

# Pathway to Pop-Up Fishing Gear

## *A ROADMAP TO AUTHORIZING POP-UP FISHING GEAR IN THE CALIFORNIA DUNGENESS CRAB FISHERY*

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## Table of Contents

- Executive Summary ..... 2**
- Introduction..... 5**
  - 1. Report Vision .....5
  - 2. Whale and Sea Turtle Entanglements and Conventional Fishing Gear .....5
  - 3. What is pop-up fishing gear? .....8
  - 4. Pop-up Fishing Gear in Context: Regulatory Landscape in the United States and California ..... 11
- Achieving the Criteria for Alternative Gear Authorization in California ..... 13**
  - 1. Safe for Whales and Sea Turtles .....13
  - 2. Reliable .....14
  - 3. Detectable and Identifiable .....15
  - 4. Enforceable.....18
  - 5. Viable for Fishermen .....19
- Proposed Pathway for Pop-up Gear Authorization..... 22**
  - 1. Initial Gear Selection and Modification Phase .....22
  - 2. Reliability Trials Phase .....23
  - 3. Initial Alternative Gear Authorization Phase .....25
  - 4. Expanded Gear Authorization Phase .....26
  - 5. Long-term Vision for Pop-up Gear .....27
- Current Progress in California ..... 29**
- Summary of Recommendations..... 31**
- Conclusion..... 32**
- Appendix: Example Data Sheet for Pop-up Gear Reliability Trials ..... 34**

# MARCH 2023

## Executive Summary

Whale and sea turtle entanglements have increased off the U.S. West Coast, resulting in fishery closures that shorten the duration of the California Dungeness crab fishing season. Current crab fishing methods, with a pot on the seafloor connected to a surface buoy by a vertical line floating in the water, create the potential for wildlife to swim into a line and become entangled. This can lead to injury or death for a whale or sea turtle as it drags the gear for miles and may struggle to feed or surface to breathe as a result. This report outlines a step-by-step approach to the testing, authorization, and scaled-up use of pop-up fishing gear in the California commercial Dungeness crab fishery to allow continued fishing in the presence of whales and sea turtles.

Pop-up fishing gear, also referred to as “ropeless” or “on-demand” fishing gear, is an innovative technology that reduces or eliminates the use of vertical lines while fishing. Rather than a rope connecting a trap on the seafloor to a buoy at the surface, pop-up gear stores the rope and buoy with the trap on the ocean floor until fishermen are ready to retrieve the gear. When ready, the rope and buoy are released and float to the surface where the gear can be retrieved. There are several different types of pop-up systems, each with a release trigger, release mechanism, surface gear management system, and virtual gear marking component.

Current regulations allow the California Department of Fish and Wildlife (CDFW) to authorize alternative gear like pop-up gear, which can be used in the spring months when conventional crab fishing is closed to prevent entanglements, providing an opportunity to extend the Dungeness crab fishing season for those who wish to use it. This report outlines an approach and recommendations rooted within California’s existing regulatory framework and designed to be informative to other fisheries, jurisdictions, and states that would benefit from the use of pop-up gear. This approach to pop-up fishing is intended for a broad audience of policymakers, resource managers, fishermen, fishing organizations, conservation organizations, researchers, and others interested in future research, engagement, and policy change.

In California, the Risk Assessment and Mitigation Program (RAMP) is the regulatory process for identifying and responding to elevated risk of entanglement in the commercial Dungeness crab fishery. Under the RAMP, the use of alternative gear (such as pop-up gear) may be authorized by CDFW as a management measure. To be authorized, pop-up gear must be detectable, retrievable, identifiable, enforceable, and beneficial to whales and sea turtles. This report details a checklist that expands upon existing regulatory criteria to include additional socioeconomic and technical considerations (Figure 1). It is informed by at-sea pop-up gear trials conducted in 2021-2022 by Oceana, Sub Sea Sonics, and local fishermen, along with input from CDFW, fishermen, manufacturers, and researchers. It is intended to meet all regulatory requirements and the needs of fishing and enforcement operations.

Safe for Whales and Sea Turtles	Reliable	Detectable & Identifiable	Enforceable	Viable for Fishermen
<ul style="list-style-type: none"> <li>•Quantity reduction in entanglement risk (vertical lines)</li> <li>•Avoid impacts to other species (acoustic signals)</li> </ul>	<ul style="list-style-type: none"> <li>•Minimal gear loss rates</li> <li>•Surfaces when expected</li> <li>•Consistent and efficient locating of gear</li> </ul>	<ul style="list-style-type: none"> <li>•Virtual Gear Marking System</li> <li>•Detectable by enforcement and other fishermen (within ¼ mile)</li> </ul>	<ul style="list-style-type: none"> <li>•Enforcement can locate, retrieve, and redeploy gear</li> <li>•Enforcement involved in all testing efforts</li> </ul>	<ul style="list-style-type: none"> <li>•Catch Efficiency</li> <li>•Fishing community support</li> <li>•Financial support</li> <li>•Economically viable</li> </ul>

Figure 1: Summary of Criteria for authorization of alternative gear under California regulations.

Pop-up gear must meet all five criteria for authorization of alternative gear in California:

- The **benefit** to whales and sea turtles is measured by the associated reduction in entanglement risk and can be monitored through a virtual gear marking (VGM) system that electronically stores and tracks the location of pop-up gear and other information.
- The **reliability** of pop-up gear is a key factor for both authorization and adoption from the fishing community, and testing efforts should aim to achieve reliability rates comparable to or better than conventional fishing gear.
- The **detectability** of pop-up gear (which combines the regulatory criteria for *detectable* and *ability to identify*), is achieved through a VGM system that provides a tiered structure of access for enforcement, permit holders, and other ocean users.
- The **enforceability** of pop-up gear requires officials to be trained on how to use the gear, have access to information on all gear deployed within their jurisdiction, and ensure the fishery is following regulations.
- Lastly, (though not a regulatory requirement) pop-up gear must be **economically viable** for fishermen and testing efforts should consider the required changes to fishing operations, associated costs, and safety concerns.



Recommended Approach to Authorization of Pop-Up Gear

We propose an incremental, collaborative approach to the authorization of pop-up gear in the California commercial Dungeness crab fishery (Figure 2).

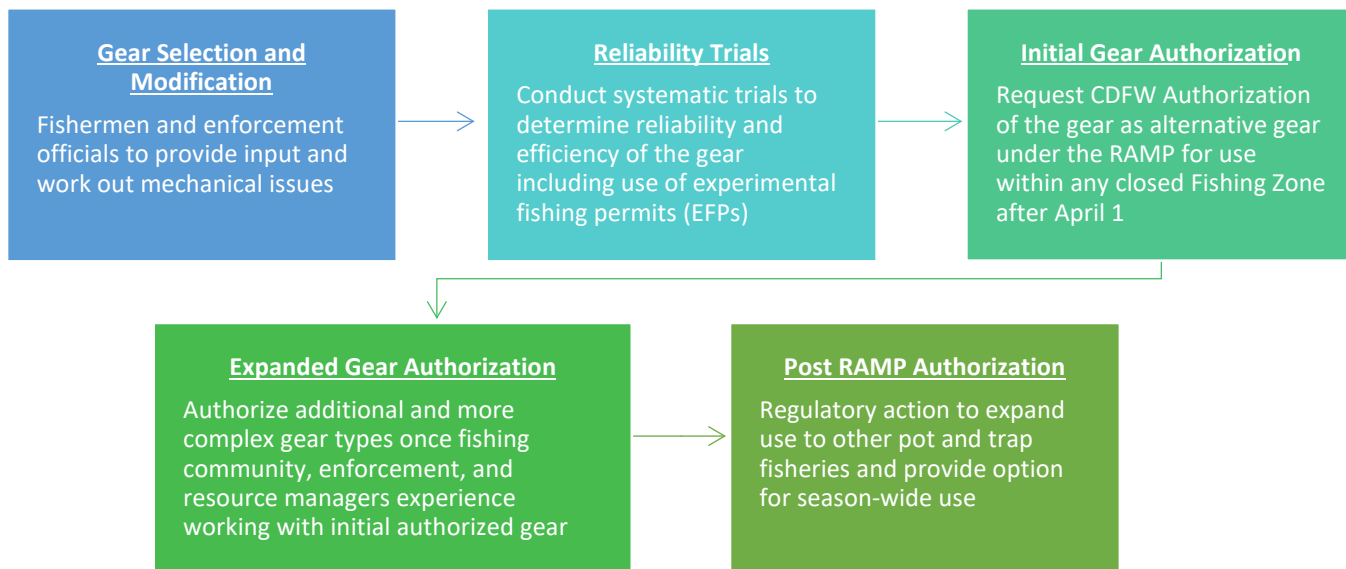


Figure 2: Pathway to Pop-up Gear Authorization Diagram

- The Gear Selection and Modification phase provides fishermen and enforcement officials with hands-on experience to select and modify gear systems for their specific fishing operations.
- The Reliability Trails phase determines the reliability and efficiency of pop-up gear and demonstrates how the gear could be gradually implemented within fishing operations. Initial trials can be conducted during the open fishery season in several trap fisheries with the use of a properly marked back-up buoy. Then, an Experimental Fishing Permit (EFP) allows fishermen to conduct scaled-up testing without a back-up buoy in realistic fishing conditions.
- Initial Gear Authorization requires an applicant to submit a request to the California Department of Fish and Wildlife that demonstrates it meets the regulatory criteria. If the Department approve the request, the gear may be authorized for use by all commercial crab fishermen in specific circumstances.
- The Expanded Gear Authorization Phase can include more complex gear types after the fishing community and resource managers gain experience and have success with the gear. This step would include implementation of an interoperable virtual gear marking system that will allow fishermen and enforcement to know the location of all authorized systems of pop-up gear that are currently deployed. This process will require long-term funding sources and participation by enforcement.
- Post-RAMP authorization, the lessons learned in the commercial Dungeness crab fishery can be applied to establish regulations to expand the use of pop-up gear in other pot and trap fisheries. In the long-term vision, further regulatory changes may enable the use of pop-up gear at additional times of the fishing seasons and in other fisheries.

## Introduction

### 1. Report Vision

The aim of this report is to outline a stepwise, iterative approach to the testing, authorization, and scaled-up use of pop-up gear in the California Dungeness crab fishery that is grounded in current political, socioeconomic, and environmental management frameworks. This includes a description of the current state of pop-up gear development within the U.S. and California, as well as a recommended path to implementation of pop-up gear through California’s regulatory framework known as the Risk Assessment and Mitigation Program (RAMP).

This report does not recommend mandating pop-up gear be used year-round, nor completely replace all conventional crab gear. We recognize that a transition to pop-up fishing gear will pose new challenges and that fishermen and fishery managers have raised potential concerns including:

- Changes to conventional Dungeness crab fishing operations
- Reliability (will it result in higher rates of gear loss, and will it surface when expected?)
- Economic implications (costs of purchasing new gear and equipment, decreased catch rate, training and time needed to learn new gear)
- Fairness and equity issues within the fishing fleet
- Challenges of creating management and enforcement regimes for a new method of fishing
- Fears that successful use will lead to a fleetwide, season-wide mandate

The goal of this report is to provide a systematic way to address these concerns through a detailed, incremental approach to the authorization of pop-up gear as alternative gear to provide a means to extend the Dungeness crab fishing season when entanglement risk is elevated, for those fishermen who voluntarily choose to use it.

While the approach and recommendations are rooted within California’s regulatory framework, they are designed to be applicable and informative to other fisheries, jurisdictions, and states that would benefit from pop-up gear. The pathway outlined in this document is intended for a broad audience of policymakers, resource managers, fishers, fishing organizations, researchers, and anyone else interested in partaking in future research, engagement, and policy change. It is informed by extensive collaboration and reliability testing that occurred from 2018-2022 with California Dungeness crab fishers, gear manufacturers, researchers, enforcement agents, and resource managers.

### 2. Whale and Sea Turtle Entanglements and Conventional Fishing Gear

Many species of whales and sea turtles migrate long distances to feed off the coasts of California, Oregon, and Washington, particularly the endangered populations of humpback whales, blue whales, and Pacific leatherback sea turtles.<sup>1</sup> Increasing ocean temperatures have led to changes in feeding patterns, and at certain times concentrations of these species feeding closer to shore, with greater

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<sup>1</sup> NOAA Fisheries. 2022. “Marine Mammals West Coast.” Last modified May 20, 2022. <https://www.fisheries.noaa.gov/west-coast/marine-mammal-protection/marine-mammals-west-coast>

overlap with fishing gear.<sup>2</sup> Over the last decade, this has resulted in a dramatic increase in the number of reported and confirmed whale entanglements off the West Coast, particularly off California (See Figure 1). The National Oceanic and Atmospheric Administration (NOAA) documented the West Coast spike, which increased from an annual average of eight confirmed entanglements between 1982-2013, to an average of 41 confirmed entangled whales between 2014-2017, of which 85% were reported off California.<sup>3</sup> While a majority of entanglements are reported off the coast of California, the initial entanglement sometimes occurs in Oregon or Washington resulting in the whale traveling long distances with the gear.<sup>4</sup>

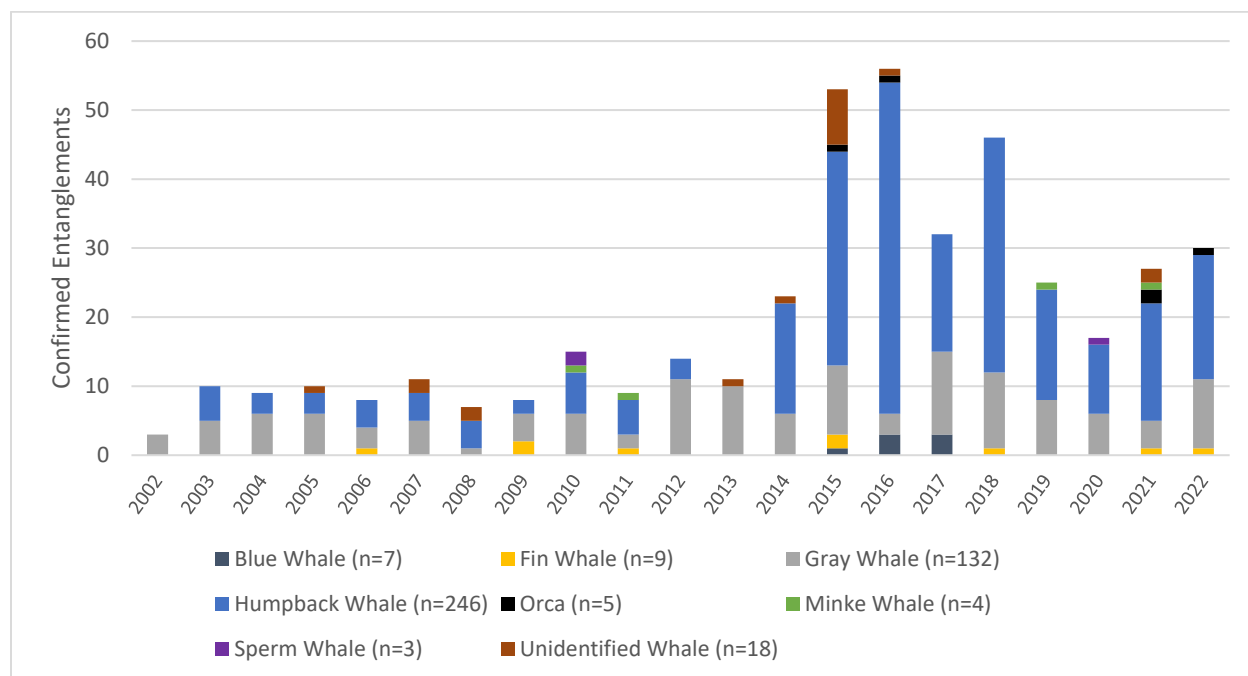


Figure 3: Number of confirmed whale entanglements by species reported to the NOAA Fisheries West Coast Region each year from 2002 to 2021. Source. NOAA Fisheries 2021 West Coast Whale Entanglement Summary. March 2022: <https://media.fisheries.noaa.gov/2022-03/2021-west-coast-entanglements-summary.pdf> supplemented by 2022 entanglements provided by L. Saez, NOAA Fisheries.

An entanglement refers to a whale or sea turtle becoming tangled in a fishing line while swimming or feeding near a fishing operation. These lines can tangle around the animal’s mouth, fluke or pectoral fins, flipper, or the neck of a sea turtle, and result in lethal injuries or drowning. Entanglements are a

<sup>2</sup> Santora, J.A., Mantua, N.J., Schroeder, I.D. et al. 2020. Habitat compression and ecosystem shifts as potential links between marine heatwave and record whale entanglements. *Nat Commun* 11, 536. <https://doi.org/10.1038/s41467-019-14215-w>

<sup>3</sup> Saez, L., D. Lawson, and M. DeAngelis. 2021. Large whale entanglements off the U.S. West Coast, from 1982-2017. NOAA Tech. Memo. NMFS-OPR-63A, 50 p.

<sup>4</sup> NOAA Fisheries News Feature Story. September 30, 2022. Team frees entangled humpback whale off Southern California coast. <https://www.fisheries.noaa.gov/feature-story/team-frees-entangled-humpback-whale-southern-californiacoast#:~:text=A%20trained%20team%20from%20NOAA,swim%20on%20Sunday%2C%20September%2022>

global problem occurring in areas with fixed gear fisheries, and in some cases, pose a major threat to species survival.<sup>5</sup>

The California Dungeness crab fishery is a fixed-gear fishery that uses traps or pots on the seafloor connected to a line with a buoy floating at the surface.<sup>6</sup> They are typically set between 30 to 600 feet deep, and the line connecting the trap and buoy can be even longer. These vertical lines create hazardous conditions when set in whale and sea turtle migration routes and feeding areas and they pose serious threats to endangered species populations. The gear most commonly interacts with and impacts blue whales, gray whales, humpback whales, killer whales, and leatherback sea turtles.



Image 1: Example conventional Dungeness crab trap.

In California, three species known to be at risk of entanglement are listed under the Endangered Species Act (ESA): humpback whales, blue whales, and leatherback sea turtles.<sup>7</sup> These species are provided legal protections under the Marine Mammal Protection Act (MMPA), federal ESA and California ESA, which prohibit the harassment, take, or harm of these animals. However, certain non-federal entities may request an Incidental Take Permit (ITP) to allow for the approved take of the listed species incidental to otherwise lawful activities, such as commercial fishing.<sup>8</sup> These permits are issued by the National Marine Fisheries Service (NMFS) if the requested take will not jeopardize the continued existence of the listed species or their habitat. A Conservation Plan (also called a Habitat Conservation Plan) for the proposed species is required as part of the ITP process under Section 10 of the federal ESA. The California Department of Fish and Wildlife is currently updating the Conservation Plan for California's Commercial Dungeness crab fishery as part of its ITP application process.<sup>9</sup> An ITP is separate from annual marine mammal authorization certificates required under the MMPA.

To address the increasing threat of entanglement to these protected species, resource managers, fishers, researchers, and NGOs are looking into solutions that decrease threats of entanglement and

<sup>5</sup> NOAA Fisheries. 2022. "Ropeless Roadmap: A Strategy to Develop On-Demand Fishing." Last updated September 16, 2022. <https://media.fisheries.noaa.gov/2022-07/RopelessRoadmapDRAFT-NEFSC.pdf>

<sup>6</sup> Santora, J.A., Mantua, N.J., Schroeder, I.D. et al. "Habitat compression and ecosystem shifts as potential links between marine heatwave and record whale entanglements," *Nat Commun* 11, no. 536 (2020). <https://doi.org/10.1038/s41467-019-14215-w>

<sup>7</sup> California Department of Fish and Wildlife. 2021. "Draft Conservation Plan for California's Commercial Dungeness Crab Fishery." <https://cdfwmarine.wordpress.com/2021/12/02/cdfw-releases-updated-draft-conservation-plan-for-commercial-dungeness-crab-fishery/>

<sup>8</sup> California Department of Fish and Wildlife. 2021. "Draft Conservation Plan for California's Commercial Dungeness Crab Fishery." <https://cdfwmarine.wordpress.com/2021/12/02/cdfw-releases-updated-draft-conservation-plan-for-commercial-dungeness-crab-fishery/>

<sup>9</sup> California Department of Fish and Wildlife. 2021. "Draft Conservation Plan for California's Commercial Dungeness Crab Fishery." <https://cdfwmarine.wordpress.com/2021/12/02/cdfw-releases-updated-draft-conservation-plan-for-commercial-dungeness-crab-fishery/>



ensure fishery longevity. This includes real-time management approaches and innovative gear systems and gear modifications. Recent regulations to prevent whale and sea turtle entanglements off California have resulted in time-area closures that have shortened the commercial Dungeness crab fishing season. While this has reduced entanglements, it has resulted in delayed the season openers and early season end dates, and impacted fishery participants that rely on a longer fishing season, particularly during the spring and early summer months (April-July).<sup>10</sup>

### 3. What is pop-up fishing gear?

Pop-up fishing gear, also referred to as “ropeless” or “on-demand” fishing gear, is an innovative technology that reduces or eliminates the use of vertical lines while fishing (Image 2).<sup>11</sup> It has the potential to provide many benefits to both the fishing industry and ocean wildlife by reducing entanglement risk, preventing gear conflict among fishers, reducing lost or ghost gear, and increased economic opportunities by allowing for continued fishing in areas that are closed to vertical lines.



Image 2: Examples of different pop-up fishing gear systems vs. conventional fishing gear.

Rather than a vertical line connecting a trap on the seafloor to a buoy at the surface, pop-up gear stores the rope and buoy with the trap on the ocean floor until fishermen are ready to retrieve the gear. When ready, the rope and buoy are released and float to the surface where fishermen can retrieve the gear. Pop-up gear systems are comprised of three different components: the release trigger, release mechanism, and the surface gear management system (Table 1).

The *release trigger* refers to how the user activates the gear to float to the surface and can either be timed-release or on-demand release. Timed-release triggers are preprogrammed by fishermen to release the buoy after a certain amount of time. On-demand triggers require fishermen to send an acoustic signal to the gear using a device that creates sound called a transducer to trigger the release of gear.

<sup>10</sup> California Department of Fish and Wildlife, Whale Safe Fisheries webpage. See Risk Assessment and Mitigation Program: <https://wildlife.ca.gov/Conservation/Marine/Whale-Safe-Fisheries#559972749-2020-21-season>

<sup>11</sup> Lebon, K.M. and R.P. Kelly. 2019. “Evaluating alternatives to reduce whale entanglements in commercial Dungeness Crab fishing gear,” *Global Ecology and Conservation* 18:e00608

Once the release is triggered, the *release mechanism* releases the line and buoy to float to the surface. Some systems include a motorized release mechanism which holds the rope and buoy in place until triggered. In other systems, the release mechanism involves sending an electric current that disintegrates a wire holding the rope and buoy in place. Another option uses a Galvanic Time Release device, which is a piece of metal that disintegrates over a specific period of time. Once disintegrated, the rope and buoy are released. These devices can also be used in combination with other release mechanisms as a back-up in case of failure with the timer or acoustic signal.

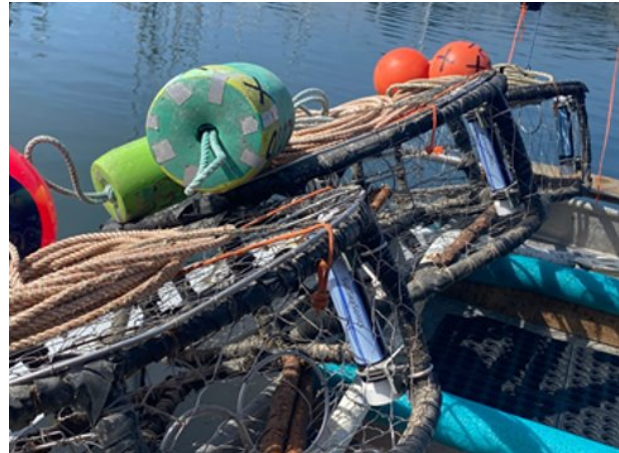


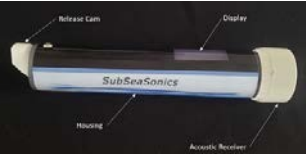








Image 3: Sub Sea Sonic TR4RT release trigger and surface gear management

Lastly, the *surface gear management system* refers to different approaches for storing and unraveling the line and buoy. This includes placing a coiled line and buoy on top of a trap, wrapping the line around a floating spool, or containing the line and buoy within a mesh bag. Some systems remove the need for a vertical line and instead utilize a lift bag retrieval system that inflates and floats the entire trap to the surface for retrieval.

Without a buoy at the surface to mark trap locations, other fishermen as well as enforcement officers need a way to see where the gear is located. A virtual gear marking system, like the Trap Timer app, records the GPS coordinates of where gear was deployed and fisher's information for enforcement use. For timed-release gear, the app also keeps a record of when the gear is programmed to pop-up to the surface.

Table 1: Release triggers, release mechanisms, and line management employed by selected example pop-up systems

<b>Pop-Up System</b>	<b>Release Trigger</b>	<b>Release Mechanism</b>	<b>Line Management</b>	<b>Example Image</b>
<b>Longsoaker</b>	Galvanic timed-release: disintegrates over specific period	Disintegrating hook releases rope and buoy	Line coil and buoy on top of trap held down with mesh	
<b>Sub Sea Sonics TR4RT (tested in this study)</b>	Digital timed release: pre-programmed by fisher	Motorized mechanical jaw: rotates to release bungee cord	Line coil and buoy held down on top of trap with bungee	
<b>Sub Sea Sonics AR4RT</b>	Acoustic release	Rotating cam hook	Line coil and buoy held down on top of trap with bungee	
<b>Puget Buoy</b>	Digital timed release	Mechanical latch with magnet	Line coiled around buoyant spool attached to top of trap	
<b>Fiobuoy F-Series</b>	Acoustic release	Motorized mechanical jaw opens to release rope	Line coiled around buoyant spool attached to top of trap	
<b>Desert Star</b>	Acoustic release	Electric current disintegrates Electrolyzed zinc wire	Floating mesh bag with loose line and buoys	
<b>EdgeTech</b>	Acoustic release	Mechanical rotating screw	Rectangular compartment holding line; buoys attached to releasable top	
<b>Ashored</b>	Acoustic release	Mechanical rotating screw	Cylindrical compartment holding line and buoys	
<b>SMELTS Crab Raft</b>	Acoustic release	Compressed air cylinder	Inflatable lift bag (may bring up entire trap or a coiled line)	

#### 4. Pop-up Fishing Gear in Context: Regulatory Landscape in the United States and California

Fishers, research entities, government agencies, and NGO's have been working on pop-up gear technology for more than 20 years.<sup>12,13</sup> Transitions to pop-up gear systems are being tested around the world due to its potential to reduce marine species entanglements.

##### **Pop-up Gear Efforts on the U.S. East Coast**

On the East Coast of the U.S. in particular, vertical lines associated with pot/trap fisheries are considered one of the greatest threats to the critically endangered North Atlantic right whale.<sup>14,15</sup> A variety of testing and collaborative efforts are underway to find solutions to reduce right whale entanglements while allowing fishing to continue. The *Ropeless Consortium* was founded in 2018 with the focus on overcoming challenges to ropeless fishing and developing regulatory pathways to make ropeless fishing legal in the U.S. and Canada. The consortium holds annual meetings with attendance from a wide variety of stakeholders from state and federal agencies, researchers, fishing industry representatives, gear manufacturers, NGOs, and more.<sup>16</sup> Additionally, *Exempted Fishing Permits* issued on the East Coast allow for commercial fishing with pop-up gear systems to reduce risk of North Atlantic right whale entanglements, such as with the black sea bass pilot project.<sup>17</sup> The NOAA Northeast Fisheries Science Center (NEFSC) conducts a variety of research and outreach with the commercial fishing industry. The NEFSC recently released the *Draft Ropeless Roadmap: A Strategy to Develop On-demand Fishing* that outlines a pathway for increasing the adoption of pop-up gear technology in U.S. East Coast commercial fisheries.<sup>18</sup> Recently, a report by Noah Oppenheim, *Assessing the Feasibility of On-demand Gear in New England Lobster Fisheries*, evaluated the impacts related to the implementation of pop-up gear to lobster fisheries and ocean governance in New England.<sup>19</sup> Recommendations within the report include continuing to evaluate the operational issues and test and evaluate new and existing pop-up gear technologies.

##### **California Regulatory Context**

###### *Risk Assessment and Mitigation Program (RAMP)*

In California, the Risk Assessment and Mitigation Program (RAMP) was developed to actively identify and respond to elevated whale and sea turtle entanglement risk.<sup>20</sup> Under the RAMP program, marine

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<sup>12</sup> DeAlteris, J. 1999. "Design, testing, and evaluation of an acoustic release system for offshore lobster buoy lines," Final Report to NMFS Fisheries Engineering Group, Kingston, RI Project No. 40EANF800065 1-17.

[https://sustainableseasdotblog.files.wordpress.com/2020/01/dealteris\\_1999.pdf](https://sustainableseasdotblog.files.wordpress.com/2020/01/dealteris_1999.pdf)

<sup>13</sup> Sawicki, Kim, "Ropeless is Real", May 2020. <https://sustainableseastechnology.org/2020/05/18/ropeless-is-real-the-report/>

<sup>14</sup> Myers, Hannah J., et al. 2019. "Ropeless fishing to prevent large whale entanglements: Ropeless Consortium report". Marine Policy 107. <https://doi.org/10.1016/j.marpol.2019.103587>

<sup>15</sup> NOAA Fisheries. North Atlantic Right Whale web page: <https://www.fisheries.noaa.gov/species/north-atlantic-right-whale>

<sup>16</sup> Woods Hole Oceanographic Institution. 2022. "Ropeless Consortium". <https://ropeless.org/>

<sup>17</sup> NOAA Fisheries. 2021. "Black Sea Bass Pot Pilot Project Exempted Fishing Permit Application." May 3, 2021, <https://www.fisheries.noaa.gov/southeast/black-sea-bass-pot-pilot-project-exempted-fishing-permit-application>

<sup>18</sup> NOAA Fisheries. 2022. "Ropeless Roadmap."

<sup>19</sup> Oppenheim, N.G. (2022). *Assessing the Feasibility of On-demand Gear in New England Lobster Fisheries*. Homarus Strategies LLC, Brunswick, Maine, USA.

<sup>20</sup> "Whale Safe Fisheries", California Department of Fish and Wildlife, Accessed September 30, 2021, <https://wildlife.ca.gov/Conservation/Marine/Whale-Safe-Fisheries>



life entanglement risk is assessed monthly. During periods of elevated risk, the RAMP outlines management action options for CDFW to implement after consulting with the California Dungeness Crab Fishing Gear Working Group (Working Group). The actions include fleet advisories, fishing depth constraints, vertical line reductions, fishery closures, and use of approved alternative gear. Alternative gear refers to gear innovations or modifications, such as pop-up gear.<sup>21</sup> Authorization of alternative gear allows the use of such gear for the commercial take of Dungeness crab within any closed Fishing Zone after April 1, if it meets certain criteria listed within the regulations: detectability, retrievability, ability to identify, benefit, and enforceability.

#### *Experimental Fishing Permit (EFP) Program*

The California Experimental Fishing Permit Program, established in April 2022, allows for commercial and recreational fishers, managers, scientists, and other interested stakeholders to test innovative fishing solutions to problems such as bycatch and entanglement.<sup>22</sup> These permits provide short-term exemptions from state fishing laws and regulations to allow for the testing and deployment of new fishing and management approaches. EFPs are approved by the California Fish and Game Commission (FGC) and implemented and managed by CDFW.

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<sup>21</sup> Risk Assessment Mitigation Program: Commercial Dungeness Crab Fishery, Title 14, California Code of Regulations 132.8 (2020). Pgs. 1-9.

<sup>22</sup> California Department of Fish and Wildlife. "What is an Experimental Fishing Permit?". Accessed December 4, 2022. <https://wildlife.ca.gov/conservation/marine/efp#572483394-what-is-an-experimental-fishing-permit-efp>

### Achieving the Criteria for Alternative Gear Authorization in California

The following section details a checklist of items required for authorization of alternative (pop-up) gear under California regulations, based on the criteria included within the regulations (Figure 2). This list expands upon the regulatory criteria to include additional considerations. We developed this checklist based on our experience with pop-up gear trials in 2021-2022, and conversations with CDFW, fishers, and researchers.<sup>23,24</sup> It is intended to meet all regulatory requirements as well as meet the needs of fishing and enforcement operations.

Safe for Whales and Sea Turtles	Reliable	Detectable & Identifiable	Enforceable	Viable for Fishermen
<ul style="list-style-type: none"> <li>•Quantity reduction in entanglement risk (vertical lines)</li> <li>•Avoid impacts to other species (acoustic signals)</li> </ul>	<ul style="list-style-type: none"> <li>•Minimal gear loss rates</li> <li>•Surfaces when expected</li> <li>•Consistent and efficient locating of gear</li> </ul>	<ul style="list-style-type: none"> <li>•Virtual Gear Marking System</li> <li>•Detectable by enforcement and other fishermen (within ¼ mile)</li> </ul>	<ul style="list-style-type: none"> <li>•Enforcement can locate, retrieve, and redeploy gear</li> <li>•Enforcement involved in all testing efforts</li> </ul>	<ul style="list-style-type: none"> <li>•Catch Efficiency</li> <li>•Fishing community support</li> <li>•Financial support</li> <li>•Economically viable</li> </ul>

Figure 2: Summary of Criteria for authorization of alternative gear to meet California regulatory requirements and economic viability.

#### 1. Safe for Whales and Sea Turtles

An important component of any type of pop-up gear includes the degree to which it reduces and avoids entanglement risk for marine species like whales and sea turtles. California alternative gear regulatory criteria requires evidence that the gear provides benefit to whales and sea turtles by reducing risk and/or severity of entanglements but provides no explicit degree of risk reduction. While it is largely accepted that pop-up gear has the potential to reduce marine species entanglement risk, the degree of risk reduction will vary for different pop-up gear types.

##### Vertical Line Risk

Acoustic, on-demand pop-up gear has the potential to provide the greatest risk reduction as the lines are only present in the water column during active retrieval of the gear. The degree of risk reduction for timed-release technology is a function of the percentage of time the system is in ropeless mode (i.e., the rope and buoy have not surfaced yet), which is determined by the return time of the fishermen relative to the pop-up time. If the fisherman arrives and retrieves the gear immediately after it surfaces, the gear will have an approximately 100% reduction in risk, similar to acoustic gear. However, if the fisherman retrieves the trap sometime later after it has initially surfaced, there will be vertical line left in the water

<sup>23</sup> California Dungeness Crab Fishing Gear Working Group. 2019. "Guidelines for Research and Development Projects, Focus on Ropeless Gear Innovations." February 2019. [http://www.opc.ca.gov/webmaster/\\_media\\_library/2019/02/Whales-Gear-Innovations-R-and-D-Guidelines-February-2019.pdf](http://www.opc.ca.gov/webmaster/_media_library/2019/02/Whales-Gear-Innovations-R-and-D-Guidelines-February-2019.pdf)

<sup>24</sup> California Department of Fish and Wildlife. 2022. "Guidance for Testing Trap Gear Modifications." May 2022. <https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=169838&inline>

column, and thus some degree of risk. Risk reduction for each timed release ropeless trap is calculated using the following formula:

$$\% \text{ Risk Reduction} = \frac{\text{Deployment Time} - \text{Popup Time}}{\text{Deployment Time} - \text{Retrieval Time}} \times 100$$

The degree of risk reduction for timed-release gear can be monitored by a VGM system by tracking the percent of ropeless time with the time the gear has popped up compared to when the gear is retrieved. Establishing the required degree of risk reduction while pursuing alternative gear authorization will be important. Additional consideration of associated risks will be required if using multiple traps per line as whales may become entangled in the ground line connecting the traps.

### **Acoustic Sound Risk**

Another area of risk for consideration includes the impacts to sensitive species from the use of acoustic gear. While acoustic-release technology likely provides the greatest risk-reduction in terms of vertical lines, there may be unintended impacts to sensitive species, such as harbor porpoises, due to the use of acoustic signals. Certain acoustic signals may result in behavioral issues, such as auditory fatigue or behavior disturbance.<sup>25</sup> The degree of impact will depend on the frequency, the power, and the duty cycle (the duration of the signal and how often it is occurring) of the signal. An acoustic gear unit that is continually sending an acoustic signal will likely have a greater degree of impact as compared to acoustic gear that only sends the signal at the time of retrieval. Determining the potential acoustic impacts will require gear manufacturers to determine the frequency, power, and required duty cycle of the gear. Additional research may be required to determine acceptable frequency and power ranges for acoustic devices for certain sensitive species.

## **2. Reliable**

The reliability of pop-up gear is a key factor for both authorization and adoption from the fishing community. California regulations require alternative gear to be retrievable with gear loss rates of no more than 10% and back-up release capability to ensure the ability to surface in the event of equipment malfunction.<sup>26</sup> In order to meet this criterion, trials must be conducted in realistic California Dungeness crab fishing conditions that demonstrate at least a 90% success rate (this translates to the required gear loss rates of 10% or less).

### **Trap Loss**

A common concern that is an important consideration for reliability is the potential for gear loss while using a fishing method without a surface buoy. Conventional trap loss in the commercial Dungeness crab fishery is estimated to be around 10% per season.<sup>27</sup> Achieving reliability rates of 90% or higher,

<sup>25</sup> Brandon Southall, personal communication, November 29, 2021.

<sup>26</sup> Risk Assessment Mitigation Program: Commercial Dungeness Crab Fishery, Title 14, California Code of Regulations 132.8 (2020). Pgs. 1-9.

<sup>27</sup> California Department of Fish and Wildlife. "Draft Conservation Plan for California's Commercial Dungeness Crab Fishery."

demonstrates that this gear will result in lower rates of gear loss than conventional gear, and will create another incentive to using pop-up gear over conventional gear.

### Assessing Reliability

The reliability of any pop-up gear system should be assessed through an incremental and iterative approach. This includes conducting preliminary trials in a controlled environment (dockside, pool, or shallow waters) during calm conditions. Once sufficient reliability rates have been established, then additional testing can occur in more inclement weather (larger swells, variety of depths). During the testing, each component of a pop-up gear system should be assessed separately for reliability, and the trials should be designed to identify which component resulted in a failed trial. This includes the use of a VGM system to determine the usability and reliability of the system for locating deployed pop-up gear. Additionally, failures can also be classified as caused by mechanical or human error. Over time, the rate of human error will decrease as fishermen gain more practice using the gear and make modifications to better suit their fishing practices and vessels.

It is important to note that determining the reliability of a pop-up system is iterative, and in some instances, it may not be possible to fully test the reliability due to regulatory or technical limitations. Collaborating with resource managers and enforcement officials can help to reduce regulatory hurdles and ensure that testing efforts follow relevant fishery protocols. Additionally, pop-up systems do not need to be perfect to be authorized, particularly for initial authorized gear. An example could include gear that has demonstrated sufficient reliability at shallower depths and thus authorized with a depth restriction. However, these limitations will require regulatory change and are described during the Initial Gear Authorization phase.

### 3. Detectable and Identifiable

Without a traditional surface marker buoy, enforcement/management agencies, fishers, and other ocean users will need to know if pop-up gear is present. This will require a robust system to prevent gear conflicts, ensure catch limits are not exceeded, and fishing operations do not occur in prohibited areas (such as Marine Protected Areas).

California regulations include two criteria that fall under the umbrella of *detectable*:

- **Detectable:** *“detectability by the department, fishermen and public, including description of how the location of Alternative Gear is available visually or virtually, equipment specifications including costs and any required specialized equipment or training to deploy, operate, or detect the gear. If “ropeless”, the gear must be used with software that enables department law enforcement and other fishing vessels within ¼ mile of the gear to identify the location of the gear at all times when deployed.”*<sup>28</sup>

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<sup>28</sup> Risk Assessment Mitigation Program: Commercial Dungeness Crab Fishery, Title 14, California Code of Regulations 132.8 (2020). Pgs. 1-9.



- **Ability to Identify:** *“means of Alternative Gear identification, including the method or description of the mechanism required for the department to identify Alternative Gear to permit holder both remotely when submerged, and at the surface.”*<sup>29</sup>

Virtual gear marking is a method of electronic monitoring that will allow any proposed pop-up system to meet these criteria. The location and other pertinent information about the deployed pop-up gear will be stored and accessed via a cloud-based backend system, accessible through an app or computer. These systems are comprised of a front-end and back-end. The front-end of a system includes the application(s) that can be accessed by fishermen and enforcement to input or view data on pop-up gear. Information stored with a VGM system may include the location of deployed pop-up gear (GPS coordinates), permit holder information, trap number, type of pop-up system, and expected pop-up time (for timed-released gear). Gear manufacturers have developed a variety of front-end applications to use in combination with their pop-up gear. The back-end of a VGM system refers to where all the data is stored, and ideally this would be a cloud-based system that is interoperable across each front-end application.

### **Accessibility**

Accessibility is a key component of any VGM system. A VGM application should provide a tiered system of access based on user-type (Figure 2), be interoperable across platforms (i.e., available on both Apple and Android operating systems), secure, and easy to use. Resource managers and enforcement officials will require access to data for all gear located within their jurisdiction, and they should be provided an opportunity to specify what specific information will be required within a VGM system. Additionally, enforcement will likely require the ability to input information on gear checks or other regulatory information for specific traps. The fishermen, or permit holder, will need access to all information about any of their deployed gear and have the ability to enter and update trap locations. Lastly, other ocean users will require the ability to determine if pop-up gear has been set within ¼ mile to avoid gear conflict. This information would be limited to geographic information, and not include private information on gear owner, fishery, or other information that could be considered personal fishery information.

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<sup>29</sup> Risk Assessment Mitigation Program: Commercial Dungeness Crab Fishery, Title 14, California Code of Regulations 132.8 (2020). Pgs. 1-9.

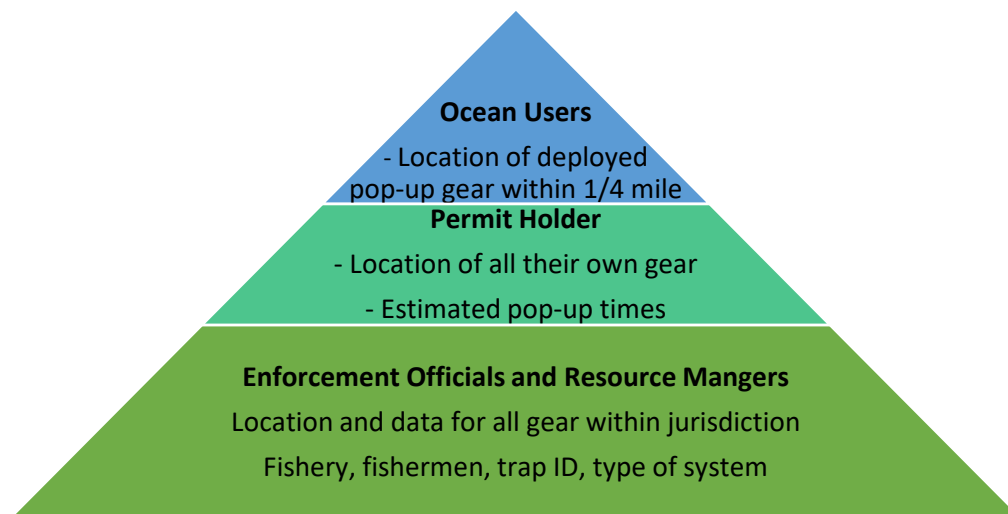


Figure 2: Tiered system of access for any VGM system

**Interoperability**

The interoperable component of VGM refers to the ability of a variety of front-end applications to operate in conjunction with a universal, back-end, data-sharing system. It is key to recognize that there will not be one system that works for all fishermen and management agencies. Instead, providing the flexibility for fishermen and management agencies to choose what front-end systems work best for their individual operations is critical while also housing the data in one universal system to allow for data sharing across platforms and regions.

Another consideration for interoperability of the front-end VGM application includes integration within existing systems, such as chart plotters, that fishermen already use. A chart plotter is a common device used by fishermen for marine navigation that integrates GPS data with navigational charts, environmental data, and other sensors.<sup>30</sup> Rather than creating another resource that requires the use of a phone or tablet, application manufacturers could work with chart plotter companies to integrate VGM software. This would streamline information access so that fishermen could access all relevant pop-up information in one place.

Last, VGM systems will require long-term funding and management. A trusted third-party would be an ideal manager of the system (such as Ocean Observing Systems or Global Fishing Watch) to minimize resource and funding burdens on governmental agencies as well as allow for creation of a universal system across states, fisheries, ocean users, and agencies.

Many of the characteristics of VGM described in this section are considered necessary or ideal in the long-term but are still in early development phases. In the short term, progress should focus on establishing simple versions of VGM software that can be used during pilot testing efforts and early authorizations to help establish fishing and enforcement protocols and meet basic regulatory criteria.

<sup>30</sup> Boat Trader. “What are Chartplotters and how do they work?” October 19, 2021. <https://www.boattrader.com/research/what-are-chartplotters-and-how-do-they-work/>

#### 4. Enforceable

Pop-up gear will require new and innovative methods of enforcement due to the lack of a conventional surface marker buoy. Under the current regulatory structure, enforcement officials rely on surface marker buoys to locate individual traps and conduct “random checks” to ensure they comply with fishery regulations. California regulations require “means by which department law enforcement can fund and retrieve the Alternative Gear at sea and costs of any necessary equipment and/or training; and that law enforcement must be able to retrieve and redeploy the gear.”<sup>31</sup> The proper enforcement of pop-up gear will require the following elements:

1. Ability to retrieve, reset and deploy gear while conducting random checks
2. Access to a VGM system with information on gear ownership, location, pop-up time (timed-release gear), and other pertinent trap information
3. Ability to ensure fishery compliance

The ability of enforcement officials to check and redeploy pop-up gear will require their involvement in early testing efforts so they can provide feedback on gear design and function and incrementally develop an approach to enforcement. For any gear to be authorized, enforcement officials will need to be knowledgeable of trap configurations and be able to retrieve, reset, and deploy pop-up gear without the presence of a fishermen or gear manufacturer. During early authorization efforts, limiting the number and complexity of pop-up gear systems will help enforcement to incrementally learn how to use the gear.

Along with physically being able to use the gear, enforcement will need access to the VGM system that allows them to see information on all deployed gear within their jurisdiction and access information on specific traps. This includes accessing this information both on the water and via computer. Minimum VGM requirements for initial authorizations of pop-up gear should be established. The specific long-term data and accessibility needs will vary among enforcement agencies and can continue to be developed and enhanced post-authorization. Regulations also mandate the development of new electronic monitoring requirements to observe fleet-wide trends and inform the potential for entanglement risk.<sup>32</sup> Rather than developing an entirely separate system for this type of electronic monitoring, enforcement officials and VGM developers should consider how to incorporate additional types of information and tracking to meet the needs of gear enforcement and fleet-wide monitoring.

#### Protocol Development

Ensuring the use of pop-up gear is compliant with fishery regulations is another key component of enforcement and will require the development of new protocols. While the long-term goal of VGM is to provide methods of ensuring compliance, early systems currently lack that ability. Long-term, there could be a requirement that gear cannot be deployed without being marked in the app (or the app will only mark a location once gear is deployed). Geographic coordinates could then be integrated within the applications so that gear is unable to be deployed within prohibited areas, such as Marine Protected

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<sup>31</sup> Risk Assessment Mitigation Program: Commercial Dungeness Crab Fishery, Title 14, California Code of Regulations 132.8 (2020). Pgs. 1-9.

<sup>32</sup> California Department of Fish and Wildlife. 2021. “Compliance Guide for the California Commercial Dungeness Crab Fishery Electronic Monitoring Program”. Updated May 3, 2021.

Areas. This type of technology may not be ready in the short-term, so for early authorizations and testing of pop-up gear, enforcement can require the use of interim electronic monitoring technology, such as AIS or Solar Loggers.

Lastly, enforcement protocols will vary for different types of pop-up gear. For timed-release gear, enforcement officials will need access to the estimated pop-up times and will be able to retrieve this gear using conventional methods at the time it surfaces. Timed-released gear cannot be accessed until its pre-programmed pop-up time, effectively preventing fishermen from tampering with the gear. This type of equipment does not require the user to purchase additional gear, making it ideal for early authorization. Alternative, acoustic gear requires the use of an acoustic transducer to activate the release of the rope and buoy. Once the trap reaches the surface, it is recovered like conventional traps. The need for additional equipment may pose a financial burden on enforcement and it therefore may not be ideal for early testing and authorization.

Authorization of pop-up gear systems will require the development of new methods of enforcement, but they will also provide enforcement with many benefits. The VGM component of pop-up gear can provide a more nuanced, regional view of the fishery and provide enforcement officials with quick access to individual permit and fishermen information. Additionally, locating gear via a VGM application can increase the efficiency of finding traps.

Thus, pop-up gear systems will not only need to work for fishermen themselves, but also enforcement officials. This will require enforcement personnel to be trained in how to use the gear itself (retrieve, reset, and deployment) and the VGM system.

## 5. Viable for Fishermen

Viability for fishermen is not a regulatory criterion, however, it is critical for ultimate authorization and acceptance. While pop-up fishing gear will reduce entanglement risk, it is important to recognize and address the additional benefits and challenges that it will pose for the fishing community. Implementation of pop-up gear will not only require significant changes to fishing operations, but also affect the dynamics of the fishery itself and dynamics among fisheries because of the changes to fishing operations.<sup>33</sup> On the other hand, pop-up gear offers many potential benefits in terms of providing more economic opportunities, increasing fishing efficiency, and reducing gear loss rates. Many individual fishermen are interested in using pop-up fishing gear as a means to continue fishing during closures, and efforts need to be made to create an accepting and supportive environment for those participation in testing and innovation.

Introduction of a new type of fishing system will require fishermen to spend time learning how to use the gear and VGM system, modify fishing techniques to increase efficiency, and spend time training crew members. Additionally, there are costs associated with acquiring and installing new equipment on fishing vessels and the time spent testing new gear. There is a wide diversity of fishing vessels, strategies, and business plans across the Dungeness crab fishery that will need to be considered.

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<sup>33</sup> Oppenheim, N.G. (2022). Assessing the Feasibility of On-demand Gear in New England Lobster Fisheries. Homarus Strategies LLC, Brunswick, Maine, USA.



The viability of pop-up gear will depend on efficiency, safety, financial cost, and acceptance within the fishing community. The efficiency of pop-up systems will need to be comparable to or better than conventional gear in the long run. Efficiency can be measured and evaluated compared to conventional gear during the reliability tests by comparing crab catch rates and servicing times. As with any new technology, efficiencies during early trainings and authorizations can be assumed to be slow at first but improve over time. Allowing fishermen opportunities to work with gear manufacturers to make gear modifications for increased efficiency at the outset is key. Additionally, for some fishers, the use of pop-up gear in conjunction with multiple traps per line and pop-up unit could increase efficiency and profitability.

Safety is another important consideration, especially ensuring that the gear can be fished throughout the wide variety of California ocean conditions. Early testing efforts should ensure the traps do not cause safety issues prior to transition to larger scale testing. This is particularly important for those considering using multiple traps per line and the implications for smaller vessels that have less deck space and capacity for handling gear.<sup>34</sup> Gear conflict with conventional gear, other trap fisheries, and commercial trawl fisheries is an additional potential safety and efficiency concern. Gear conflict refers to when a vessel or its gear comes into contact with other gear or another vessel and results in the loss or damage of a vessel or gear.<sup>35</sup> Addressing this will require outreach, education, and training with fisheries whose operations overlap with those of the California Dungeness crab fishery. Any VGM system will need to be easily accessible for other ocean users, and it would be especially helpful if integrated into existing systems, such as chart plotters.

### **Economic Considerations**

Perhaps the largest concern from the fishing community related to pop-up gear is the economic viability and impacts to the economic productivity of the fishery. This includes the time and cost associated with testing and innovation efforts, costs of acquiring gear, and the operational efficiency of the gear. Time spent testing gear is often time away from profitable fishing opportunities and can thus place economic burdens on fishers. Developing funding mechanisms to help subsidize the costs of purchasing gear and providing compensation for time spent participating in testing efforts can help to reduce some of the economic hurdles.

Compensating fishermen for their time and providing further funding to cover the costs of acquiring gear can remove or reduce economic barriers. Experimental Fishing Permits also provide an opportunity for fishermen to retain and sell crab that is caught during testing, proving an additional economic incentive for participation. Additionally, focusing on simpler models of pop-up gear that do not require changes to fishing vessels is another way to reduce costs. If additional modifications or gear is required, such as hull-mounted transducers, then providing gear free of costs or greatly subsidized is encouraged. Other opportunities to reduce costs include providing free gear to fishermen (i.e., Collaborative Gear

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<sup>34</sup> California Department of Fish and Wildlife. 2021. "Draft Conservation Plan for California's Commercial Dungeness Crab Fishery." <https://cdfwmarine.wordpress.com/2021/12/02/cdfw-releases-updated-draft-conservation-plan-for-commercial-dungeness-crab-fishery/>

<sup>35</sup> U.S Legal. "Gear Conflict Definition". Accessed December 5, 2022. <https://definitions.uslegal.com/g/gear-conflict/>

Lending Library on the East Coast), working directly with manufacturers, and obtaining grant funding (i.e., NOAA's BREP program). The Collaborative Gear Lending Library was established by NESC on the East Coast to provide fishermen with opportunities to reduce costs and access a variety of pop-up systems while participating in experimental permits.<sup>36</sup> As pop-up gear becomes more widely used, production costs will decrease and economic incentives, such as gaining access to closed fishing zones, will increase.

Another potential cost for consideration is related to gear loss potential. Conventional gear loss rates are estimated at 10% season wide.<sup>37</sup> While this cost is already factored within some business models, ensuring that pop-up gear has gear loss rates comparable to or better than conventional gear could incentivize the use of the gear.

### **Fishing Community Acceptance and Participation**

Lastly, the viability of pop-up gear is largely dependent on the participation and acceptance of the fishing community. Fleet-wide concerns about a blanket mandate requiring the use of the gear year-round have hampered good faith testing programs and created unsafe testing environments. The varying implications for small vs. large vessel operations is an additional area of contention. Larger vessels may be more flexible to regulatory changes and mandates, such as using multiple traps per line or fishing during a permanently shortened season, and able to overcome initial economic barriers to purchasing new equipment. Smaller vessels are dependent on being able to fish for greater proportions of the season, and less able to provide the upfront costs of purchasing additional gear.

Given these concerns, it is critical to take an incremental approach to the implementation of pop-up gear. Initial reliability testing and authorizations should be designed to demonstrate the viability of pop-up gear, and fishermen should be provided ample opportunities to participate in testing efforts and provide input on gear design and function.

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<sup>36</sup> NOAA Fisheries. 2022. "Protected Species Gear Research." Last updated October 19, 2022. <https://www.fisheries.noaa.gov/new-england-mid-atlantic/science-data/protected-species-gear-research>

<sup>37</sup> California Department of Fish and Wildlife. 2021. "Draft Conservation Plan for California's Commercial Dungeness Crab Fishery." <https://cdfwmarine.wordpress.com/2021/12/02/cdfw-releases-updated-draft-conservation-plan-for-commercial-dungeness-crab-fishery/>

### Proposed Pathway for Pop-up Gear Authorization

As described in the previous section, there are several socioeconomic, regulatory, and technical factors to consider for the authorization of a new, innovative fishing gear such as pop-up gear. This section details an incremental approach to the authorization of pop-up gear in the California Dungeness crab fishery within the regulations (Figure 3). It focuses on promoting collaborative interactions among the fishing community, gear manufacturers, regulatory and enforcement agencies, researchers, and other interested groups. The goal of this type of approach is to focus on and enhance economic, technical, and other incentives to pop-up gear adoption. We recognize that mandates may become a necessary incentive tool if there continues to be a lack of support and acceptance from the fishing community.

This approach was developed within the confines of the regulatory criteria for alternative gear, but the core approach and general recommendations were developed to be applicable to other fisheries, states, and jurisdictions.

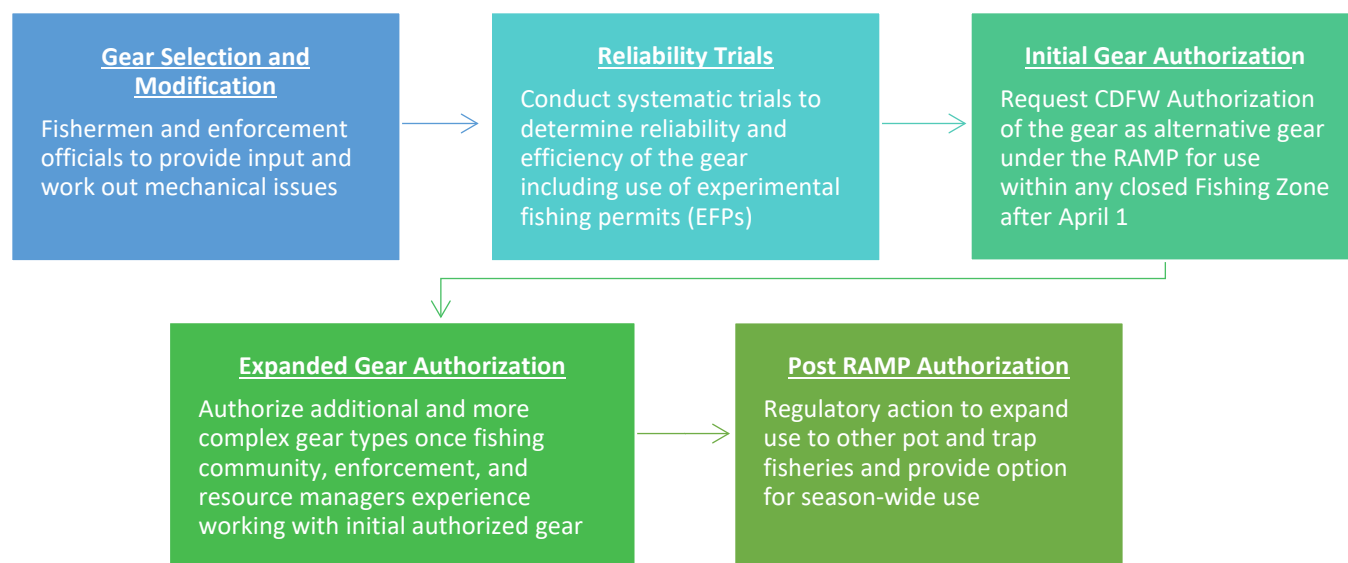


Figure 3: Pathway to Pop-up Gear Authorization Diagram

#### 1. Initial Gear Selection and Modification Phase

The first step in this approach includes selecting and modifying one or a few types of pop-up systems for the initial development of fishing and enforcement approaches. Carefully limiting the number and complexity of pop-up gear types in this phase will streamline the gear modification, reliability trials, and authorization phases and provide fishermen, resource managers, and enforcement time to become comfortable with a new type of fishing gear. Once the use of these pop-up systems and associated enforcement protocols is more widely adopted, then additional, more complex pop-up systems can be integrated.

This phase focuses on providing hands on experience to a diverse array of fishermen and enforcement officials to allow them to provide input and identify which seem like good candidates for their specific operations. Providing opportunities to refine pop-up systems to meet the needs of different fishing and

enforcement vessel types will help work out mechanical issues and adapt the gear for use within the Dungeness crab fishery prior to conducting reliability trials. We recommend testing the gear at sea, through the entire deployment and retrieval process with back-up buoys to identify modifications to improve efficiency and reduce likelihood of gear loss. The goal is to reduce the number of adjustments made during reliability trials to ensure sufficient replicates using identical systems. Additionally, this phase should also focus on selection of a VGM system to use in combination with the gear.

One recommendation is to focus on timed-release gear early in the pathway because of its simpler design and lower upfront costs. It provides an opportunity for fishermen and enforcement to gain practice using a pop-up system without purchasing additional acoustic gear. However, if fishermen indicate a strong interest in a simple acoustic system during the gear demonstrations, this can be pursued simultaneously during the reliability trials. In which case, fishing and enforcement protocols will need to be developed separately because of the differences in operation of timed release vs. acoustic systems.

### **Collaboration and Outreach**

Outreach during this phase should focus on connecting with fishery organizations, gear manufacturers, enforcement officials, and resource managers. Gear demonstration workshops can be held in areas where fishermen normally congregate, such as ports and harbors. The time of year for these workshops should be carefully considered as many fishermen participate in other fisheries when the Dungeness crab season is closed. Gear demonstrations should be followed by an opportunity for fishermen to practice using the gear to provide initial input. A goal of these workshops is to find fishermen interested in participating in the reliability trials, begin to understand their gear preferences, the specifics of their fishing operations and needs.

One potential area for modification includes the surface gear management component of the pop-up gear. Specifically, the ratio of the buoyancy of the buoy compared to the weight of the trap. If a buoy is too buoyant when released, the gear may “jump across the bottom” in the presence of a strong current or larger swell. If the buoy is not buoyant enough, it may not be able to reach the surface during larger swells and be hard to locate.

## **2. Reliability Trials Phase**

Once gear has been selected and modified, the next step is to conduct systematic trials to determine the reliability and efficiency of pop-up gear and demonstrate how the gear could be gradually implemented within fishing operations via regulatory authorization. We recommend these trials are conducted through a phased approach to allow for the training, testing, and implementation of pop-up gear in a controlled environment.

### **Preliminary Testing with Back-up Buoy**

Preliminary reliability trials should take place off the vessel in the harbor, or at a shallow, calm area in the nearby fishing grounds. California regulations require the use of a back-up buoy during these trials, and they must take place during an open fishery season where the use of pop-up gear is legal. CDFW developed a guidance document that provides information on relevant regulations, and potential testing

restrictions such as permitting, gear, and geographic locations.<sup>38</sup> The VGM system that was selected during the previous phase should be used in conjunction with each individual trial to determine the reliability and efficiency of the technology to locate the pop-up gear and store other pertinent information. Trials during this phase should focus on achieving at least a 90% reliability prior to conducting trials without a back-up buoy.

### **Testing Without Back-up Buoy: Experimental Fishing Permit (EFP)**

Once the gear has demonstrated at least a 90% reliability rate during the preliminary trials, the next step will be to apply for an Experimental Fishing Permit (EFP) to conduct further testing that otherwise would not be permitted. Most notably, this includes testing the gear without the presence of a back-up buoy and reducing any time or geographic barriers to testing within existing fisheries. Along with continuing to test the reliability, another goal during this phase is to test the efficiency of the gear compared to conventional gear. This can be accomplished by providing fishermen with enough gear to fish at a scale like conventional gear to compare set-up and haul times and catch size. Fishing the gear side by side could provide insight into the operational efficiency of retrieving, resetting, and deploying pop-up gear and any other operational or efficiency discrepancies between the gear types. Additionally, testing the use of multiple traps per line in conjunction with pop-up gear could occur under an EFP and provide valuable insight on another fishing process.

### **Data collection**

Both testing phases will require a robust data collection procedure to determine reliability, entanglement risk reduction, and communicate findings. Data collected during the trials should include at a minimum:

- Environmental data (e.g., wind speed, current, depth, visibility)
- Time/location of deployment (GPS coordinates), programmed pop-up time, time of retrieval
- Electronic monitoring data (e.g., virtual gear marking app, solar data logger)
- Retrieval, sorting and deployment time (comparison with traditional gear)
- Catch of legal-size crabs per trap (comparison with traditional gear)

See Appendix for an example data collection sheet used during reliability trials with the Sub Sea Sonic TR4RT pop-up system.

### **Collaboration**

Successful and efficient reliability trials will require significant collaboration among resource managers, enforcement officials, fishers, other fisheries, gear manufacturers, and NGOs. Reliability trials will require significant coordination, data collection, and administration components. These roles could be filled by fishers, NGO staff, or other interested stakeholders, but ideally should not fall solely on the fishermen conducting the testing. Providing an additional person to collect data during the reliability trials is encouraged.

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<sup>38</sup> California Department of Fish and Wildlife. 2022. "Guidance for Testing Trap Gear Modifications." May 2022. <https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=169838&inline>



Enforcement should be encouraged to participate in each phase of testing to establish familiarity with the gear and begin to develop enforcement protocols for a potential authorization. The EFP phase should especially focus on developing a pilot enforcement collaboration. Along with the collaboration required within the fishery, and relevant managers and enforcement, it is also recommended to collaborate with other fisheries to test the VGM software's ability to reduce gear conflict. This includes exploring other options for mitigating gear conflict and coordinating fishing activities.

### Funding

Funding is another key component to successful reliability trials. At minimum, fishermen should be compensated for their time spent training to use and testing the gear as well as provided gear to test free of charge. Consideration of a variety of funding mechanisms early in the planning process is key. Additionally, providing opportunities to retain and sell catch while testing under the EFP could provide a financial incentive to testing during other fishery seasons.

### 3. Initial Alternative Gear Authorization Phase

Once gear has demonstrated at least a 90% success rate during the reliability trials, and has met all other regulatory criteria, the next step will be to request an authorization as alternative gear. This phase is referred to as an "initial" authorization with the recognition that limiting the gear included within the application to one or a few gear types and focusing on simpler gear may have a better chance of approval. Once the fishing community and resource managers gain experience with the gear at the level of authorization, then another application can be submitted that includes additional and/or modified gear types, as described in the next phase.

The application should be developed in collaboration with any involved parties (fishers, CDFW managers, CDFW resource managers and enforcement officials, NGOs, researchers, and/or manufacturers). This is especially important regarding CDFW as they are the entity that will ultimately approve, manage, and enforce the gear. Ensuring that they are involved in the entire process, from gear selection and reliability trials, to drafting the alternative gear application will help to ensure that they are prepared for a new gear type. In this phase, this will involve consulting with CDFW early-on in the drafting process.

The Alternative Gear application requires the following elements<sup>39</sup>:

- Description of the gear including how law enforcement will retrieve and deploy the gear
- Detailed results from the reliability trials including a description of the environmental conditions, the number of trials, and gear loss rates of no more than 10%
- Explanation of how the gear meets each of the regulatory criteria (benefit, reliable, ability to identify, detectable, enforceable)

When preparing the application, we recommend the following:

- **Gear types:** We recommend limiting the number of systems in early authorizations to those that demonstrated over 90% success rate in a sufficient number of reliability trials.

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<sup>39</sup> Risk Assessment Mitigation Program: Commercial Dungeness Crab Fishery, Title 14, California Code of Regulations 132.8 (2020). Pgs. 1-9.

- **Virtual Gear Marking:** We recommend identifying a single VGM app that would be used by any authorized system, rather than multiple VGM apps that are interoperable. This will simplify data access and control as well as allow stakeholders to build capacity incrementally.
- **Additional electronic monitoring requirements:** If the VGM software does not prevent the deployment of unmarked gear or allows for marking where no gear is set, then additional electronic monitoring technology is likely required. We recommend AIS or solar loggers to provide interim data while the VGM system develops the capacity to do so. Consulting with enforcement officials will help to clarify their specific electronic monitoring needs.

### **Regulatory Changes for Initial Authorizations**

Once authorized, the use of the gear will be an option for continued fishing within any closed fishing zones after April 1 or later. The current regulations do not allow for additional restrictions on gear use such as geographic limitations and depth restrictions. However, these types of restrictions may enable initial authorizations to be more manageable and regulatory changes should be considered. The state-wide authorization of alternative gear will require the CDFW managers and enforcement staff be trained on gear protocols state-wide, and this may be considered a barrier to early authorizations. Limiting initial authorizations to smaller geographic areas (such as the Monterey Bay) will limit the amount of department resources required for gear management and reduce the potential for gear conflict. As stated, this is an iterative process. Regulatory changes should be considered as another tool in the toolbox, not as required for authorization.

### **Funding Considerations**

During this initial authorization phase, a variety of funding mechanisms should be considered to help interested fishermen overcome financial barriers to entry. There are a variety of grants and other “pots of funding” available to fishermen involved in innovative testing efforts. Additionally, development of a gear cache, like the Collaborative Gear Lending Library, could lend gear to fishermen who are interested in testing pop-up gear. This could be managed by a fishing port or other fishery organization.

## **4. Expanded Gear Authorization Phase**

Once gear has been approved in an initial authorization, and the fishing community, enforcement officials, and resource managers have gained experience using and managing the gear, the next step will be to authorize additional, more complex gear for use in closed fishing zones after April 1. Along with including more complex gear types, there are other aspects of expanded gear authorization including full development of a VGM system, funding considerations, and potential regulatory changes.

The purpose of the limited, initial authorization was to demonstrate the viability of pop-up gear at a larger scale, continue to improve the efficiency of the gear, and develop preliminary enforcement and management protocols. Once this has been achieved, an expanded authorization could include more complex gear types to continue the development of enforcement and management protocols and provide more diverse pop-up system options for fishermen to choose from. This may include acoustic systems that require additional equipment and thus present additional economic and operational considerations for both fishermen and enforcement officials. Specific acoustic systems will need to go through the same process as the initially authorized gear and demonstrate reliability rates of 90% or

greater. Authorization of multiple traps per line is another potential complex gear type to consider if it showed promise under an EFP. However, this will require additional regulatory change.

Along with more complex gear, this phase should also focus on the full development of a VGM system with an interoperable backend that is compatible with multiple gear marking applications. As the use of pop-up gear continues to expand, a robust VGM system is critical for enforcement, fishery management, and avoiding gear conflict with other fisheries. This includes obtaining funding for the development of this system as well as long-term maintenance. Careful consideration will be required for what third-party will conduct the long-term maintenance and funding of the system.

### **Regulatory Changes**

Like the initial authorization phase, regulatory changes should be considered to allow more flexibility while expanding the authorization. Regulations currently limit the use of pop-up gear to after April 1 within any closed fishing zone. Allowing gear to be used at the beginning of the season when entanglement risk is heightened (November-December) would provide an economic incentive to the transition of pop-up gear to gain access to the seasonal holiday markets. The ability to limit the geographic area in which a gear is authorized is another consideration, especially for complex gear types that aren't ready for state-wide use.

Lastly, the recreational fishery is interested in using pop-up gear, but is not included within the regulations. The Fish and Game Commission will need to establish new regulations for authorizing pop-up gear in the recreational fishery, such as including recreational gear under the regulations.

### **Funding Considerations**

Efforts in this phase should build off the funding mechanisms established during the initial phase of authorization and continue to find new funding sources. Working with legislators in California to request funds within the state budget could help to provide funding and resources to CDFW and expand their capacity to manage this gear, as well as help subsidize the costs of initially purchasing gear at scale. The NOAA Fisheries Finance Program (FFP) provides long-term fixed rate loans for fishing and aquaculture industries and may be another resource for interested fishers.<sup>40</sup> Other market-based approaches, such as sustainability certifications, could provide additional incentive for the use of pop-up gear.

## **5. Long-term Vision for Pop-up Gear**

The RAMP program provides a unique regulatory route for the gradual implementation of pop-up gear within the California Dungeness crab fishery. Expanding the use beyond the classification of alternative gear is the next step to continue implementing at scale. Other pot and trap fisheries can benefit from the use of pop-up fishing gear not only regarding reductions in entanglement risk but also with increased fishing efficiencies and reductions in gear loss and conflict due to the virtual gear marking components.

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<sup>40</sup> NOAA Fisheries. 2021. "Fisheries Finance Program." <https://www.fisheries.noaa.gov/national/funding-and-financial-services/fisheries-finance-program>

### **Expansion Within Commercial Dungeness Crab Fishery**

Once the gear has demonstrated viability as an authorized alternative gear under California regulations, some fishermen may wish to use the gear at other times in the crab seasons, or potentially all season long. Expanding the use of pop-up gear beyond the regulatory limitations of April 1 or later during closed fishing zones will provide fishermen the option to transition their fishing operations to pop-up gear if they prefer it over conventional gear. Additionally, it will also provide the opportunity to gain access to closed areas when entanglement risk is high at the beginning of the season. Allowing for gear use early in the season could provide for strong incentives to use the gear as catch rates and market prices can be relatively high. However, it is important that this opportunity be available to all crab fishermen, ideally with multiple gear types, to address fairness and equity concerns.

### **Expanding to Other Fisheries**

Expanding the use of pop-up gear other pot/trap fisheries is another potential next step. One option includes regulatory action to allow the voluntary use of pop-up gear in other fisheries. However, regulatory and economic incentives may be required for initial adoption. This could include developing programs similar to the RAMP within other fisheries by implementing time/area closures where fishing with pop-up gear is allowed. When considering authorizing new trap fisheries or exploratory Experimental Fishing Permits using traps to target new species, regulators could include requirements to use pop-up gear.

### **Marketing Considerations**

Along with regulatory action, marketing tools can help to increase adoption and long-term use of pop-up fishing gear. Consumers are increasingly more interested in purchasing “sustainable” goods, and crab or other fish caught with pop-up gear can be marketed and sold at a premium. One approach could include sustainability recommendations such as a unique ranking by Monterey Bay Aquarium Seafood Watch or working with seafood distributors on Fishery Improvement Projects or Gear Innovation Projects to market crab caught with pop-up gear as “whale safe”.<sup>41,42</sup> This approach will require traceability measures to ensure catch is caught with pop-up gear but has been a very successful tool in other fisheries. These pathways can help to increase consumer awareness of the benefits of this new type of fishing gear, and thus provide additional incentives for fishers.

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<sup>41</sup> Seafood Watch. “Certified Seafood.” Accessed December 5, 2022. <https://www.seafoodwatch.org/>

<sup>42</sup> Marine Stewardship Council. “What does an MSC label mean?” Accessed December 5, 2022. <https://www.msc.org/what-we-are-doing/our-approach/what-does-the-blue-msc-label-mean>

## Current Progress in California

### **Reliability Testing**

Pop-up gear testing efforts began in 2018 with a collaboration between Oceana, gear manufacturers, and fishermen on the Dungeness crab fishing gear working group to conduct initial pilot tests of Fiomarine and Desert Star prototypes in Bodega Bay, San Francisco, and Monterey Bay.<sup>43</sup> Feedback provided during these early demonstrations included modifications to rope and buoy storage during transportation. Other workshops and demonstrations have been hosted by CDFW and the National Marine Sanctuary Foundation, with the most recent occurring in August 2022.

The National Marine Sanctuary Foundation (NMSF), California Ocean Protection Council (OPC) and CDFW are collaborating on a gear innovation project that is focused on obtaining reliability data for four different pop-up systems.<sup>44</sup> This project will provide data on quantitative reliability to demonstrate if existing pop-up technology could qualify for authorization and identify concerns related to reliability of the gear to guide future innovations. To date, gear has been purchased for the gear innovation project along with data collection tools, and fishermen recruitment.

Oceana and Sustainable Seas Technology hosted a variety of gear demonstrations during summer 2021 that resulted in identifying the Sub Sea Sonic TR4RT pop-up system as a good candidate for early acceptance and technology readiness. During 2021 and early 2022, Oceana, Sub Sea Sonics, and a Dungeness crab fishery participant conducted extensive reliability testing and refinement of the Sub Sea Sonics TR4RT pop-up fishing system.<sup>45</sup> These trials of the TR4RT resulted in a 95% success rate (124 successes of 130 trials). Successes were defined as a full deployment and retrieval of the gear without requiring the back-up buoy. The testing efforts included the use of a back-up buoy over relatively calm environmental conditions. Both mechanical and human errors were encountered throughout the trials, and the associated component of the pop-up system causing the error was identified. Human errors occurred while coiling the rope to reset the trap and resulted in a tangle in the line upon release. Modifications to the rope coiling method were made to reduce human error and ensure that the rope is coiled efficiently and secured properly. A mechanical issue with the release mechanism on a singular trap resulted in a failed pop-up. It was identified as a battery issue, and once addressed didn't occur again. Next steps include conducting further trials without the presence of a back-up buoy over a broader range of environmental conditions, geographic areas, and depths under an Experimental Fishing Permit.

An alternative gear authorization request was submitted in February 2021 to CDFW which documented extensive successful reliability testing (described above), gear marking technologies, line handling systems as well as specified methods for vessel monitoring. The gear authorization was declined on the

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<sup>43</sup> Shester, Geoff. Initial Trials Exploring Ropeless Fishing Technologies for the California Dungeness Crab Fishery July 30, 2018 Update to the California Dungeness Crab Fishing Gear Working Group.

[http://www.opc.ca.gov/webmaster/\\_media\\_library/2018/08/ropeless-trials-update7-30-18.pdf](http://www.opc.ca.gov/webmaster/_media_library/2018/08/ropeless-trials-update7-30-18.pdf)

<sup>44</sup> National Marine Sanctuary Foundation. "Gear Innovation." Accessed September 30, 2021, <https://marinesanctuary.org/gear-innovation/>

<sup>45</sup> Shester, G., Cooper, K., and Chadwick, B. 2022. At-Sea Trials of Sub Sea Sonics Timed Release Pop-up Fishing Gear in Central California Crab Fisheries: September – December 2021 Summary Report Published December 2022. Available at: [https://usa.oceana.org/wp-content/uploads/sites/4/2022/12/Summary\\_Report\\_TR4RT\\_Pop-up-Reliability2021.pdf](https://usa.oceana.org/wp-content/uploads/sites/4/2022/12/Summary_Report_TR4RT_Pop-up-Reliability2021.pdf)



basis the Department believed that further work was required to test the gear at depths greater than 200 feet and under poor sea conditions, and that additional testing was required to ensure the gear could be properly enforced. Currently, no alternative gear applications have been approved by CDFW due to limitations to meeting enforceability, detectability, and reliability criteria. The Department further recommended that this additional testing be carried out under the state's new Experimental Fishing Permit (EFP) process.

Two EFP applications were submitted in Fall 2022 by Sub Sea Sonics and Puget Buoy and are anticipated for California Fish and Game Commission action in February of 2023.<sup>46</sup> Additionally, Sub Sea Sonics obtained a NOAA Bycatch Reduction Engineering Program (BREP) grant that would provide funding for three fishermen to fish with timed-release and acoustic gear at scale (50 units of pop-up gear per fisher). This grant would be used to compensate fishermen for participating in an EFP and cover costs of providing the gear to fishermen at no cost to them.

### **Virtual Gear Marking**

In addition to the gear testing efforts, a variety of front-end applications have been developed by gear manufacturers to be used in conjunction with their specific pop-up system. Limitations of these systems include lack of accessibility on a variety of operating systems, lack of compatibility with other gear types, and lack of access to a universal back-end database.

The Ropeless Manufacturers Working Group is an example of a collaborative approach to developing a backend system that can be used in combination with a range of VGM applications by any fishermen in the world.<sup>47</sup> The project includes representatives from eight pop-up fishing gear manufacturers and gear marking developers with the goal of developing a comprehensive approach to “data management, requirements, and integration parameters to develop an international virtual gear tracking system.”

Some researchers are advocating for the use of successive acoustic receive time (SART) self-localization that would allow acoustic traps on the seafloor to remotely communicate its position with passing ships that would be automatically updated within the back-end system.<sup>48</sup> This would allow fishermen and enforcement officials to access a trap's most recent location in the event the trap location has shifted since the most recent deployment.

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<sup>46</sup> California Fish and Game Commission, Notice of Receipt of Application. November 14, 2022.

<https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=206245&inline>

<sup>47</sup> Sustainable Seas Technology. “Virtual Interoperable Gear Marking.” Accessed December 4, 2022.

<https://sustainableseastechnology.org/the-ropeless-manufacturers-workgroup-on-virtual-interoperable-gear-marking/>

<sup>48</sup> Baumgartner, Mark F., Parton, Jim. 2021. “Self-localization of buoyless fishing gear and other objects on the sea floor.” JASA Express Letters 1, 086001. <https://doi.org/10.1121/10.0005739.1>

## Summary of Recommendations

The proposed pathway to authorizing pop-up gear presented in this report navigates many socioeconomic, technical, and regulatory considerations and is informed by lessons learned from previous gear testing and collaborative efforts. In addition to the specific recommendations offered throughout the previous sections of the report, we include several overarching recommendations to enhance economic and technical incentives to promote the transition of pop-up gear. Key recommendations for specific stakeholder groups discussed in this report are provided below:

### **Fishery managers:**

- Prioritize outreach and engagement with the fishing community and actively participate in gear demonstrations and reliability testing.
- Authorize pop-up gear that meets the regulatory requirements, even if the fishing community at large resists participating in training and testing efforts.
- Establish a goal of authorizing a suite of pop-up gear options so that the opportunity to use alternative gear is available to a diversity of large and small fishing vessels.
- Include ability to establish spatial, temporal, or depth limits on authorized alternative gear, as well as the discretion to authorize gear outside the spring months once it is shown to be successful as an authorized gear.
- Provide clear guidance and standards for independent virtual gear marking platforms and convene the fixed and mobile fleets to identify pathways and troubleshoot barriers to implementation.

### **Enforcement agencies:**

- Prioritize training enforcement staff on how to operate pop-up gear, either independently or by participating in gear trials and demonstrations.
- Develop and test new enforcement protocols within the confines of Experimental Fishing Permits or independently using actual equipment at sea.
- Actively engage in efforts to develop virtual gear marking for pop-up gear and ensure integration with other electronic monitoring requirements that will be used in enforcement.
- Provide clarity to gear manufacturers and fishermen on system protocols and electronic monitoring needed to enforce pop-up gear and ensure legal use of pop-up gear.

### **Fishing community:**

- Embrace pop-up gear as an opportunity to expand and restore fishing opportunities, and potentially reduce gear loss and confer other cost savings.
- Take a leading role in the effort to authorize pop-up gear.
- Take advantage of funding and collaboration opportunities to purchase and conduct trials of pop-up gear, including through Experimental Fishing Permits.
- Collaborate with gear manufacturers and participate in reliability trials to refine pop-up systems to better suit individual fishing operations.
- Work with suppliers and distributors to gain market recognition of pop-up gear and facilitate Gear Innovation Projects.
- Work with fishery managers and enforcement to establish a regulatory regime for pop-up gear that meets the need of the fishery while addressing entanglement risk.

### Conservation Organizations and Researchers

- Establish goal of assisting fishing organizations and regulators with authorizing pop-up gear as alternative gear.
- Focus on providing pop-up gear as an alternative gear to allow for expanded fishing opportunities, rather than a full transition to pop-up gear.
- Coordinate and share information and resources with each other toward a common goal of authorizing and advancing economically viable pop-up gear.
- Recognize the key role of pop-up gear is to allow for fishing opportunities in areas that would otherwise be closed to prevent entanglements.
- Gather a pop-up gear library of different equipment that can be transported to conduct outreach and demonstration events along the U.S. West Coast.
- Raise funds to support fishing communities to test, use, and transition to pop-up gear.

### Gear Manufacturers

- Provide gear and training resources for organized pop-up gear outreach.
- Plan to make modifications to pop-up gear and associated equipment in response to fishermen feedback.
- Collaborate with researchers, fishermen, and agencies in gear trials and Experimental Fishing Permits.
- Seek funding to provide for initial and scaled up reliability trials to enable gear authorization.
- Work toward interoperable virtual gear marking platform across manufacturers.

Additionally, CDFW is in the process of updating the RAMP regulations and should consider recommendations included throughout this report. Most notably, it would be helpful to provide the discretion and authority to authorize gear in earlier parts of the season once it has been demonstrated to be successful in the spring months as an authorized gear. This will allow for scaling up the use of the gear without needing to amend regulations.

### Conclusion

As marine species continue to alter their migration patterns in response to climate change, approaches to fishing and managing will need to adapt. Pop-up gear provides the only viable pathway to fishing for crab without risking the entanglement of whales and sea turtles off California and will help mitigate the economic impacts of existing time and area closures to protect wildlife by providing additional fishing opportunities. Other pot and trap fisheries will benefit from the use of pop-up fishing gear not only by reducing whale entanglement risk, but also with increased fishing efficiencies and reductions in gear loss and conflict. There are a variety of pop-up gear systems, and there is no single ideal pop-up system. Acknowledging the diversity of fishing operations within the Dungeness crab fishery and providing opportunities for modifications and collaboration is key in promoting acceptance and participation from the fishing community.

The RAMP program is a unique regulatory tool that provides a pathway to the gradual implementation of pop-up fishing gear. Successful implementation of pop-up gear will need to meet a variety of criteria for both regulatory approval as well as create support within fishing communities. It must reduce the

risk of entanglement and other adverse risks to whales and sea turtles, be reliable over a range of realistic fishing conditions, be detectable by fishermen, enforcement officials, and other ocean users, be enforceable to ensure fishery compliance. Meeting these criteria will require understanding a variety of behavioral, regulatory, and technical challenges. Collaborative approaches to developing new fishing and management protocols is essential, and authorization through the RAMP program in California provides a method for gradual implementation. Fishing organizations can play a key role in building support and acceptance of the gear and should be key players throughout the process.

Authorization of pop-up gear will demonstrate to the larger fishing and resource management community that pop-up gear is a viable method of fishing. Pop-up gear is the pathway to a vibrant Dungeness crab fishery where fishermen have the opportunity to keep fishing throughout the entire fishing season and consumers can know California crab comes with minimal risk to ocean wildlife.

## Appendix: Example Data Sheet for Pop-up Gear Reliability Trials

Vessel:			Fisher:			Port:			Data collector:			Pop-up systems:												
Unit #	Date	Time	Wind speed/dir	Visibility (mi)	wave height (ft)	Air temp (F)	Current (knots)	Latitude	Longitude	Depth (ft)	Substrate (S.M.U.#)	Unit #	Date	Time	Wind speed/dir	Visibility (mi)	wave height (ft)	Air temp (F)	Current (knots)	Latitude	Longitude	Depth (ft)	Substrate (S.M.U.#)	
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