Disentangling a Whale of a Problem

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Winston Churchill Travelling Fellowship
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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
- 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 UK citizens to travel overseas to learn about inspiring practises adopted by other countries to address a wide range of issues, and then return home 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 creel fishery.

Whale entanglement in fishing gear is a growing concern not just here in the UK, but globally, and my interest in this particular problem developed though 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 both a commercial and scientific diver here 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 offshore renewable developments, particularly on marine mammals and fisheries. I have also worked for several marine wildlife conservation charities and trusts in roles focussed largely on environmental education, species protection, and community conservation and empowerment. I currently volunteer as a marine mammal medic and area co-ordinator with British Divers Marine Life Rescue (BDMLR), and volunteer with the Scottish Marine Animal Strandings Scheme (SMASS). I am also a member of the UK’s Large Whale Disentanglement Team (LWDT).
Introduction

Entanglement in fishing gear poses a threat to marine mammals and fishers wherever the two overlap, with 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

Here in Scotland our 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 waters 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). Our inshore waters are also valuable creel fishing grounds where fishermen target prawns, crab and lobster year-round (Kafas et al, 2017). There are an estimated 1100 creel boats currently operating within the industry, which not only contributes significantly to the national economy but also forms the backbone of many small communities (Scottish Government 2014; Kafas et al, 2013). Creel fishing is recognised as a very sustainable industry, with minimal bycatch or impact on the seafloor (SCFF 2017). Unfortunately however, with thousands of miles of rope associated with the Scottish creel fishery in inshore waters at any given time, whales can and do come in to contact with 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 of even years. Depending on the configuration of an entanglement this 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).

Entanglement in creel lines is the single largest cause of death of minke whales (Balaenoptera acutorostrata) in Scottish waters, accounting for up to 40% of known mortalities (HWDT 2017). Work conducted by the Hebridean Whale and Dolphin Trust (HWDT) also suggests that at least 20% of minke whales in Scottish waters bear entanglement scars (HWDT 2017). A 2016 report submitted to the International Whaling Commission (IWC) suggests that Scottish inshore waters may not be able to support a sustainable population of humpback whales (Megaptera novaeangliae) due to the risk posed by entanglement in creel lines (Ryan et al, 2016), and in more than half of post mortems conducted on baleen whales around Scotland, entanglement in fishing gear has been concluded as the cause of death (Northridge et al, 2010). In recent years other species including a killer whale (Orcinus orca) and a northern bottlenose whale (Hyperoodon ampullatus) have also died as a result of entanglement in gear associated with the creel industry (SMASS 2017). Dr Andrew Brownlow, lead Veterinarian with the Scottish Marine Animal Strandings Scheme (SMASS) recently commented that “from the evidence we are seeing through strandings, 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 be 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”.

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As well as the conservation and welfare concerns surrounding entanglements, the economic cost of these events to fishermen can be substantial. The creel fishing industry is largely made up of small vessels (under 15m) 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 with it 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 also required under the Habitats Directive to establish systems for monitoring incidental takes of all cetaceans and implement measures to ensure that these do not have a significant negative impact on the species concerned. Further measures to monitor the status of habitats and species of interest 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 bycatch numbers remains poor. This is partly because regulations and monitoring programmes only cover a small proportion of the EU fishing fleet and exclude many geographic hotspots and fisheries with suspected high levels of by-catch such as the Scottish creel fishery (Dolman et al, 2016; Northridge 2011). What the limited data does indicate however is that bycatch is a conservation concern for minke and humpback whales in creel lines in the North Eastern North Atlantic (Dolman et al, 2016, Northridge et al, 2010).

As a signatory to the IWC the UK is obliged to report incidental bycatch of whales in its fisheries to inform accurate assessments of total killings over time, and set catch limits set for neighbouring whaling nations. 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 included *all* large whale species entangled in fishing gear (D. Mattila, pers. comm 28/10/2017).

Aside from the legislation, some practical measures have already 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 equipment (PPE) including helmets, life jackets and gloves form part of the kit, as does a helmet mounted GoPro for documentation. A satellite telemetry buoy together with a transmitter and vhf receiver unit is also included. 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 found again 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.
Following a refresher course in 2012 the UK team developed their 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.).

In conjunction with the LWDT, BDMLR has 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 conservation groups to produce a booklet and wallet card for fishermen that includes 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.).


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Image 4. available to download at 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 to date 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 and affected stakeholder groups, as well as research to assess the full extent of this problem in UK waters. The aims of this project therefore are as follows:

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 whales is vital. However these rescues can be dangerous and stressful events, 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 they are learning new skills, perfecting their techniques and modifying their tools.

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 is 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 will accompany researchers, fishermen and disentanglement teams at sea to better understand the details of their work. I will conduct 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 will also participate 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 for this Fellowship because this is where whale disentanglement began, and where much of the research and 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 easily and safely. They also developed a tool kit and protocols for disentangling these animals that are still used today. Stormy has since disentangled hundreds 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 this he 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 helps to coordinate and train responders for the Atlantic large whale entanglement network. The CCS MAER team is unique in that they are the only full-time response team in the world. They 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.

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 gill 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 Stranding Group (images 7 and 8.). The core aims of this program are to assist fishermen to free entangled whales and 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 in Newfoundland and Labrador. I spent the last week of my Fellowship with Wayne and Julie and gained a thorough insight into their unique and very successful programme.
My Fellowship coincided with a critical time for whale entanglement in both the USA and Canada. In 2016 record numbers of entangled whales were reported off the west coast of the USA. 48 of the 71 reports received were confirmed, which is the highest annual total since recording of these events began in 1982 (NOAA Fisheries 2017). Most were humpback whales but blue, grey and killer whales were also confirmed as entangled. Along the east coast of the USA and Canada, 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). 12 of these deaths occurred in the Gulf of St Lawrence and as a result, the Canadian government is now being forced to take action to better protect these whales, with new measures to attempt to do so only recently announced.

These entanglement events have highlighted the mitigation measures in place that haven’t worked, drawn new focus and attention to those that might, and encouraged fresh and innovative thinking. During the summer of 2017 protocols for disentanglement attempts were also revised following the tragic death of Joe Howlett. Joe was a Fisherman and founding member of the Campobello Whale Rescue team in Canada and 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 government research vessel, Joe was struck by the whale and killed. Since then the Department of Fisheries and Oceans (DFO) have implemented a revised protocol to be followed by disentanglement teams, which has proved controversial by disallowing any attempts to disentangle endangered right whales.

**Fellowship Findings**

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

“Disentanglement is a crutch that’s been leaned 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 assessment 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, and as such the UK LWDT follows the IWCs principles and guidelines for large whale entanglement response efforts (IWC 2018). Since the UK received initial training in 2007, the CCS team has 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 as a team.

- **Modified tools**
  Although the basic tool 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 the 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 tail flukes and/or flippers). 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 and Julie’s basic disentanglement kit is very simple, consisting of a long and a short boat gaff, a fillet knife, and a mask and snorkel. Wayne chooses not to use the knives
designed by CCS because whereas the CCS team are dealing mainly with whales entangled in ropes associated with lobster and crab fisheries, in Newfoundland he is more frequently encountering whales anchored in a mix of netting and ropes (image 13.). Therefore Wayne has designed his own bespoke knives capable of cutting through a mixture of gear types (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 some kits that are currently being used in large whale disentanglement attempts. The first is a spring-loaded knife (*image 15*, Moore *et al.*, 2013) which is being employed by some US disentanglement teams. This knife is used when entangling ropes are embedded deep into an animal’s skin and therefore cannot be reached using standard knives. These are an invasive tool mounted on handheld poles 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 to the whale disentanglement tool kit is 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 shot from a cross bow, with four interchangeable razor blades. 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)

![Image 16. A goblin guillotine.](image)

• **Drones**
The use of drones or unmanned aircraft systems are an emerging tool in conservation research and data collection (Pirotta *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 for the whale. During my Fellowship I asked a number of 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.*) where others, while appreciative of their value in other areas of conservation research and data collection, questioned the practicalities of using drones in whale entanglement responses.

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

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entangled whales can be located and tracked quickly and easily.</td>
<td>Use of drones in disentanglement attempts under federal permits will require yet more layers of licensing and red tape.</td>
</tr>
<tr>
<td>Known entanglement hotspots can be monitored in real time.</td>
<td>An additional team member operating from a separate boat with the appropriate permissions and skills is required to pilot a drone.</td>
</tr>
<tr>
<td>With the correct equipment high resolution imagery can be uploaded and shared in real time with authorities and advisors.</td>
<td>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.</td>
</tr>
<tr>
<td>Initial assessments of animal health, gear type and entanglement configuration can be made without the need for close vessel approaches, which limits disturbance and stress levels of the animal.</td>
<td>When an animal is anchored or towing a lot of gear, much of that gear is weighted underwater and so footage received from aerial drones may give a false sense of the extent and complexity of an entanglement.</td>
</tr>
</tbody>
</table>

- **Tags**

Attached to entangled whales and used to track their movements, telemetry buoys are an important but expensive and cumbersome element within the disentanglement tool kit. Approximately three quarters of entangled whales reported are lost because they cannot effectively be tracked, and/or because those reporting are unable to stand by an animal until a response vessel can reach it. However in California work is currently ongoing with technology developers to design an alternative tag which is smaller and more affordable. The idea is that these tags could be supplied to fishermen and patrol vessels who with training could attach these to entangled whales, thereby eliminating the need for reporters to stand by, and increasing the number of entangled animals that can 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 1980s 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 bulk of successful disentanglement work is really down to 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 potentially 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, e.g. 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 recover fishing gear removed from a whale, at the least try to secure this and take a GPS so it can be collected later and returned to the fisherman it belongs to. Again this will help build positive relationships.

**Aim 2 - To investigate 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 disentanglement team member will tell you this is not a solution to the problem. Some argue it is a crutch that has been leant on too long by governments and authorities as a conservation measure, and that it is a dangerous and expensive business. 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, many had made adjustments to this and the way they fished to try and minimise the likelihood of it happening again, and all were fearful of an uncertain future.
and the possibility of more regulations and limitations, or worst-case scenario total closure of their fishery. For both states I visited (California and Massachusetts) the issue of whale entanglement has been thrown into the spotlight more than ever before in the last three years. In 2015 and 2016 an unprecedented number of whales were confirmed as entangled along the coasts of California and neighbouring states, and in 2017 17 North Atlantic right whales, a critically endangered species teetering on the edge of extinction, died as a result of entanglements and ship strikes off the east coast of Canada and the USA. Of the surviving right whales, it is estimated that 83% have entanglement scars, and 26% gain new scars each year (Kraus et al, 2016). In an attempt to save this species by reducing the risk of entanglement, 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 would fish single traps, where each trap or pot was set individually and all had a vertical line leading to the surface. 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 for the same number of traps (NOAA 2017).

- **Sinking ground lines** – The use of floating ground lines in trap fisheries in Massachusetts has been banned, and instead sinking ground lines are now mandated to reduce the amount of excess line floating in the water column which could snare whales. To facilitate this 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 line, the scheme aimed to help alleviate the financial burden for fishermen of complying with gear regulations designed to tackle entanglements. 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 retrieved from an entangled whale, it can be identified both to a fishery and a geographic area. Traps carry unique identification tags in order to be legal which indicate the state, year, and area where the gear is allowed to be fished (image 20). Buoy lines are also required to be marked at the top, middle and bottom sections of the lines 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 entangled (image 21).

• **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 weak 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. Instead whales should be able to break free of gear at these weak points, therefore minimising the damage to themselves and the entangling fishing gear.

![](image22.png)

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

• **Reduced breaking strength ropes** – A lot of work is currently being done 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 (as opposed to current widely used ropes with an average breaking strength of over 2500 lbs), the number of life threatening large whale entanglements could be reduced by as much as 72%. These ropes would still be capable of withstanding the forces routinely involved in day-to-day fishing operations, while also allowing whales to break free of these should they become caught *(Knowlton et al, 2015)*. The introduction of RBS ropes to fisheries could in theory achieve nearly all of the mitigation legally required for US stocks of North Atlantic right and humpback whales, and it has been recommended that RBS ropes be made mandatory within four years, with a move to ropeless 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 within the bay of endangered right whales. 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 predict. In 2017 for example the Cape Cod bay closure was extended by a week because the whales stuck around longer than expected, which impacted fishermen by shortening the window they have 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 in collaboration with the Consortium for Wildlife Bycatch Reduction (NEAQ. 2017) for use in lobster and other static trap fisheries. 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 their gear, an 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. However the design is modular and therefore can be scaled to different fishing environments. Not only could this system protect whales from entanglement by removing vertical lines from the water column, it would also protect fishing gear from being damaged in entanglement events by keeping it out of the way of passing animals. But whether this system could work is reliant on three things. The first is Fishermen’s willingness to adopt a ropeless system, which would require both a huge shift in thinking and incentives such as opening up areas currently closed to fishing, but only to those using rope-less gear. Secondly the system must be affordable both to purchase (possibly through gear exchange programmes) and maintain. Thirdly, local businesses must exist and be supported to manufacture, sell and maintain the gear and specialist parts required. Most of the fishermen I spoke to on the east coast had heard of the ropeless system, and while some were skeptical others were intrigued, and more still were so exacerbated with current regulations they were willing to give it a go. 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, be the answer the whale entanglement crisis while at the same time ensuring fishing remains practical and economically viable.

*Image 23.* An illustration of the ropeless 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*). *Image 24.* The ‘on-call’ spool prototype currently being tested.

The gear modifications and restrictions detailed above have had mixed reactions. Many fishermen I met felt that these changes had not been sufficiently consulted on or trialled before becoming mandated, which had created animosity within the industry. For example both fishermen and
disentanglement teams state that weak links are not working as these are frequently being removed unbroken from entangled whales (S. Landry, pers. Comm 19/10/2017). These fishermen also begrudged the costs and time incurred to comply with these regulations without any ongoing financial assistance, and felt that they were being held over a barrel – comply or lose your licence. However it is very difficult to test these measures in advance of implementing them as many can only be tested for no effect rather than effect, but one researcher who has been involved in designing and trialling various gear modifications told me that (and his sentiments were shared by many others) “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”.

**California**

On the west coast of the USA whale populations are largely considered healthy, for example humpback whale numbers are increasing (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 as entangled, and so although there is not the conservation threat of the right whale as on the east coast, there are still significant welfare concerns for the animals at risk. In response to this spike in entanglements, rather than follow the east coast’s example of implementing closures, new regulations and gear modifications, federal staff, fishermen, conservation representatives and others formed the Dungeness Crab Fishing Gear Working Group in 2015. Following discussions the group opted to recommend voluntary best practice actions which they believed would be a viable first step towards reducing whale entanglements (image 25.). These recommendations include 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.

Another collaboration I learned about during my time in California was an initiative to remove derelict fishing gear from fishing grounds along the west coast of the USA. This buy-back scheme allows fishermen to earn money outside of the fishing season, by hauling gear lost or abandoned after the fishing seasons close. Fishermen are paid for every pot or trap they return, and the owner of that gear can then buy it back for a fee which is much lower than the cost of buying new pots. 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 told me gave them a real sense of inclusion and ownership over this issue, which contrasted markedly to what many East coast US 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, Canada 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 the entanglement risk, and certainly none that were on par with work done the USA. However new gear regulations and trials have just been announced for the 2018 snow crab fishing season. These include reducing the amount of floating line at the surface, better gear marking and mandatory reporting of lost gear (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 in fishing gear, where lives and livelihoods are potentially on the line, tensions can run high and clashes of egos, personalities, and politics are inescapable. If there is to be any hope in overcoming these, or at least reaching a point where these will be tolerated, how issues and topics are discussed, and who is involved in this is vital to ensure free flow of information, team work, 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. Clashes of personalities and a legacy of ineffective regulations have resulted in failures to communicate effectively and compromise willingly. Frustrations have arisen because whales are, much like the sea, a shared resource and because there are conservation, economic and welfare implications associated with whale entanglements in fishing gear, 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. There is a much greater sense of urgency to solve this problem on the east coast compared to the west due to the critically endangered status of the North Atlantic right whale (Kraus et al, 2016). On a positive note this situation is pushing fishermen, researchers and engineers to really think outside the box and come up with innovative solutions to allow both fisheries and the surviving right whale population to remain viable. But mistakes, arguably made in haste, have led to a serious lack of trust and respect both between and now even within these groups.

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. 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 busy 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 a group called 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 declining numbers of right whales and other whale species. The TRT covers all commercial fisheries using pot and gillnet gear from Maine to Florida, and is composed of approximately 60 people from various stakeholder groups including fishermen, environmental organisation representatives, disentanglement team members, marine mammal researchers and state and federal government representatives.

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 ultimate aim is to reduce bycatch to insignificant levels, or what is referred to as ‘potential biological removal’ (PBR), which is the maximum number of animals (excluding natural mortalities) that can be removed while still allowing that stock to maintain a sustainable population. For North Atlantic right whales PBR 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 and in turn, 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 in 2017, communications completely broken 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 felt as though they are being set up to fail which has created a lot of animosity. 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 all 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 in 2015 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. 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 largely opted for best practise voluntary actions as opposed to compulsory measures to date, 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 ever seen of stakeholder groups working together in a constructive and open way. One fisherman commented that “I really feel good about this, the NOAA guys in the group are such cool people and they’ve really been outstanding, I really personally think we’re really lucky to have the opportunity to work with them”. There seemed to be a genuine respect between members and empathy for their respective interests.

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 which opened in November, through the adoption of the 2017-18 Risk Assessment and Mitigation Program (RAMP) pilot. This is a voluntary program designed to identify and be responsive to elevated entanglement risk in 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 demoic 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 program 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.

At present in some areas of the USA a lack of trust largely between fishermen, regulators and whale advocacy groups may potentially be killing whales, by preventing the free exchange of information that might 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, fishing regulations and litigation have made fishermen in particular hesitant to report entanglement events for fear of negative repercussions against them and/or their fishery. In Massachusetts 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’d 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”.

Canada

In stark contrast, north of the border 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 DFO have been more ‘hands-off’ and as such Canadian fishermen have not faced the mandatory regulations or restrictions that their American counterparts have, and there have been no lawsuits involving whale entanglement. With this perceived threat removed from the equation, there is little
reason for fishermen or others not to report entanglement events. In addition, the disentanglement teams I met from Campobello and Newfoundland were both led by fishermen rather than federal staff or conservation groups like some in the US. As a result these teams, although trained in similar ways and operating with the same level of skill, care and attention, are not viewed as intimidating or threatening. Instead they are familiar faces from within the local community, who understand how these fisheries operate and tailor their protocols specifically to the area in which they work. For example in Newfoundland, the approach to entanglement adopted by John Lein 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 they 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 and the death of Campobello disentanglement team member Joe Howlett. Or perhaps not, if channels of communication remain open and free exchange of advice and ideas is encouraged.

Lessons learned and recommendations

This report documents measures currently being taken in the USA and Canada to address the 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 measures and schemes to reduce this threat 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 - 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 in to 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 differ, 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 and the discussions I had with disentanglement team leaders, I noted no major changes required to how the disentanglement team operates once working on an entangled whale, however several relevant recommendations were made. These included that:

- Team members should dedicate time to familiarising 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 the disentanglement (e.g. what cuts to make), and subsequent efficient removal 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, of people and organisations who may be 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 local Coast Guard and Life Boat stations, Marine Scotland and other patrol vessels, fishermen, 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, and 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.

• Love the kit! Tools aren’t cheap to replace.

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 disentanglement event, teams globally are gaining more experience with tools, how these handle, under what circumstances these do and don’t work, and adjustments required to ensure as far a possible human safety, animal welfare, and gear recovery. CCS are currently testing several modified tools and prototypes, which depending on the outcomes of these tests, may become available to other teams in the near future. The UK teams will maintain close communications with CCS as these tools develop, and as the teams here gain more practical experience in using existing tools 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 humpback and North Atlantic right whales, however in Scotland minke whales are also a species of concern. Much smaller and more delicate animals than other whales prone to entanglement, if used inaccurately some existing tools could injure entangled minkes. Therefore if rates of reporting can be improved and an increase in live minke entanglement 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 is gear modifications or changes to fishing practises are to be trialled and/or introduced 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 significant 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 and financial support to get ahead of the entanglement problem, by implementing changes to their practises on a voluntary basis e.g. reducing line scope, adding weights to any remaining floating lines, and reducing soak times. These modifications are cheap or free and take little time to instigate. With appropriate media support and engagement, they also demonstrate to regulators and the wider public that fishermen are recognising and concerned about this entanglement issue and are actively trying to minimise the risks. In turn this could stem any need for formal regulation and inspire fishermen to think of other measures that may further reduce the risk of entanglement by giving them a sense of ownership of the issue. Similarly 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 and pressure to make any formal or untested changes.

- **Really understanding the fisheries and the fishing industry you are dealing with.** Any members of disentanglement teams, regulators, fisheries managers, whale advocates or researchers involved in testing, recommending or enforcing changes within the fishing industry should be encouraged or even required to spend time on a fishing boat to really understand the at-sea operations and how gear is deployed and retrieved, and the regulations these boats are already working to. Any suggested changes to fishing gears or regulations must also 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 and modifications. Similarly, fishermen need to educate themselves on wildlife conservation law and legislation. The more you learn about a fishery or the relevant legislation or conservation status of a species at risk, the more sensitive you will be towards the work and views of others and the better equipped you will be to come up with solutions. For example 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 that, 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 don’t throw garbage out, that we want this to be around for a long time and that we know that this is finite if we mistreat it.”
• Setting realistic goals and timeframes for the implementation of any gear modifications or changes to fishing regulations. 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, and recommendations and timescales to adopt these must be clearly defined and realistic. Rather than sweeping blanket measures or complex constantly-changing regulations, 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 in a year. Setting intermediate targets can help with this, and work towards these targets must be appropriately monitored, data regularly reviewed and ongoing development and improvements funded.

Aim three – Communication
During my Fellowship I learned about and witnessed examples of how different groups and individuals involved in and concerned with whale entanglement communicate, and where and why this has and hasn’t been successful. Much like here in the UK, many coastal communities in the US and Canada are built around fisheries and beyond an opportunity to earn a living, fishing is a way of life for many that contributes to social cohesion and cultural identity within these. Some attempts to tackle the problem of whale entanglement and steps taken to force the issue have been viewed by some as an attack on fisheries, and led to hostilities and a lack of trust both within and between factions. However entanglement is not a fisheries versus whale issue. Simply put it is a case of a lot of passionate people with a lot of expertise and levels of understanding in different areas, trying to tackle the same problem and achieve the same ultimate goal – to stop whales becoming entangled in fishing gear. This lack of trust has been caused in part by a series of lawsuits filed by conservation groups against states and federal bodies for failing to protect whales form entanglement in fishing gear. These actions have been viewed as adversarial and have done nothing to bring different stakeholder groups back together, instead driving a wedge between them. However I did learn some valuable lessons in how negative relationships can be avoided and overcome here in the UK when tackling issues surrounding large whale entanglement, and many people were eager to share advise on how to keep relationships between stakeholder groups positive and engaging. These included:

• Understanding the problem. Through reports and strandings of both live and dead entangled whales around the UK coast we know that this is an issue, however the true extent of the problem remains unclear. If those working to reduce entanglements wish to be taken seriously, a better understanding of the numbers of animals affected by entanglements is required, through for example further studies of scarring rates and co-occurrence of whales and fishing gear. In addition work to encourage and improve reporting rates of entangled animals is needed which will first require an understanding of the psychology behind what motivates people to (or to not) report entangled animals, and what incentives or guarantees may promote better reporting rates.
• Presenting the problem in a non-targeted way. Whale entanglement in fishing gear is a conservation, welfare and economic concern and the finger cannot and should not be pointed in any one direction. It is also a global issue, and no one fishery or nation is in this alone. Instead the stance that should be taken is 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 - what are their fears, goals and intrinsic motivations? What do we need to know that we don’t know now, and what don’t people understand?
• Finding a common language and communicating where and in a why people are comfortable. For example fishermen are more likely to feel relaxed on their boat or in their...
own home than they are in a board room, and therefore more likely to speak openly. Different audiences may also communicate in different ways - where some may be used to web chats, emails and social media, others may prefer one-to-one phone calls and receiving information through the post and this must be considered to ensure inclusion.

- Selecting the right people to sit on working groups and lead stakeholder engagement activities and represent different interest groups is vital. 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. Some fishermen need to be convinced by the evidence available which supports the notion that whale entanglement in fishing gear is a significant problem. 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 were dubious of the science and questioned whether there really was a problem. Therefore researchers and regulators need to find ways of communicating the evidence in a tangible way to gain trust and credibility among other groups. On the flip side, scientists and researchers must take note of information gained from fishermen who are willing to share it. One fisherman told me that he felt marginalised because “information I’m offering up on changes I’ve noticed over the years in whale and prey distribution is being treated as anecdotal because I don’t have a PhD or a proper data sheet”.

- Keeping it simple. From what I learned about the processes and successes of the ALW-TRT compared to other species TRTs and the Dungeness Crab Fishing Gear Working Group, it seems that the most successful and widely accepted mitigation measures are the ones that have 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 appear to have served only to fuel frustrations and compromise the cohesiveness of groups involved (McDonald et al, 2016).

**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 the UK to aid in addressing this 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.

References


Appendix 1. Fellowship itinerary

25th September – 1st 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 extending 30 miles from shore, and is home to 34 species of marine mammals 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). 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). 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 initiative to implement a host of practical voluntary measures and best practises to further reduce the risk of entanglement 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). By chance I met Tiff Thomas, a long-standing active member of the Hawaiian Islands Disentanglement Network (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 had ad-hoc conversations with several fishermen fishing within the MBNMS, and 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.

1st – 6th 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), 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 where outcomes of the most recent Dungeness Crab Fishing Gear Working Group were discussed at length, as were reviews of safety protocols for wale disentanglements, and future proposed regulatory steps. I also 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 including boat handling, managing rope under tension, grapple throwing, telemetry buoy attachment and kegging.

6th – 21st October 2017

For the next two weeks I was based at the Center for Coastal Studies (www.coastalstudies.org) in Massachusetts. 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) and has co-authored numerous peer-reviewed publications on humpback and right whale conservation. During my time at CCS I participated in responses to two humpback whale entanglements in Cape Cod Bay involving lobster pot fishing gear, and undertook training with each member of the response 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). 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 Michael Moore, a senior Scientist and Veterinarian at the Woods Hole Oceanographic Institution (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 and animal welfare standards of large whales. 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, if it can be made affordable, may offer a way of reducing the amount of 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).

I also spent time with Brian Sharp of IFAW (www.ifaw.org), who is a NOAA Level 5 responder authorised to disentangle all whale species within US waters, and who has also assisted the UK team. He gave a lot of his time to discuss his current and past work involving large whale strandings and entanglements and I was also able to assist him and his wife Sarah, a Veterinarian with IFAW, during a mass stranding of common dolphins on the Cape.

Other meetings during my time in this area included with Regina Asmutis-Silvia, Executive Director and Senior Biologist for Whale and Dolphin Conservation in North America (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), a member-led organisation that helps state lobstermen meet the challenges they face and conserve the resource on which they depend, and some MLA members 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 British Divers Marine Life Rescue (BDMLR) and the Scottish Marine Animal Strandings Scheme (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.

22nd – 28th October 2017

On 22nd October I attended the annual North Atlantic Right Whale Consortium in Halifax, Nova Scotia (www.narwc.org). Right whales, particularly in Canadian waters, have been hit devastatingly hard this year by ship strikes and entanglements, which were the main topics of discussion at this meeting with presentations from biologists 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). Here I spent time with Ed Lyman, the Hawaiian Islands Humpback Whale National Marine Sanctuary’s Resource Protection Specialist (www.hawaiihumpbackwhale.noaa.gov/res/rescue_network). Ed coordinates a community-based network response to entangled large whales and assists NOAA Fisheries to coordinate large whale entanglement response 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), and David Mattila who coordinates both the Expert Panel and the Global Whale Entanglement Response Network through IWC (www.iwc.int/entanglement-response-network), and manages the entanglement capacity building programme which delivers entanglement training workshops globally. I also met members of the Campobello Whale Rescue team (www.canadianwhaleinstitute.ca/campobello-whale-rescue-team) and spoke with numerous leading whale biologists and researchers at the conference whose work in recent years has focussed largely on whale entanglement at the conference including Amy Knowlton, Julie van der Hoop, Tim Werner and Scott Kraus. On the last two days of the conference I attended two 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.

29th October – 3rd November 2017

After the conferences in Halifax I flew to Newfoundland where I spent my last week with Wayne Ledwell of the Whale Release and Strandings program (www.newfoundlandlabradorwhales.net). Wayne and his wife Julie have successfully released hundreds of entangled whales and built up strong and trusting relationships with the Newfoundland fishing community, so much so that under-
reporting of entanglements, a major issue in the USA and here in Scotland, is not a concern at all. Wayne’s operation differs from others in that he offers an ‘assistance program’ where fishermen are actively involved in disentanglement attempts. His attitude is that this is their gear, their whale, their problem and their story to tell, which combined with a commitment to repair and return as much gear as possible to fishermen affected by whale entanglements has allowed him to gain respect widely. Wayne has designed a number of his own cutting tools, specific to the gear he encounters on whales and was able to offer and demonstrate unique insights and skills in this area as both a fisherman and a disentanglement team leader. I also visited several fishing communities and spent time with fishermen who had encountered whales and worked with Wayne to release these.