California Ocean Litter Prevention Strategy: Addressing Marine Debris from Source to Sea

REVISED DRAFT

January 22, 2018

PLEASE NOTE*

Thank you for taking the time to review the draft *California Ocean Litter Prevention Strategy: Addressing Marine Debris from Source to Sea (Strategy).* The draft Strategy was developed based on a wide range of stakeholder input and identifies Goals, Objectives, and a list of Action Items for stakeholders to collaboratively implement to prevent and reduce ocean litter; it has been revised significantly based on input received during the first public comment period (September to October 2017), and the second Workshop that took place in November 2017.

Please note that this document is not meant to be a "consensus document" (i.e., not every organization will agree with the inclusion of all Action Items in the Strategy), but rather, is meant to provide an opportunity and a framework for many different organizations, with different mandates, to contribute to addressing the problem of ocean litter in California over the next six years. We encourage reviewers to focus on those Action Items that align with existing organizational priorities.

During this public comment period, we are soliciting feedback on the following:

1. Action Item sign-ups: Please identify any Action Items that you (and your organization) are interested in taking a lead or partnership role in implementing. Lead Organizations are committed to implementing an Action Item, given organizational and funding constraints; they will serve as the point of contact for NOAA and OPC for progress reports and check-ins throughout the Strategy's six-year timeframe, and will take a leadership role in communicating and coordinating with other collaborators/Partner Organizations on the Action Item. Partner Organizations will serve a supporting role in implementing an Action Item, in collaboration with Lead and other Partner Organizations.
    a) For those organizations that are already listed next to Action Items in the draft Strategy, please review where your organization is listed and let the planning team know if you would like your organization's status to be changed (i.e., if you would like to become a Lead Organization rather than a Partner Organization, or vice versa, or if you would like to be removed from the Action Item entirely).
    b) Note: Please be sure to specify how you would like your or your organization's name to appear in the Strategy. Additionally, please specify who from your organization should be added to our listserv, so that we know who to reach out to when the time comes to start contacting Lead and Partner Organizations.

2. OPC priorities: Please review and provide comments on OPC priorities that are outlined in this draft. In particular, please pay attention to the proposed timelines associated with the priorities, and the feasibility of achieving the priorities in the next six years.

3. Action Item language: If you would like significant changes made to the language of specific Action Items, please accompany your suggested edits with justifications.

4. **Strategy implementation scheme:** Do you think that conducting check-ins every six months will be too frequent, too infrequent?

Please send comments, edits, and questions regarding the draft Strategy to oceanlitterstrategy@resources.ca.gov **by Friday, February 23, 2018.** When sending your comments, please include your thoughts on the above four questions. We anticipate that a final draft of the Strategy will be circulated early- to mid-April.

Thanks again and we look forward to hearing from you.

Sincerely,

The Planning Team

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EXECUTIVE SUMMARY

Ocean litter is a pervasive problem at local, regional, and global scales with a wide range of consequences to human health, the environment, and the economy. Immediate, collaborative action to reduce and prevent ocean litter will ensure that California communities, environments, and economies remain productive and vibrant. The Ocean Protection Council (OPC) and the National Oceanic and Atmospheric Administration's Marine Debris Program (NOAA MDP) present this update to OPC's 2008 *An Implementation Strategy for the California Ocean Protection Council Resolution to Reduce and Prevent Ocean Litter*. The 2018 *California Ocean Litter Prevention Strategy: Addressing Marine Debris from Source to Sea* (Strategy) will provide structure and guidance for California stakeholders to efficiently address this pressing issue.

The 2008 Strategy served as a powerful and effective document to promote action on addressing ocean litter. Since 2008, many of the actions described in the document have either been accomplished or are in progress. For example, the statewide plastic bag ban was ratified by voters in 2016, and the State Water Resources Control Board's Trash Amendments were adopted in 2015. While we have made great strides in addressing ocean litter in California, our understanding of the issue has changed considerably in the last decade. For example, the investigation of microplastics' presence in aquatic ecosystems and impacts on marine life has increased dramatically over the last ten years. This 2018 update expands the previous Strategy to include projects of a variety of scales and scopes so that entities including government agencies, industry, academia, nonprofits, and tribes can collaborate on meaningful contributions to reducing ocean litter in California.

A wide range of stakeholder input was gathered during two Workshops and two rounds of public comment. The resulting Strategy is organized into Goals, Objectives, and specific Action Items. Contributors to this document developed Action Items that are politically, socially, and economically feasible for California to accomplish within the next six years. The Strategy prioritizes source reduction Goals and Action Items, as agencies and experts agree that source reduction is the most effective tactic to address ocean litter.

Most Action Items are accompanied by a list of Lead and/or Partner Organizations. Given the many dynamic and influential ocean litter stakeholders in California, the Strategy provides an opportunity for organizations to take a leadership role on Action Items that align with their respective goals and mandates. OPC and NOAA MDP are committed to providing overall leadership and coordination on tracking progress on Strategy implementation, facilitating communication between partner organizations, and sharing updates among interested stakeholders.

Throughout the process of developing the 2018 Strategy, stakeholders expressed interest in OPC articulating its priorities for ocean litter. OPC's proposed priorities to address ocean litter are laid out in the "California Ocean Protection Council Priorities to Address Ocean Litter" section of the Strategy. Implementation of OPC Priorities will occur over the next six years, and stakeholders

will receive updates on OPC staff's progress on implementing these priorities at least annually as part of the California Ocean Litter Strategy implementation process. OPC's priorities can be divided into three broad categories, land-based sources of ocean litter, microplastics and microfibers, and fishing and aquaculture gear.

In summary, this document provides a holistic, collaborative strategy for addressing ocean litter in California, with a focus on reducing land-based litter at its source. It focuses on high impact Action Items that entities can commit to working on over the next six years. The document provides both guidance and flexibility so that Lead and Partner Organizations can work collaboratively to pursue funding (where needed) and implement these Action Items. Partnership across sectors is necessary to reduce and prevent ocean litter and ensure a healthy coast and ocean for current and future generations of Californians.

LIST OF ACRONYMS

AB	Assembly Bill
ACC	American Chemistry Council
BACWA	Bay Area Clean Water Agencies
BMP(s)	Best Management Practice(s)
CalRecycle	California Department of Resources Recycling and Recovery
CASA	California Association of Sanitation Agencies
CDFW	California Department of Fish and Wildlife
CSU	California State University
CSUCI	California State University, Channel Islands
CSULB	California State University, Long Beach
DTSC	California Department of Toxic Substances Control
EPA	Environmental Protection Agency
EPR	Extended Producer Responsibility
ESRM	Environmental Science and Resource Management
FGC	California Fish and Game Commission
FTIR	Fourier Transform Infrared
GPS	Global Positioning System
IGISc	Institute for Geographic Information Science
NOAA	National Oceanic and Atmospheric Administration
NOAA MDP	National Oceanic and Atmospheric Administration Marine Debris Program
OPC	California Ocean Protection Council
PRCC	Plastic Recycling Corporation of California
SB	Senate Bill
SCAP	Southern California Alliance of Publicly Owned Treatment Works
SCCWRP	Southern California Coastal Water Research Project
SDSU	San Diego State University
SFEI	San Francisco Estuary Institute
SFSU	San Francisco State University
UC	University of California
UNEP	United Nations Environment Programme
WTO	World Trade Organization

GLOSSARY OF COMMONLY USED TERMS

Common Ocean Litter Items: Items that are most prevalent in ocean litter found in or on California's waterways, coastlines, or ocean, as defined by relevant datasets (e.g., Coastal Cleanup Day data). Currently, based on Coastal Cleanup Day data (California Coastal Commission 2017), common ocean litter items in California are primarily plastic, single-use items, items which are conventionally disposed of after one use and persist in aquatic environments.

Land-Based Ocean Litter: Items that became litter on land (via land-based activities) and subsequently entered the aquatic environment.

Lead Organization: Lead organizations are committed to implementing an Action Item, given organizational and funding constraints. Lead organizations will serve as the point of contact for NOAA and OPC for progress reports and check-ins throughout the Strategy's six-year timeframe, and will take a leadership role in communicating and coordinating with other collaborators/partner organizations on the Action Item.

Marine Debris: any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes (15 C.F.R. Part 909 Section 909.1).

Ocean-Based Debris: Litter or other debris (e.g., lost fishing gear) that entered the marine environment via activities that occurred at sea.

Partner Organization: Partner organizations will serve a supporting role in implementing an Action Item, in collaboration with Lead and other Partner Organizations.

BACKGROUND

The Global Problem of Ocean Litter

Ocean litter, or marine debris, is a persistent, well-documented problem of global scale. Anthropogenic litter has been observed on seafloors and in submarine canyons (Pham et al. 2014, Lee et al. 2006), in sediments (Claessens et al. 2011, Mistri et al. 2017), surface waters (Isobe et al. 2017, Suaria et al. 2016, Law et al. 2010), and the water column (Lattin et al. 2004), and on beaches and shorelines worldwide (Ocean Conservancy 2017, Browne et al. 2011). While there are many ways to classify ocean litter, it is common to characterize it as either land-based or ocean-based, depending on how it enters the marine environment (Galgani et al. 2015). Land-based litter can enter the ocean through poor or inefficient waste management systems, or intentional or unintentional littering by individuals and industries (UNEP and GRID-Arendal 2016, Galgani et al. 2015). Furthermore, land-based litter may be discharged directly onto coastlines (through coastal tourism or recreation, for instance), or it may make its way to the marine environment through water treatment systems (especially in the case of microplastics), storm drains, rivers, or by wind (UNEP and GRID-Arendal 2016, Galgani et al. 2015, Rech et al. 2014). Ocean-based litter, on the other hand, is generated by the intentional or unintentional discharge of debris directly into the ocean. Marine activities that generate ocean-based litter include commercial shipping, recreational and commercial fishing, aquaculture, research and military endeavors, and offshore drilling (UNEP and GRID-Arendal 2016, Galgani et al. 2015).

The majority of marine debris comes from land-based sources, though ocean-based debris can be significant in some areas (e.g., Jang et al. 2014). Debris sources are dependent on nearby human activity (recreational beach use, shipping, fishing), proximity to population centers, and the efficiency of waste management systems (Jambeck et al. 2015, UNEP and GRID-Arendal 2016, Galgani et al. 2015). Whether land-based or ocean-based, most of the litter found in the world's oceans is plastic (Galgani et al. 2015, Derraik 2002). Between 1950 and 2015, 6300 million metric tons of primary and secondary (or recycled) plastic waste was produced worldwide (Geyer et al. 2017). Approximately 12% of this plastic waste was incinerated, and 9% was recycled, while 79% was discarded and is currently sitting in landfills or the environment (see Fig. 1 for historical and projected levels of plastic waste production and disposal) (Geyer et al. 2017). Currently, most (42%) of the primary non-fiber plastic produced comes in the form of packaging, most of which is used and disposed of within the same year it is produced (Geyer et al. 2017). Globally, it is estimated that between 4.8 and 12.7 million metric tons of plastic enter the ocean from land every year (Jambeck et al. 2015).

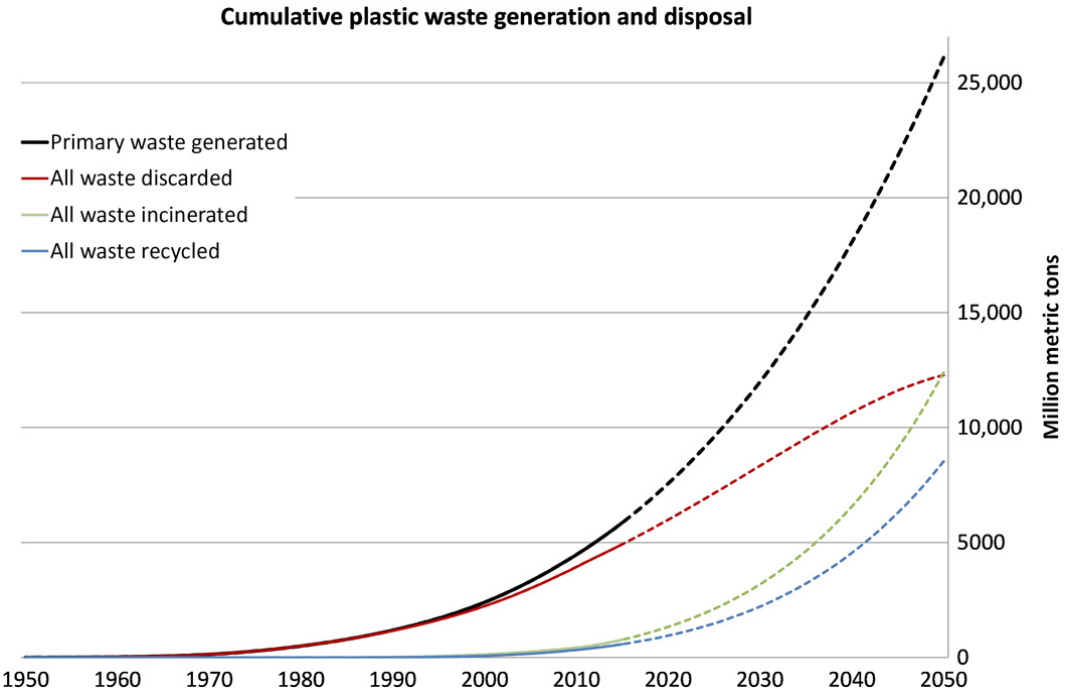


Fig.1. Historical and projected global cumulative plastic waste generation and disposal (here, disposal refers to how plastic waste is managed – either through incineration, recycling, or discard into landfills or the environment). Solid lines show historical data from 1950 to 2015, dotted lines show projections of historical trends to 2050. It is estimated that by 2050, 26,000 million metric tons of primary plastic waste will have been generated, 9,000 million metric tons of plastic waste will have been recycled, 12,000 million metric tons will have been incinerated, and another 12,000 million metric tons will have been discarded in landfills or the environment. Figure from Geyer et al. 2017.

Ocean litter has detrimental ecological, economic, and social impacts. Marine species, including seals, sea birds, sea turtles, whales, and dolphins, are entangled in debris, resulting in hindered movement, decreased feeding ability, injury, and death (NOAA MDP 2014, Kühn et al. 2015). Marine debris smothers and shades coral reefs and salt marshes, disrupting growth and surface cover (Richards and Beger 2011, Uhrin and Schellinger 2011). Fish (Boerger et al. 2010), crustaceans (Murray and Cowie 2011), shellfish (Browne et al. 2008), and zooplankton (Cole et al. 2013) ingest microplastics, and some of these organisms consume less food and have decreased energy for growth as a result (Watts et al. 2015, Cole et al. 2013). Furthermore, microplastics adsorb organic contaminants (e.g., polycyclic aromatic hydrocarbons and polychlorinated biphenyls) (Rochman et al. 2013a) and trace metals (Holmes et al. 2012) from their surrounding environments, and, depending on concentration gradients, may transfer contaminants to marine organisms, inducing harmful health effects (Browne et al. 2013, Rochman et al. 2013b). Plastics have recently been found in the digestive tracts of fish and shellfish and the soft tissues of shellfish sold at markets for human consumption (Rochman et al. 2015, Li et al. 2015, Van Cauwenberghe and Janssen 2014). A serving of six oysters grown off the coast of France could contain as many as 50 plastic particles (Van Cauwenberghe and Janssen 2014), indicating that plastic litter that we produce and allow to leak into the environment may end up back on our plates.

The economic impacts of ocean litter include costs associated with beach and harbor cleanup, loss of coastal tourism and recreation, impacts to the fishing and aquaculture industries – including costs associated with repairing damaged vessels, repairing or replacing fishing gear lost or damaged as a result of encountering marine debris, loss of catch due to ghost fishing[1] or gear encounters with marine debris, and loss of earnings due to time spent dealing with litter – and other impacts to human welfare and ecosystem services (Newman et al. 2015). The United Nations Environment Programme (UNEP) estimates that the impacts of plastic pollution, specifically, on the world's oceans amount to about $13 billion a year, accounting for time spent on cleanup, as well as revenue lost by the fisheries and tourism sectors (UNEP 2014). Ghost fishing, one consequence of lost fishing gear, can be extremely costly – both ecologically and for the fishing industry. For example, it is estimated that each year, the approximately 145,000 derelict blue crab pots in Chesapeake Bay catch more than 6 million blue crabs, killing over 3.3 million of them (4.5% of the 73 million blue crabs harvested commercially in 2014) (Bilkovic et al. 2016). These derelict pots also catch approximately 3.5 million white perch and 3.6 million Atlantic croaker every year (Bilkovic et al. 2016). The removal of ~44,000 derelict pots from Chesapeake Bay from 2008 to 2014 is estimated to have increased blue crab harvests by 38.17 million pounds, valued at $33.5 million, due to improved efficiency of active crab pots (Bilkovic et al. 2016). On average, removing one derelict pot increases blue crab harvest by 868 pounds (Bilkovic et al. 2016).

The social impacts of ocean litter include loss of earnings for fishermen and aquaculturists from time spent dealing with gear or vessel entanglement, and boater injury or death following vessel interaction with large debris items (Mouat et al. 2010, Cho 2005, Newman et al. 2015). Social impacts also include reductions in ecosystem services provided by marine and coastal environments, such as psychological benefits gained from coastal recreation (Wyles et al. 2016) and seafood production (e.g., loss of catch (e.g., Bilkovic et al. 2016)). Potential human health effects from ingestion of microplastics through seafood are largely unknown, though research from other fields, such as pharmaceutical delivery, suggests that micro- and nano-plastics have the potential to enter, circulate, and bioaccumulate within the body after being ingested (Galloway 2015). The extent and impact of human exposure to contaminants and additives through ingestion of microplastics in seafood is also largely unknown, though it is thought to be low in comparison to other pathways of dietary intake (Lusher et al. 2017).

Ocean Litter and Waste Generation in California

Ocean litter is prevalent in California watersheds and ocean waters. For example, 78% of Southern California river miles[2] and about one third of seafloors and seafloor sediments in the Southern California Bight contain trash (Moore et al. 2016). Plastic is the most prevalent type of debris found across all habitats in the Southern California Bight, with wrappers, bags, plastic

[1] Ghost fishing is the continued catch of marine species by lost or discarded gear.
[2] A river mile is a measure of distance in miles from the mouth of a creek or river.

pieces, and Styrofoam being the most commonly found plastic items (Moore et al. 2016). Seventy-three water bodies throughout the State of California are listed as having impaired water quality due to the presence of large amounts of trash (State Water Board 2015). The California coast and ocean are also impacted by lost fishing gear. Between May 2006 and November 2012, the California Lost Fishing Gear Recovery Project retrieved more than 60 tons of gear from California's coastal ocean, and collected more than 1,400 pounds of recreational gear from public fishing piers from Santa Cruz to Imperial Beach (SeaDoc Society 2017). From 2001 to 2006, 31.1% of the reported cases of injured California brown pelicans at five California wildlife rehabilitation centers were fishing gear-related, while 11.1% of injured gull cases and 2.9% of injured California sea lion cases were fishing gear-related (Kaplan Dau et al. 2009).

In 2016, California generated approximately 76.5 million tons of waste, 35.2 million tons (~46%) of which were disposed in landfills, and another 7.5 million tons (~10%) of which went to disposal-related activities such as beneficial reuse at solid waste landfills and waste to energy conversion (CalRecycle 2017b). This means that California had a disposal rate of 6.0 pounds of trash per resident per day in 2016 (CalRecycle 2017b). Roughly 24.5 million tons (~32%) of the total trash produced in 2016 were diverted through source reduction and recycling, and another 9.2 million tons (~12%) were diverted through composting and mulching (CalRecycle 2017b). Overall, about 56% of California's waste went to disposal or disposal-related activities and about 44% was diverted through source reduction, recycling, and composting in 2016 (CalRecycle 2017b). Though diversion has come a long way in 20 years, over the last three years, California's source reduction, composting, and recycling rate has declined, from 50% in 2014, to 47% in 2015, and now to 44% in 2016 (CalRecycle 2017b) (see Fig. 2 for statewide disposal and recycling from 2010 to 2016). Through AB 341, California has declared a goal that by 2020, 75% of the solid waste generated in the state should be source reduced, recycled, or composted (as compared to 1990-2010 waste generation levels[3]). This translates to a reduction in per capita disposal from the current 6.0 pounds per person per day to 2.7 pounds per person per day in 2020 (CalRecycle 2017b).

[3] AB 341 requires that 1990-2010 waste generation levels (10.7 pounds per person per day) be used as baseline data. The amount of total waste generated in California in a year is estimated by multiplying the State's population in that year by the 1990-2010 per person baseline. Source reduction is also calculated using these baseline data.

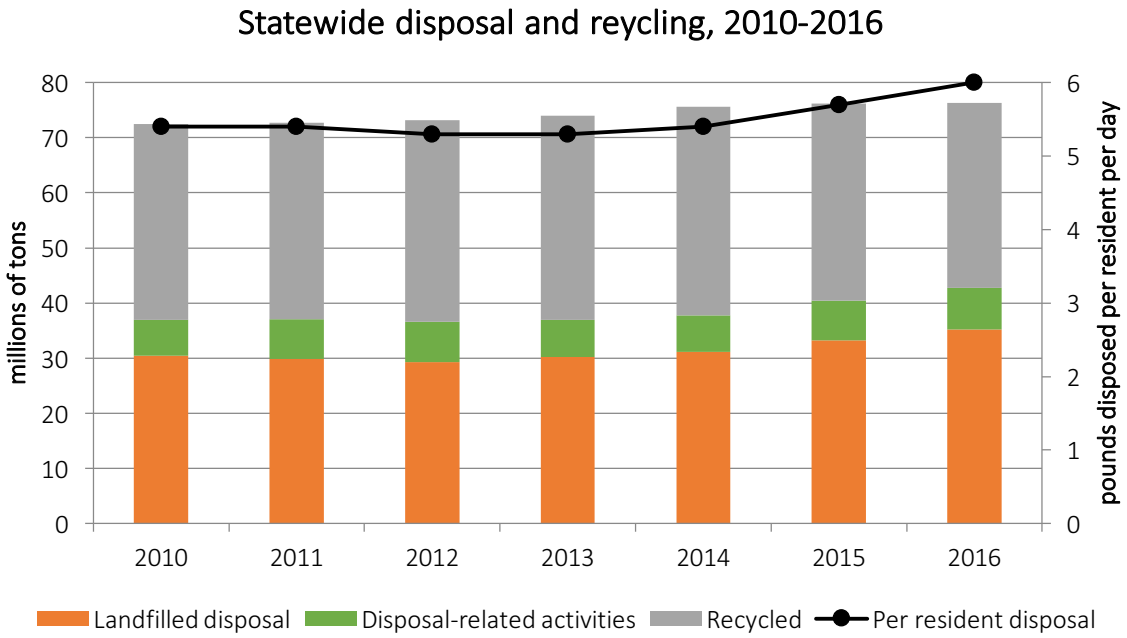


Fig.2. Amount of waste disposed and recycled in California, from 2010 to 2016. Included in this figure are estimates of the amount of waste disposed in landfills, the amount of waste managed through disposal-related activities, and the amount of waste recycled (which includes source reduction, recycling, and composting) every year in millions of tons (left axis). Also shown is the per resident disposal rate (pounds per resident per day) for each year (right axis). Figure adapted from CalRecycle's webpage "California's Statewide Recycling Rate" (CalRecycle 2017a).

California currently estimates the amount of waste that is source reduced and recycled by subtracting the quantities of waste disposed in landfills and through other disposal-related activities, and the quantities of waste that is managed through composting and mulching, from the estimated total amount of waste generated in the State (CalRecycle 2017b). This method of calculation assumes that all waste that is not disposed is source-reduced or recycled (CalRecycle 2017b). There is currently no way to know how much of California's waste ends up in the environment and becomes marine debris every year. However, Jambeck et al. (2015) estimated that in 2010, the United States had 0.25-1 million metric tons of mismanaged plastic waste available to enter the oceans, based on waste generated by populations within 50 km of the coast.

Ocean litter costs Californians money. California communities spend more than $428 million annually to cleanup and control ocean litter through waterway and beach cleanup, street sweeping, installation of stormwater capture devices, storm drain cleaning and maintenance, manual litter cleanup, and public education (Stickel et al. 2013). From July 2012 to June 2016, Adopt-A-Highway participants removed over 77,000 cubic yards of litter that may have otherwise ended up in the ocean, a service valued at $18 million annually (Caltrans 2017). Orange County, California residents go out of their way to avoid trash-littered beaches, spending extra time and money in order to visit a cleaner beach or engage in other recreational activities; it is estimated that removing 100% of the marine debris on Orange County beaches could save California residents $148 million during the three months of summer (Leggett et al. 2014). There

are no known estimates of the costs of ocean litter to California's tourism, fishing, or aquaculture industries.

2008 Strategy, *An Implementation Strategy for the California Ocean Protection Council Resolution to Reduce and Prevent Ocean Litter,* Update

Recognizing the serious threats of ocean litter to communities, the economy, and the environment, and the immediate need for decisive action in California, the California Ocean Protection Council (OPC) adopted a resolution on "Reducing and Preventing Marine Debris" in 2007. In 2008, the OPC initiated a steering committee to publish an Implementation Strategy, which outlined three Priority Actions and 13 other Actions for addressing marine debris in the State. This Strategy was designed to provide a pathway to implement the recommendations in the OPC Resolution. The three Priority Actions were as follows:

1. Implement a producer take-back (EPR) program for convenience food packaging.
2. Prohibit single-use products that pose significant ocean litter impacts where a feasible less damaging alternative is available. Products specifically called out included polystyrene food packing and plastic bags.
3. Assess fees on commonly littered items.

Since the original Strategy was developed, many of the actions described in the document have either been accomplished or are in progress (see the box below titled "Status of Actions in the 2008 OPC Strategy to Reduce and Prevent Ocean Litter"). In some cases, the State's regulatory or agency landscape has changed. For example, some items that were listed out separately in the Strategy are now being addressed under a single program, but there may be elements of those items that still need to be addressed. For instance, separate actions focused on minimizing toxics in packaging and developing sustainable alternatives are now jointly addressed by the California Department of Toxic Substances Control's (DTSC's) Safer Consumer Products Program, which is tasked with examining product-chemical combinations that may have negative impacts on human health and the environment, and requiring that manufacturers of priority products perform an alternatives analysis to determine whether such products can be made without the chemical of concern (DTSC 2013). In other cases, our understanding of the ocean litter problem has changed considerably since 2008. For example, the examination of microplastics' impacts on marine life and their interaction with persistent organic pollutants has increased dramatically over the last decade (Ryan 2015). Thus, some of the actions that were outlined in the 2008 Strategy may not cover issues of emerging concern (such as microplastics and microfibers) or may no longer be the best way to go about addressing ocean litter.

The 2018 Strategy aims to reexamine the issue of ocean litter in California, and outline action items for preventing and reducing marine debris over the next six years, in light of the needs that have been identified, the knowledge that has been gained, and the advances that have been made over the last decade.

Status of Actions in the 2008 OPC Strategy to Reduce and Prevent Ocean Litter

Below is a brief summary of the progress that has been made on the Action Items included in the 2008 Strategy. Some of these Action Items were written in an open-ended or ongoing way. This makes it somewhat difficult to determine whether an action is "complete." See the Comments column for more detail on the status of each Action.

Strategy Action	Update	Comments
Priority Action 1: Implement a producer take-back (EPR) program for convenience food packaging.	**In Progress**	CalRecycle is developing a comprehensive, statewide framework for managing all packaging that provides flexibility to apply different policy tools. Extended producer responsibility is one of those policy tools.
Priority Action 2: Prohibit Single-Use Products that pose significant ocean litter impacts where a feasible less damaging alternative is available.	**See below under each action**	See below under each action
• Polystyrene food packaging prohibition	**In Progress**	Local polystyrene bans have passed, but a statewide ban has not.
• Plastic Bag Fee	**Complete**	The voters ratified the statewide bag ban in November 2016.
Priority Action 3: Assess fees on commonly littered items	**In Progress**	Local jurisdictions have passed litter fees, but this has not been implemented on a statewide level.
Minimize Toxics in Packaging: Determine which plastic additives threaten human health and the marine environment, educate the public, and prepare a plan for a possible prohibition.	**In Progress; but continuing opportunities for further action or projects**	Initial OPC-funded project is complete. DTSC now has a Safer Consumer Products program that examines product-chemical combinations that may impact human health or the environment.
Develop Alternative Products and Promote Sustainable Alternatives	**In Progress**	This action is currently part of the Safer Consumer Products Program. The regulations require that manufacturers perform an alternatives analysis to determine whether they could make their product without the chemical of concern.
Increase Enforcement of Pre-Production Plastic Laws	**Complete**	The Water Board has trained their enforcement staff and industrial permit staff on how to correctly implement the law banning release of pre-production plastic pellets.

Strategy Action	Update	Comments
Increase Enforcement of Anti-Litter Laws	**In Progress**	This is an ongoing activity. Some local jurisdictions have increased litter fines in problem areas (like main beach in Santa Cruz).
Public Education: Coordinate an education and outreach campaign	**Complete**	The OPC has partnered with NOAA on the Thank You Ocean campaign, which includes a lot of public outreach on marine debris.
Public Education: Direct state funds for litter education to the Environmental Education Initiative	**Incomplete**	This remains incomplete, the Environment Education Initiative provides model curriculum to teachers on environmental issues.
Engaging the Public: Develop an ocean litter data card to be used by Adopt-A-Beach Volunteers through the year, and an online database to house data.	**Complete**	The West Coast Marine Debris Partnership has developed a standardized data card and database for beach cleanup efforts.
Engaging the Public: Develop an Adopt-A-Beach Advisory Committee and work with local beach managers to provide necessary support for Adopt-A-Beach efforts.	**Complete**	The Adopt-A-Beach program is supported and organized on a county-by-county basis. (You can find more information on the Coastal Commission website).
Ensure municipalities prevent litter from entering the storm drain system	**Complete, but continuing opportunities for actions with implementation.**	This action was completed through adoption of the statewide trash policy; we are now in the process of implementing the policy.
Increase lost fishing gear cleanup by creating a deposit program on fishing gear, and conduct outreach to the fishing community and publicize Sea Doc Society's hotline	**Complete, but continuing opportunities for further action or projects**	Legislative action has created a program that requires owners to pay for lost gear for some fisheries. The OPC has funded the Sea Doc Society to perform cleanups of fishing gear off the coast, and their hotline is available to report lost gear.
Work with the West Coast Governor's Agreement participants and invite the participation of Alaska, Hawaii, British Columbia, Baja California, and Baja California Sur	**Complete**	This action evolved into an Action Team under the West Coast Governor's agreement, and now into the West Coast Marine Debris Partnership, which includes British Columbia.

2018 *CALIFORNIA OCEAN LITTER PREVENTION STRATEGY: ADDRESSING MARINE DEBRIS FROM SOURCE TO SEA*

2018 Strategy Update Process

In 2016, the Ocean Protection Council and the NOAA Marine Debris Program initiated a partnership with California Sea Grant to update the 2008 Strategy. The 2018 Strategy planning team was rounded out with the participation of the California Coastal Commission and Surfrider Foundation. Representatives from organizations active in conservation, research, waste reduction, and education, as well as industry, tribes, local government, and State and Federal agencies were invited to participate in two Workshops in 2017 aimed at generating action items that would help solve the problem of ocean litter in California. All of the ideas included in this Strategy document were identified by Workshop participants.

The first of the two Workshops, held in May 2017 in Oakland, California, allowed participants to brainstorm and discuss potential solutions to the presence of (and problems associated with) ocean litter in California. One hundred and forty-eight action items to reduce and prevent ocean litter were identified during this Workshop. Following the first Workshop, duplicative and similar ideas generated by the participants were condensed and organized into a draft Strategy by the planning team, which was then circulated among the Workshop participants and posted on OPC's website for public review and comment. The second of the two Workshops, held in November 2017 in La Jolla, California, allowed for further discussion and refinement of the Strategy's Action Items, and gave organizations the opportunity to commit to taking a role in implementing proposed actions. Each Workshop was attended by approximately 50 participants. See OPC's website for links to materials from the two Workshops (agendas, participant lists) and a complete list of ideas for action items generated by Workshop #1 participants.

Following the second Workshop, the planning team revised the Strategy, and then posted it on OPC's website and circulated it to Workshop participants for a second round of public comment (January to February 2018). Final revisions to the Strategy were made based on this second round of public comment.

Throughout the process of developing the 2018 Strategy, stakeholders expressed interest in OPC articulating its priorities for ocean litter. OPC's proposed priorities to address ocean litter are laid out in the section of the document titled "California Ocean Protection Council Priorities to Address Ocean Litter."

Structure of Document

The 2018 *California Ocean Litter Prevention Strategy: Addressing Marine Debris from Source to Sea* includes a section for OPC priorities to address ocean litter and a section for stakeholder-

identified Goals, Objectives and Actions to address ocean litter. The OPC priorities section outlines the work OPC will take on over the next six years, and these priorities complement the Goals, Objectives and Actions identified by the stakeholders. OPC priorities are structured into three goals:

1. OPC Goal 1 – Land-based sources of ocean litter: Protect marine ecosystems and the communities that rely on them by promoting policies to prevent litter from reaching the ocean.
2. OPC Goal 2 – Microplastics and Microfibers: Increase understanding of the scale and impact of microplastics and microfibers on the marine environment and develop solutions to address them.
3. OPC Goal 3 – Fishing and Aquaculture Gear: Reduce fishing and aquaculture-related debris in the ocean.

The stakeholder section of the Strategy is structured around six Goals, five of which are dedicated to land-based litter, and one of which is dedicated to ocean-based debris. Nested under each of these Goals are Objectives, which outline approaches for achieving the Goals. Each Objective includes specific Action Items, concrete and measurable tasks that stakeholders can implement to contribute to an Objective and prevent or reduce ocean litter.

Broadly broken into land- and ocean-based litter categories, the six Goals of this Strategy are as follows:

Land-based Ocean Litter

1. Goal 1: Reduce the use of common ocean litter items through mandates and incentives targeting public institutions and businesses.
2. Goal 2: Reduce the prevalence of common ocean litter items through changes in product production, design, and management.
3. Goal 3: Improve waste management and interception of litter on land before it enters the ocean.
4. Goal 4: Conduct and communicate research on existing and emerging issues related to land-based ocean litter.
5. Goal 5: Generate behavior change by educating and engaging communities and individuals to reduce ocean litter.

Ocean-based Marine Debris

6. Goal 6: Reduce ocean-based debris at its source, and maximize the efficiency of control and cleanup of ocean-based debris.

The 2018 Strategy document includes the following:

- **6 Goals**: The first five Goals are dedicated to land-based ocean litter, while the last Goal is dedicated to ocean-based debris. These Goals focus on source reduction, research, behavior change, control, and cleanup.
- **17 Objectives:** Nested under each Goal, these Objectives are approaches that may be taken to achieve a Goal.
- **60 Action Items**: Listed under each Objective, Action Items are concrete and measurable tasks that stakeholders can implement to contribute to an Objective and prevent or reduce ocean litter.

Scope of Document

Data-driven Goals, Objectives, and Action Items

The Goals, Objectives, and Action Items included in this document reflect the need to base actions taken to address ocean litter in California on the most accurate available data. The term "common ocean litter items" is used frequently throughout the document to refer to the most prevalent ocean litter items found in California's waterways and ocean waters, and on its coastlines. The use of this terminology directs stakeholders to focus on the debris items that are most abundant in the environment, while also allowing for flexibility and adaptability, as the most common ocean litter items may change over time.

While the need for a comprehensive, statewide litter dataset is identified in the Action Item tables below (see Action Item 4.1.4), for now, this document relies on Coastal Cleanup Day data to define the most common ocean litter items found in the State (see Table 1 for the list of the top 10 litter items removed from California's coastlines and inland waterways on Coastal Cleanup Day from 1989-2014). Depending on the Action Item, stakeholders may also use more

Table 1. Top ten litter items removed on California Coastal Cleanup Day, 1989-2014 (California Coastal Commission 2017).

Litter Item	Count	Percentage
Cigarettes/Cigarette filters	6,992,106	37.76%
Food wrappers/Containers	1,940,013	10.48%
Caps/Lids	1,619,071	8.74%
Bags (paper and plastic)	1,462,726	7.90%
Cups/Plates/Utensils	1,014,229	5.48%
Straws/Stirrers	736,595	3.98%
Glass beverage bottles	600,871	3.24%
Plastic beverage bottles	475,799	2.57%
Beverage cans	455,433	2.46%
Construction material	330,711	1.79%

detailed, localized datasets, when available, to determine common ocean litter items in their region or to help define the scope of their work.

Focus on Land-based Litter and Lost Fishing and Aquaculture Gear

Five out of six of the Strategy's stakeholder Goals (as well as the first OPC Goal) focus on land-based litter, while the final Goal in the Strategy focuses on ocean-based debris, specifically lost fishing and aquaculture gear. Land-based litter receives the most attention in the 2018 Strategy because most of the debris found in the ocean is thought to be land-based, and a large portion of the marine debris community in California focuses on land-based litter. The Goal dedicated to ocean-based debris focuses almost entirely on lost fishing and aquaculture gear due to the fact that the participating stakeholders were mainly from the fishing and aquaculture industries. Furthermore, it was agreed that because of the large scope of ocean-based debris and the complexities involved in international regulations[4], a more significant impact could be made by narrowing the scope to lost fishing and aquaculture gear.

Emphasis on Source Reduction and Prevention

This document prioritizes source reduction Goals and Action Items, as agencies and experts agree that source reduction is the most effective tactic to address ocean litter. Source reduction, or waste prevention, refers to practices that reduce the amount of materials entering the waste stream, including changes in the design, manufacture, purchase or use of materials (EPA 2016). Preventing waste in the first place through initiatives such as product redesign, minimizing the use of single use items[5], and reusing materials is a better method for reducing waste as it decreases the amount of litter to control, capture, and dispose. This method is considered by the US EPA to be the most preferred method for dealing with waste (EPA 2017).

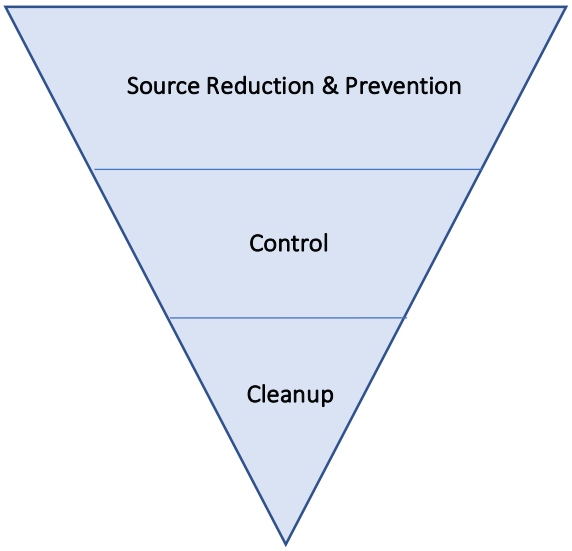
Furthermore, source reduction creates significant opportunities for industry to take initiative and responsibility for the products they produce. By altering their production, operation, and raw material use, industries can prevent litter at the source. Institutions, businesses, and consumers can play a role in source reduction too. For example, the State is the single largest purchasing entity in California, purchasing billions of dollars of products each year (Suh et al. 2017). As a result, the State can have a significant impact on, and set a good example for, preventing and reducing waste at the source through procurement policies that prioritize reusable items. Institutions and businesses can also benefit from these procurement changes, as they often lead to reduced costs associated with the purchase of disposable items, and the transportation, disposal, or recycling of waste (Maryland Department of the Environment 2017, Clean Water Action 2017). Consumers can contribute to source reduction by making changes in their own purchasing habits and supporting businesses that exhibit sustainable purchasing practices.

[4] One example of an international regulation that deals with ocean-based debris is the International Convention for the Prevention of Pollution from Ships, MARPOL, adopted in 1973, the main international convention covering pollution of the marine environment from operational or accidental discharge from ships.

[5] The term "single use items" is used here to mean items that are conventionally disposed of after a single use and that persist in the environment.

Waste management and ocean litter are inextricably linked. This Strategy is intended to be a complementary document to other waste prevention and management strategies, with a focus on the issue of ocean litter.

Fig. 3. Hierarchy of Efforts to Address Ocean Litter



Control and Cleanup

Controlling and cleaning up litter in the environment is important, but less efficient and effective in the longer term compared to source reduction and prevention. Examples of control and cleanup methods include: beach and waterway cleanups, street sweeping, stormwater capture devices, storm drain cleaning and maintenance, manual litter cleanup, and outreach and education to prevent littering. The public cost burden of these efforts makes a compelling argument for accelerating the search for effective strategies to reduce and prevent trash streams that enter our waterways and contribute to ocean litter.

In 2015, the State Water Resources Control Board (State Water Board) adopted a statewide water quality objective aimed at reducing the amount of trash that finds its way into rivers, lakes, and the ocean by prohibiting the discharge of trash into state surface waters; the water quality objective is commonly referred to as the "Trash Amendments." These Trash Amendments provide statewide consistency in efforts to reduce trash in state waters, and use a land use-based compliance approach that targets high trash generating areas such as high density residential, industrial, commercial, mixed urban and public transportation land uses. This program allows flexibility for local governments to come up with compliance approaches that work best for them to effectively eliminate trash discharge from their stormwater systems. Local governments may choose to increase trash capture in stormwater runoff, or a use combination of source reduction approaches that are equivalent to full trash capture. This Strategy provides a suite of source reduction approaches that may be cost-effective and useful to local governments as they develop their compliance approach for the Trash Amendments.

California also has a robust and successful network for implementing cleanups. From local nonprofits to municipalities, beach cleanups are held on a regular basis throughout the state. California Coastal Cleanup Day is a notable program held once a year, where approximately 60,000 volunteers pick up hundreds of thousands of pounds of trash and recyclables from beaches, lakes, and waterways. In 2016, 59,154 volunteers participated in California Coastal Cleanup Day and collected 710,781 pounds of litter (California Coastal Commission 2016). California Coastal Cleanup Day is a part of International Coastal Cleanup Day, the world's biggest effort to clean up ocean litter. Annually, nearly 12 million people volunteer to pick up litter in their communities (Ocean Conservancy 2017).

California organizations also coordinate lost fishing gear cleanups on and off the water. For example, the California Lost Fishing Gear Recovery Project, administered by the University of California, Davis' School of Veterinary Medicine and the Wildlife Health Center, encourages ocean users to report the presence of lost gear, and hires fishermen and experienced commercial SCUBA divers (depending on the gear type) to remove gear from nearshore waters in a safe and environmentally sensitive manner. Between 2006 and 2012, this program has retrieved more than 60 tons of gear from California's coastal ocean, primarily in Southern California, including around the California Channel Islands (Santa Rosa, Santa Cruz, Anacapa and Santa Catalina) (SeaDoc Society 2017).

Strategy Implementation

As described above, the scope and focus of this document were largely determined by the stakeholders involved in the two Workshops held in 2017. Attendees of the second Workshop devised the following Strategy implementation scheme:

Six-year timeframe: The operational cycle of this document is six years (2018-2024). Stakeholders believed six years was an appropriate timeframe for the Strategy, as it provides ample time for Action Item implementation, while also allowing for evaluation of progress and reevaluation of Strategy Goals and Objectives, if needed, throughout the process.

In-person check-ins every two years: Every two years, OPC and the NOAA MDP will help to organize in-person meetings amongst stakeholders to discuss progress made on Strategy implementation, and to reevaluate the Strategy's Goals and Objectives, if necessary.

Conference calls/webinars and newsletters every six months: Every six months, OPC and the NOAA MDP will organize and facilitate a webinar to allow stakeholders to discuss and share lessons learned from the Strategy implementation process. OPC and NOAA MDP will also create a newsletter to share updates on Action Item progress with stakeholders and the public; this newsletter will be populated by information provided by the organizations involved in Action Item implementation. OPC will also provide updates on its progress with implementing OPC Priorities via these webinars and newsletters annually. The form that these six-month check-ins take may change over the course of the document's six-year timeframe, depending on what stakeholders feel is most useful to facilitate communication and collaboration.

Action Item timelines and metrics: Stakeholders will form working groups around each Action Item, and will be responsible for devising implementation plans with rough timelines and metrics for each Action Item by the first six-month check-in webinar (which will be held in late 2018). OPC and NOAA MDP will provide some guidance and some ideas on how to set metrics and timelines for Action Items.

CALIFORNIA OCEAN PROTECTION COUNCIL PRIORITIES TO ADDRESS OCEAN LITTER

The ocean is an important part of California's economy, culture, and quality of life. California's ocean economy accounts for $41.9 billion in gross domestic product (NOAA ENOW 2014), and provides over 500,000 jobs. Sixty-eight percent of Californians live in a coastal county (NOAA OCM 2015), and the State's beaches are iconic for both tourism and recreation. Despite the large scale of the ocean, human impacts, through changes in land use and pollution, may reduce the benefits the ocean provides. Many ocean pollution problems originate on land, and in some cases, far inland from the coast. These pollution problems can range from nutrients, to contaminants of emerging concern, to ocean litter.

Ocean litter, like many other forms of pollution, is primarily land-based. Unlike other forms of pollution, ocean litter is very visible and its impacts are evident to stakeholders and the public. Ocean litter pollutes beaches and waterways, entangles marine life, smothers sensitive habitat, and is ingested by marine organisms. For more information on the impacts of ocean litter, please see "The Global Problem of Ocean Litter" and "Ocean Litter and Waste Generation" in the Background section.

Recognizing the many benefits the ocean provides to Californians and the need to protect California's coastal and ocean resources, the state legislature passed the California Ocean Protection Act (COPA) in 2004. COPA acknowledges the interconnectedness of the land and sea, and tasks OPC with ensuring that California maintains a healthy, resilient and productive ocean and coastal ecosystem for the benefit of current and future generations. OPC works in four ways to protect ocean and coastal ecosystems, as mandated by COPA. OPC recommends and implements policy, leads and promotes coordination among state agencies, seeks and leverages funding for catalytic and innovative projects, and informs government decision making with the best available science.

OPC has maintained a long-standing commitment to protecting ocean health through addressing ocean litter. In 2007, OPC adopted a resolution called "Reducing and Preventing Marine Debris" which outlined 13 top priority solutions to address marine debris. In 2008, OPC initiated a steering committee to publish an Implementation Strategy, which outlined three Priority Actions and 13 other Actions for addressing marine debris in the State. The 2008 Strategy was designed to provide a pathway to implement the recommendations in OPC Resolution. The three Priority Actions from 2008 were:

1. Implement a producer take-back (EPR) program for convenience food packaging.
2. Prohibit single-use products that pose significant ocean litter impacts where a feasible less damaging alternative is available. Products specifically called out included polystyrene food packaging and plastic bags.
3. Assess fees on commonly littered items.

As mentioned in the Background section, since the original Strategy was developed, many of the actions described in the document have either been accomplished or are in progress. For example, in 2016 state voters ratified the plastic bag ban, and numerous local municipalities have passed ordinances restricting the use of expanded polystyrene in foodware. Throughout the process of developing the 2018 Strategy, stakeholders expressed interest in having OPC articulate its priorities for ocean litter. OPC's proposed priorities to address ocean litter are laid out in this section. OPC's priorities can be divided into three broad categories: land-based sources of ocean litter, microplastics and microfibers, and fishing and aquaculture gear.

- Land-based sources of ocean litter: Land-based ocean litter makes up 80% of the litter found in the ocean. Land-based ocean litter goes on to entangle marine wildlife and pollute California's coastline. California communities spend more than $428 million annually to cleanup and control ocean litter (Stickel et al. 2013).
- Microplastics and Microfibers: Microplastics and microfibers are increasingly found in the marine environment and are ingested by marine organisms, including seafood species. These plastics are emerging as a concern for ocean health because they can physically block the digestive tracts of marine organisms, and chemicals associated with the plastic may be absorbed by marine organisms through ingestion.
- Fishing and Aquaculture Gear: Fishing and aquaculture gear, along with other ocean-based sources of litter, make up 20% of the litter found in the ocean. These types of ocean litter are particularly harmful to marine life, and prevention and removal of lost gear will benefit coastal communities and the ocean economy.

As a state agency, OPC works to advance and protect the interests of the public when addressing ocean litter. This means developing and recommending policy that reduces the negative costs associated with ocean litter. Most of these costs are currently borne by the public through funding cleanup and capture. OPC prioritizes source reduction to prevent ocean litter because it is cost-effective and reduces cost burdens on the public. Many policies can be used to address common ocean litter items, ranging from voluntary to mandatory. OPC is open to using all the policy options available, as long as they are shown to effectively and substantially reduce ocean litter. The state has a number of initiatives and programs that will complement OPC's California Ocean Litter Strategy. OPC has coordinated with our agency partners throughout the development of this Strategy and the OPC's priorities. A brief list summarizing these agencies' programs and initiatives is below:

- State Water Resources Control Board: Trash Amendments Implementation
- CalRecycle: Packaging Reform Process
- California Department to Toxic Substances Control: Safer Consumer Products Program
- California Coastal Commission: Energy, Ocean Resources, and Federal Consistency Program, and Public Education Program

- Fish and Game Commission
- California Department of Fish and Wildlife: Aquaculture Program

Implementation of OPC priorities will occur over the next six years. Stakeholders will receive updates on OPC's progress to implement these priorities at least annually as part of the California Ocean Litter Strategy Implementation process. Please see the Strategy Implementation section for more details on the implementation process. Some of the priority actions outlined below are particularly timely, and OPC staff has assigned timelines to them. Other priority actions are written in a broad way to allow for adaptation over the next six years, and do not have specific timelines called out at this time.

OPC GOAL 1 – LAND-BASED SOURCES OF OCEAN LITTER: Protect marine ecosystems and the communities that rely on them by promoting policies to prevent litter from reaching the ocean.

Priority Objective: Advance source reduction efforts through policy, research, and funding to prevent the production and consumption of common ocean litter items by supporting the following actions:

Policy Implementation: Develop and recommend a variety of policy tools to prevent the production and consumption of common ocean litter items at their source, including single-use food and beverage packaging and cigarette filters. Examples of actions to support policy implementation include, but are not limited to:

1. Promote changes by 2020 in state purchasing and service contracts, to reduce the state's reliance on single-use foodware that typically becomes ocean litter.
2. Recommend state and local policies that encourage consumers to bring their own reusable food and beverage containers by charging for disposable packaging use for "to go" food service by 2024.
3. Promote comprehensive waste management approaches to prevent the production of common ocean litter items through CalRecycle's packaging reform efforts, and explore methods to share responsibility between producers and the public to fund the cleanup of beaches and inland waterways that are littered with these products.
4. Support policies that reduce expanded polystyrene litter. OPC will support CalRecycle's inclusion of expanded polystyrene as a priority product to be addressed in the packaging reform framework and recommend the prohibition of expanded polystyrene[6] in foodware.

[6] OPC previously prioritized a polystyrene food packaging ban in 2008. Expanded polystyrene in food packaging should be addressed for a number of reasons: Expanded polystyrene breaks apart into tiny pieces quickly once it reaches the environment, it is easily carried by wind, and mixes into beach sand and sediment. Although expanded polystyrene is technically recyclable expanded polystyrene in use as food service ware is often too contaminated for the recycling stream.

5. Convene and foster innovative partnerships, use funding mechanisms, and recommend policies to redesign common ocean litter items such as connecting bottle caps to bottles.
6. Convene a working group to evaluate a ban on cigarette filters in California by 2020. The working group will investigate research and reports on cigarette filters, and the extent to which they impact human health. If the working group finds that cigarette filters provide no health protections to smokers, then OPC may make recommendations to the legislature to ban cigarette filters.

Research and Funding: Use research and funding to address knowledge gaps and better target policy efforts; examples of actions under this category include, but are not limited to:

1. Fund assessments of policy effectiveness to determine whether the policies are acting as intended and what, if any, changes need to be made to increase effectiveness. If local policies or ordinances are demonstrated to be effective, consider recommending for statewide implementation.
2. Fund a report synthesizing lessons learned from waste management policies and tools implementation in other countries, including policy recommendations for California, with a focus on source reduction by 2020.
3. Fund research and partner with the Department of Toxic Substances Control to address chemical additives that are commonly associated with products found in ocean litter to determine their environmental impacts. Chemical additives may include, but will not be limited to fluorinated compounds, plasticizers, and antimicrobials.
4. Fund a report compiling and synthesizing the use of plastics in agricultural practices, and the extent to which this use of plastics may contribute to ocean litter by 2023.
5. Fund innovative projects and programs that reduce the production and consumption of common ocean litter items, such as a piloting the use of a reusable “to go” container exchange at food service providers.

OPC GOAL 2 – MICROPLASTICS AND MICROFIBERS: Increase understanding of the scale and impact of microplastics and microfibers on the marine environment and develop solutions to address them.

Priority Objective: Advance research on the extent and impact of microplastics and microfibers in source waters and the ocean, and assist in the development of technological solutions to reduce their prevalence in aquatic environments through the following actions:

1. Fund the development and validation of standardized monitoring methods in California to assess the concentration and flux of microplastics by 2021. Methods are needed for

several different environments where microplastics are found, including: wastewater effluent, ambient waters, stormwater, marine sediments, and tissues of fish and bivalves.

2. Once reliable monitoring methods have been established, convene scientists and experts to develop a comprehensive research plan by 2024 to characterize microplastics' sources, pathways, ambient concentrations, risk assessments, and impacts. Research efforts may include the following:
    a. Quantify the concentration at which microplastics cause ecological impacts to marine life and ocean health at the population and community levels, as well as impacts to individual organisms' biology;
    b. Improve the understanding of the sources and pathways associated with microplastic pollution, including polymer identification;
    c. Determine whether additives associated with microfibers may cause impacts to the marine environment, research will be based on best available data and the development of studies will include relevant stakeholders;
    d. Determine whether there is a need to address textiles as a source of microplastics, and if so determine whether reformulated textiles can significantly reduce the loading of microplastics into the environment; research will be based on best available data and the development of studies will include relevant stakeholders.
    e. If wastewater treatment plant loadings of microplastics are found to have a significant impact on the environment, research the feasibility and effectiveness of technical solutions for microfibers in wastewater treatment plants, washing machines, and other points in the wastewater management system, including source control.

OPC GOAL 3 – FISHING AND AQUACULTURE GEAR: Reduce fishing and aquaculture-related debris in the ocean[7].

Priority Objective: Promote improved fishing and aquaculture gear management and sustainable innovation to reduce the potential for lost gear; remove lost gear and legacy infrastructure from the ocean by pursuing the following actions:

1. Provide best-available science and information to the California Department of Fish and Wildlife (CDFW) and the California Fish and Game Commission (FGC) as they work to develop improved fishing and aquaculture gear management, and maintain two-way

[7] Although there are many ocean-based sources of debris in the ocean, the scope of the California Ocean Litter Strategy focuses on fishing and aquaculture gear, and OPC Priorities reflect this scope.

information exchange between the CDFW, FGC, and OPC for data sharing and interagency staff coordination.

2. Promote fixed-gear best practices, including how to minimize losing traps.
3. Promote the development and implementation of regulations requiring best management practice plans for shellfish aquaculture in California by 2020, in partnership with CDFW, FGC, and the California Coastal Commission. The best management practice plans should reduce the potential for loss of aquaculture gear and require the cleanup and recovery of lost gear.
4. Develop fishery-funded gear retrieval programs through industry education and collaborations with non-governmental organizations, port and harbor districts and associations, and other partners to effectively implement existing and developing gear retrieval programs.
5. Fund sustainable innovation in fishing and aquaculture gear to reduce the potential for lost gear, including new technologies, and ensure that any new and effective fishing and aquaculture gear innovation is an allowable technology in legislation and regulations.
6. Recommend the development and implementation of regulatory tools to allow for retrieval of lost gear or traps that belong to other fishermen.
7. Fund removal of fishing gear and abandoned aquaculture materials, disused creosote pilings, and illegal artificial reefs, where liable owners and responsible parties cannot be identified.

STAKEHOLDER GOALS, OBJECTIVES, AND ACTION ITEMS

In the tables below, Action Items to prevent and reduce ocean litter are grouped under broader Goals and Objectives. Definitions of the information in each column are as follows:

- Action Items: Outlines the task that will be implemented in order to prevent or reduce ocean litter.
- Lead & Partner Organizations: Identifies the organization(s) or individual(s) that will implement the Action Item.
    - Lead Organizations are bolded and listed alphabetically, before Partner Organizations, next to each Action Item. Lead Organizations are committed to implementing an Action Item, given organizational and funding constraints. Lead Organizations will serve as the point of contact for NOAA and OPC for progress reports and check-ins throughout the Strategy's six-year timeframe, and will take a leadership role in communicating and coordinating with other collaborators/Partner Organizations on the Action Item.

- **Partner Organizations** are unbolded and listed alphabetically, after Lead Organizations, next to each Action Item. Partner Organizations will serve a supporting role in implementing an Action Item, in collaboration with Lead and other Partner Organizations.

LAND-BASED OCEAN LITTER

GOAL 1. Reduce the use of common ocean litter items through mandates and incentives targeting public institutions and businesses.

Objective 1.1. Prohibit or discourage common ocean litter items in public institutions, retail, and food service establishments through government policies or mandates.	
Action Items	**Lead & Partner Organizations**
1.1.1. Pass and implement policies that prohibit or discourage common ocean litter items at the local level[8] and consider these policies for effectiveness assessment as described under Objective 4.4.	Californians Against Waste, Clean Water Action/Clean Water Fund, Plastic Recycling Corporation of California (PRCC), Surfrider Foundation, UPSTREAM
1.1.2. Pass and implement legislation that prohibits or discourages common ocean litter items at the state level and consider these policies for effectiveness assessment as described under Objective 4.4.	Californians Against Waste, Clean Water Action/Clean Water Fund, Plastic Recycling Corporation of California (PRCC), Surfrider Foundation, UPSTREAM
1.1.3. Expand the statewide bag ban to apply to retail stores, restaurants, and food delivery, and amend the State's criteria for reusable bags to exclude bags made from plastic film[9].	Californians Against Waste, Plastic Recycling Corporation of California (PRCC), Surfrider Foundation
1.1.4. Promote reusable and refillable food and beverage packaging in the state bottle bill, and state and local packaging policies.	
1.1.5. Change procurement of common ocean litter items on UC and CSU campuses, and share lessons learned with other learning institutions (e.g., community colleges, K-12).	Clean Water Action/Clean Water Fund, Surfrider Foundation

[8] Examples of local policies include excess litter fee programs such as that implemented in Oakland, California (City of Oakland 2018), and local polystyrene food ware bans such as that implemented in San Francisco, California (San Francisco Department of the Environment 2016).

[9] Currently, the State allows reusable grocery bags, as defined in SB 270 Chapter 5.3 Article 2, to be made from plastic film, as long as the bags meet a number of requirements, including being "capable of carrying 22 pounds over a distance of 175 feet for a minimum of 125 uses and be[ing] at least 2.25 mils thick, measured according to the American Society of Testing and Materials (ASTM) Standard D6988-13." This Action Item follows the example set by the City and County of Honolulu, Hawai'i, which, in 2017, amended Oahu's plastic bag ban so that by January 1, 2020, plastic film bags will no longer be considered reusable bags (Mattison 2017).

1.1.6. Change procurement to minimize the use of common ocean litter items in local and state government buildings and events, and share lessons learned with other public institutions (e.g., federal facilities, jails, hospitals).	**Ocean Protection Council (OPC),** Californians Against Waste, Clean Water Action/Clean Water Fund, Surfrider Foundation, UPSTREAM
1.1.7. Require permits for new construction of dine-in restaurants to include dishwashing facilities on-site to accommodate reusable food ware.	Californians Against Waste, Clean Water Action/Clean Water Fund, UPSTREAM
1.1.8. Develop a toolkit with materials and strategies to share with local and out-of-state advocates to a) aid in the process of banning common ocean litter items, and b) to aid in the process of switching local governments and communities to reusable items.	**Plastic Pollution Coalition, UPSTREAM,** Institute for Geographic Information Science (IGISc) at SFSU
Objective 1.2. Incentivize institutions, businesses, and events to transition away from common ocean litter items.	
Action Items	Lead & Partner Organizations
1.2.1. Perform audits before and after institutions implement efforts to minimize the use of common ocean litter items.	Clean Water Action/Clean Water Fund
1.2.2. Incentivize businesses and corporations to transition to reusables (e.g., film industry craft services, corporate dining, water refill stations) through sharing case studies and demonstrating cost-savings.	Amcor Limited, Clean Water Action/Clean Water Fund, Surfrider Foundation, UPSTREAM
1.2.3. Promote certification for events (e.g., music festivals, concerts, sports competitions, film production) that achieve zero waste principles.	Clean Water Action/Clean Water Fund
1.2.4. Engage with companies that are already using alternative products and materials to help advocate for transition away from common ocean litter items.	Plastic Recycling Corporation of California (PRCC), Surfrider Foundation

GOAL 2. Reduce the prevalence of common ocean litter items through changes in product production, design, and management.

Objective 2.1. Support and promote extended producer responsibility (EPR) and other waste management strategies to reduce the generation of common ocean litter items, and create a mechanism for producers to fund common ocean litter item capture, cleanup, and recycling infrastructure.

Action Items	Lead & Partner Organizations
2.1.1. The Ocean Protection Council and other stakeholders will promote EPR as a policy to consider as part of CalRecycle's Packaging Reform Effort, and support giving CalRecycle legislative authority to create mandatory packaging reform policies.	**Ocean Protection Council (OPC),** Californians Against Waste, Plastic Recycling Corporation of California (PRCC), Save Our Shores, UPSTREAM
2.1.2. Create a report synthesizing lessons learned from waste management policy and tool implementation in other countries, including recommendations for California with a focus on source reduction.	UPSTREAM
2.1.3. Include performance measures in EPR programs for both prevention and recycling of common ocean litter items, with prevention being a higher priority.	Californians Against Waste, Plastic Recycling Corporation of California (PRCC), Save Our Shores, UPSTREAM
2.1.4. Ensure that all film and wrap plastics eligible for recycling (plasticfilmrecycling.org) are accepted at all drop-off locations (e.g., grocery stores), and enforce the recycling requirements that are part of the statewide bag ban[10].	
Objective 2.2. Support product redesign with the aim of preventing ocean litter through design changes and avoiding harmful substitutions[11].	
Action Items	**Lead & Partner Organizations**
2.2.1. Engage corporations in common ocean litter item redesign by implementing design challenges, and creating a venue for sharing innovative designs with brands and corporations.	**Think Beyond Plastic,** Amcor Limited, American Chemistry Council (ACC), Plastic Recycling Corporation of California (PRCC), UPSTREAM
2.2.2. Redesign and produce bottles with caps attached ("connect the cap"), and ensure that all components of these products are recyclable at all facilities in California.	American Chemistry Council (ACC), Californians Against Waste, Plastic Recycling Corporation of California (PRCC), Surfrider Foundation, Think Beyond Plastic, UPSTREAM

[10] The statewide bag ban, SB 270 (Sections 42250-42257), requires stores that make plastic carryout bags available to their customers to establish at-store recycling programs that allow customers to return clean plastic carryout bags to stores to be recycled. This Action Item calls for the enforcement of the recycling requirements outlined in SB 270, as well as an expansion of the recycling programs established at stores to accept all film and wrap plastics eligible for recycling, as defined by plasticfilmrecycling.org (including bags used for produce, bulk goods, and other products, which, while not covered under SB 270, are often single-use plastic and end up in the environment).

[11] The term "harmful substitutions" is used here to mean: 1) products that may take the place of common ocean litter items and continue to contribute to the problem of ocean litter, rather than reduce ocean litter, and 2) products that may take the place of common ocean litter items, and contain components, additives, or contaminants that are detrimental to human health and/or the environment.

2.2.3. Redesign plastic products to be circular and entirely recyclable in California, through voluntary or legislative action[12].	

GOAL 3. Improve waste management and interception of litter on land before it enters the ocean.

Objective 3.1. Support the State Water Resources Control Board's Trash Amendments.	
Action Items	**Lead & Partner Organizations**
3.1.1. Create a mechanism for local governments to fund stormwater trash programs through public or private sources.	American Chemistry Council (ACC), Clean Water Action/Clean Water Fund, Ocean Protection Council (OPC), Plastic Recycling Corporation of California (PRCC), Save Our Shores, UPSTREAM
3.1.2. Implement a statewide Adopt-A-Storm Drain program.	Plastic Recycling Corporation of California (PRCC), Save Our Shores
3.1.3. Educate the public about the Trash Amendments.	
Objective 3.2. Improve waste management in public places.	
Action Items	**Lead & Partner Organizations**
3.2.1. Establish and improve management of trash, recycling, and compost receptacles in high use areas.	Amcor Limited, American Chemistry Council (ACC), California Coastal Commission, Ocean Protection Council (OPC), Plastic Recycling Corporation of California (PRCC), Save Our Shores
3.2.2. Increase industry investment in infrastructure improvements to address waste management at schools and other public areas.	American Chemistry Council (ACC)
3.2.3. Support packaging policies that develop and expand infrastructure for recycling in California.	
3.2.4. Engage with municipalities and social programs to assess how to reduce ocean litter from	

[12] In July 2017, China informed the World Trade Organization (WTO) that by the end of 2017, it would ban the import of 24 types of waste, including "plastics waste from living sources" (Reuters 2017). China's new policy has put pressure on California's recycling infrastructure (which currently relies on the export of about one-third of the recyclable materials generated in the state to other countries), as in 2016, 62% of the 15 million tons of recyclable materials exported by California went to China (CalRecycle 2018). China's policy change has emphasized the need to promote waste prevention in California, as well as expand California's own recycling infrastructure, to reduce the amount of recyclable waste that is exported each year (CalRecycle 2018).

encampments, as one strategy to improve the health, wellbeing, and safety of homeless communities.	

GOAL 4. Conduct and communicate research on existing and emerging issues related to land-based ocean litter.

Objective 4.1. Conduct a comprehensive characterization of microplastics and macro-debris.	
Action Items	Lead & Partner Organizations
4.1.1. Convene an expert workgroup to develop a matrix of standard sample collection, processing, and characterization methods for measuring temporal changes in microplastics and macro-debris in different environments.	**San Francisco Estuary Institute (SFEI)**, **Southern California Coastal Water Research Project (SCCWRP)**, 5 Gyres Institute, American Chemistry Council (ACC), California Association of Sanitation Agencies (CASA), Clean Water Action/Clean Water Fund, Dr. Andrew Gray at UC Riverside, Dr. Erika Holland at CSULB, Environmental Science and Resource Management (ESRM) Program at CSUCI (including Dr. Clare Steele), NOAA Marine Debris Program (NOAA MDP), Plastic Recycling Corporation of California (PRCC), Surfrider Foundation
4.1.2. Develop and test laboratory methods to identify the most common macro- and micro-plastic debris polymer types through molecular techniques (e.g., FTIR, Raman, forensics).	**Environmental Science and Resource Management (ESRM) Program at CSUCI (including Dr. Clare Steele),** American Chemistry Council (ACC), Bay Area Clean Water Agencies (BACWA), Dr. Andrew Gray at UC Riverside, Dr. Erika Holland at CSULB, Southern California Alliance of Publicly Owned Treatment Works (SCAP)
4.1.3. Develop a watershed-scale program to model and monitor microplastics and macro-debris flux, transport, degradation, and fate according to a variety of endpoints (e.g., street litter, stormwater, wastewater, and direct discharges).	**San Francisco Estuary Institute (SFEI),** 5 Gyres Institute, American Chemistry Council (ACC), California Association of Sanitation Agencies (CASA), California Coastkeeper Alliance, Dr. Andrew Gray at UC Riverside, Dr. Natalie Mladenov at SDSU
4.1.4. Create a comprehensive litter dataset to identify the most common item types according to material, product, brand, and source.	**Dr. Andrew Gray at UC Riverside,** Surfrider Foundation
Objective 4.2. Quantify microplastics pathways within watersheds and develop technological solutions.	
Action Items	Lead & Partner Organizations

4.2.1. Identify and quantify microfibers and microplastics from wastewater, stormwater, airborne, and agricultural sources.	**San Francisco Estuary Institute (SFEI)**, **Southern California Coastal Water Research Project (SCCWRP),** 5 Gyres Institute, Bay Area Clean Water Agencies (BACWA), Dr. Andrew Gray at UC Riverside, Dr. Natalie Mladenov at SDSU, Environmental Science and Resource Management (ESRM) Program at CSUCI, Southern California Alliance of Publicly Owned Treatment Works (SCAP)
4.2.2. Research innovative solutions to address microfibers in textiles and apparel.	Dr. Andrew Gray at UC Riverside, Southern California Alliance of Publicly Owned Treatment Works (SCAP)
4.2.3. Research technological solutions to address microfibers at wastewater treatment plants or in washing machines.	Dr. Andrew Gray at UC Riverside, Southern California Alliance of Publicly Owned Treatment Works (SCAP)
Objective 4.3. Research ecological and toxicological impacts of commonly found ocean litter on marine resources and human health.	
Action Items	**Lead & Partner Organizations**
4.3.1. Advance research on the chemical components of common ocean litter items (by resin type) and the potential for pollutants to migrate into the environment and aquatic organisms via ocean litter.	**Ocean Protection Council (OPC),** American Chemistry Council (ACC), California Department of Toxic Substances Control (DTSC), California Lost Fishing Gear Recovery Project at UC Davis, Dr. Erika Holland at CSULB, Environmental Science and Resource Management (ESRM) Program at CSUCI (including Dr. Clare Steele), Graduate School of Public Health at SDSU, UPSTREAM
4.3.2. Assess population and community-level impacts to economically important and/or especially vulnerable species from exposure to plastics and adsorbed pollutants.	
4.3.3. Research impacts to human health via direct consumption of microplastics and seafood exposed to plastic debris.	American Chemistry Council (ACC), California Lost Fishing Gear Recovery Project at UC Davis, UPSTREAM
Objective 4.4. Assess the effectiveness of existing bans, policies, and programs.	
Action Items	**Lead & Partner Organizations**
4.4.1. Conduct cost-benefit analyses for implementation of different common ocean litter item reduction policies/strategies and provide them to cities and businesses (i.e., local ordinances to ban expanded polystyrene, deposit schemes, packaging redesign).	Dr. Andrew Gray at UC Riverside

4.4.2. Analyze the impact of the statewide plastic bag ban on reducing disposable bag use, preventing ocean litter, and reducing government costs.	American Chemistry Council (ACC), California Coastal Commission, Dr. Andrew Gray at UC Riverside
4.4.3. Conduct research into consumer behavior to assess attitudes toward reusable and disposable items, convenience, willingness to pay, and incentives to avoid commonly littered items (e.g., cigarette filters).	Clean Water Action/Clean Water Fund, Dr. Sean Anderson at CSUCI, Plastic Recycling Corporation of California (PRCC), Save Our Shores

Objective 4.5. Improve coordination among California organizations conducting ocean litter research.	
Action Items	Lead & Partner Organizations
4.5.1. Improve communication among ocean litter research entities in California through participation in the Ocean Litter Strategy implementation process.	NOAA Marine Debris Program (NOAA MDP), Ocean Protection Council (OPC)
4.5.2. Increase dissemination of research results to the public and management agencies (e.g., California Department of Fish and Wildlife).	Ocean Protection Council (OPC)

GOAL 5. Generate behavior change by educating and engaging communities and individuals to reduce ocean litter.

Objective 5.1. Increase formal and informal science-based education to raise awareness of ocean litter.	
Action Items	Lead & Partner Organizations
5.1.1. Compile and share a database of existing resources and curriculum for formal education on ocean litter.	NOAA Marine Debris Program (NOAA MDP)
5.1.2. Integrate standards-based ocean litter curriculum into school programs.	5 Gyres Institute, California Coastal Commission, Institute for Geographic Information Science (IGISc) at SFSU, Monterey Bay Aquarium, NOAA Marine Debris Program (NOAA MDP), Plastic Recycling Corporation of California (PRCC), Save Our Shores
5.1.3. Develop and distribute toolkits to empower high school and college students to educate people on their campuses and in their communities.	Monterey Bay Aquarium, NOAA Marine Debris Program, Plastic Recycling Corporation of California (PRCC)
Objective 5.2. Educate consumers about the sources of ocean litter, to drive behavior change in purchasing.	

Action Items	Lead & Partner Organizations
5.2.1. Implement coastal and inland public education campaigns about common ocean litter items, to drive changes in purchasing.	California Coastal Commission, Californians Against Waste, Environmental Science and Resource Management (ESRM) Program at CSUCI, Plastic Recycling Corporation of California (PRCC), Save Our Shores, Surfrider Foundation
5.2.2. Develop messaging for consumers and producers on microfibers given our current state of knowledge on this emerging issue.	Bay Area Clean Water Agencies (BACWA), California Association of Sanitation Agencies (CASA), Californians Against Waste, Environmental Science and Resource Management (ESRM) Program at CSUCI
5.2.3. Implement a public education campaign about cigarette filters.	California Coastal Commission, Californians Against Waste, Save Our Shores, UPSTREAM

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GOAL 6. Reduce ocean-based debris at its source, and maximize the efficiency of control and cleanup of ocean-based debris.

Objective 6.1. Leverage industry knowledge to prevent lost fishing gear.	
Action Items	Lead & Partner Organizations
6.1.1. Leverage veteran fishermen's knowledge about gear loss prevention and share strategies with the commercial and recreational fishing industries.	California Lost Fishing Gear Recovery Project at UC Davis, Channel Islands National Marine Sanctuary, NOAA Marine Debris Program (NOAA MDP)
6.1.2. Share lessons learned from the fishing industry with management agencies and other stakeholders to focus policy and funding on prevention and recovery of lost gear.	California Lost Fishing Gear Recovery Project at UC Davis, Channel Islands National Marine Sanctuary
6.1.3. Work with the fishing community to design gear to be more durable, less likely to be lost, and less harmful to the environment once lost.	
Objective 6.2. Implement Best Management Practice (BMP) Plans for reducing lost gear within the aquaculture industry.	
Action Items	Lead & Partner Organizations

6.2.1. Compile key outcomes desired for effective BMP Plans for the aquaculture industry through a collaborative process with, and between, growers.	**California Department of Fish and Wildlife (CDFW)**
6.2.2. Update Fish and Game Commission policies to include BMPs in permitting considerations such as the issuance of aquaculture leases, and educate growers and stakeholders about BMPs to help in the implementation process.	**California Department of Fish and Wildlife (CDFW),** Channel Islands National Marine Sanctuary
6.2.3. Include aquaculture BMP Plan implementation requirements in coastal development permits, where appropriate.	

Objective 6.3. Improve tracking of lost fishing and aquaculture gear in order to better understand lost gear patterns and impacts, and to facilitate removal.

Action Items	Lead & Partner Organizations
6.3.1. Improve the reporting system for lost fishing gear by developing and identifying manager(s) of a centralized database for reporting GPS locations of lost commercial and recreational gear without penalty to fishermen.	California Lost Fishing Gear Recovery Project at UC Davis, Channel Islands National Marine Sanctuary, Dr. Andrew Gray at UC Riverside
6.3.2. Implement a pilot project to assess the effectiveness of different tagging and marking methods for aquaculture gear.	NOAA Marine Debris Program (NOAA MDP)
6.3.3. Include aquaculture gear marking and debris collection reporting requirements in coastal development permits, where appropriate.	

Objective 6.4. Increase the removal of ocean-based debris.

Action Items	Lead & Partner Organizations
6.4.1. Research and provide recommendations to overcome policy barriers to lost gear removal and ocean-based marine debris cleanup.	California Lost Fishing Gear Recovery Project at UC Davis, Channel Islands National Marine Sanctuary
6.4.2. Support and expand existing programs for the prevention and removal of abandoned or derelict vessels (e.g., funding for removal of commercial vessels).	
6.4.3. Implement a buyback, return, and/or recycling program for old and/or unused fishing gear.	California Lost Fishing Gear Recovery Project at UC Davis

6.4.4. Identify and remove, when deemed appropriate based on potential impacts of removal, legacy aquaculture debris from historic aquaculture lease operations (e.g., Tomales Bay).	California Lost Fishing Gear Recovery Project at UC Davis
6.4.5. Engage and partner with boaters, fishermen, divers, growers, local communities, and other ocean stakeholders to implement regional cleanup programs (e.g., in bays, ports, or harbors).	Channel Islands National Marine Sanctuary (Coastal Cleanup Day and Get Into Your Sanctuary Day), California State Parks Division of Boating & Waterways and California Coastal Commission, Environmental Science and Resource Management (ESRM) Program at CSUCI
6.4.6. Place large receptacles at ports and harbors for fishermen to dispose of trash that has been collected while fishing.	

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