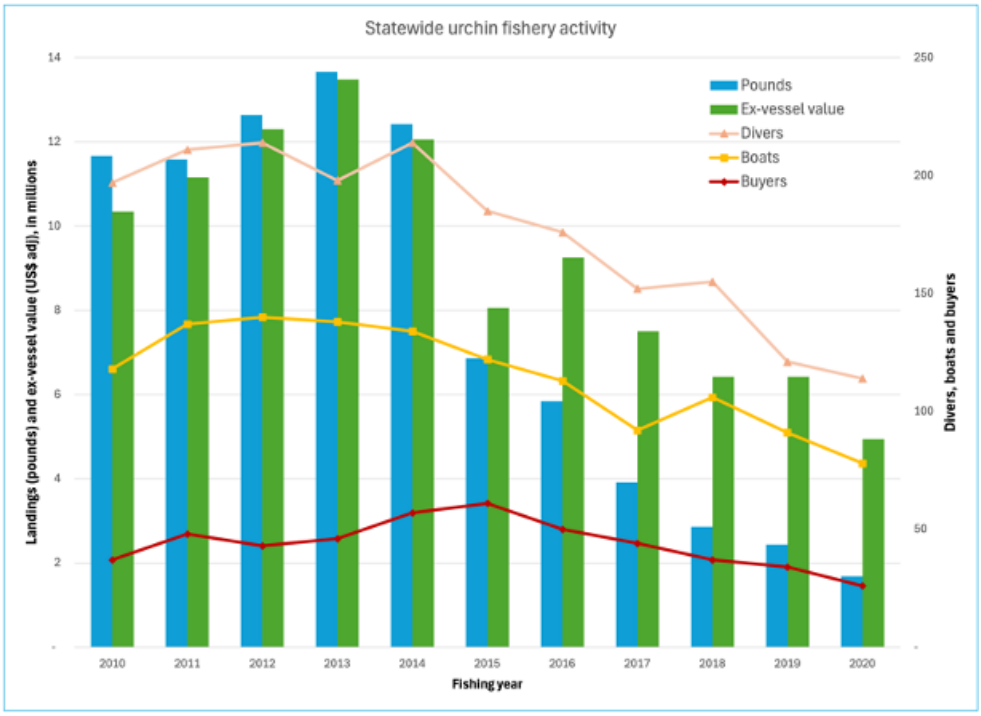

Figure 3. Statewide California red sea urchin dive fishery activity, commercial fishing years, 2010–11 through 2020–21. (Source: CDFW data.)

Overall, urchin fishery activity peaked in the fishing year 2013–14, then declined through 2020–21. Many factors contributed to these outcomes including the implementation of state marine protected areas (MPAs; 2012 onward), sea star wasting disease (2013 forward), the marine heatwave (2014–17) and associated kelp loss, a purple urchin population "explosion" in multiple areas off the California coast and islands, harmful algal blooms which led to abalone die-offs[8], tariffs (especially 2017 forward) and the Covid-19 pandemic (2020 forward).

[8] Abalone have long played an important social, cultural and economic role in the North Coast – and especially the Mendocino and Sonoma county – economies. See, e.g., Reid et al. (2016) and Rogers-Bennett and Catton (2019).

Recent Patterns and Trends in the Northern and Southern Fisheries

There are notable differences between the northern and southern fisheries' environmental, socioeconomic, operational and regulatory circumstances. They differ in their management measures (e.g., size limits, season structures), abundance and maximum sustainable yield (MSY), and harvest rates (CSUC 2018). And whereas Mendocino County is the primary locus of activity in the northern region, followed by Sonoma and San Mateo counties, the southern fishery is active off the coast of all the region's counties and at the offshore islands. These regional differences are due in large part to particularly challenging environmental and logistical considerations in the north, which limit activity at sea and shoreside.

The two fisheries also differ in the nature of and access to markets. The southern fishery occurs near larger, more socio-culturally and economically diverse urban centers and markets. With its proximity to Los Angeles and San Diego area airports, the southern fishery also has greater access to international and out-of-state markets. By contrast, the northern fishery's landing sites are more remote and typically 3–4 hours' drive to the San Francisco Bay area and its airports.

Historically, the southern fishery has accounted for significantly more activity and production than the northern fishery (Figure 4, Table 3). For example, over the study period, the southern fishery accounted, on average, for about 70% of landings and 75% of ex-vessel (or dockside) value (EVV) per year, and 4 to 6 times as many divers, boats and buyers, compared to the northern fishery. At the individual level, however, annual landings and EVV per diver, boat and buyer in the northern fishery over the study period were, on average, greater than those for participants in the southern fishery. This pattern shifted mid-decade, even as activity in both the southern and northern fisheries declined substantially. By 2020, average landings and EVV per participant in the southern fishery exceeded those in the northern fishery.

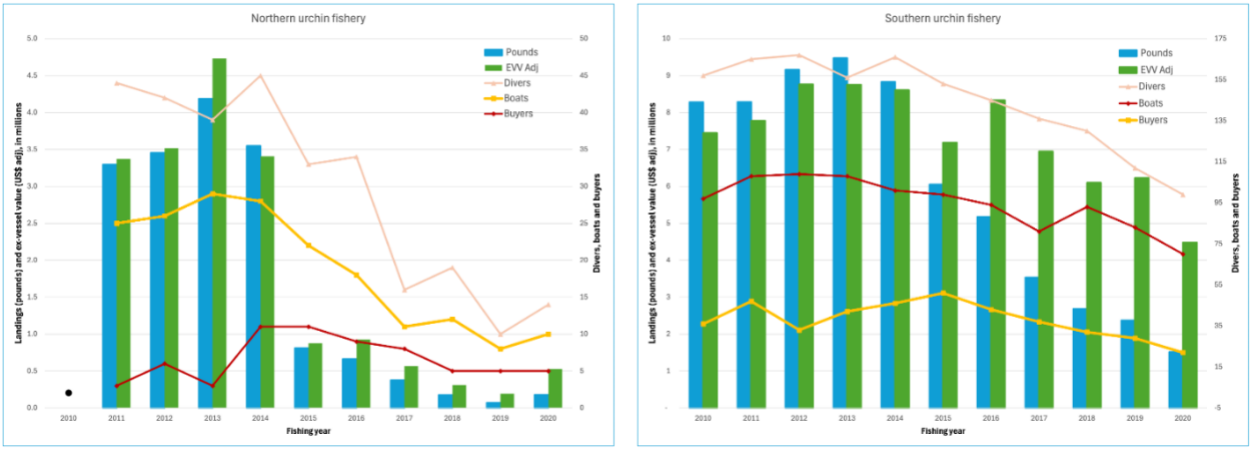

Figure 4. Northern and southern red sea urchin fishery activity, by commercial fishing year (April–March), 2010–20. "●" indicates confidential data due to > 0 and <3 divers, boats and/or buyers. (Source: CDFW data.)

Table 3. Commercial red sea urchin fishery activity by region, northern and southern. Dollar values are US$, adjusted for inflation using base year 2022. (Source: CDFW data.)

	Northern fishery		Southern fishery	
	2010–20 average	2020	2010–20 average	2020
Landings (pounds)	1,829,657	176,232	5,941,242	1,510,790
Ex-vessel value (US$)	1,939,326	528,616	7,326,338	4,481,300
Price ($/lb)	1.51	3.00	1.57	2.97
Divers	31	14	144	99
Boats	19	10	95	70
Buyers	6	5	38	22
Tickets	1,625	412	7,460	3,262

The two fisheries also differ in their participants' dependence on the fishery relative to other fisheries.[9] Whereas most divers, crew and buyers in the northern fishery specialize in and are highly dependent on the urchin fishery, those in the southern fishery typically are more diversified, with other small-scale invertebrate fisheries such as lobster and sea cucumber along with fishing for various finfish species.

The Northern Fishery

Fisheries—both commercial and recreational—have long been central to the identity and socioeconomic wellbeing of North Coast port communities. (See, e.g., Norman et al 2007, Pomeroy et al. 2010.) The commercial urchin dive fishery has figured prominently, especially at Mendocino County's Noyo Harbor (Fort Bragg), with Albion and Point Arena playing an important, if variable, role as well. Since the mid 2010s, Pillar Point Harbor in San Mateo County has accounted for an annual average of about 16% of EVV in the northern fishery. Bodega Bay in Sonoma County also has been the site of urchin fishery activity, though at a much lower level and less consistently during the study period, averaging about 2% of EVV. The Greater Farallones Association (GFA) and Greater Farallones and Cordell Bank National Marine Sanctuaries (GFNMS and CBNMS) lead kelp restoration efforts at Fort Ross Cove and Timber Cove. Part of this effort includes purple urchin removals by commercial urchin divers. Urchins are landed at Bodega Bay, unloaded by a local fish receiver and purchased by the GFA to be composted.

The Northern Fishery's Social System

The northern fishery's social system ("the affected environment" in impact assessment terms) includes people, businesses, government entities and other organizations that play one or more roles in the fishery (Figure 5). Fishery participants include fishermen—divers and crew (or tenders)—and fish businesses—unloaders/receivers, processors, wholesalers, and those who provide urchin products to

[9] This comparison is primarily limited to consideration of other California fisheries, as the CDFW data only pertain to activity associated with landings at California ports. However, as interviewees and other sources of data indicate, some participants in California's urchin fishery also participate in fisheries outside the state.

consumers. They rely on one another and fishery-support businesses locally and further afield that provide goods and services necessary for safe, effective and profitable activity. In turn, those fishery-support businesses depend on the urchin fishery and seafood supply system.

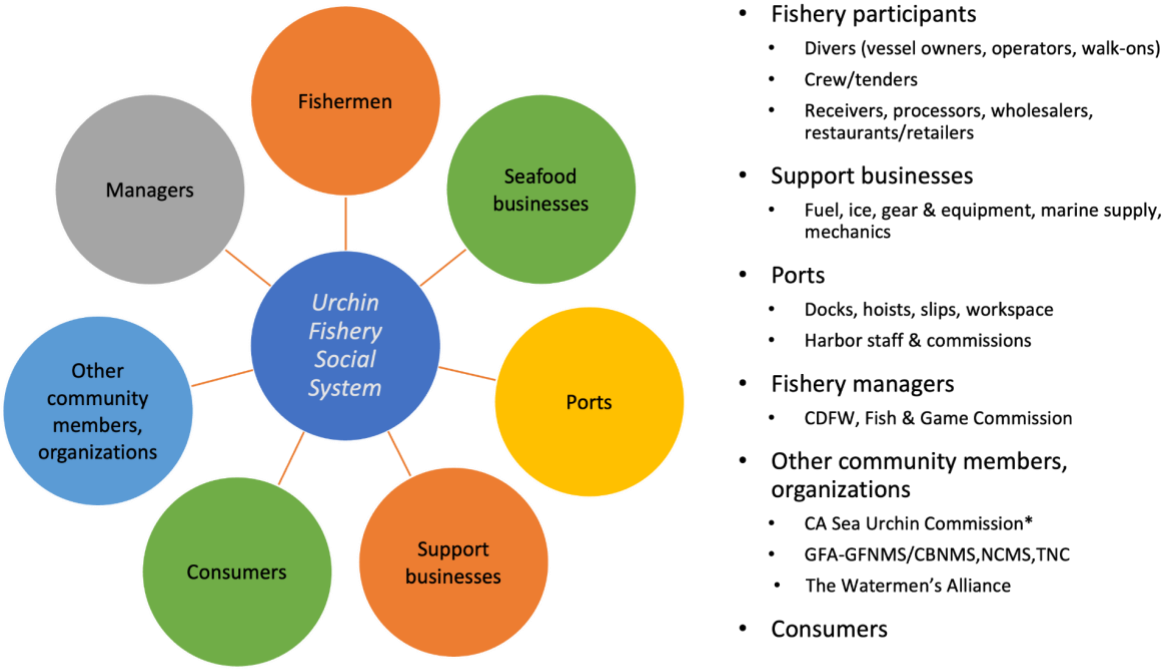

Figure 5. The northern California commercial red sea urchin fishery social system. (GFA-GFNMS/CBNMS = Greater Farallones Association-Greater Farallones National Marine Sanctuary/Cordell Bank National Marine Sanctuary, NCMS = Noyo Center for Marine Science, TNC = The Nature Conservancy)

The total number of permitted divers based in northern California counties dropped by about 18% from an annual average of 82 for 2010–15 (pre-disaster) to 68 for 2016–20 (since the disaster). About half of permitted divers (41) based in the north were active during the first period, dropping by more than half to about 19 divers (28% of permitted divers) during the second period. Between the two periods, the average annual number of crew permits dropped by half, from about 61 to 31. (As noted above, the CDFW landings data do not account for crew active in these operations.)

Most divers involved in the northern fishery reside in the region, typically in the county where they land the greatest proportion of their catch. Divers, on average, are about 17 years older (~54 years old) than crew (~37 years old). While the average age of divers has increased modestly, the median age of divers increased from 52 in 2010 to 59 for active divers and 61 for inactive divers in 2020. This provides some evidence for the "graying of the fleet" seen in many – especially restricted access – fisheries. Almost all divers and crew are male, although some women have participated in the fishery.

The number of vessels participating in the northern fishery dropped from a high of 29 in 2013 to a low of 6 in 2020, with an annual average of 25 during 2010–15 to 11 during 2016–20. The vast majority—about 80%—of these vessels are homeported in Mendocino County and especially at Noyo Harbor (Fort Bragg), with the remainder based primarily in Sonoma and Marin counties.
A total of 25 unique fish businesses received red sea urchin in the northern fishery between 2010 and 2020, ranging from fewer than 3 in 2010 to 14 in 2015 and averaging 6 per year throughout the study period. Most of these fish businesses are based in the northern fishery region and hold multifunction fish business licenses, enabling them to receive, process and sell the catch.[10] Some hold more limiting types of fish business licenses (e.g., receiver, fisherman's retail). With the exception of the two resident urchin processors at Noyo Harbor, fish business participation in the northern fishery has been highly variable from year to year, with three to five businesses accounting for more than 95% of the annual EVV of urchin landings.

The primary ports associated with the northern urchin fishery are Fort Bragg, Albion and Point Arena, but also include others such as Bodega Bay and Half Moon Bay/Pillar Point Harbor. These ports differ in many ways, including their governance, which influences their authority, access to financial resources, and other capacities to support the fishery (Table 4) (Pomeroy et al. 2024). They also vary in the infrastructure, goods and services they provide. Since about 2010, Fort Bragg's Noyo Harbor has not had a serviceable fuel dock, which is essential for all motorized vessel operations, but has two resident urchin buyers and associated facilities to support the fishery. Albion has very limited infrastructure: a riverfront dock with side ties, an unloading platform, and a hoist, all of which have fallen into disrepair. Point Arena has a pier with two hoists, one of which is used for launching and retrieving boats up to 25 feet in length, with a second hoist used for unloading the catch and loading/unloading gear.

Table 4. Urchin fishery-relevant infrastructure, goods and services at ports, north to south, where the northern red sea urchin fishery operates (Pomeroy et al. 2010, 2024).

Port	Governance Authority	Fuel	Ice	Resident urchin buyer	Public hoist	Live storage	Cold storage
Ft Bragg	Independent Harbor District	No*	Yes	Yes	Yes	Yes	Yes***
-Albion	Private	No	No	No	No	No	No
Point Arena	City	No	No	No	Yes	No	No
Bodega Bay	County	Yes	Yes	Yes**	Yes	Yes	Yes***
San Francisco	City & County	Yes	Yes	No	Yes	Yes	Yes
Pillar Point Harbor	Independent Harbor District	Yes	Yes	No	Yes	No	Yes

[10] See https://wildlife.ca.gov/Licensing/Commercial-Fish-Business/Descriptions for more information about fish business license types.

* Dolphin Isle Marina, located upriver from Noyo Harbor, has a fuel pump, but the marina is inaccessible to boats >25' in general and to all boats at low tide.
** Previously a buyer consistently bought red urchins from divers. Current unloader does not (yet) have experience with red urchin, but unloads purple urchin for the GFA-GFNMS/CBNMS-led project.
*** Limited cold storage operated by resident buyers.

These ports along with local and out-of-area businesses and other entities provide infrastructure, goods and services necessary for the safe and productive operation of the fishery. For fishermen, these include docks, hoists and work space along with providers of fuel, gear and equipment, and various services for maintaining operations. Whereas some divers rent slips (e.g., at Noyo Harbor), others trailer their boat to port (e.g., Point Arena) or other launch sites, requiring parking for their truck and trailer and a boat hoist or launch ramp. Divers and crew also require specialized gear and equipment – including custom wetsuits and other dive gear, urchin rakes and bags, and hookah gear and onboard compressors. These, in turn, require maintenance and repair services. Urchin buyers (including fishermen who handle their own catch) and processors also require port infrastructure such as docks, hoists, and cold storage for holding urchin prior to and after processing. They also require processing and packing equipment, supplies and services. While some of these goods and services are available from local providers, much of it is available - and increasingly must be found - in the San Francisco Bay area or ordered online.

Commercial Fishery Activity Pre- and Post-Fishery Disaster

To gain a sense of the cumulative impacts of these events and illustrate the substantive changes in the fishery statewide and then the northern and southern fisheries, we compared annual average measures of fishery activity for two periods: prior to (2010–15) and during (2016–20) the fishery disaster (Table 5). Between the first and second periods, participation of divers, boats and buyers dropped by 30.6%, 27.6% and 23.4%, respectively. Fishery output declined even more in terms of pounds landed, ex-vessel value and the number of fish tickets, down 73%, 38.9% and 50.7%, respectively. Although average annual ex-vessel price increased more than two-fold, average annual landings, ex-vessel value and tickets per diver, boat and buyer declined significantly between the two periods. Even so, the statewide fishery did not meet the criteria for a fishery disaster declaration: an 80% drop in ex-vessel value compared to the average of the previous five (non-disaster) years. (See the next section for comparison of the northern and southern fisheries.)

Table 5. Percent change in annual average fishery activity metrics for California's red sea urchin fishery, pre-fishery disaster (2010–15) and since the onset of the fishery disaster (2016–20), statewide and by fishery region. Cells shaded in pink highlight losses > 80%; cells shaded in yellow highlight losses between 35 and 80%.[11] (Source: CDFW data.)

[11] Whereas we focus on comparing the two five-year periods for the fishery, NOAA's fishery disaster determination process compares a fishery's economic losses *in a single year* to the annual average of the previous five non-fishery disaster years. Losses > 80% typically qualify for a fishery disaster declaration; where economic losses are between 35 and 80%, NOAA will evaluate the situation to determine whether economic impacts are severe enough to determine that a fishery resource disaster has occurred. See https://www.fisheries.noaa.gov/national/resources-fishing/frequent-questions-fishery-resource-disaster-assistance, accessed 8/27/24.

	Statewide fishery	Northern fishery	Southern fishery
Pounds	-73.0%	-91.0%	-66.2%
Ex-vessel value (US$)	-38.9%	-83.8%	-21.4%
Fish Tickets	-50.7%	-73.0%	-44.9%
Divers	-30.6%	-56.1%	-25.5%
Boats	-27.6%	-52.0%	-22.1%
Buyers	-23.4%	16.7%	-27.9%

Both the northern and southern fisheries experienced significant declines in average annual diver and vessel participation along with landings, ex-vessel value and fish tickets between the two periods. The declines in the northern fishery were much greater than those in the southern fishery. The one exception was the percent change in the average annual number of buyers, which increased slightly in the northern fishery while it decreased in the southern fishery. The increase in the northern fishery is due in part to some fishermen obtaining fish business licenses (e.g., fishermen's retail) to handle some of their catch. Although increased average price per pound in the southern fishery helped to offset the decline in landings, average ex-vessel value of the landings in that region still declined by more than 21%. However, the northern fishery was hit particularly hard, not only clearly meeting the criteria for a federal fishery disaster declaration, but also experiencing a range of profound losses and changes.

How the Northern Fishery Disaster Unfolded

To contextualize fishery disaster responses, impacts and implications for the northern urchin fishery and associated port communities, we first sought to understand how the fishery disaster unfolded. Interviewees variously discussed their observations of environmental change while fishing and/or handling the catch. As has been noted in other work as well, they spoke about significant changes in the ecosystem including declines in the abundance and distribution of kelp, abalone and sunflower sea stars (*Pycnopodia helianthoides*):

> *We started seeing the disaster in 2014. We saw the Pycnopodia dying and saw everything getting bad - no kelp, starving and dying-off abalone and all that.*

> *I remember one of the divers telling me it was in 2014, he said, "Man, the bottom is changing. It looks like it's dying." And they were still doing good on the urchin because the last of the good kelp was still around. But after the storms of that winter coming into 2015, the kelp never really came back like that ever again, ever since. So then I guess that's what led to that disaster… 2015 was sort of transitional, I mean, in that the shallow urchins were no longer any good...*

Although the changes observed were remarkable, prior experience led some to view them as consistent with commonly observed and experienced cycles. The region's bull kelp (*Nereocystis luetkeana*) had become less abundant in the past, for example during the 1982–83 and 1997–98 El Niño events, which negatively affected the abundance and availability of urchin to the fishery along with its market quality.

As cooler water temperatures returned, environmental conditions and the fishery improved again. But with the 2014–17 marine heatwave, things were different:

> *You know, the kelp comes back. [The current conditions] kind of came in waves, you know, there was a couple of years of poor conditions, El Niño conditions, and then it just got worse and worse.*
>
> *But in 2013, '14, around that time, the kelp didn't come back. It's an episodic, that means now and then it comes and it grows here and there and yeah, sometimes not at all. But those years, the kelp was just gone.*

Interviewees said that it took some time for the larger community to realize the severity of decline in the fishery, attributing it in part to the fishery not having as high a profile compared to other local and regional fisheries and the very limited local market for and consumption of urchin in local seafood is relatively limited.

> *We were telling our processors, I was telling people I knew and nobody believed it until Fish and Game closed the recreational abalone... And I told them, I've been talking about [urchins declining] for like 2 or 3 years now, and nobody cared. And it's just … because of what our industry is. There isn't a general benefit to the community. So crab fisheries, everybody gets excited because it's like, "Oh, I want to go get some sport crab. I want to buy crab, salmon - oh, I want to go buy some fresh salmon." Urchins is [sic] year round. Nobody wants to go buy urchins. It's just not something that … the typical American doesn't eat sea urchins, right?*

At the same time, interviewees noted changes in abundance, distribution and behavior of both purple and red urchin. With declines in kelp and *Pycnopodia*, purple urchins became more abundant and voracious, exacerbating the kelp loss in nearshore waters and seeming to out-compete red urchins. Divers found that the abundance of red urchins on the fishing grounds they had worked for years declined significantly, with no clear indication that either would rebound as they had following previous warming events.

> *Yeah. It's hand in hand. Like I said, we started seeing the disaster [in] 2014. We saw the Pycnopodia dying and saw everything getting bad. No kelp, starving and dying-off abalone and all that.*
>
> *Returning to the same areas where kelp would be and the urchins next to kelp, well, the kelp was gone. So I'd go out deeper and find kelp on the outer edge. They [the purple urchins] were eating the holdfast and everything that was left. And meanwhile I'm starting to work 50 and 60 foot [depths]*.

Responses to and Impacts of Declining Red Urchin Availability

Urchin fishing requires gear, equipment, knowledge and skills that are distinct from most other fisheries. Shoreside handling, processing and marketing likewise stand apart. Moreover, those involved in the northern fishery tend to be more specialized than their southern counterparts, with livelihoods that historically have been tailored to and highly dependent on the urchin fishery. This, in turn, affects responses to and impacts of the fishery disaster.

Initially, divers, crew and buyers responded to the emerging fishery disaster by coping – "riding it out" – continuing to participate in the fishery as they had done for as long as possible even amid substantial economic loss.

> *We kept going. We have so much invested in this. Myself, especially, I mean, I have so much invested with all the gear and the boat and everything. I couldn't just switch over to something else. So I stuck through it and I kept diving.*

Some made short-term adjustments to their urchin fishery practices and/or other parts of their lives. For divers and crew, such adjustments included experimenting with running to areas further from port and/or diving in deeper water:

> *Well, for a while we did fairly well diving really shallow. In fact, I had a couple of my best years when I got back diving on another guy's boat. Um, diving really shallow. It's rough conditions, but we were finding good urchins and then it got to where we couldn't find good quality, and began to go farther and farther afield. Went up to Westport. We were diving the last bits of kelp that we could find.*

> *2015 was sort of transitional, I mean, in that the shallow urchins were no longer any good, but it kind of forced, the divers went looking around more, and they found urchins way out in the deep. I want to say way out. I mean, like 70, 80, 90, 100ft. Where before they were used to working, you know, 15 to 50 feet.*

Diving in particular, takes a heavy toll on fishermen's health – risking decompression sickness ("the bends") and more. This coupled with the marked and persistent decline in urchin abundance and availability reportedly contributed to some divers exiting the fishery altogether:

> *We started losing divers. I mean, there weren't people diving out of Point Arena anymore. There weren't a lot of people diving out of Albion anymore. Bodega Bay had pretty much shut down. I think there was only one guy diving out of Bodega Bay.*

The relatively few northern fishermen with access (permits), appropriate vessels, gear, equipment, experience and a market for their catch in other fisheries shifted to (or increased their participation in) other fisheries:

I kind of had to, but like I say, being diversified makes it pretty, you're always bouncing back and forth, and that's pretty much the secret to commercial fishing anymore. You've got to have a lot of different throwbacks to go to.

Based on the CDFW landings data, the other fisheries urchin dive permittees participated in primarily included sea cucumber, nearshore rockfish, salmon and sablefish. However, the revenue from these fisheries remained quite low throughout the study period and did not make up for the sharp decline in urchin revenue. Northern crew permittees participated in (and earned revenue from) other fisheries including Dungeness crab, salmon, sablefish and other groundfish species. While the ex-vessel value of their landings declined overall from 2011 through 2015, it increased in 2016 and varied thereafter.[12]

For locally based buyers, coping meant being ready to unload divers and handle the catch if and when fishermen delivered it to the docks. As with divers, buyers with experience in and capacity to handle other species and products likewise discussed coping, having adapted their operations previously. One southern California-based buyer noted:

As the volume's gone down, you know, the overhead per pound has kind of gone up, right? That's one of the reasons I had to diversify. Because I had my El Niño in '98 and all of a sudden there's no market in Japan and the sea urchins weren't very good. So my numbers didn't work, you know, and so that's when I diversified and started buying more seafood.

As conditions persisted into 2016 and the scale of the unfolding fishery disaster became more clear, responses shifted from coping to adapting. Fishermen began to adapt by making more substantial and/or long-term changes to their fishing operations and practices. These included two or more divers teaming up and tending each other rather than having a designated urchin crewmember or, in some cases, fishing alone (without a tender on the boat) to reduce costs. Divers also would travel further and dive lesser known or unknown areas and deeper depths on a regular basis. Shoreside, some divers also worked to develop more direct markets as a complement or alternative to delivering their catch to traditional processors.

Some divers and processors also directed their knowledge and skills toward kelp restoration activities, most notably purple urchin removal, through various collaborations with the GFA-GFNMS/CBNMS at Bodega Bay, The Nature Conservancy (TNC) and the Noyo Center for Marine Science (NCMS) at Fort Bragg and the Watermen's Alliance at Caspar Cove. These efforts have variously provided some modest income in addition to covering expenses for a small number of fishery participants.

The whole start of this kelp restoration work was really a subsidy, so we still were diving and picking urchins out deep for food market product … but it wasn't the same amount

[12] CDFW landings data do not identify crew other than the licensed commercial fisherman reporting landings on a fish ticket and each fishing operation has its own system for allocating costs and earnings,making it difficult to depict and interpret the landings data for these fishermen and fishing operations.

of money we used to make and it was getting harder and harder. So any little bit of kelp restoration work we could do, it was a really great subsidy.

For shoreside buyers and processors, adaptations included, for example, reducing core staffing with owners and remaining staff stepping in to cover many urchin handling tasks. With fewer and smaller deliveries, one northern processor adjusted work schedules so that urchin handling and packing could be done before workers headed to other (more regular) daytime work. In addition, shoreside buyers reported holding live or processed urchin longer before distributing it or having an out-of-area wholesaler pick it up to then continue to move it through the seafood supply system. Processors adapted by diversifying into other fisheries – unloading various species (other urchin) for out-of-area buyers or participating (or increasing their participation) in urchin fisheries outside the state. As one noted, "Processors have a lot more overhead so they can't just take a vacation" when the local fishery slows down.

For Mendocino County's ports and fishery-support businesses, ongoing changes in the area's commercial and recreational salmon and groundfish fisheries and the recreational abalone fishery[13] had resulted in reduced activity at the ports and among local fishery-support businesses (Pomeroy et al 2010, Reid et al. 2016). At Noyo Harbor, these included closure of the fuel dock (owned and operated by an urchin processor) and the local dive shop, along with the continuing decay of the ice facility.[14] At Albion, the privately owned campground increasingly relied on recreational visitors – less there to fish as in decades past and more to enjoy the remote coastal setting – and reduced efforts to maintain the commercial dock and unloading facilities. At Point Arena, the City, which owns and operates the pier, coped by relying on other fisheries (which also face serious challenges) and tapping into its general fund to offset the shortfall in urchin fishery-related revenue (Larson 2019).

In response to these and other challenges, Noyo Harbor administration has initiated or joined efforts to secure funding support from the State Coastal Conservancy and other state and federal sources to help address some of these impacts and issues. It also has co-founded a regional partnership, the Noyo Ocean Collective, focused on understanding and addressing opportunities to reinvigorate the region's ocean economy.[15] And in 2023, amid persistent and increasing challenges related to fisheries, sea level rise and other issues, the City of Point Arena secured State Coastal Conservancy grant funding "to prepare the Arena Cove Harbor Access and Resilience Plan, which will include plans, designs, and

[13] The socially, culturally and economically important North Coast recreational abalone fishery declined significantly following a 2011 harmful algal bloom (HAB) off Sonoma and Mendocino counties that killed thousands of abalone (Reid et al. 2016). Stricter regulations were implemented in 2014 and the fishery was closed in 2017.

[14] In the interim, a local fish business owner has stepped in with funding and labor to help maintain it. Another fish business also owns and operates a smaller ice machine, providing ice to others on a limited basis.

[15] Founding members of the Noyo Ocean Collective include the City of Fort Bragg, Noyo Harbor District, Noyo Center for Marine Science, Mendocino College, Sherwood Valley Band of Pomo Indians and West Business Development Center. See https://noyooceancollective.org/, accessed 9/1/24.

environmental review for a variety of improvements to protect and enhance existing and future use of the Point Arena Pier, Harbor, and Cove for commercial and recreational purposes."[16]

In addition to the impacts on fishery participants, support businesses and port communities, the fishery disaster has also affected the CSUC and CDFW. The urchin industry assesses its landings per pound to fund the CSUC's work on their behalf. The CSUC's work includes funding and participating in research on the resource and the fishery; developing management alternatives, educational and marketing programs; and advocating for the industry. For fishing year 2013-14, the industry assessed itself $0.01 per pound of urchin landed, generating more than $136,000 statewide, including more than $94,000 from the northern fishery, to support the Commission's work. As the fishery disaster continued, the funds generated declined to less than $51,000 by 2020-21, based on the assessment rate (increased in 2019) of $0.03 per pound. This meant an overall decline of more than 70% statewide and more than 90% for the northern fishery between the pre-disaster and post-disaster periods, straining the CUSC's resources and its efforts.

The decline in urchin fishery activity likewise has meant a decline in fishery-related revenue to CDFW. Urchin landings are assessed $0.047 per pound by the state, generating more than $64,000 statewide and nearly a third (nearly $20,000) from the northern fishery for fishing year 2013-14 and declining significantly after that. CDFW also earns revenue from the sale of general licenses and permits along with fishery-specific permits.

Implications and Concerns

The fishery disaster and its impacts, in turn, have longer-term implications for fishery participants, port support businesses and communities, and the larger fishery and seafood supply system. They have led to destabilization of livelihoods and loss of wellbeing for fishery participants and fish businesses that depend in part or in full on the northern fishery.

Fishery participants and others expressed deep concern about the long-term impacts of losing key fishery-related human, social, financial and physical capital—the people, relationships, money and facilities that make the fishery work. The significant slow-down in fishery activity—fishing, unloading and handling of urchin at the region's historically active ports—has reduced demand for and use of infrastructure, goods and services. This, in turn, has destabilized ports, fishery-support businesses, and their communities.

> *Point Arena (pier) was integral to the sea urchin fishery, …. and that hoist, I mean, the cable broke this year, and dropped a boat…I don't know exactly how it was caused, but maintenance comes to mind. There's just not a lot of money around to keep it going. The pier, you lose that, that's a core to, a pier and hoist and a hub of, some of the best urchin or historic urchin grounds on this north coast.*

[16] https://scc.ca.gov/2023/12/01/press-release-state-coastal-conservancy-announces-awards-for-coastal-resilience-public-access-restoration-and-storytelling/, accessed 8/14/24.

Everything's pretty much gone away on the commercial side. Albion's become a sport fishing dock. It was a really booming place. It had a hoist and, you know, truckloads and truckloads of urchins would come out of there. And, you know, we had maybe 10 boats at one time. But now the dock, the hoist hasn't been used in years and they don't intend to reopen it any time soon. They just upped the dockage fee a couple hundred percent. So the few remaining commercial, the local guys, pulled their boats out of there… but no, locals can't afford it now. So it's a ghost town.... In the summer, it'll be busy, they'll have lots of tourists there.

With the decline of urchin activity at two of Mendocino County's three key urchin ports, Noyo Harbor has become all the more critical for ocean access, unloading, and handling the catch. Both Albion and Point Arena have played critical roles in the fishery, providing access to valued urchin grounds beyond those readily accessible from Noyo Harbor. They also have provided back-up for Noyo Harbor-based operations, as occurred when a fire at a processing plant closed it for several months (Pomeroy et al. 2010). The reduction or loss of such redundancy increases risk not only for urchin fishery participants but also for the larger north coast fishing community.

Similarly, maintaining markets (customers), which require a reliably consistent supply of quality urchin, has become increasingly challenging as well. A number of other factors, including international and domestic economic conditions, availability and quality of urchin from other sources, and consumer demand, also have affected markets for California urchin statewide. As one interviewee noted, "The biggest trauma has been the quality of urchins we have because of the lack of kelp. If we had regular kelp, then I could compete against Mexico and they would not be a problem. But we don't, as we know."

The persistence of poor conditions beyond the 2016–17 fishery disaster, resulting in the 2018-19 declaration, has exacerbated these issues. Moreover, it has added to sentiment among some that the fishery will never be the same along with broader uncertainty about the future of the fishery. A recurring topic among many in the northern fishery is how to maintain the human, social, economic and physical capacities needed and supported by the fishery.

The two biggest "end of days" [challenges] are climate change and kelp loss, which I see as two related things. The other is sea otter expansion. It poses a huge existential threat. If you remove these big impending bombs, then it's more about port infrastructure keeping a robust enough fishery to support multiple processors.

Some interviewees expressed concern about the limited availability of financial and human resources needed to implement/maintain/expand and monitor kelp restoration activities, especially as they require sustained effort. They also expressed concern about the possibility of translocating southern sea otters to the area in general and as a kelp restoration and purple urchin population control strategy.

I don't think predation by sea otters is going to make any difference to the purples, because they're going to be the last thing they eat, the ones on the fringe of the only very little kelp that we have here. And the first thing they'll do is go for all these abalones

that are pushed into these intertidal areas that are completely exposed. That's the only area [with] any organic matter left, and they're completely unprotected from predation by otters. And they would go away instantly along with any red sea urchins left that had any gonad in them. The last thing to go would be the empty purples.

At the same time, growing interest in locally produced seafood and an increase in direct-to-consumer markets have created opportunities to sell smaller quantities of red urchin as a complement rather than replacement for traditional markets. In addition, efforts to enhance purple urchin gonad size and quality to then sell to higher end domestic markets have had some success, although the sustained economic viability of this strategy remains to be seen. Others are focused on the development of new products from purple urchin shells and spines and market feasibility for those products.

Sources of and Ideas for Fishery Resilience

Resilience of the northern fishery to recent and future environmental disruptions hinges on the wellbeing of the fishery's interdependent ecological and social systems. This includes the kelp forest ecosystem and the urchin that depend on it for food *and* the fishery's capacity to harvest, handle and market the catch. In discussions about fishery resilience, interviewees highlighted both of these. Several spoke to the need for, and in many cases their own and others' engagement in, efforts to restore kelp and, by extension, red sea urchin, primarily through purple urchin removal. All spoke to the need to maintain the human, social, economic and physical capacities needed and supported by the fishery.

Fishery participants' responses to the 2016–17 fishery disaster (and since) reveal multiple sources of resilience - key capacities that have enabled them to cope and adapt to dynamic and changing conditions at sea and shoreside. These include experience and knowledge related to fishery operations and practices, ocean ecosystem dynamics, and the seafood supply system, among others. Divers and shoreside operators have diverse skills including professional diving; vessel, equipment and gear maintenance and operation; and locating, collecting and handling urchins and other species. They also have demonstrated creativity, ingenuity and problem-solving, for example, developing tools and strategies for use in purple urchin removal.

With the fishery disaster, many have redirected these capacities to kelp restoration activities, thereby addressing the twofold and interdependent challenges of restoring the fishery's ecological system and maintaining its social system. They have applied their diverse skills, honed over decades, to efficiently remove purple urchins, often in collaboration with other NGOs. In addition, some have developed and tested tools to more thoroughly and effectively reach and remove smaller purple urchins. They also have sought to share their knowledge of the ocean environment with recreational divers, researchers, and agency and environmental NGO staff.

Recommendations for Improving Fishery Resilience

We distilled seven recommendations for improving the resilience of the northern commercial red urchin fishery from the information shared through the interviews, discussions leading up to and during the February 2024 workshop, and discussions at a July 2024 seminar with agency staff, fishery participants

and fishing community members. We first grouped these into themes, which reflect key needs of the fishery and the fishing community (Box 1), and then developed recommendations. We presented these recommendations and received feedback from agencies, northern commercial fishery participants and community members, and other key stakeholders at the July 2024 seminar.

Below we briefly discuss the seven recommendations (summarized in Box 2), including the motivating needs, challenges and considerations related to their feasibility, examples of current efforts to address them, and suggestions for next steps to advance the recommendations. Although these recommendations are based primarily on our work with the northern fishery, we understand that the needs are cross-cutting between the northern and southern fisheries, as the southern fishery has faced similar, if somewhat less disruptive, challenges.

Box 1: Key Needs of Fishery Participants and Community
Fishery-support infrastructure
Sustaining industry capacities
Fuller engagement in kelp restoration research
Fishery management accommodations
Alternative markets or marketing strategies

Box 2: Recommendations

1. *Prioritize support for efforts to repair, renovate, and/or replace and ensure access to fishery-support infrastructure on working waterfronts.*
2. *Facilitate connections to explore and encourage collaborative research and restoration activities among fishery participants, researchers, and managers.*
3. *Develop programs to attract new divers as a way to maintain fishery-related knowledge and skills into the future.*
4. *Adjust fishery management measures to increase flexibility of fishing.*
5. *Explore experimental permits for purple urchin collections to expand diver opportunities in kelp restoration.*
6. *Support efforts to minimize or mitigate risk for fishery participants.*
7. *Explore additional uses, markets, and marketing strategies for purple and red urchins.*

1. ***Prioritize support for efforts to repair, renovate and/or replace and ensure access to fishery-support infrastructure on working waterfronts.***

The need: Access to well maintained, functional port infrastructure is a common need and concern across commercial fisheries in California (Culver et al. 2007, Pomeroy et al. 2010). Such infrastructure needs include: docks and slips, hoists for unloading the catch and for loading and unloading equipment, gear and launching small boats (common in the urchin fishery), cold storage (for holding urchin before processing), live storage (for holding urchin until ready for transport to market), and fuel docks. The most pressing infrastructure needs at the northern fishery's primary ports (i.e., in Mendocino County) are a functional fuel dock at Fort Bragg[17] and safe, reliable physical infrastructure for launching and landing. Recent and ongoing efforts to document the status of infrastructure across California ports (e.g., Culver et al. 2007, Drakopulos and Pomeroy 2021, Pomeroy et al. 2010, 2024) can be used along with the results of this project to support and enhance ongoing efforts to identify and prioritize needs for maintenance, repair, replacement and new construction. Continued and enhanced collaboration among port managers, fishery participants and other harbor users to identify, prioritize and secure funding to address local infrastructure needs is vital. Coordination with nearby ports to provide some redundancy of urchin (and broader) fishery-support infrastructure is essential for mitigating problems (e.g., breakdown of hoists) at any one port. In addition, especially given the northern urchin ports' limited resources, state and federal acknowledgement of these needs along with financial and logistical assistance could – and in fact has begun - to help advance local and regional efforts.

Challenges and considerations: Repair, replacement or improvement of existing infrastructure requires financial resources beyond those needed for basic harbor operations. Grants, loans and, for public harbor entities such as cities, counties or harbor districts, bonds or other types of public funding are available but can be quite competitive. Planning, permitting and construction also require considerable additional time, effort and capacities on top of substantial ongoing needs and challenges. At Noyo Harbor, as most of the waterfront property is privately owned, the harbor district's revenue sources and authority to repair or improve fishery-related infrastructure are limited. For example, the harbor district cannot charge wharfage for unloading seafood except at the public dock at south harbor, which it owns. As such, the harbor district and local property owners need to continue and expand efforts to collaborate to address infrastructure needs across the waterfront.

Recent and ongoing efforts: Harbor managers and commissions of the three North Coast counties' largest ports, Noyo Harbor, Eureka Humboldt and Crescent City, are collaborating on efforts to secure funding to help meet local and regional infrastructure needs.[18] In September 2024, the State Coastal

[17] Neither Albion nor Point Arena has had a fuel dock in the past, so divers and other boaters have obtained fuel at facilities that primarily serve non-marine customers.

[18] In 2022, the US Department of Transportation Maritime Administration awarded more than $8 million to Crescent City Harbor District and the Humboldt Bay Harbor, Recreation and Conservation District for infrastructure

Conservancy awarded $750,000 to the Noyo Harbor District to undertake the Noyo Harbor Marina Redevelopment Planning Project which consists of conducting community engagement and a planning study. In addition, as noted above, in 2023, the City of Point Arena secured State Coastal Conservancy grant funding to prepare the Arena Cove Harbor Access and Resilience Plan toward addressing its needs.

The Noyo Harbor Blue Economy Visioning, Resiliency and Implementation Plan development process is a collaborative effort among the City of Fort Bragg, Noyo Harbor District and California Sea Grant, with grant funding from the California Coastal Commission.[19] The process includes work to update the city and county local coastal programs and collect and synthesize information to better understand climate impacts on the environmental, physical, social and economic conditions at Noyo Harbor, fishery-related and other harbor infrastructure needs, and community priorities, then incorporate these into resiliency goals, policies and programs.

Next steps: Noyo Harbor and the City of Fort Bragg and the City of Point Arena are on the way to identifying, prioritizing and addressing site-specific infrastructure needs for the northern fishery at their respective harbors. Expanding this effort to account for the connections with other ports in the region that likewise support and depend on the urchin fishery (and other fisheries) could enhance their respective efforts and resilience to future challenges. In addition, the Noyo Harbor planning effort could be looked to as a potential model for conducting similar assessments of fishery-support infrastructure needs at other urchin fishery ports in the northern region and statewide.

2. ***Facilitate connections to explore and encourage collaborative research and restoration activities among fishery participants, researchers, and managers.***

The need: Collaborative fisheries research involves creating partnerships among fishery participants, scientists, managers and others to design and conduct research to improve fisheries management. Combining these actors' diverse experience, expertise and ideas can lead to the generation of novel information and shared understanding, ultimately leading to better social and ecological outcomes than typically can be achieved by any one group alone. Such efforts related to the state's commercial fisheries have addressed social and ecological information needs for the California halibut fishery (Pomeroy et al. 2016), rock crab and spiny lobster fisheries (Culver et al. 2010; Culver & Pomeroy 2016), and the urchin fishery (Schroeter et al. 2009), among others. Research related to kelp loss and restoration also has entailed varying degrees of collaboration and cooperation among agency and NGO researchers and the north coast fishing community.

projects including fishery-related repair and renovation of a seafood packing and truck loading area and installation of EV infrastructure to power cold storage trailers used to move seafood products to market at Crescent City and repair and replacement of pilings at Eureka's Fishermen's Terminal (https://huffman.house.gov/media-center/press-releases/huffman-announces-over-8-million-headed-to-north-coast-for-port-infrastructure-improvements, accessed 9/11/24).

[19] https://noyooceancollective.org/, accessed 9/11/24.

Continuing and enhancing existing partnerships and building new ones to more fully engage, leverage and integrate the diverse knowledge and capacities of fishery participants, researchers and others can, in turn, enhance the quality and quantity of these efforts. In addition to their experiential knowledge and skills, fishery participants have vessels, gear, equipment and in some cases, shoreside facilities that can be used to support a range of research and restoration activities. Although all may donate some of their time and capacities to collaborative research, equitable recognition of and compensation for the costs of these contributions will help to sustain such efforts. More opportunities for diver involvement throughout the process from the conception of research projects through implementation and monitoring is key to successful collaboration. Additionally, involving new divers, ideally mentored by experienced divers, in research and restoration activities can provide a pathway for maintaining and transferring fishery-related knowledge (Recommendation 3). Creating a mechanism for encouraging and facilitating collaborative research and restoration partnerships related to the northern fishery (and kelp ecosystems), perhaps modeled on or informed by the state's experience with Collaborative Fisheries Research West, an OPC-established program that operated from about 2010 through 2016.

Challenges and considerations: Collaborative research and restoration activities, where fishery participants, researchers and practitioners engage with one another in the design and implementation of research to inform management and restoration activities requires the development and maintenance of relationships based on trust and mutual respect for different perspectives and types and sources of knowledge. Given the distinct cultures (and goals) of researchers, fishery participants and marine conservation practitioners, this can be difficult to accomplish. In addition, there can be practical challenges to conducting collaborative research such as obtaining scientific research permits (depending on the nature of the work; for all participants regardless of their profession), addressing insurance requirements for certain types of work and/or funders, and ensuring adequate and appropriate compensation for collaborators.

For any research or restoration project, various team members may require training, depending on project design and implementation. Training needs may include data collection and/or analysis methods, or how to dive safely and effectively in kelp and urchin areas.

Recent and ongoing efforts: Currently, kelp restoration efforts—including projects led by The Nature Conservancy, Greater Farallones Association and Greater Farallones and Cordell Bank National Marine Sanctuaries, and Reef Check—involve urchin divers in kelp restoration and research to help remove purple urchins from restoration sites.

For the urchin fishery, the California Sea Urchin Commission is funding a long-term study in collaboration with scientists at University of California Santa Barbara (Schroeter et al. 2009) on larval settlement rates of red sea urchins at multiple sites in southern and northern California, providing information on stock health and abundance. This long-running project (since 1990) extends from San Diego County to Mendocino County and could serve as a model for developing a similar program in the north, potentially in collaboration with groups also involved in kelp restoration.

Next steps: Explore ways to build and strengthen relationships and partnerships among urchin divers and buyers, researchers, managers and others to design and implement collaborative fisheries research as well as build upon or integrate with other efforts.

3. ***Develop programs to attract and train new divers as a way to maintain fishery-related knowledge and skills into the future.***

The need: With the "graying of the fleet" among urchin divers and tightly limited access to the fishery, urchin fishery participants are concerned about the knowledge, skills and capacities needed to participate in and maintain the fishery being lost. Developing programs that attract new and/or younger divers such as apprenticeships and collaborative fisheries research opportunities will be key to addressing this concern. Urchin crew permittees, who are on average about 20 years younger than dive permittees, may be best primed and suited to receive such training. Maintaining an adaptive workforce that can move between the fishery and, for example, research and restoration efforts, can provide a source of livelihood and identity - and help maintain the fishery's physical and social infrastructure and its culture.

Challenges and considerations: Developing and implementing programs to train (potential) new entrants to the fishery requires funding, capacity and personnel. And given the ongoing efforts to reduce capacity in the fishery especially given the impacts of kelp loss and other factors on urchin abundance and quality, some in the urchin industry may be hesitant to increase the potential for new entrants in the near term.

Recent and ongoing efforts: In light of California's "graying" commercial fleet and myriad challenges to entering the state's commercial fisheries, California Sea Grant developed the California Commercial Fishing Apprenticeship Program, "to help educate young people about the opportunities in commercial fishing, as well as the regulations, skills and co-management approaches necessary to keep commercial fishing economically, ecologically and socially sustainable"(California Sea Grant 2023). The program provides training on fishery-relevant marine science, fisheries management, data collection, safety, seamanship, marketing and business, along with hands-on experience learning from California commercial fishermen how to prepare, operate, maintain and repair boats, equipment and gear, and handling and sale of the catch.

Next steps: Explore expanding the California Commercial Fishing Apprenticeship Program to the northern urchin fishery or developing a fishery-specific collaborative training program involving experienced urchin fishery participants and others with knowledge of the fishery, science and management to attract and train the next generation of urchin fishery participants.

4. ***Adjust fishery management measures to increase flexibility of fishing.***

The need: Fishery management measures could be adjusted to increase the flexibility of the fishery through increasing the number of harvest days, or by opening up restricted areas to fishing. Increasing the flexibility of when and where urchin divers harvest can contribute to a more reliable

supply of fresh product to sell to domestic markets and would allow the divers and fishing community to adapt to changing market conditions.

Limitations for commercial red urchin harvest in northern California—both in space and time—cause difficulties for fishers due to variable and more severe weather conditions, compared to their southern California counterparts. The current closures for the fishery were instituted in the early 1990s to curb resource depletion, including restricting harvest days to Monday through Thursday from July through October and restricting harvesting in the South Caspar Point off Mendocino's coast. According to a petition brought to the Marine Resources Committee of the Fish and Game Commission by the California Sea Urchin Commission, the current June–October harvest schedule of Monday through Thursday is resulting in delayed market replenishment at the beginning of each week and lower quality products being sold due to loss of freshness (Rogers & Ashcraft 2024). An extension to the fishing week would be especially beneficial for the northern fishery where water conditions can be dangerous. More days on the water also allow for flexibility in selecting diver days with safe conditions. Increased days on the water would also allow divers to more easily participate in local markets.

Challenges and considerations: Considerations for opening days or areas for diving occur on a case-by-case basis by the state fishery managers. Many factors and data (e.g., landing data) are required to assure that regulation changes do not impact population sizes or viability of the fishery. This can take time and money by state agency staff, but is possible. For example, Tankers Reef in Monterey was opened to unlimited take of sea urchins in early 2021 by the California Fish and Game Commission through a rule change.

Recent and ongoing efforts: There are several proposed changes to regulations and permits being considered through CDFW, later to be voted on by the California Fish and Game Commission. In June 2023, the California Sea Urchin Commission submitted a regulation change petition to request to open the northern commercial urchin fishery on Fridays between June 1 and October 1, and to remove the commercial urchin fishing prohibition at South Caspar Point, which was closed in 1989 to allow for sea urchin refuge and research endeavors. At the Commission's Marine Resources Committee meeting in July 2024, the Commission reviewed and discussed CDFW's recommendation (Rogers & Ashcraft 2024) which would add 21 days to the fishery during the summer (Ashcraft 2024). The Commission also discussed opening South Caspar Point, which is closed to commercial urchin fishing. CDFW and the Commission are exploring options including partial opening to prevent impact on an experimental kelp restoration project ongoing until 2029. In addition, CDFW proposed changes to create a new daily sea urchin crew permit under a new permit authority (FGC 9054.5). The creation of a new daily sea urchin crew permit would result in less burdensome requirements and time delays by allowing for more deckhands on urchin fishing vessels.

There is also interest in opening more areas in protected areas to commercial red sea urchin harvest. In November 2023, the California Sea Urchin Commission put in a petition to the Fish and Game Commission for allowing commercial urchin fishing within nine State Marine Conservation Areas (SMCAs), which is being considered by the Fish and Game Commission and CDFW in their MPA

Regulation Change Petition Evaluation Process (California Fish and Game Commission 2024, Marine Super Team 2024). The rationale cited was that allowing urchin take in SMCAs "will improve the sustainability of the urchin industry and may also support kelp recovery efforts."

Next steps: Continue conversations between the CDFW, the California Fish and Game Commission, the California Sea Urchin Commission, and others to identify the best paths forward for increasing flexibility and safety for the northern fishery's operations.

5. ***Explore experimental permits for purple urchin collections to expand diver opportunities in kelp restoration.***

The need: Experimental permits for purple urchins only would create opportunities for divers interested in kelp restoration who do not already hold a commercial red sea urchin fishery permit. Currently, purple urchin removal for kelp restoration is limited to current holders of commercial sea urchin diving permits and also recreational divers with a limit of 35 purple urchins per day, with a recent exception to allow up to 40 gallons per day in the waters off Humboldt, Mendocino and Sonoma counties. In addition to increasing the number of hands, skills, and resources (e.g., equipment, boats) available to kelp restoration projects, an experimental permit for purple urchins would also be a helpful way to pass on skills to the next generation of divers that currently cannot apply for a sea urchin permit (Recommendation 3).

Challenges and considerations: Creation of a new permit is a lengthy process. According to a conversation with staff at the CDFW, creating a new permit requires a regulatory process and may take at least a couple of years. This would delay opportunities for fishers and require their shift to harvest other species.

Recent and ongoing efforts: The FGC approved a change to the recreational bag limit to 40 gallons of purple urchin per day in waters off Humboldt, Mendocino and Sonoma counties (versus 35 urchin per day elsewhere in the state) for personal use. In addition, the FGC amended the regulations to allow unlimited take of purple urchin at Caspar Cove through April 1, 2029 "for the purpose of kelp restoration" (FGC Title 14 CCR §29.06)

Next Steps: Continued efforts and collaboration between state agencies, the fishing community, and other relevant stakeholders to explore new permit possibilities.

6. ***Support efforts to minimize or mitigate risk for fishery participants.***

The need: The commercial red urchin fishery, like other fisheries, is vulnerable to risk resulting from climate change and the limited ability to predict when, where and how fisheries will be affected. Insurance could help mitigate some of this risk and buffer fishing communities from losses. While fisheries management aims to manage risk by incorporating fisheries science and uncertainty into decision-making, the use of risk management as a proactive approach is potentially underutilized for most fisheries (Sethi 2010).

Insurance as a risk mitigation tool for the fishing community is not new. However, insurance programs have focused on property (e.g., vessels, buildings, vehicles) rather than fishery resources and their production per se. Other types of coverage include coverage for protection and indemnity, loss of earnings, pollution liability, and injury for the crew. However, the concept of insuring production/landings, as is done via the Federal Crop Insurance Corporation for agricultural production, is gaining traction in climate-ready fisheries discussions. In a crop insurance contract, farmers acquire insurance coverage for crop acreage against losses due to adverse events beyond the farmer's control (RMA 2001). In most cases, insurance covers the loss of yield that exceeds a deductible. Similar to crop insurance, fishery insurance would provide an expedited process to access funds to help cover a production/harvest loss to businesses, communities, or other entities (Watson et al.2023).

Challenges and considerations: Insurance for fisheries is in its early stages and requires more exploration. Topics to research and understand include determining the science, information and logistics required to launch a program, exploration of different insurance scheme approaches available, identification of who pays for the insurance and the structure of such a program, and development of policy.

Recent and ongoing efforts: The world's first fisheries index insurance scheme to protect against extreme weather events was launched in July 2019 (Sainsbury et al. 2019). This insurance protects against financial loss from hurricane damage to fishing vessels, gear, and infrastructure, and pays out within 14 days of an index-triggering event. Researchers in the climate-ready fisheries space are beginning to investigate fisheries insurance as a potential risk reduction tool (e.g., parametric fisheries insurance[20]).

Next steps: Continued investment in fisheries insurance research, and collaboration between scientific experts, insurance industry, fishing community members, and relevant decision makers to explore insurance as a risk mitigation tool is needed. Grant opportunities with open calls to support risk reduction or mitigation in fishing communities should be expanded.

7. Explore additional uses, markets, and marketing strategies for purple and red urchins

The need: As the red urchin fishery disasters have limited opportunities for fishery participants, exploring additional markets for red urchin may increase the livelihood of fishermen. Further, diminished demand for urchin for the local culinary market in Northern California is driving the need to get product to consumers in other places, thus prompting the need for effective marketing strategies to make California's uni more attractive or competitive. Efforts should focus on exploring the creation of additional markets (e.g., non-food), uses (e.g., calcium source for animal feed), and new or supplementary marketing strategies (e.g., labels to distinguish local catch).

[20] Examining the viability of parametric fisheries insurance as a tool for conservation https://emlab.ucsb.edu/projects/examining-viability-parametric-fisheries-insurance-tool-conservation

Developing products and markets for purple urchins should also be explored. Given the population boom of purple urchin, creating a market for the large populations of non-marketable purple urchins could be a lucrative option. Possible uses for purple urchins include as natural dyes and calcium source for animal feed (see "Recent and ongoing efforts" below). If successful, this strategy could also support kelp forest restoration efforts as one objective is to decrease the population sizes of purple urchins in kelp forest urchin barrens. As urchin barrens are present throughout the state, this would benefit both the Southern and Northern California kelp forest ecosystems and red urchin fishery.

Challenges and considerations: The development of a new or the transition to additional markets for both purple or red urchins may be lengthy as new protocols and/or regulations may be needed. For red urchins, there will need to be enough supply of red urchins for a profitable fishery in Northern California. Red urchin populations must increase, for example through kelp forest restoration efforts, in order for marketable strategies to be deployed. For purple urchins, creation of new markets, such as for dye or chicken feed, will require collaboration with the textile industry and animal feed producers to harvest and trial the products. Another challenge is that new equipment and skill development can be expensive and require divers to expand their portfolios.

Recent and ongoing efforts: CSUC is working on developing markets for both purple and red urchin across a few projects. One project involves developing marketing materials and labels to highlight California-harvested red urchin. Another mentioned above, CSUC is also exploring developing a market for purple urchins as a source of purple dye in the textile industry. Finally, they are also studying if and how urchins can be used as a calcium source in chicken feed for both purple or red urchins. Urchinomics is another business combining aquaculture with purple urchin removal for kelp restoration. Urchinomics is exploring urchin ranching, where the empty "zombie" urchins from barrens are fed in ranching facilities to grow roe until marketable.

Next Steps: Continue to invest in and support projects that explore alternative markets and marketing strategies to help sustain the fishery.

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Appendix 2: Workshop Report

Social & Economic Resilience of the Northern California Commercial Red Sea Urchin Fishery

Summary of an OST Facilitated Workshop

February 9th, 2024

Town Hall, Fort Bragg, CA

About the Workshop

Since 2014, kelp forests along the Northern California coast have declined significantly due to changing ocean conditions, with as much as a 93 percent decline in kelp cover. This kelp loss has had significant and detrimental impacts on the marine ecosystem. Further, the people and communities that depend on healthy kelp forests for their livelihood and well-being have experienced social and economic impacts, including the northern California commercial red sea urchin fishery[21], which was officially declared a federal fishery disaster in 2016–17 and 2018–19.

In 2022, a team led by California Ocean Science Trust (OST) and including experts at UC Santa Cruz (UCSC), the California Sea Urchin Commission, and the Greater Farallones Association was awarded funding from the Department of Commerce passed through the Pacific States Marine Fisheries Commission (PSMFC) via a competitive process resulting from the 2016–17 fishery disaster. The aim of the project is to assess social and economic impacts of the fishery disaster and identify strategies to enhance the fishery's resilience to environmental disturbances such as kelp loss and resulting red urchin declines.

Using a mixed-methods approach, this project explores the social and economic impacts of this fishery disaster through (1) conducting commercial fishery data analysis and interviews with North Coast red sea urchin fishery participants and fishing community members, (2) convening a workshop to collaboratively identify and evaluate potential strategies to improve resilience to current and future challenges, and (3) engaging and communicating results to the fishing community, resource managers and partners to facilitate their use in local, state, and federal decision-making. The overarching goal of this work is to assist agencies and the fishing community in enhancing responsiveness and resilience to kelp loss and associated fishery impacts.

As part of this project, OST and the project team hosted a half-day, in-person workshop on February 9th, 2024 in Fort Bragg, California. The goal of the workshop was to collaboratively identify and evaluate potential strategies to improve the fishery's and the fishing community's resilience to future environmental disturbances. Workshop participants included Fort Bragg commercial red sea urchin

[21]Throughout this report, "red urchin fishery" or "red sea urchin fishery" are often used as a shorthand and refer to the northern California commercial red sea urchin fishery. "North Coast" is also used synonymously with "northern California."

divers and processors directly affected by the North Coast fishery collapse, staff from state agencies with jurisdiction in the science and management of the red urchin fishery[22], local officials, environmental non-governmental organizations (eNGOs) staff, and community members involved in resilience-building initiatives (see Appendix 3 for a list of workshop attendees). The northern California commercial red sea urchin fishery is composed of divers, handlers and processors with knowledge, experience and perspective concentrated in Mendocino County and extending south to Sonoma and Marin counties.

The workshop included presentations to provide context and set the scene by walking through the federal fishery disaster process, preliminary findings from the ongoing socioeconomic impact assessment, and kelp restoration efforts involving northern California commercial red sea urchin divers (see Appendix 3 for the full agenda and list of talk titles). This was followed by focused brainstorming and discussion of the needs, opportunities, and challenges facing the northern California commercial red urchin fishery and fishing community and ideas for building resilience. The workshop results summarized in this report are being shared with industry, resource managers, and partners to help inform local, state and federal discussions and decision-making to address future disturbances and associated fishery impacts. Workshop participants had the opportunity to review this workshop report. A final project report will provide the results of the socioeconomic impact assessment, a brief summary of this workshop, and a synthesis of ideas and insights for enhancing fishery resilience.

Background: Northern California Commercial Red Sea Urchin Fishery Disaster Declaration and Impacts to the Fishery and Fishing Community

Beginning in 2014 and 2015, a "perfect storm" of events led to the dramatic decline of California's kelp forests and subsequent impacts to the ecosystem when a sea star wasting disease killed large numbers of sea stars that predate on purple sea urchins. Shortly after, a marine heatwave known as "the blob" in 2014 followed by El Niño events in 2015 warmed nearshore waters, causing massive kelp declines. Without kelp to eat, red sea urchin gonads (reproductive organs) shriveled, rendering them unmarketable, and in some cases causing red urchin mortality. Further exacerbating the issue, the smaller and more robust purple sea urchin voraciously feeds on remaining kelp, resulting in urchin barrens. Ultimately, the kelp collapse and subsequent cascading effects have had significant socioeconomic impacts on the northern California commercial red sea urchin fishery and fishing community, prompting a request for a federal fishery disaster Declaration and disaster relief funds.

In 2017 the California Sea Urchin Commission asked the then-Director of the California Department of Fish and Wildlife (CDFW) for assistance to obtain a disaster declaration for the fishery by compiling evidence to submit to NOAA Fisheries. The Urchin Commission then petitioned then-Governor Jerry Brown to request a federal fishery disaster declaration for the statewide fishery. That request was denied due to the fishery not meeting the required minimum revenue loss of 35 percent compared to the average of the previous five years. Whereas the statewide revenue loss of 15 percent did not meet

[22]Staff from the Ocean Protection Council and California Department of Fish & Wildlife attended virtually due to state policy that prevented travel.

the criteria for a disaster determination, the northern fishery's 77 percent loss did. In 2019, Governor Gavin Newsom successfully re-applied for a 2016 and 2017 federal fishery disaster for the Northern Management Zone only, as the northern and southern fisheries are managed distinctly. In 2020, Congress allocated $3.3 million to the northern commercial red urchin fishery. Funds were allocated based on a spend plan developed by CDFW in consultation with the urchin industry, with 79 percent for affected divers and processors, 20 percent for mitigation and research, and 1 percent for PSMFC overhead. This project, along with projects addressing marketing, alternative uses of purple urchins, and kelp restoration efforts, are supported with the mitigation and research funds. With the fishery continuing to experience losses, Governor Newsom subsequently requested federal fishery disaster assistance for the northern fishery for 2018 and 2019, with the request approved in October 2023 and an allocation of $1.6 million announced in January 2024. New changes to the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) allow the fishery to apply again. Having received two federal fishery disaster declarations over a 4-year period, the northern commercial red urchin fishery is reevaluating a new application for years 2020–2023 in collaboration with CDFW. Receiving additional federal fishery disaster funding is not a guarantee nor a long-term remedy, highlighting the need for additional and alternative resilience strategies for the fishery and fishing community.

To date, responses to the fishery disaster have focused on kelp restoration with several efforts and research projects underway along the North Coast. These efforts variously involve eNGOs, academic and agency researchers, and recreational dive and commercial red sea urchin fishery organizations, with state, federal, and private funding support, plus volunteer efforts. In addition, the state has created a research program, developed action plans, and announced $5 million in additional funding for kelp restoration and research.

Workshop Results

The primary goal of the workshop was to convene northern California commercial red urchin fishery participants, including divers and processors, and other community members, as well as key state agency staff to 1) collaboratively identify and evaluate potential strategies to improve the fishery’s and the fishing community’s resilience to future environmental disturbances, and 2) discuss the opportunities, challenges, and needs for implementing those resilience strategies. For this project, “resilience strategies'' include *actions* and *approaches* that could help improve the fishery’s and fishing community’s ability to cope with or adapt to future environmental disturbances. The workshop and this project were designed so that resilience strategies are identified by fishery participants and fishing community members, and are grounded in and informed by their knowledge and experience.

In preparation for the workshop, OST staff members Dr. Lauren Linsmayer and Dr. Heidi Waite reached out to fishery participants and other fishery- and kelp-connected community members primarily in the Fort Bragg/Mendocino area to begin to learn about their ideas for resilience strategies. These preliminary strategies were combined with those identified by co-PI Dr. Carrie Pomeroy (UCSC) and project partner David Goldenberg (California Sea Urchin Commission) in their ongoing research (interviews, commercial fishery data analysis) to assess the socioeconomic impacts of the fishery

disaster. The resulting preliminary list of resilience strategies provided a basis for discussions at the workshop, though not all of the preliminary strategies were discussed at the workshop (Table 1).

Fishery Disaster Impacts on the Community

As a result of the reduced abundance and condition of the North Coast red urchin, the fishery and fishing community have experienced significant social and economic impacts. In both informal conversations ahead of the workshop and interviews conducted for the socioeconomic impact assessment, fishery participants shared their responses to the fishery collapse. Some diversified their local fishery-related activities, while others shifted to urchin and/or other fisheries in other regions or states (e.g., sea cucumber in Alaska); and some pursued employment in land-based jobs, whether temporarily or longer-term. Some divers, especially those who are older, retired from the fishery or from fishing entirely. For others, the northern commercial red sea urchin fishery was and still is a family business and involves multiple generations working in the fishery in various capacities. Because North Coast communities like Fort Bragg are small and depend on fisheries, the kelp loss and fishery disaster have caused ripple effects throughout the community.

In response to the fishery disaster, some northern California commercial red sea urchin divers have engaged in kelp restoration efforts, particularly purple sea urchin removals. Financial compensation for their work has helped to offset fishery income losses, although it is not sufficient, nor intended, to replace fishery income. Moreover, funds available are limited and participation is not feasible for some North Coast divers. Workshop participants discussed concerns about the limited amount and inconsistency of funding and dependence on such limited and inconsistent funds to support them in the absence of a recovered fishery.

Resilience Strategies Explored

This workshop aimed to discuss and identify potential strategies for enhancing the fishery's and fishing community's resilience to future perturbations. Results of interviews and informal conversations prior to the workshop were used to draft a preliminary list of resilience strategies, which provided a foundation for discussions at the workshop (Table 1).

Kelp restoration. Much of the workshop discussion centered around kelp restoration, given the multiple ongoing efforts in the region involving commercial urchin divers. Since kelp loss began in 2014, multiple entities have mobilized to fund and test various kelp restoration approaches. Some of these efforts have involved northern California commercial red urchin divers, given their experience, knowledge, and skills removing urchins. Workshop participants discussed restoration tools and methods, appropriate payment for commercial divers, and valuing and making fuller use of diver knowledge and skills in the design and implementation of restoration activities (e.g., site selection, planning and outplanting, as well as purple urchin removal).

Identifying effective methods. Kelp restoration efforts to date have focused on either purple urchin removals and/or kelp outplanting. Despite testing and implementing several methods, kelp recovery rates remain very low in the North Coast. Workshop participants discussed the need to find successful methods for supporting kelp recovery, which is foundational to the recovery of red urchins. Among many divers at the workshop, clearing as many purple urchins as possible, in addition to outplanting kelp, remains a priority. Some discussed the importance of safeguarding and protecting remnant kelp areas by focusing on removing purple urchins around those strongholds and continuing removals to maintain those areas.

New restoration tools. Some divers have developed purple urchin removal methods and tools such as an "airlift." (An airlift is a low-pressure vacuum used underwater by divers to transfer the urchins they rake off the seafloor to a collection bag or the vessel they are diving from.) Divers at the workshop who have been involved in developing such methods are interested in securing funding and fishery management support for adoption of those methods. They also are seeking approval for use of those methods in national marine sanctuaries, where they currently are not allowed. Other workshop participants suggested the need to evaluate the effectiveness of these techniques before wider adoption.

Leverage diver expertise. Many of the divers have been diving the North Coast for decades and have extensive knowledge of different sites, conditions and local ecology. Those at the workshop noted that while they do not typically share their dive sites with each other when competing for red urchins, they are more inclined to collaborate and share knowledge for kelp restoration. Many divers said they want their knowledge to be utilized in choosing sites for restoration efforts. In addition, many of them have boats that can be utilized for restoration efforts and extensive experience navigating the region's often challenging weather and ocean conditions.

Flexible approaches. Workshop participants also identified a need for more flexibility (or alternative approaches) for removing purple urchins. Currently, kelp restoration teams organize work days at specified sites where divers collect purple urchins. Workshop participants suggested that if they had the flexibility to work at their own pace and at multiple locations identified as priority sites, they could be more efficient in removing urchins. Divers have particular and considerable knowledge and experience of ocean conditions and how they differ across location, time of day, and season, which affect access to sites, safety, viability, and effectiveness of purple urchin removal efforts. Having a flexible system for restoration would allow divers to be less constrained to get on the water when conditions are suitable. Workshop participants also expressed interest in collaborating to develop a "hit list" of priority purple urchin removal sites.

Involving divers in monitoring. Some workshop participants expressed interest in using their specialized diving skills and being trained to assist with monitoring. They also noted that they have experience, skills, and equipment that enable them to work effectively and frequently at multiple depths and locations where science teams typically cannot, which would allow them to collect more data more frequently. Workshop participants discussed whether underwater photographs

could be used for monitoring over time, though water column visibility conditions could limit the effectiveness of this approach.

Equitable payment for divers. Currently, commercial divers participating in ongoing, externally funded and led kelp restoration efforts are paid a fixed hourly or daily rate for their work. Some workshop participants indicated a preference for paying divers for their output (e.g., pounds of purple urchins removed) rather than for their time. They noted that this is similar to how the commercial fishery works and felt that this would both enhance the incentive to work efficiently and be more equitable. Others disagreed, noting that payment per pound might incentivize divers to only take the largest purple urchins and leave behind smaller urchins. After the workshop, a supporter of the airlift method noted that use of that method, which is suitable only in deeper waters where small urchins are commonly found, could help address this issue.

Scaling up restoration efforts. Many workshop participants were interested in expanding kelp restoration efforts, by both increasing the geographic scale and scope and spending more days on the water. It was mentioned that a challenge will be to ensure that regulations are in sync to allow scaled up restoration efforts. While specific regulatory needs were not discussed at the workshop, any proposed changes would be under the jurisdiction of the California Fish and Game Commission and CDFW.

Increased funding and support for divers. While state, federal, eNGO, and locally raised private funds have gone to support kelp restoration and research, workshop participants discussed concerns about there being enough consistent, long-term funding for kelp restoration efforts, at appropriate geographic and time scales. With fishery participants' significant loss of income from the fishery disaster, payment for their engagement in kelp restoration activities has been important for those divers. Some workshop participants expressed interest in more direct funding to divers for their involvement in kelp restoration. It was suggested that this could be achieved by directing funding to entities with lower overhead costs, so that a larger proportion of the funds are available for direct costs such as diver effort.

Alternative or flexible permits. Some divers at the workshop expressed interest in alternative or more flexible permits. Since 1985, CDFW has required that licensed commercial fishermen have a non-transferable red sea urchin dive permit to dive for red urchins. Additional fishery management measures include minimum size restrictions and multi-day closures at times throughout the year. In response to changing ocean conditions, flexible or alternative fishing permits have been suggested as a way to enable fishermen to adapt in real time. For example, this includes exploring options for permits to be used during times or in areas that are otherwise restricted (e.g., in marine protected areas). There was also interest among workshop participants in special permits for purple urchin removals, as has been done with the recreational fishery, to assist restoration efforts.

Fishery insurance. Fishery insurance was mentioned at the workshop, but details were not discussed. Fishery insurance, potentially analogous to crop insurance, could be a risk management tool for fisheries

that experience unexpected losses, particularly in the face of climate change impacts, although it has yet to be implemented for wild capture fisheries in the U.S.

Developing markets for purple urchins. Given the purple urchin population explosion since 2014, a number of different ideas for developing markets for purple urchin products have emerged. One is urchin "ranching," which involves fattening up harvested purple urchins (in ocean enclosures or land-based facilities) to marketable size and quality uni for human consumption. Another is looking into using purple urchin spines to create pigment dyes for textiles, fertilizer for growing grapes or other crops, and using the whole shell as a calcium source for chicken feed. Developing new markets may also enable processors to use their facilities, which are tailored for processing urchins, for these and other activities (e.g., converting to ranching). However, according to processors at the workshop, urchin ranching is not sufficiently profitable to justify such an investment. Workshop participants expressed interest in an economic feasibility study of converting their operations for urchin ranching.

Improving port and harbor infrastructure. Currently, North Coast ports and harbors associated with the commercial urchin fishery face various challenges in providing and maintaining fishery-support infrastructure, goods, and services. Infrastructure needs for Mendocino County ports include hoists for deploying and retrieving small vessels used in the fishery and unloading urchin (Point Arena, operated by the city), a fuel dock (in Noyo Harbor), and affordable, accessible slips and unloading facilities (e.g., Albion, a private site). Workshop participants expressed the need for basic infrastructure maintenance and efficient access to ports, especially in areas closest to kelp restoration and urchin diving sites. A workshop participant noted that Port Arena has become expensive and unreliable. It was discussed that more funding and resources for making these basic infrastructure improvements is needed.

Table 1: Preliminary list of resilience strategies identified in pre-workshop conversations and interviews with fishery participants and other fishing community members.

Human (Socioeconomic) Resilience
● Address infrastructure needs (e.g., docks, unloading facilities, processing facilities, fuel dock) ● Change permits to expand access to fishing areas/times (i.e., flexible fishing permits) or gear types (e.g., trapping methods) ● Change permit system to increase entry into fishery (i.e., transferable permits or lottery permit system) ● Explore developing fishery insurance ● Avoid closing nearshore diving areas (to reduce cost and overnighters) ● Open up some marine protected areas to the fishery allowing for adaptive fishery management ● Diversify fishing portfolio (e.g., participate in other fisheries) or move into new fishery ● Move between northern and southern commercial red sea urchin fisheries or deeper depths ● Transition into land-based careers ● Equip next generation of divers with fishery knowledge and skills
Ecological Resilience
● Increase funding for kelp restoration efforts ● Proactively invest in research to be more responsive to future environmental disturbances ● Promote information-sharing among kelp restoration projects (e.g., southern and northern sites, between different groups) ● Test new methods for kelp restoration / purple urchin removal ● Restore sunflower sea star (*Pycnopodia*) populations
Both
● Continue funding / expansion of kelp restoration activities (e.g., more geographic coverage, additional sites) ● Encourage diver participation in kelp restoration / equitable pay ● Coordinate / consult with divers to utilize expertise (e.g., site selection), boats, equipment, and dockside facilities for restoration and monitoring ● Increase collaboration among agencies, fishery participants, and scientists (e.g., management, research, restoration) ● Develop markets for purple urchin products / ranching purple urchins ● Provide opportunities with the urchin fishery representatives to explore adaptive management strategies in real time within a defined area

Opportunities, Challenges, and Needs Discussed

Sense of urgency / prioritizing action. Workshop participants expressed a sense of urgency about the state of the northern California red urchin fishery and kelp restoration. While some were skeptical, others expressed hope about the possibility of the fishery recovering. A need to clarify the community's long term goals for the fishery and kelp restoration was identified as well. Continuing conversations to explore fishing community members' goals and desired outcomes for both the future of the fishery and kelp restoration will help clarify and prioritize specific actions, coordinate efforts, and identify funding opportunities.

Future funding. Workshop participants expressed a desire for consistent, long-term funding to support rebuilding the fishery and kelp restoration efforts. However, it has been difficult for the urchin dive community to obtain grant funding for leading kelp restoration work, with funding tending to go to organizations. Non-governmental sources of funding or emerging blue carbon credit schemes for kelp restoration were identified as potential sources of funding to be explored further. Since the most recent disaster declaration for this fishery, an update to the Magnuson-Stevens Act that excludes fishery disaster years when evaluating economic loss opens the possibility for additional federal disaster relief for the red urchin fishery. However, future, and repeated, fishery disaster requests may not be granted or the total appropriations may be reduced amid increasing numbers of requests from this fishery and others across the country.

Scientific research needs. Workshop participants discussed some of the science needed to inform efforts to restore kelp and rebuild the northern California commercial red urchin fishery, and potential opportunities for divers to become more involved in some of these efforts and/or utilize their firsthand knowledge. Two key research topics identified were where and how thorough urchin removals need to be to make a meaningful improvement in kelp recovery and identifying and evaluating the most effective methods for restoration.

Limited entry permit system and supporting the next generation. Since the fishery collapse, the future of the northern California commercial red urchin fishery has been uncertain. Workshop participants expressed concern about the next generation of urchin divers, given there are few opportunities for young people to become involved in the urchin fishery. The fishery is managed using a limited entry system, with about 230 urchin dive permits and a capacity goal of 150 permits set by the Fish and Game Commission in 2017. Urchin dive permits are non-transferable with a CDFW-managed lottery that requires 11 permits to be retired before a new permit can be offered. This has all but eliminated access to the fishery for new (and typically younger) entrants. Workshop participants discussed concerns about the loss of knowledge and skills in the fishery, its durability, and the viability of markets. Beyond ensuring access to the fishery for future divers, other ideas for supporting the next generation were not discussed at the workshop.

Other concerns. Workshop participants also raised concerns about proposed sea otter reintroduction and impacts of the 2011 Fukushima nuclear accident on the marine environment. However, these were tabled for future discussion as they were beyond the scope of the workshop.

Summary and Next Steps

Fisheries in a changing climate and other environmental disturbances face many unprecedented challenges and uncertainties. Federal fishery disaster relief has helped to mitigate some of the negative impacts on fishery participants and communities. However, this funding is not ensured for the long-term, as environmental conditions continue to change and demands on that support system increase. There is a need to understand the economic and social impacts of fishery disasters and explore new tools, management practices, and strategies for coping and adapting to them. This workshop launched a conversation among fishery participants, government agencies, NGOs, and other community members to build shared understanding and explore opportunities, challenges, and strategies to help enhance the resilience of the northern California commercial red sea urchin fishery and fishing community under changing ocean conditions. Ongoing interviews and socioeconomic data analysis for this project will further inform these efforts. A final project report will provide the results of the socioeconomic impact assessment, a brief summary of this workshop, and a synthesis of ideas and insights for enhancing the northern California commercial red sea urchin fishery resilience. Results of the workshop and final results from all components of the project will be shared with industry, affected communities, legislators, resource managers, NGOs, and others to spur further collaboration on new tools and practices for a resilient fishery.

Appendix 3

Workshop Participants

Project Team	
Heidi Waite	Ocean Science Trust
Lauren Linsmayer	Ocean Science Trust
Anthony Rogers	Ocean Science Trust
David Goldenberg	California Sea Urchin Commission
Carrie Pomeroy	University of California, Santa Cruz
Tyler Mears	Greater Farallones Association, Greater Farallones and Cordell Bank National Marine Sanctuaries
Gina Contolini	Greater Farallones Association, Greater Farallones and Cordell Bank National Marine Sanctuaries

Participants	#
Divers (past & present) & deck hands	8
Processors & associated fishing community	6
Harbor master	1
Kelp restoration NGOs	1

Agency Participants	
Derek Stein	California Department of Fish and Wildlife
Kirsten Ramey	California Department of Fish and Wildlife
Joanna Grebel	California Department of Fish and Wildlife
Mike Esgro	Ocean Protection Council
Pike Spector	Ocean Protection Council
Katie Cieri	Ocean Protection Council, Sea Grant Fellow

Agenda

Red Sea Urchin Fishery Social & Economic Resilience Workshop

February 9, 2024 12 pm - 4:30 pm
Town Hall, Fort Bragg, CA

Background: The California Ocean Science Trust (OST), California Sea Urchin Commission, Greater Farallones Association (GFA), and experts at UC Santa Cruz are partnering on a project that seeks to understand the social and economic response and resilience of the North Coast red sea urchin fishery and fishing community to kelp forest collapse. This project is funded by a Pacific States Marine Fisheries Commission grant resulting from the federal fishery disaster declaration for the commercial red urchin fishery in 2016 and 2017.

Prior to the workshop, project partners Dr. Carrie Pomeroy of UC Santa Cruz and David Goldenberg of the California Sea Urchin Commission are conducting interviews with fishery participants and others to assess the social and economic impacts of the North Coast red sea urchin fishery disaster on the fishery participants and the fishing community. These results will inform discussions at the workshop.

Objectives: This half-day workshop, organized by OST, is designed to convene a small group of red urchin fishery participants, processors, and community members as well as key agency staff and government officials to 1) collaboratively identify and evaluate potential strategies to improve the fishery's and the fishing community's resilience to future environmental disturbances, and 2) discuss the opportunities, challenges, and needs for implementing those resilience strategies.

Outputs: OST will provide workshop results to the industry, resource managers, and partners to facilitate their use in local, state, and federal decision-making and to assist in developing a more responsive framework to minimize kelp loss and associated fishery impacts.

Contacts: Lauren Linsmayer (lauren.linsmayer@calost.org), Heidi Waite (heidi.waite@calost.org)

Agenda

12:00 - 12:15 | Welcome & Introductions

- Overview of workshop goals and agenda, *OST*
- Round Robin introductions, *all*

12:15 - 1:35 | Fishery Disaster Impacts & Responses // LUNCH (provided)

- "Red Sea Urchin Disaster: High-Level Overview of the Disaster Process", *CDFW (10 min)*
  - *Brief overview of process and timeline for disaster funds for the red sea urchin industry*
- "Red Sea Urchin Fishery Social & Economic Resilience Workshop:Overview of 2016, 2017 Red Urchin Fishery Disaster Declaration", *Dave Goldenberg* (10 min)
  - *Set context of the North Coast collapse and where funding was allocated in the community, overview of types of projects being funded from disaster declaration, and updates on the 2018-2019 disaster declaration*
- "The Northern California Sea Urchin Fishery & Disaster: Brief history, assessing impacts of 2016-17 fishery disaster, and potential strategies for resilience", *Carrie Pomeroy (20 min)*
  - *Summary of the fishery's complex history and list of potential strategies that emerged from interviews*
- "Urchin Removals for Kelp Restoration in Greater Farallones National Marine Sanctuary", *Greater Farallones Association (10 min)*
  - *Recap of GFA-led kelp restoration efforts, techniques, and impact on red sea urchin fishery*
- "Overview of Mendocino Kelp Recovery Efforts with the California Sea Urchin Fishery", *Kelp restoration NGO (10 min)*
  - *Recap of kelp restoration efforts, techniques, and impact on red sea urchin fishery*
- Audience Q&A *(20 min)*

1:35 - 1:45 | Break

1:45 - 3:00 | Small Group Discussions - Identify Resilience Strategies & Needs

- Set goals and guidelines, *OST*
- Small groups discussions
  - *Provide feedback and refinement of compiled preliminary strategies list that emerged from surveys and add additional strategies. Begin to identify opportunities/challenges of advancing or implementing potential strategies*

3:00 - 3:15 | Break

3:15 - 4:20 | Full Group Discussion - How to Advance Resilience Strategies

- Facilitated group discussion, *OST*
  - *Share and discuss strategies, key actors to engage, challenges, and next steps to advance or implement each identified strategy*

4:20 - 4:30 | Wrap Up, Next Steps & Close

4:40 - 6:00 | Informal Happy Hour