

# Disentangling a Whale of a Problem



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Winston Churchill Travelling Fellowship

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## **Acknowledgements**

I would like to extend a huge and heartfelt thank you to the Winston Churchill Memorial Trust for making this Fellowship possible, and for their continued support. I would also like to give special thanks to all those across the USA, Canada and further afield who made this trip the once-in-a-lifetime experience it was.

In California Peggy West-Stap, Stephanie Marcos and the volunteers with Marine Life Studies, Fishermen Richard Ogg and John Mellor, Kathi Koontz and Pieter Folkens of California Whale Rescue, and NOAA's Dan Lawson, Justin Veizbicke, Justin Greenman, Lauren De Maio, Lauren Saez and Jamison Smith.

At the Center for Coastal Studies in Massachusetts I would like to express my sincere gratitude to Scott Landry and his team Everett Sacrey, Lisa Sette, Maria Harvey and Bob Lynch, as well as Stormy Mayo and Owen Nichols, for generously sharing their time, insights and expertise.

I would also like to thank David Mattila of the International Whaling Commission, Ed Lyman of the Hawaiian Islands Disentanglement Network, Brian Sharp of the International Fund for Animal Welfare, Michael Moore and Jim Partan of the Woods Hole Oceanographic Institution, and Doug Coughran of the Western Australia Department of Environment and Conservation for their invaluable contributions to this Fellowship.

In Newfoundland I give huge thanks to Wayne Ledwell and Julie Huntington of the Whale Release and Strandings Group for sharing their own unique experiences in whale disentanglement and views on the issues surrounding this.

Thanks must also go to Beth Casoni of the Massachusetts Lobstermen's Association, Regina Asmutis Silva of Whale and Dolphin Conservation, and to all of the fishermen, disentanglement team members, researchers, whale advocates, fisheries representatives and federal staff I met along the way who welcomed me into their homes, offices and on to their boats, who gave up lunch breaks and evenings to answer my questions, and who trusted me to listen to their frustrations, hopes and fears. Your words and stories shone new light and offered fresh perspectives on the issues discussed and pushed me to challenge my own perceptions of these and the people involved. I thank you all for your stark honesty, candid advice and unwavering passion.

In the UK I would like to thank Andrew Brownlow from the Scottish Marine Animal Stranding Scheme, and Stephen Marsh from British Divers Marine Life Rescue who have both been a huge support throughout this process.

## **Dedication**

This Fellowship is dedicated to the life and memory of Joe Howlett. Joe was a Fisherman and founding member of the Campobello Whale Rescue team, who lost his life during a whale disentanglement attempt in July 2017. Through the words and memories of others Joe made a significant contribution to this report.

## **Abbreviations**

- BDMLR – British Divers Marine Life Rescue
- CCS – Center for Coastal Studies
- CWR – California Whale Rescue
- DFO – Department of Fisheries and Oceans Canada
- ESA – Endangered Species Act
- HWDT – Hebridean Whale and Dolphin Trust
- IFAW – International Fund for Animal Welfare
- IWC – International Whaling Commission
- LWDT – Large Whale Disentanglement Team
- MAER - Marine Animal Entanglement Response
- MLA – Massachusetts Lobstermen’s Association
- MMPA – Marine Mammal Protection Act
- NARWC – North Atlantic Right Whale Consortium
- NEAQ – New England Aquarium
- NMFS – National Marine Fisheries Service
- NOAA – National Oceanographic and Atmospheric Administration
- PBR – Potential Biological Removal
- RBS – Reduced Breaking Strength
- SCFF – Scottish Creel Fishermen’s Federation
- SMASS – Scottish Marine Animal Stranding Scheme
- SMM – Society for Marine Mammalogy
- TRT – Take Reduction Team
- WDC – Whale and Dolphin Conservation
- WHOI – Woods Hole Oceanographic Institution

## Foreword

In 2017 I was awarded a prestigious Winston Churchill Memorial Trust Fellowship. Churchill Fellowships fund British citizens to travel overseas, to learn about inspiring practises adopted in other countries to address a wide range of issues. Fellows then return to the UK and use the skills and knowledge gained from this experience for the benefit of communities here. They offer a unique opportunity to expand your personal and professional horizons, and I cannot thank the Trust enough for investing in me.

During my Fellowship I visited the USA and Canada to explore the growing issue of large whale entanglement in fishing gear. Between September and November 2017 I travelled to California, Massachusetts, Nova Scotia and Newfoundland to learn more about how entanglements in US and Canadian trap and pot fisheries are currently being addressed. My aim was to return to the UK with an enhanced knowledge base and improved skills set to address similar problems here, particularly within the Scottish inshore creel fishery.

Whale entanglement in fishing gear is a growing concern globally, and my interest in this particular problem developed through varied connections I have both personally and professionally to the fishing industry, whales, and the marine environment as a whole. I grew up on the Isle of Skye and as the daughter of a creel fisherman some of my earliest and favourite memories are of times spent at sea around the Scottish coast fishing and wildlife watching. I have worked as a commercial and scientific diver in the UK and overseas, and as a whale watching guide, during which time I had some incredible encounters with a whole host of marine life. I have worked for a number of environmental consultancy firms where I specialised in the environmental impacts of aquaculture and offshore energy developments, particularly on marine mammals and commercial fisheries. I have also been employed by several marine wildlife conservation charities in roles focussed largely on environmental education, species protection, and community conservation and empowerment. I currently volunteer as a marine mammal medic, area co-ordinator and large whale disentanglement team member with British Divers Marine Life Rescue (BDMLR), and as a sampling volunteer with the Scottish Marine Animal Stranding Scheme (SMASS).

## **Introduction**

Entanglement in fishing gear poses a threat to marine mammals and fishers wherever the two overlap, and can have conservation, welfare and economic consequences (Reid 2008). It is estimated that over 300,000 whales, dolphins and porpoise (collectively known as cetaceans) are killed as a result of incidental by-catch and entanglement in fishing gear each year (Reeves *et al*, 2013; Reid *et al*, 2006). The problem is so great that it is now recognised as the single largest threat to these animals, replacing whaling as the major anthropogenic cause of cetacean mortality (Van der Hoop *et al*, 2013). It is even driving some species to the brink of extinction including the critically endangered Vaquita (*Phocoena sinus*) and the North Atlantic right whale (*Eubalaena glacialis*) (Reid 2008).

### ***The problem in Scotland***

Scottish waters are incredibly rich in terms of cetacean diversity, with over 20 different species recorded (Clark *et al*, 2010; Reid *et al*, 2003). Many frequent inshore areas and as a result Scotland is considered one of the best locations for land-based whale and dolphin watching in Europe (Parsons *et al*, 2003). These waters are also valuable fishing grounds where creel fishermen and trawlers target prawn, crab and lobster year-round (Kafas *et al*, 2017). Creel boats make up approximately 74% of the Scottish inshore fishing fleet, with an estimated 1100 registered vessels currently active (SCFF 2017; Scottish Government 2014). As well as contributing significantly to the national economy, the inshore creel fishery forms the backbone of many small communities (Kafas *et al*, 2013). Unfortunately however with thousands of miles of rope associated with this industry deployed in inshore waters at any given time, whales (and other marine animals) can and do become entangled in this (Northridge *et al*, 2010).

Entanglements can occur through the mouth and around the body, pectoral fins and tail, and the consequences of these interactions can be devastating. Some animals free themselves while others drown quickly, but many remain entangled for weeks, months or even years. Depending on the configuration of an entanglement it can inhibit an animal's ability to feed, swim and reproduce.

Ropes can cut through baleen and blubber and amputate fins and flukes, causing severe stress and pain and posing a serious welfare concern (Rolland *et al*, 2017; IWC 2016; Knowlton *et al*, 2012; Moore and van der Hoop 2012). In more than half of post mortems conducted on baleen whales found dead around the Scottish coast entanglement has been concluded as the cause of death (Northridge *et al*, 2010). A 2016 report submitted to the International Whaling Commission (IWC) suggests that due to this threat, our inshore waters may not at present be able to support a sustainable population of humpback whales (*Megaptera novaeangliae*) (Ryan *et al*, 2016).

Interactions with creel lines is also recognised as the single largest cause of death in minke whales (*Balaenoptera acutorostrata*) accounting for up to 40% of known mortalities, and work conducted by the Hebridean Whale and Dolphin Trust (HWDT) indicates that at least 20% of live minkes bear entanglement scars (HWDT 2017). In recent years other species including killer whale (*Orcinus orca*) and northern bottlenose whale (*Hyperoodon ampullatus*) have also died in Scottish waters as a result of entanglement in gear associated with the creel fishery (SMASS 2017).

As well as the conservation and welfare concerns surrounding entanglements, the economic cost of these events to fishermen can be substantial. The Scottish creel fishing industry is largely made up of small vessels (under 10m) with a skipper and one or two crew, all working on a self-employed basis at the mercy of weather and sea conditions. On average each boat will lose 7-8% of its fishing gear per year, worth approximately £5000 per vessel (Northridge 2010). Causes of lost gear are usually unknown but typically attributed to bad weather and conflicts with towed gear (dredges and trawls) however whale entanglement should be viewed as a contributing factor (Northridge *et al* 2010). When entangled, whales can inflict serious damage not just to themselves but also the gear they are caught in. If a whale is strong enough to swim away with this gear attached, then it and any catch associated is lost, and the cost of replacing this is absorbed by the fishermen who are often already operating to tight financial margins (Marine Scotland Science 2017).

### ***Existing UK legislation and mitigation measures***

The UK is bound by legislation to protect cetaceans and monitor bycatch of these animals within its fisheries. For example, all marine mammals are protected under Article 12 of the EU Habitats Directive, whereby it is an offence to deliberately capture, kill or disturb cetaceans, or cause deterioration or destruction to their breeding or resting places (European Commission 1992). Member states are required to establish systems for monitoring incidental takes of all cetaceans, and to implement measures to ensure that these do not have a significant negative impact on the species concerned. Further measures are required under the Marine Strategy Framework Directive (MSFD, European Commission 2008) and the reformed Common Fisheries Policy (CFP, European Commission 2014). To date however reporting of entanglements within EU fisheries has been woefully inadequate, and knowledge of total bycatch numbers remains poor. This is partly because current regulations and monitoring programmes only cover a small proportion of the EU fishing fleet and excludes many geographic hotspots and fisheries with suspected high rates of bycatch (Dolman *et al*, 2016; Northridge 2011). What the limited data does indicate however is that bycatch in creel lines is a conservation concern for minke and humpback whales in the North Eastern North Atlantic (Dolman *et al*, 2016, Northridge *et al*, 2010).

To inform accurate assessments of total killings over time and to set catch limits for neighbouring whaling nations, the UK is also obliged to report incidental bycatch of whales to the IWC. But again entanglements are severely under-reported and those that are are done so poorly, in part because at present there aren't the appropriate reporting structures in place. Only one in every 10 entanglements are thought to be reported in UK waters, and as few as 1 in every 200 in other areas. This is a huge concern because what is known from entanglement reports that have been received by the IWC is that these have involved *all* known species of large whale (D. Mattila, pers. comm 28/10/2017). From evidence gathered through strandings around the UK coast, Dr Andrew Brownlow, lead Veterinarian with the Scottish Marine Animal Stranding Scheme (SMASS), recently commented that *"I believe entanglement is the most significant welfare problem of our time for many species of large marine animals, causing profound debilitation and chronic suffering. What we don't know however is the extent of this problem, and there is a good chance that many cases are going under-reported. If what we are seeing is just the tip of the iceberg then entanglement could also be significant at a conservation level- we know this is the case for north Atlantic right whales in the western Atlantic, and it may also be the case for species in our waters. Urgent action is therefore necessary to both quantify the problem and begin addressing ways of mitigation"*. (A. Brownlow, pers. comm 16/01/2018).

Despite this weak legislation and issues with under-reporting, some practical measures have been implemented to tackle whale entanglements in UK waters. For example in 2007 members of the UK marine mammal rescue charity British Divers Marine Life Rescue (BDMLR) travelled to the Center for Coastal Studies (CCS) on Cape Cod, Massachusetts to be trained in methods of whale disentanglement by the global leaders in this field. Following a week of training, the newly formed Large Whale Disentanglement Team (LWDT) returned to the UK and later received a disentanglement kit from CCS comprised of a series of bespoke tools and equipment. Personal protective gear including helmets, life jackets and gloves also formed part of the kit, as did a helmet mounted GoPro for documentation and a satellite telemetry buoy with transmitter and vhf receiver unit. Once attached to an entangled whale, this telemetry system allows an animal to be tracked remotely so that if for example a disentanglement attempt has to be abandoned due poor weather, light or sea conditions, the animal can be tracked and the disentanglement effort resumed at a later date. The UK team also purchased a trailer to store and transport kit, and a combat rubber inflatable craft (CRRC) with an outboard motor to serve as a response vessel. Following a refresher course in 2012 the team developed its own LWDT training manual and course, and expanded. Today there are two fully-equipped disentanglement teams in the UK composed of highly trained volunteers, who



respond to reports of entangled whales around the British coast and further afield when required (*images 1. and 2.*).

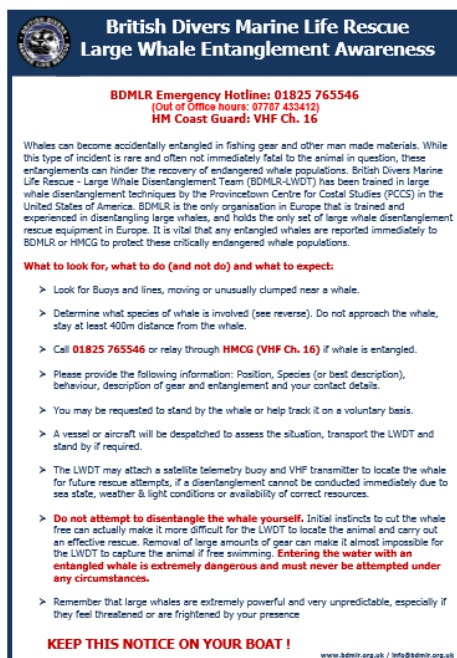


*Image 1.* The Scottish LWDT disentangling a humpback whale caught in creel lines in Loch Eriboll, 2016. Image credit: Noel Hawkins.



*Image 2.* The Scottish LWDT training at Findhorn, 2017.

In conjunction with the LWDT, BDMLR has also created and distributed a whale entanglement guide for fishermen and other marine users, to raise awareness and encourage reporting of entanglement events (*image 3.*). In 2017 BDMLR also collaborated with the Scottish Creel Fishermen’s Federation (SCFF) and numerous research and conservation groups to produce a booklet and wallet card for fishermen with advice on best practices for gear setting to minimise the risk of an entanglement occurring, and details of who to contact when they do (*image 4.*).



*Image 3.* Available to download at [www.bdmlr.org.uk/uploads/documents/resources/LWDT-Vessel-awareness-poster.pdf](http://www.bdmlr.org.uk/uploads/documents/resources/LWDT-Vessel-awareness-poster.pdf)



*Image 4.* Available to download at [www.scottishcreelfishermensfederation.co.uk/entanglement.htm](http://www.scottishcreelfishermensfederation.co.uk/entanglement.htm)

## **Aims and objectives**

Although whale entanglement in fishing gear has now been recognised as a concern in Scottish waters, attempts to mitigate this have so far been limited. The UK LWDTs are on stand-by 24/7, however low levels of reporting mean these teams are not utilising their skills as often as they likely could. Inadequate legislation and limited allocation of funds has also restricted the amount of formal engagement there has been with the fishing industry and other concerned groups to date, as well as research to assess the full extent of this problem in Scottish waters. The aims of this project therefore were:

1. To learn the latest and most effective methods of disentangling large whales caught in fishing gear. The ultimate goal is to prevent whales from becoming entangled in the first place, but until this can be achieved the work of teams to free already-tangled animals is vital. These rescues can be dangerous and complex events however and so it is imperative that rescuers are equipped with the best and most up-to-date knowledge and tools available. US and Canadian teams are currently disentangling dozens more whales per year than their UK counterparts, and with each one these teams are developing new skills, perfecting their techniques and modifying their tool usage.
2. To investigate the effectiveness of modified fishing gears, deployment techniques and gear recovery initiatives to reduce the likelihood of entanglements occurring. In the USA a vast array of voluntary and mandated alterations to fishing gears and practises have been introduced in recent years, some of which may be applicable to Scottish fisheries.
3. To learn how those involved in and affected by entanglements are engaging and working together to tackle this problem, and where and why this is and isn't proving successful. Whale entanglement in fishing gear is a contentious issue involving a wide array of stakeholder groups who are driven by differing ideas, beliefs and priorities. This can and has to date resulted in heated debates and breakdowns in communication, but also in the exchange of innovative ideas and the development of exciting collaborations which Scotland can learn from.

The purpose of this Fellowship was to broaden my own understanding of the scientific, technical, legal, economic and cultural aspects of whale entanglement, and of the wider issues surrounding this. During my trip I accompanied researchers, fishermen and disentanglement teams at sea to better understand the details of their work. I conducted both formal and informal interviews with key players on all sides of the entanglement issue, in a bid to pick apart the subtleties of this complex and divisive issue and understand the frustrations, fears and future hopes of those at the heart of it. I also participated in a number of workshops, training events, inter-agency debates and Q&A sessions on this topic. A full itinerary and details of my Fellowship are given in the Appendix.

## **Why the USA and Canada?**

I chose to visit the USA and Canada because this is where whale disentanglement began, and where much of the work to try to reduce the threat of entanglements is currently being conducted.

In the late 1970s and early 1980s two men serendipitously became pioneers of large whale disentanglement. In Provincetown Massachusetts, Stormy Mayo began receiving calls about entangled whales in Cape Cod bay. A founder of CCS, Stormy responded to these calls alongside centre staff including David Mattila, who would later become Director of the disentanglement programme. Over time these two men adapted the old whaling technique of kegging used by Stormy's Father and Grandfather, to tire and slow entangled whales so that they could be worked on

more safely. They also developed a tool kit and protocols for disentangling animals that are still used today. Stormy went on to disentangle dozens of whales and today serves as a Senior Scientist and Director of the ecology department at CCS. David Mattila currently works as shared staff between CCS and the IWC where he coordinates both the IWC's Expert Panel on Entanglement Response, and the Global Whale Entanglement Response Network. He also manages the Global Entanglement Capacity Building Program, designed to develop a worldwide network of professionally trained and equipped entanglement responders. So far David has reached over 1000 trainees from 40 countries including Greenland, Russia, Columbia and Peru (IWC 2018). Scott Landry is the current Director of the Marine Animal Entanglement Response (MAER) Program at CCS. He trained with David Mattila and Stormy Mayo in the 1990s and now coordinates and trains responders in the Atlantic Large Whale Disentanglement Network. Scott's MAER team is unique in that they are the only dedicated full-time response unit in the world, and members are also involved in several long-term cetacean research studies and conservation programs (*images 5 and 6.*). I was incredibly fortunate to spend two weeks at CCS and meet and learn from all three of these men, who are widely recognised as the global leaders in whale entanglement response.



*Image 5.* The CCS MAER team (L – R):  
Maria, Bob, Everett and Scott.



*Image 6.* The CCS team in action. Image  
credit: NOAA permit #18786

Five years earlier in Newfoundland, John Lien, a Biopsychology Professor at Memorial University, was contacted by a fisherman who had a humpback whale caught in his nets. John had no prior experience in whale disentanglement but agreed to help, and after freeing this whale he started to receive calls from other fisherman who also had whales tangled in their gear. Recognising the scale of the problem he invited fishermen from nearby towns to meet and discuss the issue further, and on realising how big a concern this really was, John applied for a grant from the Department of Fisheries and Oceans (DFO). This was the beginning of the Whale Disentanglement and Assistance Program, which today is run by husband and wife team Wayne Ledwell and Julie Huntington as the independent Whale Release and Strandings Group (*images 7 and 8.*). The core aims of this programme are to assist fishermen in freeing entangled whales to minimise fishing downtime and damage to their gear, to release entrapped animals as quickly and safely as possible, to collect information from fishermen and communities about the marine animals inhabiting the waters around them, and to add to the scientific knowledge of these species around Newfoundland and Labrador. I spent the last week of my Fellowship with Wayne and Julie and gained a thorough insight into their unique approach and very successful programme.



*Image 7.* Wayne Ledwell and Julie Huntington of the Whale Release and Strandings Group in Newfoundland.



*Image 8.* Wayne Ledwell assessing a humpback whale anchored in fishing gear. Image credit: Wayne Ledwell.

My Fellowship coincided with a critical time for whale entanglement in both the USA and Canada. In 2016 71 reports of entangled whales were received off the US west coast. 48 of these reports were confirmed which is the highest annual total since recording of these events began in 1982 (NOAA Fisheries 2017). Most were humpbacks but blue, grey and killer whales were also confirmed caught in or towing fishing gear. Along the east coast, 2017 proved to be a devastating year for the critically endangered North Atlantic right whale. Of the estimated 450 animals that remain 17 were killed, most as the result of entanglement in fishing gear or ship strikes (NOAA 2018). These events highlighted the mitigation measures aimed at preventing entanglements that haven't worked, focussed fresh attention to those that might, and encouraged innovative thinking among groups to devise further potential solutions to this crisis. During the summer of 2017 protocols for disentanglement attempts were also reviewed following the tragic death of Joe Howlett. Joe was a Fisherman and founding member of the Campobello Whale Rescue team who had over the years rescued dozens of stricken whales. During a disentanglement attempt of a North Atlantic right whale in July 2017 while working on board a DFO research vessel, Joe was struck by the whale and killed. Following the incident DFO implemented a revised protocol to be followed by disentanglement teams, which proved controversial by temporarily disallowing any attempts to assist endangered right whales.

## **Fellowship Findings**

***Aim 1 - to learn the latest and most effective methods of whale disentanglement, including perfected techniques and tool development.***

*“Disentanglement is a crutch that’s been leant on for too long, it should not be viewed as a long-term solution to the entanglement crisis”*

– Large whale disentanglement team member, Massachusetts.

When a report of an entangled whale is received and has been verified by BDMLR, an operational risk or pre-mobilisation assessment is undertaken by the most senior team member. This includes an assessment of the sea, weather and light conditions, access points for launching a rescue vessel, what resources are available (e.g. boat support) and team availability and fitness. Like the USA the UK is a member of the IWC, a global body charged with the conservation of whales and the management of whaling. As such the UK LWDT follows the same IWC principles and guidelines



for large whale entanglement response efforts as the USA and other members (IWC 2018). However since the UK team received initial training in Massachusetts in 2007, the CCS and other US and Canadian teams I met and trained with have had significantly more practise in disentangling whales, which has allowed them to hone and perfect every aspect of their operation. From receiving and documenting an entanglement report and launching a rescue response, assessing the condition of an animal and configuration of the entanglement, to formulating a plan of action and working safely and efficiently together, these teams are the elite and there was much to learn from them.

- **Modified tools**

CCS design, approve and supply all standard disentanglement tools to teams globally. Although the basic kit remains the same, CCS have modified a number of their knives and introduced new cutting tools in line with fishing gear modifications, for example increased thickness and strength of ropes, and to avoid or at least minimise the amount of time spent in the 'danger zone' (the area immediately in front of and beside an animal that is in range of the head, tail and/or fins). Some of these modifications are illustrated below in images 9 – 12.



*Image 9.* An original welded one-piece flying knife that can be deployed using a pole and attached to lines on or trailing from a whale, to allow cutting to be done from a distance.



*Image 10.* an updated prototype ready for testing. This version has a wider gape for cutting thicker ropes, and replaceable blades which means only these need to be replaced when dulled, rather than the entire knife. The breaking strength of fishing ropes has doubled since the 1990s and therefore tougher knives are now essential to cut these.



*Image 11.* A traditional stainless steel fixed serrated knife with safety tip.



*Image 12.* This knife has been modified with an adjustable hinge, so that the knife can be angled when attached to a pole.

In Newfoundland Wayne Ledwell has designed his own knives for use in whale disentanglements. He rarely uses the knives designed by CCS because whereas they are dealing mainly with both anchored and free-swimming whales entangled in ropes associated with lobster and crab fisheries, in Newfoundland Wayne is more frequently encountering whales anchored in a mix of ropes and

netting (*image 13.*). Therefore, he has designed bespoke knives capable of cutting through a mixture of these gear types at close range (*image 14.*).



*Image 13.* Examples of the types of fishing gear whales and disentanglement teams in the US and Canada are encountering.



*Image 14.* Wayne Ledwell's disentanglement knives. The angles and gapes of these knives differ from the CCS ones. The serrated and smooth blades are interchangeable.

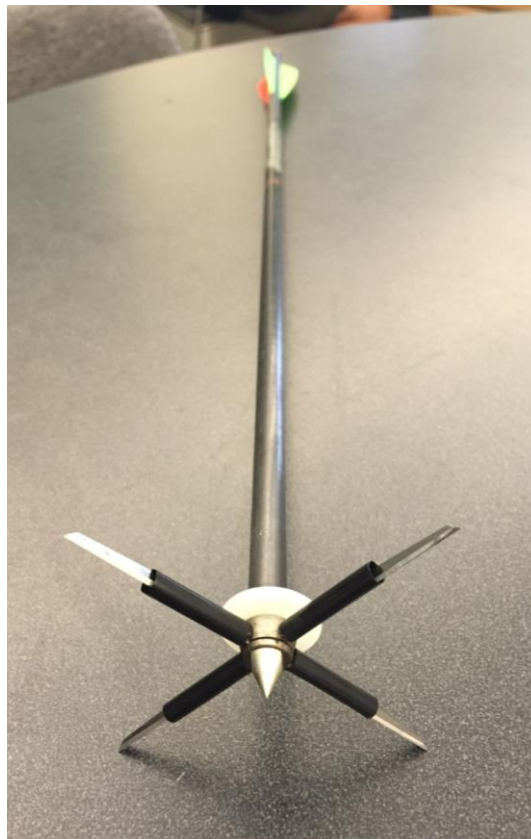


- **New tools**

As well as getting to grips with these modified tools, I was also introduced to several new additions to kits that are currently being employed by US teams during large whale disentanglement attempts. The first was a spring-loaded knife (*image 15*, Moore *et al*, 2013). This knife is used when entangling ropes are embedded deep into an animal's skin and therefore cannot be reached using standard knives. This is an invasive tool mounted on a handheld pole with a plunger, which when in contact with the skin surface releases a spring-loaded blade that acts like a mini guillotine (Moore *et al*, 2013). Another new addition I was able to handle was the goblin guillotine (*image 16*). Aimed at reducing the need for disentanglement teams to enter the 'danger zone' by allowing cuts to be made from afar, the goblin guillotine is comprised of an arrow with four interchangeable razor blades that is shot from a cross bow. Originally designed for hunting turkeys, the guillotine is very effective at cutting or creating weak points in rope from a safe distance.



*Image 15.* A spring-loaded knife.



*Image 16.* A goblin guillotine arrowhead.

- **Drones**

The use of drones or unmanned aircraft systems is an emerging tool in conservation research and data collection (Pirota *et al*, 2017). In the assessment of whale entanglements they can eliminate the need for close vessel approaches currently required to assess animal health and entanglement configuration, the noise of which can be distressing to the animal in question. During my Fellowship I asked several disentanglement team members in each area I visited what their thoughts on drones were, in the context of adding these to the disentanglement tool kit as a means of gathering documentation. Feelings were mixed with some teams already employing them (e.g. in California, *images 17 and 18*.) while others, though appreciative of their value in other areas of conservation research and data collection, questioned the practicalities of using drones in whale entanglement responses.



Images 17 and 18. Drone footage captured during a humpback whale disentangling in Crescent City, California in 2017. Image credits: Bryant Anderson/NOAA Fisheries MMHSRP Permit# 18786-01.

The following table summarises the perceived pros and cons of introducing drones to the disentangling tool kit.

Advantages	Disadvantages
Entangled whales can be located and tracked quickly and easily.	Use of drones in disentangling attempts under federal permits will require additional licenses, creating further layers of bureaucracy and complex red tape.
Known entangling hotspots can be monitored in real time.	An additional team member operating from a separate boat with the appropriate permissions and skills will be required to pilot a drone. This will significantly increase the cost of each entangling response.
With the correct equipment high resolution imagery can be uploaded and shared in real time with onshore authorities and advisors.	Time and energy spent launching and manning a drone may distract from other priorities e.g. establishing a control line or attaching a telemetry buoy to a whale.
Initial assessments of animal health, gear type and entangling configuration can be made without the need for close vessel approaches, thereby limiting disturbance to the animal.	When an animal is anchored or towing a lot of gear much of this is weighted underwater. Therefore footage received from aerial drones may give a false impression of the extent and complexity of an entangling.

- **Tags**

Attached to entangled whales and used to track their movements, telemetry buoys are an important but expensive and cumbersome element within the standard disentangling tool kit. In some areas approximately three quarters of free-swimming entangled whales reported are subsequently lost because those reporting are unable to stand by the animal until a response vessel can reach it, or because the animal cannot be effectively tracked (P.Folkens, pers. comm 04/10/2017). In an attempt to reduce these losses, work is currently ongoing with technology developers in California to design an alternative smaller and more affordable tag. The idea is that these tags could be supplied to fishermen and patrol vessel crews who with training, could attach these to gear trailing from an entangled whale. This would eliminate the need for reporters to stand by and increase the number of entangled animals that could potentially be helped (P.Folkens, pers. comm 04/10/2017).



Image 19. A standard telemetry buoy used to track entangled whales.



- **Communication and teamwork**

Disentanglements began in the 1970s and since then tools and techniques to assist in this process have been trialled, tested, tweaked and superseded. However from what I learned during my Fellowship, the success of any disentanglement attempt ultimately rests on good decision making, considered and careful planning, and teamwork. It is essential that individuals within a team know what their specific role is, that there is clear and continuous verbal communication, and that everyone is using a common language and the correct terminology. Additional advice offered by disentanglement team members I met regarding team communications included the following:

- Continuously ask yourself 'is what I'm doing stupid?' There is no room for egos or a hero mentality during a disentanglement attempt. You are part of a team and these can be very dangerous and unpredictable situations involving a wild animal. At times your life may be in other people's hands and theirs may be in yours.
- There should be at least one pair of eyes on the whale at all times, making a continuous visual assessment of the whale's condition and behaviour. Remember that these are wild animals, do not get complacent because the whale appears to be 'behaving'.
- Disentanglement attempts can be mentally, physically and emotionally draining. Check in with your team regularly to see how everyone is doing.
- Take time after each manoeuvre or cut to assess what you have just done and how it may have changed the configuration of the entanglement, or influenced what the next move should be.
- Decisions must be team decisions, adopt an 'all for go one for no' approach. If one team member is uncomfortable with a particular plan or manoeuvre then reassess the situation and consider an alternative course of action.
- Maintain contact with those who reported the entanglement and/or who have been standing by. This keeps people involved and engaged, and helps to build and maintain positive relationships.
- If you cannot immediately recover fishing gear removed from a whale, at the least try to secure this and take a GPS so that it can be collected later and returned to the fisherman it belongs to. Again this will help build positive relationships.

***Aim 2 - To investigate the potential and effectiveness of modified fishing gears, deployment techniques and gear recovery initiatives to reduce the likelihood of entanglements occurring.***

*"If we can shoot a man to space and put him on the moon, surely we can figure a way to fish without catching whales. And if we can do that here, maybe we can help fisheries and whales everywhere".*

- NMFS Officer, California.

Though disentanglement teams are an essential fire-fighting tool in the current global whale entanglement crisis, as any team member will tell you their work should not be viewed or relied upon as a long-term conservation measure. Disentanglement attempts are dangerous and expensive events and can be life-threatening to both the people and animals involved. The ultimate goal is instead to prevent animals from becoming entangled in the first place.

***Massachusetts***

In Massachusetts I spent a lot of time with fishermen affected by whale entanglement. Some had had whales caught in their fishing gear, all had made adjustments to this to minimise the likelihood of it happening again, and all were fearful of an uncertain future filled with more regulations and limitations, or worst-case scenario, total closure of their fishery.

Though both states I visited (California and Massachusetts) have had the issue of whale entanglement thrown into the spotlight more than ever before in recent years, on the east coast the critically endangered status of the North Atlantic right whale has added a real sense of urgency to the situation. 17 of these animals were confirmed dead as a result of entanglement or ship strikes in 2017 and of those that remain an estimated 83% bear entanglement scars, with 26% gaining new scars each year (Kraus *et al*, 2016). In an attempt to save this species from extinction several modifications to fishing gears and practices have been mandated along the east coast of the USA. These include:

- **Trawling up** – Traditionally many lobster fishermen fish single traps, where each trap or pot is set individually with its own vertical line leading to a surface marker. Trawling up requires fishermen to string traps together to increase the number they have per line, therefore reducing the amount of vertical rope in the water column that could potentially snare whales, for the same number of traps (NOAA 2017).
- **Sinking ground lines** – The use of floating lines in Massachusetts trap fisheries has been banned and instead sinking ground lines are now compulsory to reduce the amount of excess line floating in the water column. To facilitate the move to sinking lines, in 2006 Massachusetts inshore lobster fishermen participated in a gear exchange organised and funded by the International Fund for Animal Welfare (IFAW), the Massachusetts Lobstermen’s Association (MLA), and the federal government. By allowing fishermen to exchange their used and now illegal floating line for new sinking ropes, the scheme aimed to help alleviate the financial burden faced by fishermen when complying with gear regulations. The scheme was deemed a success and as a result it is estimated that Massachusetts lobstermen have removed 3,000 miles of floating rope from the water column (MLA 2009; IFAW 2005; McKiernan 2004).
- **Gear marking** – All trap fishing gear in Massachusetts must be marked in a number of ways so that if it is retrieved from an entangled whale, it can be identified both to a fishery and a geographic area. Traps must carry unique identification tags which indicate the state, year, and area where the gear is allowed to be fished (*image 20.*). Top, middle and bottom sections of buoy lines are also required to be marked with different coloured rope so that again if removed from an entangled whale, it can be determined in which section of the line, and therefore where in the water column, the animal became caught (*image 21.*).



Image 20. Trap tags.



Image 21. Buoy line markings.

- **Weak links** – In Massachusetts all buoys, flotation devices and weights used in standard static fishing gear set-ups must be attached to the surface buoy line with a weak link (*image 22.*). These links have a breaking strength lower than that of the rope they are attached to

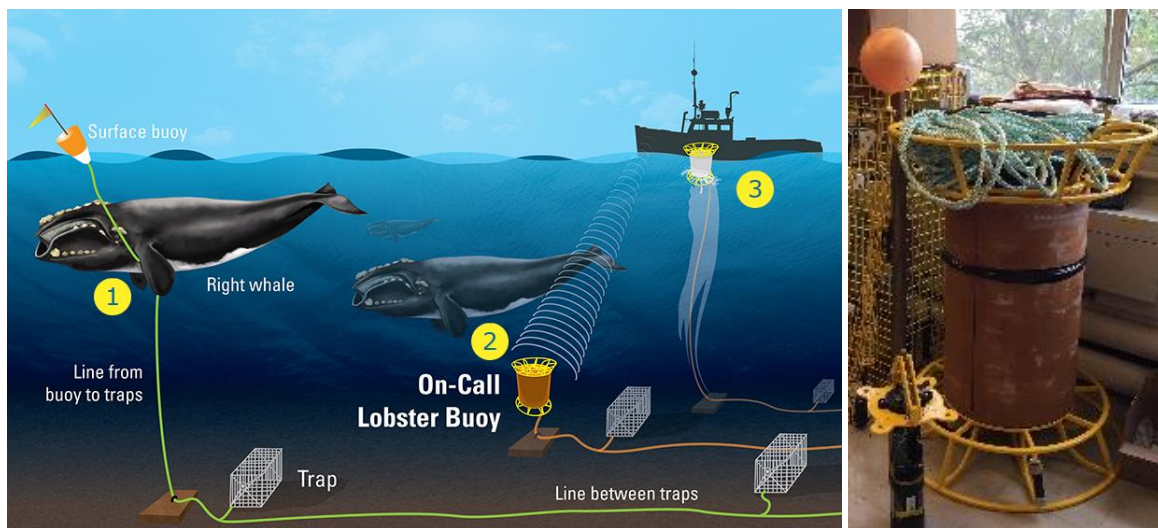
and are designed to limit the severity of entanglements by preventing whales from becoming anchored in gear and drowning, or towing away gear. Instead whales should be able to break free of lines at these weak points, therefore minimising the damage to themselves and the entangling fishing gear.



Image 22. Examples of weak link designs. Image credit: NOAA

- **Reduced breaking strength ropes** – A lot of work is currently being conducted to assess the potential impact reduced breaking strength (RBS) ropes could have on the number and severity of large whale entanglements. Research conducted by scientists based at the New England Aquarium (NEAQ) suggests that by adopting ropes with a breaking strength of 1700lbs or less along the east coast (as opposed to current widely used ropes with an average breaking strength of over 2500lbs), the number of life threatening whale entanglements could be reduced by as much as 72%. These ropes would still be capable of withstanding the forces involved in day-to-day fishing operations, while also allowing whales to break free should they become caught (Knowlton *et al*, 2015). The introduction of RBS ropes could in theory achieve nearly all of the mitigation legally required for the conservation of US North Atlantic right and humpback whale stocks, and it has been recommended that this be made mandatory within four years, with a move to rope-less gear (please see below) in 10 years (A. Knowlton, pers. comms 26/10/2017).
- **Seasonal area closures** – Cape Cod bay is closed to both commercial and recreational fishermen from February to April each year, which coincides with peak feeding activity of endangered right whales within the area. Closures such as these are very effective in regards to whale protection - with no gear in the water the risk of entanglement is eliminated. However the movement of whales and their preferred food sources is becoming less and less predictable as a result of climate change and other factors, and therefore the timing and boundaries of closures and closed areas is also becoming harder to forecast. In 2017 for example the Cape Cod bay closure was extended by a week because the whales lingered longer than expected, which impacted fishermen by shortening the window they had in which to earn a living.
- **Rope-less fishing** - While in Massachusetts I visited Jim Partan, an Engineer at the Woods Hole Oceanographic Institution (WHOI). Jim is currently working on a prototype 'rope-less' or 'on call' fishing buoy for use in lobster and other trap fisheries, in collaboration with the

Consortium for Wildlife Bycatch Reduction (NEAQ 2017). The system consists of spools of rope with buoys attached, which are anchored to the seafloor along with the traps. When a fisherman wants to retrieve his gear, a unique acoustic signal is sent to release the buoy and spool, which then rise to the surface to be hauled (*images 23 and 24.*). The prototype I saw is being designed for the east coast offshore shelf fishery where extreme depths and currents mean other mitigations measures mentioned above (e.g. weak links and RBS rope) may not be appropriate. The design is modular however and therefore could be scaled to different fishing environments. This system could protect both whales from entanglement and fishing gear from damage, by removing vertical lines from the water column. However the design would need to be introduced in conjunction with ocean zoning, and its success would ultimately be reliant on fishermen’s willingness to adopt the system. This would require a huge shift in thinking, but incentives to encourage adoption of the on-call method could be introduced concurrently, for example opening-up currently closed fishing areas to those using rope-less gear. In addition the system would need to be affordable to purchase and install, and financial assistance would be required to facilitate this switch. Most of the fishermen I spoke to on the east coast of the USA had heard of the rope-less system, and while some were intrigued others were very skeptical. The prototype has so far undergone successful initial testing in controlled environments and although it is not yet commercially ready, the design process has contributed to research that may, with further testing and development, provide the answer to the whale entanglement crisis while at the same time ensuring fishing remains practical and economically viable.



*Images 23 and 24.* An illustration of the ‘rope-less’ or ‘on-call’ system during deployment. 1- whales and other animals can get entangled in long vertical ropes connecting lobster traps to surface floats, often with serious and sometimes fatal consequences. 2 - The ‘on-call’ buoy eliminates dangerous vertical lines by coiling them around a buoyant spool attached to an anchor. 3 - To retrieve their traps, Fishermen trigger an acoustic signal to detach the spool from the anchor, unspool its line, and float up to the surface for hauling (*Image credit: LaCapra 2016*).

The existing modifications and restrictions detailed above have had mixed reactions. One researcher currently involved in designing new approaches told me that *“the best ideas and solutions are the ones that come from those closest to the issue, and in the case of whale entanglement those people are the fishermen”*. This sentiment was echoed by many others including disentanglement team members and fisheries advocates, however many fishermen I spoke to felt that current systems had not been sufficiently consulted on or trialed before becoming mandated, and some have since been proven not to work. For example both fishermen and disentanglement team members told me that weak links have been removed unbroken from entangled whales (various, pers. comm 19/10/2017).



These fishermen also begrudged the costs and time incurred conforming to the above-mentioned regulations without any ongoing financial assistance, and felt that they are being held over a barrel – comply or lose your fishing licence.

## California

Along the US west coast whale populations are largely considered to be healthy, for example humpback whale numbers are increasing steadily (NOAA 2016). However California did experience record numbers of confirmed whale entanglements in 2015 and 2016, with most attributed to the Dungeness crab fishery (NMFS 2017). Humpback, blue, grey and killer whales were all reported caught in fishing gear, and although entanglement does not pose an immediate conservation threat to these species as is the case with North Atlantic right whales along the east coast, there are still significant welfare concerns. In response to this increase in entanglements federal staff, fishermen, conservation representatives and others came together to form the Dungeness Crab Fishing Gear Working Group (OPC 2016). Following discussions the group opted to recommend voluntary best practice actions as a first step towards reducing the entanglement risk within the fishery (*image 25*). These low cost recommendations included removing any excess line floating in the water column or at the surface, avoiding setting gear in the vicinity of whales whenever possible, maintaining gear to ensure lines and buoys are in good working condition and will not break and become lost or irretrievable, using the minimum amount of scope required to compensate for tides, currents and weather, and removing all fishing gear by the end of each season.

**Excess Slack Surface Line and Whale Entanglements**  
Ocean users, including members of the fishing community, are seeing a shift in fishing practices towards increased surface line and the use of multiple surface buoys. During a review of documented entanglements from recent years, fishermen, disentanglement responders, and others see a potential connection between slack surface line and the number of trailer entanglements.

**Taking these important, proactive steps to voluntarily reduce slack surface line will help to provide continued opportunities to harvest crab and maintain the fleet's access to the resource.**

**California Dungeness Crab Fishing 2016-17 Best Practices Guide to Minimize Whale Entanglement Risk**

**Support for Best Practices**  
National Marine Fisheries Service (NMFS) has confirmed significant increases in large whale entanglements over the last few years, and specifically in California Dungeness crab fishing gear. This situation threatens the stability of the fishery and coastal fishing communities. In response, a Working Group has developed this Best Practices Guide to highlight voluntary actions believed to be an important step towards reducing whale entanglements.

**BEST PRACTICES**

- No excess lines should be floating at the surface. Floating line should only be between the main buoy and trailer.
- When changing set location across depths, adjust the length of trap lines by adjusting shots (i.e., measured length of line) to maintain taut vertical lines.
- Avoid setting gear in the vicinity of whales whenever possible.
- Maintain gear to ensure lines and buoys are in good working condition and will not break under natural conditions causing gear to become lost or irretrievable. Lost gear contributes to marine debris and increases the risk of whale entanglements.
- All gear should be clearly marked consistent with applicable regulation. All gear should be maintained so markings are clearly legible to facilitate correct identification of the origins of the gear involved in entanglements.
- Use the minimum amount of scope required to compensate for tides, currents and weather, as necessary. Whales are more likely to become entangled with slack lines, which can potentially create a "floating snare".

**BUOY SET-UP BEST PRACTICES**

Diagram showing Main Buoy, Trailer, and Trap. Total distance between the main and final trailer buoy.

Category	Requirement
RECREATIONAL	short as possible, max of 2 fathoms (12ft) at any depth
COMMERCIAL	short as possible, max of 3 fathoms (18ft)
30-50 fathoms	short as possible, max of 4 fathoms (24ft)
Outside 50 fathoms	short as possible, max of 5 fathoms (30ft)

Minimize # of buoys in set up—no more than 1 trailer buoy inside 30 fathoms

Keep line between trap and main buoy running vertical and taut

**Dead Whales**  
If you observe a dead whale, please report it to the NMFS whale entanglement response hotline at (877) 762-5422 or call the U.S. Coast Guard on Channel 16, if possible, to report the whale.

**Entangled Whales (>100 yards away)**  
If you observe a whale entangled in fishing gear, please report it to the NMFS whale entanglement response hotline at (877) 762-5422 or call the U.S. Coast Guard on Channel 16, if possible, to report the whale.

**What to do if you observe a whale entangled in fishing gear:**  
1. Tag: lines on the body; trailing lines (including distance from whale); netting (if present).

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Image 25. California Dungeness Crab best practice guide for reducing whale entanglement risk. Available to download at [www.opc.ca.gov/webmaster/\\_media\\_library/2016/](http://www.opc.ca.gov/webmaster/_media_library/2016/)

Another collaboration I learned about during my time in California was an initiative to remove derelict gear from fishing grounds along the coast. This buy-back scheme allows fishermen to earn money out-with the fishing season by hauling lost or abandoned gear. Fishermen are paid for every pot or trap they return, and the owner of that gear can then buy it back for a fee much lower than the cost of replacing it. Money earned is deposited into an escrow account to support the program during subsequent seasons, and any gear not purchased is recycled. This is a Fishermen-led initiative funded by NOAA's Marine Debris Program, and it has been so successful that the Dungeness Crab Task Force (a sub-set of the working group) have now voted to recommend legislation to create a

permanent state-wide crab gear retrieval program based on this model (Marine Debris Alliance 2016). Through the working group fishermen have also been trained in entanglement response and attended gear innovation workshops which many said had given them a real sense of inclusion and ownership over this issue, which contrasted markedly to what many east coast fishermen told me.

### **Canada**

Of the 17 known right whale deaths recorded along the east coast in 2017, 12 occurred in the Gulf of St Lawrence which was previously not considered core habitat for these animals (Taylor and Walker 2017). In response DFO announced the closure of part of the Gulf to snow crab fishing gear and put shipping speed restrictions in place in a bid to prevent further deaths due to ship strikes, the second main anthropogenic cause of death for these animals. Prior to 2017 Canada did not have any real measures in place to mitigate entanglement risk, and certainly none on par with work being done in the USA. However new gear regulations and trials have recently been announced for the 2018 snow crab fishing season. These include reducing the amount of floating line at the surface, better gear marking, mandatory reporting of lost gear, and a rope-less trial (DFO 2018).

### ***Aim 3 - To learn how those involved in and affected by entanglements are working together and communicating, and where and why this has and hasn't been successful.***

*"If you're not at the table you run the risk of being on it, so pull up a chair"*  
- Fisheries advocate, Massachusetts

As with any issue as contentious as whale entanglement where lives and livelihoods are potentially on the line, tensions can run high and clashes of opinions and politics are inescapable. If there is to be any hope of overcoming these, or at least reaching a point where these will be tolerated, *how* issues and topics are discussed, and *who* is involved in these conversations is vital to ensure free flow of information and to build trust and respect. To date in the USA and Canada, approaches to communications between those involved in and affected by whale entanglements in fishing gear have been mixed, with varying degrees of success.

### **Massachusetts**

On the east coast of the USA in particular, the issues surrounding whale entanglement and fisheries management appear to be a political and bureaucratic minefield, where a legacy of ineffective regulation has resulted in failures to communicate effectively and compromise willingly. Furthermore because there are conservation, economic and welfare implications associated with whale entanglements, the issue brings together an array of people from different factions whose priorities, opinions and values differ markedly. These include fishermen, researchers, policy makers and environmentalists who despite all sharing the same ultimate goal – to stop whales getting caught in fishing gear – have so far largely failed to come to any sort of consensus on how best to achieve this. Mistakes arguably made in haste due to the urgent need to protect the North Atlantic right whale from extinction, have led to a serious lack of trust and respect both between and now even within these groups, and is preventing the free exchange of information that may be crucial to solving the current entanglement crisis. For example under-reporting of entanglement events is a problem globally, resulting in uncertainties surrounding the true extent of this issue. In some cases this may be because people do not know how or who to report entanglements to, but in Massachusetts in particular regulations and legal actions around the issue have made fishermen hesitant to report entanglement events for fear of negative repercussions against them and their fishery. One lobster fisherman working out of Scituate told me that *"we're [fishermen] being encouraged to provide bad information because if I say 'oh yeah, I'm catching whales' then we'll all just get hammered with more and more restrictions and lawsuits. I don't want to catch whales, I*

*don't want to hurt them, I've complied with every regulation that's been thrown at us but I'm trying to earn a living here".*

The body that governs fisheries in the USA is the National Marine Fisheries Service (NMFS), a sector of the National Oceanographic and Atmospheric Administration (NOAA). NMFS is a department of commerce, responsible for governing a multibillion-dollar fishing industry. It also has responsibility under the Endangered Species Act (ESA) for ensuring the protection of marine mammals. The ESA states that the federal government (which includes NMFS) is forbidden from engaging in or granting permits for any activity that would place an endangered species in jeopardy, and so in the case of whale entanglement in fishing gear, there is an inherent conflict of interest (NMFS 2016b). This places NMFS staff between a rock and a hard place, trying to satisfy the economic interests of fishermen and fisheries managers, as well as the conservation concerns of wildlife protection groups and the law, but often it seems failing to please either side despite their best efforts (MacDonald *et al*, 2016). For example many of the fishermen I met during my time in Massachusetts were exacerbated by the number of regulations and gear restrictions that have been placed on them over the past 20 years by NMFS, in attempts to reduce the risk of whale-fisheries interactions (please see above). At the same time a group of wildlife protection organisations were filing a lawsuit against NMFS for not doing enough to protect whales from becoming entangled in lobster and other commercial fishing gear (Peek 2018).

The gear modifications and restrictions detailed in the previous section for US east coast fisheries were instigated by NMFS, following recommendations from the Atlantic Large Whale Take Reduction Team (ALW-TRT). The ALW-TRT was established in 1996 under the Marine Mammal Protection Act (MMPA) in response to the decline of right whales and other whale species. The TRT covers all commercial pot and gillnet fisheries from Maine to Florida and is composed of approximately 60 members from various stakeholder groups including fishers, environmental organisations, disentanglement teams, research centres and state and federal agencies. The immediate goal of the TRT is to, within six months of implementation, reduce whale bycatch to a level that allows whale stocks to remain viable. Long term the aim is to reduce bycatch to insignificant levels, or what is referred to as 'potential biological removal' (PBR). PBR is the maximum number of animals (excluding natural mortalities) that can be removed from a stock while still allowing maintenance of a sustainable population, and for North Atlantic right whales this is zero. To achieve this the team's mandate is to agree on and suggest regulations and actions to NMFS to reduce the incidental capture of whales in fishing gear through a take reduction plan. NMFS are not required to act on team suggestions, but the idea is to give stakeholders an equal say and to build trust and understanding between groups which in turn should minimise litigation. Unfortunately from what I learned the opposite has happened, and the TRT has instead fed conflicts and polarised members to a point where at a recent the TRT meeting, communications completely broke down (anonymous TRT member, pers comm. 14/10/2017). The TRT timeframes are viewed as unrealistically tight, and coupled with seemingly constant changes to regulations, fishermen in particular feel as though they are being set up to fail. Many I spoke with in Massachusetts felt it was *"regulation for regulation's sake, the Feds need to be seen to be doing something"*. However others were more accepting of the regulations and understood there was a need for industry-wide compliance.

### **California**

In California no TRT for large whales is currently in place and the fishermen and NOAA staff I met with were eager to avoid the formation of one. Fortunately humpback whales, the most common species reported as entangled, are increasing in population size along the west coast of the USA by 6-7% annually (NMFS 2016a). Therefore although there is still a lot of pressure to solve this problem from a welfare perspective, there is not a species at immediate risk of extinction requiring such a hard line approach. Instead the Dungeness Crab Fishing Gear Working Group was convened by the California Department of Fish and Wildlife in partnership with California Ocean Protection Council

and NMFS, to address the increase in large whale entanglements in crab gear (OPC 2016). The working group is composed of a similarly diverse range of stakeholder groups to the east coast TRT, but it is smaller with only 20 members. As discussed in the previous section the group have opted for best practise voluntary actions as opposed to compulsory measures, with members working collaboratively towards agreed goals. The members of the working group who I spoke with, some of whom had been working in their respective fields for over 40 years, all agreed that it was the best example they had seen of stakeholder groups working together in a constructive and open way. There seemed to be a genuine respect between members and empathy for their respective interests with one fisherman commented that *"I really feel good about this, the NOAA guys in the group they've really been outstanding, I really personally think we're lucky to have the opportunity to work with them like this"*.

Another progressive step currently being taken by the Working Group is an assessment of the relative risk of whale entanglement during the 2017/18 Dungeness crab fishing season through the adoption of a Risk Assessment and Mitigation Program (RAMP) pilot. This is a voluntary programme designed to identify and be responsive to elevated entanglement risk within the fishery, based on the following four factors - (1) delay to the season opening (the opening of the 2016/17 Dungeness crab season was delayed by four months due to high domoic acid concentrations which can pose a threat to human health); (2) foraging and ocean conditions, for example El Nino events and the location and abundance of whale prey such as krill and anchovies; (3) whale concentrations within the fishery area; and (4) rate of entanglements. The aim of this programme is to have flexible responses to each scenario prepared in advance, to allow fishing to continue uninterrupted while at the same time minimising the entanglement risk.

### **Canada**

In Newfoundland, I heard of no issues with under-reporting or of any major conflicts between stakeholder groups. This may be because until very recently Canadian fishermen have not faced the mandatory regulations or restrictions that their American counterparts have, and there have been no lawsuits involving whale entanglement. Therefore there is little reason for fishermen or others not to report entanglement events. In addition, the disentanglement teams I met from both Campobello and Newfoundland are both led by fishermen rather than federal staff or private conservation or research groups like some in the US. As a result these teams, though trained in similar ways and operating with the same level of skill, care and attention, are made up of familiar faces from within local fishing communities who understand how these fisheries operate. For example in Newfoundland the approach to entanglement adopted by John Lein in the 1970s and 80s and continued today by Wayne Ledwell and Julie Huntington has always been *'fishermen helping fishermen'*. As a result the Newfoundland team have successfully disentangled more whales than all other North American teams combined (W. Ledwell, pers comm 02/11/2017) and are highly respected within both the scientific and fishing communities. Tensions may well emerge this year following the implementation of new gear regulations recently announced by DFO, with more expected to be unveiled shortly in light of the high number of right whale deaths in Canadian waters in 2017.

### **Lessons learned and recommendations**

This report documents some of the measures currently being taken in the USA and Canada to address issues surrounding large whale entanglement in fishing gear. These nations have to date been far more involved in tackling this problem than Scotland, adopting a broad and comprehensive suite of actions and schemes with varying degrees of success. With 30 years of trial and error to draw upon, Scotland can and should now take valuable lessons from work done in the USA and Canada in how to, and how to not, tackle this problem.



My Fellowship had three main aims. These were to learn the latest and most effective methods of disentangling whales, to investigate the potential and effectiveness of modified fishing gears, deployment techniques and gear recovery initiatives to reduce the likelihood of entanglements occurring, and to learn how those involved in and affected by entanglements are working together to tackle this problem, and where and why this has and hasn't been successful. By spending time with disentanglement teams, fishermen, policy makers, whale advocates, researchers and fisheries representatives I was able to gain valuable and unique insights into the scientific, legal, cultural and political elements of whale entanglement. The key lessons learned and recommendations to emerge from this Fellowship are detailed below.

***Aim one: Methods of disentangling whales***

In regards to disentanglement, the make-up of the USA, Canadian and UK disentanglement teams vary, as does the amount of experience each has. However the UK teams are following the same procedures and protocols as their North American counterparts, in line with IWC guidelines and as per training received from CCS in 2007. As a result and from the training I participated in (*image 26*) and the discussions I had with disentanglement team leaders, I noted no major changes required to how the UK LWDTs operate once working on an entangled whale. Several relevant recommendations were made however. These include the following:

- Team members should familiarise themselves with all fishing gear types used in UK and neighbouring waters, including the components of this gear (ropes, buoys, pots/creels etc.) and the in-water configuration of how it is set. This will help inform initial assessments of entanglements, planning of disentanglements (e.g. what cuts to make), and subsequent efficient removal and repair of gear.
- Up-to-date databases of entanglement reports and summaries including timelines and any photos, video footage and sketches should be maintained and shared with the whole team, and be made accessible to other teams. This will allow for a thorough review of each case, feedback, and continued team development and improved understanding. Each team member involved in an entanglement response should also write up their own summary and evaluation to highlight any areas for personal development.
- Time and effort needs to be invested in forming and maintaining a solid network of contacts across regions. This network should include people and organisations likely to report entanglements, and/or be able to assist during disentanglement attempts by, for example, providing boat support or standing by an animal until the disentanglement team can be assembled. Contacts could include fishermen, local coast guard and life boat stations, Marine Scotland and other patrol vessels, harbour masters, ferries and boat tour operators. In Scotland one of the biggest challenges faced by the disentanglement team is geography, poor road infrastructure and unpredictable weather. However by having such a network, potentially training members of this in disentanglement techniques and equipping them with some basic tools, response times and the efficiency of disentanglement operations could be much improved.



*Image 26. On-water disentanglement team training in Long Beach, California with the NMFS Marine Animal Strandings and Entanglement Response Team and volunteers from local animal rescue organisations.*

The evolution and addition of tools to the disentanglement kit will be a continual process as long as disentanglements are necessary. With every event, teams globally are gaining more experience with how tools handle, under what circumstances they do and do not work, and adjustments required to ensure as far as possible human safety, animal welfare, and gear recovery. CCS are currently testing several modified tools and prototypes which may become available to others in the future. The UK LWDTs will maintain close communications with CCS as these develop, and as they gain more practical experience and familiarity with gear types most frequently encountered, tools here may too be modified or replaced.

All tools currently used by CCS and the other teams I met are designed for use mainly on entangled humpback and North Atlantic right whales. However in Scotland minke whales are a key species of concern. Much smaller and more delicate than other whales prone to entanglement, if used inaccurately some existing tools could cause injuries. Therefore if rates of reporting can be improved and an increase in live minke entanglements are received, UK disentanglement teams may wish to consider adapting existing tools to suit, for example by introducing smaller, lighter grapples. The main challenge to doing so will be cost and time available to test and become familiar with any new additions, as BDMLR are reliant on charitable donations and all members of the LWDT are volunteers.

### ***Aim two – Gear modifications***

Numerous fishing and gear modifications, restrictions and regulations have been introduced into US fisheries over the years in an attempt to mitigate whale entanglements, and several have recently been announced by Canada for the snow crab fishery. The effectiveness of these measures can be difficult to assess, and some such as the weak links have proved ineffective. Therefore if any gear modifications or changes to fishing practises are to be proposed or trialled in Scottish waters, lessons must be taken from other areas and the gift of hindsight utilised, to avoid repeating any mistakes. A thorough cost-benefit analysis of any changes must also be conducted, and if costs to individual fishermen are likely to be incurred, funding must be made available to support these. Some suggestions from fishermen, NMFS staff and conservation bodies regarding changes to gear and fishing practices included:

- Getting ahead of the problem - Fishermen I met in both California and Massachusetts suggested that their Scottish counterparts be encouraged and afforded the opportunity to get ahead of the entanglement problem, by implementing small low cost changes to their practises on a voluntary basis e.g. reducing line scope, adding weights to any remaining

floating lines, and reducing soak times. With appropriate media support and engagement this could demonstrate to regulators and the wider public that fishermen are recognising and concerned about this entanglement issue, and actively trying to minimise the risks. In turn this could stem any need for formal regulation and inspire fishermen to take ownership of the issue. Similarly, sponsored fishermen-led clean ups and collections of derelict gear could encourage greater awareness of the problem while at the same time lessening the amount of potentially dangerous gear in the water.

- Understanding the fishing industry you are dealing with. The more you learn about a fishery and the relevant conservation status of a species affected by this, the more sensitive and understanding you will likely be to the work and views of others, which in turn may better equip you to come up with solutions which protect both the fishery and species in question. One Dungeness crab fisherman told me that *“I try to be as easy going and as good a representative for the fishermen as I can be, and I want people to understand that we are custodians of the ocean and we’re not here to pillage and plunder it. This is our life and our home and our livelihood, this is where we live and it’s probably where we’ll die, and I don’t know how to express that so people can see it, unless I take them out and let them actually experience what we go through, even if it’s for a short burst, to see how we pick up gear...that we look out for the animals, that we want this to be around for a long time and that we know that this is finite if we mistreat it”*. Therefore members of any group involved in recommending changes within the Scottish (or any other) fishing industry in a bid to protect whales from entanglement should be required to spend time at sea on a fishing boat. This will give them the opportunity to really understand the at-sea operations of these vessels and their crews, how gear is deployed and retrieved, and the regulations these men and women are already adhering to. In addition any suggested changes to must be made in close consultation with fishermen, and tested by them as thoroughly as possible before being formally introduced to the industry, with adequate time allowed for feedback. Similarly, fishermen need to educate themselves on wildlife conservation law and legislation surrounding affected species.
- Setting realistic goals and timeframes for the implementation of gear modifications or regulation changes. It was strongly recommended by numerous people I met across all stakeholder groups that progressive efforts to gradually reduce entanglement rates are what is needed, rather than sweeping blanket measures or complex constantly-changing regulations. Recommendations and timescales to adopt these must be clearly defined and realistic, and the scale of any gear modifications or changes to fishing practices should reflect the capacity of fishermen at a regional level, and the resources available to implement these effectively. Expectation management is also crucial by all involved in or concerned with whale entanglements - this is not a problem that can be solved quickly. Setting intermediate targets can help with this, but work towards these targets must be appropriately monitored and reviewed, and ongoing development and improvements funded.

### ***Aim three – Communication***

Much like here in Scotland, many coastal communities in the US and Canada are built around their local fishing industry. Beyond an opportunity to earn a living, fishing is a way of life for many in these areas that contributes significantly to social cohesion and cultural identity. Therefore whale entanglement and any proposed strategies to mitigate this, if viewed as posing a threat to these fisheries, is a sensitive issue. However entanglement should not be viewed as a fishery versus whale issue. Simply put it is a case of lots of passionate people with varying levels of expertise and understanding in different areas, all trying to tackle the same problem and achieve the same ultimate goal – to stop whales becoming entangled in fishing gear. Reasons why people want to stop whale entanglement may vary, for example some may be primarily concerned with animal welfare

while others prioritise the threat to their livelihood. Regardless of their motivations however nobody I met with during my Fellowship wanted to close down fisheries, but failures in communication and a lack of understanding of other people's motivations had led to animosity and distrust. For example a series of lawsuits filed against states and federal bodies for failing to protect whales from entanglement in fishing gear have been viewed by fishermen as an attack on their industry, but everybody I spoke to during my Fellowship recognised that fishermen are the solution to this crisis, not the problem. Making this clear in Scotland will be key to tackling this issue, and many people were eager to share advice on how to keep relationships between stakeholder groups positive and engaging. This included:

- Presenting the problem in a non-targeted way. No-one wants to be or is deliberately entangling whales, and the finger cannot and should not be pointed in any one direction. This is a global issue which poses conservation, welfare and economic concerns, and no one fishery is in this alone. Therefore, it should be made clear that we are all in this together, and lessons can be learned from and shared around the world.
- Taking the time to really get to know and understand what drives people involved in and affected by whale entanglements. For example, understanding the psychology behind what motivates people to (or to not) report entangled animals is vital - what are their fears, goals and intrinsic motivations? What do people need to know that they don't know now? What do and don't they understand and what help do they require?
- Finding a common language and communicating where and in a way people are comfortable with. For example fishermen are more likely to feel relaxed and therefore perhaps speak openly on their boat or in their own home than they are in a board room. Different audiences may also communicate in different ways. Where some may be used to conference calls, emails and social media, others may prefer face-to-face meetings or receiving information through the post. This must be considered and different methods utilised to ensure inclusion.
- Selecting the right people to sit on working groups and lead stakeholder engagement activities and represent different interest groups. The political playing field surrounding whale entanglement is complex, and there will be individuals in each corner with their own agendas. Therefore people chosen to represent their stakeholder group must be well respected and trusted within their own field and be sensitive to the problems of others and the way they work, as well as capable of presenting information in a clear, concise and non-threatening manner.
- Trusting the science. Although the available data suggests that entanglement in fishing gear is a significant problem, some fishermen will never have seen or experienced this and therefore may be dubious. For example while I met some fishermen who had had whales caught in their gear on an almost annual basis, I also met fishermen who had spent over 30 years at sea and never encountered an entangled animal. These men questioned whether there really was a problem, therefore researchers must find ways to communicate the evidence in a tangible way.
- Keeping it simple. From what I learned about the processes of the ALW-TRT compared to other species TRTs and the Dungeness Crab Fishing Gear Working Group, the most successful and widely accepted mitigation measures were the ones that had been drafted by small teams, with simple, affordable and easy-to-follow regulations. In contrast, complex layers of regulations that are costly to implement and difficult to understand have served only to fuel frustrations and compromise the cohesiveness of groups involved.

## **Conclusion**

I undertook this Fellowship to investigate how the issues surrounding large whale entanglement in fishing gear are currently being tackled in the USA and Canada, with the aim of bringing information, ideas and a fresh perspective back to Scotland to aid in addressing the same problem here. What I learned was that while different approaches and attempts to mitigate entanglements have been adopted in different areas, this is a complex and highly emotive topic that extends far beyond science and policies. At the heart of it are a lot of people whose interests, motivations and beliefs around this issue differ, but who also have a lot in common. The fishermen, whale advocates, policy makers, engineers, disentanglement team members and fisheries managers I met were all thoughtful and steadfast in their convictions, and passionately devoted to their own line of work. They had also all invested time and energy into solving this matter, were hopeful that a resolution would be found, and fearful of the consequences if one were not.

Finding a solution to whale entanglement in fishing gear that will allow fisheries and whales to co-exist in an ecologically and economically sustainable way will require a concerted effort from multiple agencies, organisations and individuals who will all need to adapt and compromise. Here in Scotland we can now learn from the successes and failures in other areas and use these to guide our own approach to this with a clean slate, which in turn may inspire others and contribute to the survival of whales and fisheries both here and further afield.

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## **Appendix 1. Fellowship itinerary**

### ***25<sup>th</sup> September – 1<sup>st</sup> October 2017***

My trip began in the Monterey Bay National Marine Sanctuary (MBNMR), a federally protected marine area off California's central coast. The sanctuary encompasses 276 miles of shoreline and 6,094 square miles of ocean and is home to 34 species of marine mammal including humpback, fin, blue, gray and killer whales. The MBNMS was established for the purpose of resource protection, research, education and public use. Commercial fishing and recreational activities like diving, kayaking, boating and surfing are widespread, and whale watching is a growing industry within the sanctuary.

During my time in this area I stayed with Peggy Stap, Founder and Executive Director of Marine Life Studies ([www.marinelifestudies.org](http://www.marinelifestudies.org)). Peggy is also the founder of the Whale Entanglement Team (WET) for central and north California, directed under the authority of the National Oceanic and Atmospheric Administration (NOAA) Marine Mammal Health and Stranding Response Program. During the four days I spent at sea with Peggy and members of her team operating under a NOAA research permit I was able to gain experience in various methods of data collection including fin, fluke and entanglement scar ID imagery, documenting the position of derelict fishing gear for retrieval, and recording whale behaviours. The Marine Life Studies research and patrol vessel has on board a full disentanglement kit, and so I was also able to see and handle some of the tools that have been added to and/or modified from those currently in the UK kit. I was also able to experience first-hand the process of reporting, documenting and launching an entanglement response. As well as spending time at sea with Peggy and her team I also travelled to San Francisco to meet with members of the Dungeness Crab Fishing Gear Working Group ([www.opc.ca.gov/whale-entanglement-working-group](http://www.opc.ca.gov/whale-entanglement-working-group)). These included two Dungeness crab fishermen who have been involved in the working group since it began. In addition to conforming with federal regulations on fishing seasons and gear marking, these men have also played a huge role within their own communities, using their experience and initiative to implement a host of practical voluntary measures and best practises to further reduce the risk of whales becoming entangled in their fishing gear. Also on the Working Group is Kathi Koontz, who has formed a very close working relationship with these fishermen as a founder of the California Whale Rescue (CWR) network, which aims to organise, unify, and advance the entangled whale response network in California, with a focus on prevention and safety ([www.cawhalerescue.org](http://www.cawhalerescue.org)). By chance I met Tiff Thomas, a long-standing active member of the Hawaiian Islands Disentanglement Network ([www.hawaiihumpbackwhale.noaa.gov/res/rescue\\_network](http://www.hawaiihumpbackwhale.noaa.gov/res/rescue_network)). Speaking with Tiff was very interesting as although every NOAA-approved disentanglement team follows the same IWC protocols, each operates slightly differently depending on the area they cover, species they most commonly encounter, the make-up and individual expertise of their team, and the community they operate within. I also had ad-hoc conversations with several fishermen fishing within the MBNMS, whale watch boat captains and naturalists who are part of the entanglement reporting network, and also spent time on board several fishing vessels to learn more about their operations and experiences in whale entanglement.

### ***1<sup>st</sup> – 6<sup>th</sup> October 2017***

From Monterey I travelled down the coast to Long Beach. Here I spent five days with the NOAA NMFS team ([www.fisheries.noaa.gov](http://www.fisheries.noaa.gov)), two of whom also sit on the Dungeness Crab Fishing Gear Working Group. Within NMFS there is a Marine Animal Strandings and Disentanglement Team led by Justin Viezbicke, who cover an enormous geographical area and have been leading responses to a record number of whale entanglement reports within this in recent years. During my time there I sat

in on a number of team meetings and briefings with the NMFS and Protected Resources divisions. Outcomes of the most recent Dungeness Crab Fishing Gear Working Group were discussed at length, as were reviews of safety protocols for whale disentanglements, and future proposed regulatory steps. I attended a classroom-based disentanglement training event and completed a day of on-water training with Justin and his team, which offered a great opportunity to observe how this team functions in comparison to the UK team, further review safety protocols, and practise key skills needed to perform safe and efficient whale disentanglements. I also had a lengthy video call with Pieter Folkens, co-founder of the Alaska Whale Foundation and California Whale Rescue, and a level 4 whale disentanglement leader for NMFS. Pieter has over 20 years' experience in large whale disentanglement and shared his expert knowledge and insights with me, offering advice and information on best practise and the importance of public education and fisherman involvement in entanglement responses.

### **6<sup>th</sup> – 21<sup>st</sup> October 2017**

For the next two weeks I was based at the Center for Coastal Studies ([www.coastalstudies.org](http://www.coastalstudies.org)) in Massachusetts, a private non-profit institution with a focus on marine mammal conservation and research. My main contact here was Scott Landry who directs this Marine Animal Entanglement Response (MAER) program. Scott and his team are currently the only full-time entanglement response team in the world. He trained with David Mattila and Stormy Mayo (two of the original and still-active leaders of disentanglement efforts globally) and has been part of the southern New England Disentanglement team since the 1990s. Scott also coordinates and trains responders for the Atlantic Large Whale Disentanglement Network ([www.iwc.int/entanglement-response-network](http://www.iwc.int/entanglement-response-network)) and has co-authored numerous peer-reviewed publications on humpback and right whale conservation. During my time at CCS I participated in a response to a humpback whale entanglement in Cape Cod Bay on board CCS's research and response vessel, and undertook training with each member of the team.

Out-with Scott's team I met with Charles 'Stormy' Mayo who co-founded CCS in 1976. Stormy's ancestors hunted whales and he appropriated certain whale hunting techniques (e.g. 'kegging') to perform the first successful disentanglement of a free-swimming whale in 1984. He is currently a Senior Scientist and Director of the ecology department where he oversees right whale biology and habitat research, and has witnessed first-hand how the nature and frequency of whale entanglements have changed over several decades ([www.coastalstudies.org/whale-rescue](http://www.coastalstudies.org/whale-rescue)). I also met with Owen Nichols, Director of marine fisheries at CCS. Owen's primary research interests include marine mammal/fishery interactions and ecosystem-based fishery management. Owen has led a number of very successful research projects within the Cape Cod Bay area, working in close collaboration with local fishermen.

Away from CCS I met with Michael Moore, a Senior Scientist and Veterinarian at the Woods Hole Oceanographic Institution ([www.whoi.edu](http://www.whoi.edu)). His research interests include forensic analysis of marine mammal mortalities, interaction of natural and man-made impacts on fish and marine mammal stocks, and the development of systems to enhance medical intervention with large whales and marine animal welfare standards. I also met with Jim Partan, an Engineer at Woods Hole who together with offshore shelf fishermen in the Gulf of Maine has developed a prototype for an on-call or 'ropeless' buoy system. Jim demonstrated his design which in the future may offer a way of reducing the amount of vertical rope in the water associated with lobster and crab pot fishing, therefore lowering the risk of whale entanglements in this gear type ([www.bycatch.org/sites/default/files/Partan%26Ball\\_2016.pdf](http://www.bycatch.org/sites/default/files/Partan%26Ball_2016.pdf)).

Other meetings during my time in this area included with Brian Sharp of the International Fund for Animal Welfare ([www.ifaw.org](http://www.ifaw.org)) who is a NOAA Level 5 responder authorised to disentangle all whale species within US waters, and who has a close relationship with the UK LWDT. We discussed

his current and past work involving large whale strandings and entanglements, and I was able to assist his team during a mass stranding of common dolphins on the Cape. I spent an afternoon with Regina Asmutis-Silvia, Executive Director and Senior Biologist for Whale and Dolphin Conservation ([www.whales.org](http://www.whales.org)). Regina has been active in whale research, conservation and education since 1990 and currently sits on the federally appointed Atlantic Large Whale, Harbour Porpoise, and Atlantic Trawl Gear Take Reduction Teams. I also met with Beth Casoni who is the Executive Director of the Massachusetts Lobstermen's Association ([www.lobstermen.com](http://www.lobstermen.com)), a member-led organisation that helps state lobstermen meet the challenges they face and conserve the resource on which they depend, and spent time with several lobster fishermen who took me out fishing and showed me some of the gear modifications and markings that they are now required to use. I also spoke with Kate Swails, a NOAA marine mammal policy analyst who coordinates the ALW-TRT, and David Morin, a NOAA Biologist who coordinates the Atlantic large whale disentanglement network. Finally I attended the Greater Atlantic Regional Strandings Conference and presented on the work of BDMLR and SMASS, two organisations I volunteer with in Scotland that respond to, rescue and collate information on stranded, entangled and distressed marine mammals around the UK.

### **22<sup>nd</sup> – 28<sup>th</sup> October 2017**

On 22<sup>nd</sup> October I attended the annual North Atlantic Right Whale Consortium in Halifax, Nova Scotia ([www.narwc.org](http://www.narwc.org)). Right whales, particularly in Canadian waters, have been hit devastatingly hard this year by ship strikes and entanglements. These were the main topics of discussion at this meeting with presentations from various researchers and whale disentanglement teams, and a Q&A session involving the aforementioned as well as fishermen, shipping representatives and engineers. I spent the rest of this week at the Society for Marine Mammalogy Biennial Conference ([www.marinemammalscience.org/conference](http://www.marinemammalscience.org/conference)). Here I met with Ed Lyman who is the Hawaiian Islands Humpback Whale National Marine Sanctuary's Resource protection specialist ([www.hawaiihumpbackwhale.noaa.gov/res/rescue\\_network](http://www.hawaiihumpbackwhale.noaa.gov/res/rescue_network)). Ed also coordinates a community-based entanglement response network and assists NOAA Fisheries to coordinate entanglement responses in Alaska and along the US west coast. I also met with Jamison Smith who is the Atlantic whale entanglement response co-ordinator with NOAA Fisheries for the US eastern seaboard ([www.greateratlantic.fisheries.noaa.gov/protected/stranding/disentanglements/whale/alwdn](http://www.greateratlantic.fisheries.noaa.gov/protected/stranding/disentanglements/whale/alwdn)), and David Mattila who coordinates both the expert panel and the global whale entanglement response network through IWC ([www.iwc.int/entanglement-response-network](http://www.iwc.int/entanglement-response-network)), and manages the entanglement capacity building programme which delivers entanglement training workshops globally. Others I met included members of the Campobello Whale Rescue team ([www.canadianwhaleinstitute.ca/campobello-whale-rescue-team](http://www.canadianwhaleinstitute.ca/campobello-whale-rescue-team)) and numerous leading whale biologists and researchers whose work in recent years has focussed largely on the threats and consequences surrounding whale entanglement including Amy Knowlton, Julie van der Hoop, Tim Werner and Scott Kraus. On the last two days of the conference I attended workshops led by David Mattila and Brian Sharp. David's focussed on marine mammal bycatch and entanglements in global fisheries and measures for capacity-building within communities to address these, while Brian's focussed on live large whale strandings.

### **29<sup>th</sup> October – 3<sup>rd</sup> November 2017**

After the conferences in Halifax I flew to Newfoundland where I spent my last week with Wayne Ledwell and Julie Huntington of the Whale Release and Strandings program ([www.newfoundlandlabradorwhales.net](http://www.newfoundlandlabradorwhales.net)). Wayne and Julie have successfully released hundreds of

entangled whales and built up strong and trusting relationships with the Newfoundland fishing community. Wayne and Julie's operation differs from others in that they offer fishermen an 'assistance program', sharing the attitude that this is their gear, their whale and therefore their problem to solve and story to tell. This combined with a commitment to repair and return as much gear as possible to fishermen affected by whale entanglements has allowed them to gain respect widely. Wayne has designed a number of his own cutting tools specific to the gear he encounters most frequently on whales, and shared his unique insights and skills in this area as both a fisherman and a disentanglement team leader.