Staff Recommendation
October 25, 2018

Item 5b and 6a

Proposition 84 Competitive Grant Program Funding Recommendations: Ocean Acidification, Hypoxia and Other Changes in Ocean Conditions from a Changing Climate and Sustainable Fisheries & Aquaculture Projects Administered by the California Sea Grant Program

Paige Berube, Program Manager
Jenn Phillips, Program Manager

RECOMMENDED ACTION: Authorization for the California Sea Grant Program to disburse up to $3,000,000 for research projects on: (1) ocean acidification, hypoxia, and other changes in ocean conditions from a changing climate and (2) sustainable fisheries and aquaculture to the following grantees:

Ocean Acidification, Hypoxia & Other Changes in Ocean Conditions from a Changing Climate

- $246,114 to the University of Washington for "An ecophysiological framework to assess hypoxia driven habitat loss in the California Current Ecosystem"
- $247,246 to the University of California Santa Barbara for "Benefits beyond biomass: Bio-physical feedbacks within Marine Protected Areas may promote ecosystem resilience in the face of global climate change"
- $250,000 to the San Francisco State University for "Present and future climatic drivers of domoic acid toxicity in coastal ecosystems of California"
- $250,000 to the University of California Davis for "Geography of stress: Impacts of ocean acidification along the California Coast"
- $225,690 to the University of Massachusetts Amherst and the NOAA Southwest Fisheries Science Center for "Understanding ocean warming impacts on shrinking body sizes of California fishes: Linking pattern & mechanism to support future sustainable fisheries"
- $249,912 to the University of California Davis for "Assessing the combined effects of ocean acidification and warming on disease susceptibility and restoration success of the critically endangered white abalone"

Sustainable Fisheries & Aquaculture

- $249,890 to the Pfleger Institute of Environmental Research for "Habitat characterization, fishery development and stock structure of swordfish off California"
- $249,169 to San Diego State University for "A multi-faceted approach to enhance sustainability of the California spiny lobster fishery"

- $246,545 to the Scripps Institution of Oceanography at the University of California San Diego for "Reconstructing the population dynamics of southern California Paralabrax species in the face of a changing ocean"
- $239,103 to the University of California Davis for "Enhancing management under the Marine Life Management Act (MLMA) by accounting for effects of Marine Life Protection Act (MLPA) Marine Protected Areas (MPAs) on fisheries"
- $249,804 to Moss Landing Marine Labs at San Jose State University for "Sea Feeds: Identification and culture of Californian marine macroalgae capable of reducing greenhouse gas production from ruminant livestock"
- $249,997 to the Scripps Institution of Oceanography at the University of California San Diego for "A DNA metabarcoding approach to monitoring fish spawning and population connectivity in Coastal Southern and Central California"

This staff recommendation authorizes up to $3,000,000 for research projects on ocean acidification, hypoxia, and other changes in ocean conditions from a changing climate, and sustainable fisheries and aquaculture to be administered by the California Sea Grant Program. The accompanying Proposition 84 staff recommendation for agenda items 5b, 7 and 8a-d authorizes up to $3,000,000 for research projects on sea-level rise adaptation and coastal resilience, coastal sediment management, marine pollution, and marine renewable energy projects to be administered by the USC Sea Grant Program. Together, this represents a total Ocean Protection Council (OPC) Proposition 84 investment of up to $6,000,000 not including administrative costs for both Sea Grant Programs. This Competitive Proposition 84 Grant Program was approved by the Council at its August 7, 2017 meeting.

LOCATION: Statewide

STRATEGIC PLAN OBJECTIVES: Science-based Decision Making, Climate Change, Sustainable Fisheries and Marine Ecosystems, Existing and Emerging Ocean Uses

EXHIBITS

Ocean Acidification, Hypoxia & Other Changes in Ocean Conditions from a Changing Climate
Exhibit 5b1: "An ecophysiological framework to assess hypoxia driven habitat loss in the CA Current Ecosystem" – Letters of Support
Exhibit 5b2: "Benefits beyond biomass: Bio-physical feedbacks within Marine Protected Areas may promote ecosystem resilience in the face of global climate change" – Letters of Support
Exhibit 5b3: "Present and Future Climatic Drivers of Domoic Acid Toxicity in Coastal Ecosystems of California" – Letters of Support
Exhibit 5b4: "Geography of Stress: Impacts of Ocean Acidification Along the California Coast" – Letters of Support

Exhibit 5b5: "Understanding ocean warming impacts on shrinking body sizes of California fishes: Linking pattern & mechanism to support future sustainable fisheries" – Letters of Support
Exhibit 5b6: "Assessing the combined effects of ocean acidification and warming on disease susceptibility and restoration success of the critically endangered white abalone" – Letters of Support

Sustainable Fisheries & Aquaculture
Exhibit 6a1: "Habitat characterization, fishery development and stock structure of swordfish off California" – Letters of Support
Exhibit 6a2: "A multi-faceted approach to enhance sustainability of the California spiny lobster fishery" – Letters of Support
Exhibit 6a5: "Sea Feeds: Identification and culture of Californian marine macroalgae capable of reducing greenhouse gas production from ruminant livestock" – Letters of Support

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 Ocean Protection Act;
2) The proposed projects are consistent with OPC's Proposition 84 grant guidelines (Interim Standards and Protocols, August 2013); and
3) The following proposed projects are not 'legal projects' that trigger the California Environmental Quality Act (CEQA) pursuant to Public Resources Code section 21068 and Title 14 of the California Code of Regulations, section 15378, because they will not cause a direct physical change or reasonably foreseeable indirect physical change in the environment:
    - Present and future climatic drivers of domoic acid toxicity in coastal ecosystems of California
    - Geography of stress: impacts of ocean acidification along the California Coast
    - Enhancing management under the Marine Life Management Act (MLMA) by accounting for effects of Marine Life Protection Act (MLPA) Marine Protected Areas (MPAs) on fisheries
4) The following proposed projects are categorically exempt from review under CEQA pursuant to Title 14 of the California Code of Regulations Section 15306 - Information Collection, because they involve basic data collection, research, experimental management, and resource evaluation activities that will not result in a serious or major disturbance to an environmental resource
    - An ecophysiological framework to assess hypoxia driven habitat loss in the California Current Ecosystem
    - Benefits beyond biomass: Bio-physical feedbacks within Marine Protected Areas may promote ecosystem resilience in the face of global climate change

- Understanding ocean warming impacts on shrinking body sizes of California fishes: Linking pattern & mechanism to support future sustainable fisheries
- Assessing the combined effects of ocean acidification and warming on disease susceptibility and restoration success of the critically endangered white abalone
- Habitat characterization, fishery development and stock structure of swordfish off California
- A multi-faceted approach to enhance sustainability of the California spiny lobster fishery
- Reconstructing the population dynamics of southern California Paralabrax species in the face of a changing ocean
- Sea Feeds: Identification and culture of Californian marine macroalgae capable of reducing greenhouse gas production from ruminant livestock
- A DNA metabarcoding approach to monitoring fish spawning and population connectivity in Coastal Southern and Central California

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 $3,000,000 to 12 grantees as follows:

1. $246,114 to the University of Washington for "An ecophysiological framework to assess hypoxia driven habitat loss in the CA Current Ecosystem"
2. $247,246 to the University of California Santa Barbara for "Benefits beyond biomass: Bio-physical feedbacks within Marine Protected Areas may promote ecosystem resilience in the face of global climate change"
3. $250,000 to the San Francisco State University for "Present and Future Climatic Drivers of Domoic Acid Toxicity in Coastal Ecosystems of California"
4. $250,000 to the University of California Davis for "Geography of Stress: Impacts of Ocean Acidification Along the California Coast"
5. $225,000 to the University of Massachusetts Amherst and the NOAA Southwest Fisheries Science Center for "Understanding ocean warming impacts on shrinking body sizes of California fishes: Linking pattern & mechanism to support future sustainable fisheries"
6. $249,912 to the University of California Davis for "Assessing the combined effects of ocean acidification and warming on disease susceptibility and restoration success of the critically endangered white abalone"
7. $249,890 to the Pfleger Institute of Environmental Research for "Habitat characterization, fishery development and stock structure of swordfish off California"
8. $249,169 to San Diego State University for "A multi-faceted approach to enhance sustainability of the California spiny lobster fishery"
9. $246,545 to the Scripps Institution of Oceanography at the University of California San Diego for "Reconstructing the population dynamics of southern California Paralabrax spp. in the face of a changing ocean"

10. $239,103 to the University of California Davis for "Improving management under the Marine Life Management Act (MLMA) by accounting for effects of Marine Life Protection Act (MLPA) Marine Protected Areas (MPAs) on fisheries"
11. $249,804 to Moss Landing Marine Labs at San Jose State University for "Sea Feeds: Identification and culture of Californian marine macroalgae capable of reducing greenhouse gas production from ruminant livestock"
12. $249,997 to the Scripps Institution of Oceanography at the University of California San Diego for "A DNA metabarcoding approach to monitoring fish spawning and population connectivity in Coastal Southern and Central California"

COMPETITIVE PROPOSITION 84 PROGRAM BACKGROUND:
The proposed projects were selected through a competitive grant process which will be funded through OPC's Proposition 84 funds. OPC approved the initiation and implementation of the Proposition 84 competitive grant program at its August 2017 meeting.[1] The OPC Proposition 84 Competitive Grant Program has involved a close partnership between California Sea Grant, the University of Southern California Sea Grant (Sea Grant Programs), and OPC staff. OPC staff worked with the Sea Grant Programs to develop a pre-proposal solicitation, assemble the review committees, and develop the full proposal solicitation[2]. The review committees were composed of academic scientists, subject matter experts, and state and federal agency staff. OPC staff participated in the review committee meetings; however, OPC staff did not provide a score for the proposals. The review committee recommended a ranked list of projects for funding to OPC staff, and final funding recommendation decisions were made by the OPC Executive Director to be provided to the OPC. If the projects are approved by OPC, the Sea Grant Programs will administer the awards to the project applicants and be responsible for ongoing grant management.

AGENDA ITEM 5(b): OCEAN ACIDIFICATION, HYPOXIA & OTHER CHANGES IN OCEAN CONDITIONS FROM A CHANGING CLIMATE[3]

Agenda Item 5(b)(1) PROJECT SUMMARY: An ecophysiological framework to assess hypoxia driven habitat loss in the California Current Ecosystem – University of Washington

Project Description
This project, which is a partnership between of University of Washington, University of South Florida, and the Southern California Coastal Water Research Project, focuses on assessing present and future species vulnerability to hypoxia in the California Current Ecosystem. The goal

[1] The staff recommendation is available here. OPC staff provided additional detail on the competitive grant program at the November 2017 meeting, and the staff memo with additional information is available here.
[2] Full Request for Proposals (RFP) is available here, which includes the priority topic areas and selection criteria.
[3] Agenda Item 5(c), addressing sea level rise, Agenda Item 5(d), addressing coastal sediment management, Agenda Item 7, addressing marine renewable energy, and Agenda Item 8(a), addressing marine pollution, are included in a separate staff recommendation for competitive Prop. 84 projects being administered by the University of California Sea Grant.

of this project is to apply a mechanistic ecophysiological framework and statistical species distribution models within an earth systems model to evaluate species responses to temperature-dependent hypoxic habitat compression in the California Current Ecosystem (CCE) ecosystem. This project will involve four major steps that link laboratory measurements and field observations with high-resolution ocean modeling and communication to stakeholders. First, the team will measure the temperature-dependent hypoxia tolerance for three key species in the CCE. Second, they will use those data in combination with ocean model hindcasts, to compute historical habitat variability using ecophysiological models. Third, they will project future changes in aerobic habitat constraints using climate change projections of warming and oxygen loss downscaled to the CCE using the same high-resolution ocean model. Finally, they will engage in outreach with resource managers and agencies to best consider how this framework can be used for assessing habitat vulnerability. This last element will include stakeholder meetings and disseminating data resources and visualizations of hypoxia vulnerability for present-day and future conditions, with a particular emphasis on the differential exposure across the current network of Marine Protected Areas in California, so managers can be proactive and prepared in future decision-making under global ocean change by conducting vulnerability assessments, managing coastal pollution, and framing decisions within realistic and informed projections of climate change effects on species. Overall, this project will document the potential impact of hypoxia on marine organisms and answer a key management question identified by California and West Coast marine resource and water quality managers: What marine functional groups and habitats are most vulnerable to hypoxia and co-occurring stressors (e.g. temperature, acidification), and how will they impact ecosystem services?

This project builds upon a broader project recently funded by the National Oceanic and Atmospheric Administration (NOAA) to evaluate vulnerability of the California Current Ecosystem to multiple stressors of temperature and oxygen loss driven by climate change. That project used many of the same scientific assets and frameworks, but focuses on groundfish and benthic invertebrates, in contrast to the pelagic species addressed in this project. Specifically, this work advances the understanding of vulnerability for anchovy, sardine, and squid. This project will allow for assessment of present and future species vulnerability to hypoxia in the California Current Ecosystem, as well as provide support for California fisheries management and water quality regulatory processes (through entities such as the California Department of Fish and Wildlife and the State Water Resources Control Board) through updated habitat assessment tools.

Project Timeline

This is a 3-year project that would end in December of 2021.

Project Financing

Staff recommends that OPC approve disbursement of up to $246,114 from Sea Grant to the University of Washington to implement “An ecophysiological framework to assess hypoxia driven habitat loss in the CA Current Ecosystem”.

Agenda Item 5(b)(2) PROJECT SUMMARY: Benefits beyond biomass: Bio-physical feedbacks within Marine Protected Areas may promote ecosystem resilience in the face of global climate change -- University of California Santa Barbara

Project Description
Marine Protected Areas (MPAs) are a critical tool for conservation and management of economically, socially, and ecologically valuable species in California. The positive effects of MPAs on the biodiversity and abundance of targeted (fished) species are well-described; however, the objective of this research is to consider whether MPAs can promote ecosystem resilience in the face of global climate change. Many commercially important species are at risk due to changing ocean conditions including acidification and hypoxia. This project will examine the potential for MPAs to serve as climate change refuges to economically important species via persistence of kelp forests that mediate the physical and chemical environment. By assessing these additional ecosystem services provided by MPAs, the outcomes of this research can help guide evaluation and adaptive management of California's MPAs, and help California prepare for and reduce harmful impacts of climate change on ecosystems and the services they provide to California's residents and economy.

Project Timeline
This is a 3-year project that would end in December of 2021.

Project Financing
Staff recommends that OPC approve disbursement of up to $247,246 from Sea Grant to the University of California Santa Barbara to implement "Benefits beyond biomass: Bio-physical feedbacks within Marine Protected Areas may promote ecosystem resilience in the face of global climate change".

Agenda Item 5(b)(3) PROJECT SUMMARY: Present and future climatic drivers of domoic acid toxicity in coastal ecosystems of California -- San Francisco State University

Project Description
Domoic acid, a neurotoxic amino acid produced by 26 species of the ubiquitous diatom, Pseudo-nitzschia, poses a significant health threat to marine mammals, seabirds, and humans via transfer of the toxin through the marine food web. Exposure in humans causes a neurotoxic illness known as amnesic shellfish poisoning (ASP); ASP develops when domoic acid--contaminated shellfish are consumed, and is characterized by symptoms ranging from mild gastrointestinal distress to seizures, memory loss, coma and death. Historically, regular monitoring of DA concentrations in edible shellfish tissues has been an effective reactive strategy to protect human consumers from acute exposure, but understanding the environmental factors that contribute to the accelerated growth and enhanced toxicity of Pseudo-nitzschia cells will greatly improve predictive forecasting, and provide a proactive

means to minimize exposure when an ecosystem is expected to turn toxic. At present, there are no reliable metrics linking the environmental drivers of DA production and accumulation by natural Pseudo-nitzschia blooms in the coastal waters of California. This project will test the hypothesis that increased accumulation of DA-producing cells is driven by the levels of two environmental stressors associated with the future ocean: warmer temperatures and more acidic (lower pH) ocean conditions. Whereas previous studies have focused on examining single environmental stressors, this project will seek to understand multiple environmental stressors and their interactions on the production of particulate DA (pDA). The insights from this study will include an understanding of which environmental parameters are valuable predictors of potential DA exposure in coastal ecosystems, and will enable modelers to establish the critical windows of opportunity for enhanced growth and pDA production under climate change scenarios. These findings will be used by water quality and fisheries managers to characterize the degree of risk of DA toxicity to marine ecosystems, crucial fisheries and human health, with the intent of ultimately shaping regulatory and management response around high value fisheries and ecosystems impacted by domoic acid.

Project Timeline
This is a 3-year project that would end in December of 2021.

Project Financing
Staff recommends that OPC approve disbursement of up to $250,000 from Sea Grant to the San Francisco State University to implement "Present and future climatic drivers of domoic acid toxicity in coastal ecosystems of California".

Agenda Item 5(b)(4) PROJECT SUMMARY: Geography of stress: impacts of ocean acidification along the California Coast -- University of California Davis

Project Description
To inform appropriate management and policy responses to address impacts from altered ocean chemistry on California's marine ecosystems and coastal communities, this project aims to understand ecosystem and social vulnerability associated with ocean acidification, or OA on the California coast, with an integrated study of human communities, oceanographic variability, and thresholds for key species to best understand the ways in which OA will affect species and therefore the communities that rely on those species for their livelihoods. The proposed study will synthesize several oceanographic and ecological datasets on the effects of OA and other stressors for harvested shellfish and key ecological species within California. The project team will merge these syntheses with new social science data collected to understand factors that influence adaptive capacity in at-risk communities. This work is a collaborative effort by scientists from several disciplines, has been informed by guidance from stakeholders and managers, and will result in data that can be utilized by the Department of Fish and Wildlife as they consider new regulatory solutions for managing state fisheries and aquaculture in a changing climate.

Although California is at the forefront of science-based policy solutions, long-term planning will be required to prepare for the impacts of these perturbations to ocean chemistry. Thus, a critical need for California is an integrated, transdisciplinary analysis of where and how vulnerability to OA exists so that efforts and management steps can be appropriately targeted and scaled commensurate with the threat and magnitude of changing ocean chemistry. Understanding intertwined natural and social vulnerability requires analyses that are conducted in collaboration with decision-makers, local communities, businesses, and stakeholders.

Project Timeline
This is a 2-year project that would end in December of 2020.

Project Financing
Staff recommends that OPC approve disbursement of up to $250,000 from Sea Grant to the University of California Davis to implement "Geography of stress: Impacts of ocean acidification along the California Coast".

Agenda Item 5(b)(5) PROJECT SUMMARY: Understanding ocean warming impacts on shrinking body sizes of California fishes: Linking pattern & mechanism to support future sustainable fisheries -- University of Massachusetts Amherst and the NOAA Southwest Fisheries Science Center

Project Description
Reductions in body size of marine fishes linked to ocean warming have been reported across numerous ecosystem types and species. These smaller body sizes are in turn linked to lower population biomass and reproductive output, which have serious potential implications for future fisheries yield projections, stock assessments, and ecosystem stability. The underlying mechanisms for this pattern largely remain untested, yet one hypothesis, termed the Gill-Oxygen Limitation Theory (GOLT), has begun to be adopted into models forecasting climate impacts on fisheries. GOLT proposes that reduced body sizes result from constraints on gill size relative to increased metabolic demands and decreased oxygen solubility under warming, however, it has not been empirically validated and its assumptions have been strongly debated. The quality of model projections is inherently defined by correct representation of underlying processes; thus, if this theory is not valid, the parameter values may be fundamentally flawed and produce projections that are incorrect, potentially by orders of magnitude. Depending on the true mechanisms and how they operate, this could mean great under- or overestimation of climate change impacts on fisheries yields. Getting these forecasts right is critical to support sustainable fisheries and ecosystem-based management under climate change, especially in California where ocean resources support the livelihoods and generate hundreds of millions of dollars of revenue each year.

To address this knowledge gap, this project, which is a partnership between University of Massachusetts Amherst, the NOAA Southwest Fisheries Science Center, and the University of California, Davis, tests the proposed mechanisms in a species of high value to California fisheries and ecosystems, the Pacific sardine. Specifically, the project team will (1) quantify the roles of oxygen limitation and gill surface area-body size relationships under variable temperatures; (2) examine relationships of energetic demands and life history trade-offs (i.e., timing and investment in growth vs. reproduction) related to temperature and reduced body sizes; (3) compare the roles of phenotypic plasticity and local adaptation in shaping population level responses to ocean warming. Direct project outcomes include the establishment of valid physiological mechanisms underlying current patterns that can ultimately be integrated into stock assessments and ecological models to predict climate change impacts on California fisheries yields and ecosystems under different management scenarios.

This project will be the first examination of a theory that is being applied in global fisheries projections, perhaps prematurely and with critical consequences for fisheries management. This project aims to provide critical insight into if and how this theory should be applied in future fisheries biomass forecasts and therefore the results will be directly applicable to California fisheries managers.

Project Timeline
This is a 3-year project that would end in November of 2021.

Project Financing
Staff recommends that OPC approve disbursement of up to $225,690 from Sea Grant to the University of Massachusetts Amherst and the NOAA Southwest Fisheries Science Center to implement “Understanding ocean warming impacts on shrinking body sizes of California fishes: Linking pattern & mechanism to support future sustainable fisheries”.

Agenda Item 5(b)(6) PROJECT SUMMARY: Assessing the combined effects of ocean acidification and warming on disease susceptibility and restoration success of the critically endangered white abalone -- University of California Davis

Project Description
The white abalone is an iconic California species, which once supported a lucrative commercial fishery. This long-lived, marine snail ranging from Point Conception, California to Baja California, Mexico was prized as the most delicate and delicious of the seven US abalone species, and fetched the highest price at market. Due to high demand and resulting overfishing, in 2001 it became the first marine invertebrate designated by the federal government as an endangered species, and was recently named one of eight “Species in the Spotlight” by NOAA Fisheries. This designation highlights species that are among those most at risk of extinction in the near future. With only a few thousand animals left in the wild and a population that is declining at a rate of >10% per year, recent success in captive breeding fuels new hope for this species. A successful program for captive white abalone propagation housed at UC Davis Bodega Marine

Laboratory has produced tens of thousands of new young white abalone destined for stocking. Because of the many decades it will take to restore breeding populations of wild white abalone, however, an understanding of how captive breeding and stocking efforts will fare in the face of ocean acidification and changing temperature regimes is crucial for white abalone species recovery. Ocean acidification is an important stressor for marine molluscs, including white abalone. A temperature-dependent disease called Withering Syndrome (WS) is another principal concern for white abalone recovery. This project will carry out experiments on the combined effects of ocean acidification and a temperature-dependent disease (WS) to inform abalone white abalone recovery efforts.

White abalone is an advantageous model species for this work because it is particularly sensitive to WS compared to other California abalone species; however, this work will also inform the recovery efforts for other depleted, abalone species, such as red, green, and pinto abalone, as well as commercial red abalone aquaculture in California. The central approach in the recovery plan for the white abalone is to outplant hatchery-raised individuals into historic habitat where the agent that causes WS is endemic and where OA conditions will occur with increasing intensity and frequency. The project team will investigate how OA and disease might impact captive breeding efforts, as well as stocking and eventual species recovery. They will also investigate potential adaptive capacity in this species to changing ocean conditions by examining the role of different parental lineages under experimental treatments. These results about sensitivity will be immediately applied and incorporated into ongoing efforts to restore white abalone.

Project Timeline
This is a 2-year project that would end in November of 2020.

Project Financing
Staff recommends that OPC approve disbursement of up to $249,912 from Sea Grant to the University of California Davis to implement “Assessing the combined effects of ocean acidification and warming on disease susceptibility and restoration success of the critically endangered white abalone”.

SUSTAINABLE FISHERIES & AQUACULTURE

Agenda Item 6(a)(1) PROJECT SUMMARY: Habitat characterization, fishery development and stock structure of swordfish off California -- Pfleger Institute of Environmental Research

Project Description
This project is a collaborative effort that stems from recent gear innovations and identified data gaps that directly impact management of the California swordfish fishery. This project is focused on improving the essential fishery information and long-term sustainability of the north Pacific swordfish, a valuable West Coast resource that is targeted by California vessels and

contributes significantly to local jobs and economy. California is one of the largest consumers of swordfish globally, and California increasingly relies on imported swordfish to meet domestic demand. In response to the decline in West Coast participation in the swordfish fishery, regional managers, industry, and other partners prioritized the development and trial of alternative methods for harvesting West Coast swordfish. Deep-set buoy gear, a gear design that selectively targets swordfish well below the thermocline during the day in order to decrease risk of interaction with protected species, has been developed and tested in southern California for over seven years under both research and exempted fishing conditions. Throughout gear trials, marketable catch rates have remained above a 95% selectivity level. In early 2018, NMFS issued over 60 experimental fishery permits for deep-set buoy gear. Pacific Fishery Management Council efforts are focused on including deep-set buoy gear as an allowable gear type in the West Coast Fishery Management Plan for Highly Migratory Species, with current work focused on permitting and crafting fishery specifics.

In the eastern North Pacific, swordfish are managed as two independent stocks that vary with respect to productivity, size and current exploitation status. The Eastern Pacific Ocean stock is smaller, less productive and recent projections have determined that overfishing is occurring. The Western and Central North Pacific stock is proposed to be a much larger and healthier stock, with current fishing mortality assumed to be at a sustainable level. The two stocks are managed independently, as the Western and Central North Pacific stock is under oversight of the International Scientific Committee for Tuna and Tuna-like Species, and the Eastern Pacific Ocean stock is managed by the Inter-American Tropical Tuna Commission.

As California moves towards initiating and sculpting the size and characteristics of the new West Coast deep-set buoy gear fishery, clarifying the stock boundary designation and better understanding which stock is being exploited by California fishers is important to ensure sustainable management of this important California resource. This project would conclude in June 2021, and interim information sharing will occur throughout the duration of the project.

Current stock assessments for north Pacific swordfish do not use spatial movement data, and stock delineation is based on historic fishery-dependent data. Pilot swordfish tagging efforts have documented movements that suggest a California Eastern Pacific Ocean stock affiliation, which is a stock that is currently experiencing overfishing. Furthermore, swordfish fine-scale data that are both vertically and horizontally coupled do not exist, and existing modeling efforts utilize either fishery dependent catch data or movement information from other regions. This project will leverage previous OPC and National Marine Fisheries Service (NMFS) funded research as the foundation to test hypotheses and address data needs identified during the development and implementation of a new gear type for the West Coast fishery for swordfish, deep-set buoy gear. This project will (1) couple innovative tagging and genomic techniques to address important regional distribution and stock structure questions, and (2) integrate fine-scale vertical and horizontal movements obtained from tagged fish into habitat-use models currently being developed by NMFS collaborators.

Specific objectives and deliverables of this work include:

1. Document stock affiliation for West Coast swordfish across the California fishery area.
2. Collect fine-scale data on swordfish that are vertically and horizontally coupled.
3. Refine swordfish stock boundary considerations with tagging and genomic analyses.
4. Propose refined West Coast harvest estimates that better reflect stock origin.
5. Publish a fishery independent estimate of swordfish movements and proposed California swordfish stock origin.
6. Incorporate horizontally and vertically coupled swordfish data into Regional Ocean Modelling Systems to inform management of the swordfish fishery in California.

Tagging activities will coincide with deep-set gear trials and ongoing fieldwork. Swordfish caught on deep-set buoy gear or linked buoy gear will be leadered, tagged and released during the summer and fall fishing seasons. Swordfish will be tagged with two types of satellite tag technology both intended to provide horizontal and vertical movement information that will be used to address stock delineation and habitat use questions. Mark-Recapture satellite tags (MR-PATs) will be deployed on at least 40 swordfish off the California coast. An additional 15 or more swordfish will be outfitted with a combination of tag technologies to assess fine-scale habitat use at specific locations. Movement data from this project will be coupled with previous deployments along with all other tagging studies for the West Coast to generate hypotheses on swordfish population structure.

Project Site

The swordfish fishery is primarily between Santa Barbara and San Diego; however, this project will inform where exactly the stock delineation is located off the coast and which stock or stocks California vessels are fishing.

Project Timeline

This is a 2.5-year project that would end in June of 2021.

Project Financing

Staff recommends that OPC approve disbursement of up to $249,890 from Sea Grant to the Pfleger Institute of Environmental Research to implement “Habitat characterization, fishery development and stock structure of swordfish off California.”

Agenda Item 6(a)(2) PROJECT SUMMARY: A multi-faceted approach to enhance sustainability of the California spiny lobster fishery -- San Diego State University

Project Description

The overarching goal of this project is to enhance the sustainability of the California spiny lobster fishery by providing data with direct management application to the state of California. Through a sampling program conducted in collaboration with commercial lobster fishers

throughout Southern California and northern Baja California Mexico, this project proposes to improve understanding of California spiny lobster population dynamics and fishery interactions at a regional scale. Specifically, this project will:

1. Increase the precision of two reproduction parameter estimates used within state management models: female lobster size-at-maturity and fecundity-at-size. Both demographic parameters could inform the state's population model which uses spawning potential ratio as a harvest control rule.
2. Employ next-generation sequencing to determine fine-scale population genetic structure and quantify regional variation in genetic diversity associated with climatic and anthropogenic influences. These data will establish an understanding of the current population structure of spiny lobsters and regional differences in their adaptability to future environmental change. Spatially explicit measures of population connectivity and genetic health will be provided with the goal of improving understanding of regional lobster population dynamics and to provide the basis for predictive models that integrate future climate states.
3. Conduct field experiments to quantify handling mortality of sub-legal sized lobsters and trap-related predation mortality, both of which may differ spatially due to regional variation in fishing effort and predator density. These sources of mortality have the potential to alter lobster abundance estimates because of a recent reduction in the number of traps an individual fisher can deploy and the recent increase in abundance and size of California sheephead, an important lobster predator. Findings from these experiments could inform the state management model.

The California spiny lobster is an ecologically and economically valuable species, and is also considered a keystone species within kelp forests ecosystems. OPC has previously supported work to support the development of the California spiny lobster Fishery Management Plan (FMP), and this work will enhance the management of this important fishery under the FMP. An overarching goal of this regional work is to strengthen collaboration among lobster fishers, researchers working in California and Mexico, and conservation NGOs by engaging stakeholders throughout the research process. Little information is currently available to compare lobster biology across the U.S.-Mexico border, though the current understanding of spiny lobster larval biology suggests that a significant portion of the U.S. stock is spawned in Mexican waters. Thus, an improved understanding of transnational variation in lobster demographics and potential population structure will be of value to future sustainable fisheries management decisions.

Project Site

The California spiny lobster fishery is primarily between Santa Barbara and San Diego. This project will also include a transboundary partnership with Mexico. This species is commonly found on rocky reefs from central California through Magdalena Bay, in Baja California, Mexico. This transboundary partnership is just one component of the above project, and this partnership will benefit California fisheries management and ocean

resources by improving the current understanding of spiny lobster larval biology, which suggests that a significant portion of the U.S. stock is spawned in Mexican waters. An improved understanding of transnational variation in lobster demographics and potential population structure will be essential for future sustainable fisheries management decisions.

Project Timeline
This is a 2-year project that would end in December of 2020.

Project Financing
Staff recommends that OPC approve disbursement of up to $249,169 from Sea Grant to San Diego State University to implement "A multi-faceted approach to enhance sustainability of the California spiny lobster fishery."

Agenda Item 6(a)(3) PROJECT SUMMARY: Reconstructing the population dynamics of southern California Paralabrax species in the face of a changing ocean -- Scripps Institution of Oceanography at the University of California San Diego

Project Description
The saltwater basses (*Paralabrax* species) are an economically-important and popular recreational fishery in California. This state-managed fishery is comprised of three species that are managed as a single unit: Barred Sand Bass, Kelp Bass, and Spotted Sand Bass. The California Department of Fish and Wildlife (CDFW) recently amended the Marine Life Management Act (MLMA) Master Plan for Fisheries, which emphasizes applying the best available scientific information in fisheries management, ensuring fisheries management is adaptive and responsive to the effects of changing ocean conditions, and conserving the health of marine ecosystems, among other priorities. The ability to manage the bass fishery is limited by the lack of long-term species-specific abundance data and limited knowledge of the relationship between environmental variation, fishing effort, and species-specific fishery yields.

California Cooperative Oceanic Fisheries Investigations (CalCOFI) maintains the longest fishery independent dataset for the basses (a 67-year time series of larvae abundance), yet to date these ichthyoplankton (fish larvae and egg) samples have not been identified to specific species. This project proposes the reconstruction of 67 years of California Cooperative Oceanic Fisheries Investigations (CalCOFI) *Paralabrax* species ichthyoplankton (fish eggs and larvae), using a combination of molecular and morphological identification to evaluate species-specific spatio-temporal trends in their population dynamics relative to oceanographic conditions. Pairing long time-series of fishery-independent population abundance with physical (e.g., oceanographic and atmospheric indices) and biological (e.g., prey recruitment index) time series will likely improve estimates of current and future fishery status under changing natural and anthropogenic influences, and will enable investigation of reliable species-specific environmental indicators. These additional tools will help improve monitoring and assessment

and form a framework that to support incorporation of changing ocean conditions into management.

California Cooperative Oceanic Fisheries Investigations (CalCOFI) Background:
Since its inception in 1949, CalCOFI has conducted quarterly surveys to collect discrete hydrographic and biological samples (e.g., fish larvae abundance) at defined sampling locations throughout the southern California Bight. Due to its long temporal coverage and high spatial resolution, the survey has enabled researchers to detect natural and anthropogenic influence on larval fish populations in southern California, and it has the potential to assist additional recreational fishery assessments. Combined with catch and effort data, the CalCOFI data provide the unique opportunity to assess historical and recent spatio-temporal trends in saltwater bass populations.

The proposed research will result in several products, including a long-term fishery-independent time series of *Paralabrax* larval abundance, a species-specific predictive spatial distribution model of larval abundance, and additional diagnostic tools for species identification of formalin-preserved *Paralabrax* larvae. The time-series will be made publicly available via the CalCOFI website and will be valuable to state resources managers for several reasons: 1) it will allow assessment of individual bass stocks; 2) it will help link the deep history of the populations to historical and contemporary ocean conditions and ongoing climate changes; and, 3) it will establish a basis for assessment approaches that explicitly incorporate oceanography and climate change for the genus. In addition, the spatial model has the potential to be used as a template for other fish species. Overall, this project would provide the information necessary to support the State's efforts to sustainably manage the important bass fisheries under the MLMA Master Plan, and in the face of a changing ocean.

Project Timeline
This is a 3-year project that would end in December of 2021.

Project Financing
Staff recommends that OPC approve disbursement of up to $246,545 from Sea Grant to the Scripps Institution of Oceanography at the University of California San Diego to implement "Reconstructing the population dynamics of southern California Paralabrax species in the face of a changing ocean".

Agenda Item 6(a)(4) PROJECT SUMMARY: Improving management under the Marine Life Management Act (MLMA) by accounting for effects of Marine Life Protection Act (MLPA) Marine Protected Areas (MPAs) on fisheries -- University of California Davis

Project Description
This project seeks to understand future management outcomes under both the Marine Life Management Act (MLMA) and the Marine Life Protected Act (MLPA) by utilizing existing data

sources to project the variation in species responses to combined MPA management and fisheries management. This project will develop new species life history models, utilizing information on growth rates, mortality rates, and age-specific fecundities, to address adaptive management of the contribution of Marine Protected Areas (MPAs) to fisheries yields outside of MPAs. Ultimately, objective 1 of this project will develop predictions of transient changes in fishery yield following MPA implementation for nineteen fishery species. These predictions will account for existing knowledge of stock status and expected fishing fleet behaviors. The project will provide a description of how the expected transient increase in fishery yield due to implementation of MPAs may depend on differences in life histories and fishing level, for different levels of larval connectivity and the stock-recruitment parameters.

The second objective of this project is to use this life history information to quantify potential benefits of MPAs to fished populations, such as the increase in resilience to environmental variability, including climate change. The project will use a new concept describing how age structured populations like marine fish, invertebrates, and birds respond to random environmental variability, a phenomenon termed cohort resonance. Cohort resonance analyses will translate life history information (more specifically the age-dependence of spawning) into the change in resilience and stability (i.e. the reduction in variance) of a fish population provided by MPAs. This project will provide a description of how restoration of natural age structures in MPAs may reduce variability and increase resilience along the coast in conjunction with interspersed areas of managed fisheries. Results and outcomes from this project will be made publicly accessible.

The project's research objectives will advance the linkages between adaptive management under the MLMA and MLPA, in terms of prediction, quantification of effects, and data reporting by improving understanding of how MPAs may contribute to increases in fisheries yields outside of MPAs.

Project Timeline
This is a 2-year project that would end in December of 2020.

Project Financing
Staff recommends that OPC approve disbursement of up to $239,103 from Sea Grant to the University of California Davis to implement "Improving management under the Marine Life Management Act (MLMA) by accounting for effects of Marine Life Protection Act (MLPA) Marine Protected Areas (MPAs) on fisheries."

Agenda Item 6(a)(5) PROJECT SUMMARY: Sea Feeds: Identification and culture of Californian marine macroalgae capable of reducing greenhouse gas production from ruminant livestock -- Moss Landing Marine Labs at San Jose State University

Project Description

To address climate change in California beyond carbon-based gases, the state has recently passed legislation to reduce short-lived climate pollutants. In particular, the state aims for a 40% methane reduction by 2030. Several reductions may come through existing technologies associated with landfills and energy producers. However, the state's largest contributor to methane production is cattle, specifically 1.4 million resident dairy cows and 1 million beef cattle. Methods to reduce gases produced from cattle have largely been unexplored in California. However, recent research in Australia has shown that some species of sub-tropical seaweed can reduce methane production from cattle by up to 99% when used as a feed additive at 2% inclusion rates of organic matter. Temperate species have not yet been assessed for methane reducing properties, but many of the species present in the California Current Ecosystem are closely related to these sub-tropical species. This project's objectives consist of measuring the *in vitro* effects of 20 different species of local seaweed on total gas production and digestibility when added to cattle diets. Methane reducing candidate species will be cultured at Moss Landing Marine Labs to determine optimal culture conditions and scalability to be used as a feed additive for ruminant livestock. The most promising seaweed species will be examined *in vivo* on dairy cattle to determine the whole animal effect on digestion and methane emissions. While this proposal does not address details associated with large-scale seaweed cultivation necessary for growing the quantities necessary for livestock feed, it is prudent to theoretically consider the scalability of seaweed production, and the potential for seaweed as a feed additive for cattle to reduce overall methane emissions in the state.

Specific project objectives include:

1. To collect and identify macroalgal species present off the California coast that may reduce the enteric production of methane when used as feed additives in ruminant diets using *in vitro* methods.
2. To measure growth/nutrient uptake rates and suitability of candidate methane reducing macroalgae for aquaculture production systems.
3. To determine the *in vivo* digestibility and enteric methane production for dairy cattle fed the candidate macroalgal species displaying the best aquaculture potential and enteric methane reduction.

Specific project outcomes and deliverables include:

1. Generate nutrient profiles for 20 species of seaweed found in California
2. Establish digestibility as a feed additive of all 20 species of seaweed in cattle using *in vitro* techniques
3. Determine total gas/methane production from 5 candidate seaweed species at several inclusion rates in cattle using *in vitro* techniques
4. Assess growth rate, productivity and nutrient uptake rate for 5 candidate seaweed species in tumble culture systems at 2 different temperatures
5. Produce 200 kg (dry weight) of the seaweed showing the best combination of enteric methane reduction and aquaculture potential in the culture system

6. Determination of candidate seaweed species effects on digestibility and methane gas emissions in whole dairy cows
7. Communicate project outcomes to agency, industry, academic, and other stakeholders

This project would utilize an existing land-based aquaculture facility to advance project objectives to scientifically quantify which seaweeds are capable of both greenhouse gas reductions and rapid absorption of dissolved nutrients during cultivation. The project is framed in the context of seaweed aquaculture having shown to be effective in bioremediation of coastal eutrophic areas in terms of absorbing agricultural nutrient nonpoint source pollutants, as well as seaweed aquaculture being relatively lower impact. Results from this project would inform the California Air Resources Board and the California State Water Resources Control Board regarding methane and nutrient reductions, respectively. It would also theoretically consider the scalability of seaweed production, and the potential for seaweed as a feed additive for cattle to reduce overall methane emissions in the state, which would inform the potential for aquaculture industries to provide alternative economic growth for coastal communities in California.

Project Timeline
This is a 3-year project that would end in December of 2021.

Project Financing
Staff recommends that OPC approve disbursement of up to $249,804 from Sea Grant to the Moss Landing Marine Labs at San Jose State University to implement “Sea Feeds: Identification and culture of Californian marine macroalgae capable of reducing greenhouse gas production from ruminant livestock.”

Agenda Item 6(a)(6) PROJECT SUMMARY: A DNA metabarcoding approach to monitoring fish spawning and population connectivity in Coastal Southern and Central California -- Scripps Institution of Oceanography at the University of California San Diego

Project Description
Changes in global climate are impacting many parameters of the ocean environment including temperature, pH, nutrient levels, and oxygen concentrations. These changes, along with direct anthropogenic impacts may be altering the distribution and abundance of marine fish in California's coastal ecosystems with potentially significant consequences on commercial and recreational fisheries. Although changes in distributions of adult fish may be more apparent, alterations in reproductive activity may be harder to identify, and in some cases, only impact adult populations years later. Fine scale temporal studies of the distribution and abundance of fish eggs and larvae can provide early notice of changes in spawning activity that could play an important role in fisheries management and conservation efforts. This project will develop methods of DNA metabarcoding, which is a DNA-based method of species identification, to provide a cost-effective and comprehensive analysis of fish spawning at six shore stations that are part of the Southern California Coastal Ocean Observing System (SCCOOS) and the Central

and Northern California Coastal Observing System (CeNCOOS). This will leverage the extensive environmental data collected at these observing system sites towards gaining an understanding of key factors influencing temporal variation in coastal California fish populations. Building on standard metabarcoding approaches, this project will use techniques for species identification, as well as a highly variable genetic marker frequently used to examine levels of connectivity among populations within species. This will require development of a control region barcode database which will be established from an existing set of DNA samples from over 600 species of California marine fish. The resulting data set will be unprecedented in providing information on both spawning patterns as well as population structure for all species obtained (in sufficient numbers) across the six sites along the coast from La Jolla in the south to Santa Cruz in the north.

This project will develop a comprehensive analysis of fish spawning activity and connectivity between California coastal populations through the following specific objectives:

1. Collect weekly plankton samples from six SCCOOS and CeNCOOS shore stations for two years. Analyses will focus on fish eggs obtained from these samples, but the remainder of the samples. will be ethanol preserved and made available for use in future studies by other investigators
2. Develop an efficient DNA metabarcoding approach to characterizing coastal California ichthyoplankton communities.
3. Test the performance of the metabarcoding approach over a 24-month sampling period by comparing results of egg-by-egg barcoding to the bulk metabarcoding approach in a large set of split samples taken from the La Jolla and San Luis Obispo shore stations.
4. Develop a novel approach to simultaneously address both species identification and population structure in a metabarcoding framework. The approach expands a standard metabarcoding method to include a type of control region sequencing which has significant capacity for revealing population connectivity.
5. Share results regarding the distribution of fish eggs in time and space at stations from Santa Cruz to San Diego and initial estimates of connectivity for all species collected in two or more stations.

This project seeks to provide direct information on spawning activities and population connectivity among numerous species along the coast which may facilitate evaluation of MPAs and other ecosystem-level management actions. By allowing the rapid processing of large numbers of samples, metabarcoding technology will help fill key data gaps, providing taxonomically resolved data on impacts of environmental change on reproduction in coastal fish communities. The methodology also has potential for future analyses of other fish communities, such as those sampled by the CalCOFI program. By revealing the reproductive behavior of a large number of coastal fish species, ichthyoplankton surveys can provide a sensitive indicator of ecosystem response to environmental change, which will help inform management decisions for these species.

Project Site
This project will focus on six sites along the coast from La Jolla in the south to Santa Cruz in the north.

Project Timeline
This is a 2-year project that would end in December of 2020.

Project Financing
Staff recommends that OPC approve disbursement of up to $249,997 from Sea Grant to the Scripps Institution of Oceanography at the University of California San Diego to implement "A DNA metabarcoding approach to monitoring fish spawning and population connectivity in Coastal Southern and Central California."

FUNDING SOURCE FOR ALL PROJECTS AND CONSISTENCY WITH PROPOSITION 84: (Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006)
The anticipated source of funds for these projects is OPC's appropriation pursuant to the Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006 (Proposition 84). Proposition 84 authorizes the use of funds for purposes consistent with Section 35650 of the Public Resources Code, establishing the California Ocean Protection Trust Fund (Pub. Res. Code § 75060(g)). Under Section 35650(b), Ocean Protection Trust Fund monies may be expended for projects authorized by the OPC that are identified as appropriate Trust Fund purposes, as specified. The project is consistent with the Trust Fund purposes as discussed in the following section.

Summary of Recommended Proposition 84 Ocean Acidification & Hypoxia and Sustainable Fisheries & Aquaculture Projects	**Recommended OPC Funding from Prop 84**
Ocean Acidification, Hypoxia & Other Changes In Ocean Conditions From A Changing Climate	
An ecophysiological framework to assess hypoxia driven habitat loss in the CA Current Ecosystem	$246,114
Benefits beyond biomass: Bio-physical feedbacks within Marine Protected Areas may promote ecosystem resilience in the face of global climate change	$247,246
Present and future climatic drivers of domoic acid toxicity in coastal ecosystems of California	$250,000
Geography of Stress: Impacts of ocean acidification along the California Coast	$250,000
Understanding ocean warming impacts on shrinking body sizes of California fishes: Linking pattern & mechanism to support future sustainable fisheries	$225,000

Assessing the combined effects of ocean acidification and warming on disease susceptibility and restoration success of the critically endangered white abalone	$249,912
Sustainable Fisheries & Aquaculture	
Habitat characterization, fishery development and stock structure of swordfish off California	$249,890
A multi-faceted approach to enhance sustainability of the California spiny lobster fishery	$249,169
Reconstructing the population dynamics of southern California Paralabrax species in the face of a changing ocean	$246,545
Improving management under the Marine Life Management Act (MLMA) by accounting for effects of Marine Life Protection Act (MLPA) Marine Protected Areas (MPAs) on fisheries	$239,103
Sea Feeds: Identification and culture of Californian marine macroalgae capable of reducing greenhouse gas production from ruminant livestock	$249,804
A DNA metabarcoding approach to monitoring fish spawning and population connectivity in Coastal Southern and Central California	$249,997
SUBTOTAL	**$2,953,650**
Recommended in other staff recommendation for Items 5, 7 & 8	$2,951,135
Competitive Prop 84 Grant Program projects recommended at this meeting – TOTAL	**$5,904,785**

CONSISTENCY WITH CALIFORNIA OCEAN PROTECTION ACT:

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

- Improve the management of fisheries
- Foster sustainable fisheries
- Allow for increased public access to, and enjoyment of, ocean and coastal resources, of those resources
- Improve management, conservation, and protection of coastal waters and ocean ecosystems
- Provide monitoring and scientific data to improve state efforts to protect and conserve ocean resources
- Protect, conserve, and restore coastal waters and ocean ecosystems
- 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

Research funded through this Prop 84 Competitive Grant Program will meet these directives because the projects will directly focus on collecting and disseminating information and conducting research across a suite of priorities that will inform current data and knowledge gaps for managers.

CONSISTENCY WITH OPC'S STRATEGIC PLAN:
All of the staff-recommended Ocean Acidification, Hypoxia & Other Changes In Ocean Conditions From A Changing Climate and Sustainable Fisheries and Aquaculture projects implement the following OPC Strategic Plan focal areas: Focal Area A: Science Based Decision Making, Focal Area B: Climate Change, Focal Area C: Sustainable Fisheries and Marine Ecosystems, Focal Area D: Coastal and Ocean Impacts from Land, and Focal Area E: Existing and Emerging Ocean Uses.

CONSISTENCY WITH THE OPC'S GRANT PROGRAM FUNDING GUIDELINES:
The proposed project is consistent with the OPC's interim Grant Program Funding Guidelines for Proposition 84, in the following respects:

Required Criteria

1. Directly relate to the ocean, coast, associated estuaries, or coastal-draining watersheds: *All projects directly relate to the ocean, coast, associated estuaries and/or coastal-draining watersheds and the suite of research projects will improve understanding of ocean and coastal resources and may lead to improved resources management.*
2. Support of the public: *See Exhibits 5a1-6b5*
3. Greater-than-local interest: *Many of these projects are statewide or regional in nature with the potential to inform other regions or localities.*

Additional Criteria

1. Improvements to management approaches or techniques: *The suite of research projects in this staff recommendation are innovative because they require researchers to directly link their work to management issues and therefore could result in more swift management improvements or techniques.*
2. Resolution of more than one issue: *Given the diversity of projects listed above, this funding has the ability to advance understanding across a range of issues and offer potential solutions.*
3. Leverage: *Many projects leverage current, ongoing work or field experiments, and some projects build upon previous OPC-funded projects and investments.*
4. Coordination: *Links are necessary between university natural and social scientists, state resource managers and policy makers to ensure that research informs long-term policies that lead to the recovery and sustainability of the state's coastal resources. OPC staff and the Sea Grant programs will work closely with the grantees throughout the projects as appropriate to share findings and deliverables.*

Additionally, evaluation of all aforementioned projects by the review committees was based on the following criteria, as stated in the Request for Proposals:

1. **Project Rationale and Relevance:** The degree to which the proposed project addresses an important issue, scientific problem, information gap, or opportunity in the health, development, use or management of marine or coastal resources and ecosystems, as stated in the list of priority topic areas.
2. **Research/Scientific Merit:** The degree to which the proposed project will advance the state of the science or discipline through use of state-of-the-art robust methods.
3. **Innovativeness**: The degree to which new approaches to solving problems and exploiting opportunities in resource management or development will be employed in the proposed project
4. **User Relationships:** The degree to which the users or potential users of the proposed project's results have been brought into the planning of the proposed project, will be brought into the execution of the proposed project or will be kept apprised of progress and results.
5. **Qualifications of Investigators:** The degree to which investigators are qualified by education, training and/or experience to execute the proposed project. Evidence of any record of achievement with previous funding.

COMPLIANCE WITH THE CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA):

The following proposed projects are not 'legal projects' that triggers the California Environmental Quality Act (CEQA) pursuant to Public Resources Code section 21068 and Title 14 of the California Code of Regulations, section 15378, because they will not cause a direct physical change or reasonably foreseeable indirect physical change in the environment:

- Present and future climatic drivers of domoic acid toxicity in coastal ecosystems of California
- Geography of stress: impacts of ocean acidification along the California Coast
- Enhancing management under the Marine Life Management Act (MLMA) by accounting for effects of Marine Life Protection Act (MLPA) Marine Protected Areas (MPAs) on fisheries

The following proposed projects are categorically exempt from review under CEQA pursuant to Title 14 of the California Code of Regulations Section 15306 - Information Collection, because they involve basic data collection, research, experimental management, and resource evaluation activities that will not result in a serious or major disturbance to an environmental resource. Staff will file Notice of Exemptions for these projects upon approval by OPC:

- An ecophysiological framework to assess hypoxia driven habitat loss in the California Current Ecosystem
- Benefits beyond biomass: Bio-physical feedbacks within Marine Protected Areas may promote ecosystem resilience in the face of global climate change
- Understanding ocean warming impacts on shrinking body sizes of California fishes: Linking pattern & mechanism to support future sustainable fisheries

- Assessing the combined effects of ocean acidification and warming on disease susceptibility and restoration success of the critically endangered white abalone
- Habitat characterization, fishery development and stock structure of swordfish off California
- A multi-faceted approach to enhance sustainability of the California spiny lobster fishery
- Reconstructing the population dynamics of southern California Paralabrax species in the face of a changing ocean
- Sea Feeds: Identification and culture of Californian marine macroalgae capable of reducing greenhouse gas production from ruminant livestock
- A DNA metabarcoding approach to monitoring fish spawning and population connectivity in Coastal Southern and Central California