Protected rays – occurrence and development of mitigation methods in the New Zealand tuna purse seine fishery

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1 Objectives

Objectives:

1. To identify methods to mitigate captures of protected rays and assess the fate of live released rays

Specific Objectives:

- 2.1 Identify methods to mitigate the capture of protected rays in commercial purse seine fisheries.
- 2.2 Make recommendations for future work to develop and/or assess the efficacy of methods to mitigate the capture of protected rays in commercial purse seine fisheries.
- 2.3 Assess the fate of live released protected rays captured in commercial purse seine fisheries and describe their spatial behaviour. [This objective is not addressed by the current report.]

2 Overview

Two species of rays in the Family Mobulidae are known to occur in New Zealand waters – spinetail devilray (*Mobula japanica*) and manta ray (*Manta birostris*) (Gilbert & Paul 1969, Paulin et al. 1982, Stewart 2002, Duffy & Abbott 2003). Both species have been protected under Schedule 7A of the Wildlife Act (1953) since July 2011, therefore receiving absolute protection such that no-one may kill or have in their possession any such animal, unless they have a permit to do so. Those who accidentally or incidentally kill or injure marine mammals or protected wildlife are required to report this to a conservation or fishery officer. Internationally, both species have also been listed by the IUCN with a status of 'Near Threatened" *for M. japanica* and "Vulnerable to Extinction" for *M. birostris*, and *M. birostris* has been added to the Convention on Migratory Species (http://www.cms.int/news/PRESS/nwPR2012/01_jan/nw_130112_cop_manta_ray.htm). Other species of *Mobula* and *Manta* may also occur in New Zealand waters, at least seasonally as migrants from tropical waters, but their presence has not been confirmed.

Devil and manta rays are caught in purse seine fisheries for tuna worldwide (Bailey et al. 1996, Romanov 2002, Molony 2005). In New Zealand, bycatches of mobulid rays have been reported from the domestic skipjack tuna (*Katsuwonus pelamis*) purse seine fishery, which has operated since the mid 1970s. The fishery occurs around the northern North Island in summer and autumn, with the key areas being the Bay of Plenty, east Northland, west Northland and North Taranaki Bight (West 1991, Kendrick 2006, Langley 2011). Skipjack tuna prefer subtropical waters having surface temperatures of 19 – 22 ^{o}C, with most catch taken near the edge of the continental shelf in seabed depths less than 200 m (Habib et al. 1980, 1981, West 1991)

A bycatch of “Mobulidae” (species not identified) is mentioned by Habib et al. (1981, table 1) from reports by observers in 1975–81, but there are no details in their data tabulation. These data may have been purposely omitted in favour of their inclusion in a paper reporting spinetail devilray from New Zealand for the first time (Paulin et al. 1982). Paulin et al. (1982) reported data for 235 specimens of spinetail devilray caught by purse seiners between 1975 and 1981. The rays were caught at (presumably surface) temperatures of 17.2 – 22.5 ^{o}C over seabed depths of 110 – 434 m. 128 specimens were measured, and ranged between 100 and 310 cm disk width (DW). Five foetuses measured 58–85 cm DW. Bailey et al. (1996) analysed New Zealand Ministry of Agriculture and Fisheries observer data for 904 sets in the purse seine fishery between 1976 and 1982. They found that 74 sets (8.2%) contained “manta ray *(Mobula japonica)*” with an average number of 2.2 rays per occurrence, suggesting a total of about 163 rays caught in 904 sets (0.18 per set).

Observer coverage of the purse seine fleet ceased in 1982, and was not reinstated until 2005. Bycatch of mobulid rays since then has apparently not been reported in detail, though the weight of “manta rays” observed, with species identified as “*Mobula japanica”* or “Myliobatidae” have been reported in New Zealand’s “Country reports” to the Western Central Pacific Fisheries Commission (WCPFC) (e. g. Anon 2010). The amounts reported and how they are reported vary, but a mobulid ray bycatch was one of the main bycatch species (up to 58% by weight of the annual bycatch total), but representing between 0.06 and 0.35% of the total catch, (table 1). Further analysis of these data is warranted, as it is clear that catch rates are highly variable and that species identity requires clarification.

Table 1. Summary of data as reported to WCPFC by New Zealand. The number of observer trips and weight of mobulid ray bycatch caught and the percentage of the total catch are given by calendar year or for multiple years, along with the total number of sets observed each year, as a percentage of total number of sets made.

Calendar Year(s)	Trips observed	Mobulid ray bycatch (t)	% of catch
2005	3	1450	0.35
2005 & 2006	4	1450	0.14
2006 & 2007	7	3840	0.07
2007 & 2008	11	none	
2009	4	1355	0.10
2009 & 2010	8	752	0.06
2010 & 2011	8	2122	0.06

Calendar Year	Sets observed	% of total sets made
2005	37	4.7
2006	104	17.5
2007	77	14.8
2008	118	27.6
2009	83	10.4
2010	83	8.6
2011	109	8.8

It appears that spinetail devilray comprises most of the “manta ray” bycatch in New Zealand purse seine fisheries, but the true manta ray may also be caught in unknown quantities.

Hereafter we use the term “manta and devil rays” to cover both species and as part of this project will, if feasible, determine the relative proportions of the two species in the catch, and address the three specific objectives in relation to both species if they are both represented.

3 Research methods

3.1 Specific objective 1.2.1: To identify methods to mitigate the capture of protected rays in commercial purse seine fisheries

In order to identify and develop successful mitigation methods, a good understanding of the current fishing practices aboard New Zealand vessels is crucial, along with a review of existing information worldwide on release methods for these and similar species. Using information gathered from these first key activities, it was anticipated that a number of potential mitigation methods might be identified, developed and tested through the co-operation with the Industry and observers from the Ministry for Primary Industries (MPI) observers onboard.

3.1.1 Key activities 1 & 2: Review of existing information and knowledge both internationally and within the New Zealand Fishing Industry

The first key activity was to conduct a thorough literature search, and to canvas experts worldwide. Relevant literature and experts were identified from a number of sources, including:

- Search of published and grey literature, and conference abstracts and proceedings, through scientific abstracting services
- Search of meeting reports and publications from regional tuna fisheries management organisations, especially WCPFC, the Inter-American Tropical Tuna Commission (IATTC), the Indian Ocean Tuna Commission (IOTC), and the International Commission for the Conservation of Atlantic Tunas (ICCAT).
- Identify and liaise with tuna scientists worldwide to identify previous, current and planned bycatch mitigation studies involving purse seine fisheries.
- Liaise with and monitor the success of the International Seafood Sustainability Foundation’s (ISSF) Purse-Seine Bycatch Mitigation Research Project.
- Identify and liaise with scientists working on manta rays, and other cartilaginous fishes (mainly sharks and rays) taken as fisheries bycatch. Sources include a wide range and number of personal collaborators and contacts, as well as umbrella organisations representing many such scientists, for example the IUCN Shark Specialist Group, (SSG), the American Elasmobranch Society (AES), the Oceania Chondrichthyan Society (OCS) and the European Elasmobranch Association (EEA).
- Identify and liaise with non-governmental organisations devoted to the conservation of cartilaginous fishes, for example WildAid, Traffic, Shark Alliance, Pew Environment Group, Save our Sharks and The Shark Trust.

Notice of our research project, and a request for information on similar studies elsewhere, was sent to a number of international listservers with worldwide circulation, NGOs, research organisations (particularly those working on tuna fisheries) and personal scientific contacts. In total, we had direct correspondence with 18 scientists working on various aspects of mobulid biology and behaviour, elasmobranch bycatch mitigation, satellite tracking and post-release survival. Information gathered from this correspondence and literature from the above sources was collated and summarized to give an overview of current research in this area.

A key element in developing mitigation techniques is to understand how and when manta rays are caught in purse seine nets and how they are handled when caught. A number of approaches were used to gather this information. During the 2011/2012 season MPI observers onboard purse seine vessels completed a data collection form for any encounters they observed (Appendix 1). This form included prompts for information on when and where the rays were first sighted, the capture process, behaviour of the rays, how they were handled by the crew and when they are accessible for attempted release. It also facilitated species identification and collection of data on size and sex composition. In addition, a field identification guide to the manta and devil rays of the Indo-West Pacific Ocean was obtained from the Manta Trust and provided to observers. This enabled them to determine whether any species other than the two known rays (*Manta birostris* and *Mobula japanica*) are being taken as purse seine bycatch in New Zealand.

Following the start of the fishing season, contact with the vessel skippers and request for informal interviews was made via the observers, and through the fishing companies operating the purse seine vessels. The companies contacted were Sanford Ltd, Talley's Group and Pelco NZ Ltd. The purpose of these interviews was to collect anecdotal information on previous encounters and discuss ideas for developing alternative mitigation techniques. Not all requests were successful, but during the season, a series of informal face-to-face and telephone interviews were held with MPI observers, skippers and spotter plane pilots. The combined answers to key questions in summarized in section 4.1.2 and gives an overview of the perceived frequency and nature of encounters, behavioural observations and thoughts on release methods.

An additional source of information was the MPI *COD* (observer) database and associated trip reports, diaries and photographic records kept by observers in previous years. Observer coverage of the purse seine fleet was re-instated in 2004/2005 and a data extract was obtained from COD under the companion project POP2011-03 (Protected fishes) spanning2004/2005 through to 2010/2011. The extract provided information about when and where manta and devil rays were recorded as part of the bycatch during purse seine trips with observers present along with a greenweight. These data were mapped along with data for commercial catches to assess any spatial, temporal and depth patterns in manta and devil ray encounters relative to the overall footprint of the tuna purse seine fleet. The logbook details for all manta and devil ray records in COD were requested from the Observer Programme to ascertain if they contained any useful information on capture and release, and species and size composition that was not on the database. Where available, information from these records was used to categorize and assess the frequency of release methods for manta and devil rays.

3.1.2 Key Activity 3: Development and testing of manta release method(s)

Depending on the findings of key activities 1 and 2, the following options were considered for key activity 3;

(a) Recommend continuation with existing methods if they are deemed suitable.
(b) Develop modifications of existing methods to improve them if necessary.
(c) Development of new methods.

Part of this activity involved consultation with Industry representatives to seek input on the development and testing of any alternative method, if thought appropriate. Input from the industry representatives was necessary to ensure any proposed method was technically feasible onboard and was safe and simple for both the crew and the vessel to implement.

3.2 Specific objective 1.2.2: To make recommendations for future work to develop and/or assess the efficacy of methods to mitigate the capture of protected rays in commercial purse seine fisheries

Work undertaken in specific objectives 1.2.1 and 1.2.3 during 2011-12 will be used to better understand how the purse seine fishery interacts with manta rays, establish a best practice method for handling and release from the deck and make progress towards the development of possible mitigation techniques that allow release while still in the water, as well as an understanding of manta survival and behaviour after release from a purse seine net.

4 Results

4.1 Specific objective 1.2.1: To identify methods to mitigate the capture of protected rays in commercial purse seine fisheries

4.1.1 Key Activity 1 - International literature and current research

Mobulid rays are reported as bycatch in purse seine fisheries for tuna in the Pacific, Atlantic and Indian oceans. In the Western and Central equatorial Pacific, “manta rays” make up 1.8% of the non-target catch in Papua New Guinea purse seine fishery (Lack & Sant 2009) and are recorded in 1.5% of observed sets in the US purse seine fishery (Coan et al. 2000). Molony (2005) reported over 1000 mobulid rays from nearly 650 sets listed in the Secretariat of the Pacific Community (SPC) observer databases between 1980 – 2004 and more recent statistics suggest bycatch varies from 100 to over 3000 individuals a year (Hall & Roman in press). For the eastern Pacific Ocean, IATTC reported an average annual bycatch per set of 7 metric tons of Mobulidae in non-associated school sets between 2004 – 2011 for larger vessels covered by the observer programme. This represents 6.6% of the annual bycatch (IATTC 2012). In the European Atlantic purse seine fishery, “rays” represented 1% of the bycatch, with a catch rate of 0.9 t/1000 t of tuna (Amandè et al. 2010). Observer coverage of Soviet purse seiners in the western Indian Ocean between 1986 - 1992 indicated an average annual bycatch of “mobulas and mantas” of around 53 – 112 t, at a rate of 0.02 t per successful set on free tuna schools, or 1.128 t/1000 t tuna caught (Romanov 2002). More recent data, reported by Pianet et al. (2009) found rays including *Mobula* species *and Manta birostris* made up 1.7% of the catch from sets on non-associated tuna schools, equating to 0.2 t/1000 t of target catch. In all these areas, the highest catch of mobulid and other rays is in sets made around free-swimming, non-associated tuna schools compared to those sets made around schools associated with objects such as natural and man-made Fish Aggregation Devices (FADs), whale sharks, dolphin schools and seamounts (Pianet et al, 2009; Amande, et al 2010; IATTC, 2012).

The Regional Fishery Management Organizations have had mixed success with regard to the effective governance and development of best practice bycatch mitigation (Gilman 2011). Frequent reference is made at the meetings for the need for improved monitoring of the levels of bycatch of vulnerable species, including manta rays, as well as a better understanding of their behaviour, interactions with tuna schools, and the development of best practice handling guidelines. Some progress has been made with certain bycatch species groups such as dolphins and turtles. In the eastern Pacific, unacceptably high mortalities from setting on dolphin-associated schools of yellowfin tuna have been substantially reduced using techniques developed by the Industry themselves (Hall 1998, Hall et al. 2000). Defined procedures and practices adopted by the Agreement on the International Dolphin Conservation Program require vessels that set purse seines on dolphin-associated tuna schools to perform a backdown manoeuvre during every set in which dolphins are captured (Figure 1), set no later than 30 min after sunset, with at least one crew member deployed to aid the release of dolphins. This technique consists of putting the vessel in reverse, forcing the corkline to sink and open up an escape route for the dolphins which aggregate at the surface. A medina panel, placed in the part of the net with which dolphins most often come in contact, with mesh size no larger than 3.2 cm (stretched) is also required to minimize the chances of dolphins becoming meshed in the area of escape. Vessels are also required to carry speedboats with wing bridles, tow lines and a raft suitable for the observation and rescue of dolphins, plus underwater face masks and lights. This live release occurs prior to “sack-up” procedure. These practices could be suited to manta rays, especially if they are swimming at the surface near the corkline.

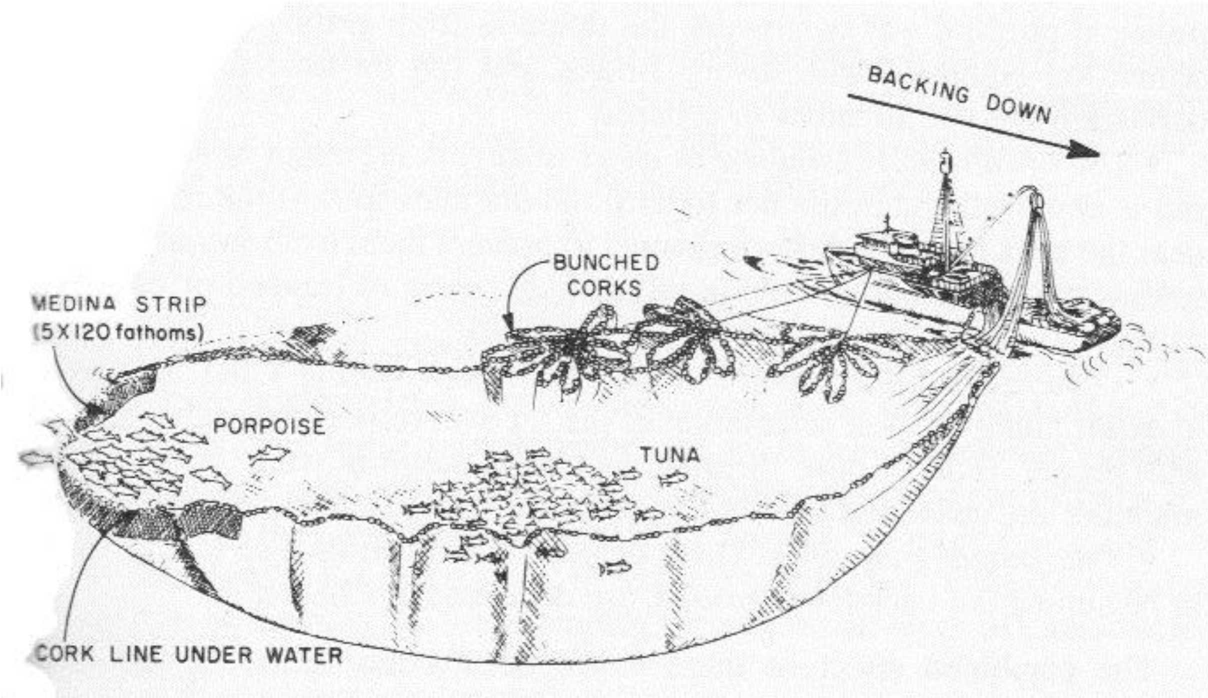

Figure 1. Backdown procedure to allow dolphins to escape over the submerged corkline. Image credit: National Research Council Committee on Reducing Porpoise Mortality from Tuna Fishing. 1992. Dolphins and the Tuna Industry. National Academy Press, Washington D.C.

Sea turtles are occasionally caught in purse seine fisheries, with most interactions occurring where turtles are attracted to FADs by the potential feeding opportunities (FAO, 2010). Resolutions have now been passed by the IATTC (2007), WCPFC (2008) and the IOTC (2009, updated in 2012) to avoid encircling, or safely release those entangled in the net, including stopping net rolling as soon as an entangled turtle comes out of the water and not start again until it is released. Both the IOTC and WCPFC also require purse seine vessels to carry specified turtle release equipment (dip nets). These resolutions follow recently published FAO Guidelines on reducing turtle mortality (FAO 2010). Avoiding encircling manta and devil rays is unlikely to be accepted by Industry as a viable measure given the frequency of occurrence with tuna schools and lack of visibility prior to setting in some cases. The handling of large mobulid rays is likely to be less straight forward than handling most turtles with dip nets only useful for small specimens. The much more significant bycatch of sea turtles in longline and gillnet fisheries has stimulated research into sensory-based approaches to bycatch mitigation, such as the use of acoustic and visual deterrents (Southwood et al. 2008). These include the use of light sticks and shark silhouettes to trigger avoidance behaviour (Wang et al. 2010), with the suggestion that differing visual sensitivities in the ultra violet light range between turtles and pelagic fish could be exploited. Such approaches could have applications for separating tuna from elasmobranchs, including manta rays.

A Bycatch Reduction Workshop hosted by the National Marine Fisheries Service (NMFS) in 2006 explored a number of ideas for separation of target from non-target species, including reducing incidental capture of sharks through the use of bait and/or deterrents, sorting grids for smaller tuna and other fish bycatch, bubble gates and vacuum pumps (Kondel & Rusin 2007). Nelson (2004) carried out experiments to herd tuna through different designs of grids including a flexible grid constructed of steel cable, however results were not encouraging with the flexible openings allowing larger tuna to escape (Kondel and Ruskin, 2007). In Ecuador a number of grid configurations have been used as part of an industry initiative since the early 2000s, but there is little quantitative data on their effectiveness (Hall 2012). Bubble gates have been suggested as a mechanism to corral either target or non-target species into certain areas of the net and recent feasibility studies in Norway have assessed the use of vacuum pumps as a viable option for even large fish such as tuna (M. Hall, pers comm). This technology could allow highly selective and rapid removal of target species from the pursed net, leaving large bycatch such as manta and devil rays to be released from the net following pumping.

For sharks, the IATTC has drafted resolutions annually since 1999 to evaluate and reduce elasmobranch bycatch. Resolution C-05-03 (2005) and the WCPFC Conservation and Management Measure 2010-071 (2010) both require the release of live sharks and prohibit the practice of finning and dumping of shark bodies overboard. Resolution C-04-05, adopted in 2006 which requires fishermen on purse seine vessels to "*promptly release unharmed, to the extent practicable, all sharks, billfishes, rays, dorado, and other non-target species*." and "*encourage fishermen to develop and use techniques and equipment to facilitate the rapid and safe release of any such animals."* The resolution also calls for funds to carry out experimental testing of ideas to allow "*rapid, live release of species such as sharks, rays, whale sharks and turtles*".

Despite these recommendations, there are currently few fully-developed mitigation techniques for use with sharks in purse seine tuna fisheries and this area has been the focus of a major collaborative research project between IATTC and the ISSF. A white paper prepared by the ISSF gave an overview of the state of bycatch research in the world's tuna fisheries (including longlines and FAD associated purse seines) and outlines existing programmes designed to reduce bycatch and discarding (ISSF 2009). Since then a series of scientific meetings and skipper workshops have been held to promote this initiative, explore and develop ideas and gauge likely acceptance of different mitigation techniques (Restrepo 2010, Itano & Restrepo 2011). Following these meetings, ISSF Bycatch Project research cruises have been conducted in the Indian Ocean (2 cruises), the eastern Pacific (Schaefer & Fuller 2011), one in the WCPFC Convention Area, and one has been planned for the eastern Atlantic (Gulf of Guinea). Research has focused around the four main stages of the purse seine process; avoidance of bycatch prior to encirclement; release from the net after encirclement but before sacking and brailing; live release from the deck and utilization to convert bycatch to non-target retained catch. Reducing the catch of (1) undesirable size of bigeye tuna, (2) pelagic sharks and (3) turtles have been prioritized (Restrepo 2010, Itano & Restrepo 2011), but it has also been noted that alternative ways to bring fish on deck and best practice handling techniques for whale sharks and manta rays need to be developed. In their report to the 7th scientific committee of the WCPFC, Itano and Restrepo (2011) outlined further details of current practices for dealing with whale sharks from skipper's workshopsto. A common method of removal of small and medium sized whale sharks has been to secure the tail with a heavy hawser or sling and winch it tail-first out of the net, but the extreme weights involved and fragility of the caudal peduncle, clearly make this method unsuitable. The alternative method suggested is to allow the shark to swim head-first over a sunken corkline. The authors noted that the practice of waiting until the purse seine is sacked and ready from brailing may have detrimental consequences; this confinement in the crowded net can result in crushing and reduced oxygen flow to the gills, which likely reduces chances of survival for any bycatch released (Itano & Restrepo 2011).

Further cruises have been conducted in 2012 in the Western Central Pacific (Itano et al. 2012b), with research focusing on estimating size and species surrounding FADs before setting, the vertical and horizontal behavior of tuna and other species around floating objects, the behavior of tuna and bycatch in the net and studies of oceanic shark behaviour and post-release survival rates. Scuba and snorkel surveys found evidence for separation by size and species inside the net with silky sharks, for example, remaining in the upper 20m of the water column and often aggregating at the far end of the net away from the fishing vessel. Following these observations, an escape panel with zipper line was designed and sewn into the purse seine net below the corkline (Itano et al. 2012a). The panel was opened and closed by a crew member in a workboat or towboat to allow sharks to swim out of the net Initial results were not promising, with sharks appearing not to recognize the escape route, possibly due to poorer water clarity during the trials compared to initial observations. Escape panels could also potentially be used for manta rays if they display similar behaviour to sharks, but this measure requires alteration close to the end of the net, which is not desirable in terms of the risk of losing target species, as well as the deployment of a small vessel and crew member to operate.

Another research initiative into bycatch mitigation in tropical tuna fisheries, the recently completed EU funded MADE (Mitigating ADverse Ecological impacts of open ocean fisheries) project involved 13 institutions from 8 countries with research carried out in the Atlantic, Mediterranean and Indian Ocean (http://www.made-project.eu/). The project focused primarily on mitigating shark bycatch in FAD associated purse seine and longline fisheries using spatial as well as technical management measures. Nearly 50 sharks were electronically tagged during the course of the project (including silky, blue and whitetip), providing information on behaviour and migrations as well as post-release mortality (Dagorn 2011). Much research was devoted to the study of the behaviour of sharks around FADs, along with experiments to assess the effectiveness of bait trails to attract sharks away from the FADs. Spatial management approaches included assessment of “hot spot” areas from observer data that could be avoided by fishers (Amandè et al. 2011). In collaboration with another project funded by the French fleet organization ORTHONGEL, scientists participated in commercial purse seine trips to observe current handling and release practices and electronically tag released fish. Of the 20 silky sharks tagged during these trips, nearly half died immediately after release or between 2 – 15 days later (Poisson et al. 2011). The authors noted that the initial mortality rates of sharks were strongly linked to how they were handled; sharks that were retrieved after being brought onboard by the brailer and dropped into the hopper, were far more likely to be dead (73%) than those not dropped into the hopper, and immediate mortality also increased with increasing catch size. Larger sharks were less likely to end up on the lower decks and less likely to be dead.

The importance of the condition in which elasmobranchs are returned to the sea has been highlighted by a number of studies, but also how the probability of survival is higher for some species than others. Campana et al. (2009) used satellite telemetry to ascertain post-release mortality of blue sharks and found that survivorship was high for this species as long as animals were released in a “healthy” condition. Using a risk-based approach to assess post-capture survival based on indices of physical injury (evidence of abrasion, wounds, bleeding and sea lice damage) and reflex impairment, Braccini et al. (2012) predicted high post-capture survival for many demersal sharks and rays, but lower survivorship for pelagic species such as gummy and school sharks in a southern Australian gillnet fishery. The at-haulback survival of elasmobranchs caught on pelagic longlines in the Atlantic was higher for larger fish, as well as being species-specific, with higher percentages of blue sharks (around 90%) being alive at haulback compared to other species such as silky sharks and smooth hammerheads (Coelho et al. 2011). In this fishery, nearly 100% of manta rays caught were alive at haulback, with most specimens being released while still in the water by cutting the line. The effects of aerial exposure and thermal stress can have potentially lethal effects on the physiology of elasmobranchs (Skomal & Mandelman in press), and can be particularly pronounced for certain species (Marshall et al. 2010), especially when the differences between air and water temperature are high during certain seasons (Cicia et al. in press).

Figure 2. Recommended handling techniques for large manta rays taken from Poisson et al., (2012). “Good practices to reduce the mortality of sharks and rays caught incidentally by the tropical tuna purse seiners”

In light of these studies, it is clear that minimizing time on deck and appropriate handling practices can ensure a high likelihood of post-release survival for discarded sharks and rays. An outcome of the MADE project collaboration with the fleet was the development of a manual of best practice release techniques for sharks and rays (Poisson et al. 2012). This document is available on the WCPFC Bycatch Mitigation Information System web site (http://bmis.wcpfc.int/), and highlights the vulnerability of these species, the adverse conditions they experience, such as lack of oxygen, sun exposure and crushing, and the recommended methods of handling both small and large animals. Figure 2 illustrates how large manta rays can be released from deck using the brail net directly or a canvas sling. Similarly, the FAO report on tuna bycatch (Hall & Roman in press) documents some of the standard release methods, which may potentially result in post-release mortality (Figure 2) and recommends that if a manta ray is observed in the brailer, a cargo net should be placed on or over the hopper to catch the manta ray and lift it overboard.

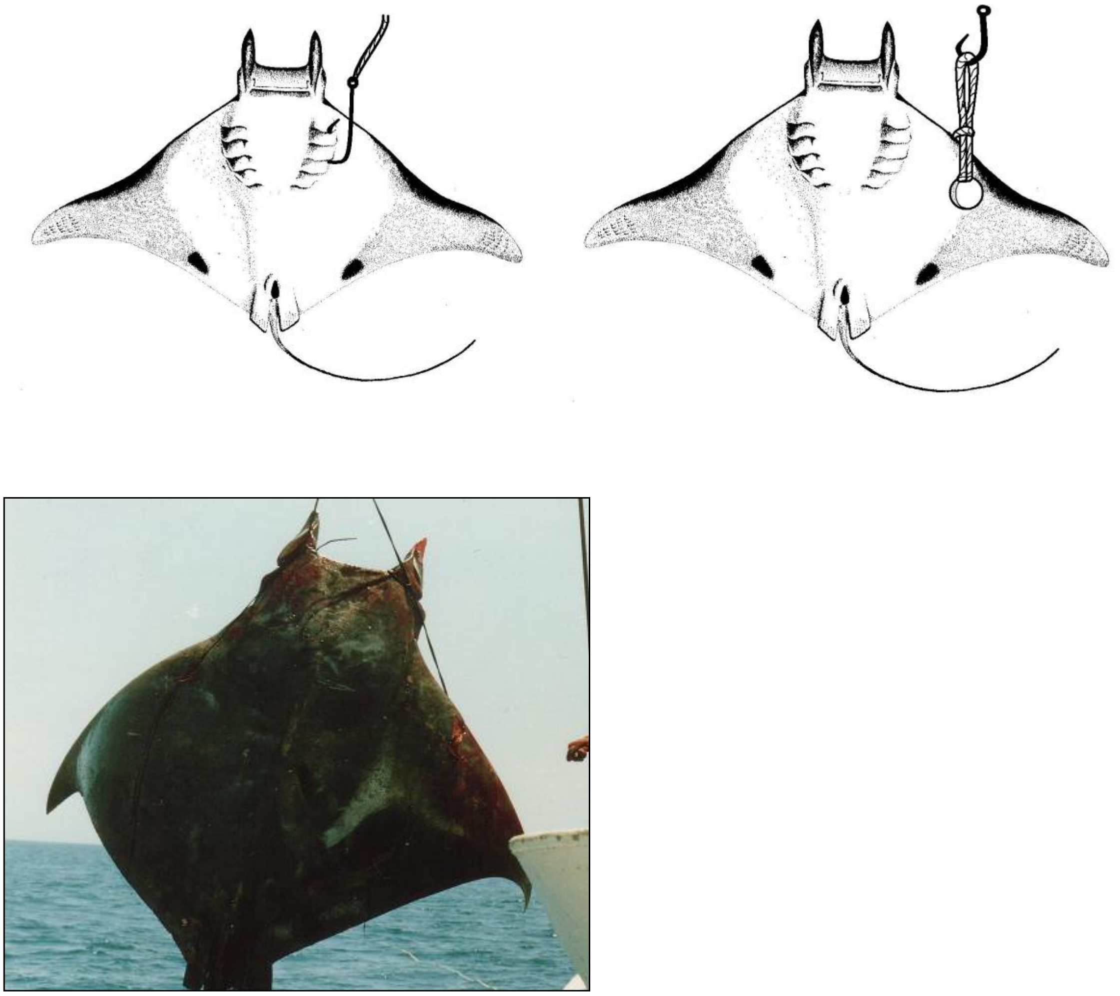

Figure 3. Commonly used techniques to release manta and devil rays, which may result in injury or mortality (Source: Hall & Roman, in press)

Gilman (2011) pointed out that "numerous gaps remain in making progress towards implementation of measures to mitigate problematic bycatch and meaningful performance standards are largely lacking." One of these gaps remains knowledge of the effectiveness or otherwise of current handling practices for manta and devil rays and any research to progress novel methods for release prior to the brailing process, or avoiding their capture altogether.

4.1.2 Key Activity 2 - Description of the fishing process aboard New Zealand vessels

The purse seine fleet currently consists of five small (<500 GRT) purse-seine vessels (around 23-36 m length, and 600 kW engine power) that operate exclusively within New Zealand waters, and four larger “super seiners” (60-80 m, 2500 kW engine power, >1000 GRT, that operate principally in equatorial waters of the western and central Pacific Ocean (WCPO), but sometimes (only one vessel in recent years) move into New Zealand waters during the skipjack tuna season (Langley, 2011). The smaller vessels use purse seine nets with a floatline length of 700 – 1100 m and a fishing depth of approximately 100 m. The larger vessels operate nets of up to 1600 - 2200 m length and 120 – 250 m fishing depth.

The tuna fishery operates principally from the Bay of Plenty around the North Island to the North Taranaki Bight (Figure 4) and is highly seasonal, corresponding to the arrival of warmer water along the east coast of the North Island. The majority of the catch is taken on the east coast between January and March in sea surface temperatures of 21 – 22.5° C. The fishery starts later (March / April) off the west coast in sea surface temperatures of 19.5 - 21° C (Langley, 2011). The smaller, domestic fleet is based principally in Tauranga with fishing activity concentrated in the Bay of Plenty. The larger vessels join the domestic fishery intermittently, often later in the season and tend to concentrate on the North Taranaki Bight, with fishing effort off east Northland equally distributed between the two fleet components (Langley, 2011). Outside this seasonal fishery, the smaller vessels target other pelagic species such as jack mackerel and kahawai whilst the super seiners move back to the equatorial regions.

Fishing takes place during daylight hours with activity and visibility of the skipjack tuna schools dependent on water temperature, cloud cover and location. Although FAD fishing has previously been used in New Zealand waters, this method is currently banned and the vessels target free-swimming tuna schools using fish spotter pilots to locate the schools at the surface and direct the vessels to them. Once a school is identified, a visual identification and estimation of size is made and the vessel manoeuvres into position. Setting of the net is generally carried out using a powerful skiff, although some of the smaller vessels don’t employ one and set the net from the main vessel directly. The larger super seiners may employ a helicopter as well as the spotter plane to help guide the skiff. Once encircled, pursing of the net commences and in some cases, helicopters, speed boats, and fluorescent dye bombs and explosives thrown by the crew, may be used to hem the fish into the farthest part of the net and deter them from escaping. The pursing process is a critical point when tuna schools can escape.

When the tuna do evade the net, this is known as a “skunked shot” and Langley (2011) noted that 37% of all purse-seine sets in the observer database between 2000 and 2009 caught no skipjack tuna, and a considerable loss of fish (greater than 5 t) during the fishing operation was recorded for about 25% of the remainder of the sets. These schools may often be targeted again and subsequently caught.

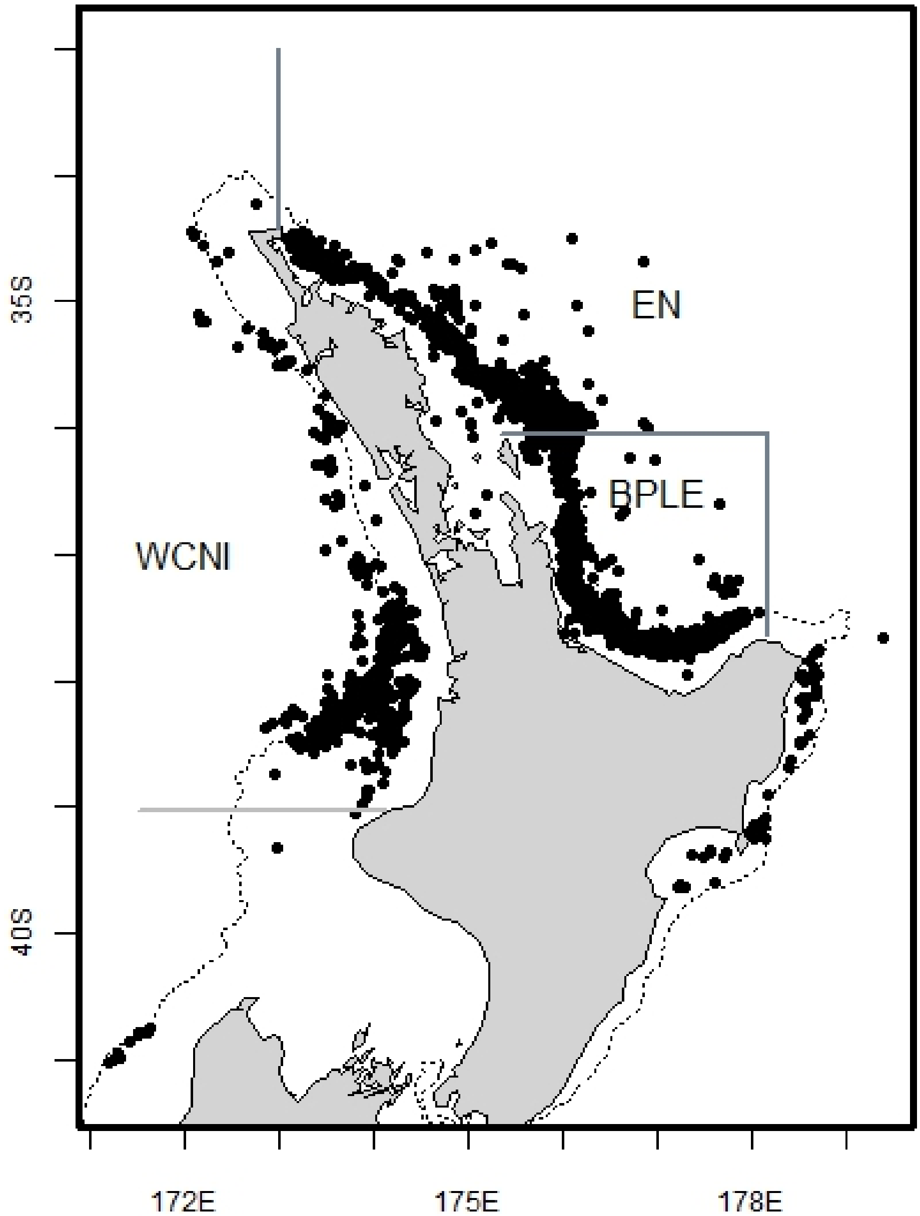

Figure 4. Location of purse seine sets targeting skipjack tuna from 1999/2000 to 2008/09. The solid grey lines denote the boundaries of the main fishery areas (EN, east Northland, BPLE, Bay of Plenty; WCNI, west coast North Island). The dashed line represents the 200 m depth contour. Source: Langley (2011).

Once successfully pursed, the net is brought onboard (“rolling” and “sacking”) using a hydraulic power block, pulling the bottom of the net upwards to reduce the volume inside and concentrate the fish in the “sack” or “bunt” of the net alongside the vessel. Fish are scooped from the pursed net using a brail net (brailer) and emptied into a deck hold and transferred below deck. Brailers on the super seiners are around 2.5 m diameter and scoop between 4 – 6 tonnes. Smaller vessels use somewhat smaller brailers. Bycatch is generally separated once the brail has been emptied into the deckhold and is usually immediately discarded. The timing of these processes depends on the size of the vessel and the school of fish targeted as well as weather conditions. Generally sets are 2 – 3 hours duration, with the net set in 4-6 min, pursed in 12 – 15 min, but the process of rolling, sacking and brailing taking upwards of 2 hours (Baird 2009).

Informal interviews were carried out with 3 MPI observers, 2 spotter plane pilots, 2 current skippers, one navigator and one retired skipper. The two current skippers operate a superseiner and a smaller domestic vessel. Although further interviews were sought with other current skippers, none were willing to participate.

When and where are manta and devil rays observed?

All those interviewed agreed that January was usually the peak period for sightings and encounters, with some commenting that they "*followed the warm water, around 20°, around the 100 fathom mark, arriving January / February*", sometimes ahead of the tuna arriving, along with sunfish.

Many cited the area between Great Barrier Island and the Poor Knights Islands as a "hotspot" for encounters with manta and devil rays, more broadly between North Cape and east Coromandel, with fewer caught in the Bay of Plenty and on the west coast North Island. One of the observers interviewed, has only worked on purse-seine boats on the west coast, and has never seen a manta or devil ray caught, although the super seiner skipper and navigator interviewed stated that they have caught them occasionally on the west coast around the 100 fathom mark off Ninety Mile Beach, Hokianga and as far south as the Manukau Harbour.

Most commented that ray abundance was variable from year to year, with high numbers sighted in some years and described as being a "*bloody plague*" and a "*nuisance*" on occasion. One commented that he had caught "*up to 12 in one year, but 1-2 in other years*". For the 2011/2012 season, both spotter plane pilots felt there were more sightings than normal, but not as many larger ones and they also occurred in shallower water than usual, 50 m or less.

How often are manta and devil rays associated with tuna and what is their behaviour?

In the areas and time of year where they do occur, it seems likely that manta and devil rays are often associated with tuna schools. Two interviewees thought that around 40-50% of schools could have manta and devil rays swimming with them. It was commented that the association was more frequent in New Zealand than elsewhere. One skipper commented that when conditions were good for tuna fishing, with warm water, and sunny calm weather, manta rays and sunfish were also often found. All agreed that the manta and devil rays were usually readily visible from air with spotter pilots warning the vessels if they saw them. However, in four of the encounters recorded from the 2011/2012 season, the mantas were not seen by the pilot or the skipper in the crows nest until towards the end of net retrieval.

Both spotter plane pilots felt they were able to distinguish between the two species but thought that the behaviour was similar for both. Pilots and skippers described the behaviour of manta and devil rays, as usually observed at the outskirts of the tuna school, often at the surface "*looping and somersaulting*", "*cruising along at the surface*" and "*feeding and sunning themselves*". No obvious behavioural differences were noted between groups and solitary individuals.

How often do they get caught and what methods are used to release manta and devil rays?

Given a choice, a vessel will usually target a school without manta or devil rays as they are generally seen as a nuisance. If a set is made on a tuna school with manta or devil rays associated, one commented that there was "*a high chance, maybe 85%, that the mantas would be caught*". Almost all those interviewed, apart from those working on the super seiner, commented on the problem of manta and devil rays "*spooking the tuna*" and "*chasing them out of the net*", resulting in a "skunked" set where the tuna evaded capture. In many of these cases, the manta or devil rays end up being caught. A number commented that this happened "*maybe 50% of the time*", "*usually*", "*most of the time*" when manta and devil rays were associated with a school. It was thought that this was caused by the manta or devil ray's movements scaring the tuna school which dived rapidly, while the slower moving rays did not. In many of these cases, manta and devil rays could be released whilst still swimming free in the water by simply opening the auster (forward end of the net) to create a gap or sinking the corks. Sometimes the manta and devil rays become entangled in the meshes of the net, particularly in the bunt where the meshes are smaller. In these cases the crew try to free the animal and roll it out under the chain line, or cut meshes to drop the ray out of the net either while it is still in the water or with the net suspended over the side of the vessel. In most ("*nine out of ten*") cases this can be done without the animal coming onboard. However, it is not desirable to cut too many meshes as this creates work to mend the hole. This may mean it is harder for the animal to fall free of the net and in some cases the crew may make an incision in the wing to allow a hook or rope to be used to pull the animal free.

If tuna and manta or devil rays are caught together, one interviewee thought that a lot of the time "*maybe 60 – 65%, the manta rays are visible swimming at the surface and following the corkline*". This behaviour was observed in two video clips taken by observers. However, others commented that sometimes, mantas swim among and underneath the tuna, seemingly "*not realizing they are caught*" and don't tend to search for escape routes. This was in contrast to the behaviour of dolphins that one interviewee felt stayed at the surface and "*were more passive*" or sharks that tended to be "*panicky*". This behaviour would make them difficult to separate or release while tuna are still in the net. Smaller rays may "drown" as the volume is reduced and sink to the bottom of the net. One observer commented that when the mantas are visible, and can be seen at the surface, most vessels will attempt to release them into the water, although how this is done and whether it is done before or after the brailing process was not made clear.

Once the brailing process begins, most comments suggested that, if caught in the brailer, a manta or devil ray is easily visible and invariably ends up on top of the tuna. Comments on when manta rays are released during the brailing process varied. Some stated that they were left until after the catch was brailed and the net volume reduced and if caught before then, may be tipped back into the net to allow brailing of the catch to continue. Others stated that the manta and devil rays are targeted first, scooping with the brailer and releasing straight over the side, even if this meant losing some of the catch. However, one interviewee also commented that many ("*maybe 70 %"*) of the rays are too large to easily fit in the brailers of the smaller vessels. This suggests that these animals cannot always be released using the brailer to lift out of the purse seine net and therefore presumably are left until after the catch is removed and then released from the main net directly.

Interviewees felt that catching manta and devil rays was generally "*a rare occurrence*" and "*very few*", "*3-5% of the time*", "*not a huge problem' "one or two a year"*. This is taken to refer to the times an animal is landed on the deck, given previous comments about occurrence with tuna schools and skunked sets. Where, for whatever reason, a manta or devil ray is not released directly from the purse seine net or over the side using the brail net, some participants indicated that the animal would have to be man-handled out of the brailer and over the side. The very large size, weight and behaviour, "*agro, flapping about and very strong*", means that this can only be done using a hook inserted through the flesh or gills, or using a strop passed through a hole made in one of the wings. A number of photos indicate that this has been and may still be the method used to remove these animals from the deck or if tangled in the net. A number of interviewees felt that these animals are fairly resilient and whilst they may incur damage such as incisions, abrasion to the skin etc, they actively swim away when released. One observer mentioned that skippers have commented on seeing manta rays with scars on the wings, which they took to indicate surviving previous encounters.

In contrast to the skippers and observers working on the smaller vessels, those working onboard the superseiner commented that manta and devil rays were not caught in skunked sets, perhaps due to the larger, deeper nets resulting in fewer occasions where the tuna escape in this fashion. Manta and devil rays were generally not released whilst in the water but instead brought onboard with the much larger brail net. Instead of handling on the deck, the crew of this particular vessel have made up a cargo net with 2 ft (61 cm) meshes (Figure 5). This is stretched tightly over the hopper so that tuna pass through and into the hold whilst the manta ray or other large bycatch does not. It is then lifted and released using a sacrificial rope that is cut to free the manta over the side. This cargo net was very similar to the concept suggested to the other skippers interviewed as an alternative method of release. One believed this would be a feasible option to avoid man-handling of animals on deck, the other felt that this would increase the amount of time and handling of the animal and that the brail net was sufficient.

Figure 5. The cargo net used onboard the superseiner, *San Nanumea* for return of large bycatch over the side (top left). Photographs show a brail net containing target species and two sunfish being brought onboard (top right); the brail is released and the cargo net used to catch the sunfish (bottom left and right)

Observer Database Records

An extract from the observer database (COD) from 2004/2005 through to 2010/2011 contained 59 records of manta or devil ray bycatch (MJA and MNT) from purse seine sets (PS).Between 2005 and 2011, nearly 10.4 metric tons of manta and devil ray bycatch were recorded on purse seine trips. The location of manta and devil ray occurrences in purse seine sets is shown in Figure 6 along with the position of all sets observed during the time period. Compared to the overall extent of the purse seine fishery, observed manta and devil ray encounters appear to be localized both spatially and temporally. Most records were confined to the area off Great Barrier Island to Cape Brett (between 35 and 36.5° S), in water depths of 150 – 350 m, and largely during January and February. Two records were from the Bay of Plenty in January and a further two records from the west coast of the North Island (North Taranaki Bight) in March. The manta and devil rays are caught in the deeper sets compared to the depth range of all observed sets (Figure 7). An extract of commercial catch data completed for the companion project POP2011-03 indicates that manta and devil rays have also been caught in the eastern Bay of Plenty and the west coast of the North Island (M. Francis, unpubl. data).

Table 2 summarises the number of trips targeting skipjack tuna on which observers were present in each fishing year since the Observer Programme coverage of purse seine vessels was re-started in 2005, the total number of sets made and the number of trips and sets where manta rays or devil rays were recorded as part of the bycatch. This table includes an additional record noted in an observer diary from a skunked set, where the manta or devil ray was not recorded in the catch, as well as records from the 2011/2012 season, bringing the total number of sets catching manta or devil rays to 65. The frequency of occurrence in observed sets ranged from 1.8% in 2007/08 to 27.8% in 2006/07. The latter high value was due to manta rays being caught in 20 sets from a single trip. This is likely a rare occurrence, although several other trips recorded multiple (>5) sets with manta or devil ray bycatch. The overall frequency of manta and devil ray bycatch in observed sets was 8.6 %, similar to the 8.2% frequency reported from the fishery in the 1970s and early 1980s (Bailey et al. 1996). Table 3 presents the frequency of manta or devil ray bycatch off Northland and Great Barrier Island (north of 36.5° S), the Bay of Plenty (south of 36.5°S) and the west coast (North and South island combined). The frequency is nearly 23% of observed sets off the northeast coast compared to < 2% of observed sets in the Bay of Plenty and <1% along the west coast. Partitioning the observer coverage by these areas indicates that in the years with a higher proportion of observed sets located in the Northland and Great Barrier Island area, a higher overall occurrence of manta or devil ray catches were recorded, especially where multiple catches were made during the trip, e.g. in 2006/07, 42 out of a total of 79 sets (53%) were in this area, compared to 13 sets out of 111 (12%) the year before, when the observer coverage was concentrated on the west coast of the North island and the frequency of manta ray catches was <2%.

It should be noted that before inclusion and in Section 7A of the Wildlife Act, catches of manta and devil rays may not have been as well reported by either observers or fishers, so the frequencies estimated here may be an underestimate. An example of this was the diary note of a manta or devil ray caught and released in a skunked tow, but not recorded in the COD database. The COD database reports greenweight only and not numbers, although the diary extracts often noted the number of rays caught (up to 5 in one set). Given the incompleteness of these data only presence / absence was reported here.

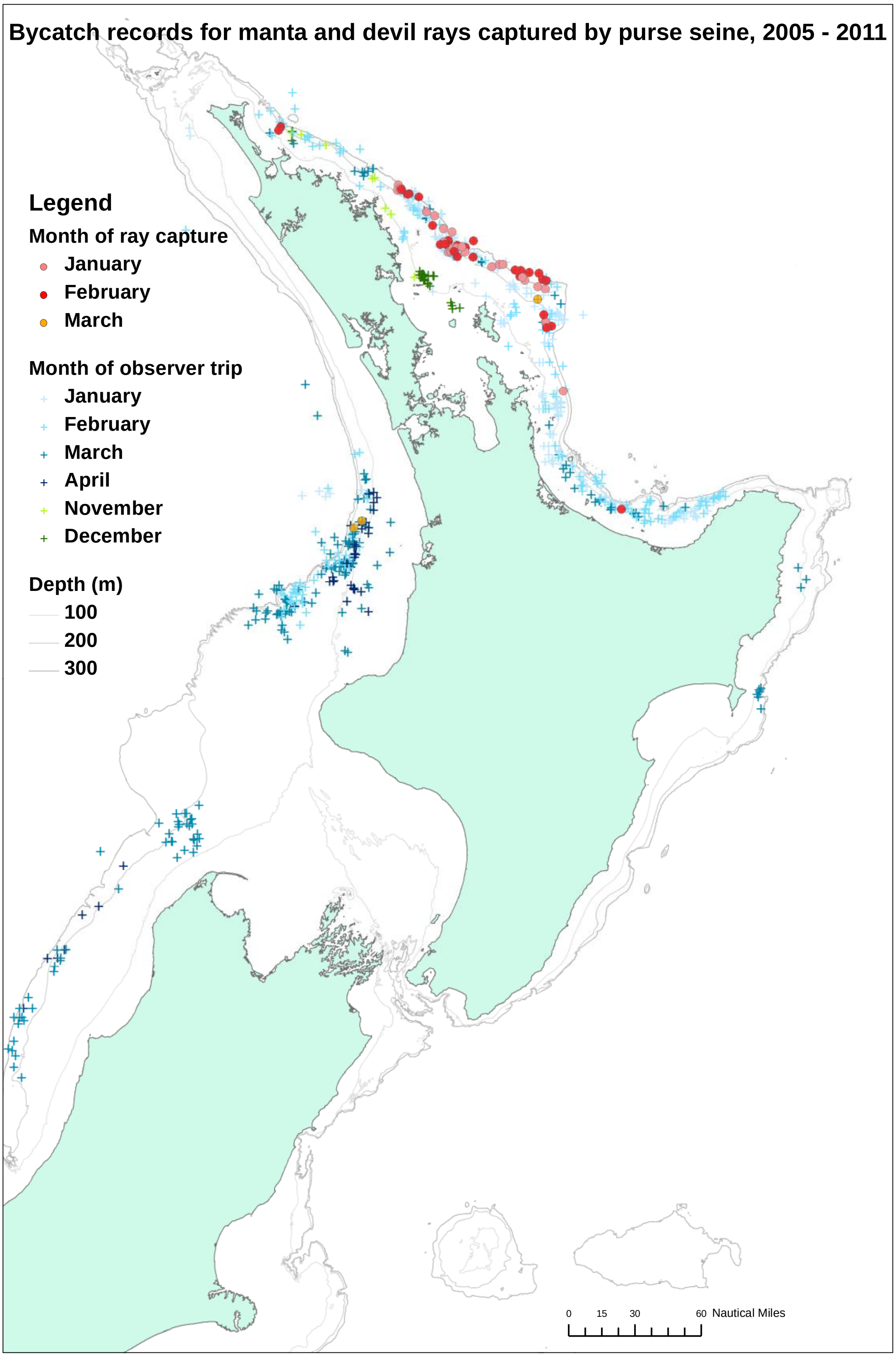

Figure 6. Location and timing of manta and devil ray bycatch in the domestic purse-seine fishery between 2004/05 and 2010/11

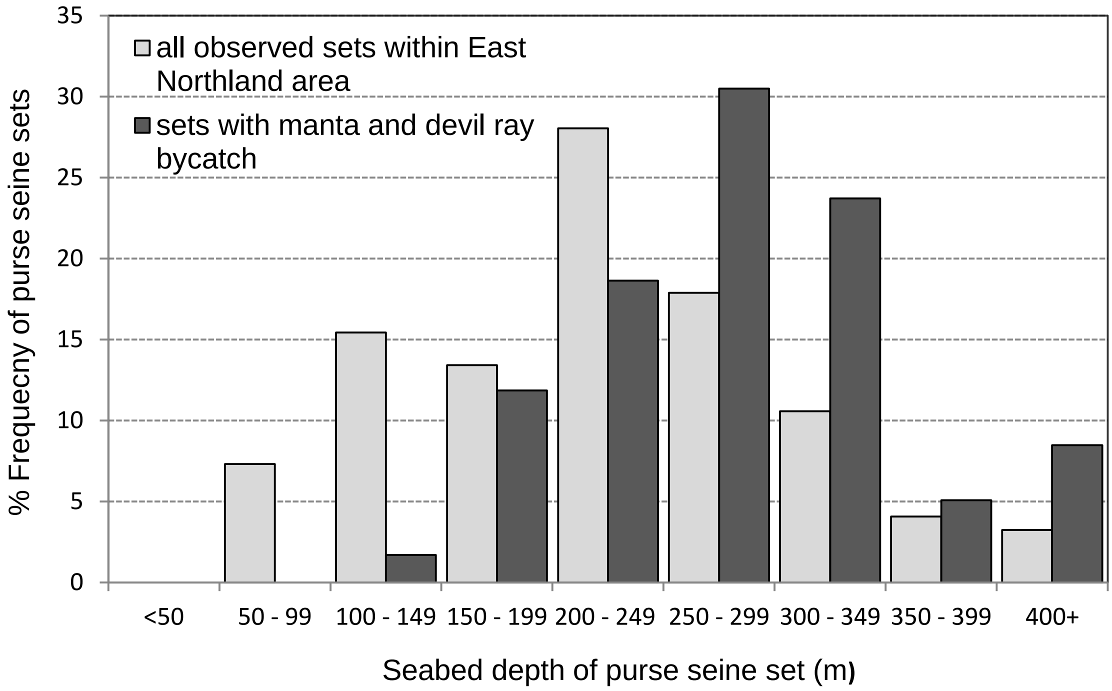

Figure 7. Percent frequency of seabed depth for observed purse seine sets in the East Northland area (north of 36.5°S) and those with manta and devil ray bycatch.

Table 2. Summary of Observer Programme data from the domestic purse-seine fishery by fishing year. The number of unique fishing trips, total number of sets observed and the number of sets and trips where a bycatch of either manta ray or spinetail devil ray were observed is presented.

Fishing year	No. of trips	No. of trips with MJA / RMB / MNT	No. of sets	No. of sets with MJA / RMB / MNT	% of observed sets with MJA / RMB / MNT
2004/05	3	2	30	3	10 %
2005/06	3	1	111	2	1.8 %
2006/07	5	2	79	22	27.8 %
2007/08	6	3	115	4	3.5 %
2008/09	4	2	83	15	18.1 %
2009/10	4	2	83	4	4.8%
2010/11	4	2	142	10	7.0%
2011/12	3	2	113	5	4.4%
Total	32	16	756	65	8.6%

Table 3. Summary of Observer Programme data from the domestic purse-seine fishery by fishing year and area.

Area	Fishing Year	No. of trips	No. of sets	No. of sets with MJA / RMB / MNT	% of observed sets with MJA / RMB / MNT
West coast (North & South Island)	2004/05	0	0		
	2005/06	2	98	0	
	2006/07	2	24	0	
	2007/08	2	30	2	
	2008/09	2	28	0	
	2009/10	1	11	0	
	2010/11	2	60	0	
	2011/12	1	51	0	
West coast Total		**12**	**302**	**2**	**0.66%**
Bay of Plenty (south of 36.5° S)	2004/05	2	3	0	
	2005/06	0	0		
	2006/07	3	13	0	
	2007/08	5	57	1	
	2008/09	3	19	1	
	2009/10	3	42	0	
	2010/11	2	15	0	
	2011/12	2	32	1	
Bay of Plenty Total		**20**	**181**	**3**	**1.66%**
East Northland & Great Barrier Island (north of 36.5° S)	2004/05	3	18	3	
	2005/06	2	13	2	
	2006/07	3	42	22	
	2007/08	4	28	1	
	2008/09	3	36	14	
	2009/10	2	30	4	
	2010/11	4	67	10	
	2011/12	1	30	4	
East Northland & Great Barrier Island Total		**22**	**264**	**60**	**22.73%**

Observer diaries from ten historical trips were successfully sourced, some with photos, from trips between 2005 – 2011, along with photos from another trip without a diary available. There were no diary extracts or photos available for three trips. In addition to these, the questionnaire forms for five sets where spinetail devil rays were caught during two observer trips in 2011/2012 were added. See Figures 8 and 9 for examples of some of the images taken.

Figure 8. Images of spinetail devil rays at the surface of the purse seine before (left) and after (right) the net has been sacked.

All historic records in the observer database are recorded as MJA (*Mobula japanica)* or MNT (*Mobula* spp.), and all photographs examined were identified as either spinetail devil ray or not distinguishable from spinetail devil ray based on the image. One observer diary noted that records of MJA may have been mis-identified, but this could not be confirmed. All mobulid ray bycatch in the 2012 season was identified as spinetail devil rays and we conclude that this species represents the majority, if not all records of "manta rays" caught in the purse seine fishery in New Zealand.

There were 21 sets described as "skunked", with no, or very reduced tuna catch, representing 32% of all observed sets. A further 6 sets were suspected as being skunked based on their short duration (<2h), which would account for 43% of the encounters with manta and devil rays. Of these skunked sets, only two observations clearly indicated that the manta or devil rays remained in the water and were able to swim out of the net. For others, comments indicated that the rays had become entangled in the bunt of the net, which had to be lifted out of the water and sometimes on deck, to enable meshes to be cut. In other cases, where a small amount of tuna were caught, the manta or devil rays were brought onboard with the brailer. For the remaining observations, there was no indication as to how the bycatch was handled.

Figure 9 Images showing spinetail devil rays meshed in the bunt of the purse seine net (top), brought onboard using a brail net (middle left), and handling practices onboard New Zealand vessel

Table 4 Frequency of different release method for manta and devilray bycatch as inferred from observer diary entries and photo evidence.

Release method	Set description			Total
	Skunked	Successful	Unknown	
Released in water, swam out of net	2	1		3
Tangled in bunt, lifted out of water / brought on deck	6	2 (on deck)		8
Brailed onboard with small tuna catch	7	18		25
Tangled but released whilst still submerged			1	1
Unknown	6	8	14	28
Total	21	29	15	65

Where observations were made of manta rays caught with successful tuna catches, the comments of the observers from trip report summaries, and specifically for those sets, implied that bycatch was brought onboard, either in the brailer or in the bunt, before being removed onto the deck; "*observed in brail*", "*Put overboard alive*", "*on deck for a short period of time*", "*Both returned to water alive*", "*the crew make great efforts to remove the fish from the deck hold*". In addition to these comments, photographs from six different sets were taken of manta ray bycatch either on the deck, being removed from the brailer onto the deck or lifted over the side of vessels using a hook or strop through the gills or flesh.

Overall, it is estimated that around half of the manta and devil ray interactions resulted in them being lifted out of the water and / or brought on deck because they were either entangled in the bunt or scooped up in the brailer. For 28 sets, handling details are unknown. In only four cases were manta or devil rays known to have swum free of the net or been released without lifting from the water, representing only 11% of the sets where release information available. Despite being brought out of the water, entangled in the netting, and in some cases being removed using hooks or strops passed through gills or incisions, in all cases where the status of the manta rays was noted, observers commented that the animals were released alive and likely to survive.

4.1.3 Results: Key Activity 3: Development and testing of manta release method(s)

Based on key activities 1 and 2, it was concluded that existing methods of release could be improved in the short term and the development of alternative methods should be still be considered. Through reviewing appropriate literature and contact with other researchers during key activity 1, potential methods of releasing manta rays whilst still in the water included adaptations of techniques used / proposed to release whale sharks and dolphins from purse seine nets by sinking the net and cork floats along one edge of the net or unlacing the net ties to open a "window" (D. Itano, pers. comm.). For entangled manta or devil rays the method used to reduce turtle bycatch by positioning a small boat under the main net while it is being hauled from the sea up through a lifting block on the purse seiner seems appropriate. For the purposes of this project, the most promising method that, to our knowledge, had not been tested or implemented, was the suggested use of a cargo net that could be manoeuvred under the manta or devil ray while in the water, or placed on the deck underneath the brail net as it is being emptied (M. Hall, IATTC, email correspondence).

Input from Industry representatives was requested in the construction of a suitable cargo net for testing, or other suggestions. Initial contact was largely with smaller vessels, which operate in N.Z. waters earlier in the season. The responses were mixed; one positive, with input on appropriate dimensions and materials and one negative with no value seen in the concept.

Following this initial guidance, a cargo net was made up (4.5 x 4.5 m), using smooth rip-stop PVC sheeting to reduce abrasion on the skin of the manta ray, with drainage holes and reinforced with webbing. Extension straps (2 m long) were attached at each corner.

However, the smaller vessels approached saw no value in this method, were not targeting tuna or carrying an observer. Contact was subsequently made with super seiners, which join the New Zealand fishery later in the season. The skipper and navigator of one vessel were interviewed and were open to co-operating, but were in fact already operating their own version of a cargo net to deal with manta rays and other large bycatch. The experimental cargo net was therefore not tested in the 2011/2012 fishing season. However, the vessel using a similar approach has provided a description of their own cargo net and video footage of how it is used (see previous section).

Summary

1) Observed manta and devilray bycatch was largely confined to east Northland between Great Barrier Island and Cape Brett. The frequency of occurrence in these areas, based on observer data could be as high at 23% of sets compared to <2% in other areas.
2) Photographic evidence indicates that the majority of incidences involve spinetail devilray.
3) The current approach of vessels is to try and release manta rays alive where possible, but the requirement to process the catch in as short a time as possible is the priority, and limited their acceptance of proposed methods that might hinder this process.
4) Observer database records from the last seven years suggest that in a high proportion of occurrences, the manta rays are brought on deck in the brailer and then lifted from the deck over the side using hooks or ropes passed through gills or pectoral wings. These handling practices may result in an unknown, possibly unacceptable, level of post-release mortality.
5) Observations from interviews indicated varied behaviour by manta rays with some active escape searching along the corkline but other situations where the manta rays are mixed in with the catch, meshed in the bunt and sometimes not even noticed until the volume of the net is well reduced. Thus release methods used for dolphins and whale sharks where the net and cork floats along one edge are sunk or a “window” is opened up may not always be feasible. This method also requires time spent to release the manta ray before the process of sacking, rolling and brailing.
6) Where skunked tows catch manta rays that become entangled in the bunt, the animals are freed in a process similar to one recommended with meshes being cut in the net, although there is a preference for minimizing meshes cut, which may then require the use hooks or lines to pull the manta ray free.
7) One skipper suggested that manta rays were or could be targeted and removed using the brail net at the beginning of the brailing operation. It is not clear if this is current practice amongst vessels, if it would work for larger rays, and no such descriptions were found in observer records to support the efficacy of this approach.
8) If manta rays can be caught and released over the side from the brail net directly, without coming onboard, it is potentially an effective mitigation method. One disadvantage of this method however, is the potential abrasion from the twine and the small size of the brailer used on some vessels compared to the size of many manta & devil rays.
9) The practice developed by one super-seiner of using a large mesh cargo net placed over the hopper, allows a rapid transfer overboard once the brailer is emptied and eliminates the need to use hooks etc. This method is a more practical version of the originally proposed canvas cargo net.
10) Although the initial consultation with small vessel skippers did not result in uptake of the canvas cargo net approach, the large mesh cargo net technique may be a more acceptable option where it is not feasible to catch and release the manta from the brailer directly (eg, if it is scooped up with a large amount of tuna).

4.2 Specific objective 1.2.2: To make recommendations for future work to develop and/or assess the efficacy of methods to mitigate the capture of protected rays in commercial purse seine fisheries

Based on the existing evidence from diaries, photos and discussions, it is possible that a proportion of manta rays caught may suffer post-release mortality as a result of the conditions and injuries sustained during purse seining. The primary recommendation of this study is that there is a need to improve methods for handling and release. Given the information currently available, the following recommendations are made;

- The recently developed handling manual produced by the EU MADE project should be distributed to skippers as a general guide.
- It is recommended that, wherever feasible, manta and devil rays be released prior to hauling and sacking by sinking the corkline and guiding the fish out of the net in some way.
- If this is not possible, removal from the sacked net by targeting and scooping using the brail net should be encouraged and documented. The earlier in the brailing process that this is achieved, the higher the chance of survival.
- If these methods are not feasible, a large mesh cargo net made from soft webbing, should be placed over the hopper before the brail containing the manta / devil ray is emptied. This cargo net can then be used to "sieve" the ray from the tuna catch and lift immediately over the side of the vessel (see Figure 10).
- Leaving manta and devil rays on deck for any length of time should be avoided.

It is critical that the survival of animals released using the above methods are ascertained. It is therefore recommended that a trial of a large mesh cargo net be attempted in the 2012 / 2013 fishing season, with released manta and devil rays tagged using satellite telemetry.

It is fully acknowledged that the best approach to solving bycatch issues and finding practical solutions is to find an effective way to engage skippers and crew in the process. An informal skippers workshop, supported by the fishing companies, is suggested as the most efficient use of skippers time, allowing the reasons for these recommendations to be outlined, the practicality of the above suggestions and likely acceptance in the longer term to be discussed as well as other ideas developed. Such workshops have proved invaluable in many other bycatch mitigation initiatives worldwide.

It is also recommended that more detailed information is collected on manta and devil ray encounters over the longer term. Observers should ensure they are clear on the identification of different species and codes, and continue to record details around the behaviour of captured manta and devil rays and release methods of rays caught in both skunked as well as successful sets using the form provided (Appendix 1). A simple way of scoring condition prior to release (e.g. Braccini et al. 2012) should be developed for use by MPI observers.

It is also recommended that spotter plane pilots could record their observations of manta and devil rays using the sheet already used to record tuna schools. This would provide valuable information on spatial and temporal patterns of occurrence.

In the longer term, these data and observations may allow the development of mitigation methods, such that manta rays and the problems associated with them (such as skunked tows, lost time to remove from nets) may be avoided completely.

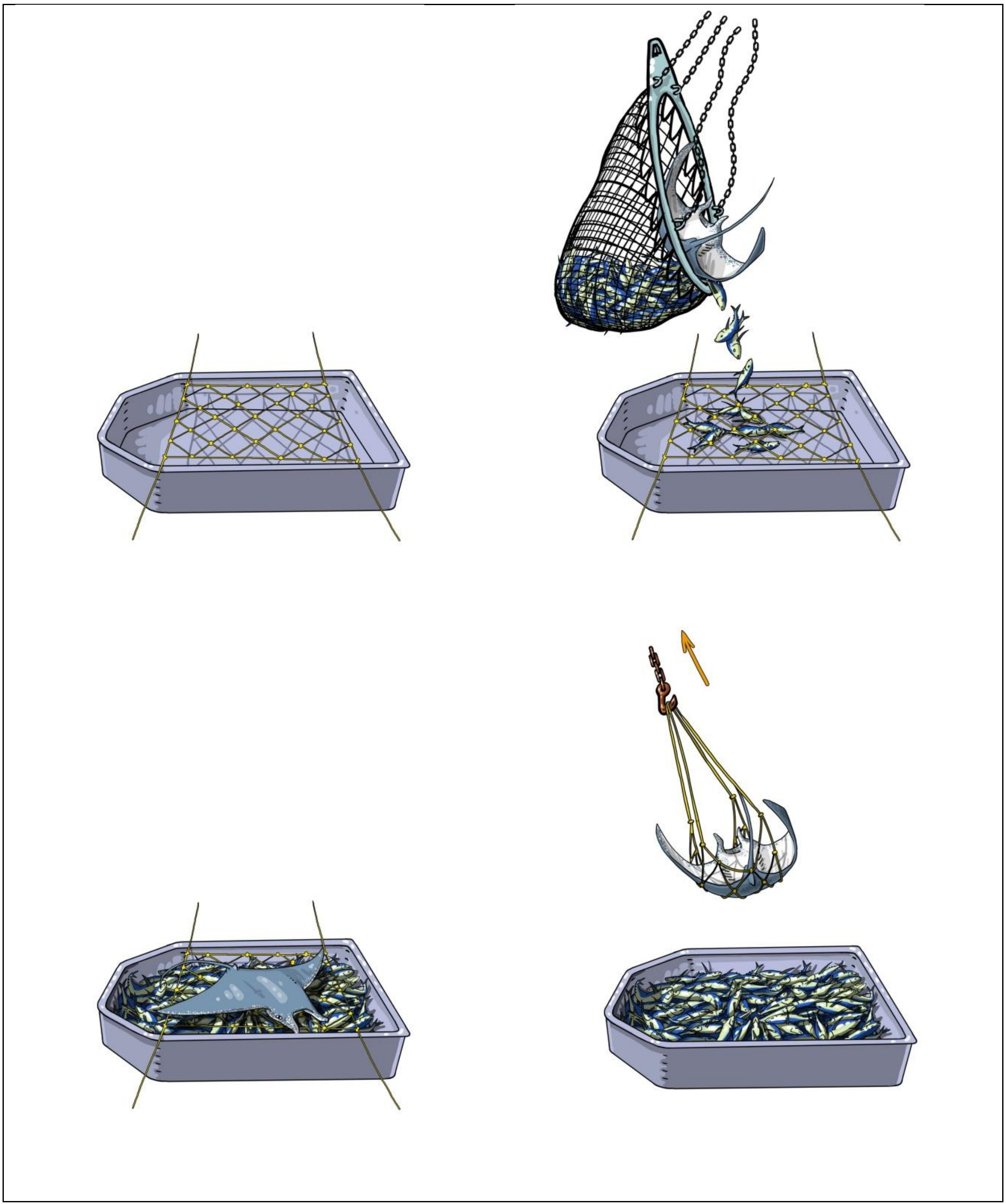

Figure 10 Proposed method of releasing manta and devil rays brought onboard in a brailer with catch (drawings courtesy of Francois Poisson, IFREMER).

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7 Appendix 1 - Manta & devil ray By-catch Form (MIT2011-01)

Manta & devil ray By-catch Form (MIT2011-01)

TRIP NO. & SET NO:

1. Manta location & capture

When & where (in relation to fish school) was the manta ray first observed in the fishing process by crew, observer or spotter plane?

Was the manta(s) visible inside the seine net, & if so where, for how long and what was it doing?
e.g. evidence of avoidance of tuna, vessel, net, behaviour at surface etc

If brought onboard during brailing, estimate of when – early on in procedure or in last of the catch?

Where in brail net was manta – top / bottom / unknown?

How was manta returned to sea from seine net, from deck? Describe method amount of handling etc

Approximate length of time in seine net / brail net (if known)/on deck:

Species: Count:

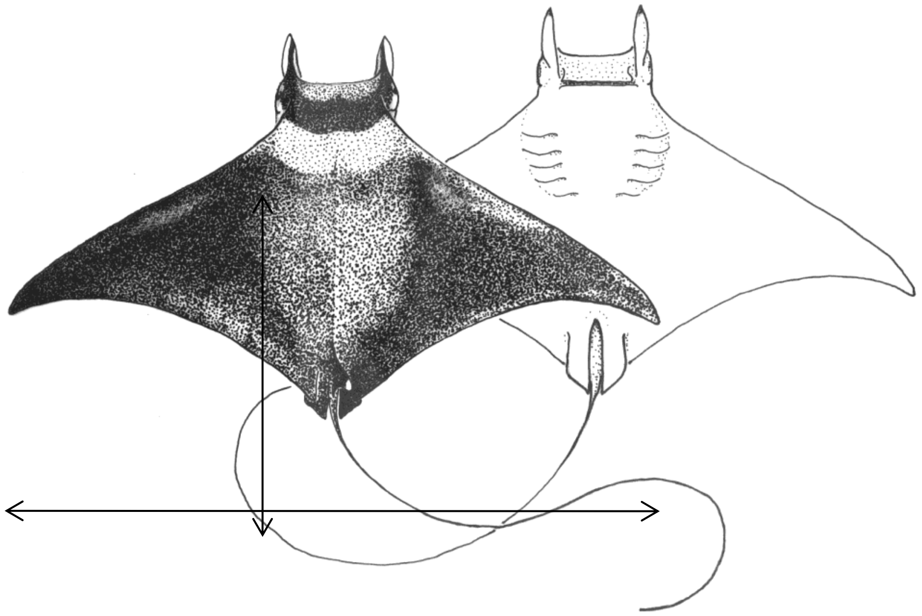
Size – Disc width (wing tip to wing tip) & Body length (front of head excluding horns to end of pelvic fins) (see diagram below for measurements):

Sex:

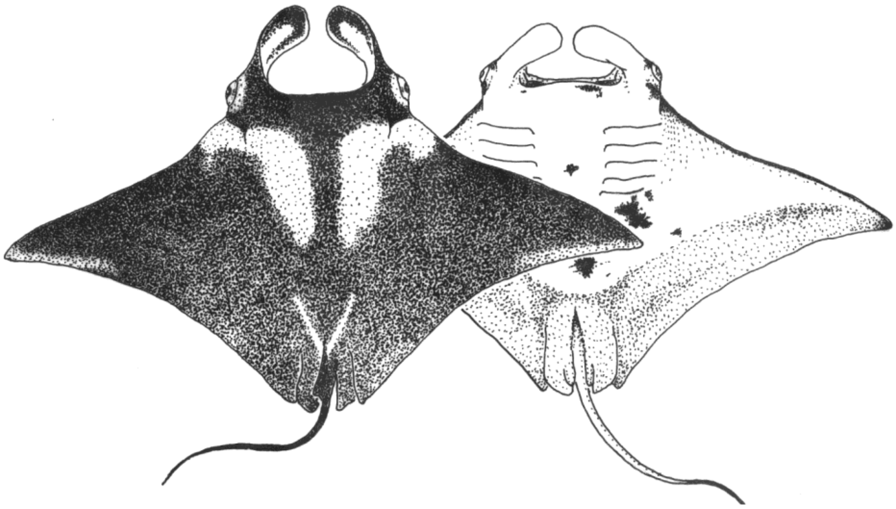
Condition: Healthy Injured Dead

If injured – use diagram below to indicate type / extent of injury:

M. japanica



M. birostris



Drawings from Bigfish project (http://www.bigfish.net.nz/)

Future Mitigation

Can you or anyone else onboard recommend any ways to avoid manta ray capture and / or getting them back to the sea alive, including comments on methods tried already?

Would the skipper be willing to participate in a brief interview by phone or in person? If so please supply contact details on this form & send to:

Dr Emma Jones
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Newmarket, Auckland 1149
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09 375 2056 (office)
0212 977 984 (mobile)