OCEAN PROTECTION COUNCIL

Item 7

Staff Recommendation
June 14, 2022

Consideration and Approval of Disbursement of Funds for Facilitation of Market Squid Fishery Advisory Committee and Supporting Enhanced Population Genomics Research

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RECOMMENDED ACTION: Staff recommends that the Ocean Protection Council approve the disbursement of up to $338,000 to the Resources Legacy Fund to fund both the facilitation of the Squid Fishery Advisory Committee and the completion of population genomics research to inform potential updates to the Market Squid Fisheries Management Plan.

LOCATION: Statewide

STRATEGIC PLAN GOALS AND OBJECTIVES: Goal 3: Enhance Coastal and Marine Biodiversity, Objective 3.3: Support Sustainable Marine Fisheries and Thriving Fish and Wildlife Populations; Goal 4: Support Ocean Health Through a Sustainable Blue Economy, Objective 4.1: Advance Sustainable Seafood and Thriving Fishing Communities

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FINDINGS AND RESOLUTION:

Staff recommends that the Ocean Protection Council (OPC) adopt the following findings:

"Based on the accompanying staff report and attached exhibit(s), OPC hereby finds that:

1) The proposed projects are consistent with the purposes of Division 26.5 of the Public Resources Code, the California Ocean Protection Act;
2) The proposed projects are consistent with OPC's Proposition 68 Grant Guidelines, adopted May 2019; and
3) The proposed projects are not 'legal projects' that trigger the California Environmental Quality Act (CEQA) pursuant to Public Resources Code section, section 15378."

Staff further recommends that OPC adopt the following resolution pursuant to Sections 35500 *et seq.* of the Public Resources Code:

"OPC hereby approves the disbursement of up to $338,000 to the Resources Legacy Fund to fund both the facilitation of the Squid Fishery Advisory Committee and the completion of population genomics research to inform potential updates to the Market Squid Fisheries Management Plan. This authorization is subject to the condition that prior to disbursement of funds, Resources Legacy Fund shall submit for the review and approval of the Executive Director of the OPC detailed work plans, schedules, staff requirements, budgets, and the names of any contractors intended to be used to complete the projects, as well as discrete deliverables that can be produced in intervals to ensure the projects are on target for successful completion. All projects will be developed under a shared understanding of process, management and delivery."

EXECUTIVE SUMMARY:

Market Squid is California's largest climate-impacted fishery and is already seeing rapid population fluctuations and range shifts driven by oceanographic changes, particularly ocean temperatures. These shifts have accelerated the need to review the existing Fishery Management Plan (FMP) to potentially update management practices and increase the climate-resiliency of this fishery. The first step in updating and modernizing the FMP is to convene a Squid Fishery Advisory Committee (SFAC) and ensure that the committee has access to all necessary biological, environmental and landing data needed to accurately assess the state of the fishery. The funds requested will support the Squid Fishery Advisory Committee process and allow for the completion and incorporation of critical population genomics research.

OPC is committed to facilitating a better understanding of the impacts of climate change on California's marine ecosystems and fisheries as well as supporting efforts to maintain sustainable marine fisheries. Updating the market squid FMP is just one task in a much broader effort to develop and implement climate-ready fishery management strategies across California. These strategies include (but are not limited to) building climate-responsiveness into current management strategies, modernizing data collection and monitoring efforts, and increasing our understanding of environmental effects on both species population structure and recruitment patterns.

PROJECT SUMMARY:

Background:

The Market Squid Fishery

The market squid fishery is routinely the largest commercial fishery in California in terms of volume and value of landings (second only to Dungeness crab). Market

squid are short-lived, terminal spawners meaning the entire population replaces itself in less than one year. Recruitment is highly influenced by environmental variation leading to boom-and-bust cycles in fishable biomass and seasonal or long-term shifts in spatial distribution. Depending on the season, landings can vary from over 100,000 tons (generally cooler/La Niña years) to less than 30,000 tons (more recent El Niño years)[1]. Market squid is also important forage for many species in the California Current Ecosystem and to the recreational fishery as either live or dead bait.

Market Squid Fishery Management Plan (FMP)

The fishery is managed under the California Department of Fish and Wildlife's Market Squid Fishery Management Plan, which is one of the oldest FMPs for California state-managed species. The current FMP was implemented in 2005 after a five-year stakeholder engagement process and research effort. Fishery controls include:

- A limited entry permit program to minimize the size of the fishing fleet
- A seasonal-catch limit of 118,000 tons to prevent the fishery (which operates year-round) from over-expanding
- Weekend closures to provide for periods of uninterrupted spawning
- Gear regulations regarding light shields and wattage
- Monitoring programs designed to evaluate the impact of the fishery on the resource
- Establishment of a special closure at the Gulf of Farallones National Marine Sanctuary to protect nesting seabirds

Although not an explicit fishery control, California's Marine Protected Area network also functions as refuge for uninterrupted spawning and as forage reserves for many of the species that consume market squid.

Current Climate Impacts

While market squid is currently considered a sustainable fishery, there is a need for modernization of management to account for environmental variability due to climate change, particularly the effects of rising ocean temperatures. Since market squid are highly responsive to changes in water temperature, populations can experience dramatic variability in abundance over time and space as ocean conditions increasingly fluctuate between warm and cold regimes.

Such variability is already affecting the fishery and those effects have been documented by researchers over the last two decades. Findings include:

[1] California Department of Fish and Wildlife. 2020 Market Squid, *Doryteuthis (Loligo) opalescens*, Enhanced Status Report.

- Landings from primary fishing grounds are significantly lower during El Niño events[2]
- Larval abundance is lower during warmer periods[3,4]
- The growth rate and size at maturity during warmer periods are decreased[5,6,7]
- Changes to growth rate and mature size may also reduce the reproductive output of females[8]

Despite documented low catches in warm years, the market squid fishery has historically rebounded quickly when conditions revert. However, given the short life span of squid (approximately nine months), extended warm water periods could significantly impact their lifecycle and the fishery by association.

Climate change may also result in shifts in suitable habitats for market squid. Research has shown that market squid recruitment may be influenced by the availability of sandy bottom habitat between 10 and 12 °C (50 and 53.6 °F)[2], and there may be a shift in these habitats to either deeper or more northerly areas. Embryo habitats may be more limited by pH or oxygen availability than temperature[9], and these factors are also expected to change in the future. Conversely, decreases in the oxygen content of deep ocean waters off the coast of California could compress the depth range for adult market squid[10,11]. As a result of these changes, there may be shifts in the locations where fishing and landings occur.

Within a typical fishing season, stock productivity varies between the more northern and more southern regions of the State. While historically most landings came from southern California, in recent years this has shifted to central and

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[2] Zeidberg LD, Hamner WM, Nezlin NP, Henry A. 2006. The fishery for California (*Loligo opalescens*) (Cephalopoda: Myopsida), from 1981 through 2003. California Department of Fish and Game. *Fish Bulletin* 104(1): 46-59.

[3]Koslow JA, Allen C. 2011. The influence of the ocean environment on the abundance of market squid, *Doryteuthis (Loligo) opalescens*, paralarvae in the Southern California Bight. *CalCOFI Reports* 52: 205-213.

[4] Van Noord JE and Dorval E. 2017. Oceanographic influences on the distribution and relative abundance of market squid paralarvae (*Doryteuthis opalescens*) off the Southern and Central California coast. *Marine Ecology* 38:e12433.

[5] Butler J, Fuller D, Yaremko M. 1999. Age and growth of market squid (*Loligo opalescens*) off California during 1998. *CalCOFI Reports* 40: 191-195.

[6] Jackson GD and Domeier ML. 2003. The effects of an extraordinary El Niño / La Niña event on the size and growth of the squid *Loligo opalescens* off southern California. *Marine Biology* 142: 925-935.

[7] Reiss CS, Maxwell M, Hunter JR, and Henry A. 2004. Investigating Environmental effects on population dynamics of *Loligo opalescens* in the southern California Bight. *CalCOFI Reports* 45: 87-97.

[8] Henry AE, McDaniel JD, Chan CD. 2003. Size differences, by sex, of adult market squid (*Loligo opalescens*) at-harvest in distinct temperature areas near the Channel Islands. Proceedings of the Sixth California Islands Symposium, Ventura, California. 453-460.

[9] Navarro MO, Parnell PE, Levin LA. 2018. Essential market squid (*Doryteuthis opalescens*) embryo habitat: a baseline for anticipated ocean climate change. *J Shellfish Res* 37:601–614.

[10] Bograd SJ, Castro CG, Di Lorenzo E, Palacios DM, Bailey H, Gilly W, Chavez FP. 2008. Oxygen declines and the shoaling of the hypoxic boundary in the California Current. *Geophysical Research Letters* 35(12).

[11] Stewart JS, Hazen EL, Bograd SJ, Byrnes JE, Foley DG, Gilly WF, Robison BH, Field JC. 2014. Combined climate-and prey-mediated range expansion of Humboldt squid (*Dosidicus gigas*), a large marine predator in the California Current System. *Global Change Biology* 20(6): 1832-1843.

northern California, and market squid is now found frequently within the entire California Current all the way to the Canadian border and beyond.. These shifts indicate that climate and oceanography alter the seasonal and spatial patterns in market squid spawning activity, and therefore impact fishing behavior, fleet dynamics, and ultimately the socioeconomic impacts to fishing communities[1]. Given that climate change is expected to alter both El Niño and La Niña frequencies and durations, there is now an even greater need to understand and respond to environmental forcing as environmental conditions shift. The squid fishery is an ideal test case for exploring fishery dynamics and environmental and ecosystem interactions to inform statewide management and climate resilience.

Project Summary:

This project will accomplish the following objectives:

- Establish and Facilitate the Squid Fishery Advisory Committee (SFAC):
    - The SFAC process will be a one-year effort with approximately 8 targeted meetings
    - Funds will support a facilitator to develop the working group for maximum productivity, run meetings, focus conversations, and facilitate the development of collaborative, science-based, recommendations to update the existing fishery management plan.
    - Includes informal research advisors to inform SFAC discussions and modelling
- Advance Research on Squid Population Dynamics:
    - Funds will support the rapid completion and build on population genomics work already underway at UCLA. Results of this work will increase understanding of population structure, recruitment and population-level impacts due to climate change.
    - Population genomics work will provide added value to an associated iterative population modelling effort (through UC Santa Cruz, funded separately by Resource Legacy Fund) associated with SFAC facilitation. This work will help us understand the effects of changing ocean conditions on squid population genomic structure and the relative importance of individual spawning areas to the entire California population(s).

The Squid Fishery Advisory Committee and the FMP review process

The FMP review is a multi-part effort conducted by the SFAC. The SFAC will advise/inform the process of updating existing squid fishery management and will be composed of representatives from key constituencies (fishing industry representatives, researchers, and conservation groups) who will provide advice, feedback, and recommendations regarding fishery management.

The SFAC process consists of two phases, Phase 1 is funded separately by RLF and is currently underway, and Phase 2, supported by proposed OPC funds. Phase 1 entails contacting and interviewing stakeholders to understand their concerns

about the fishery and then developing a draft process design. The process design includes determining the make-up of the SFAC, describing committee roles, identifying what management/policy directions should be considered and developing a process timeline. Phase 1 is anticipated to wrap up during summer 2022. OPC funding will then allow for a quick transition to Phase 2, which will involve implementation of the process outlined in Phase 1, beginning with convening the SFAC and ensuring that all relevant research and necessary data are aggregated and available for consideration by the advisory committee.

At the completion of Phase 2, the SFAC will deliver recommendations for how best to update the FMP to account for the results of the research and fisheries data products reviewed by the committee. Recommendations can focus on any aspect of the market squid fishery including changes to harvest control rules, management strategies, fisheries data collection needs, and monitoring requirements.

Science to Support the SFAC

In addition to supporting Phase 2 of the SFAC process, OPC funds will also facilitate rapid completion and build on population genomics work currently underway in the lab of Dr. Paul Barber at UCLA. This work was originally begun as part of the California Conservation Genomics Project, where the entire market squid genome was sequenced. This allowed researchers to begin looking for regional or population level variance in market squid sampled along the California coast. OPC funds will facilitate the expansion of this work to incorporate samples collected from many more sites across the state encompassing multiple years under varying environmental conditions. Such an expansion will help answer key questions as to the effects of changing ocean conditions on squid population structure, the relative importance of individual spawning areas to the entire California population(s), if certain regions or stocks contribute a greater percentage than others to the overall fishery harvest, and provide clues as to how the stock may respond to rapidly changing ocean conditions.

To further support the SFAC process, RLF and the Pew Charitable Trusts are also funding a post-doctoral researcher (working with Dr. Steven Munch at UC Santa Cruz) to use Empirical Dynamic Modelling (EDM) as a means to explore and disentangle the key factors driving fishing dynamics, forecast landings at multiple spatial scales, and simulate the performance of both static and dynamic management procedures designed to be adaptive under changing environmental conditions.

Updating Fisheries Management with Novel Science

The SFAC process and associated ecological and genomic modelling will utilize novel sampling techniques, long-term datasets and industry knowledge to

advance the sustainability of one of California's core fisheries through science-based, collaborative management. Ultimately, this effort will help lead to a better understanding of the impacts of climate change on one of California's premier marine fisheries as well as the development of new strategies to maintain fisheries sustainability in the face of changing ocean conditions.

About the Grantee

RLF is a 501(c)(3) nonprofit organization that partners with leaders in philanthropy, communities, government, science, and business to promote smart policies and secure equitable public funding for the environment, climate change resilience, and healthy communities. Across the American West and internationally, RLF manages large, multi-year grantmaking programs and fiscally sponsors projects that accelerate change on the environmental and equity goals shared with their partners.

Project Timeline

- Summer 2022: Funding awarded and Phase 1 facilitation completes
- Summer 2022: SFAC process begins – nominations made
- Fall 2022 – Fall 2023: SFAC process
- Summer 2023: EDM and population genomics work concludes
- Fall 2023: SFAC provides management recommendations

PROJECT FINANCING:

Staff recommends that the Ocean Protection Council (OPC) authorize encumbrance of up to $338,000 to Resources Legacy Fund for facilitation of the Squid Fishery Advisory Committee and completion of critical population genomics research.

Ocean Protection Council	$338,000
Resources Legacy Fund	$155,000
Pew Charitable Trusts	$50,000
TOTAL	**$543,000**

The anticipated source of funds will be OPC's FY 2018/2019 appropriation of Proposition 68 funds (Chapter 9 – Ocean, Bay, and Coastal Protection). Per OPC's Proposition 68 Grant Guidelines, this funding source prioritizes projects intended to

conserve, protect, and restore marine wildlife and healthy ocean and coastal ecosystems.

CONSISTENCY WITH CALIFORNIA OCEAN PROTECTION ACT:

The proposed project is consistent with the Ocean Protection Act, Division 26.5 of the Public Resources Code, because it is consistent with trust-fund allowable projects, defined in Public Resources Code Section 35650(b)(2) as projects which:

- Improve the management of fisheries and/or foster sustainable fisheries.
- Provide monitoring and scientific data to improve state efforts to protect and conserve ocean resources.
- Provide funding for adaptive management, planning coordination, monitoring, research, and other necessary activities to minimize the adverse impacts of climate change on California's ocean ecosystem.

COMPLIANCE WITH THE CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA):

The proposed project is categorically exempt from review under the California Environmental Quality Act ("CEQA") pursuant to 14 Cal. Code of Regulations Section 15306 because the project involves only data collection, research and resource evaluation activities that will not result in a serious or major disturbance to an environmental resource.