Forensic Review Workshop REPORT
Reviewing the Gear Involved in West Coast Whale Entanglements

Sponsored by

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with generous support from

The Aquarium of the Pacific
The Marine Mammal Commission
Oregon Whale Entanglement Working Group

On August 29 and 30, 2018, over 30 experts including fishermen, whale entanglement responders, scientists, and gear experts met in Long Beach, California to review and discuss the collective knowledge and available forensic data surrounding whale entanglements in an effort to enhance the collective understanding of common characteristics of whale entanglements that can be used to better understand and address U.S. west coast entanglements in fixed gear fisheries, including Dungeness crab gear. Specific goals of the workshop included:

- Discuss forensic analysis of recent whale entanglements with fixed gear fisheries on the U.S. west coast to help understand entanglements including:
    - how whales are entangled
    - in what types of gear
    - in what components of gear
    - the relative effectiveness of documentation and assessment efforts to date
    - what can be learned from whale re-sightings.

- Discuss how to improve forensic analysis work.

- Discuss how to prioritize and improve entanglement data collection/documentation by responders and other ocean users.

- Review existing best practices documents in light of forensic review information.

- Discuss possible improvements in gear marking would help to better identify entangling gear.

- Discuss what gear modifications or gear modification research might be suggested by forensic analysis results and/or expertise of participants.

List of Workshop Participants

Jim	Anderson	Fisherman, Halfmoon Bay, CA
Dan	Ayres	Washington Department of Fish and Wildlife
Ryan	Berger	The Marine Mammal Center
Zed	Blue	Fisherman, Bellingham, WA
Cody	Chase	Fisherman, Newport, OR
Kelly	Corbett	Oregon Department of Fish and Wildlife
John	Corbin	Fisherman, Warrenton, OR
Kelsey	Cutting	Fisherman, Ilwaco, WA
Lauren	DeMaio	NOAA Fisheries -West Coast Region
Calder	Deyerle	Fisherman, Moss Landing
Pieter	Folkens	Whale Entanglement Response
Karin	Forney	NOAA Fisheries -SW Fisheries Science Center
Shelia	Garber	Englund Marine Supply
Justin	Greenman	NOAA Fisheries -West Coast Region
Dennis	Heinemann	Marine Mammal Commission
Dan	Lawson	NOAA Fisheries -West Coast Region
Scott	Mazzone	Quinault Indian Nation
Laura	McCue	NOAA Fisheries -West Coast Region
John	Mellor	Fisherman; San Francisco, CA
Pete	Nelson	H.T. Harvey and Associates/UC Santa Cruz
Dick	Ogg	Fisherman, Bodega Bay, CA
Kortney	Opshaug	Blue Ocean Gear
Fran	Recht	Pacific States Marine Fisheries Commission
Jim	Rice	Oregon State University
Penny	Ruvelas	NOAA Fisheries -West Coast Region
Doug	Sandilands	SR^3 SeaLife Response, Rehabilitation, and Research
Lauren	Saez	NOAA Fisheries -West Coast Region
Chugey	Sepulveda	Pfleger Institute of Environmental Research (P.I.E.R.)
Geoff	Shester	Oceana
Jenn	Tackaberry	Cascadia Research
Justin	Viezbicke	NOAA Fisheries -West Coast Region

Forensic Review Workshop

Executive Summary

Pacific States Marine Fisheries Commission (PSMFC) and National Oceanic and Atmospheric Association Fisheries (NMFS) convened a two-day workshop in Long Beach, California, to review and discuss forensic analysis of available data and documentation related to recent whale entanglements on the U.S. west coast with thirty-one invited experts from a diversity of backgrounds. These experts included members of the U.S. west coast fishing industry as well as entanglement responders, scientists and managers knowledgeable about fishing gear and/or whale entanglements.

With regard to entanglements, "forensic analysis" refers to the organized evaluation of various characteristics of entanglement reports, from individual case studies, including the type of gear involved, the nature of how that gear is entangled on or around a whale, and what additional information can be gleaned from the available documentation to better understand the origins of entanglements and how they can progress over time. The purpose of forensic analysis is to inform potential actions that might be helpful in reducing the number of whale entanglements that have been reported on the U.S. west coast in recent years.

In addition to solicitation of feedback from workshop participants on the methodology and results of the forensic review that has been conducted by NMFS to date, goals of the workshop were to discuss the implications of these results and to utilize the group's collective knowledge to identify the most promising avenues to pursue to increase understanding of the dynamics of entanglements and the ways to reduce them.

The first day of the workshop was highlighted with presentations by NMFS and other workshop participants relevant to forensic review analysis and the current state of knowledge surrounding important factors related to U.S. west coast entanglements. The second day concluded presentations of forensic review, discussed trends in U.S. west coast Dungeness crab fishing gear, current gear research efforts and the perspectives of workshop participants regarding potential ways forward to address the issue. Throughout the workshop, there was substantial discussion of the nature and variable mechanisms of entanglements and suggestions for how improve the ability to understand these aspects better. There was also substantial discussion of potential ideas to explore to reduce the likelihood and/or severity of entanglements. During the workshop, participants provided recommendations on the most promising avenues to address these various topics. Highlighted recommendations that appeared to be widely supported by workshop participants (though no consensus was sought or reached) are as follows:

- There was support expressed for further development of an entanglement gear repository by NMFS where gear removed from entangled whales could be stored after evaluation.
- There was support expressed for regular engagement of the fishing industry and other experts in this forensic review work.
- There was support expressed for further improvements in gear marking that involve a coordinated system across the entire U.S. west coast to improve the ability to identify the origins of gear involved in entanglements.
- There was support expressed for exploring alternative ways to connect buoys/lines on the gear to minimize the use of knots and splices, especially on the upper portions of gear that appear to be a place where gear often ends up wrapped, snagged, or otherwise entangled with whales by the time entanglements are sighted.
- There was general agreement that best practices guidelines and ideas to reduce entanglement need to address the use/scope of vertical lines, and that best practices guidelines need to be more widely disseminated and more easily accessible for commercial and recreational fisherman.
- There are outstanding questions about the physics related to the tension and drag forces of gear components, and how those forces may relate to entanglements, that could use further study to support refinement/development of best practices and ideas to minimize whale entanglements.

A more complete record of feedback and recommendations provided by participants during the workshop is generally described in the report below.

The appendices are not attached to this report as some are very large. They are available for download at the PSMFC website under the Forensic Workshop Review section: http://habitat.psmfc.org/preventing-whale-entanglement/

Forensic Review Workshop- Presentation Notes & Summaries

(Appendices are available on the PSMFC website: http://habitat.psmfc.org/preventing-whale-entanglement/ under the Forensic Review Workshop section.

Presentations and Discussions

Synthesized versions of presentations given during the workshop are provided in the appendices as indicated. Key discussion points and feedback provided by workshop participants relevant to the intended outcomes of the workshop are highlighted as part of summary provided for each agenda topic.

Day 1

Overview, goals, and outcomes (Appendix A) - Dan Lawson; NMFS West Coast Region

An introduction to the overall format and purposes of the forensic review workshop was provided, emphasizing the need for the workshop and desired outcomes, as outlined above. With regard to entanglements, "forensic analysis" refers to the organized evaluation of various characteristics of entanglement reports, working from individual case studies, including the type of gear involved, the nature of how that gear is entangled, and what additional information can be gleaned from the available documentation to better understand the origins and evolution of entanglements. The purpose of forensic analysis is to inform potential actions that might be helpful in reducing the number of whale entanglements that have been reported on the U.S. west coast in recent years.

The efforts of forensic analysis of entanglements in other places were discussed, including specifically highlighting successful past efforts on the U.S. east coast with the fishing industry helping to review a collection of gear removed from entangled whales. It was acknowledged that in lieu of having a large collection of gear removed from U.S. west coast entanglements currently in hand, the sharing and discussion of forensic analysis conducted by NMFS, based on what documentation was available, was the best step that could be taken at this time. Previous limitations to the collection and storage of gear on the U.S. west coast were discussed, but there was general agreement that it was important for improved forensic review to increase and enhance this capacity.

U.S. West Coast Data Summary (Appendix B) - Lauren Saez; NMFS West Coast Region

A summary of the data on whale entanglements reported to NMFS West Coast Region was presented, featuring the time period 2013-2018 (June). This is the time period of entanglements that were the subject to the forensic analysis review to be presented during the workshop. The data highlight the dramatic increase in entanglements that have been reported in recent years, most notably of humpback whales. While the data do indicate that Dungeness crab gear is the most commonly identified source of confirmed entanglements, the data also indicate that the gear origins of more than half of confirmed entanglements are unknown.

The discussion that followed included questions relating to a number of forensic review elements that were going to be covered in more detail later in the workshop. There were questions surrounding the varying quality and quantity of reporting up and down the coast, as well as limitations on the potential for tracking whales after entanglement/disentanglement. The discussion brought forward several questions regarding the nature of varying injuries and the evolution of entanglements over time that were very useful in highlighting issues that would be address in later workshop presentations. In particular, the group acknowledged the difficulty in interpreting exactly where contact with the gear by a whale may have initially occurred.

Introduction to Case Studies (Appendix C) - Dan Lawson

The general concept and approach of evaluating the forensics of specific cases was introduced and discussed by the group by walking through some specific example case studies of recent entanglements. Some of the key forensic categories highlighted include:

- Importance of conversations with fishermen whose gear was involved with an entanglement to fully understand gear configurations and information such as: depth and location of gear set; use of leads; type, size (diameter), and color of lines
- Gear identification, and the ability to identify any markings or tags on buoys that are observed
- Identification of the relative portion of gear that appears to be entangled with a whale when observed (with the caveat this is not necessarily where in the gear the entanglement started)
- The apparent attachment point(s) of gear on the body of the whale
- The relative extent and involvement of the surface gear (buoys and surface lines) associated with entanglements
- The apparent involvement of (and challenges interpreting) multiple sets of gear
- The apparent involvement of (and challenges interpreting) lost or derelict gear

For illustration purposes, some definitions and example forensic scoring of an entanglement case is provided in Appendix C.

(The full presentation of all documentation related to all the individual cases referenced at the workshop is not provided here, given the extensive additional context that was provided orally while examining the images. Such description is necessary to properly interpret the documentation).

Several topics that were discussed included thoughts from participants about the variety of ways that whales appear to get entangled, how whales might respond to entanglement incidents, and how gear might react in-kind. There was discussion about how the presence/absence of pots on the gear could affect the evolution of entanglements and injuries, and how this could be contingent to the type of entanglement and the location of the entanglement on the body. It was acknowledged that not all entanglements are of equal concern, and that some types of entanglements are more urgent than others, based in part on how and where the gear is entangled.

Introduction to Forensic Review (Appendix D) - Dan Lawson, Lauren Demaio, and Lauren Saez; NMFS West Coast Region

Several staff from NMFS gave presentations that helped introduce and describe the forensic review analysis and present results from the review that had been conducted of 193 confirmed entanglements from the U.S. west coast reported to NMFS from 2013 through early June, 2018. Some of the forensic results were accompanied by characteristic case study illustrations. This first presentation of forensic review analysis results included information related to: attachment points of entangling gear on whales, knowledge of the depth where gear involved in entanglements was originally set, comparisons of entanglement report locations with knowledge of the locations where entangling gear was originally set, evidence of possible association of entangling gear as lost gear or marine debris, and the incidence of entanglements that may have involved multiple sets of gear.

Forensic Results Highlighted:

- Attachment points for entangling gear appear to occur at relatively similar rates across different parts of the body for humpback whales; gray whale entanglement attachment points are more common in the fluke/peduncle area. These are likely related to morphology and feeding behavior of humpback whales along the coast compared to gray whales migrating through the area.
- Entanglements are often complex with multiple attachment points apparent when observed.
- When trailing gear behind the whale is removed (by well-intentioned but uninformed lay people) the life threatening wraps are often left on the whale and make it even less likely that a full disentanglement can occur.
- We don't know very much about the depth of fixed gear associated with entanglements. Humpback whales are known to get entangled in gear set across all depths; gray whales appear to get entangled more commonly in shallower gear.
- When known, the location of gear set that is involved in entanglements is usually the same state where the entanglement is reported (81%). Within California, it is more likely than not a whale is observed entangled in the same region (north, central, or south) as the gear was set in.
- Dungeness crab gear can be carried great distances before being reported entangled, especially by humpback whales
- Very few entanglement cases are known to involve lost gear or marine debris, but this is difficult to distinguish from active gear or entanglements that have been ongoing for a while.
- While not common, entanglements that are known or appear to occur with multiple sets of gear often involve at least one piece of Dungeness crab gear and have been occasionally associated with whales known to have died.
- Identifying gear to an individual fisherman and being able to communicate with them is crucially important to address multiple aspects of forensic analysis discussed in this section; depth and location of gear set, as well as timing to indicate if the gear was lost.

During the questions and discussion, it was widely acknowledged that there are a large number of entanglements where these forensic characteristics could not be evaluated with the information and documentation at hand. It was pointed out the mouth and fluke area are common final resting points for gear on an entangled whale (as seen in the data) as entanglements develop over time. A number of questions were raised surrounding the potential impact of pots remaining attached to entangling lines, with a number of possible scenarios described, including variation in gear set depth. There appears to be an opportunity to develop more specific questions regarding the nature and complexity of attachment points for entangling gear that could help inform future data collection from entanglements. It was also noted that the apparent directionality and distribution of entangled whales between the likely origin of entanglement (where gear was set) and the ultimate location of where the entanglement was sighted should be related to, and could be explained in part by, the difference in migratory distributions of various distinct population segments (DPS) of some whales (e.g., humpbacks) that are found along the U.S. west coast.

Lessons Learned from Responding to East Coast Whale Entanglements (Appendix E) - Doug Sandilands; SR³ SeaLife Response, Rehabilitation, and Research

A presentation was given on general lessons learned about entanglement forensics as a result of entanglement response activities on the U.S. east coast, primarily through association with the Center for Coastal Studies (CCS). The large whale entanglement response at CCS began in 1984 and evolved over the following decades. The initial goal was to save individual whales. As CCS realized that many more whales were becoming entangled than were reported, they realized that preventing entanglements would need to be the ultimate goal and that the information collected during entanglement response would be key to managing the problem. Documentation of entanglements includes: identifying the whale (images of flukes, dorsal fin, biopsy of skin and blubber), images that document the gear on the whale, documentation of the gear collected from the whale (characteristics of the gear, cuts, knots and other modifications made during the response and marks identifying it to a fishery), documentation of wounds and other health parameters, and behavior of the whale. Necropsy of entangled whales that have died and come ashore is also a key resource for understanding how entanglements happen and their impacts on individual whale. The International Whaling Commission has held regular meetings since 2009 about welfare issues associated with large whale entanglements. The 2011 meeting in Provincetown, MA included a sample data form for entanglement responses that is an excellent guide to documenting entanglements. As a result of documentation collected from entangled whales, managers on the east coast have developed gear modifications (such as weak links and sinking line), and instituted line marking to help identify gear when buoys and traps have come off. Gear collected from entangled whales on the east coast has been warehoused by NMFS for ~20 years. This gear has been analyzed by researchers for the drag effects of line, traps and buoys carried by whales and the analysis of line strength of gear removed from whales has shown that the characteristics vary by species and age class indicating that whales are more likely to survive entanglement in weaker line. Entanglement response is a critical component of mitigating and preventing large whale

entanglements, as without the information collected during large whale entanglements efforts to modify gear cannot be successful.

Discussion of this presentation included future consideration by NMFS and responders on the U.S. west coast of a consistent and comprehensive format for documentation of response and disentanglement efforts, including gear forensics. There was acknowledgement that knots can be a common source of entanglements, especially in the baleen. It was pointed out that one of the biggest challenges for entanglement response in the Pacific Northwest is the large area of coverage and lack of full time dedicated staff on hand to respond immediately, along with the limited success of reporting parties being able to stand by until responders can be mobilized (in comparison to entanglement reports on the U.S. east coast). There was a great deal of discussion about the influence of different types of line, line size, and pot weight on the dynamic/working loads and breaking strength of lines involved in entanglements, with general agreement that smaller gear would be increasingly easier for larger whales to break free from; and that more information was needed on the size, type, loads, and breaking strengths of U.S. west coast gear involved in entanglements. The concept of marking lines to improve the identification of gear involved in entanglements was also introduced.

Evolution of Entanglements and Injuries over Time (Appendix F) - Pieter Folkens; Whale Entanglement Response

A presentation was given that provided a comprehensive description of the types and mechanisms of injuries that have been documented and deduced from a wide range of entanglement cases on the U.S. west coast and other places over the last few decades. The types of entanglements were generally characterized and categorized by the different attachment points of the entangling gear and the different types of injuries that occur with each attachment point. In particular, mouth and fluke entanglements were described as especially serious entanglements given the types of injuries that can occur at those locations. Further descriptions of varying entanglement injuries associated with different types of gear/line were also provided. The general progression of the different types of entanglements and associated injuries over time was discussed, particularly in the context of the behavior(s) of line in the water and during entanglements. Finally, the capability to evaluate the various type and extent of entanglements that have occurred to animals previously based on the evidence of scarring present on whales was described in summary.

Through this presentation and the discussion, the dynamic nature of entanglements and injuries were highlighted and it was acknowledged that the progression and severity of injuries created by entanglements was closely related to the type of entanglement and location of the gear on the body, as well as the species involved. Similar to the previous presentation, the discussion again touched on the potential contribution of knots, leads and splices in creating backlash which could further the development of entanglements.

There were also questions about the relative impact of line size on injuries, and it was noted that smaller diameter lines appear to cut through tissue more easily. As an example, it was noted that gear carried from Alaska to Hawaii by humpback whales often involves ¾ inch line that does not necessarily cut through tissue despite long journey and large amounts of drag. The vision capabilities of whales relative to the color of lines under water was questioned, and the general extent of knowledge by workshop participants pointed to work done that suggested there might be evidence that whales that feed on krill see red colors in contrast better than some others.

Entanglement Response Case Studies (Appendix G) - Justin Viezbicke and Justin Greenman; NMFS West Coast Region

A presentation was given that highlighted the entanglement response for recent cases on the West Coast. In approximately 75% of these cases, the final outcomes of what happens to the whale were unknown as teams were not able to remove the gear and the whale was not sighted again. In about 10% of the cases, response teams were able to get out onto the entanglement whale and remove some or all of the entanglements, while in about 15% of the cases the whales themselves were responsible for getting out of the gear. The presentation then explored the breakdown of fisheries involved and what percentages of those incidents resulted in the animal being released to help illustrate success rates for disentanglement from gear associated with various fisheries. The presentation also covered a standard "after action review" from one of the recent entanglement events up in Crescent City, CA. The review highlighted many important aspects of the event; in particular, the participation of the fishermen both in describing their gear and the planning of the disentanglement event and how the team worked together safely and successfully through all the protocols and challenges of the event to release the whale. In addition to the response, the presentation highlighted some of the key aspects of documentation and how important the documentation is to the program in terms of safety and working to better develop solutions in the future that will help to minimize these entanglements. Finally, the presentation focused on entanglement cases with deceased whales providing a breakdown of which species were found and in what part of the gear they were believed to be entangled, as well as from which fishery it originated from if it was identifiable. This included walking through a few of the recent dead stranding cases to help show the varying levels of information that we can get from these different stranding situations. Ultimately, the presentation highlighted that responses to both live and dead entangled whales continue to provide opportunities to learn more about the nature of the entanglements as well as the overall effects to the individual whales over time.

During the presentation, it was emphasized and reiterated that the reporting of entangled whales and the prospects for successful disentanglement require reporting as soon as possible and having a vessel to stand by to keep track of the whale's location until a rescue vessel or other stand by vessel arrives. Very few whales are re-located unless a vessel stands by. In addition, the need for accurate reporting and photo documentation of any dead whales seen along the coast is useful in helping to avoid potential confusion about whales that may have been dead and then drifted into gear. Questions were raised about the disentanglement of gillnets, and it was acknowledged that gillnet entanglements are very

challenging to get ahold of by responders without trailing lines. The tradeoffs between the potential seriousness of injuries for whales that maybe anchored compared to free-swimming animals was discussed in comparison to the general capability to detect and respond to these situations. For example; there could be a reduction in the amount of vertical lines by increasing the number of pots per vertical line, but that would likely lead to entanglements in heavier gear that are more likely to anchor the whale. Anchored whales may be easier to access and disentangle, but there could be more potential for longer term injuries/effects from the heavier gear; and if not detected and disentangled, these animals may die more quickly. Ultimately, there was no clear cut sense of which scenarios are likely to be preferred, and the specific circumstances of any case could differ widely.

Related Forensic Review Analysis (Appendix H) - Dan Lawson and Lauren Saez

Staff from NMFS continued presentation of forensic review analysis. This presentation included information related to: the extent of surface gear associated with entanglement cases, the known or apparent involvement of surface gear as part of the entangling gear on the whale, knowledge of the size, color, and types of line, as well as the use of leads associated with the entangling gear.

Forensic Results Highlighted:

- Use of "extensive" surface gear[1] does not appear to be associated with the majority of entanglements, although it would be informative to know more about the prevalence of "extensive" surface gear use throughout the fleet to understand the implications for relative entanglement risks.
- However, there is evidence that the likelihood of surface gear involvement in entanglements could be influenced by the use of extensive surface gear.
- Species specific considerations: surface gear involvement in entanglements is more common for humpback whales; less so for blue whales and gray whales.
- A large number of entanglements (at the point in time when we see them) appear to involve and/or ultimately end up in the upper few fathoms of gear; especially for humpback whales.
- Without talking to the fishermen who set the gear and with relatively few instances where gear is recovered intact, we really don't have extensive forensic knowledge about key aspects of gear configurations to analyze at this point.
- We don't understand much about which size and type of vertical lines are more likely to entangle or how the use of leads may contribute to entanglements (all types of gear end up entangling whales) - even if we had more information we would need to know more about relative use in the fleet.
- While all colors of line have been associated with entanglements, blue/green line are the most common colors of line reported. This is generally consistent with the prevalence of lines like

[1] Extensive surface gear was defined for the purposes of this forensic analysis as use of more than 2 trailer buoys and/or more than 5 fm of surface gear/line in total. This was derived using example of surface gear restrictions being considered for Dungeness crab gear in California.

"Blue Steel," and more information about relative use of line colors by the fleet is needed to interpret results.

Through the discussion, it was generally agreed that interpretation of forensics was challenging given that where the original contact with the gear by whales is not necessarily where the gear ends up by the time an entanglement is sighted later. It was suggested that it might be possible to evaluate the relative progression of entanglement for individual cases based on the apparent location of an entanglement on the gear and the nature of injuries as part of future forensic analysis. While the direct involvement of the surface gear may not be a factor with the majority of entanglement cases, it was acknowledged that the extent of surface gear could play a role in many entanglements because the presence of surface gear can create a large amount of drag and tension on the line during an entanglement as it is developing. With regard to many of the gear forensic analysis questions, the discussion noted the difficulty of interpreting what practices may be more likely to result in entanglements than other without a more comprehensive understanding of what gear the fleet is using and how they are fishing on a coastwide basis. Questions were raised about what gear characteristics can be surveyed from on-water or aerial surveys of fishing grounds. Challenges surrounding the limitations of identifying the type of lines associated with entanglements based strictly on descriptions or pictures of line color were discussed, although it was pointed out that some of the line tracer markings and other characteristics that might be visible from a photo could be used to help identify line. Responders emphasized that use of black lines for fishing gear makes entanglement response very dangerous as it cannot be easily seen in the water.

Photo Identification of Entangled Whale (Appendix I) - Jenn Tackaberry; Cascadia Research

A presentation was given about using photo identification techniques to identify individual whales on the U.S. west coast and to track their life history over time, both before and after being documented as involved in entanglements. Purposes for this work include identifying the specific population of individuals whales that are documented entangled to assess population level impacts resulting from entanglements (e.g., on ESA-listed distinct population segment of humpback whales or the Pacific Coast Feeding Group of gray whales). In addition, this work can potentially be used to track population level survival and scarring rates for whales, and how those rates may be changing over time. The presentation highlighted the challenging and time-consuming nature of these efforts, while also pointing to the success that has been achieved to date. The presentation also highlighted the importance and need for improved documentation of entangled whales when sighted, including specific focus on taking pictures of flukes for identification, and suggested that responders (and other likely reporting parties) be provided information and trained in more standardized protocols for complete documentation of entanglement cases.

Questions were raised during the discussion about the utility of photos of dorsal fins and rostral knob patterns for photo identification of entangled whales. While it was acknowledged these can be useful for aiding the identification process, they typically are only reliable for identification on a short timescale such as within an individual year or season on the foraging grounds. It was emphasized that efforts to

prioritize shots of flukes (which aren't always possible since entangled whales can be limited in their swimming and diving patterns) are key to putting together the life histories of entangled whales. When asked about how to best approach comprehensive photo identification data collection, it was suggested that a large number of people in the whale-watching industry are interested. Increased Level 1 and 2 entanglement response training on how to document entangled whales was also recommended. Also, development of listservs to promote awareness of previously documented and/or currently entangled whales that people on the water can be on the look-out for on a coastwide basis was suggested. Ultimately, funding through sources such as the Prescott Grant or others could help NMFS' partners further develop these capabilities.

Group Discussion

Toward the end of the first day, participants were asked to provide feedback on the information and analysis provided up to that point, and to discuss initial thoughts and recommendations for moving forward on forensics and understanding entanglements. The conversation was wide-ranging, with some of the main points summarized below:

- There was wide agreement that the forensic review evaluation would benefit from expanded and regular participation from fishermen and other experts in the process. There were suggestions to form some sort of coastwide group that could meet on a regular basis (e.g., once a year?) to review entanglement documentation. This would be particularly effective in concert with further development of a gear repository by NMFS.
- There was general agreement that there is a need to improve capabilities to identify the gear involved in entanglements, and that further developments in gear marking that involved a coordinated system across the entire U.S. west coast would be key to that effort. Some possible approaches to line marking were discussed (e.g., east coast requirements), balancing the potential utility with the increased burden on industry to comply. Questions were raised about our ability to go back to previous entanglement reports and determine how much line is usually available for identification from each case to help inform any line marking requirements. It was suggested that at a minimum some line markings on the top portions of the gear could be helpful based on the forensic analysis results that suggests a large number of entanglements "end up" in the top portion of the gear. The potential efficacy of using individual buoy pattern registration requirements on a coastwide basis (currently used for Dungeness crab in WA) was discussed as another option.
- Similar to the coordination efforts along the U.S. west coast, additional collaboration with international neighbors was recommended to improve identification of gear, as well as understanding of the overall state of the entanglement issue within the migratory paths of these whales.
- A need was identified to better educate and train entanglement responders and members of the public who may report entanglements about the type of information that is useful for forensic analysis so they can prioritize collecting it in real time as much as possible.

Homework Exercise: Forensic Scoring (Appendix J)

As part of the forensic review workshop, participants were provided with documentation (combination of photos and written documentation) of a few entanglement cases to conduct independent forensic review on their own, in preparation for collective review and discussion the following day.

Homework Exercise: Best Management Practices Document review (Appendix K)

Workshop participants were also provided copies of the California, Oregon and Washington best management practices document to review and compare, in light of the information shared. Discussion of these documents are noted below and these documents are attached as part of the appendices.

Day 2

Discussion of Forensic Review Homework (Appendix L) - Dan Lawson

The discussion of the homework highlighted the challenges associated with interpreting various aspects of forensic review given the often limited information and perspective available regarding entanglement cases. The group discussion was wide-ranging shifting focus from the specific cases to the bigger picture of dynamics and mechanics of entanglements as well as possible ways to modify gear to potentially minimize entanglements. Specific topics included thoughts on how to interpret fouling and wear on parts of the gear (e.g., line, tags, and buoys) in terms of lost or derelict gear. Although there was no consensus, there was some sentiment that the first case discussed was with gear that would not have been behaving normally for some time. With the second case, there was again discussion of the role of knots and a likely attachment point that occurred as a result of the connections between the vertical line, main buoy, and trailer line.

Looking to the big picture, the group discussed the pros and cons of having buoys and/or traps break away during entanglements as they develop. While having gear break off from either the buoy or trap end seems like it would be helpful to potentially allow drag forces to floss line off the whale, there is not a clear cut answer as to what would the best approach. It was acknowledged that no solution would likely solve everything, but if something could help in a significant amount of cases it's worth exploring. While it might generally be more desirable to have buoys break off compared to pots for several reasons, it was pointed out that if buoys break away, identification of gear would have to rely even more upon line marking. There was discussion of the need to evaluate ideas such as line cutters and the "Chinese finger trap" sleeves for connecting lines (referred to as "Yale grips" herein) that have been developed by fishermen on the east coast. All of this discussion was held with the understanding that the need to implement solutions would have to be balanced by minimizing risks of increasing gear loss and marine debris.

Forensic Review (Appendix M) - Dan Lawson

The presentation of forensic review analysis for the workshop was concluded with results looking at the presence of buoys, buoy numbers, buoy tags, and gillnet floats in entanglement cases along with their relative effectiveness for aiding identification of gear origins. These analyses and resultant discussion are expected to be useful in future considerations of how to develop/improve gear marking for increased identification of gear involved in entanglements.

Forensics Results Highlighted:

- Buoys are reported observed in about 2/3rd of entanglement cases. If buoys are seen, we can identify something about the origins of the gear ~50% of the time. When buoy tags are observed, we identify origins ~90% of cases. If buoys or netting are not observed, our success rate in identifying anything about origins is very low (~13%).
- Buoy numbers are successfully identified in only 1/3rd of cases where buoys are reported, and half of those times it occurs in conjunction with dedicated disentanglement response and/or recovery of the gear in hand.
- Printing on both sides of a tag could help increase the ability to track down the origins of gear and learn more about forensics of gear configurations when buoy tags are observed but tags are facing the wrong way or otherwise obscured (this occurs in over 30% of entanglement cases where buoy tags are reported).
- Relative to gear marking improvements, we note (when known or apparent) that ~60% of entanglements end up near or at the top of gear/water column; and ~90% from middle of the gear up. This suggests marking lines on at least the upper part of gear could be useful to improving identification of gear.
- With respect to gillnets, the marking of floats may be useful for better identification of origins in about half of gillnet entanglement cases.

The discussion of these results brought forward a few highlights:

- A desire for improved gear marking that goes beyond buoy numbers and tags (although tags are very helpful). It was acknowledged that consideration should be given to the fact that some ideas could be very expensive and time-consuming for fishermen.
- The idea of buoy color pattern registration does seem like an efficient way to improve the ability to identify associated fisheries and owners of gear involved with entanglements even if buoys are only thing seen. Even if multiple fishermen might have same buoy pattern registrations, you can probably start to narrow things down from there. However, it was noted that maintaining this was challenging from the fishermen's perspective.
- There was general agreement that printing of information on both sides of tags is useful and doable, recognizing there are some increased costs to this.
- There was suggestion to go back through previous cases and assess how often pots appear to still be present on gear when entanglement is report - the effort can be done but it is unclear how definitive that assessment will be.

- It was pointed out that in some other places, fishermen are required to put identification numbers on each gillnet float.

Feedback on Forensic Review

Additional feedback provided by workshop participants upon reflection of the forensic review presentations and discussions overall included:

- There was a suggestion that effort be made to conduct an engineering study of drag/tension relationships and the effects of variable such as: pot weight, diameter and type of line, etc.
- There were sentiments from some participants suggesting that while some attention to minimizing surface gear is OK, they would like to focus more on the vertical line in the water.
- There was a suggestion to consider using a smoother type of line that does not fray and get hung up so easily - e.g., kernmantle rope. It was suggested this may also limit damage after entanglement by not cutting through tissue so easily.
- In order to facilitate forensic review in the future, there were suggestions to conduct forensic evaluations in more real-time (e.g., in the field) in the future. Also, there was continued support for increased engagement in forensic review on a regular basis with other experts; however, participants recognized that it is not as easily done as it sounds.
- There were some sentiments expressed that while forensic review analysis and the workshop was doing a good job looking closely at gear configurations and forensics, ultimately more information is needed to understand entanglements (and build solutions to prevent entanglements) than just knowing gear configurations. We also need to look at what was going on with the whales, the fishery, environmental conditions, etc., with each entanglement case.
- There was continued support expressed for further development of entanglement gear repository by NMFS.

West Coast Fishing Gear Survey (Appendix N) - Sheila Garber; Englund Marine

A presentation was made by an industry gear expert on the results of an informal survey of fishing gear distributors on the U.S. west coast done by the PSMFC with input from NMFS and Englund Marine. The presentation also involved her personal expert opinion regarding trends in fishing gear use on U.S. west coast that might be relevant to entanglements in fixed fishing gear. It was noted that rope size has changed very little in the past 20 years, with 3/8" and 7/16" diameter is still the highest selling lines. The biggest change in the fishery in the last 10 years has been the use of neutral buoyancy and sinking rope. These ropes are primarily used as middle/top shots for crab gear and similar fisheries. The use of a sinking/neutral buoyancy rope was introduced to help reduce excessive rope floating primarily on the surface with the added benefit of reducing gear loss. With the increased use of neutral buoyancy rope, the need for leads to minimize rope floating on the surface has diminished considerably. Leads are usually slid on to another smaller line or twine and spliced into the rope; this inherently led to weak

spots in the line where leads are placed. It was/is very common to find the rope hockling (kinks/twists/bends) and eventually breaking within 18" +/- of where the leads were splice into the rope.

The commercial Dungeness crab fishery uses a very hard lay rope. This type of rope is rarely used in a recreational fishery since it is difficult to splice. Also, for the most part recreational fishers use smaller crab buoys, and usually only one or two of them. The color of the rope can provide an idea of what the rope might be. The neutral buoyancy has polyester in the rope. You can see a white tracer that is usually wider than a standard tracer and has a "rougher" texture. The sinking rope has more polyester (which absorbs water) and the surface of the rope is visibly different it too has a rougher feel and texture to the rope. The sinking rope is most often white since it is hard to dye a polyester rope. However, there are many different colored ropes so it is best to get as many specifics you can on the rope; color, tracers, lay, to help identify the type of rope involved in an entanglement.

During the discussion, it was acknowledged that it is difficult to relate any trends in gear use with increased entanglements in recent years given that there have been more and more whales seen by many fishermen during the same period, along with some of the other unusual fishery conditions such as season delays for domoic acid. It was noted that much of the line that was apparent in the photos of entanglements that had been shown during the workshop appeared to be "Blue Steel", which is the most popular line used on the U.S. west coast. The notable increasing usage of neutral buoyant line (over half the crab fleet in some areas are now using it), which is stronger and lasts a little longer than the equivalent floating line, was discussed. The potential "benefit" of using leads since they are known to create weak points in line where gear often parts was discussed, although their potential for snagging was also noted.

Gear Testing Work and Observations - Dick Ogg, Calder Deyerle, and John Mellor; commercial fishermen

Several fishermen attending the workshop spoke about their perspectives and experience with exploring modifications of existing fishing gear for use, including ropeless gear and weak manilla rope on the top shot of line and using swivels on the line as well as participation in line profile studies described below. While no practical solutions appear to be immediately available to them, they reiterated their interest in continuing to test alternatives and to think outside of the box to find new ideas. While their general sentiment was to keep things as simple and inexpensive as possible, it was acknowledged that modifications are going to cost something but that incentives could be developed to decrease those costs. Given the global nature of the problem, they were hopeful that collaboration among scientists and fishermen could occur at that scale. Fishermen have also worked to test a smart buoy sensor with Blue Ocean Gear that would identify if a whale became entangled in gear and could indicate and track gear position.

Line Profile and Working Load Research (Appendix O) - Peter Nelson; H.T. Harvey and Associates

A presentation was provided summarizing the preliminary results of cooperative research conducted with Dungeness crab fishermen in California regarding characteristics of gear behavior that might be influential on the relative risk or tendency of gear to become involved in entanglements. Research results covered comparisons of line profiles using different configurations such as floating line vs neutral buoyant line in different portions of gear, as well as effects of important environmental factors such as currents and tides on line profiles in the water column. The current efforts to measure working loads and breaking strengths of various lines that are, or could be, used in the Dungeness crab fishery was also summarized, as well as the potential visual characteristics of those lines under water. This research is still in the early stage on the U.S. west coast, although results to date do suggest that the overall profile of neutral line in the water column is smaller than floating line. However, the implications of this for entanglement risk are not clear at this time.

The discussion that followed the presentation ranged from specifics about these research results to more general considerations of possible ideas for gear modifications. It was suggested that a more complete assessment of drag forces on all components of the gear would be useful in trying to better understand how the gear (and any modifications) moves around in the currents and tide. There was discussion about tensioning or "telescoping" both the surface gear and vertical lines as a way to minimize slack lines under variable current and tide conditions, if such systems could be practical for use. Although acknowledged as currently not feasible from the industry perspective due to costs and other operational considerations, there were sentiments expressed by some workshop participants that the ropeless gear ideas being developed and tested probably offer the best chance to actually avoid entanglements compared to other gear modifications.

Discussion and Recommendations for Next Steps

The workshop concluded with group discussion related to the specific goals mentioned at the beginning of the workshop, as well as the overall impression of the information presented and discussed during the meeting. Highlights and recommendations that emerged from this discussion are summarized below in association with the guiding questions that were posed to workshop participants. No consensus was sought or achieved:

Are the existing best practices guidelines (Appendix K) that have been developed by the whale entanglement working groups in each state consistent with your observations from the case studies and forensic analysis review? If not, what improvements to "Best Practices" would you suggest?

- There is general agreement that best practices need to focus more on the scope of vertical lines.
- There is some support for featuring "do's" and "don'ts" as suggested by WA draft best practices.
- There is general agreement that best practices need to be more widely disseminated and more easily accessible.

- Although there might not be a best practice to suggest beyond minimizing the use and size of knots and splices, there was a suggestion to investigate alternatives for ways to connect buoys/lines on gear.
- There are outstanding questions about the physics of the contribution of surface gear (and its extent) to entanglements, and how entanglements often end up towards that part of the gear, that could use further study to support refinement/development of best practices (and solutions) across the various States.

Are there priorities for improvements in entanglement reporting we want to focus on to assist with better data analysis? How do we best disseminate this information?

- There is general support for further development of a U.S. west coast gear repository.
- There is some support for improvement in standardization of data collected during entanglement responses, including focus on forensic data analysis in real time.
- There is some support for dissemination and collection of photos from entangled whales, especially whale flukes, via a listserv to a network of people who can be on the lookout for these whales.
- There is general support for increased interaction and engagement in forensic review by NMFS and other responders with fishermen and other experts.

Would improvements in gear marking help us better understand entanglements? If so, what would the gear marking priorities be?

- In terms of priority, there was general agreement that: primarily, gear marking should make it easy to identify inforcrmation on fishery and state of origin of the gear (all fixed gear - not just Dungeness crab). Secondarily, it should be identifiable to individual fisherman to facilitate better understand of gear configurations and other aspects such as depth, location, etc.
- There was general agreement that coordination of gear marking requirements should occur at the Tri-State level to develop consistent markings as much as possible.
- There was some support for, although also many questions about, further considerations of line marking requirements especially in light of fishermen who might travel to different states with gear. There was some suggestion that consideration of at least marking lines near the top of the gear toward the surface could be useful for gear identification in a number of entanglements.
- There was some support for further consideration of individual buoy pattern registration as a step that could help accomplish many gear marking goals (although not all since buoys are not always seen).

Are there any promising avenues for gear modification or for gear modification research that you would suggest?

- There is general agreement that the Yale grip idea should be further explored and potentially tested as potential alternative to knots/splices to connect lines on gear and to create a weak link that could break away during an entanglement.

- There is general support for efforts to develop less abrasive lines for use in fishery applications, given the abrasive damage on whales of current lines used.
- In term of future consideration of using break away or weak links, any widespread support would generally be limited to looking at their use on the surface gear, and to times and areas where alternatives to avoid entanglements are needed but limited.
- There is some interest in exploring the feasibility of using a short piece of weaker lines on the top.
- There is general agreement that efforts to develop capabilities to track gear (for locating entangled whales, lost gear, etc.) sound promising and should be supported.
- There is some agreement that ropeless gear could be a future option, but there is general agreement that the technology needs more work before widespread use is feasible.
- There were some sentiments expressed in support for prioritizing the development and implementation for solutions that can prevent entanglements from occurring over (but not excluding) solutions that might primarily reduce severity once an entanglement occurs.
- There was some interest expressed in evaluating the trade-offs of the potential benefit in reducing the number of lines (using larger pots, trawling up) to reduce the number of entanglements vs the increased severity of entanglement injuries.

Post Workshop Exchange

After the workshop was concluded, numerous exchanges of thoughts and ideas occurred between workshop participants through emails addressed to participants at large and/or through feedback provided directly to the workshop conveners. Several topics were addressed, and in summary:

There were a number of participants that reiterated their perspective on the tendency of knots and splices to be tangle points or create backlash in numerous fishing operations, and likely binding points of many entanglements that were reviewed during the workshop. There was additional commentary on how the splicing of leads can “hockle” the line, causing a tendency to want to loop. If fishermen didn’t have to change depths so regularly, they could more easily consider using other types of splices that aren’t as bulky as an eye splice. There was reiteration of interest developing a fast, low cost method of joining 2 pieces of line together that could avoid knots and splices. As discussed in the workshop, there was continued interest in learning more about Yale grips. Following up on this interest, PSMFC facilitated a call on September 27 with John Haviland and Lori Caron of the South Shore Fishermen's Association of Massachusetts to learn more about the sleeves they have been developing on the U.S. east coast to create weaker vertical lines. The history of the issue facing fishermen there and the development of the sleeves was described, and the follow-up questions and discussion highlighted the need for focused consideration of how to tailor development of any similar concepts to U.S. west coast fisheries. In the interest of information exchange, samples of the sleeves from the U.S. east coast have been provided for sharing and discussion by fishermen at several upcoming meetings on the U.S. west coast. A number of fishermen have subsequently requested some sleeves to test.

During the post workshop exchanges, there were additional comments on the tendency of three strand ropes to loop more because of the twist of the lay, as well as unravel after parting and “catch” other pieces of line. As discussed during the workshop, there was reiteration of interest in developing no-twist kernmantle line for fishery applications, and of attempting to do some basic testing of the less abrasive nature of kernmantle line versus other lines on a dead whale when the opportunity arises. There was some caution expressed about kernmantle line being expensive and hard to splice, given that big knots like carrick bends, bowlines, are what we are trying to avoid. There was a suggestion to consider running a small piece of this type of line on the top portion of gear.

There was description of an alternative used in a different fishery setting that including threading surface lines through hose or tubing to increase rigidity, to reduce looping potential, and to streamline surface lines, which received some positive feedback as an interesting idea to consider further.

Relative to some newer versions of line cutter devices that were mentioned during the workshop and other ideas for modifications that have been circulating, there was general agreement that folks would want to see evidence of effectiveness of any concept before investing much time and money in them. If such devices work, it was suggested there could be mixed results regarding reducing the impacts of entanglements. In some cases, it could reduce the severity of entanglement wounds by removing the weight and drag from the pot, but it would not reduce the severity of wounds that happened before the device cut the line. It was also noted that this concept could lead to more whales becoming free-swimming (as opposed to anchored) with long, high-drag trailing gear, that may make it more difficult for responders to find and disentangle whales.

There was also some support expressed by individual participants for further exploring of other ideas:

- Using top shots of lower breaking strength; or of stiffer rope with larger bend radius
- Zinc/timed releases of pot and/or buoy or other methods of gear coming free
- Telescoping trailer buoy lines to minimize surface gear length
- Continued development of gear that can detect lost gear or entanglements (e.g., Smart Buoys)

There was some exchange regarding the role of government in helping subsidize costs for fishermen to implement solutions, considering any/all of them will cost time and money. In response, it was acknowledged that there is some precedence for this in general, and perhaps this is something Congress or other government entities could entertain when there is wide support for a direction to head. It was pointed out that even if it happened, it is likely these would be one-shot efforts to subsidize a change and fishermen would probably have to pick up costs after to maintain them. Hope was expressed that marketing changes could lead to higher incomes for fishermen through the willingness of buyers/consumers to pay for "whale safe" crab and other fish.

Appendix B

U.S. West Coast Data Summary

Lauren Saez

NOAA Fisheries - West Coast Region

Understanding U.S. west coast whale entanglements

NOAA FISHERIES

West Coast Region

Lauren Saez

Forensic Review Workshop

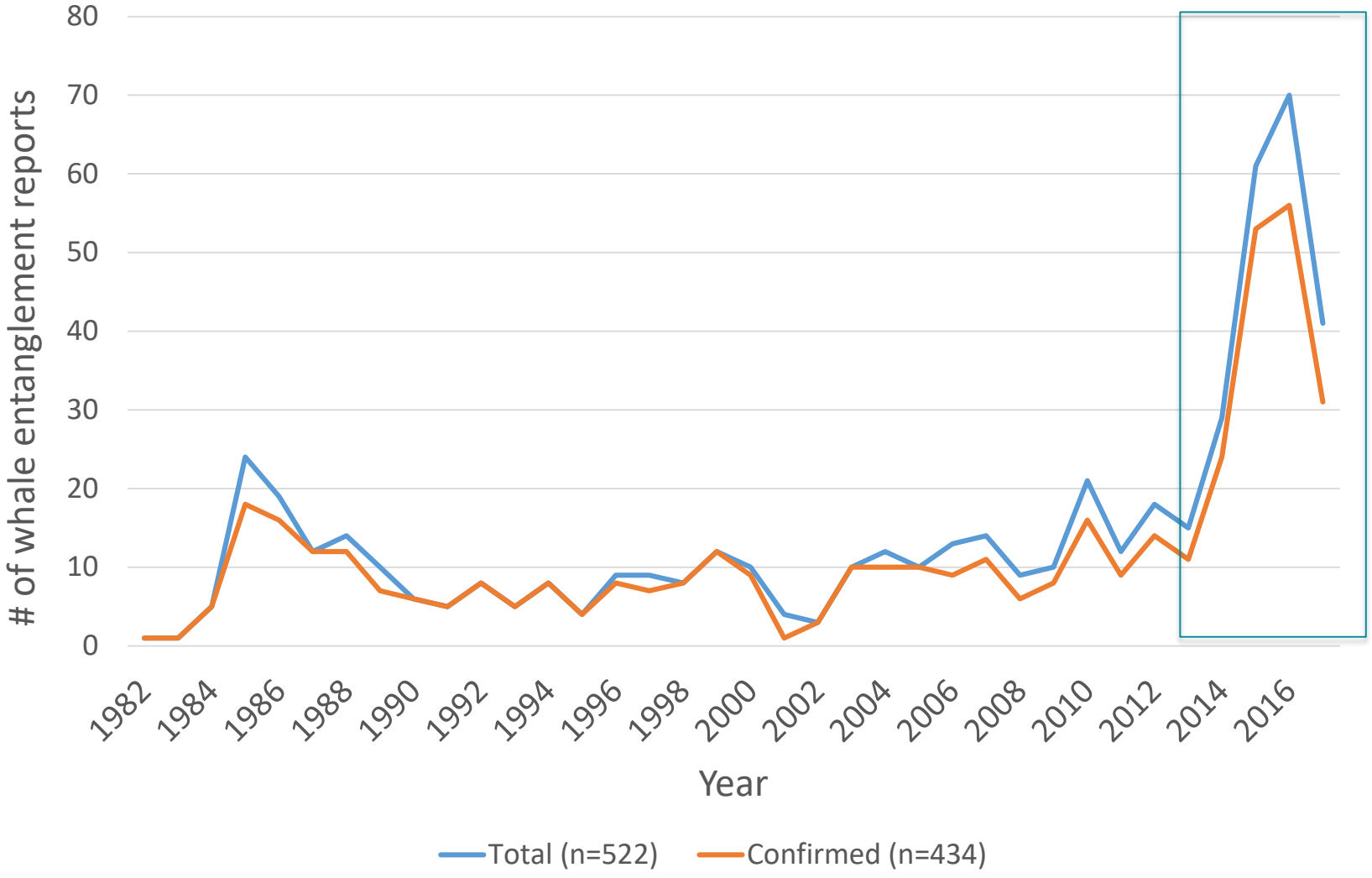
August 29, 2018

Long Beach, CA

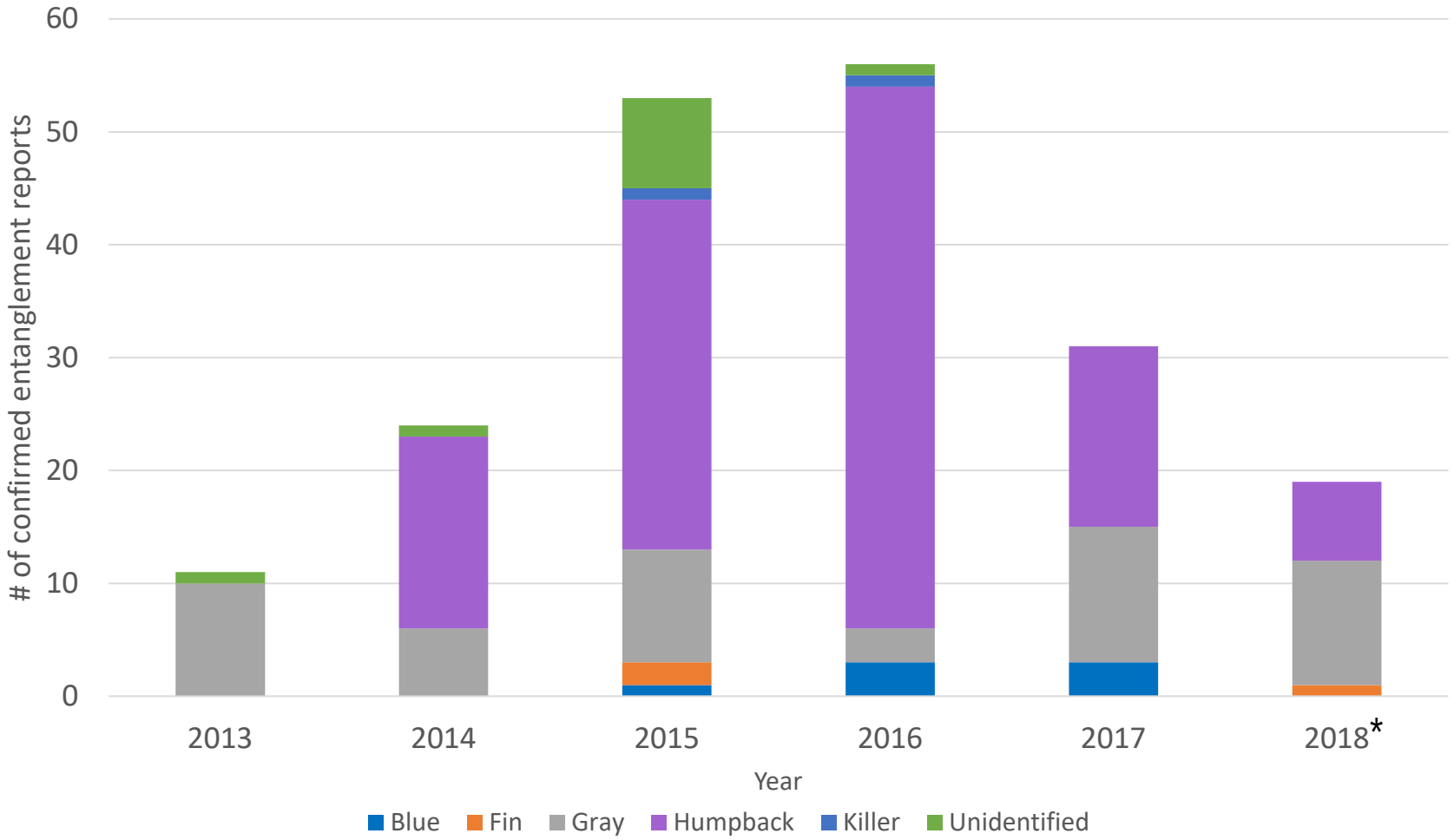
The concern

- Entanglement of marine mammals in fishing gear is a global problem
- NMFS has identified large whale entanglement in fishing gear along the US West Coast as a priority management issue
- Entanglement reports
  - Opportunistic sightings from a variety of sources
  - Underestimate of total entanglements (emaciated whales sink quickly)
  - Gap in identification of whale species & gear involved
- 362 whales reported entangled between 2000 and 2017 (California, Oregon, and Washington)
  - 178 Humpbacks, 114 Grays, 8 Blues, 6 Fins, 2 Minke, 2 Sperms, 2 Killer whales, and 50 Unidentified species

Long term trend of whale entanglement reporting



Records reviewed for workshop: confirmed entanglements 2013-2018

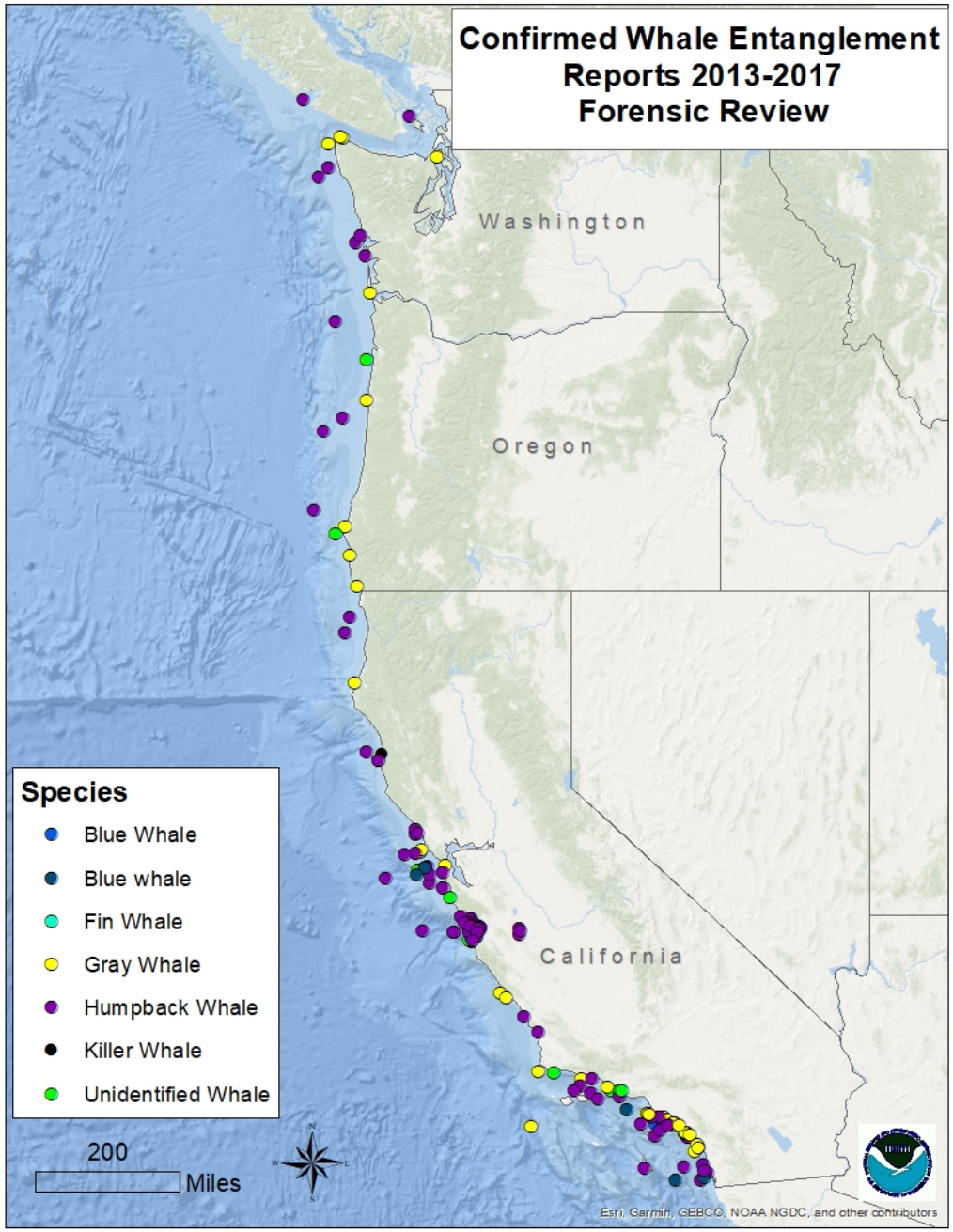


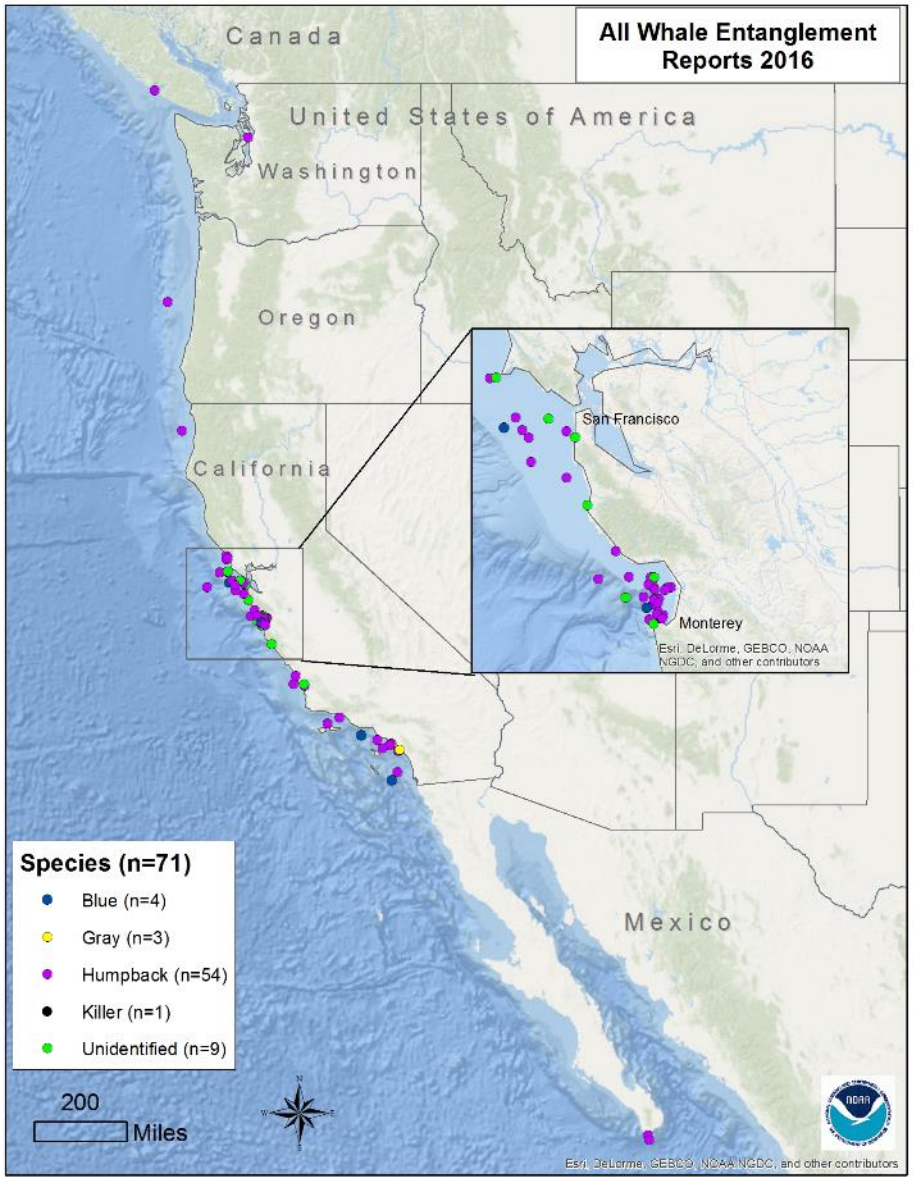
*2018 through 6/6

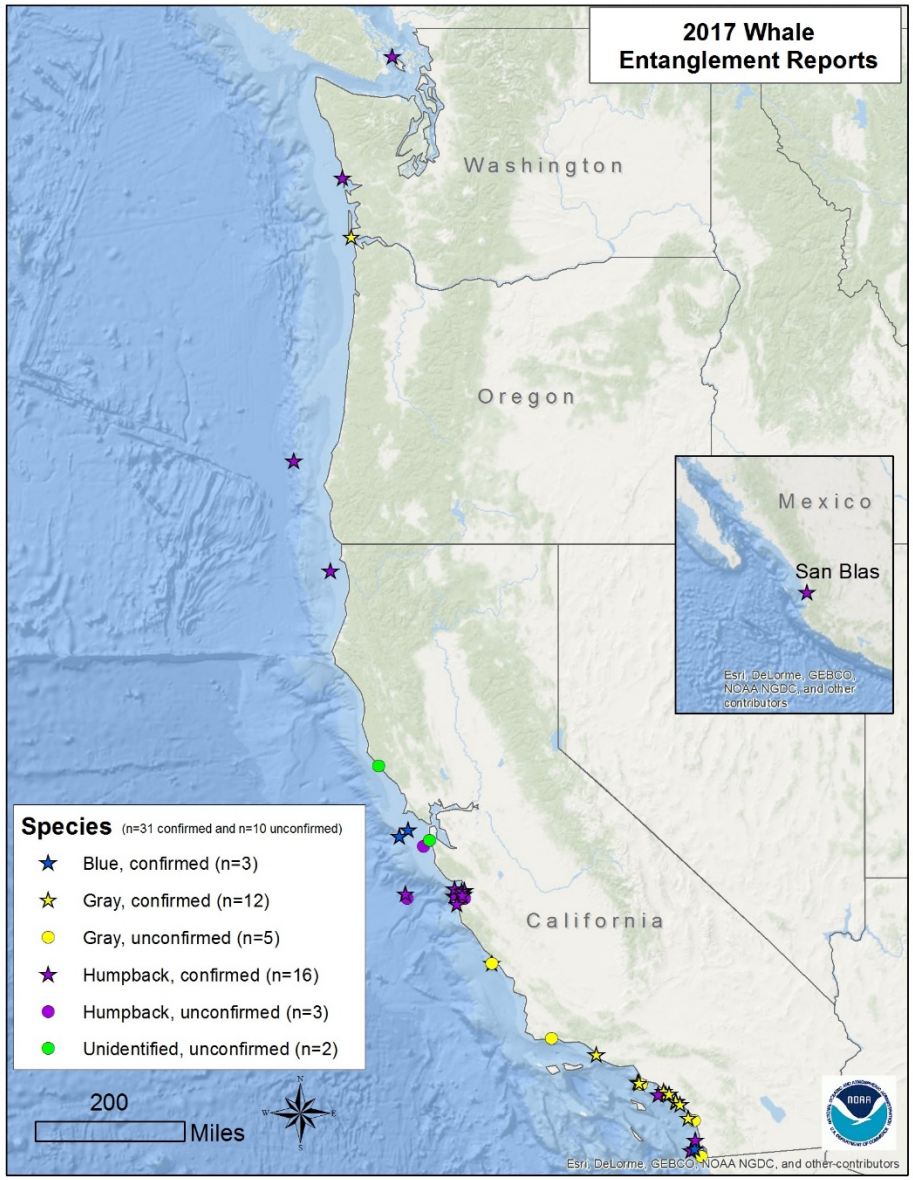
2018 whale entanglement numbers

Updated: 8/16/2018 ***Data is preliminary and has not been formally reviewed by NMFS

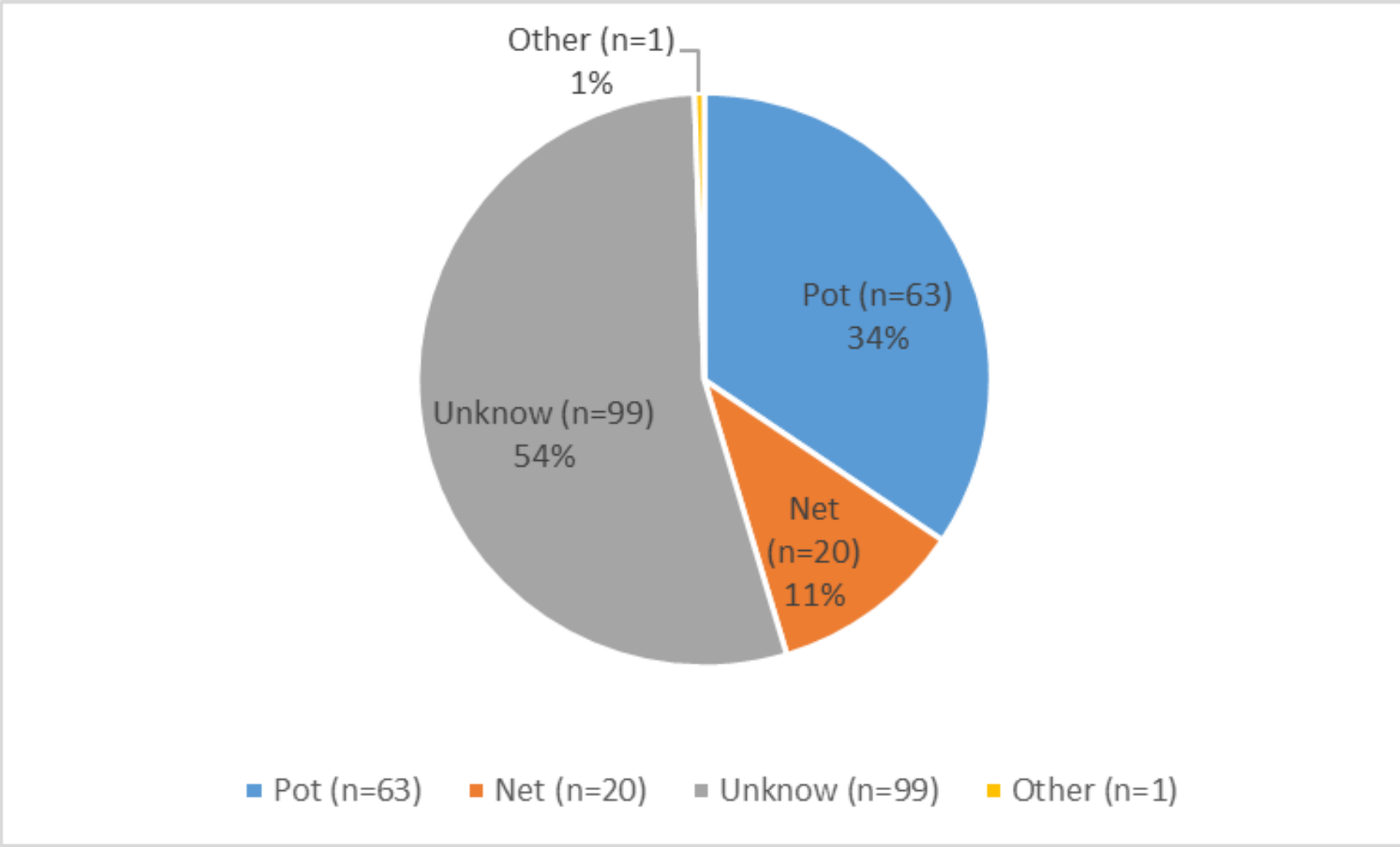
- 32 confirmed entangled whales, 39 total reports
  - Gray whales: 11 confirmed, 13 total
  - Humpback whales: 20 confirmed, 23 total
  - Fin whale: 1 confirmed, 1 total
  - Unidentified: 0 confirmed, 1 total
  - Blue: 0 confirmed, 1 total
- 2018 records reviewed for this workshop through 6/6/2018 (n=19)
  - Gray whales: 11 confirmed
  - Humpback whales: 7 confirmed
  - Fin whale: 1 confirmed


Confirmed Whale Entanglement Reports 2013-2017 Forensic Review
Washington
Oregon
California
Species
Blue Whale
Blue whale
Fin Whale
Gray Whale
Humpback Whale
Killer Whale
Unidentified Whale
200
Miles
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

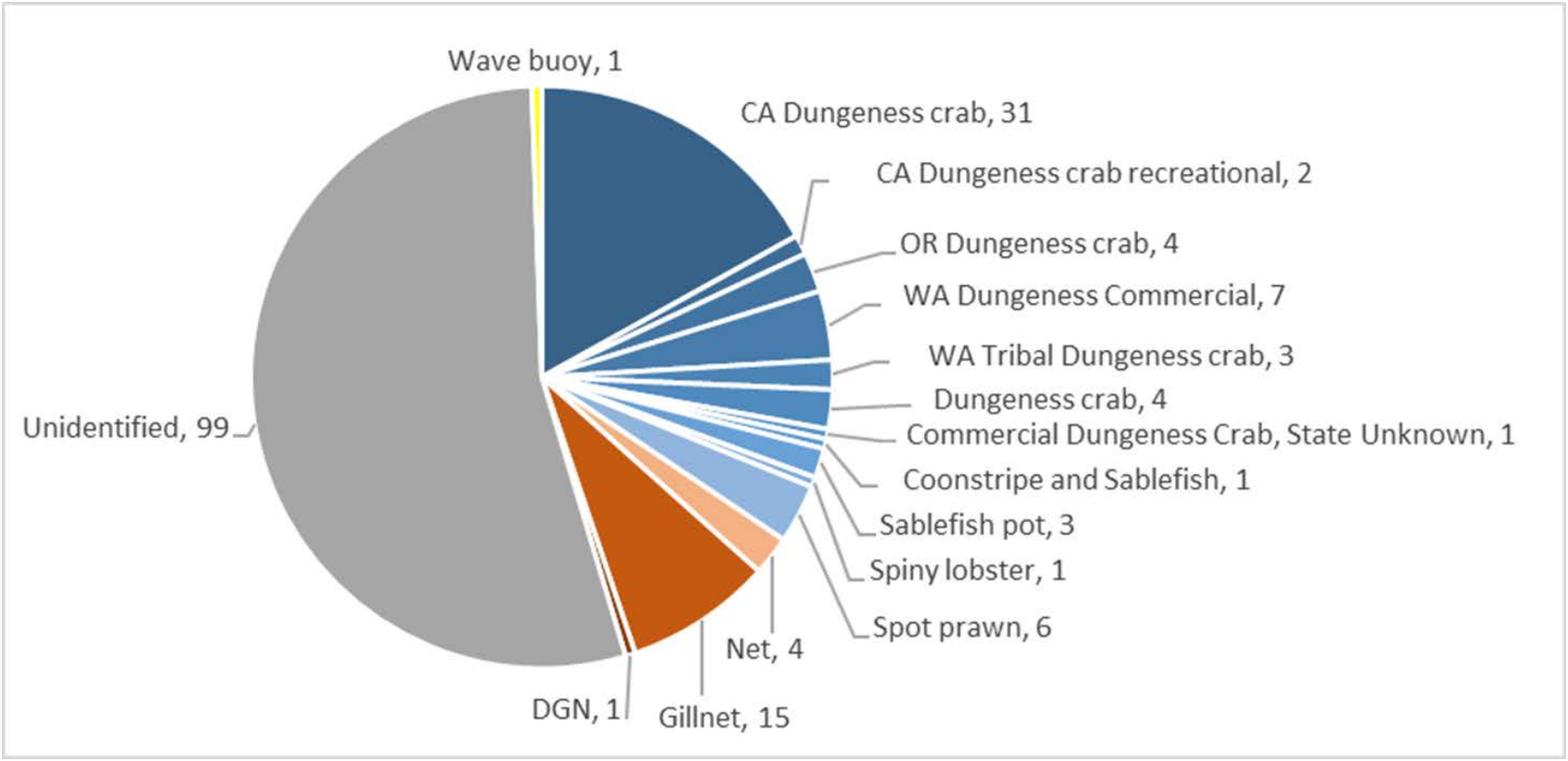

All Whale Entanglement Reports 2016
Canada
United States of America
Washington
Oregon
California
Mexico
San Francisco
Monterey
Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Species (n=71)
Blue (n=4)
Gray (n=3)
Humpback (n=54)
Killer (n=1)
Unidentified (n=9)
200
Miles


2017 Whale Entanglement Reports
Washington
Oregon
California
Mexico
San Blas
Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Species (n=31 confirmed and n=10 unconfirmed)
Blue, confirmed (n=3)
Gray, confirmed (n=12)
Gray, unconfirmed (n=5)
Humpback, confirmed (n=16)
Humpback, unconfirmed (n=3)
Unidentified, unconfirmed (n=2)
200
Miles
Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors

Sources of entanglements



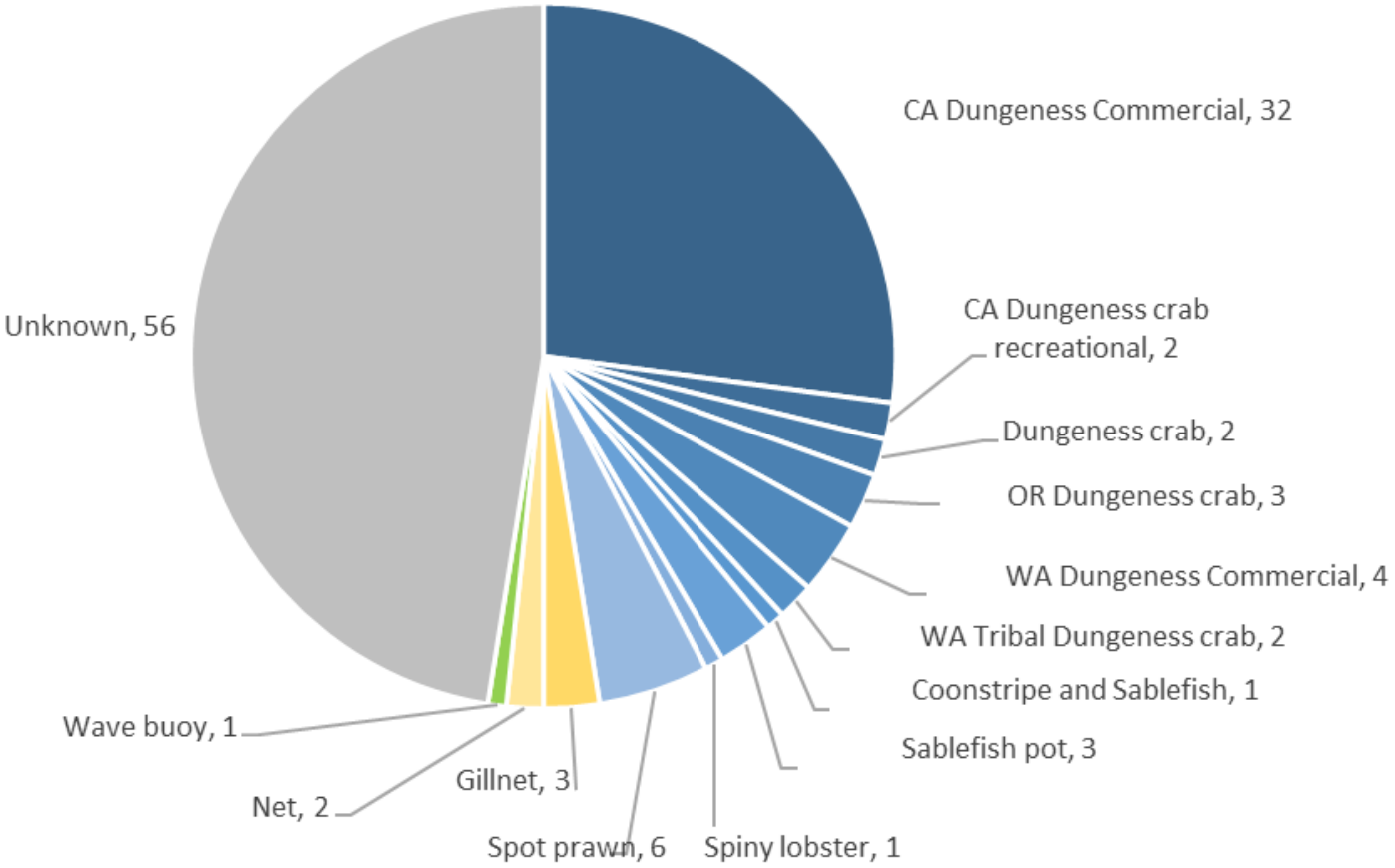
Sources of entanglement



Whale entanglements + Fisheries

Humpback whales (n=118)

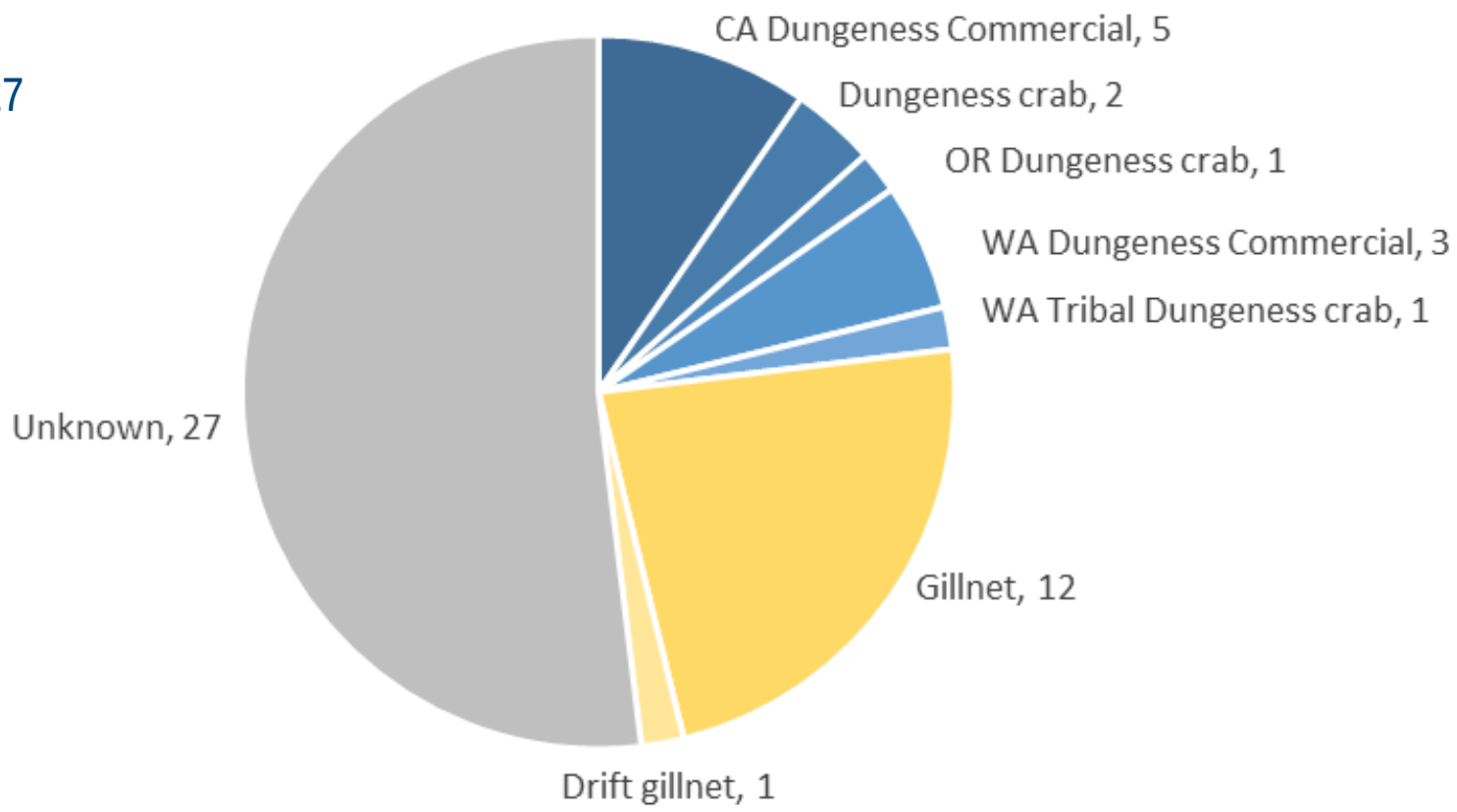
Pot: 56
Net: 5
Wave Buoy: 1
Unknown: 56



Whale entanglements + Fisheries

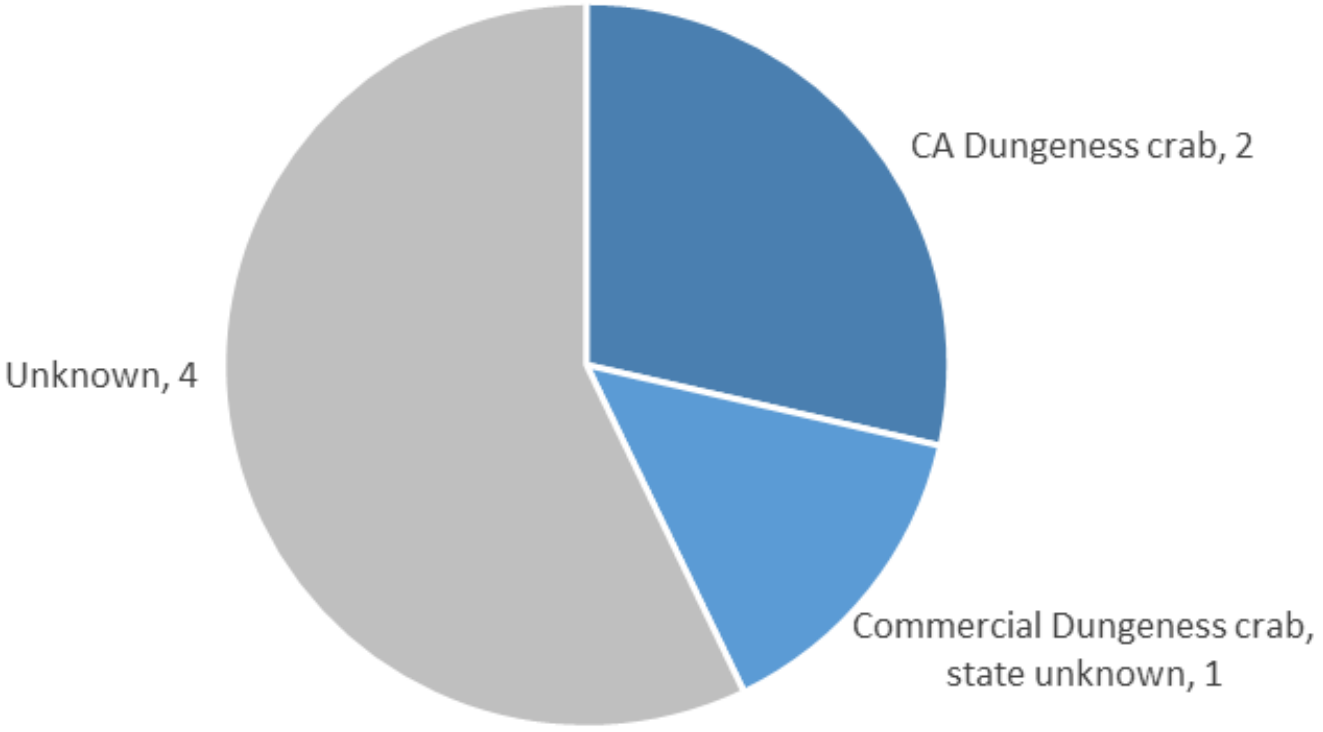
Gray whales (n=52)

Pot: 12
Net: 13
Unknown: 27



Whale entanglements + Fisheries
Blue whales (n=7)

Pot: 3
Net: 0
Unknown: 4



What we know

- NMFS West Coast Region is receiving an **increasing number of whale entanglement reports (especially Humpbacks)**
  - Potentially contributing factors: increased outreach/awareness, changing distributions of whales and fishing effort (Environmental? Economic?)
- **Blue whales** are being reported as entangled! No reported prior to 2015
- Recent increase in entanglements reported in **central California**
- Whales can carry gear for long distances

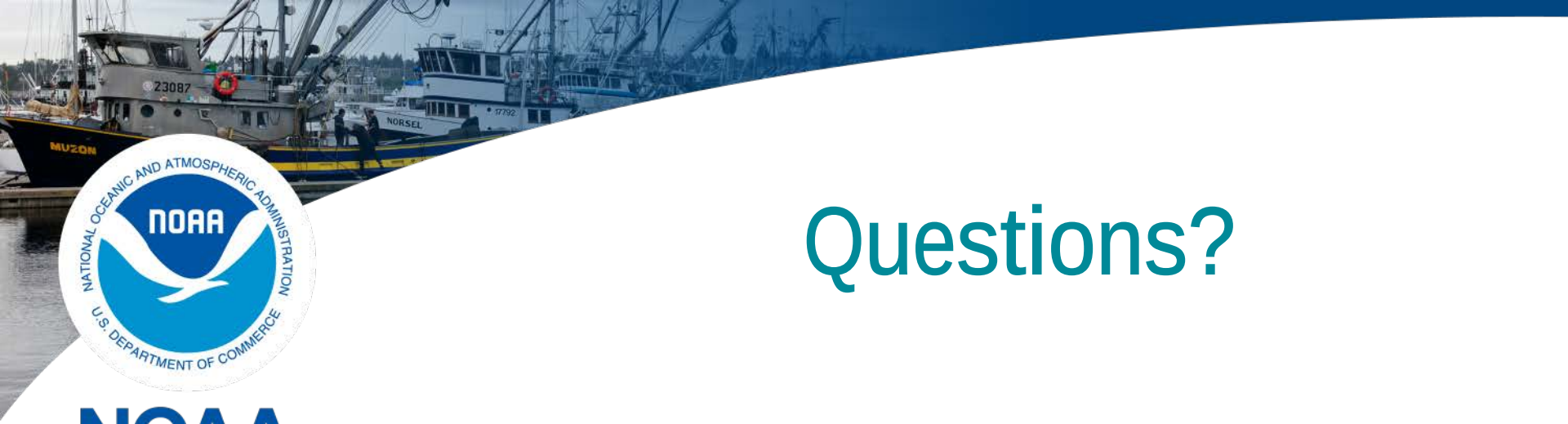
What we know (continued)

- More detailed documentation/better reporting and increasing response in recent year has **increased ability to identify gear (along with trap tags)**, but still limited
- **Trap/pot fisheries** are being identified as the majority entangling gear (of identified gear types); **commercial Dungeness crab gear** has the highest confirmed entanglement reports
- Dungeness crab is the largest trap fishery off the west coast with the highest number of participants and number of traps/lines:
  - may not be anything special about crab gear as much as relative extent of overlap in terms of extent of gear in water
- Whales are getting entangled every way possible, in all types/colors of line – not likely to be one easy fix to solve all problems…**Forensic Review!**

What we don't know well

Entanglement Data

- Identifying entanglement origins
  - Fishery
  - Locations
  - Timing (where to focus management and research efforts)
- Understanding of gear configurations involved in entanglements & how it affects entanglement
- Knowing the total # of entanglements that occur (unobserved)
- Understanding how whale behavior and gear configuration could make an interaction become an entanglement
- Understanding outcomes of entanglements (long term survival, serious injuries, impacts of reproduction)



NOAA FISHERIES

Questions?

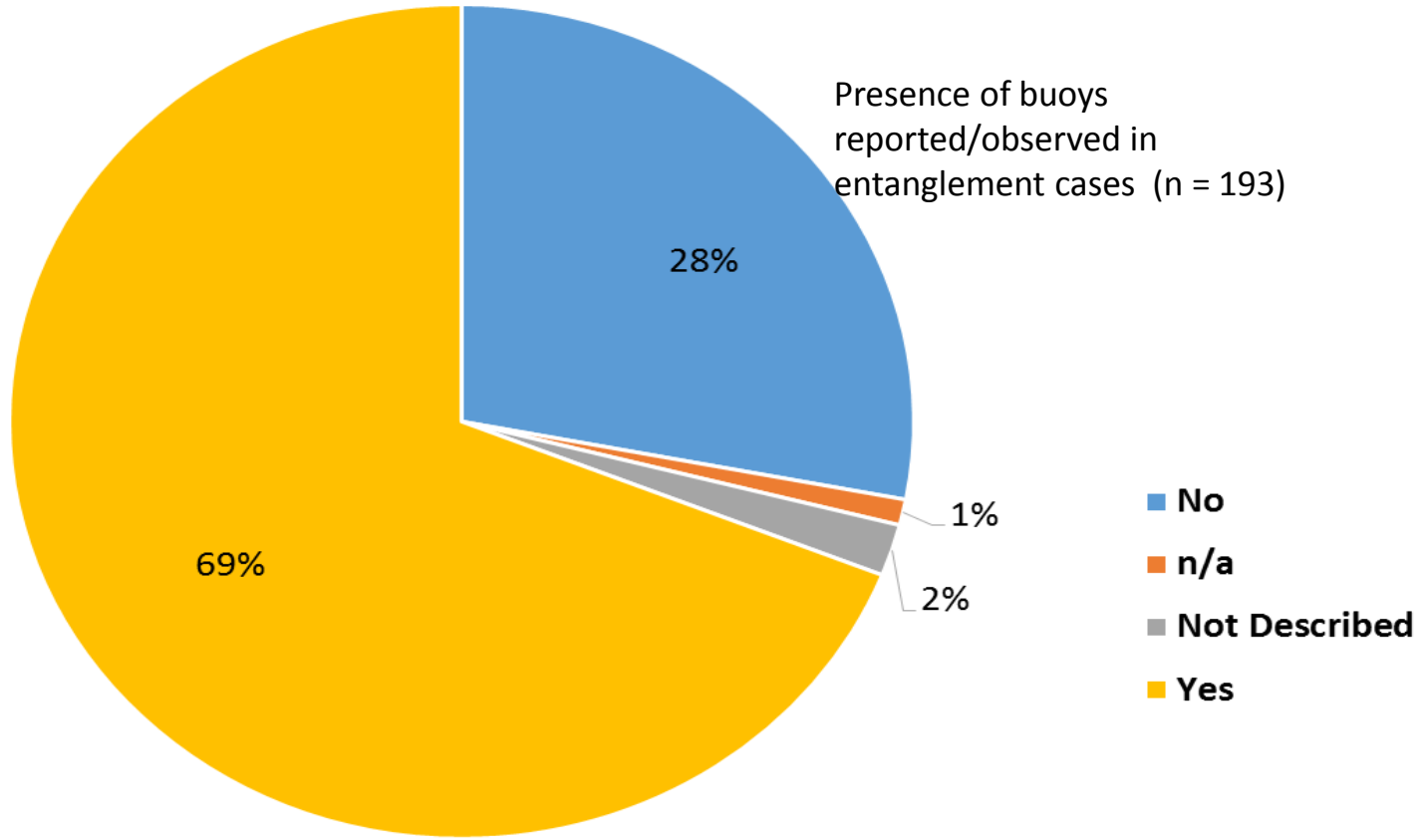
Appendix M

Forensic Review

Dan Lawson

NOAA Fisheries - West Coast Region

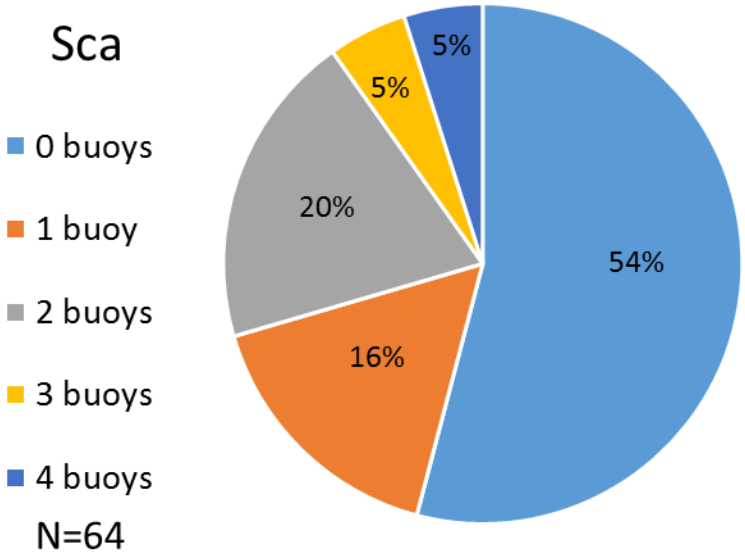
Buoys and Entanglement Reports



Number of buoys seen	# of cases
1	33 (25%)
2	53 (40%)
3	22 (16%)
4	11 (8%)
5	2 (4%)
6+	3 (2%)
not well described	14 (10%)
n/a	1 (1%)
Grand Total	**134**

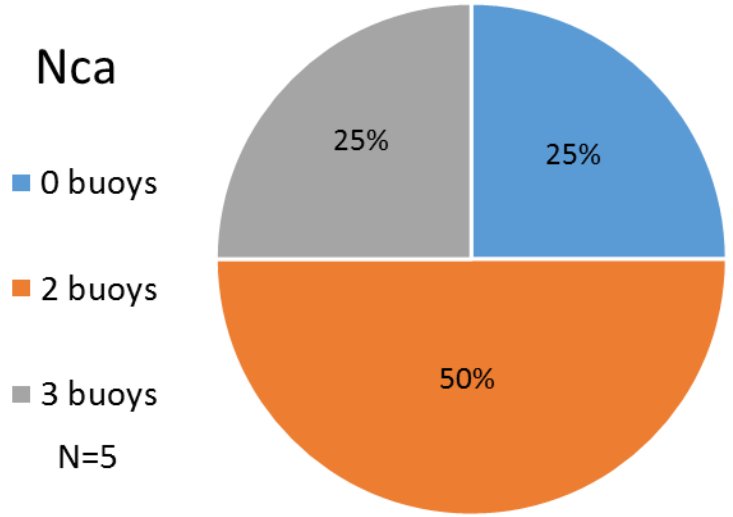
Regional Report Location

Sca



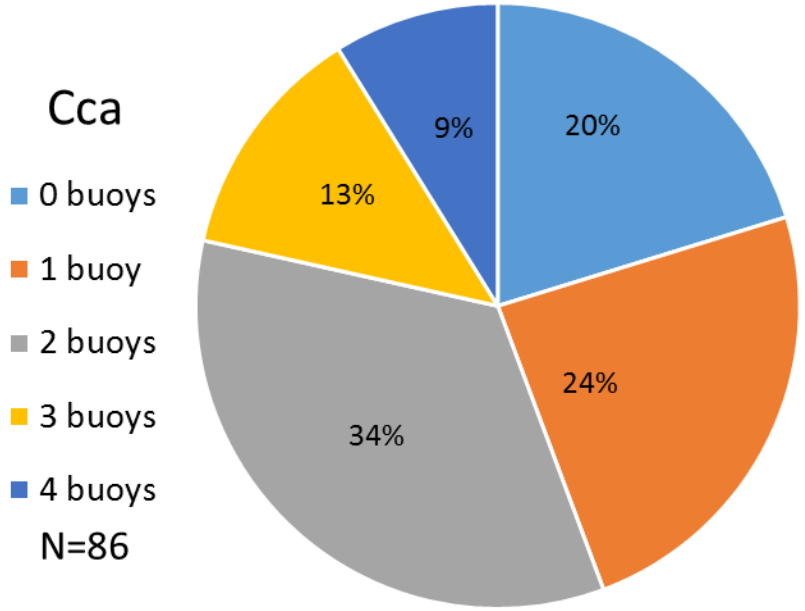
N=64

Nca



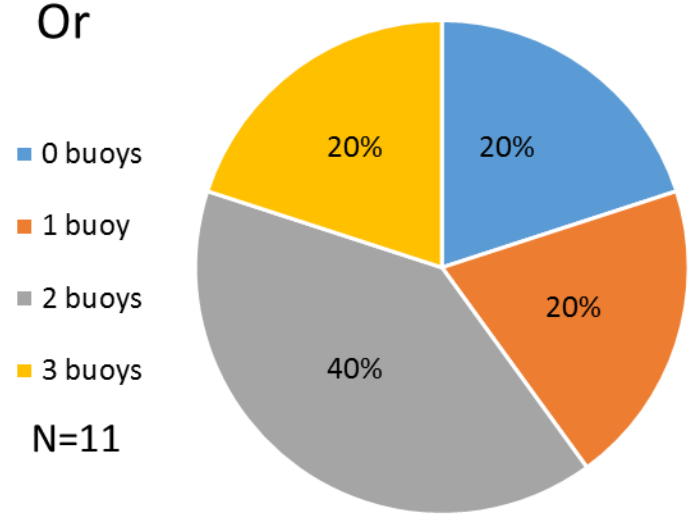
N=5

Cca



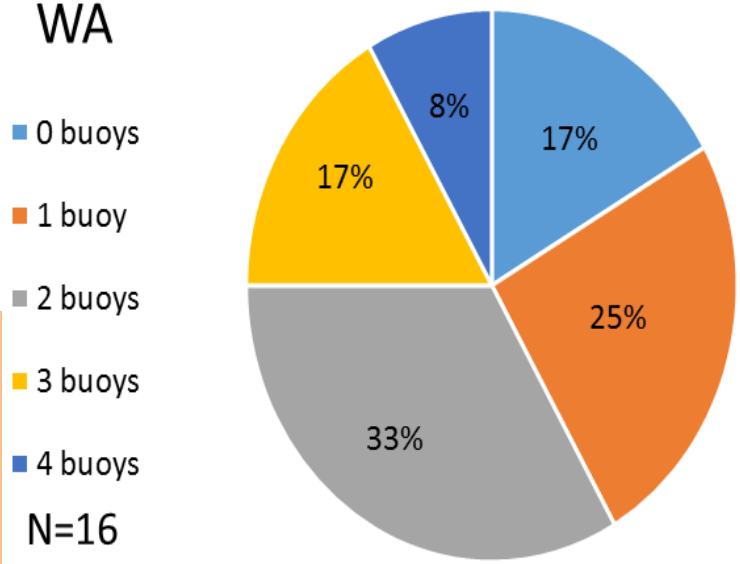
N=86

Or



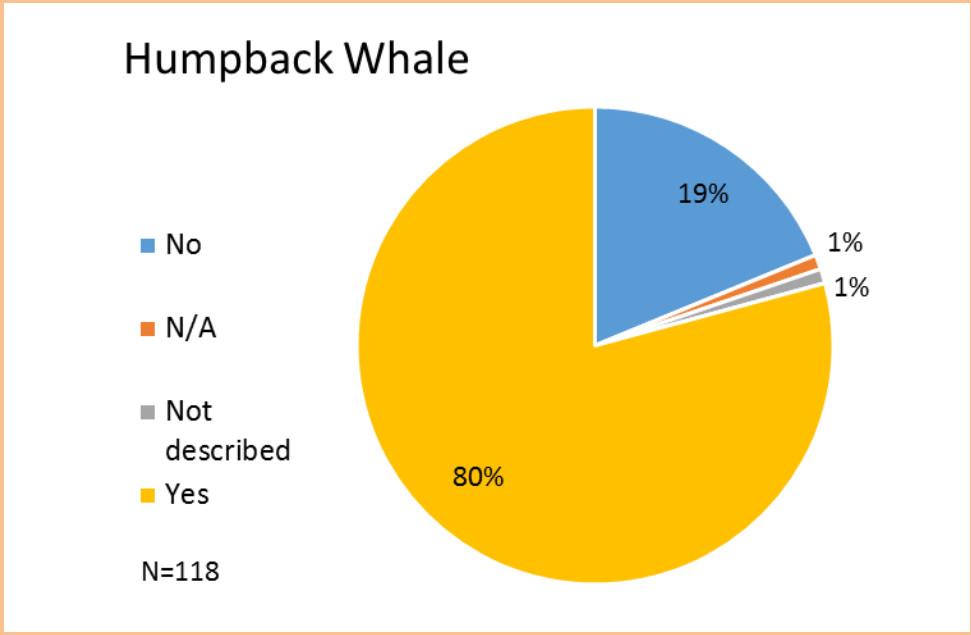
N=11

WA

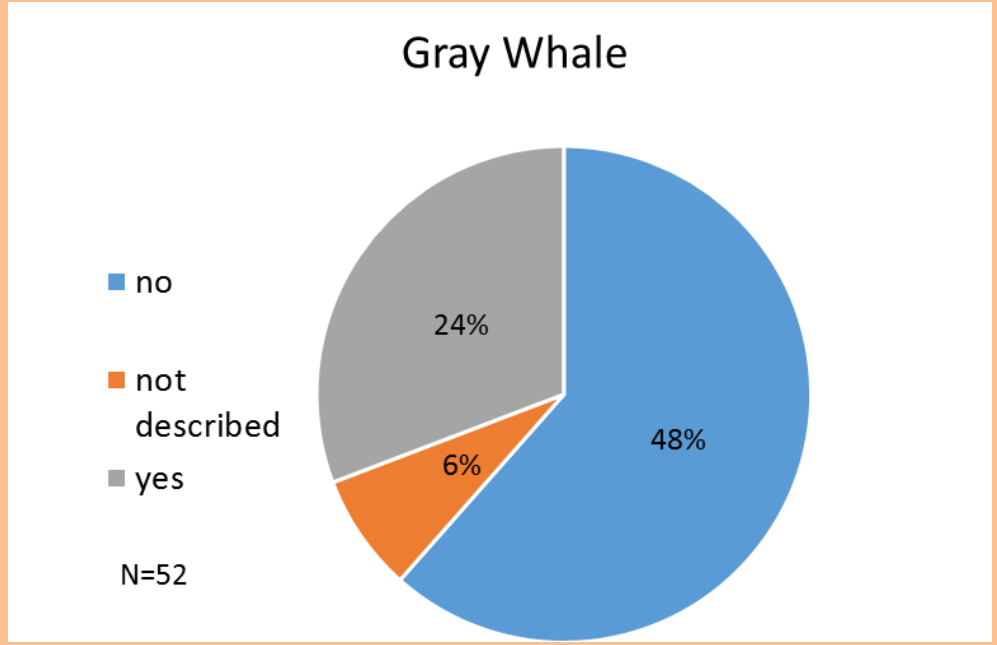


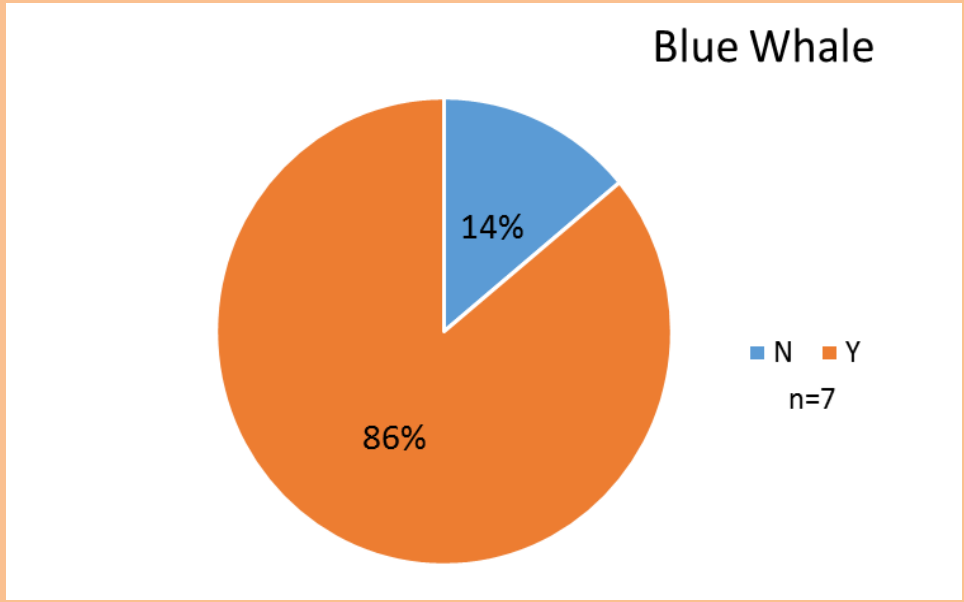
N=16

Buoys Observed and Species

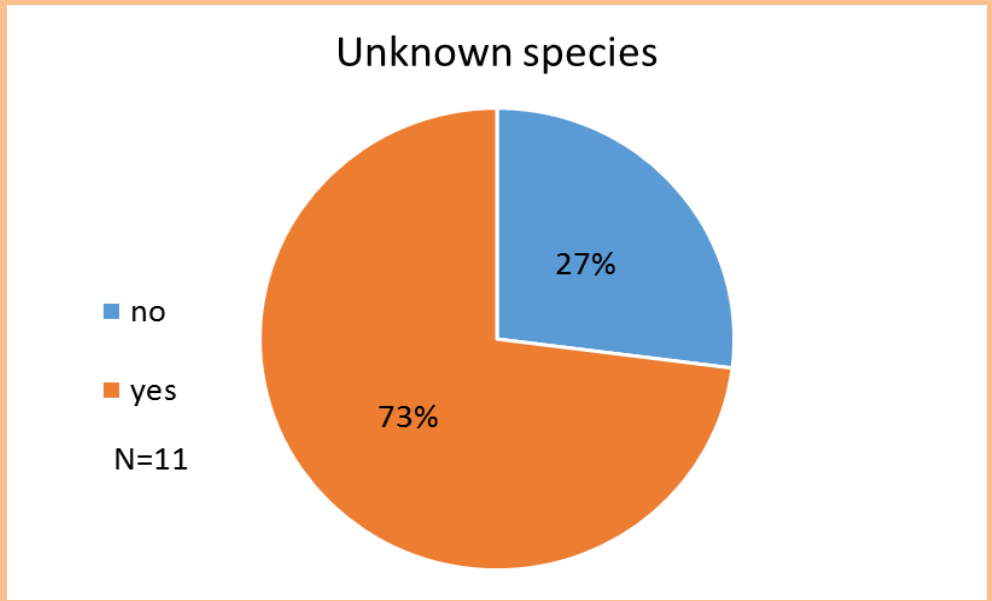


Fin Whale: 3 without buoys

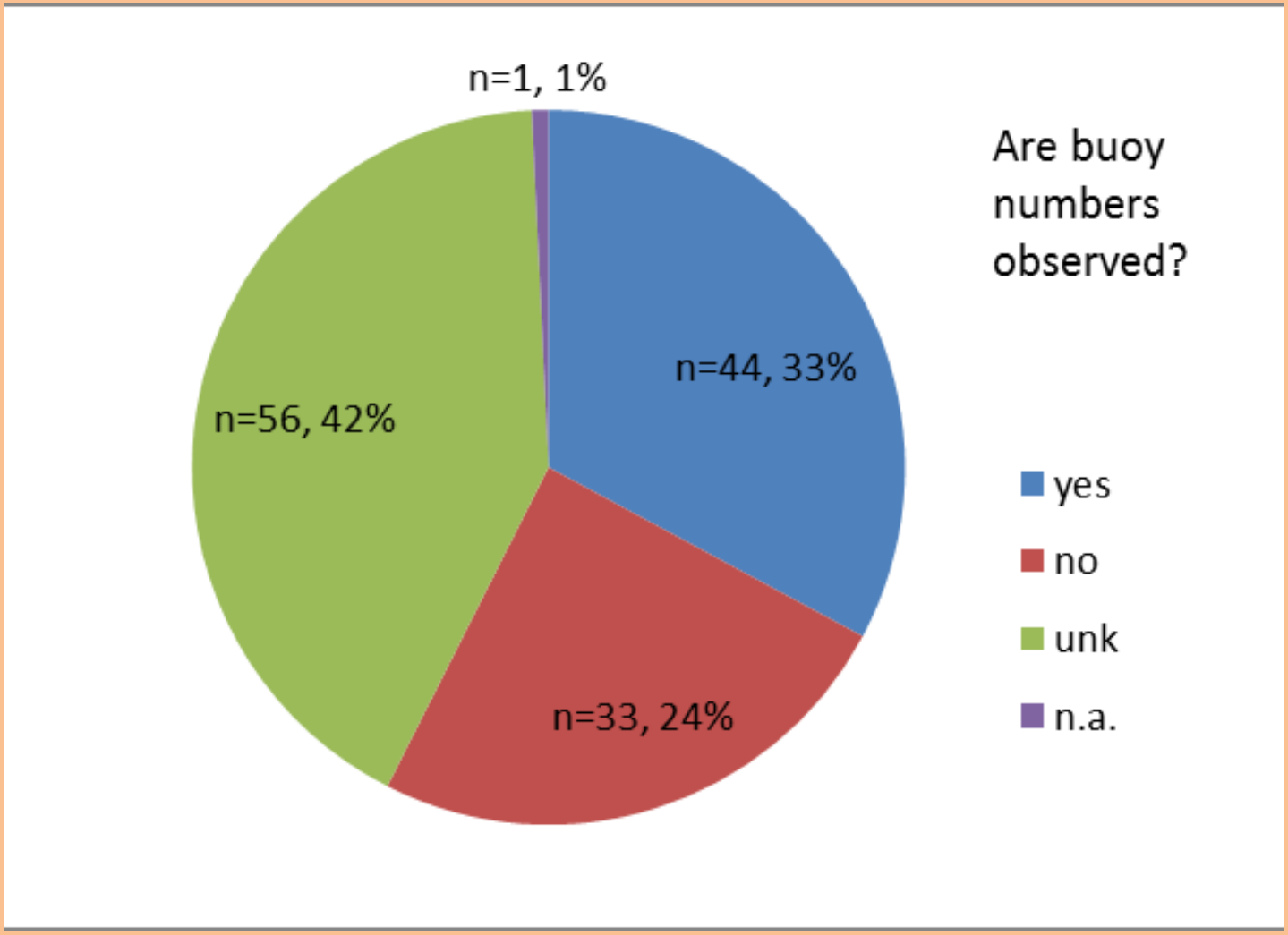




Orca: 2 with buoys



Buoy Numbers: Observed/legibility



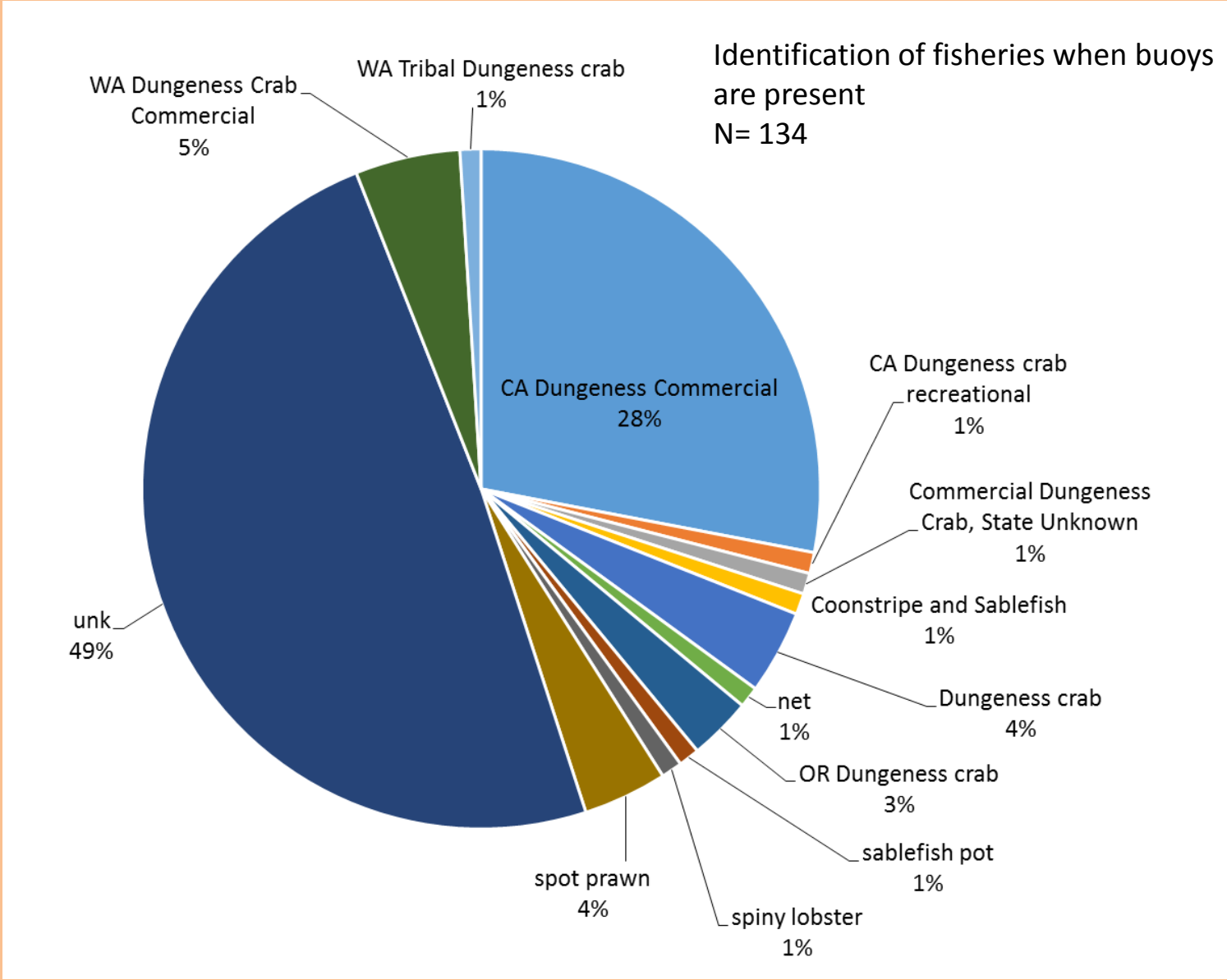
- Legible: 41 of the cases
- ~50% of time it takes disentanglement response including documentation and/or recovery of gear

Contribution to Gear Identification

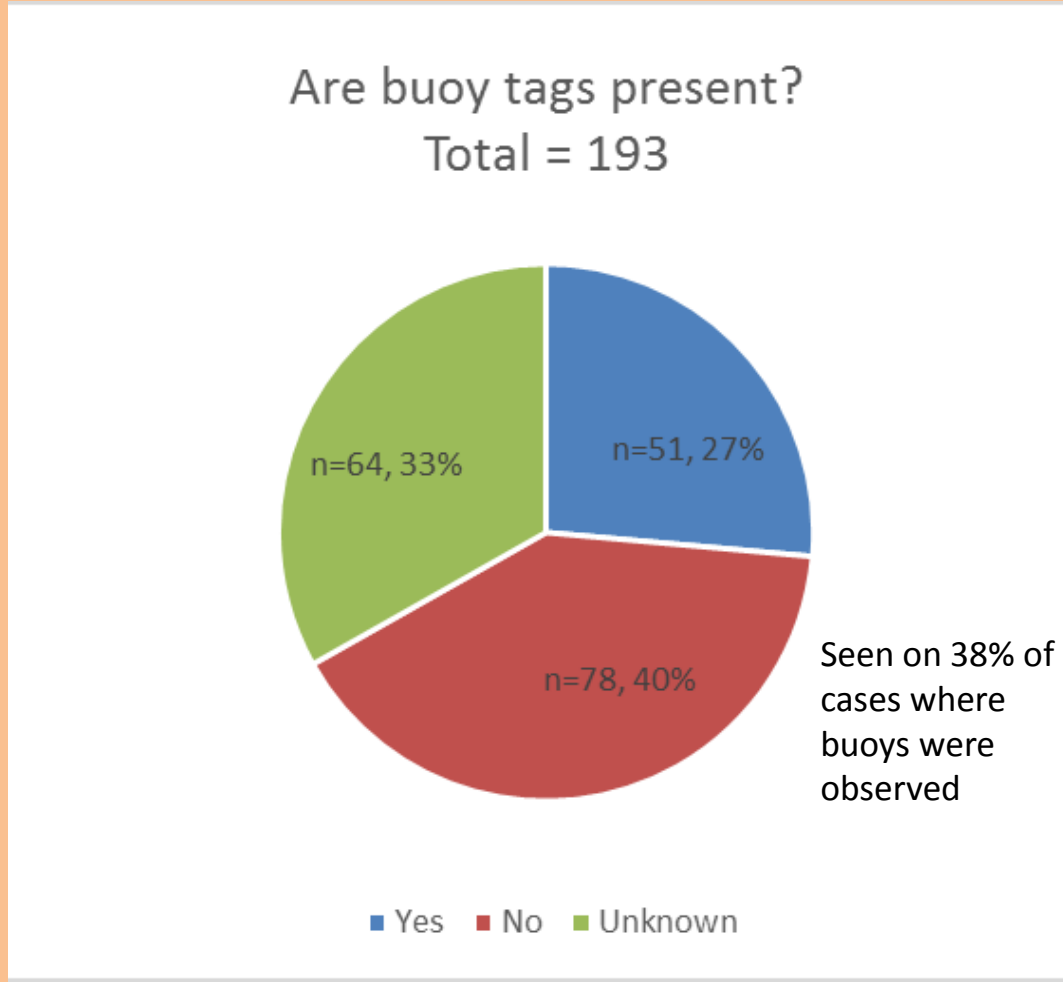
Buoys not observed: 59 cases

- 20 net/gillnet cases
- 3 Dungeness crab
- 1 spot prawn
- 1 sablefish pot

If buoys are not observed: little chance of gear ID

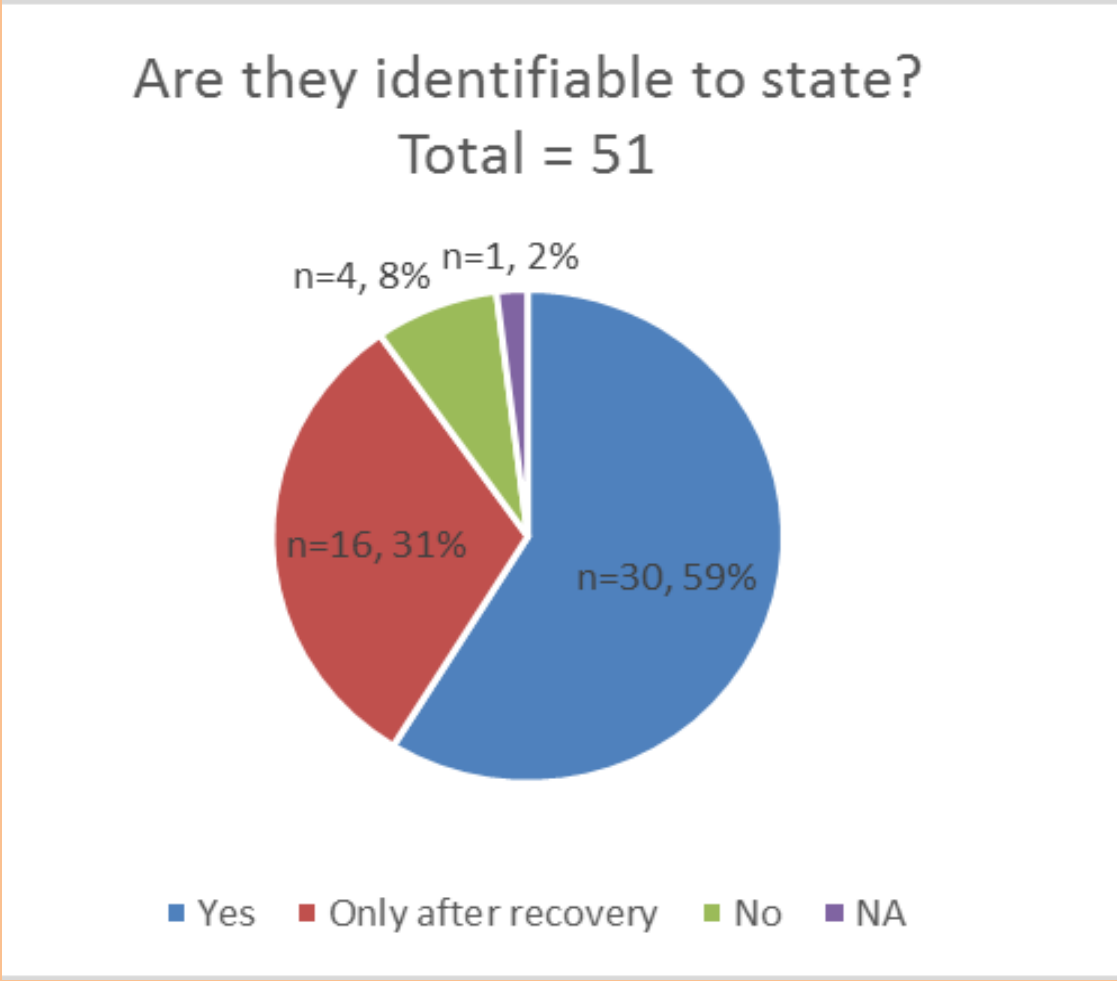


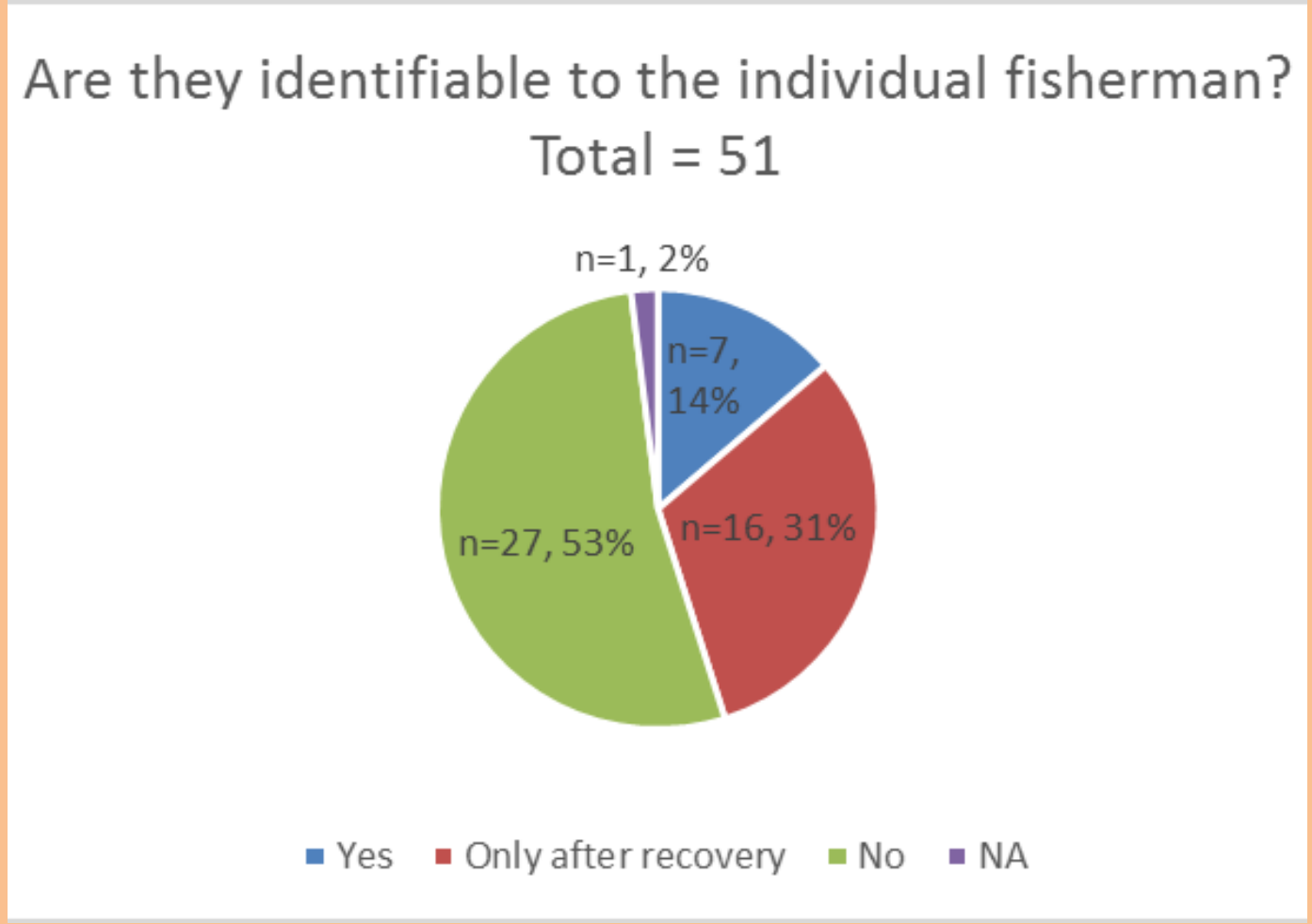
Buoy Tags and Entanglement Reports



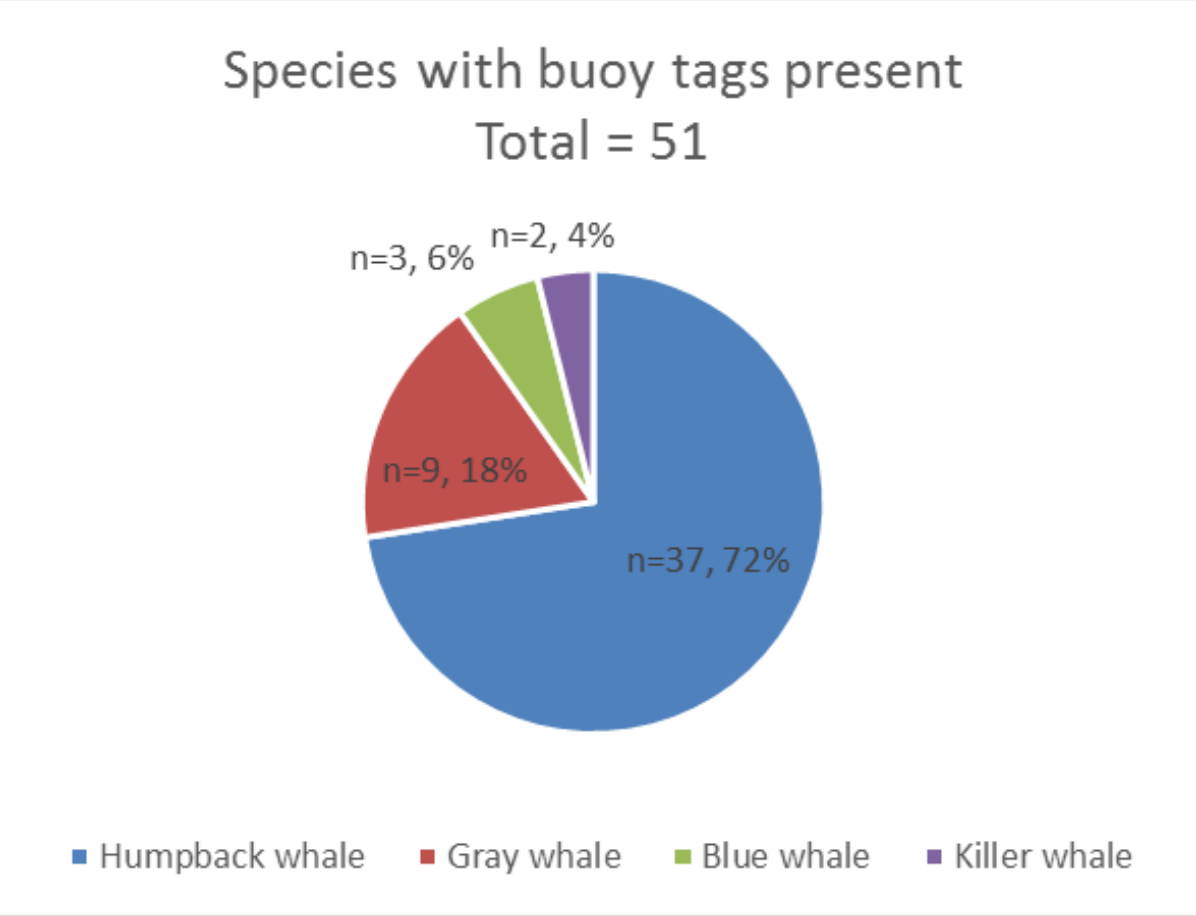
Seen on 38% of cases where buoys were observed

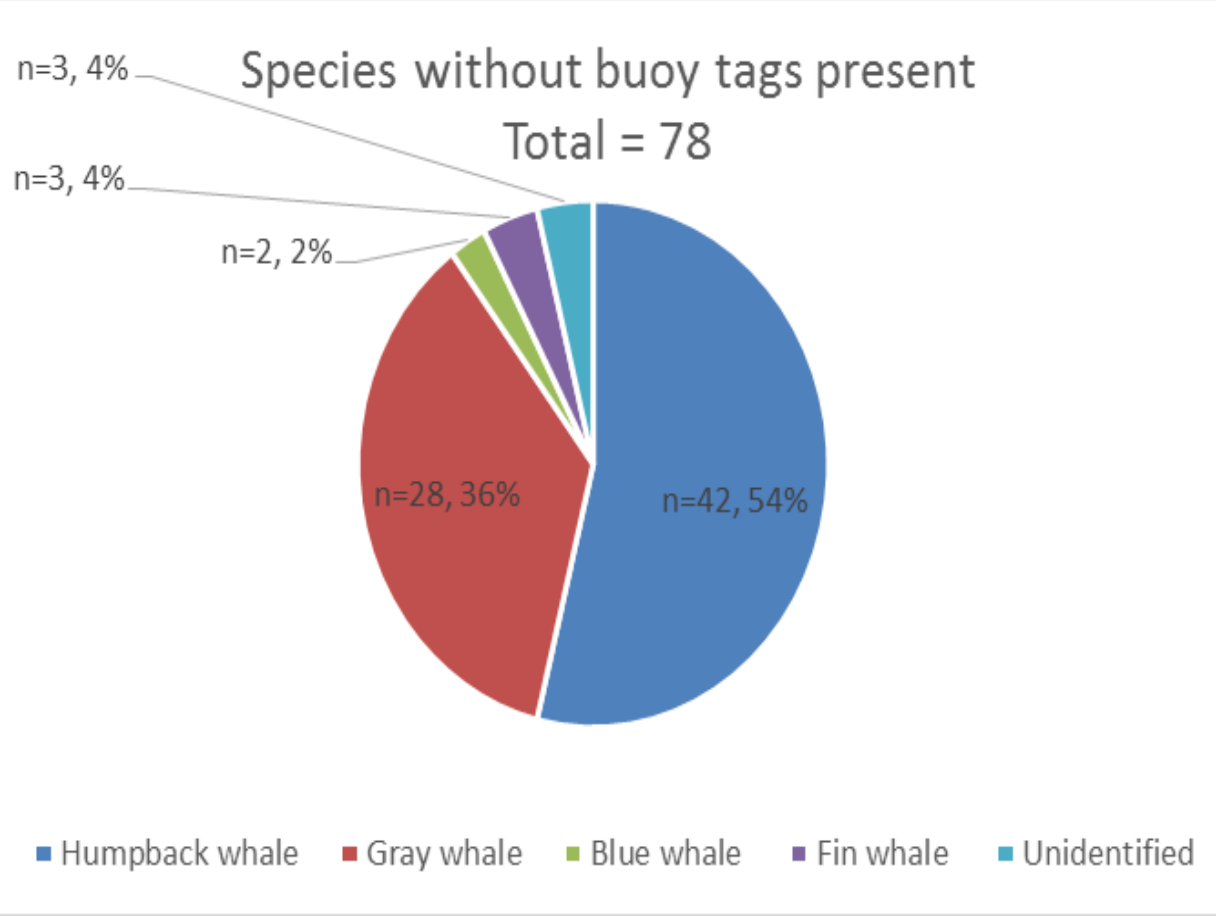
Are buoy tags identifiable?





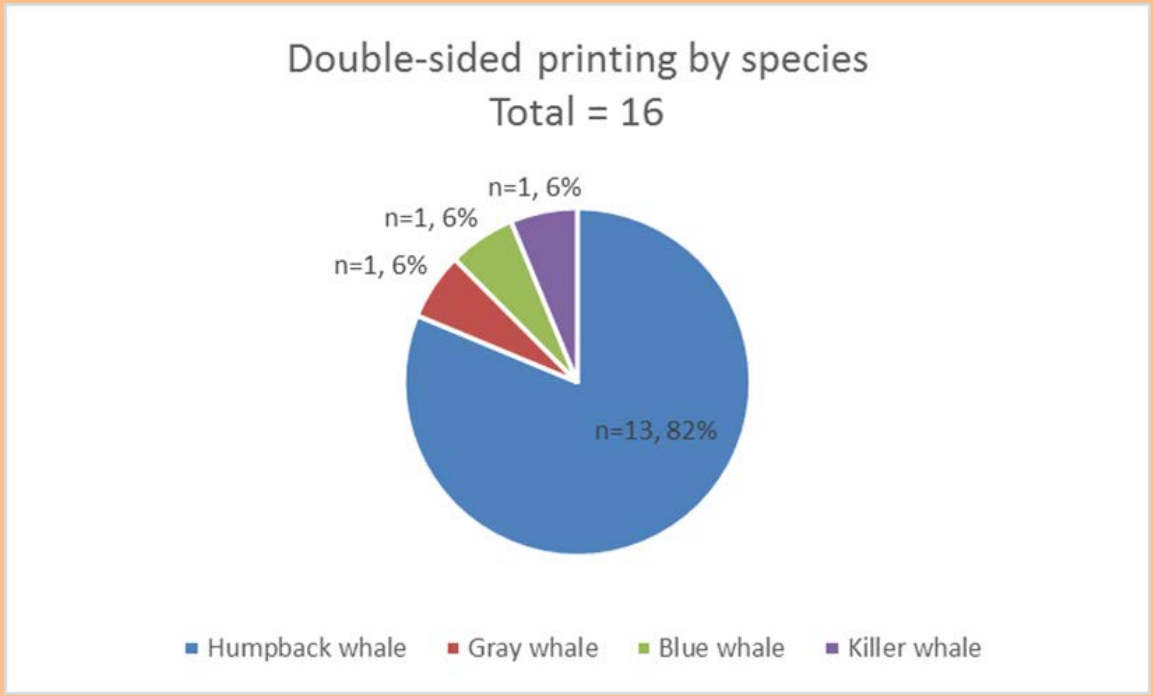
Buoy Tags by Species

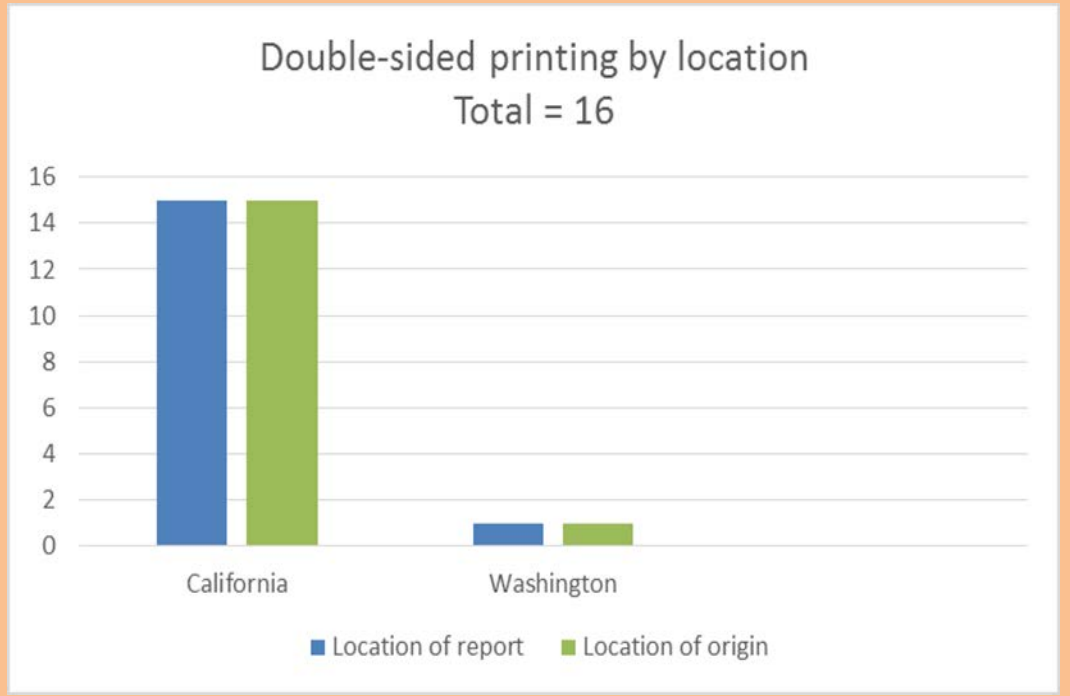




Is Double-sided Printing a Good Idea?

- 16 cases (of 51 cases): may have helped ID individual fisherman
  - Tag facing the wrong way: 13 cases
  - Tag numbers obscured: 3 cases





Gear Marking: What Can We See?

- Buoys: how often we ID gear with Buoys? Tags? Without?
  - Present 2/3rds; if seen - ~50%; if tags seen - ~90%* (to State)
  - If buoys not seen (and not nets) – 13%; buoys/no tags – 47%
- Vertical lines: which portion of gear do we most often see?
  - ~60% gear at or near top; ~90% from middle up* (when known)
- Gillnets: marking on floats?
  - Seen/described 9 out of 20; black or red color most common