Ministry for Primary Industries
Manatū Ahu Matua

# Synthesis of New Zealand Gamefish Tagging Data, 1975 to 2014

New Zealand Fisheries Assessment Report 2016/24

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The New Zealand Gamefish Tagging Programme (NZGTP) was established by the Ministry of Agriculture and Fisheries in 1975, at the request of game fishing clubs. After a slow start, the concept of tag and release was embraced by fishers and their parent organisation; the New Zealand Sport Fishing Council. On average, between 2000 and 3000 fish have been tagged each fishing year since 1993–94. Inter-seasonal variations in the abundance of migratory fish, together with weather conditions are important factors influencing levels of fishing effort and fishing success.

Data presented in the present report cover the period from 1976 to 2014, comprising 68,775 tag records. Striped marlin is the most important and most-tagged species, followed by yellowtail kingfish, mako shark and blue shark, which together comprise 90% of all fish tagged. These four species were confirmed as priority species in a review of the programme held in 1991. Yellowfin tuna were added to the list of species to be tagged in 2001, but since that time the recreational catch has fallen to insignificant levels, with the result that only 1245 have been tagged in New Zealand waters in total. This report provides a synthesis of release and recapture information since the inception of the NZGTP. A series of annual reports have been produced over the years that provide seasonal highlights and details of individual releases and recaptures.

There have been 2166 fish of 20 species recaptured in the NZGTP to the end of June 2014. The recapture numbers are dominated by yellowtail kingfish (1462) and mako shark (368) but the highest recapture rate has been for school sharks (22%). Of the species with substantial release numbers however, the recapture rate for yellowtail kingfish is 6.89%, while the rate for mako shark is 2.53%. Return rates for billfish are much lower: 1% for broadbill swordfish, 0.7% for blue marlin and 0.4% for striped marlin. Tag shedding has been suggested as a cause of low tag return rates in striped marlin. The introduction of Hallprint PIMA nylon-headed tags since 2005 has not demonstrated any major improvement in striped marlin recapture rates but the use of PIMA tags is not yet widespread amongst New Zealand anglers. Satellite tagging of striped marlin in New Zealand waters has shown high survival rates of striped marlin post-release after the fish were caught with standard sport fishing methods and equipment. The probable cause of the low recapture rates is less likely to be post-release mortality than various other possibilities; tag shedding, the movement of billfish into areas where there is low fishing effort, or non-reporting of tag recoveries.

Striped marlin, mako and blue shark recaptures have been widely spread across the South Pacific. To date all but six recaptures in the NZGTP have been from the Southwest Pacific, showing regional fidelity for the main species tagged in the NZGTP. Pacific and southern bluefin tuna have spawning grounds outside the southwestern Pacific but relatively few of these species have been tagged and recaptured in the NZGTP.

Some care is needed when interpreting the movement information for the NZGTP and similar tagging programmes. Fish are tagged where the recreational fishery operates and some skippers are more committed and diligent than others. So tagging is not spread across the distributional range of the species and plots of recaptures naturally tend to movement away from these tagging “hot spots”. Similarly, points of recapture are dependent on where and when effective fishing effort occurs. These can lead to fishery dependant biases in the movement patterns observed.

New technology and techniques can provide more detailed insights into fish movement and population structure. Electronic archival and pop-off satellite archival tags can provide detailed information on temperature, depth and light levels and migration which are fishery independent. Advances in genetic techniques and stable isotope analysis will also provide greater resolution around stock structure of high migratory species.

## 2. INTRODUCTION

The New Zealand Gamefish Tagging Programme was initiated by the Ministry of Agriculture and Fisheries in 1975 following requests from gamefish clubs. Similar programmes had been established by New South Wales Fisheries in 1973 and by Woods Hole Oceanographic Institute, USA, in 1954. Generally cooperative tagging programmes are opportunistic, supplying numbered spaghetti tags and matching tag report cards to fishers that release part or all of their catch. The type of tag in conjunction with guidance from programme coordinators usually determines the main species tagged in each region. Following tag and release fishers are encouraged to return the tag card with release information to their club or to the address printed on the back. Along with a unique prefix and tag number a return address and the word "Reward" is printed on the tag. The programme coordinator maintains a database of all the release and recapture information. When a recapture is reported this is matched with the release information and the tagger is sent a letter informing them when and where the fish they tagged was recaptured. The fisher returning a tag also gets a letter and a reward shirt, cap or cash.

Generally, cooperative tagging programmes aim to provide basic information on movement and migration patterns; age, growth, and longevity; and stock structure for defining management units (Ortiz et al. 2003). These programmes have gained widespread support from recreational anglers and often provide the only logistically and economically feasible way to tag large numbers of billfish (Pepperell 1990).

This report is a synthesis of New Zealand Gamefish Tagging Programme (NZGTP) data prepared by Blue Water Marine Research Ltd as a reporting requirement for the Ministry for Primary Industries (MPI), project TAG2010/01.

### 2.1. Overview and objectives

**Overall objectives:**

1. To undertake a detailed analysis of the New Zealand Gamefish Tagging Programme data.

**Specific objectives:**

1. To review and summarise all the data collected through the Gamefish Tagging Programme.

2. Describe methodological changes and changes to the tag database over time.

3. To develop graphical descriptions of linear displacements for each species tagged, released and recaptured by the programme.

4. To review displacements in terms of time-at-liberty, fish size, season and area.

5. To review individual tagger success.

6. To distribute the final report to fishers and clubs involved in the Gamefish Tagging Programme.

### 2.2. Tag types

Since the programme's inception in 1975, several tag types have been used, ( Figure 1 and Table 1.) All have printed yellow streamers with a prefix and tag number. Floy and Hallprint SSD tags have stainless steel tag heads capable of being implanted with the same slotted stainless steel applicator. Hallprint PIMA (plastic head intra-muscular) tags have a nylon double barbed anchor requiring a different applicator tip.

### 2.1. Issuing tags

From 1975 until 1991 tags were issued free of charge to fishers. Following a review of the programme in 1992 the New Zealand Sport Fishing Council (NZSFC) has purchased and distributed tags to recreational fishers at cost through gamefish clubs and some tackle shops. A record is kept of the tag numbers sent to each club or shop. Clubs and retailers are encouraged to also keep a record of who buys tags from them in order to help track recaptures with missing release data. The ordering and importation of tags is still managed by an MPI contractor, as is the printing of report cards with the corresponding tag number.

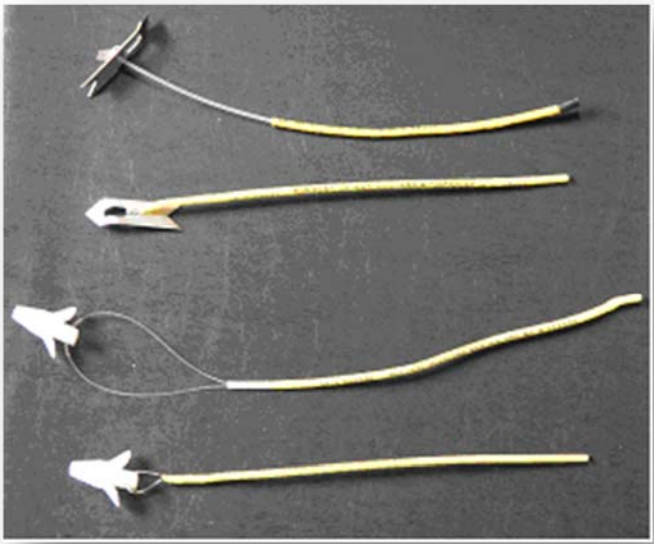


**Figure 1: Tag types used in the NZGTP from top down:**

**Floy FH-69**

**Hallprint SSD**

**Hallprint PIMA nylon leader**

**Hallprint PIMA wire leader.**

**Table 1: Summary of tag types used by NZGTP since its inception in 1975.**

| Tag type. | Timescale of use. | History. |
|---|---|---|
| **Floy FH-69** | 1975–1985 | Stainless steel tag head. Supplied by US Marine Fisheries Service (NMFS) Prefix H before tag number. |
| **Floy FH-69A** | 1985 | Stainless steel tag head. 1000 modified tags supplied with prefix G before tag number. |
| **Hallprint SSD** | 1986–present | Stainless steel tag head. Plastic streamer. Prefix G continued. Some tags were recovered during 1996/7 with broken streamers rendering the tag number unidentifiable. |
| **Hallprint SSD (modified)** | 1996–2004 | Modified SSD tag with stainless steel wire extending the full length of the streamer. Tag numbers G-53501-G92500. |
| **Hallprint PIMA (nylon leader)** | 2005–present | Nylon double barbed anchor. Developed by The Billfish Foundation (USA) and the NMFS and has been widely used on billfish in the USA and more recently in Australia. 24 kg nylon line attaches the streamer to the anchor. Tag numbers N 102501- N 103500. |
| **Hallprint PIMA (wire leader)** | 2007–present | Nylon double barbed anchor. This variant features a stronger stainless steel wire connector. Tag numbers N 108001- N 109000. Both PIMA tags require a different applicator tip to the FH69/SSD tags, are more expensive than the G series tag and are recommended for billfish only. Both tag types are still in use. |

A few selected fishers have been provided free tags in return for measuring all the yellowtail kingfish they tag and recapture. In 2010 participants in the kingfish monitoring project were also provided free tags as an incentive to measure all the kingfish they caught and keep the heads from landed fish for otolith removal and age analysis.

Commercial fishers have always been provided free tags and applicators if they request them. This included foreign licenced Japanese surface long liners who were all issued tags and instructions as part of their licence conditions in the late 1980s and 1990s following the introduction of the Billfish Moratorium.

## 2.2. Tag cards

Although the design of the tagging report card has changed over time, the basic information collected on all cards since 1975 remains: species, location, date, length or weight, remarks, anglers name and address and skipper's name and address. Initially the name of the fishing club and line weight was included, although both criteria have since been removed. Vessel name and fight time have subsequently been added. More changes were made in 2000 with the addition of latitude and longitude, skipper's phone number and tick boxes for capture method with options for: Lure; 'Live bait', 'Dead bait' and 'Hook removed'. In 2015 a further option was added, requesting anglers to specify the hook type used: whether J or circle hook.

Changes in return address have been problematic at times. The address since 2002 (and current) is:

**Ministry for Primary Industries**
**PO Box 19747, Avondale,**
**Auckland**
**New Zealand.**

For a while after each address change the old address was monitored but it is inevitable that some release and recapture information has been lost.

## 2.3. Database

The original hard copy filing system was established by P. Saul working for the Ministry of Agriculture and Fisheries in 1975. The numerically ordered tag card files and date ordered recapture letter files continue to be maintained in much the same way. In the early 1990s J. Holdsworth started an electronic recapture and release filing system. Vessel name was not recorded on the early tag cards and angler's name and address was not punched while the backlog of old cards was entered. In 1997 the database was handed over to NIWA and converted into a relational MS Access file by B. Hartill. Periodically data is loaded onto the MPI *tag* database which was designed around tagging on research vessels. In 2000 the NZGTP was put out to competitive tender by the Ministry of Fisheries. Blue Water Marine Research was awarded the contract to manage the database for three years. Subsequent contracts have also been awarded to Blue Water Marine Research by the Ministry for Primary Industries.

## 2.4. Rewards

Tagging certificates can be issued by fishing clubs to anglers who tag and release a fish. Until the late 1980s the angler or reporter of a tag recapture was sent a letter with details of release and recapture and a NZ$ 10.00 note. A tagging programme printed T shirt was used as a recapture reward from the late 1980s to 2000. Since 2000 the fisher reporting a recaptured fish is sent a printed polo shirt as a reward along with a letter describing the release date and location, growth, movement, and time at liberty of the fish. A copy of the recapture letter is also sent to the skipper and angler who tagged the fish and the skipper for the recapture.

Following the discussion and recommendations of an international panel review of the tagging programme in 2008 an additional $1000 annual lucky draw for a fisher returning a tag and information has been introduced. The NZGTP is the only programme we know of which sends a printed T Shirt to the fisher releasing a fish that has subsequently been recaptured.

# 3. FISHERY REVIEW

The New Zealand Gamefish Tagging Programme (NZGTP) was introduced as a multi species gamefish tagging programme to study the seasonal and short-term movements of gamefish species of importance to New Zealand fisheries. While the intention was to tag billfish, it was accepted that a variety of gamefish species would be tagged as fishers got used to tag and release methods (Saul & Holdsworth 1992). Initially the number of fish tagged in New Zealand was low, comprising mostly mako shark and yellowtail kingfish.

In 1991 a review of the NZGTP and its objectives was conducted by the Ministry of Agriculture and Fisheries. One of the outcomes was an intention to focus tagging effort on four species - striped marlin (*Kajikia audax,*) shortfin mako shark (*Isurus oxyrinchus*,) blue shark (*Prionace glauca*) and yellowtail kingfish (*Seriola lalandi*.) (Saul & Holdsworth 1992). These species were selected on the basis that either there was potential to tag substantial numbers of fish and make sufficient recaptures to provide useful data, or they were species of national or international significance or concern (Saul

& Holdsworth 1992). Yellowfin tuna (*Thunnus albacares*) were added to the group of species to be tagged from 2000–01. Recreational anglers responded well to the focus of the programme, although the decline in availability of yellowfin tuna in New Zealand since 2001 has meant fewer of this species have been tagged than expected.

The recreational fishery for large pelagic species is very important for many New Zealanders and attracts tourist fishers from around the world. The fishery operates mainly over the warm summer and autumn months and is least active over winter. The sport fishing year is from 1 July to 30 June the following year.

Striped marlin is the mainstay of the game fishery on the Northland east coast, with blue marlin (*Makaira nigricans*), swordfish (*Xiphias gladius*), and small numbers of black marlin (*Makaira indica*) and shortbill spearfish (*Tetrapturus angustirostris*), also caught. Yellowfin tuna and yellowtail kingfish have historically been caught in large numbers, although successive poor yellowfin seasons between 2007/08 and 2013/14 have seen an increase in targeting of striped marlin and blue marlin. Shark species have been important as a recreational target species in southern regions, but less so in recent years. Game fishing has developed on the west coast of the North Island over the last 25 years with, at times, a very productive marlin and tuna fishery accessed from the west coast harbours and beaches as far south as Taranaki, (Figure 2).

The game fishery in the South Island is centred off Canterbury, Otago, and Fiordland, principally targeting an abundant blue shark population. Porbeagle shark (*Lamna nasus*), albacore (*Thunnus alalunga*) and occasionally southern bluefin tuna (*Thunnus maccoyii*) are also targeted. There is a seasonal (winter) fishery for Pacific bluefin tuna (*Thunnus orientalis)* off the central west coast of the South Island, accessed from the ports of Greymouth and Westport. Large Pacific bluefin feed on spawning aggregations of hoki (*Macruronus novaezealandiae)* that are targeted by commercial trawl vessels offshore between July and September (Figure 2). A list of species codes and common names is provided in Appendix 1.

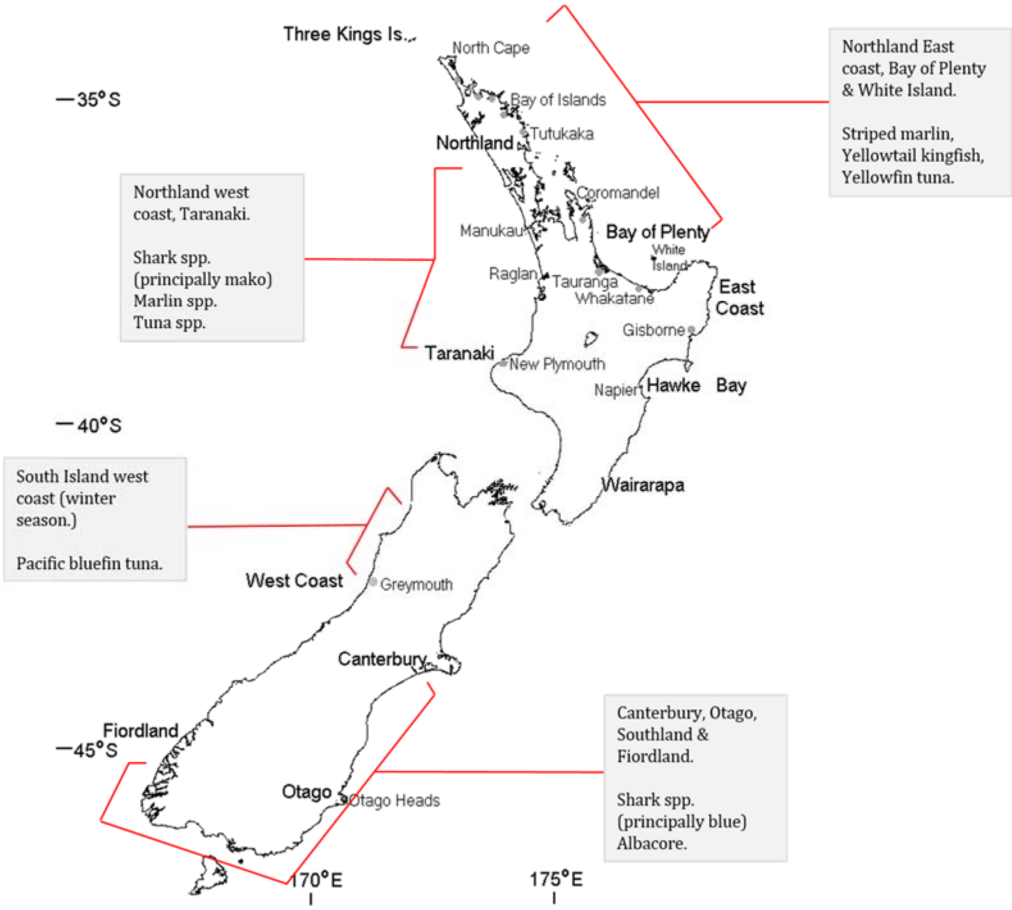



**Figure 2: Location, distribution and primary species targeted by New Zealand recreational gamefish fisheries.**

Marlin species are also a bycatch of the commercial surface longline fishery that mainly targets bigeye tuna (*Thunnus obesus*), swordfish and southern bluefin tuna. Within the New Zealand Exclusive Economic Zone (EEZ), commercial fishers are obliged by regulation to release all billfish, except swordfish, alive or dead. This regulation includes a provision that live billfish should be tagged if possible, and previously tagged marlin recaptured by commercial fishers are allowed to be landed and brought to port for scientific study.

## 4. RESULTS

### 4.1. Programme summary

Although the The New Zealand Gamefish Tagging Programme was initiated in 1974, it took over 10 years to win broad acceptance and fisher participation. There was significant growth in the numbers of fish tagged between 1985 and 1995 (Figure 3). Since then between 2000 and 3000 fish have been tagged each year, mainly by recreational fishers. The peak was in the warm 1994–95 year when 4,639 fish were tagged in New Zealand fisheries waters. In total 66,796 fish tagged in New Zealand waters are entered in the database and 1,979 have been tagged elsewhere in the Southwest Pacific as of 30 June 2014.

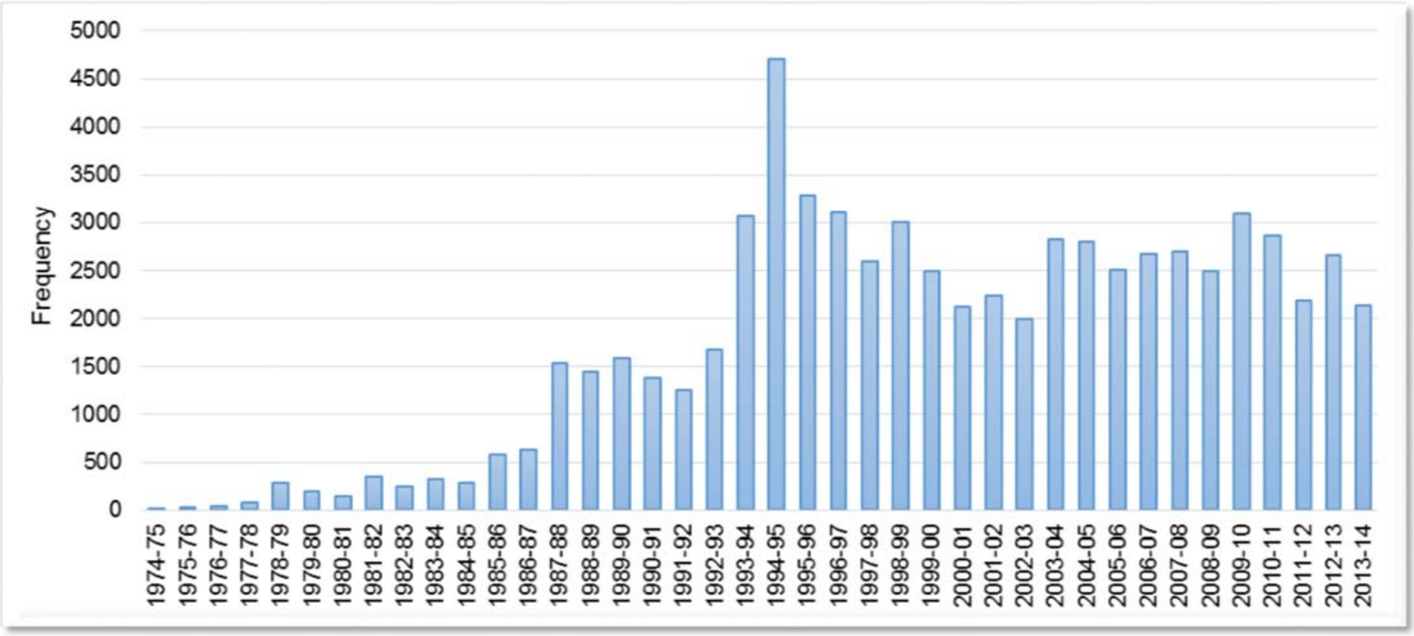



**Figure 3: Total annual number of gamefish (comprising 49 recorded species,) tagged and released by NZGTP inside the New Zealand EEZ between 1974 and 2014.**

The proportion of fish tagged can be combined into four species groups: billfish (36%); yellowtail kingfish (31%); sharks (30%); and tunas (3%). The number of billfish tagged has been the most consistent group since 1994–95 with an average of 1,097 (s.d. 243) fish tagged per year (Figure 4) of which 91% were striped marlin. The number of yellowtail kingfish tagged peaked in 1994–95 and since then 790 (s.d. 302) have been tagged per year. Sharks tagged also peaked in in 1994–95 and since then 733 (s.d. 373) have been tagged per year (Figure 4). The number of tuna tagged has been relatively low. Between 1992 and 2000, fishers were discouraged from tagging tuna as they were not a species included in the objectives of the NZGTP and since 2005 they have been largely absent from New Zealand waters. Fishers supplied with tags do occasionally tag other species such as mahi mahi with the other-species category accounting for just 0.33% of the total (Figure 4).

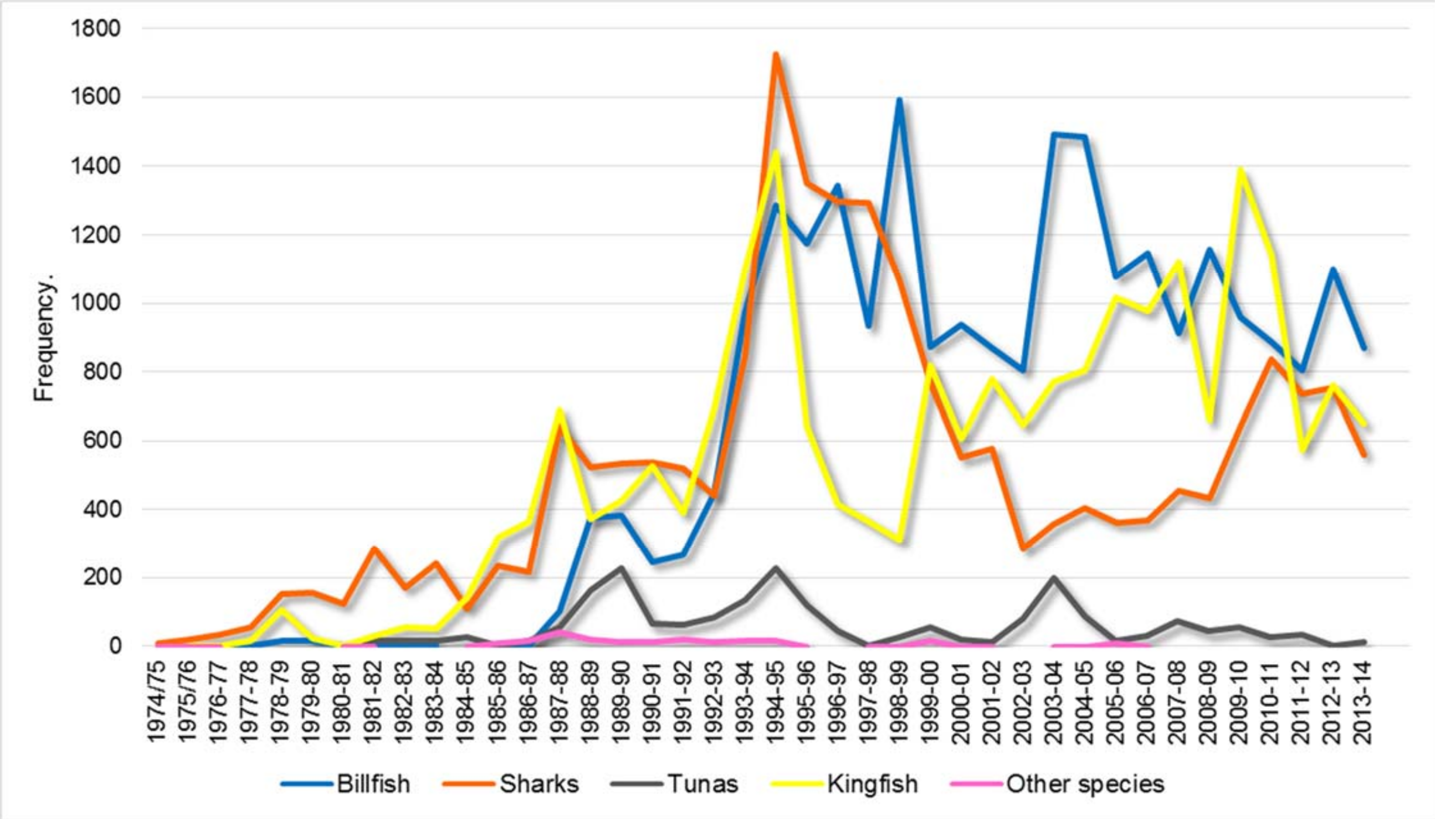



**Figure 4: Number of fish tagged and released by group and season, for fish tagged inside and outside New Zealand EEZ.**

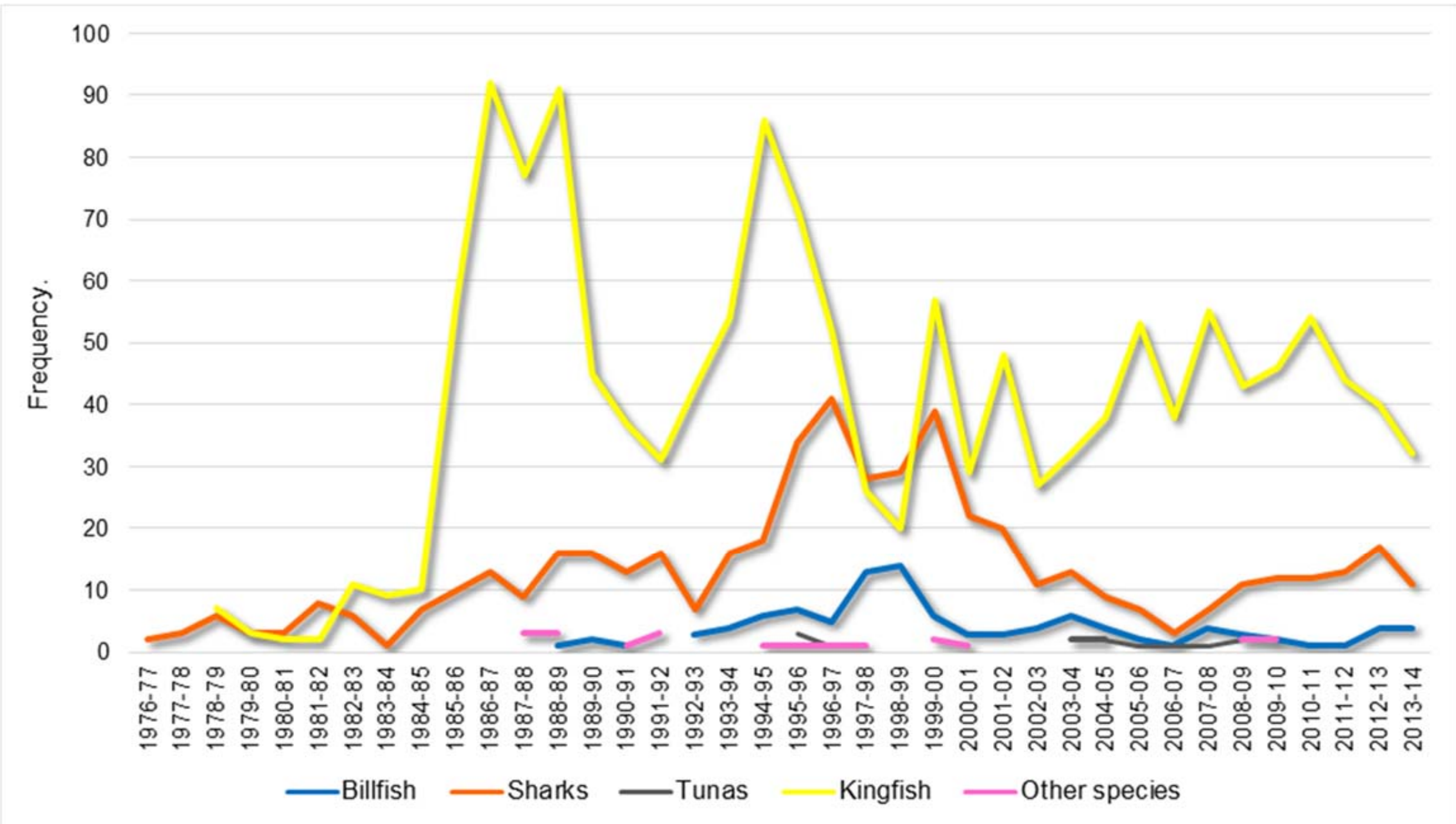



**Figure 5: Number of fish recaptured by species and season, for fish tagged inside and outside the New Zealand EEZ.**

## Total releases and recaptures by species

90% of all recorded releases from 1975 to 30 June 2014, both inside and outside the New Zealand EEZ, comprised four species: striped marlin, yellowtail kingfish, shortfin mako shark, and blue shark (Figure 6). The highest number of recaptures over the same period was yellowtail kingfish, (Figure7). All other species had less than 50 recorded recaptures making further analysis problematic.

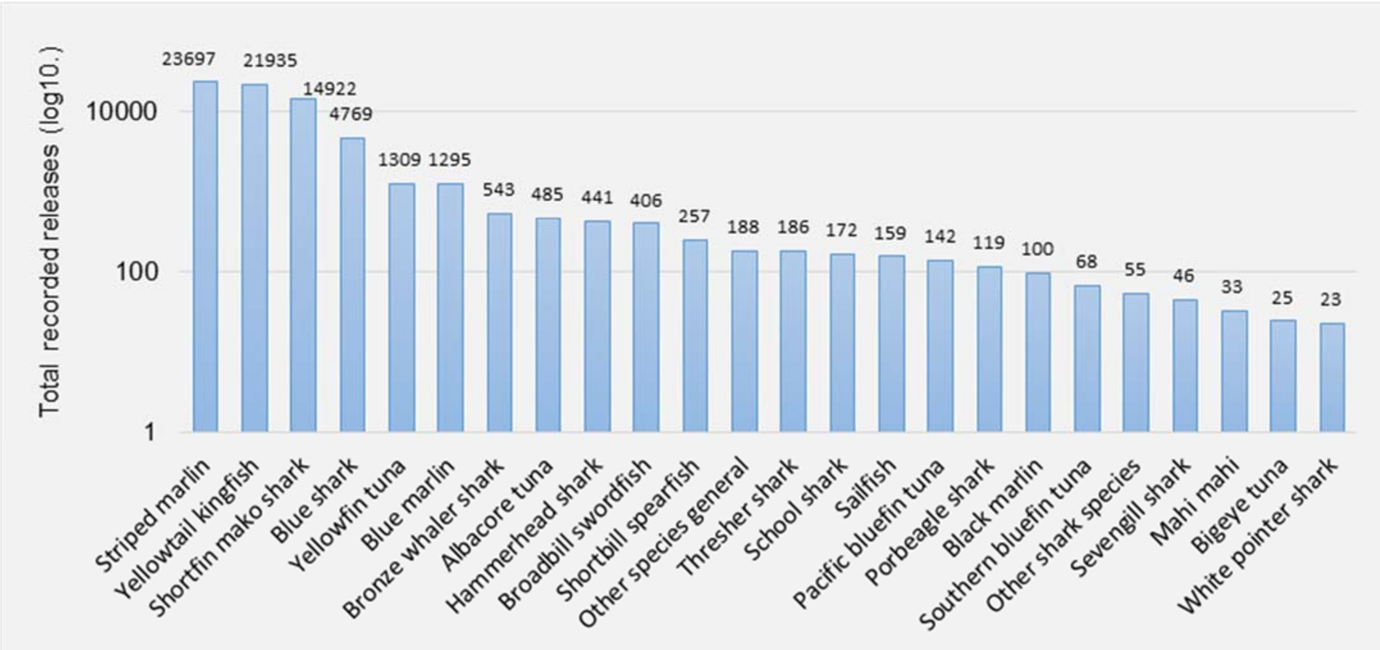



**Figure 6: Total recorded releases by species both inside and outside New Zealand EEZ, 1975–2014 on a log scale.**

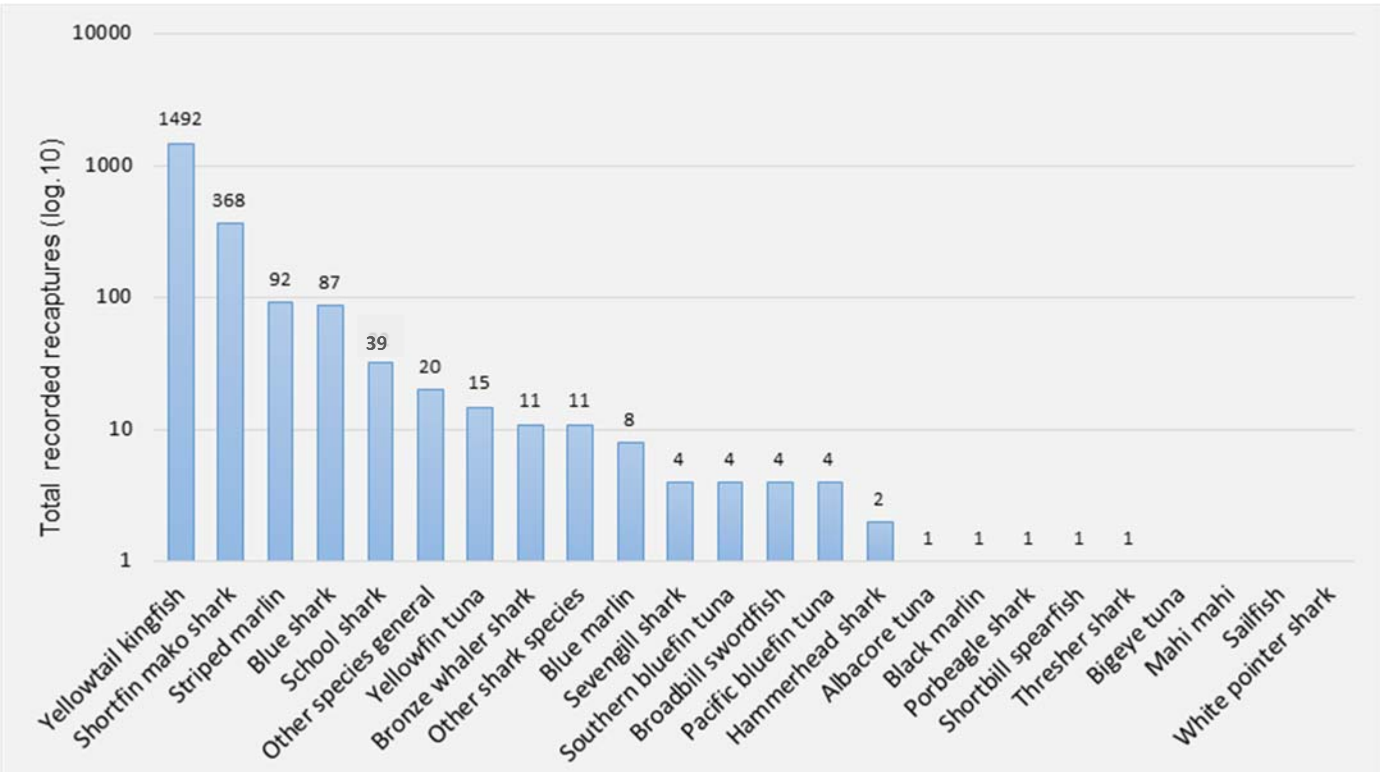



**Figure 7: Total recorded recaptures by species both inside and outside New Zealand EEZ, 1975–2014 on a log scale.**

### Recapture rates by species

Recapture rates remain relatively low; with all but five species having a recapture rate of less than 5%. Interestingly, although relatively few school sharks (*Galeorhinus galeus)* have been tagged and released (172 individuals since 1975,) over a fifth have been recaptured (Figure 8). The Hallprint tags hold well in school sharks which are long lived and appear to have a relatively high exploitation rate. The relatively high recapture rates for yellowtail kingfish and seven gill sharks appear to be related to resident portions of the population that are recaptured close to their release site. Relatively few bluefin tuna have been tagged but the recapture rates are comparatively high.

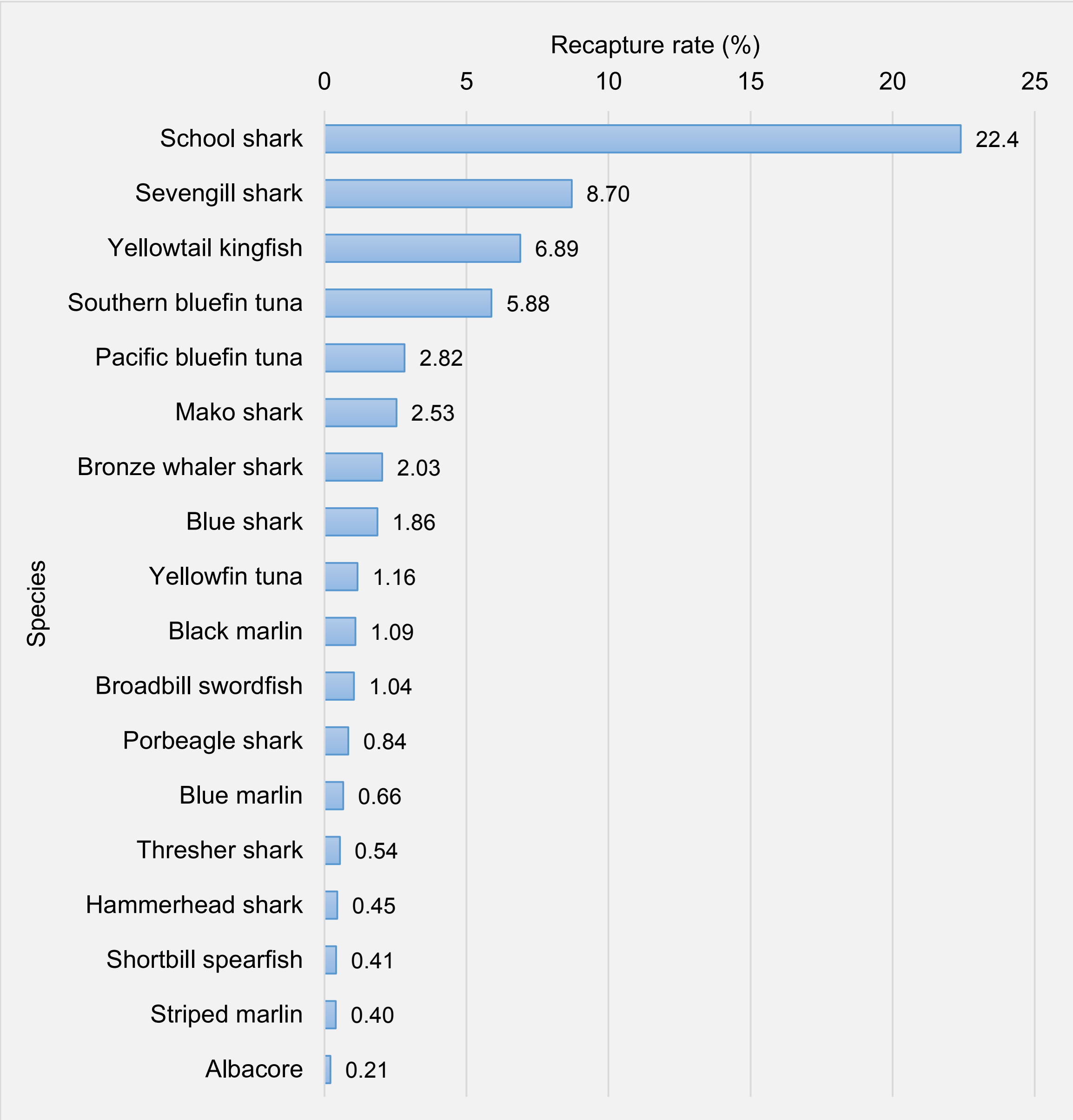
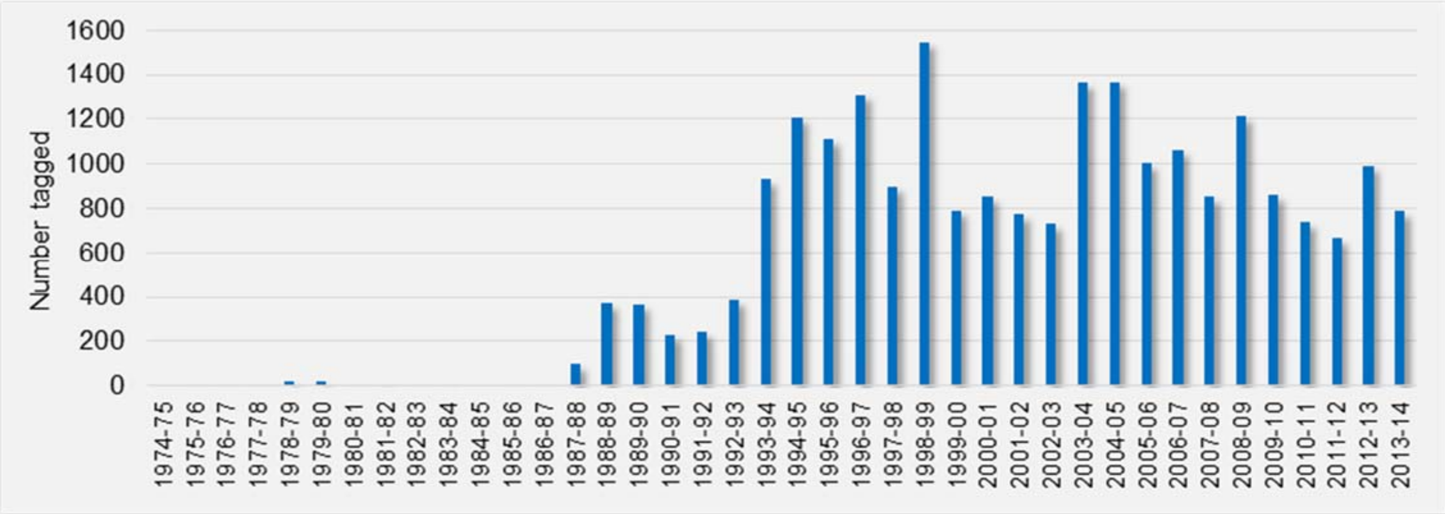



**Figure 8: Percentage recapture rate by species both inside and outside New Zealand EEZ.**

## 4.2. Billfish

### 4.2.1. STM: Striped marlin (*Kajikia audax*)

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 21 591 | 939 | 90 | 0.40 | 3137 | 3.08 |



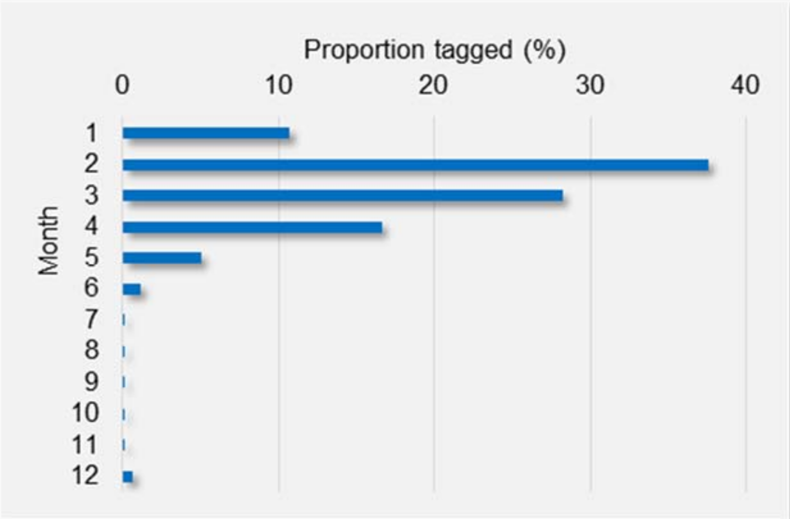



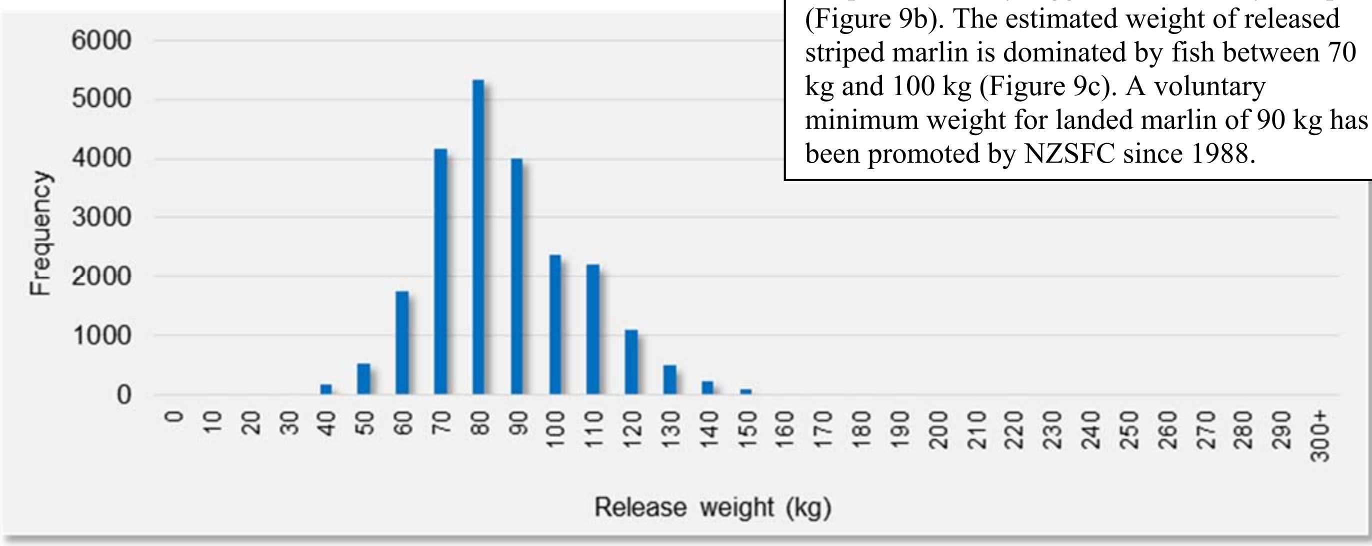

***Figure 9 a–j.***

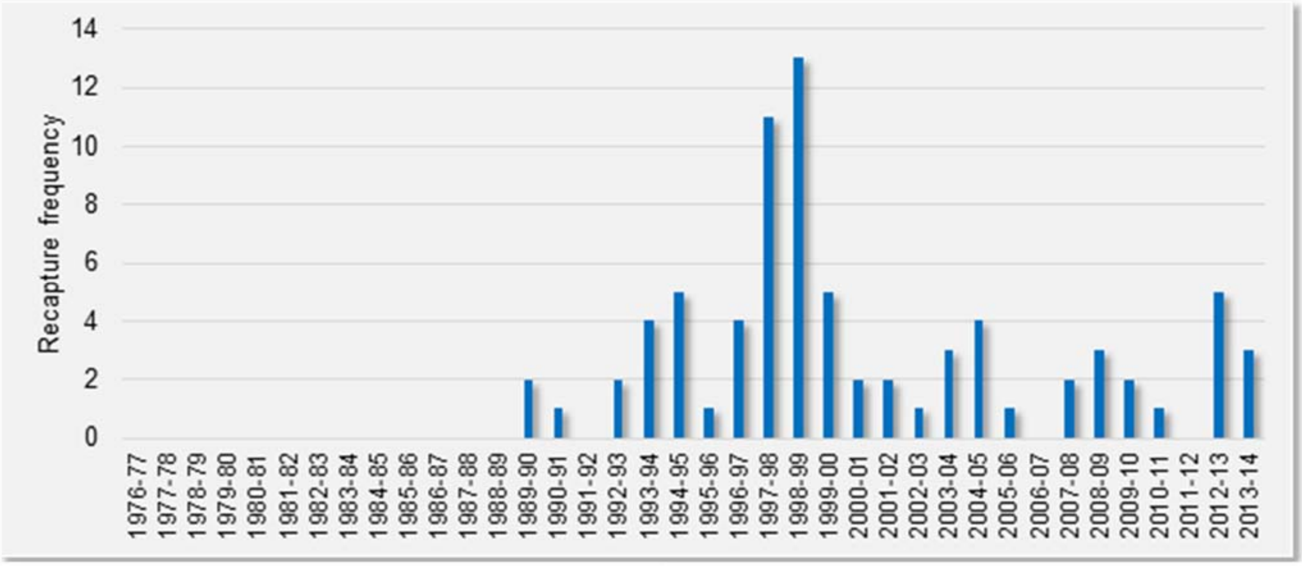
***a) Above.*** Striped marlin tagged and released by year 1974–2014.

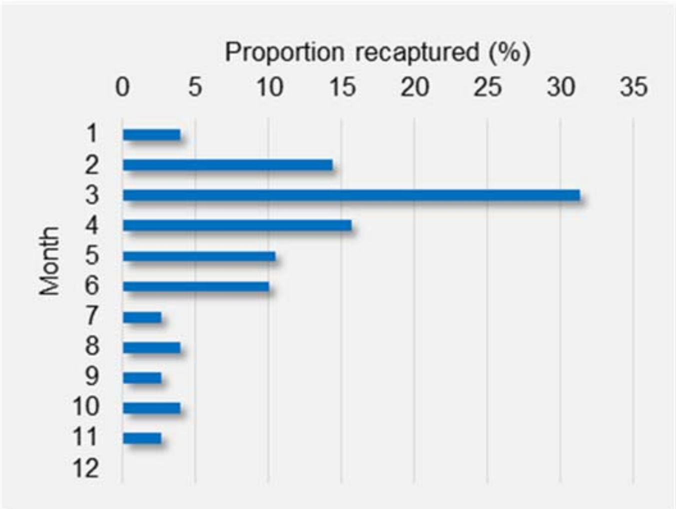
***b) Left.*** Proportion of striped marlin tagged by calendar month 1974–2014.

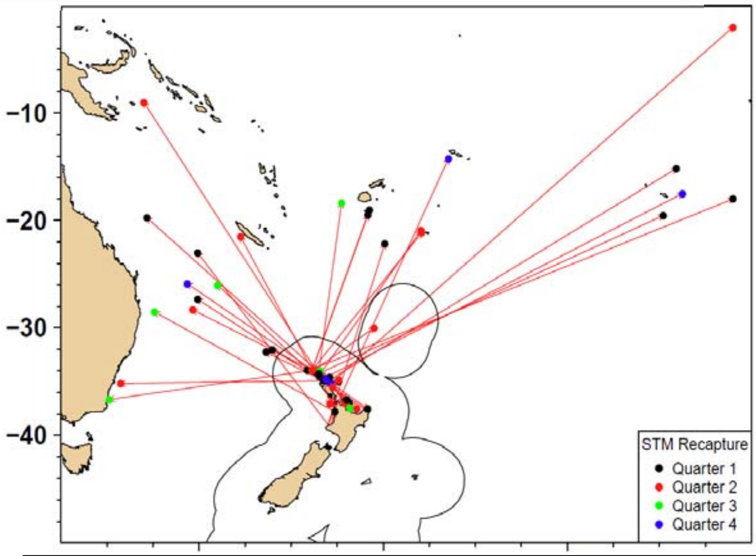
***c) Below.*** Weight (kg) of tagged striped marlin released 1974–2014. (Note. Discrete weight/length frequency bars represent the lower limit of weight/length values, e.g. (below) release weight of 90kg (frequency 4000) represents 4000 tagged fish weighing between 90.00 and 99.99kg.

Striped marlin has been a major species tagged in the NZGTP since the late 1980s when Minister Colin Moyle challenged recreational fishers to tag 50% of marlin (Figure 9a). They are predominantly tagged from January to April (Figure 9b). The estimated weight of released striped marlin is dominated by fish between 70 kg and 100 kg (Figure 9c). A voluntary minimum weight for landed marlin of 90 kg has been promoted by NZSFC since 1988.





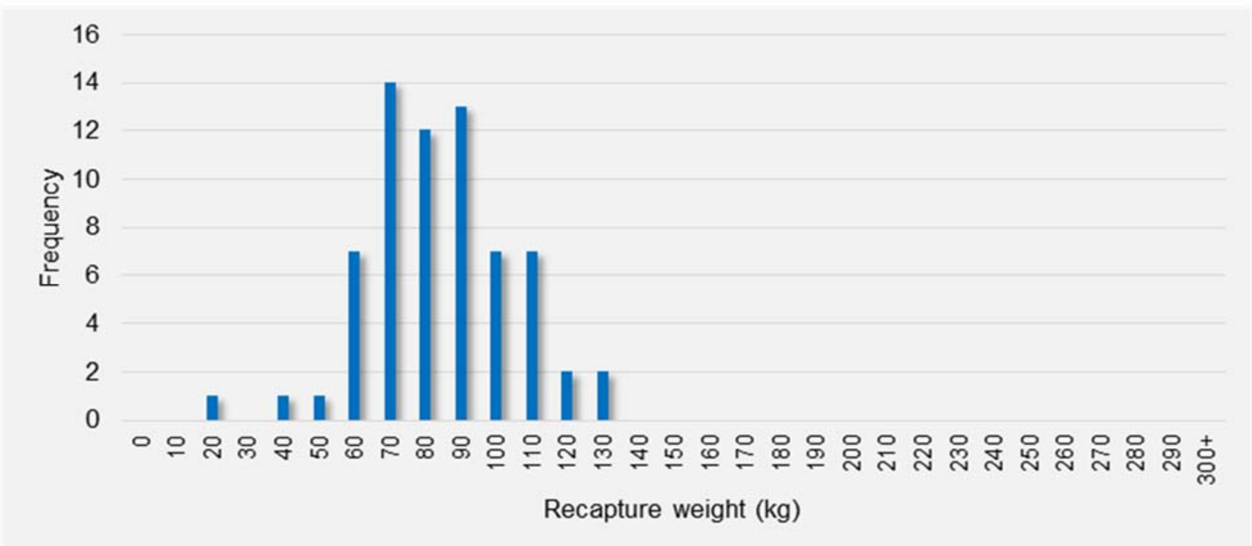

***d)*** ***Top.*** Striped marlin recaptures by year 1976–2014.

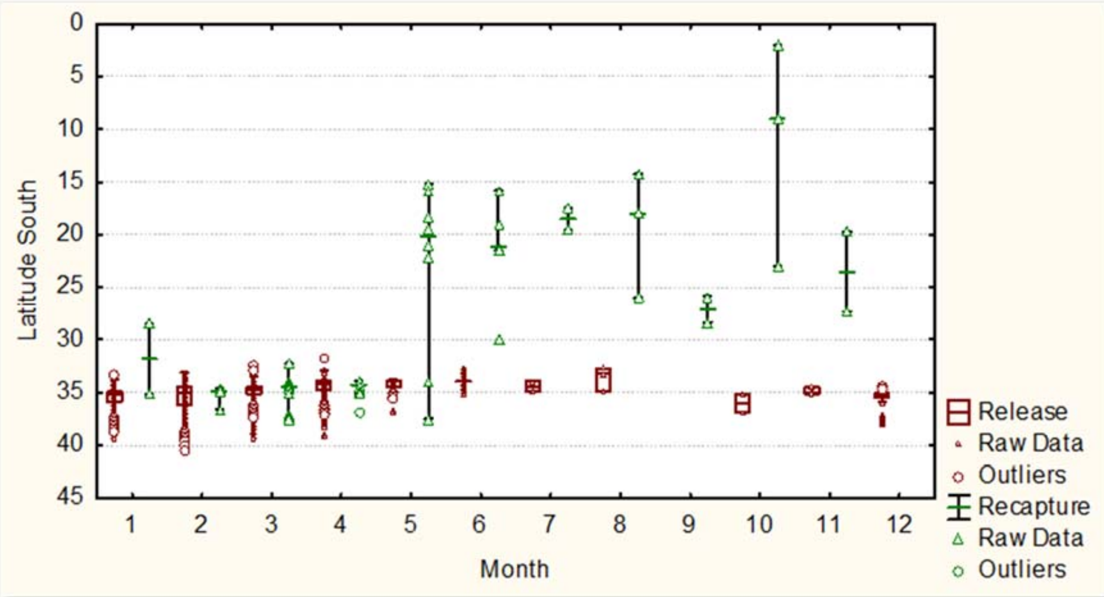
***e)*** ***Above.*** Proportion of striped marlin recaptures by calendar month 1976–2014.

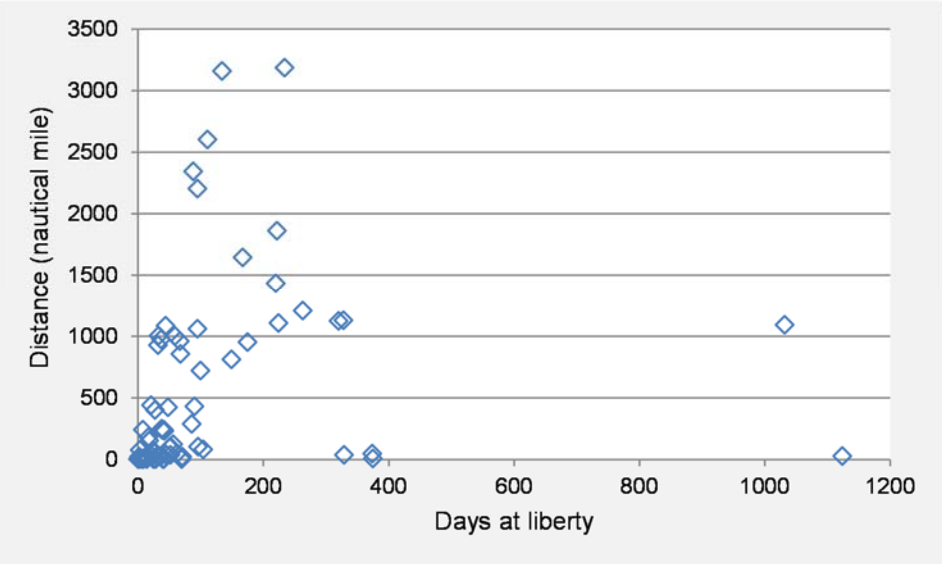
***f)*** ***Right.*** Distribution of striped marlin recaptured (by quarter) 1976–2014.

***g)*** ***Below.*** Weight (kg) of striped marlin recaptured 1976–2014.

The number of striped marlin recaptures by year have been variable with a peak in the late 1990s (Figure 9d). They have been recaptured in every month except December with a third recaptured in March (Figure 9e). Recaptures made between June and November are almost all from commercial fishers spread across the SW Pacific from Eastern Australia to French Polynesia (Figure 9f). Most recapture weights are between 60 and 110 kg with 58% reported as estimated weight (Figure 9g).





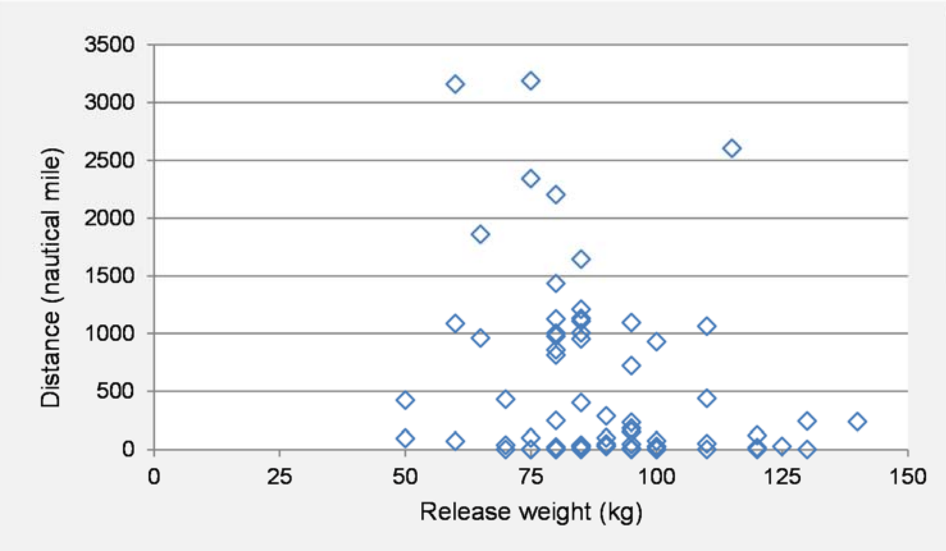




**h)** ***Top.*** Striped marlin releases in New Zealand waters and recaptures from all areas by latitude.

**i)** ***Left.*** Distance moved by days at liberty for recaptured striped marlin.

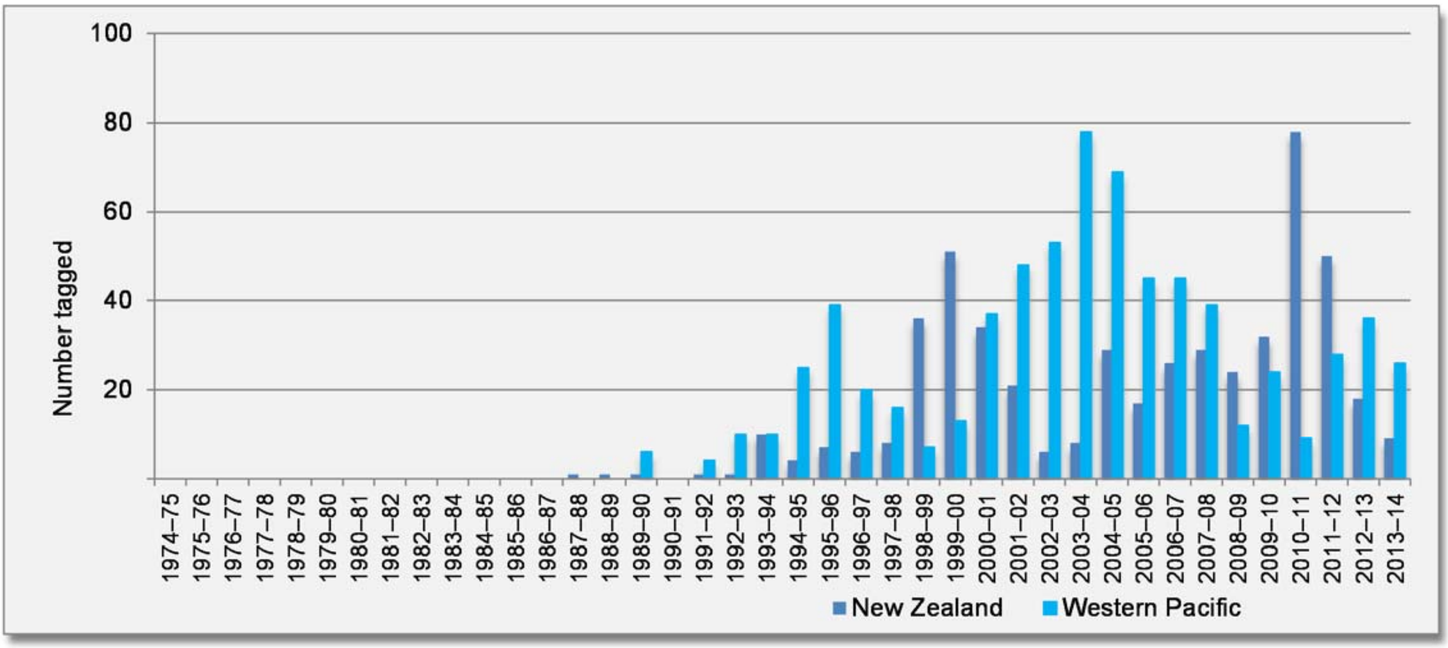
**j)** ***Below.*** Distance moved by striped marlin release weights

Most striped marlin tagged in New Zealand were caught between 33° and 39° S (Figure 9h). Small numbers have been tagged from surface longline vessels in winter months. Recaptures at lower latitudes are mainly from May to November. Most recaptures made during the New Zealand game fishing season are generally short-term recaptures by sport fishing vessels or in a few instances (4%), in a subsequent season (Figure 9i).
Smaller striped marlin have travelled furthest but also have been tagged in larger numbers (Figure 9c and 9j).



### 4.2.2. BEM: Blue marlin (*Makaira nigricans*)

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 508 | 699 | 8 | 0.66 | 1005 | 3.19 |



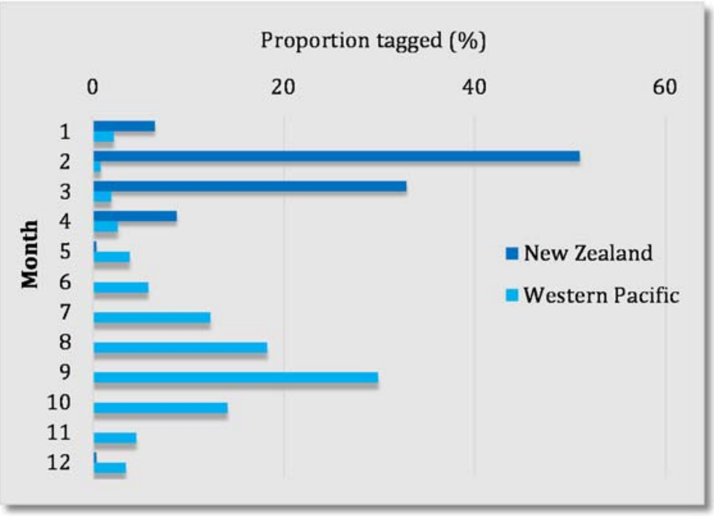



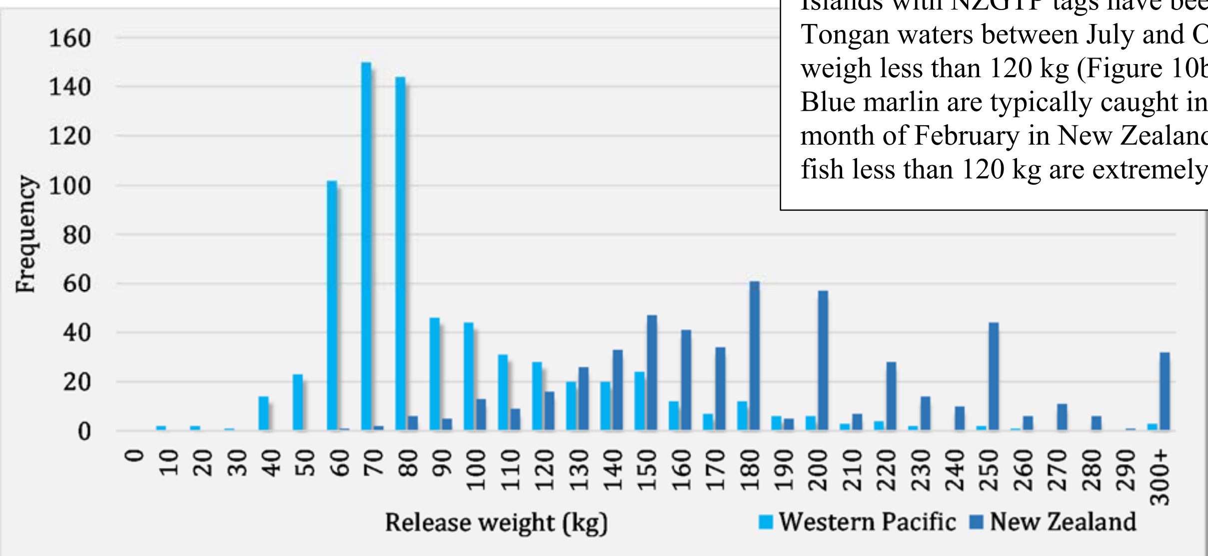

***Figure 10 a-e.***

***a)*** ***Above.*** Blue marlin tagged and released by year 1974–2014.

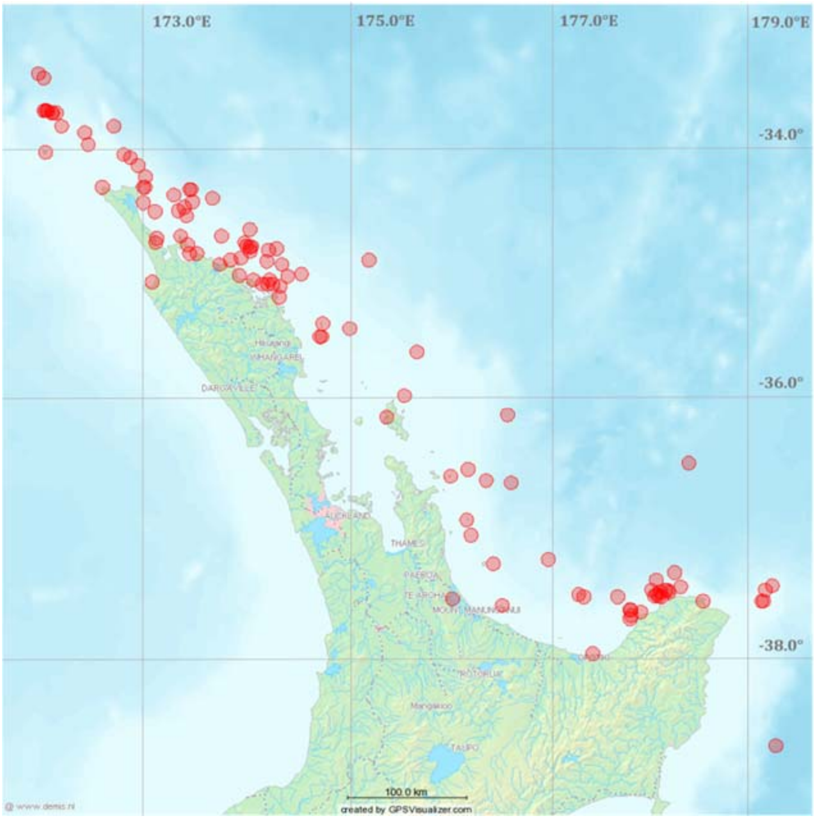
***b)*** ***Left.*** Proportion of blue marlin tagged by month in New Zealand waters and elsewhere in the SW Pacific 1974–2014.

***c)*** ***Below.*** Weight (kg) of tagged blue marlin released in New Zealand waters and elsewhere in the SW Pacific 1974–2014.

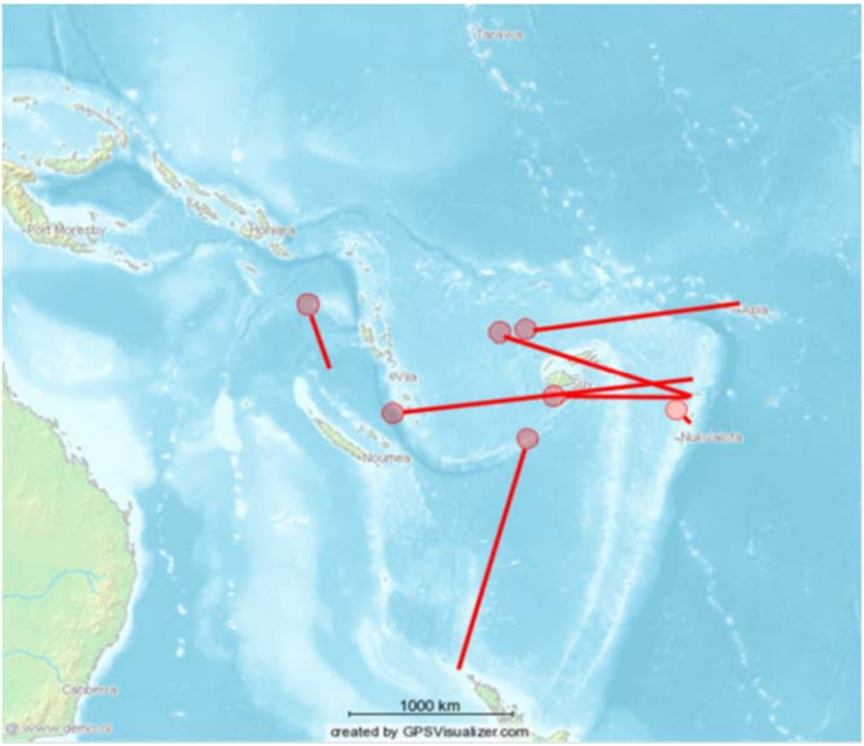
There are some years when blue marlin are not within the range of New Zealand recreational fishers and the number tagged per year is quite variable, while they are more consistently available in Pacific Island counties (Figure 10a). Most blue marlin tagged in the Pacific Islands with NZGTP tags have been caught in Tongan waters between July and October and weigh less than 120 kg (Figure 10b and 10c). Blue marlin are typically caught in the warmest month of February in New Zealand waters and fish less than 120 kg are extremely uncommon.



> ***d) Right.*** Distribution of tagged blue marlin in New Zealand waters.
>
> ***e) Below.*** Distribution of blue marlin recaptured, 1976–2014.

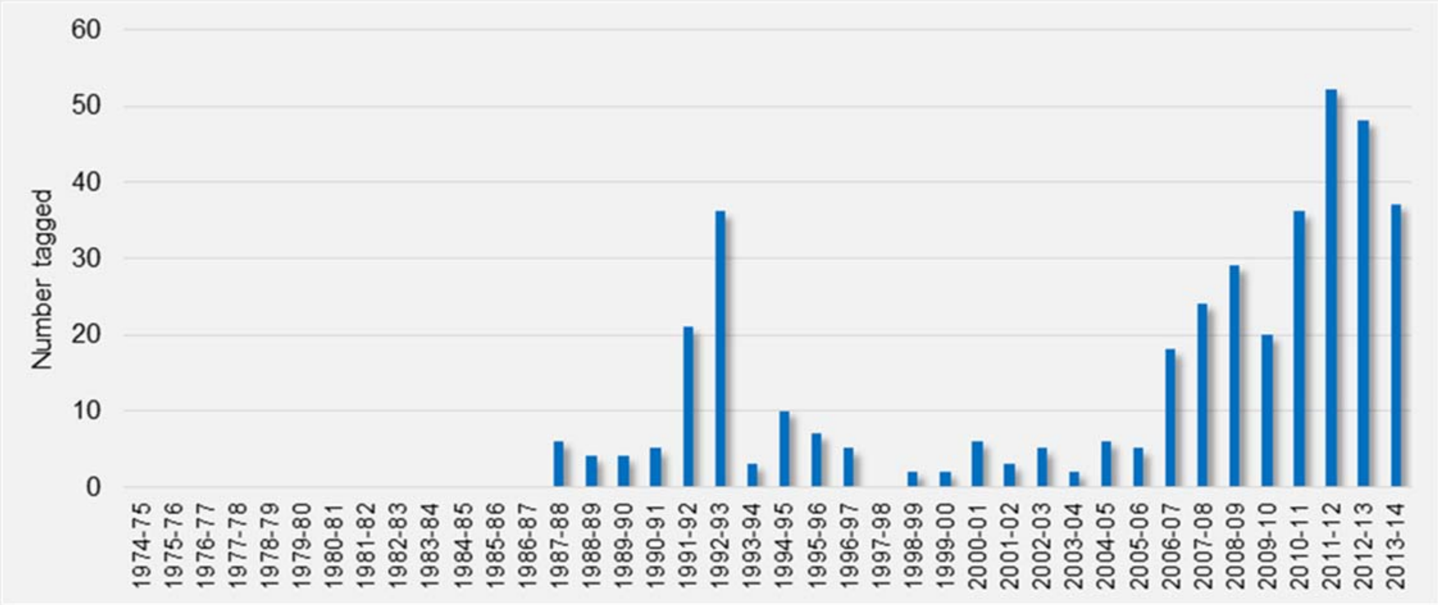



Blue marlin have predominantly been tagged off Northland and the eastern Bay of Plenty with few in between (Figure 10d). Seven blue marlin recaptures have been reported, all by commercial fishers in tropical waters of the SW Pacific (Figure 10e). Recapture weights were not recorded but measured lengths of 190 to 250 cm equate to fish of 60 to 160 kg. Just one fish tagged and released in New Zealand has been recaptured.



### 4.2.3. SWO: Broadbill swordfish *(Xiphias gladius)*

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 379 | 5 | 4 | 1.04 | 1360 | 10.7 |



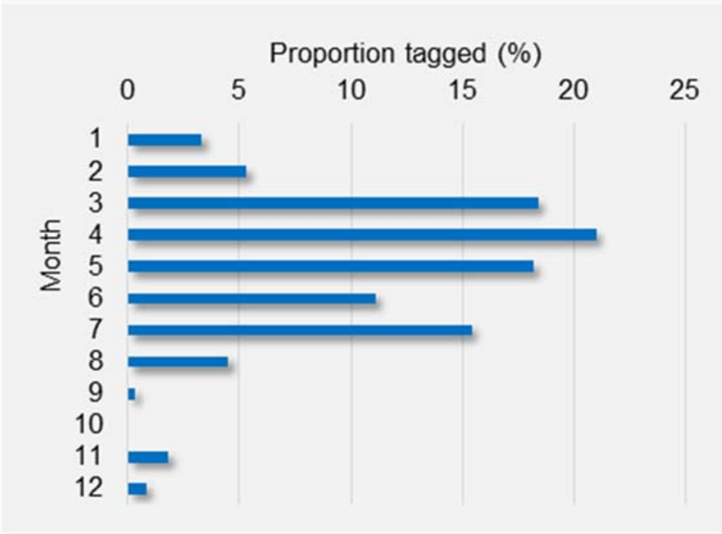



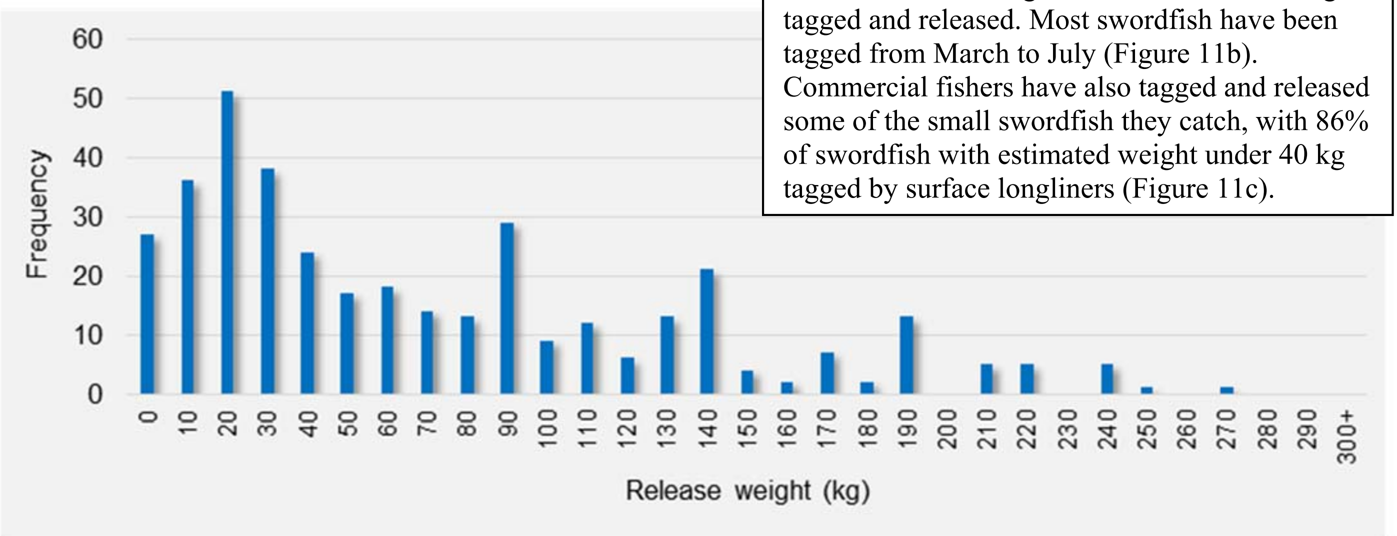

***Figure 11 a–f.***

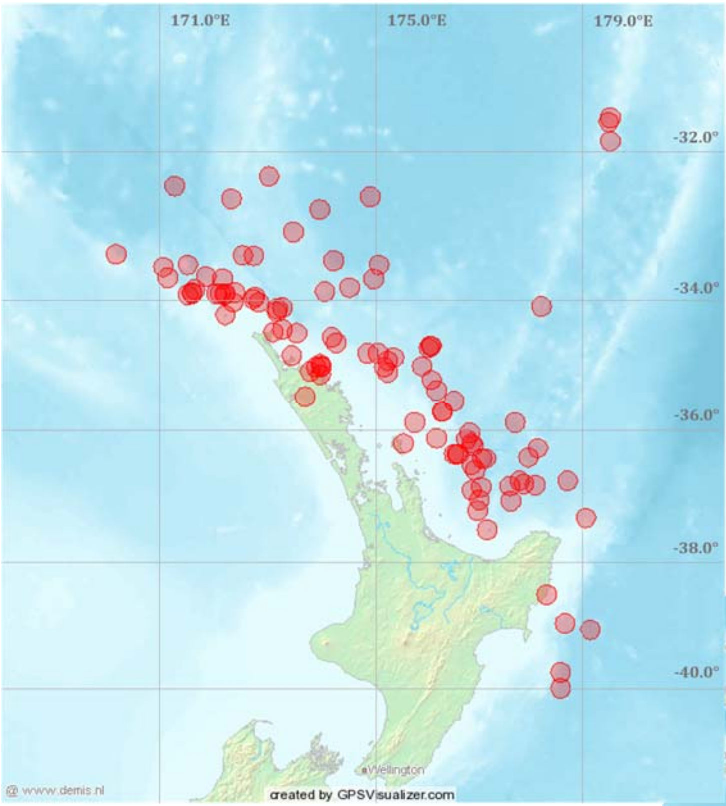
***a)*** ***Above.*** Broadbill swordfish tagged and released by year 1974–2014.

***b)*** ***Left.*** Proportion of broadbill swordfish tagged by calendar month 1974–2014.

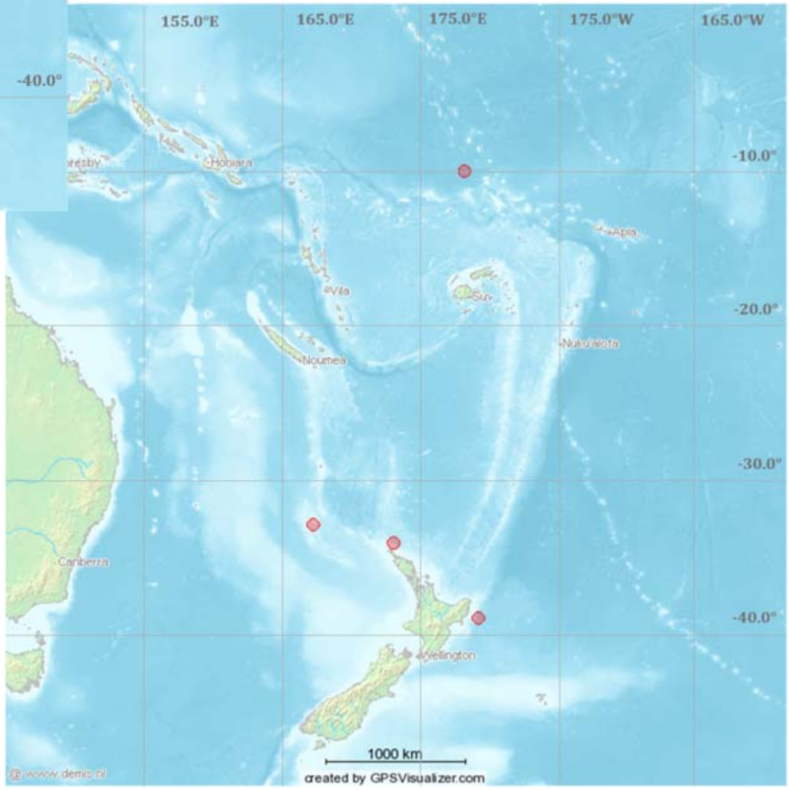
***c)*** ***Below.*** Weight (kg) of tagged broadbill swordfish released 1974–2014.

Since 2006–07 broadbill swordfish have become increasingly important in the recreational fishery as anglers learned how to target them during the day as well as the older method of fishing with baits and chemical light sticks during the hours of darkness (Figure 11a). By 2013–14, swordfish were being caught in similar numbers to blue marlin and increasing numbers were also being tagged and released. Most swordfish have been tagged from March to July (Figure 11b). Commercial fishers have also tagged and released some of the small swordfish they catch, with 86% of swordfish with estimated weight under 40 kg tagged by surface longliners (Figure 11c).





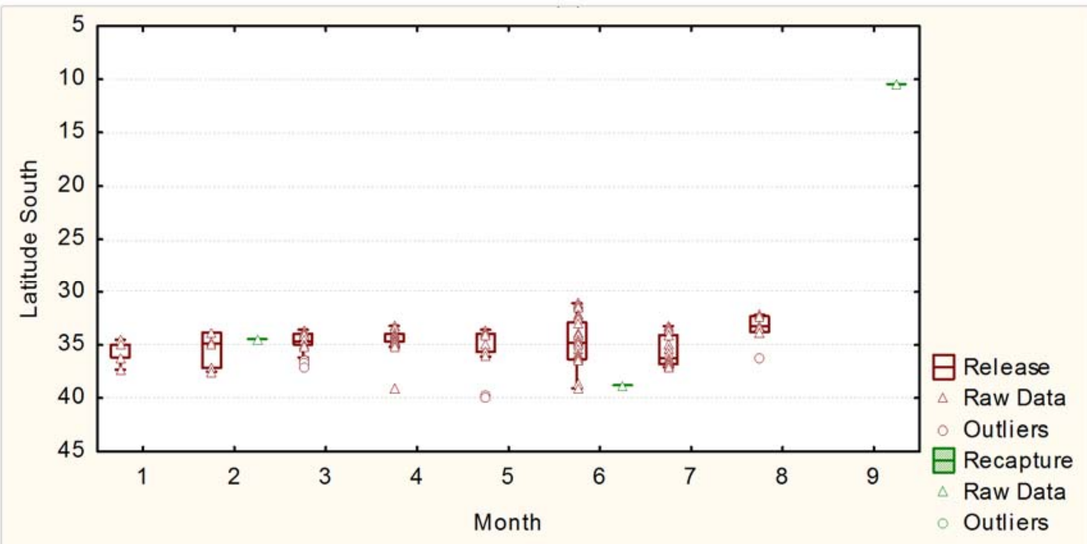

The spread of tagged swordfish in northern New Zealand is largely due to releases from commercial vessels (Figure 11d). Recreational catch to date has been focused on a limited number of locations from the Three Kings area to central Bay of Plenty. A small number of recaptures were achieved including one in which the same angler fishing from the same boat recaptured a swordfish he had tagged the previous year in the same location. Two swordfish tagged from commercial vessels have also been recaptured, one of them on the Wanganella Banks 10.6 years after release (Figure 11e).




***d)*** ***Above.*** Distribution of tagged broadbill swordfish in New Zealand waters, 1976–2014.

***e)*** ***Right.*** Distribution of broadbill swordfish recaptured, 1976–2014.

***f)*** ***Below.*** Broadbill swordfish releases and recaptures by latitude and month.



### 4.2.4. SSF: Shortbill spearfish (*Tetrapturus angustirostris*)

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 231 | 26 | 1 | 0.39 | - | - |

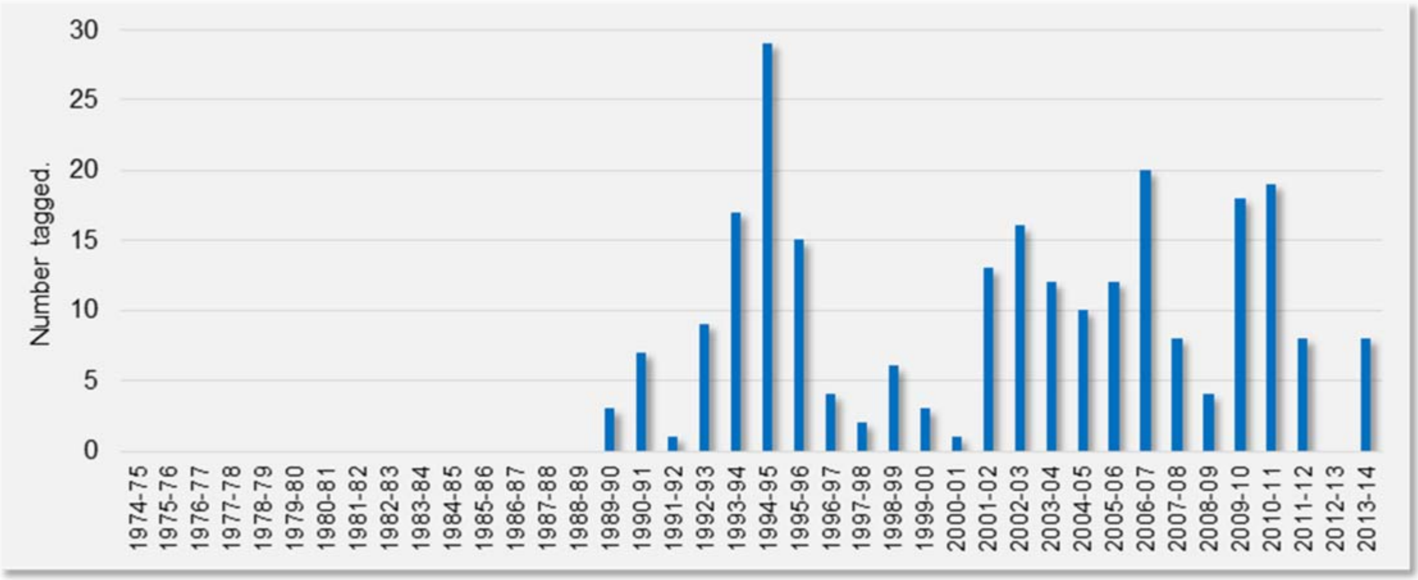


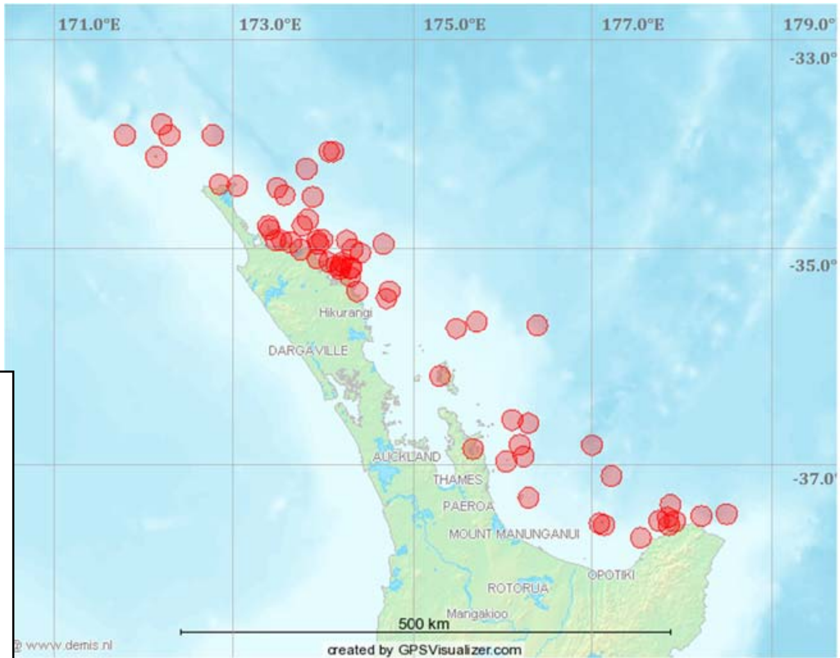

***Figure 12 a-d.***

***a) Above.*** Shortbill spearfish tagged and released by year 1974–2014.

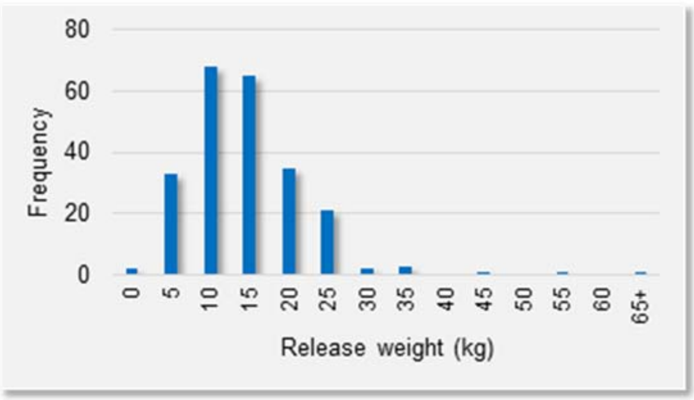
***b) Right.*** Distribution of tagged shortbill spearfish in New Zealand waters 1976–2014.

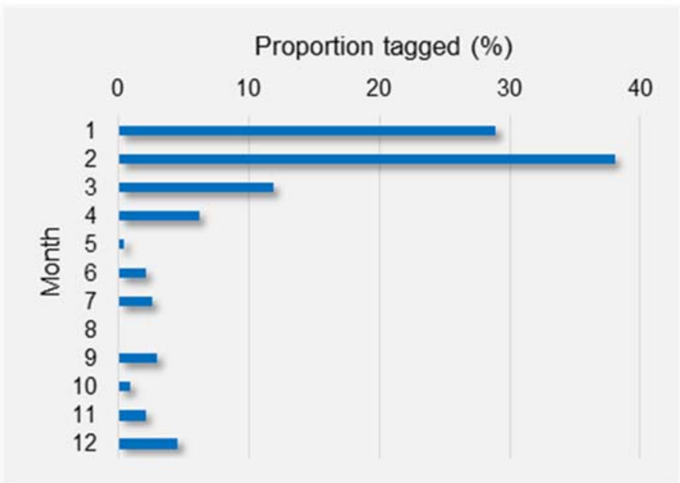
***c) Below.*** Weight (kg) of tagged shortbill spearfish released 1974–2014.

***d) Below right.*** Proportion of shortbill spearfish tagged by calendar month 1974–2014.



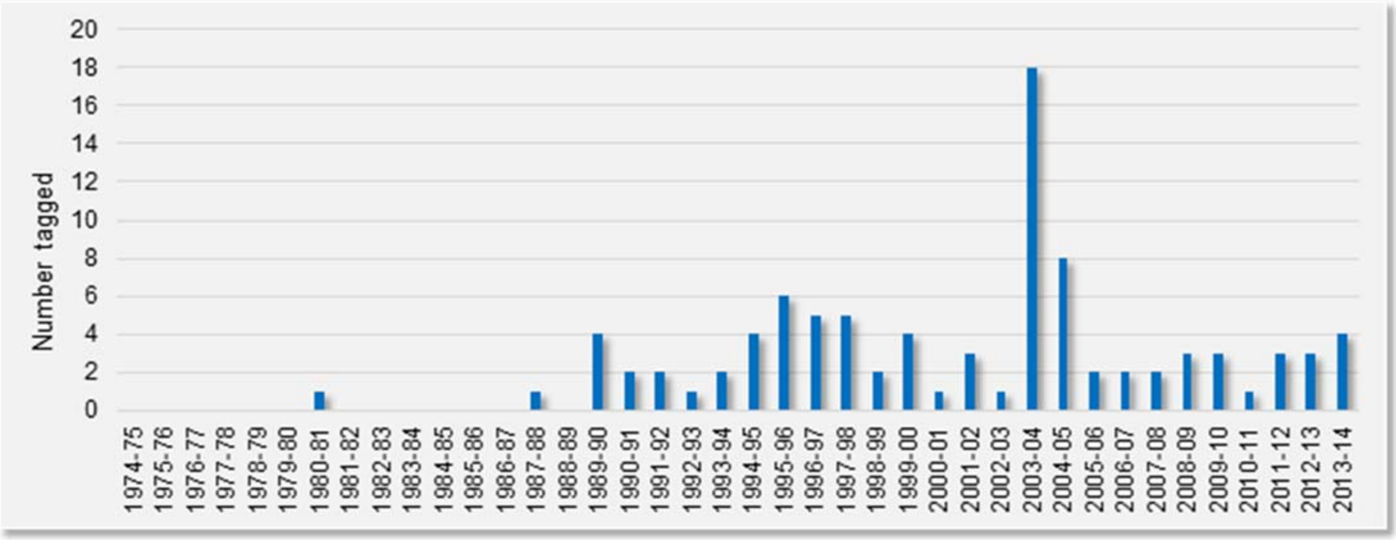

Modest but relatively consistent numbers of shortbill spearfish have been tagged each year since 1990 (Figure 12a). This was about the time when trolling artificial lures became popular. 98% of tagged SSF have been caught on lures. East Northland and the eastern Bay of Plenty are the main areas where SSF have been tagged (Figure 12b). Few SSF heavier than 30 kg have been tagged and they can be caught early in the fishing year, December and January (Figure 12c and d).

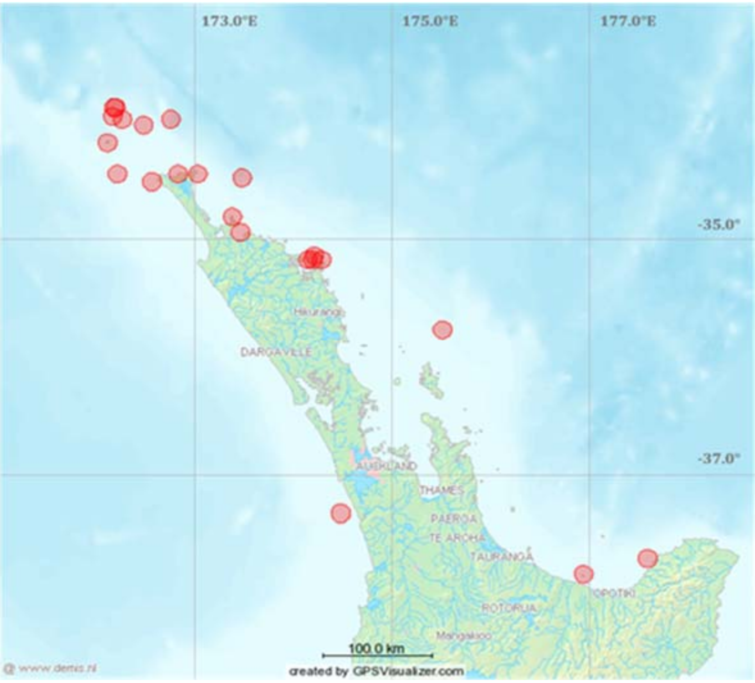


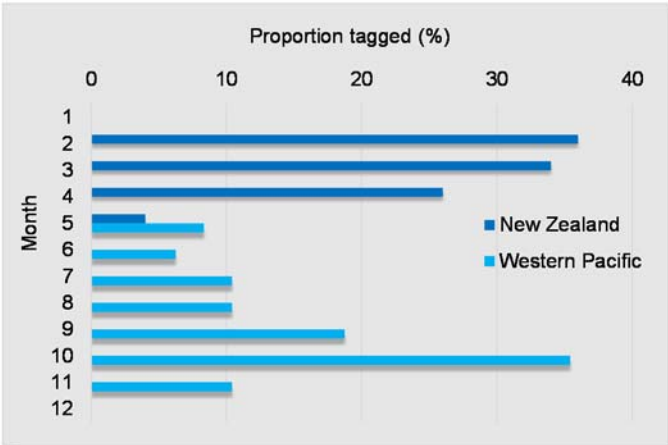



### *4.2.5.* **BKM: Black marlin *(Istiompax indica)***

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 45 | 47 | 1 | 1.09 | 103 | 0.05 |




Few black marlin are tagged per year, with most caught in February to April in New Zealand and July to November in the Pacific Islands (Figure 13a and c). Black marlin of 60 to 130 kg are mostly tagged in New Zealand while larger fish are often landed (Figure 13d).

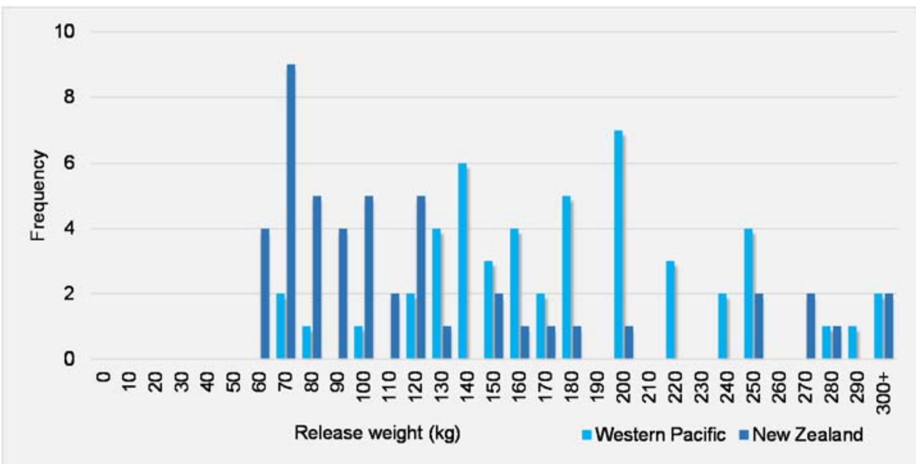
***Figure 13 a-d.***

***a)*** ***Top.*** Black marlin tagged and released by year 1974–2014.

***b)*** ***Above.*** Distribution of tagged black marlin in New Zealand waters 1976–2014. The single reported recapture (not shown) was off the south coast of American Samoa (lat.; -18.00, long.; 188.00.)

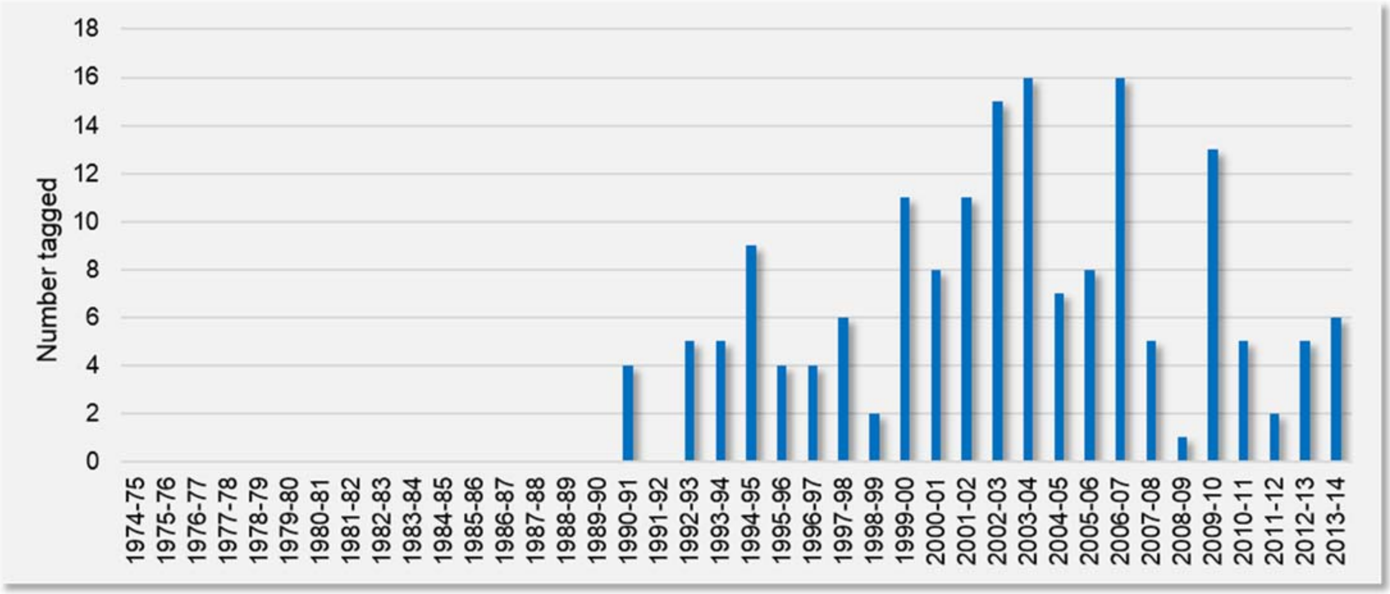
***c)*** ***Above right.*** Proportion of black marlin tagged by calendar month 1974–2014.

***d)*** ***Right.*** Weight (kg) of tagged black marlin released 1974–2014.



### 4.2.6. SAI: Sailfish (*Istiophorus platypterus*)

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 0 | 168 | 0 | - | - | - |



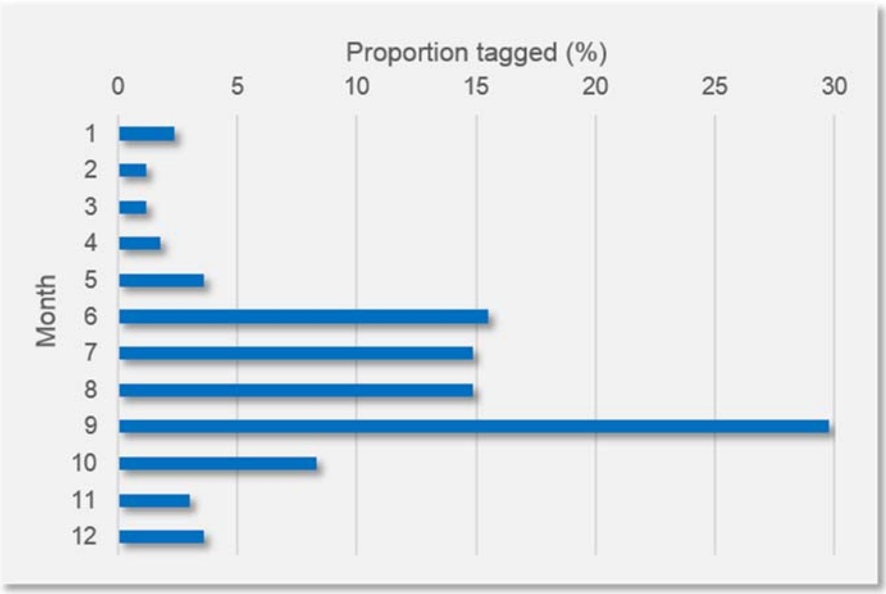




***Figure 14a-b.***

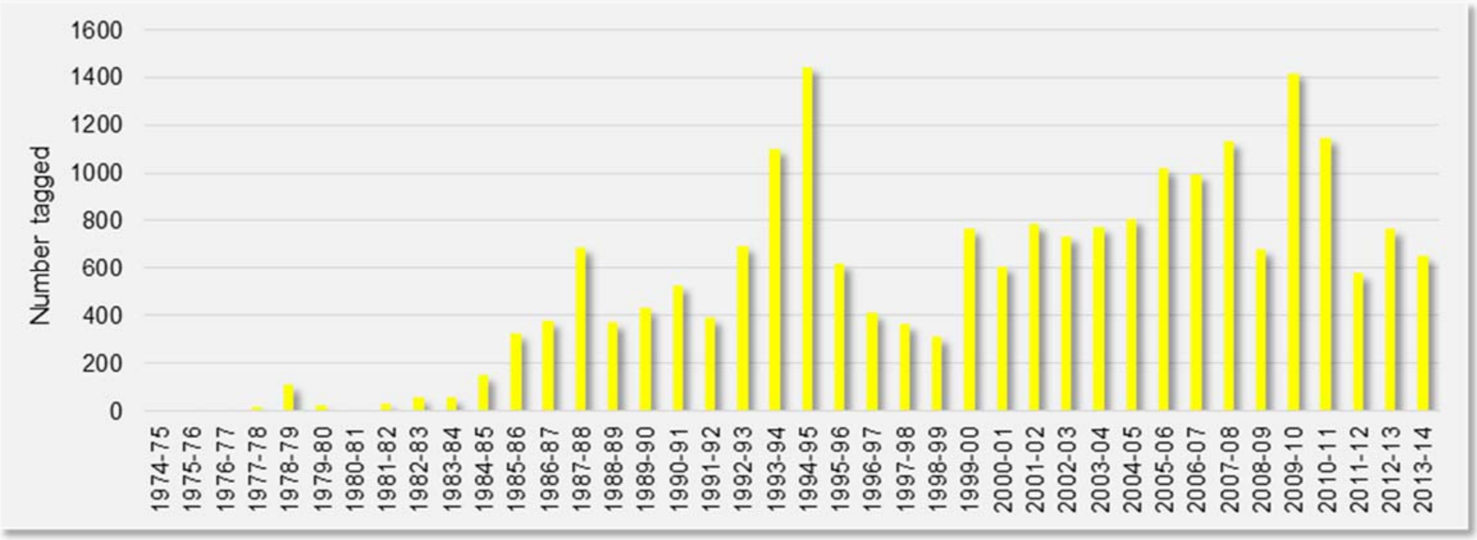
***a)*** ***Above.*** Sailfish tagged and released by year 1974–2014.

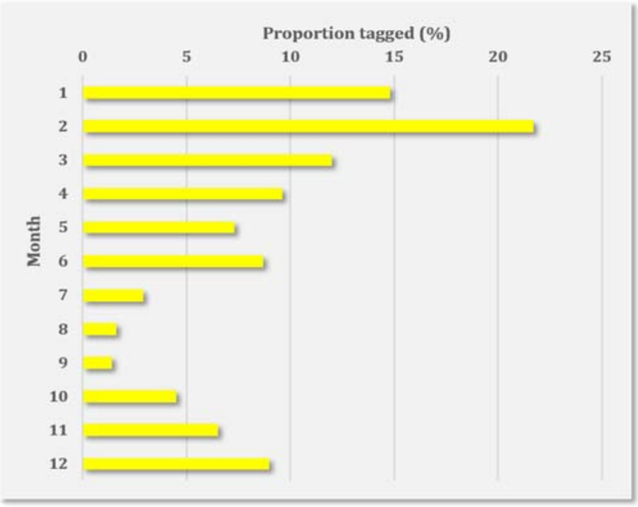
***b)*** ***Left.*** Proportion of sailfish tagged by calendar month 1974–2014.

Small numbers of sailfish have regularly been tagged since 1993 (Figure 14a), all of them in subtropical Pacific Islands. Most have been tagged between June and October (Figure 14b) when fishing effort by tourist anglers is at its peak.

### 4.3. KIN: Yellowtail kingfish *(Seriola lalandi.)*

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 21 210 | 3 | 1462 | 6.89 | 1619 | 14.7 |




Between 300 and 1,400 kingfish have been tagged and released each year since 1986 (Figure 15a).
The peak month is February with an August/September low in the number tagged (Figure 15b). Participants in the NZGTP are encouraged to measure kingfish accurately on release and recapture (Figure 15c).
A number of small kingfish were tagged before a minimum legal size was set. The current legal size of 75 cm or larger was introduced in 2004 and fishers are asked not to tag fish smaller than this size.

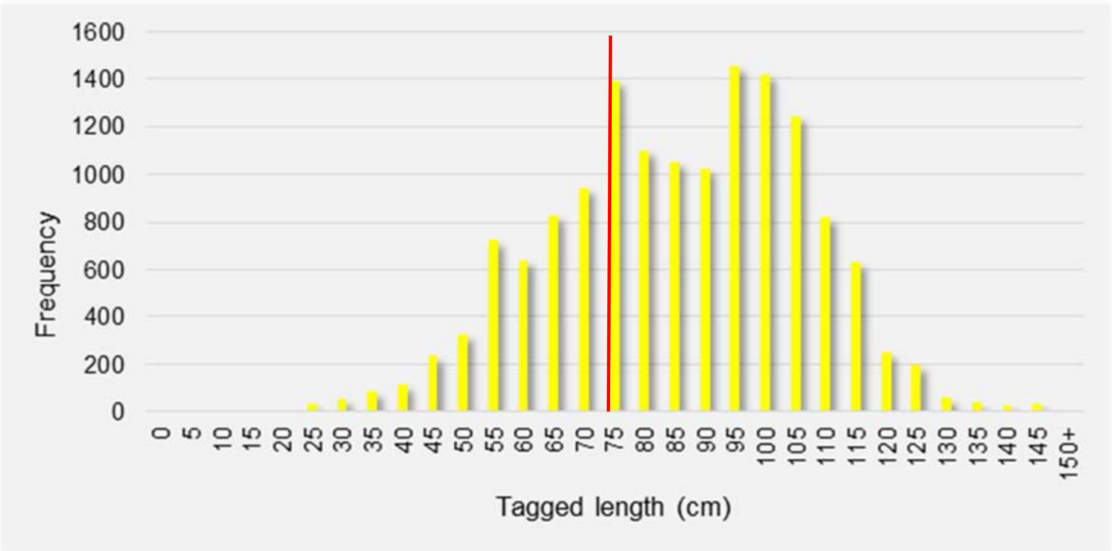
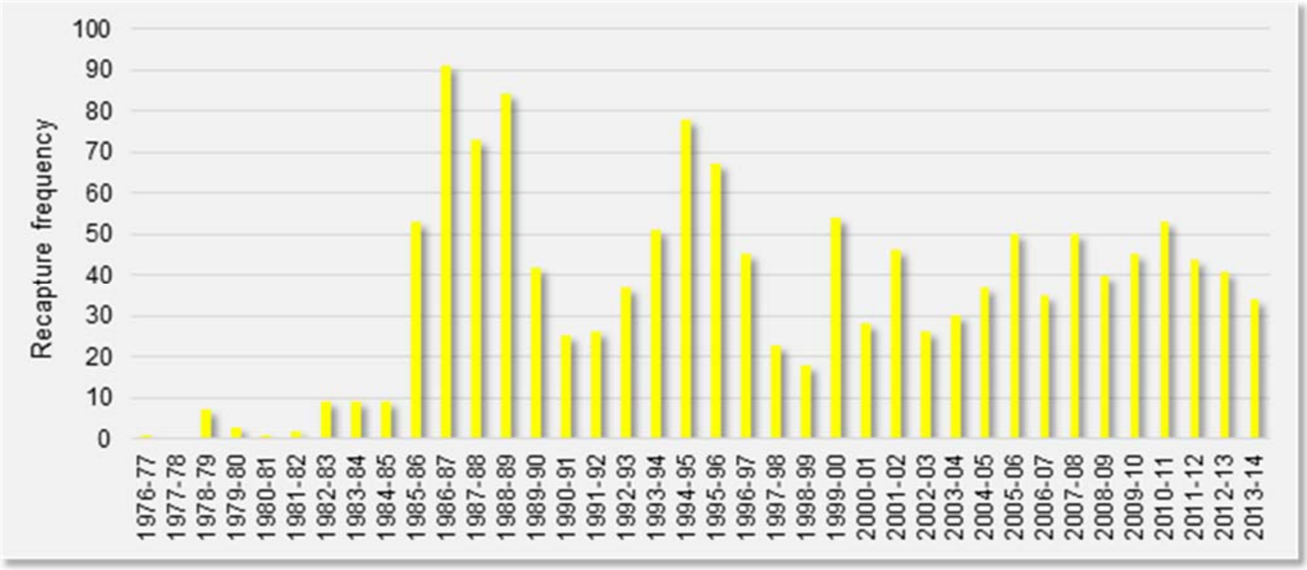
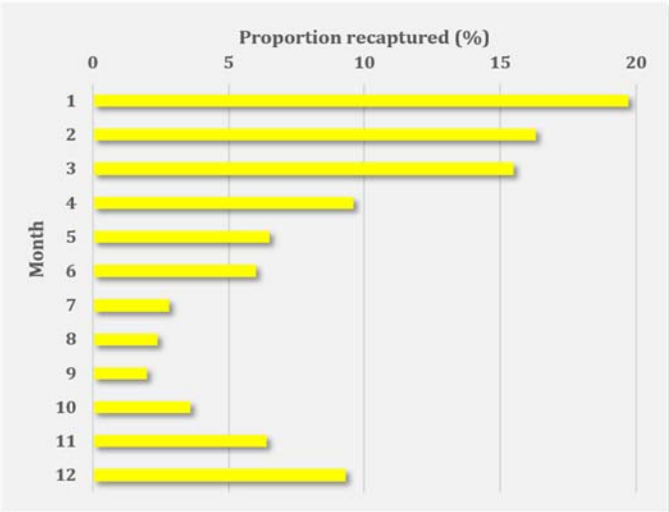



***Figure 15 a-l.***

- ***a)*** ***Top.*** Yellowtail kingfish tagged and released by year 1974–2014.
- ***b)*** ***Above left.*** Proportion of yellowtail kingfish tagged by calendar month 1974–2014.
- ***c)*** **Right.** Estimated and measured kingfish lengths (cm) at time tagging 1974–2014. (minimum legal size indicated; (75cm).



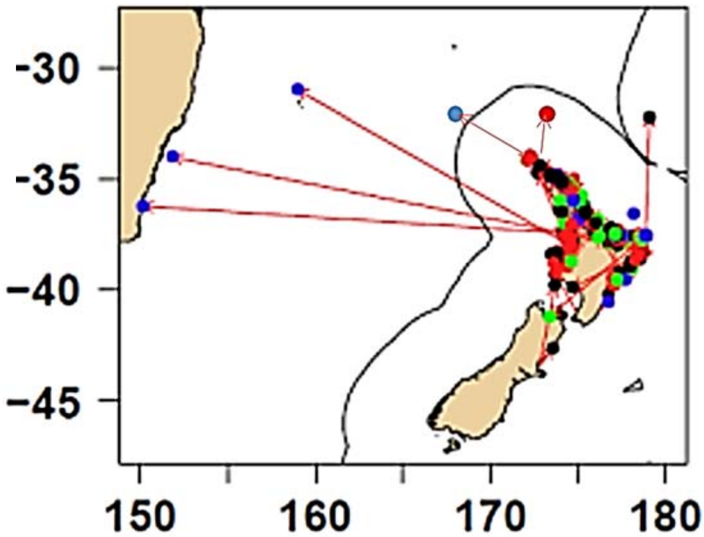

The number of kingfish recaptured has varied since 1986 with about 40 per year in recent years (Figure 15d). Recaptures and fishing effort is lowest in winter months (Figure 15e). There have been recaptures around the North Island and some have crossed the Tasman (Figure 15f). Fish between 95 and 110 cm are the size most often recaptured (Figure 15g).

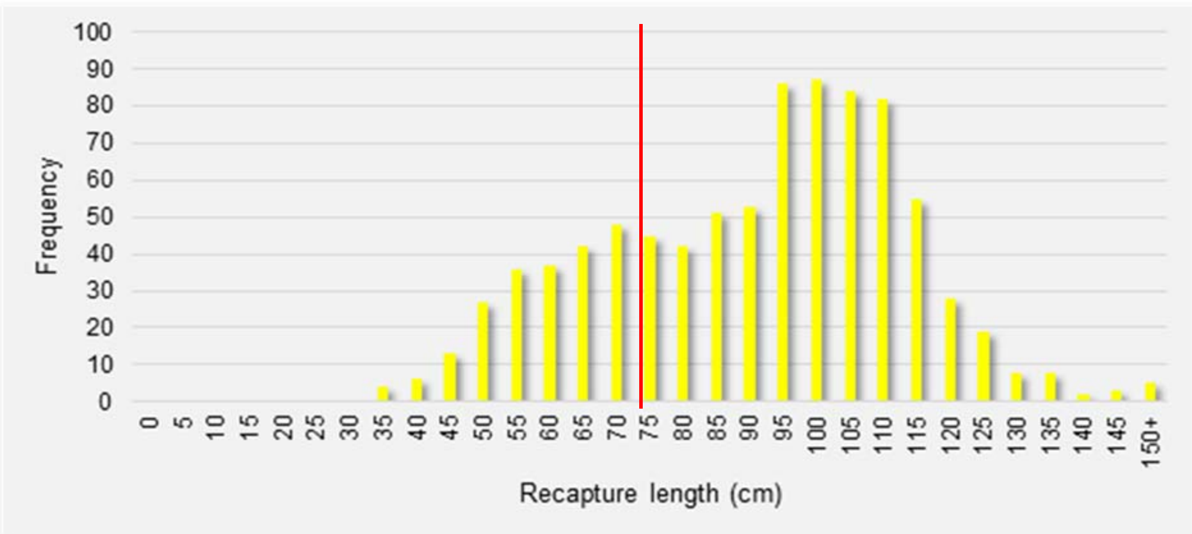
***d)*** ***Top.*** Yellowtail kingfish recaptures by year 1976–2014.

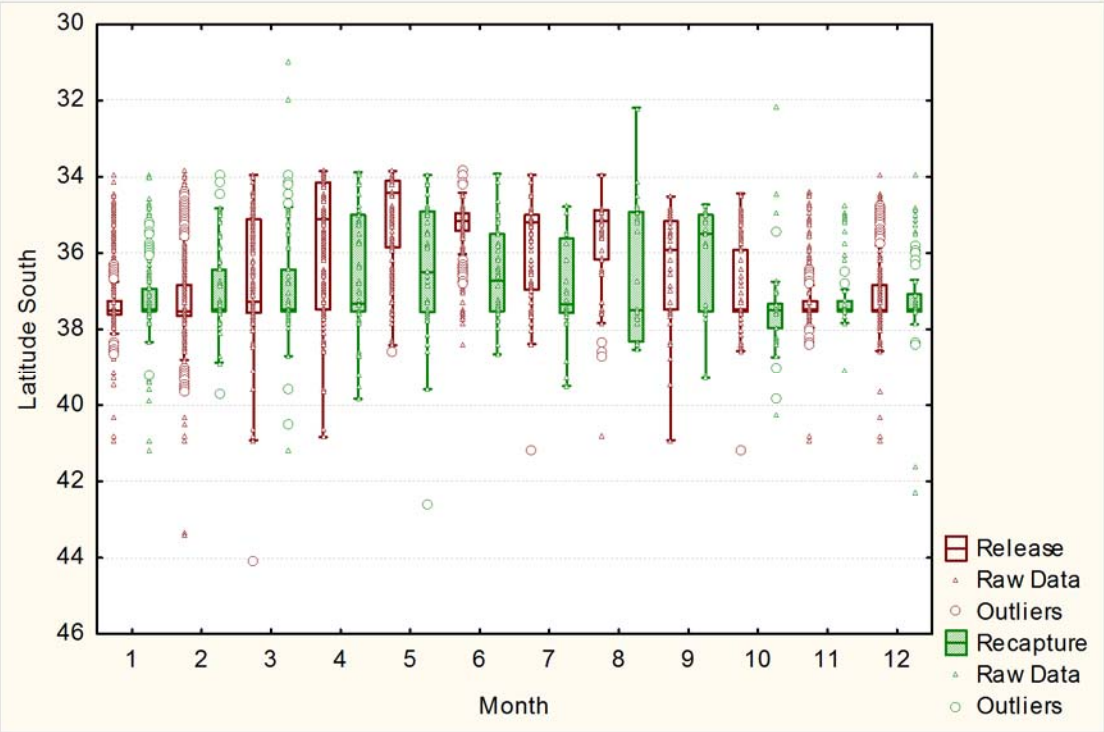
***e)*** ***Above.*** Proportion of yellowtail kingfish recaptured by calendar month 1976–2014.

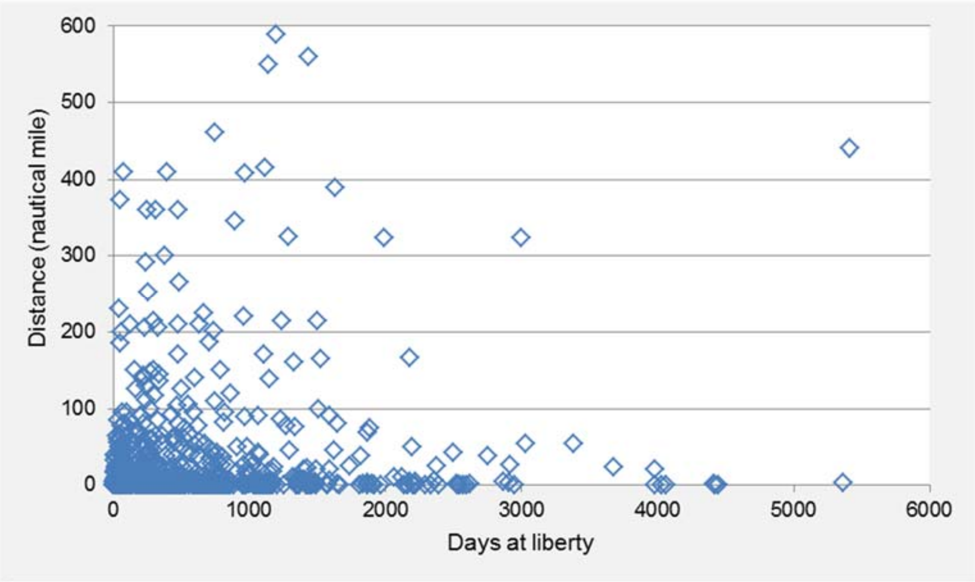
***f)*** ***Right.*** Broad scale distribution of recaptured kingfish.

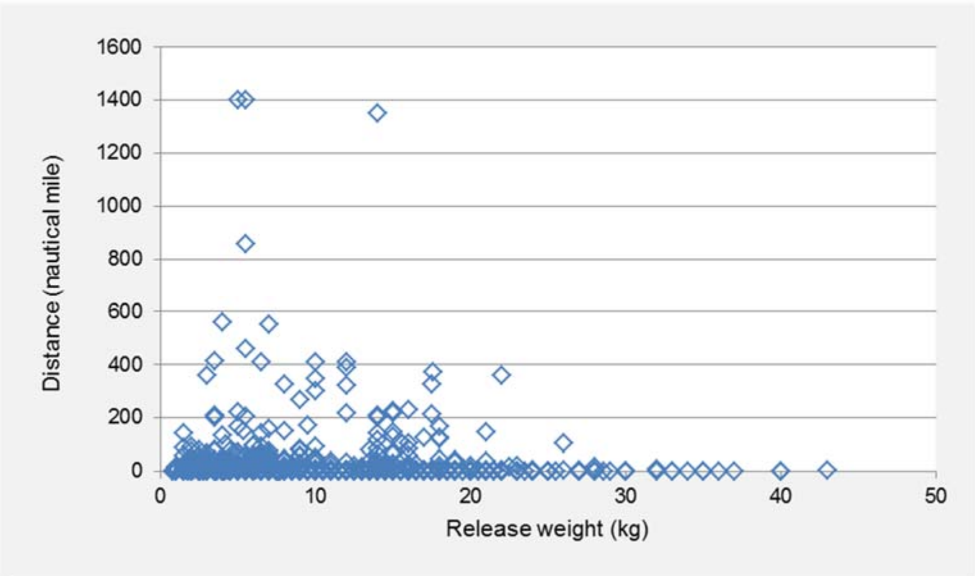
***g)*** ***Below.*** Estimated and measured kingfish lengths (cm) at time of recapture; 1976–2014. (Minimum legal size indicated 75cm.)





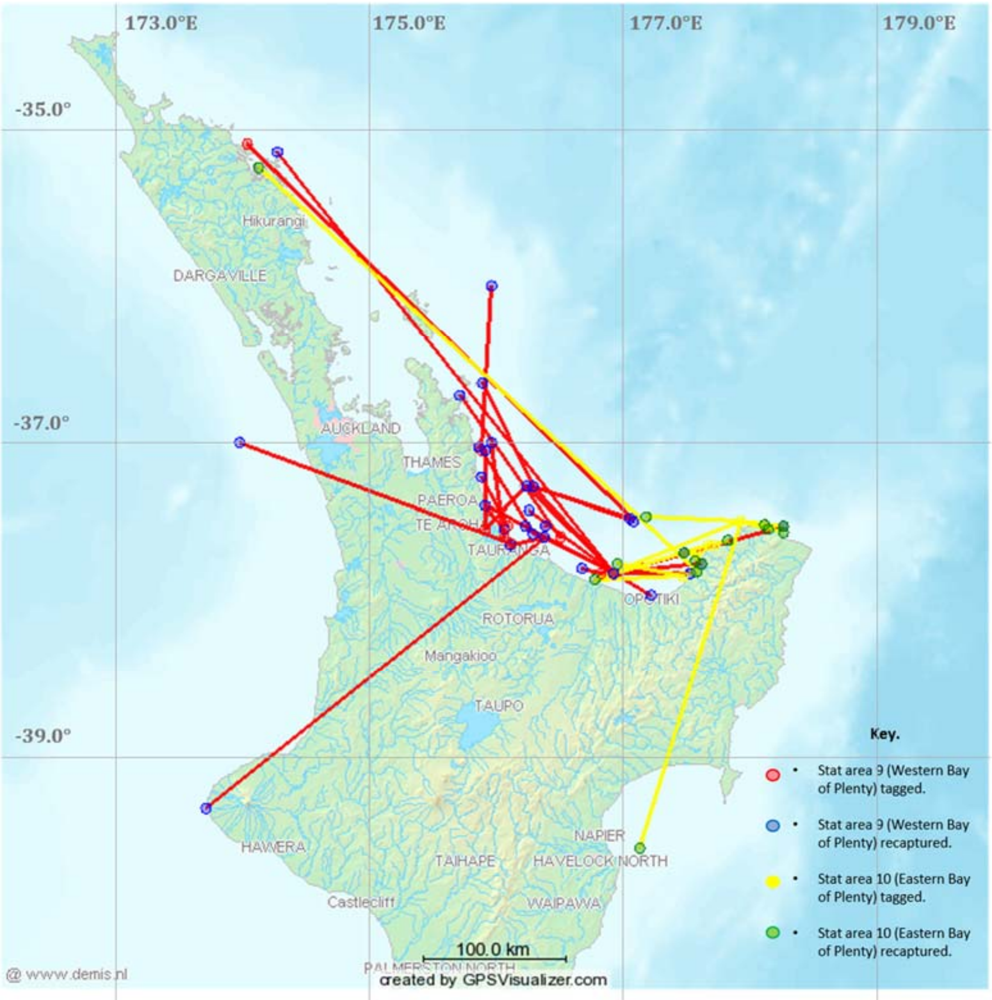

***h) Above.*** Yellowtail kingfish releases and recaptures by latitude and month.

***i) Left.*** Distance travelled (truncated to 600 n. miles) by days at liberty.

***j) Below.*** Distance travelled by kingfish release weights.

Yellowtail kingfish have been tagged across a broad range of latitudes (Figure 15h). Most kingfish are tagged in the north in May and June which is likely to be due to charter boat effort moving from Bay of Plenty ports to the Far North. There is no correlation between displacement distance and days at liberty, other than a decline in the number of recaptures with time (Figure 15i). There is more movement of kingfish of less than 22 kg release weight than larger fish which appear to be mainly resident (Figure 15j).

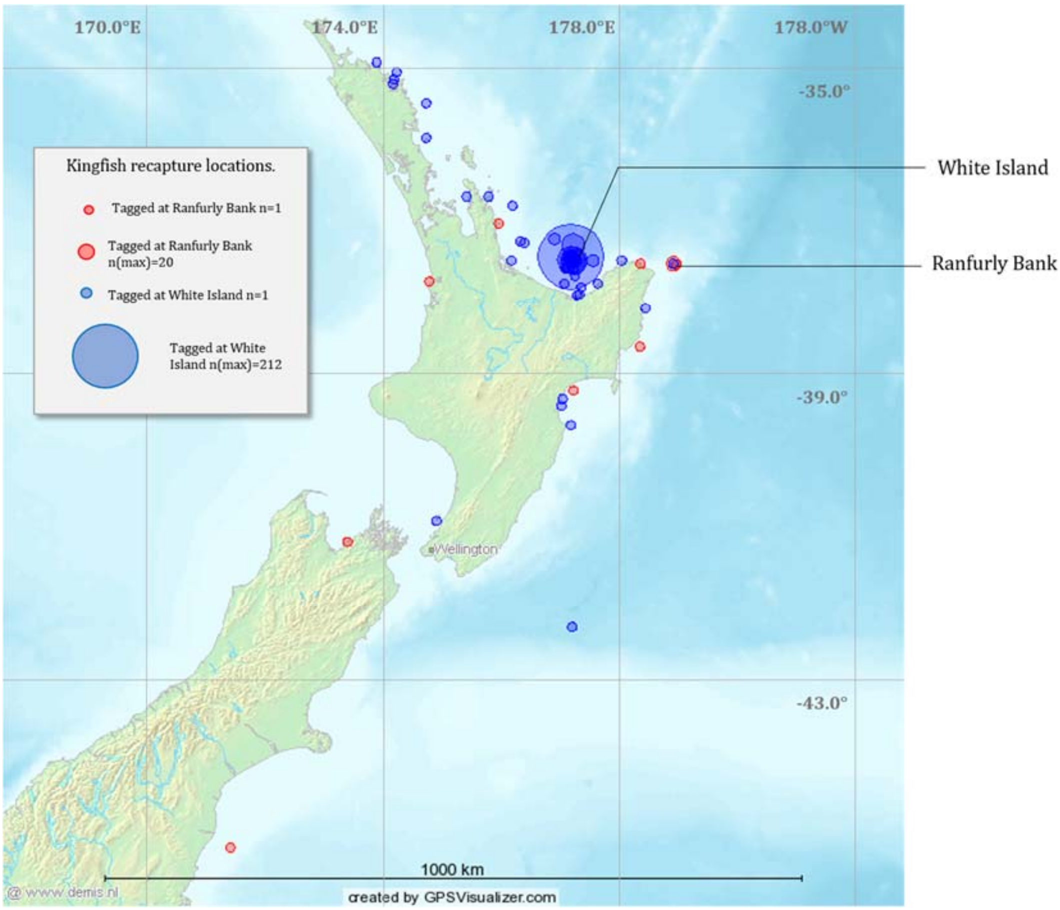
## Yellowtail kingfish recaptures by release location




***k) Left.*** Yellowtail kingfish release and recapture locations for fish tagged inshore in Statistical Area 009 (red/blue) and 010 (yellow/green).

***l) Bottom.*** Recapture locations for kingfish tagged offshore at White Island and Ranfurly Bank.

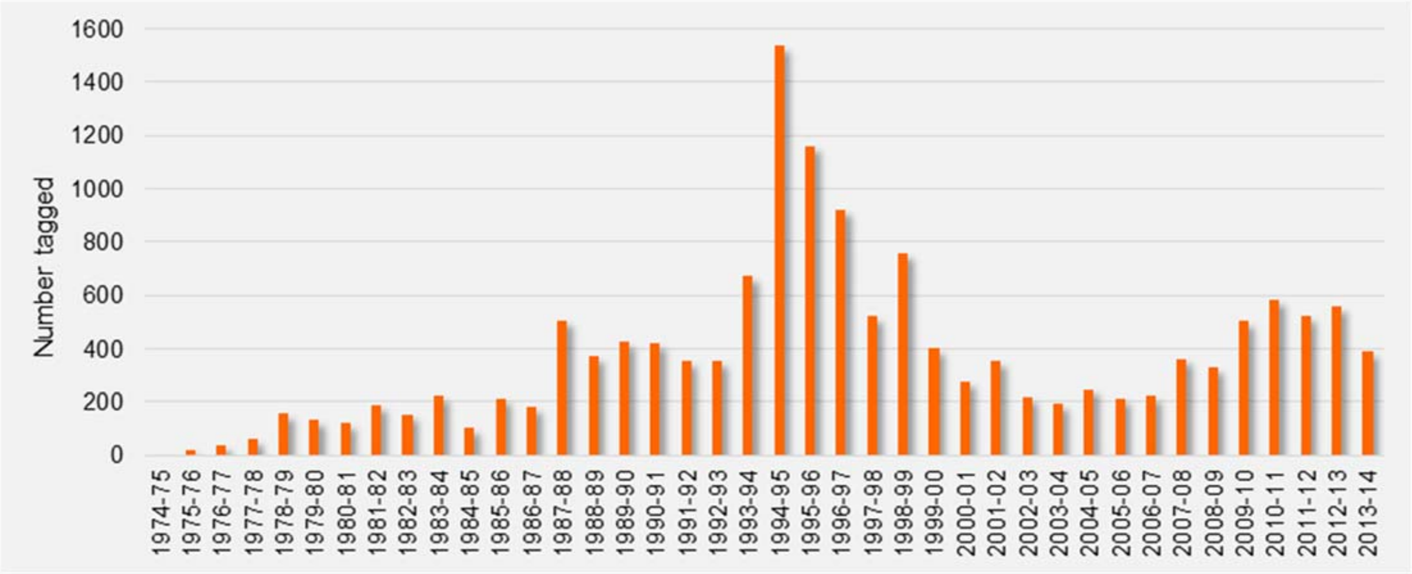
While some tagged kingfish move considerable distances, there is limited overlap of recapture locations between inshore western and eastern Bay of Plenty (Figure 15k). There is also limited overlap of recapture locations between fish tagged offshore at White Island and Ranfurly Bank (Figure 15l). There is some movement from offshore to inshore habitats but these are a small proportion of total recaptures from these areas. In fact, only 3.5% of kingfish tagged at White Island were recaptured elsewhere; indicating the presence of a largely resident population.



### 4.4. Sharks

#### 4.4.1. MAK: Shortfin mako shark (*Isurus oxyrinchus*)

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 14 519 | 5 | 368 | 2.53 | 2960 | 9.93 |



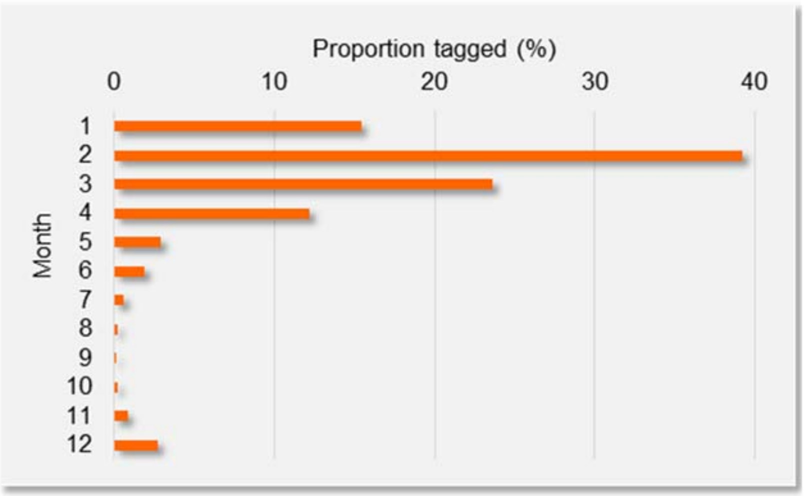



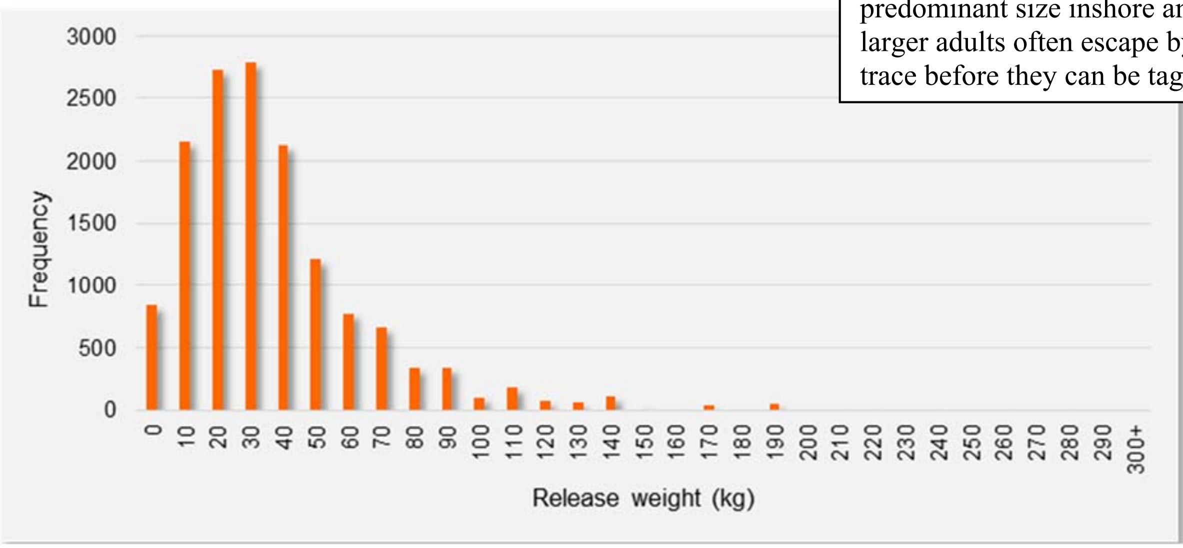

***Figure 16a-j.***

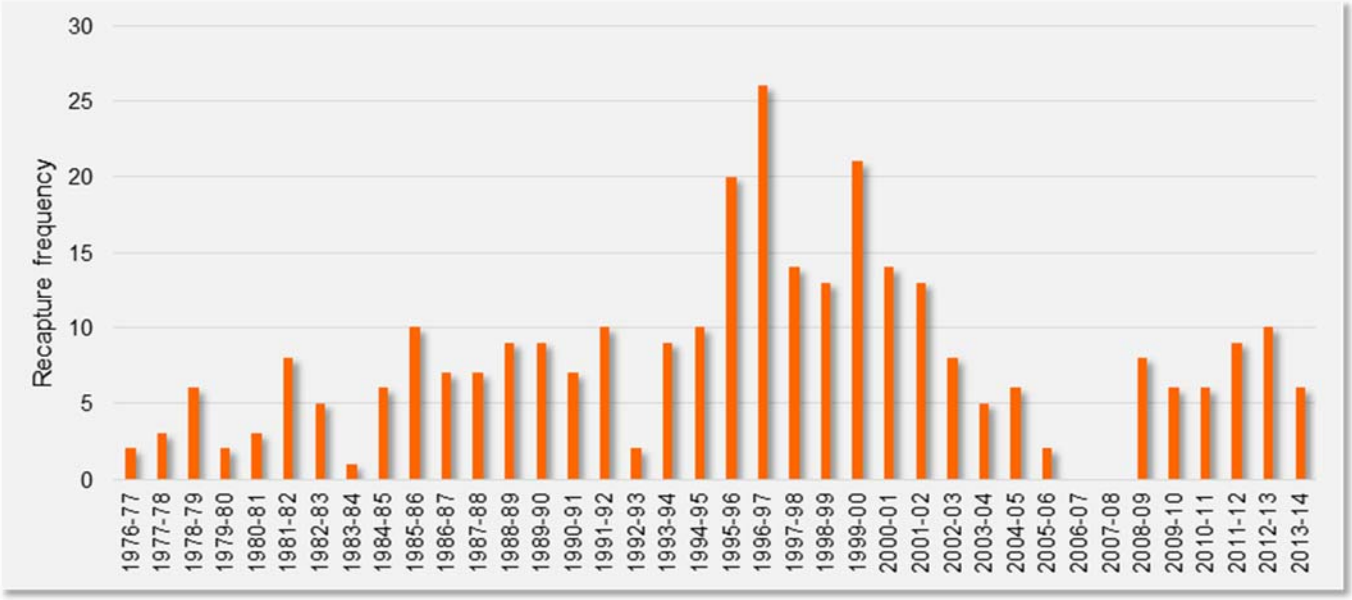
***a) Above.*** Shortfin mako shark tagged and released by year 1974–2014.

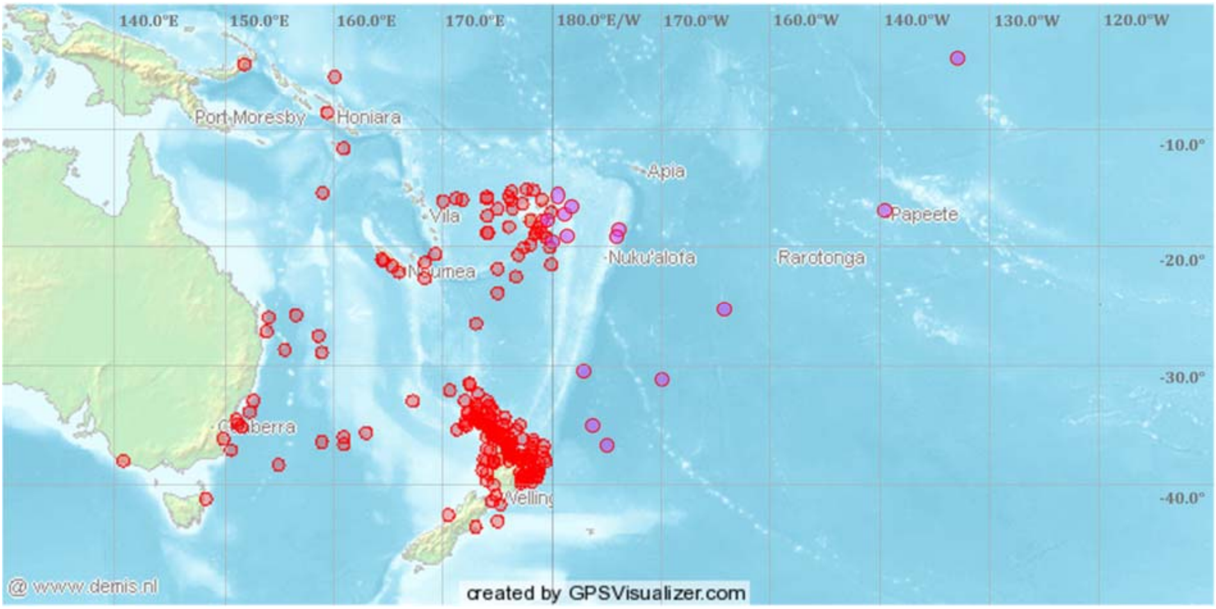
***b) Left.*** Proportion of shortfin mako shark tagged by calendar month 1974–2014.

***c) Below.*** Weight (kg) of tagged shortfin mako sharks released 1974–2014.

Mako sharks are mainly a by-catch of the billfish fishery. Catches are highest in the summer and autumn (Figure 16b) and have risen in recent years after a period of low abundance between 2002 and 2007 (Figure 16a). The size of mako tagged; mostly between 10 kg and 40kg, (Figure 16c) reflects both the predominant size inshore and the fact that larger adults often escape by biting through the trace before they can be tagged.





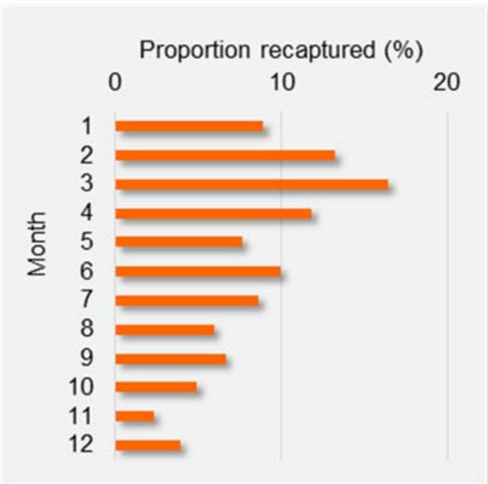

Mako recaptures have been between 2% and 3% for many years. Recaptures peaked after the high release numbers in 1994–95 to 1996–97 (Figure 16d). Recaptures have been achieved in every month (Figure 16f), distributed in an arc from South Australia to French Polynesia. A high number of recaptures have also been reported from around the New Zealand North Island (Figure 16e).

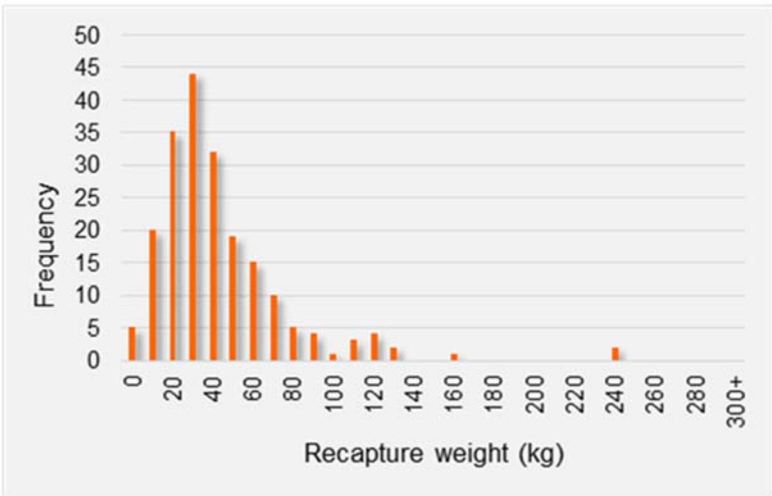
***d)*** ***Top.*** Shortfin mako shark recaptures by year 1976–2014.

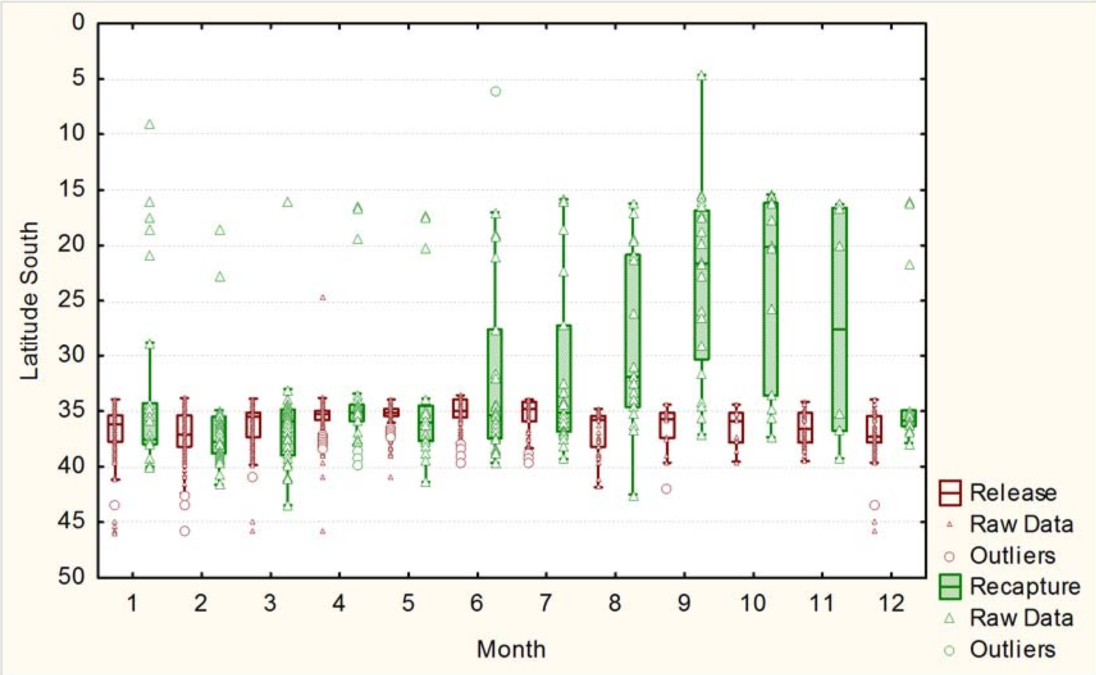
***e)*** ***Above.*** Distribution of mako sharks recaptured 1976–2014.

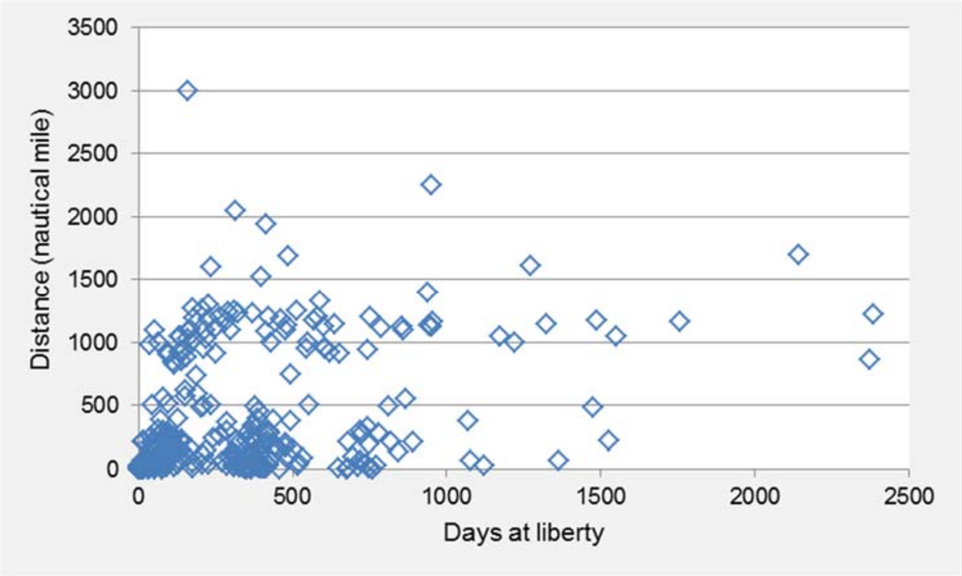
***f)*** ***Below Left.*** Proportion of mako shark recaptures by calendar month 1976–2014.

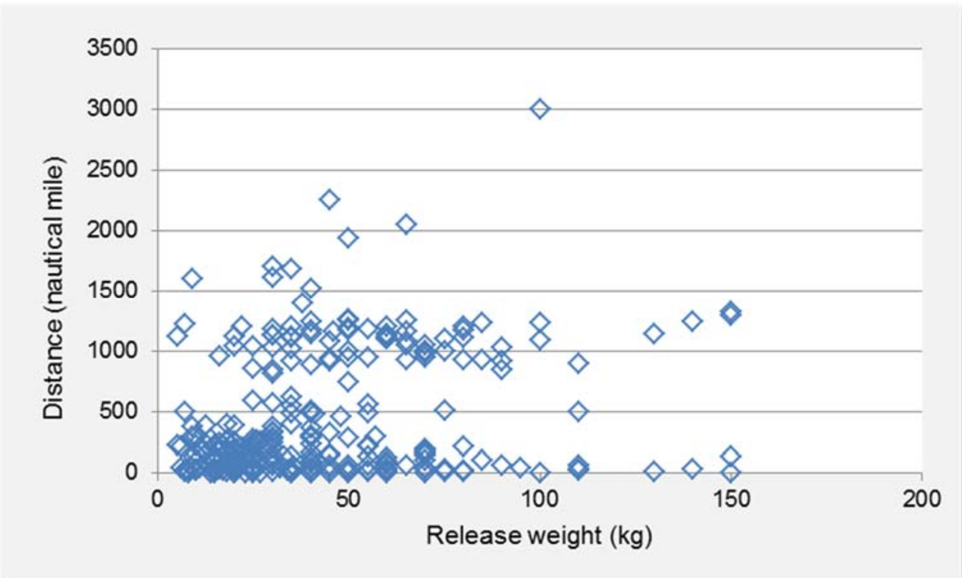
***g)*** ***Below.*** Weight (kg) of mako sharks recaptured 1976–2014.






***h)*** ***Above.*** Shortfin mako shark releases and recaptures by latitude and month.

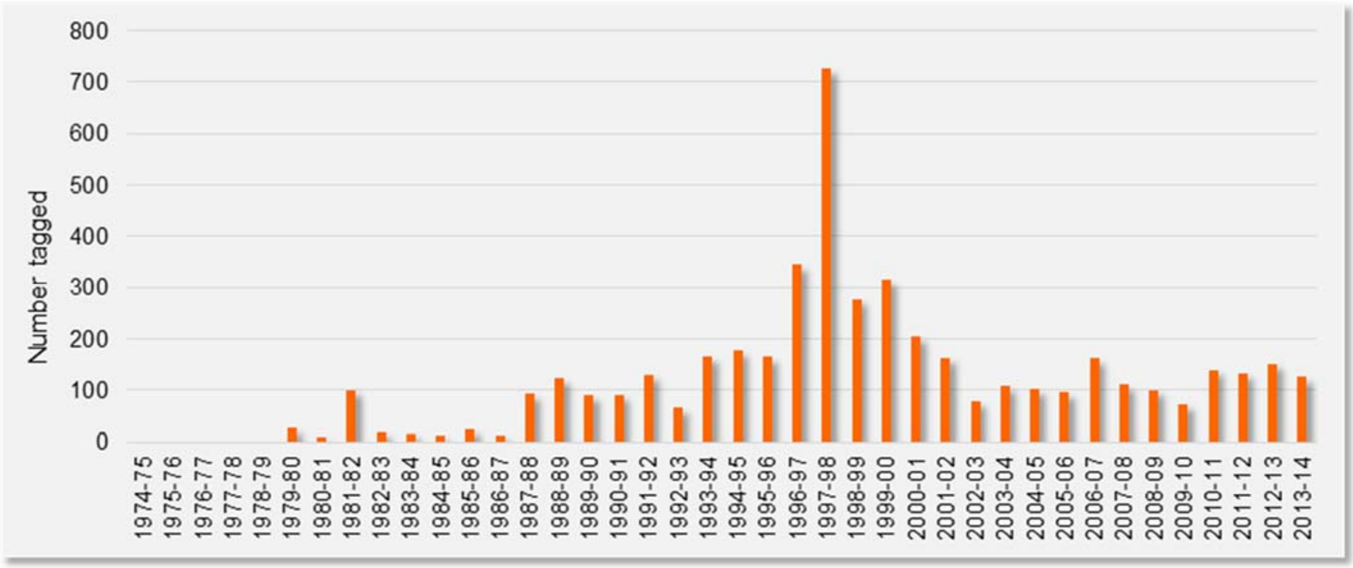
***i)*** ***Left.*** Distance travelled by days at liberty for mako sharks.

***j)*** ***Below.*** Distance moved by mako shark release weights.

While mako sharks have been tagged year round in New Zealand waters, most of the recaptures from June to November are from lower latitudes (Figure 16h). Displacement distances show a pronounced clustering back in New Zealand waters after 1 or 2 years (Figure 16i). There is no increase in recaptures outside the region (over 1,500 n.miles) for fish over 1000 days at liberty, although admittedly the sample size is small. Many of the small fish tagged are caught within New Zealand waters, but for fish over 50 kg on release there is no clear trend in displacement by weight, which is either close to zero or close to 1000 n.miles (Fiji, Tonga, Vanuatu, Australia) (Figure 16e and j).

### 4.4.2. BWS: Blue shark (*Prionace glauca*)

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 4684 | - | 87 | 1.86 | 4609 | 3.29 |



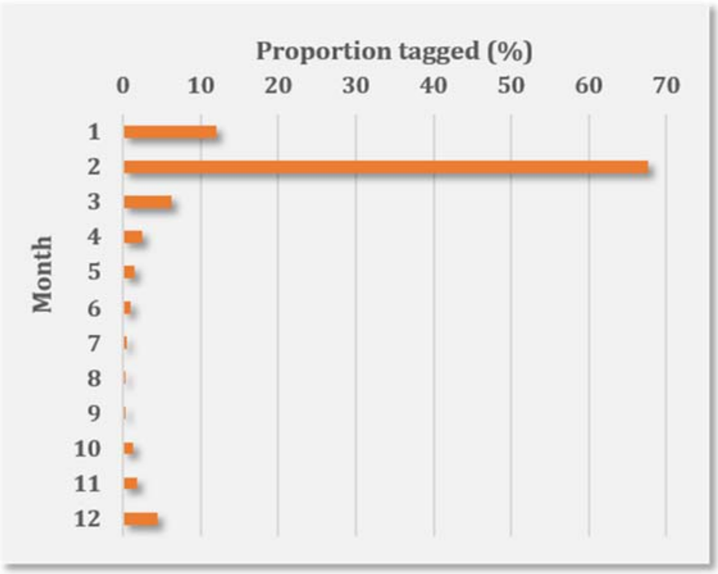



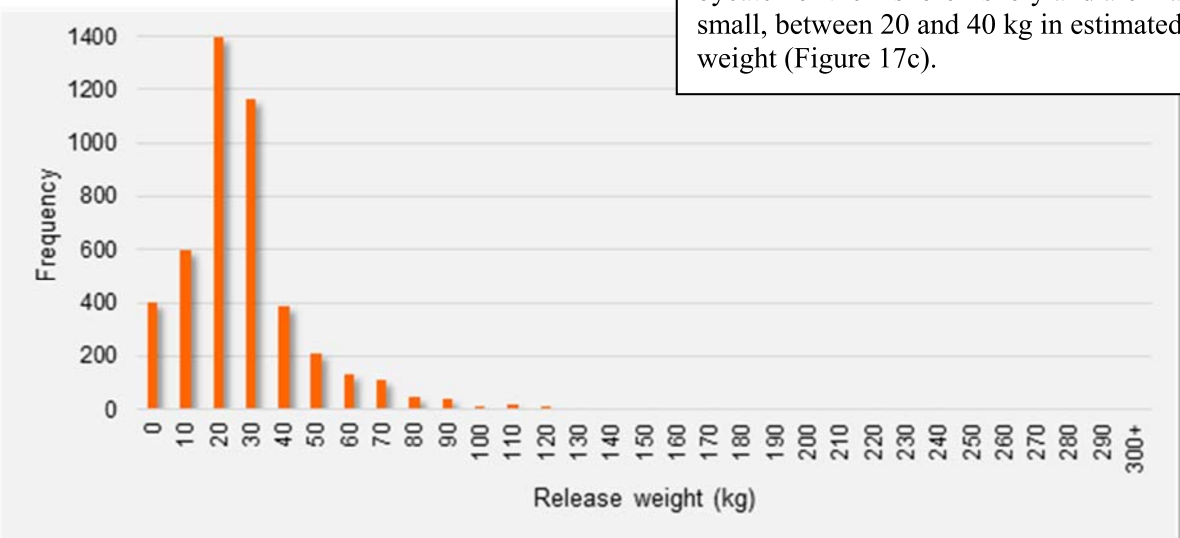

***Figure 17a-i***

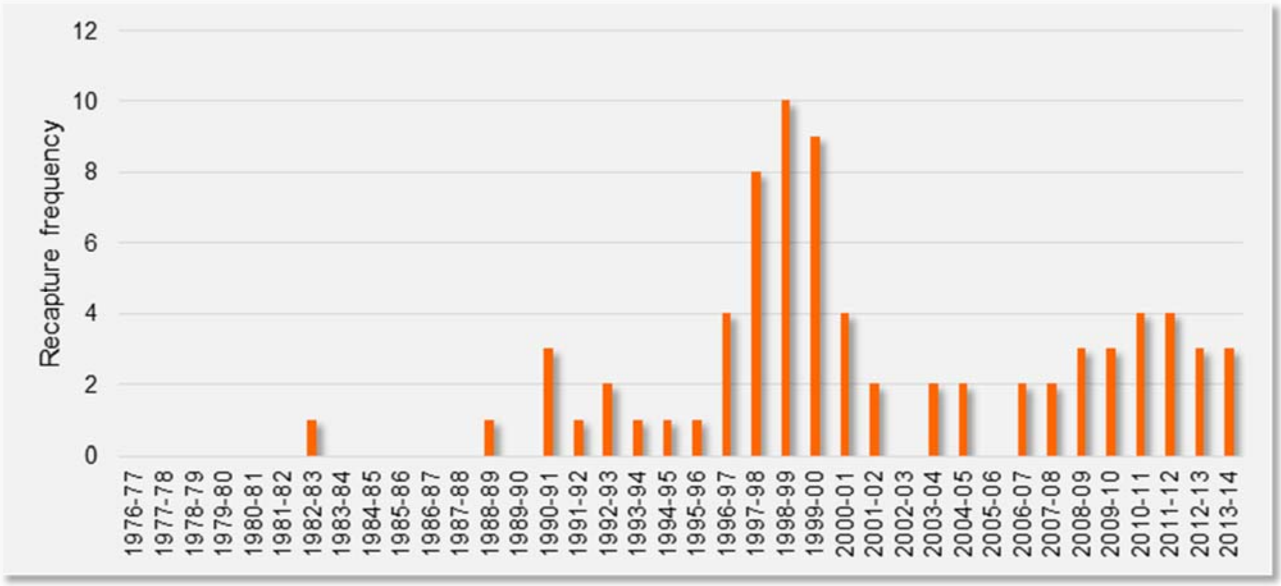
***a)*** ***Above.*** Blue sharks tagged and released by year 1974–2014.

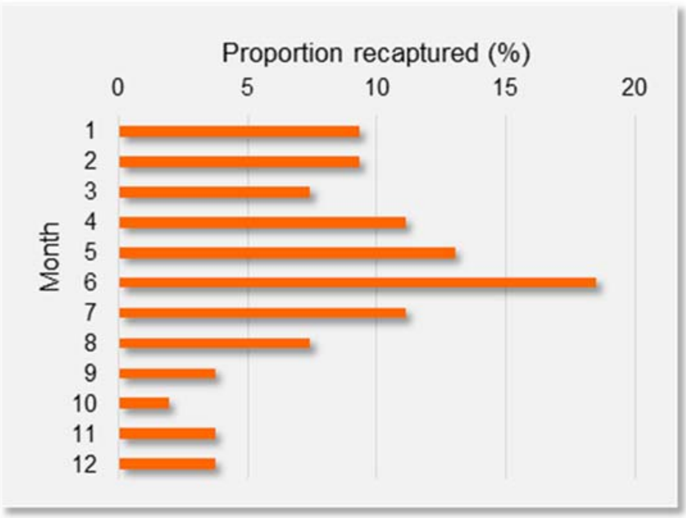
***b)*** ***Left.*** Proportion of blue shark tagged by calendar month 1974–2014.

***c)*** ***Below.*** Weight (kg) of tagged blue sharks released 1974–2014.

Blue sharks have been tagged consistently in small numbers since 1987–88, with the exception of the large peak in 1997–98 (Figure 17a). The very strong seasonal peak in February each year reflects the influence of the NZSFC National Contest (Figure 17b). Blue sharks are mostly caught by recreational fishers as a bycatch of the inshore fishery and are mainly small, between 20 and 40 kg in estimated weight (Figure 17c).





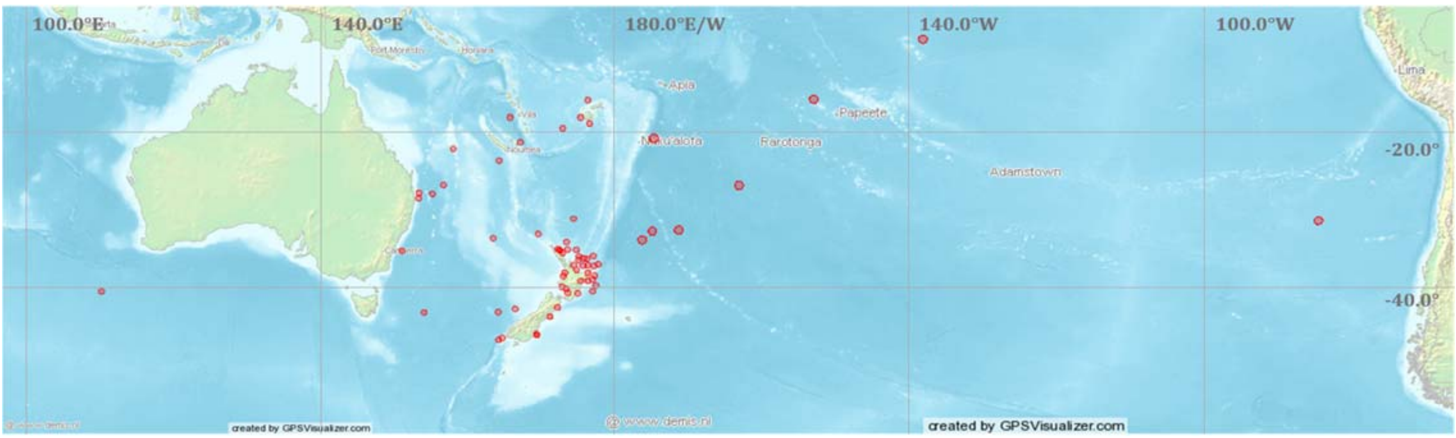



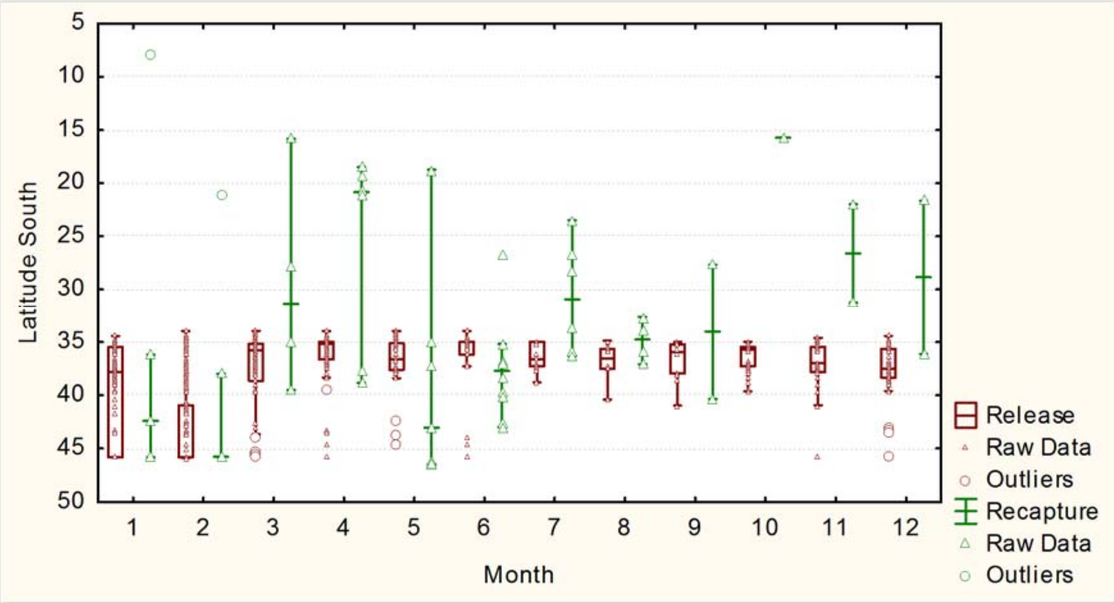

***d)*** ***Above.*** Blue shark recaptures by year 1976–2014.

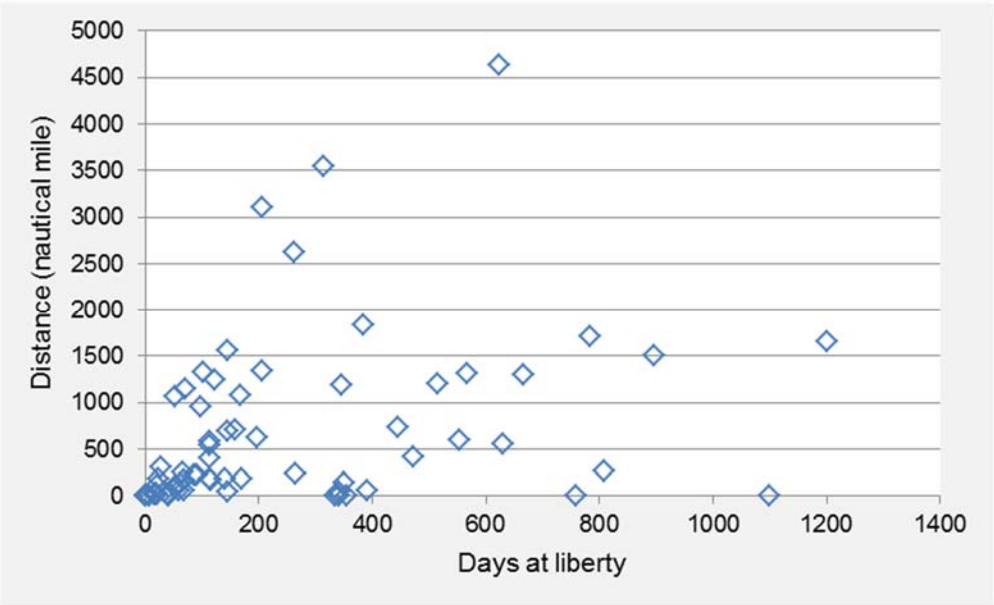
***e)*** ***Left.*** Proportion of blue shark recaptures by calendar month 1976–2014.

***f)*** ***Below.*** Distribution of blue sharks recaptured 1976–2014.

Tagged blue sharks have been recaptured in every month (Figure 17e). To date blue sharks are the only species in the NZGTP to have left the SW Pacific. An individual caught off South America holds the record for the greatest displacement for any fish in the NZGTP at 4609 n. miles, and another was caught in the Indian Ocean 3105 n. miles from where it was tagged (Figure 17f).





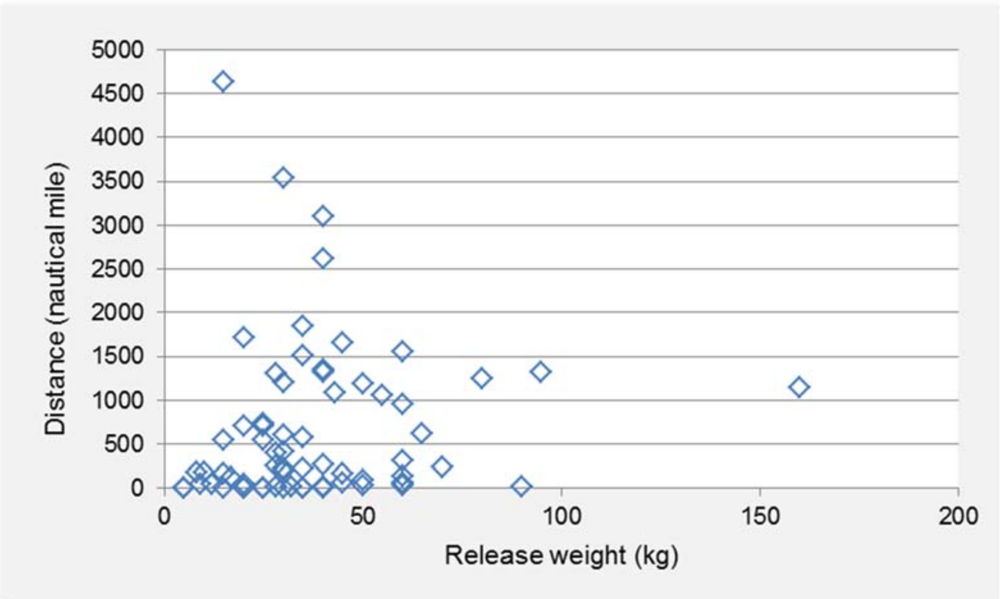

g) ***Above.*** Blue shark releases and recaptures by latitude and month.

h) ***Left.*** Distance travelled by days at liberty for blue sharks.

i) ***Below.*** Distance moved by blue shark release weights.

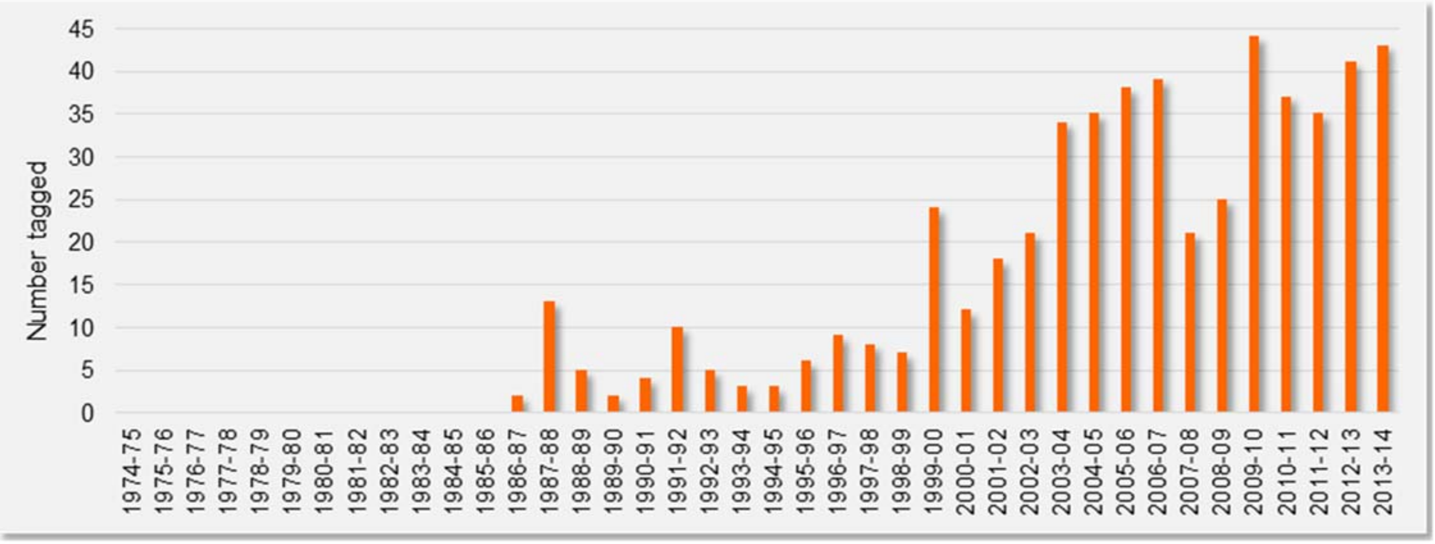
Blue sharks are tagged in all months in northern New Zealand, while there is a concentration of tagging effort during the summer which corresponds to a targeted fishery in southern latitudes (Figure.17g).

A wide range of displacement distances are seen after a few months at liberty and there have been several recaptures close to the release point after 1 or 2 years and one at Otago Heads after 3 years (Figure 17h). Release weight does not have much influence on displacement distance. If anything it is the relatively small fish in this database that moved the largest distances (Figure 17i).



### 4.4.3. BWH: Bronze whaler shark (*Carcharhinus brachyurus*)

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 541 | - | 12 | 2.03 | 1426 | 3.07 |



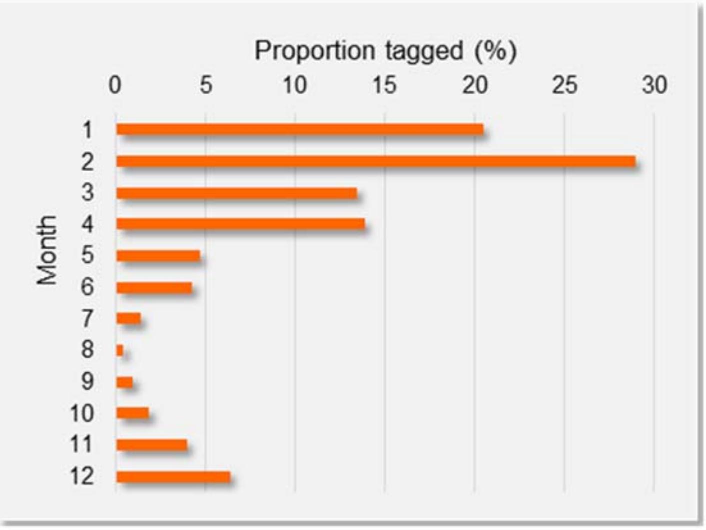



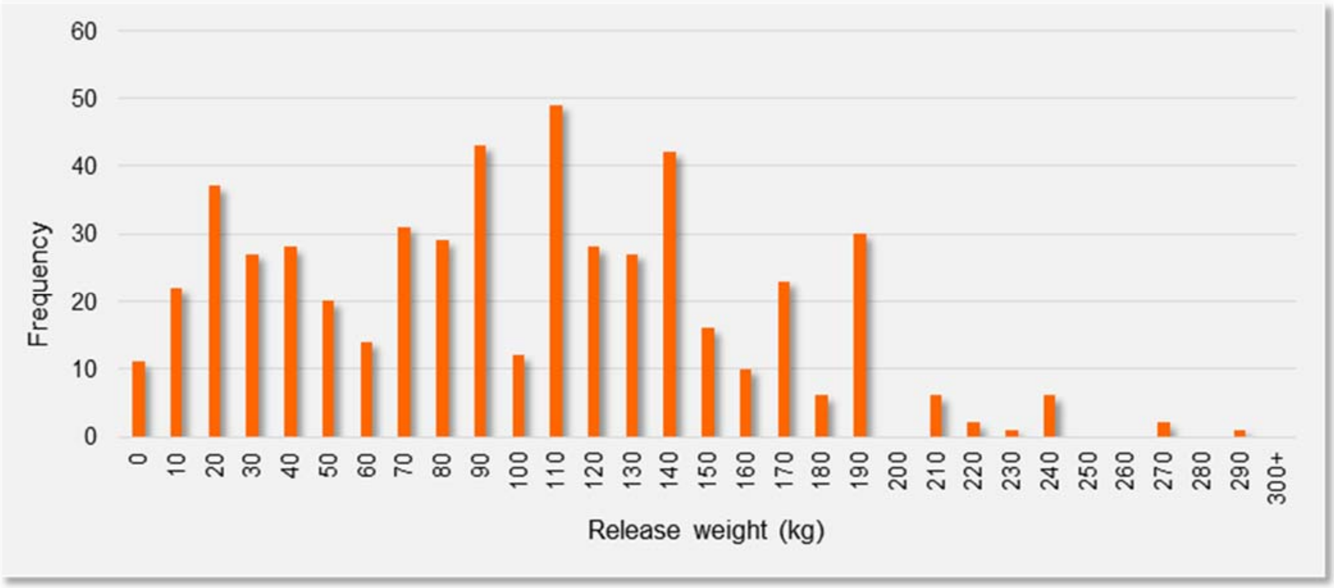

***Figure 18 a-f.***

***a) Above.*** Bronze whalers tagged and released by year 1974-2014.

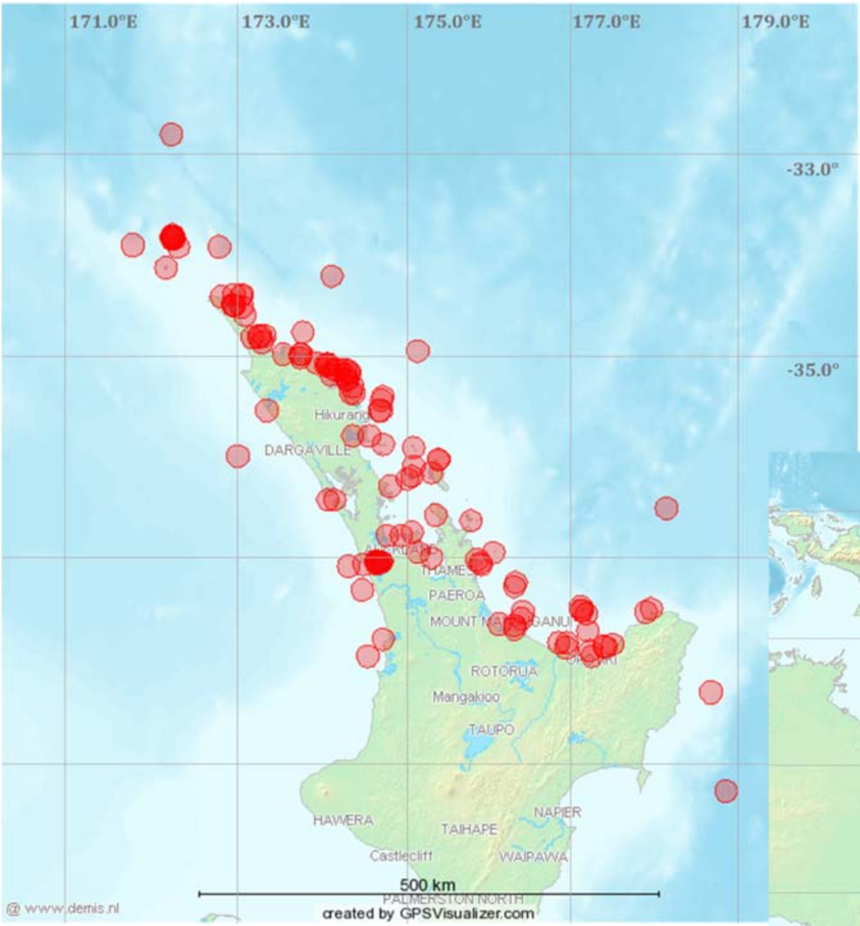
***b) Left.*** Proportion of bronze whaler sharks tagged by calendar month 1974–2014.

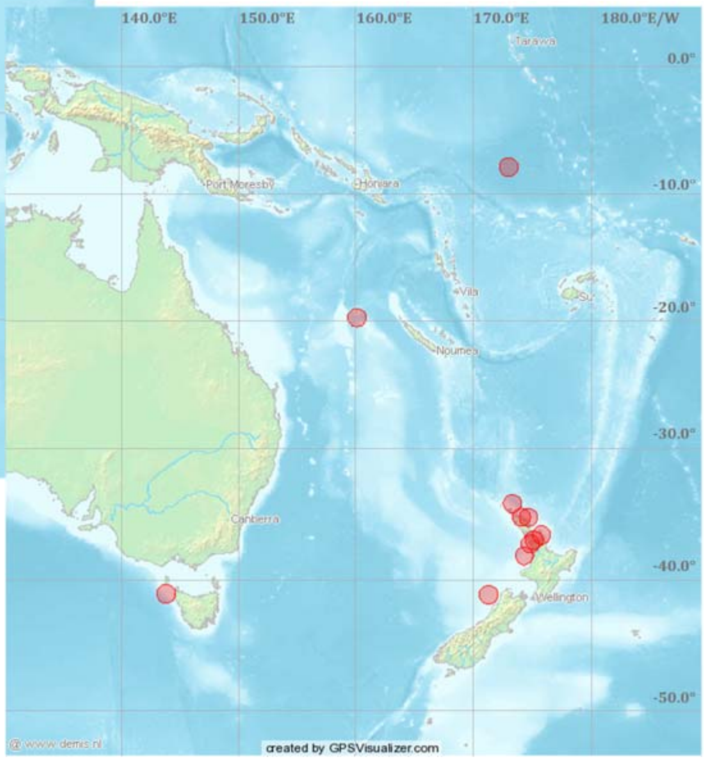
***c) Below.*** Weight (kg) of tagged bronze whaler sharks released 1974–2014.

The number of bronze whaler sharks reported as being tagged has increased markedly since 1999–00 (Figure 18a). They are tagged mainly in the summer months (Figure 18b). There is some doubt as to species identification with whaler sharks. Some very small ones may have been confused with school sharks (Figure 18c).



Bronze whalers have been tagged on the east and west coasts of northern New Zealand (Figure 18d), while the recapture distribution suggests that a variety of oceanic whaler species that visit New Zealand waters in summer may have been tagged along with bronze whalers that are resident in local waters (Figure 18e and f).

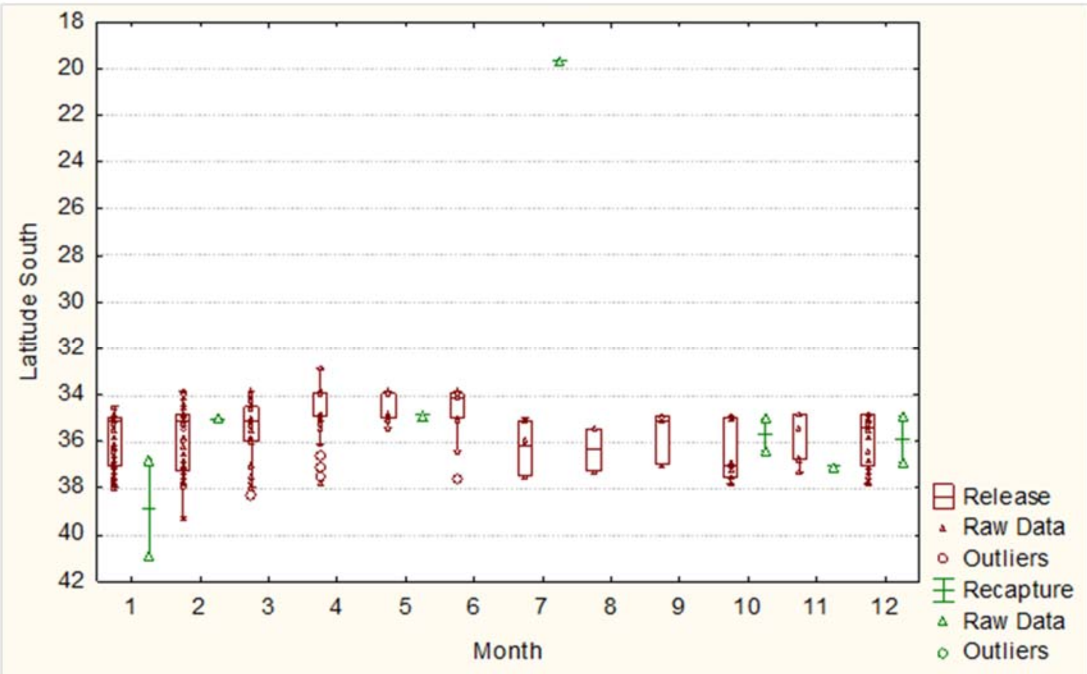



***d) Above.*** Distribution of bronze whaler sharks tagged, 1974-2014.

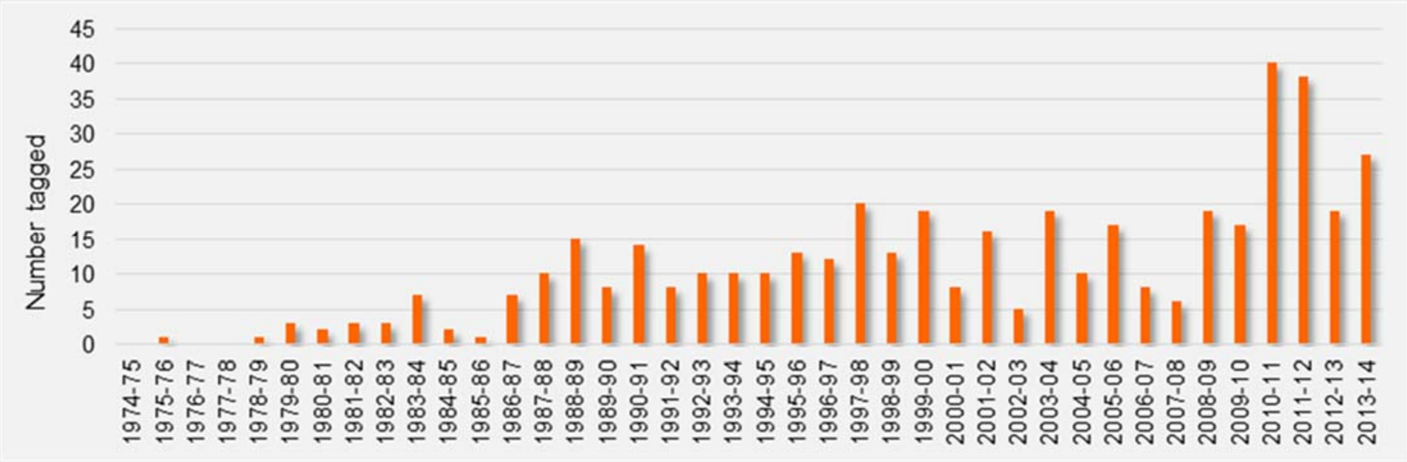
***e) Right.*** Distribution of bronze whaler sharks recaptured 1976–2014.

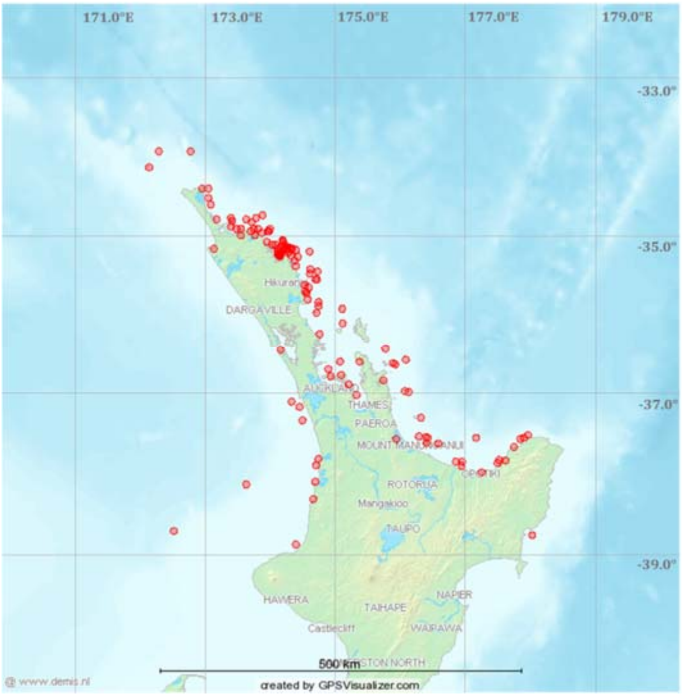
***f) Below.*** Bronze whaler shark releases and recaptures by latitude and month.

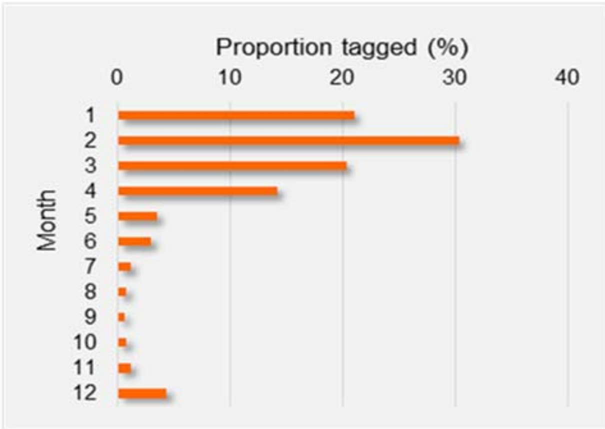


### 4.4.4. HHS: Smooth hammerhead shark (*Sphyrna zygaena*)

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 444 | - | 2 | 0.45 | 1060 | 884 |




Hammerhead sharks have also been tagged in modest numbers since the 1980s with a more coastal distribution than other pelagic sharks (Figure 19a and b). They are mainly caught from January to April (Figure 19c). Two clear spikes in release weight (<20kg and 90-150kg) may indicate breeding and/or nursery areas in New Zealand coastal waters (Figure 19d).

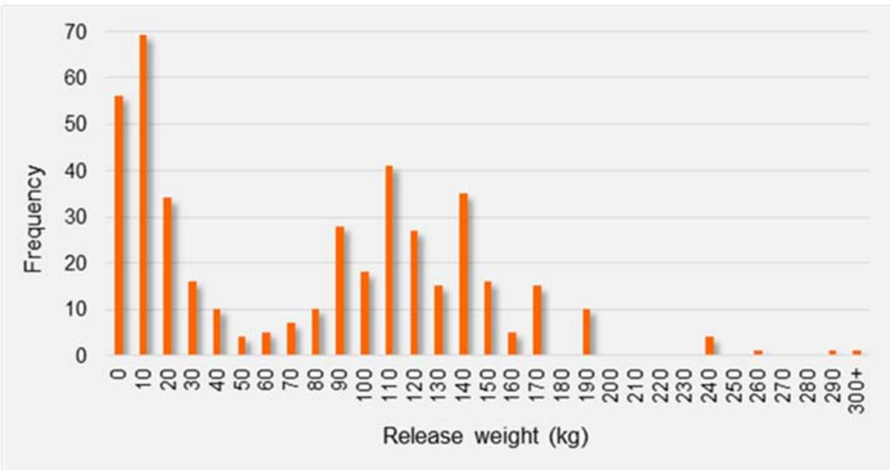
***Figure 19 a-e.***

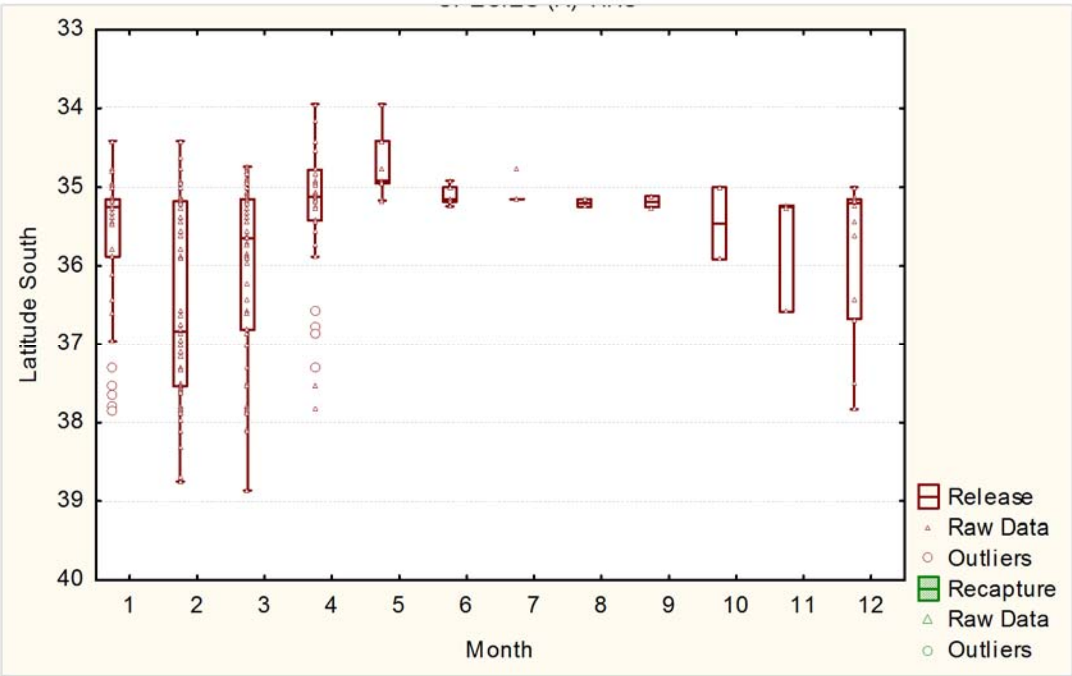
***a)*** ***Top.*** Hammerhead sharks tagged and released by year.

***b)*** ***Above.*** Distribution of tagged hammerhead sharks in New Zealand waters 1976–2014.

***c)*** ***Above right.*** Proportion of hammerhead sharks tagged by calendar month 1974–2014.

***d)*** ***Right.*** Weight (kg) of tagged hammerhead sharks released 1974–2014.



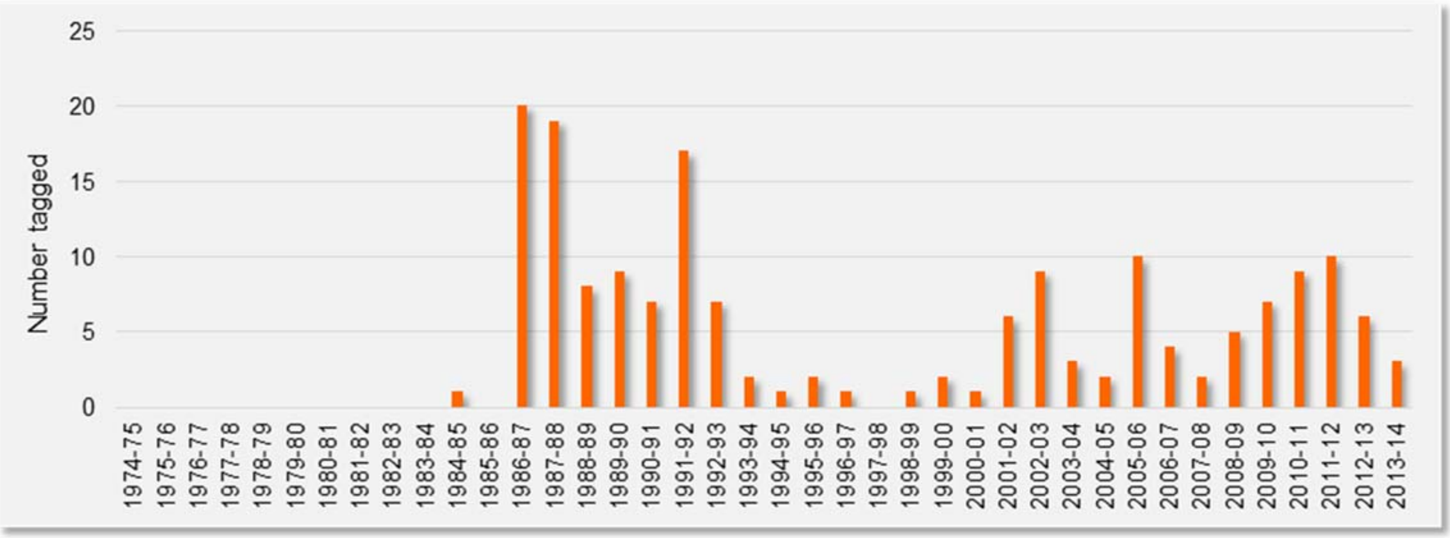


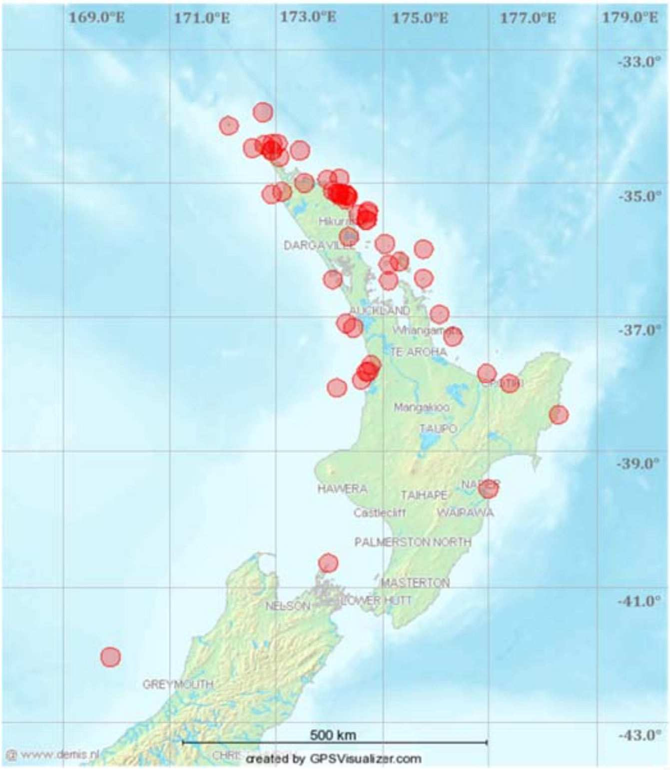

***e) Top.*** Hammerhead sharks tagged and released by latitude and month.

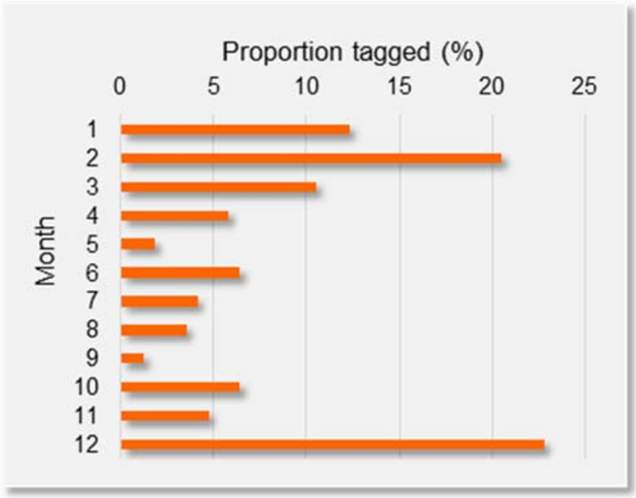
Hammerhead sharks tend to arrive with warm oceanic water in summer and are tagged furthest south in February and March and furthest north in May (Figure 19e).

#### 4.4.5. SCH: School shark (*Galeorhinus galeus*)

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 173 | 1 | 39 | 22.4 | 1063 | 19.25 |




The numbers of school sharks tagged per year has been quite variable with most tagged around northern New Zealand (Figure 20a and b). School sharks are predominantly tagged in summer months and are usually less than 40 kg on release (Figure 20c and d).

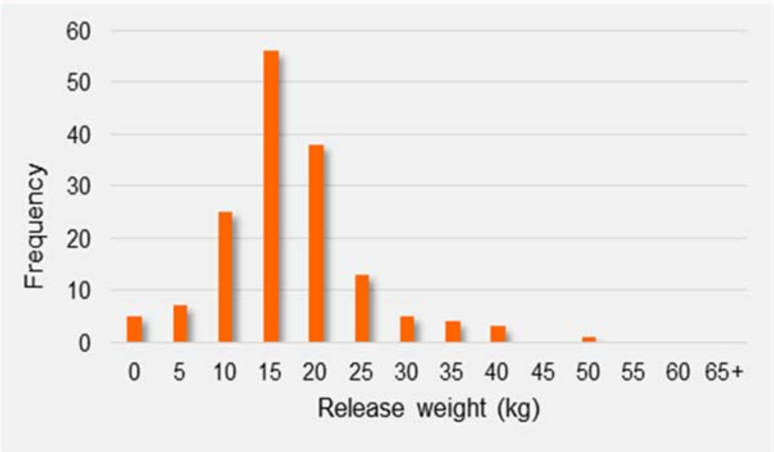


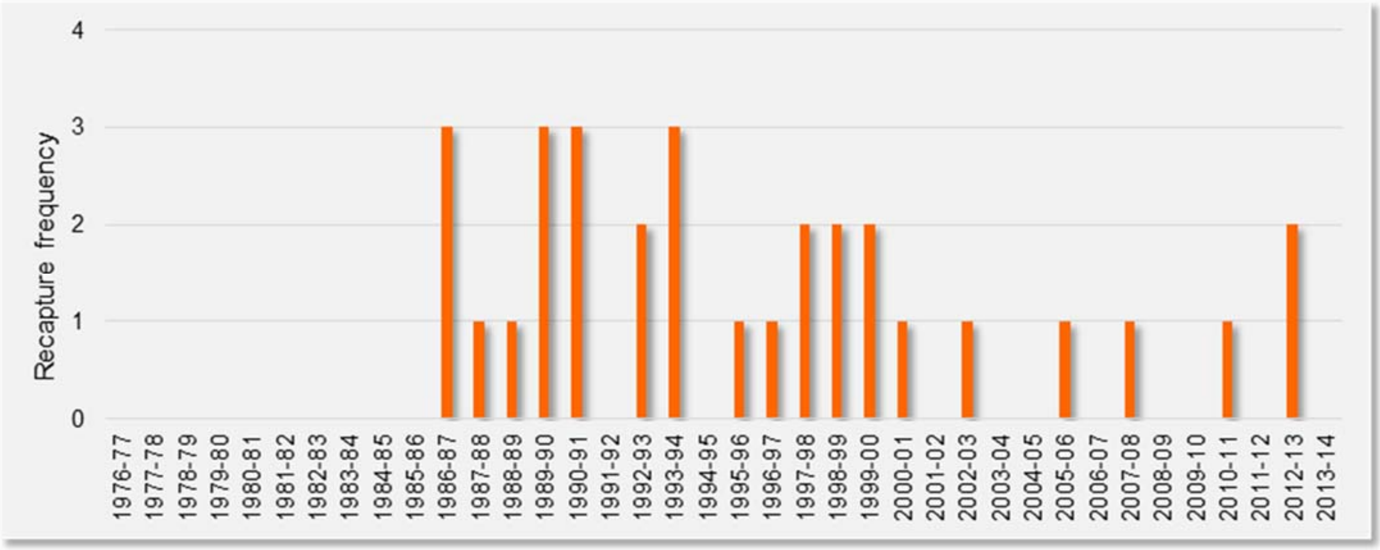

***Figure 20 a-k.***

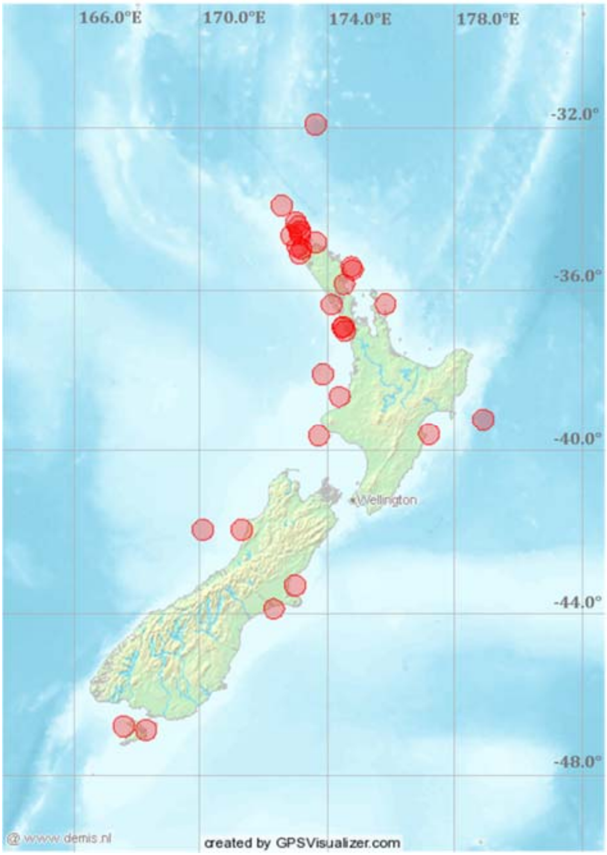
***a)*** ***Top.*** School sharks tagged and released by year.

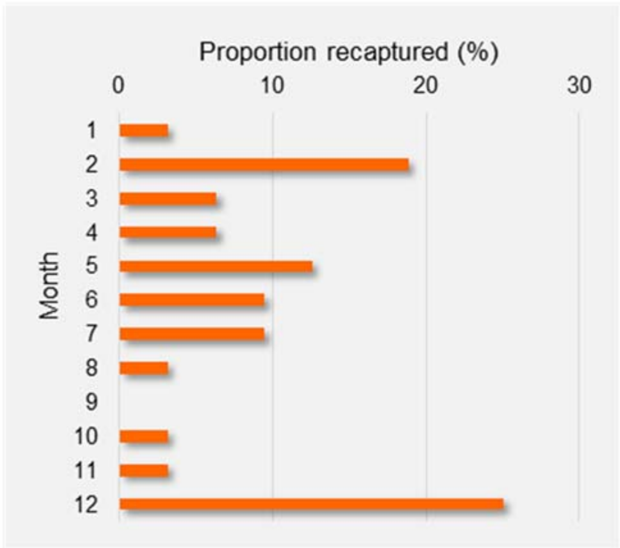
***b)*** ***Above.*** Distribution of school sharks tagged in New Zealand waters, 1974–2014.

***c)*** ***Above right.*** Proportion of school sharks tagged by calendar month 1974–2014.

***d)*** ***Right.*** Weight (kg) of tagged school sharks released 1974–2014.



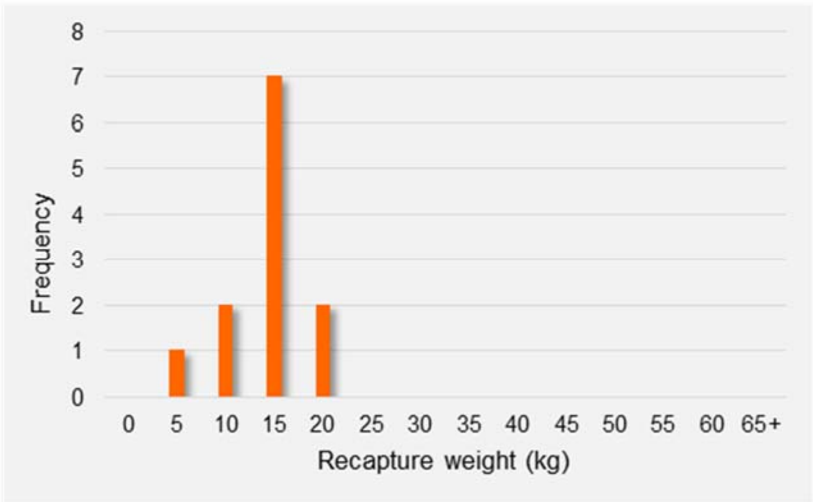

The recapture rate for school shark is the highest in the NZGTP, at 22.4% (Figure 8). The maximum time at liberty of more than 19 years shows that school sharks are long-lived, while the recaptures around the South Island (Figure 20f) and one in Australian waters (not shown) 1063 n. miles from the tagging location show that these small sharks may be more mobile than most anglers might suspect. Recapture weights have a strong mode at 15–19.9 kg (Figure 20h).

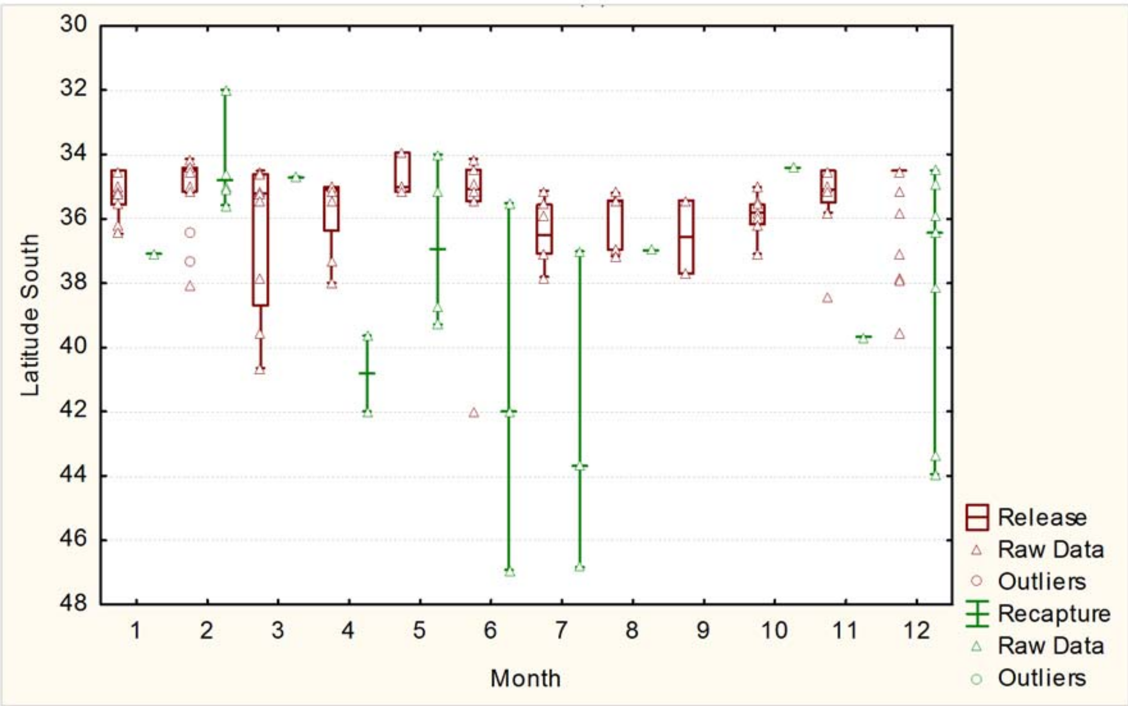
***e)*** ***Top.*** School shark recaptures by year.

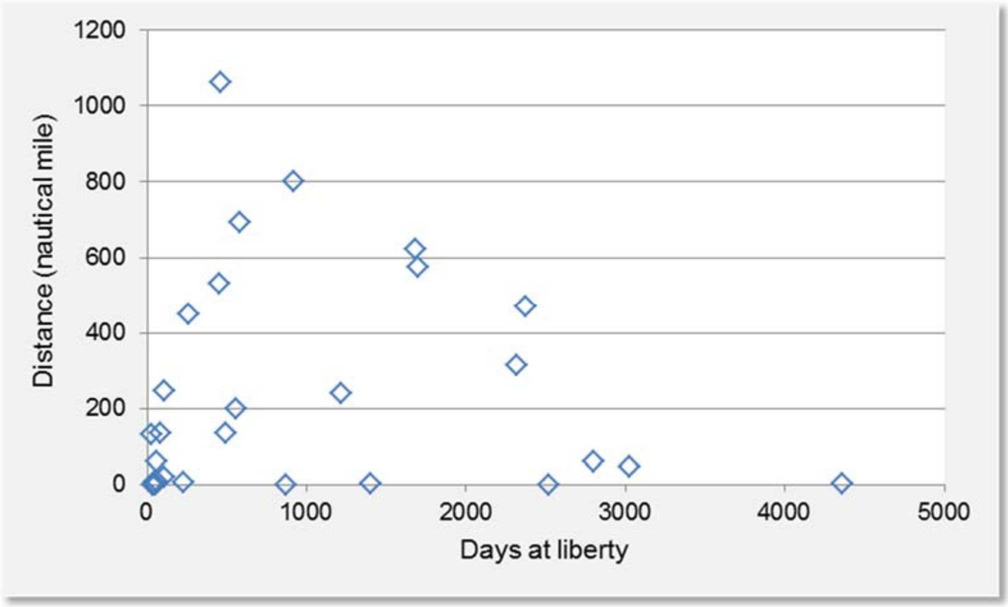
***f)*** ***Above.*** Distribution of school sharks recaptured 1976–2014.

***g)*** ***Above right.*** Proportion of school shark recaptures by calendar month 1976–2014.

***h)*** ***Right.*** Weight (kg) of school sharks recaptured 1976–2014 where recapture weight recorded (n= 12.)





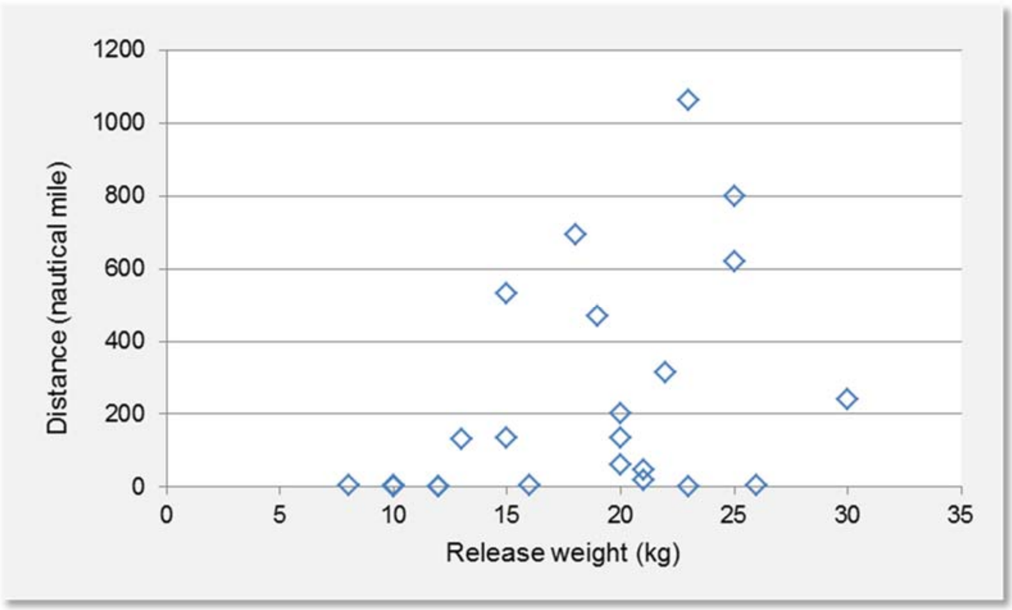




*i)* ***Top.*** School shark releases and recaptures by latitude and month.

*j)* ***Left.*** Distance moved by days at liberty for school sharks.

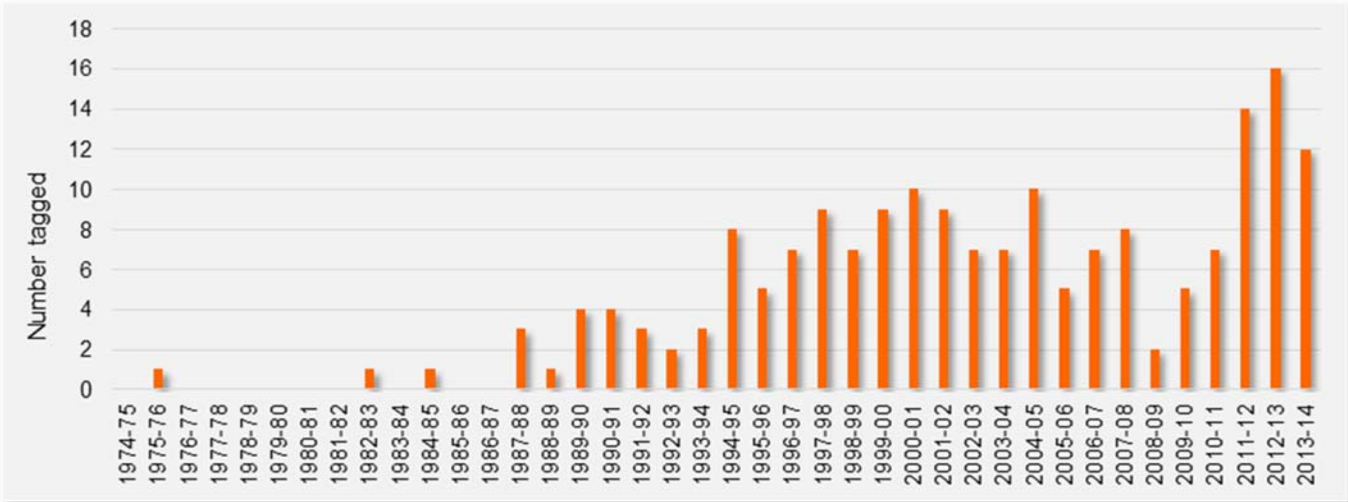
*k)* ***Below.*** Distance moved by school shark release weight.

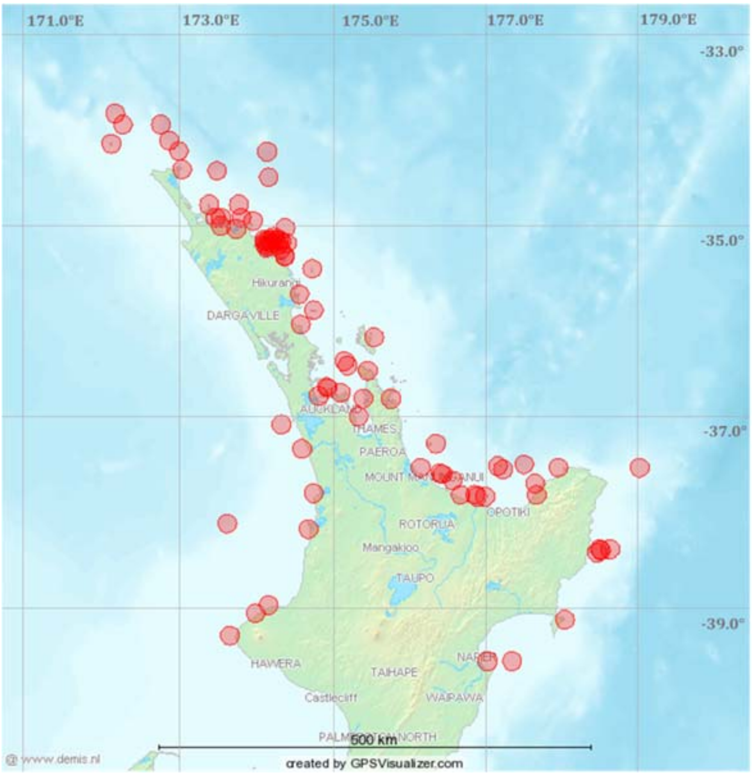
School sharks tend to be tagged by recreational fishers between 34° and 37° S and caught around New Zealand by commercial fishers (Figure 20f and i). Some of the longest term recaptures have been close to their release point (Figure 20j). Size at release does not appear to influence displacement distance (Figure 20d and k). Most (60%) recaptures did not include information on weight and some of those that were may have been processed weight. Overall the distribution of recapture weights was smaller than release weights (Figure 20d and h).

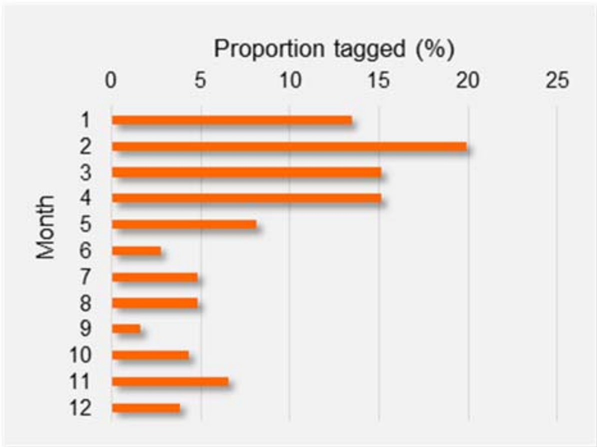


### 4.4.6. THR: Thresher shark (*Alopias spp.*)

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 186 | - | 1 | 0.54 | - | - |




The number of thresher sharks tagged has increased in recent years and they are present in coastal and offshore waters around the North Island year round (Figure 21a, b and c). These sharks range in size from young juveniles to large adults (Figure 21d). Many of the largest world record thresher sharks have been caught by anglers in New Zealand.

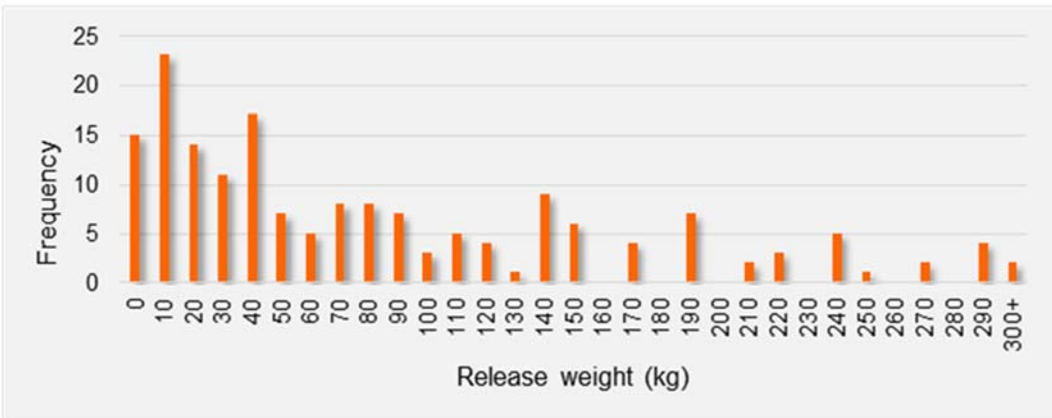
***Figure 21 a-d.***

***a) Top.*** Thresher sharks tagged and released by year.

***b) Above,*** Distribution of thresher sharks tagged in New Zealand waters, 1974–2014.

***c) Above Right.*** Proportion of thresher sharks tagged by calendar month 1974–2014.

***d) Right.*** Weight (kg) of tagged thresher sharks released.



#### 4.4.7. POS: Porbeagle shark (*Lamna nasus*)

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 119 | - | 1 | 0.84 | 0 | 1 |

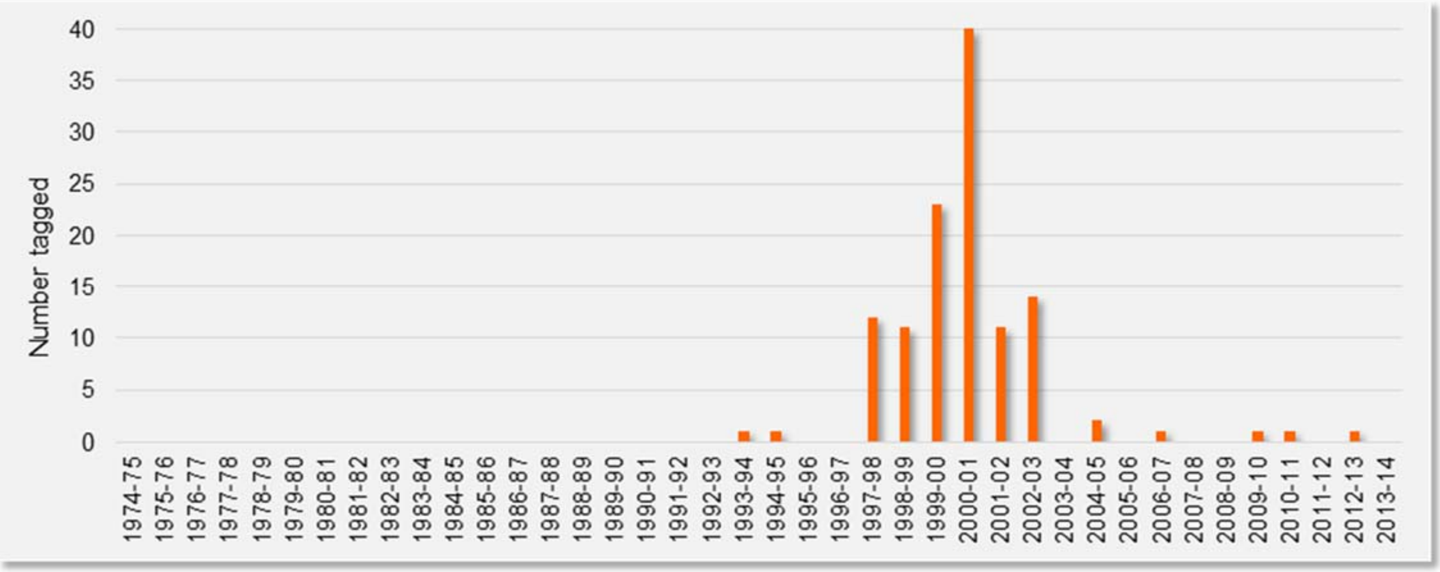
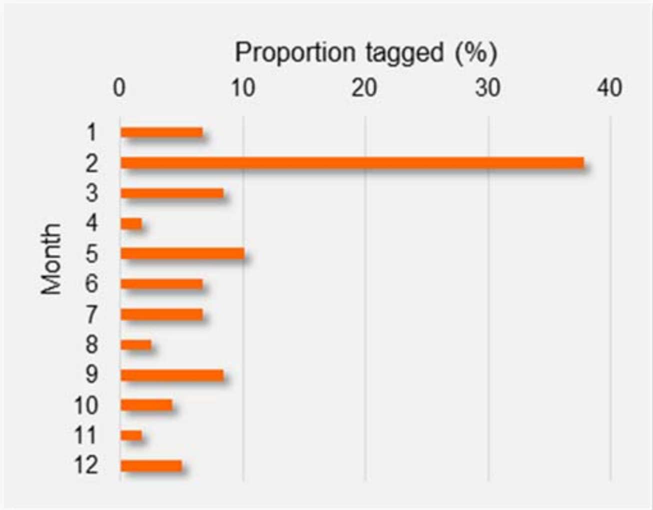


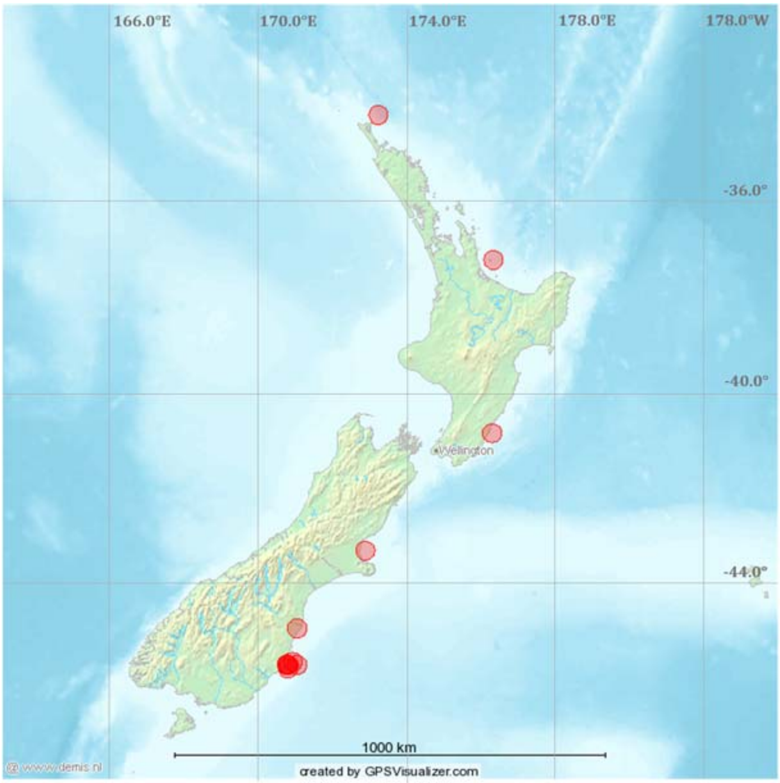

***Figure 22 a-c.***

***a)*** ***Above.*** Porbeagle sharks tagged and released by year 1974–2014.

***b)*** ***Right.*** Proportion of porbeagl***e*** sharks tagged by calendar month 1974–2014.

***c)*** ***Below.*** Distribution of porbeagle sharks tagged in New Zealand waters, 1974–2014. (Note; 98 of the 119 sharks tagged were caught around Dunedin.)

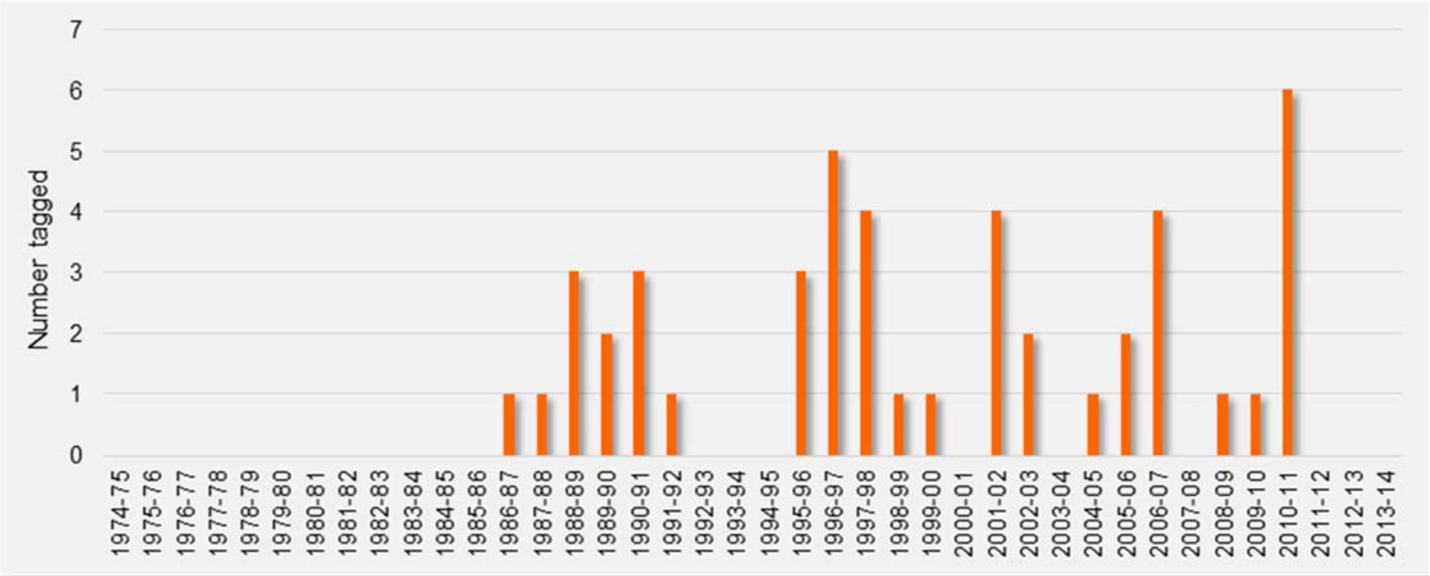


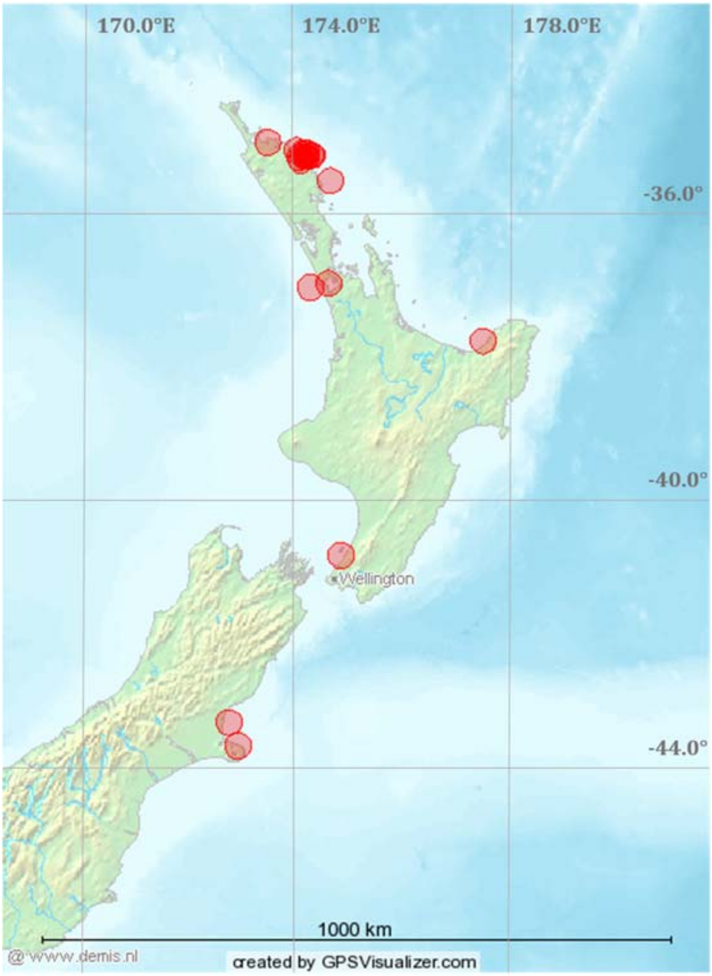




Most porbeagle sharks were tagged between 1998 and 2003 in association with a targeted sports fishery off Otago heads in February each year (Figure 22a, b and c). The average weight was 54 kg (s.d.=14.2). Porbeagle sharks tagged off the North Island, including four off Mayor Island, Bay of Plenty were caught during winter.

#### 4.4.8. SEV: Broadnose sevengill shark (*Notorynchus cepedianus*)

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 46 | - | 4 | 8.7 | 287 | 1.95 |



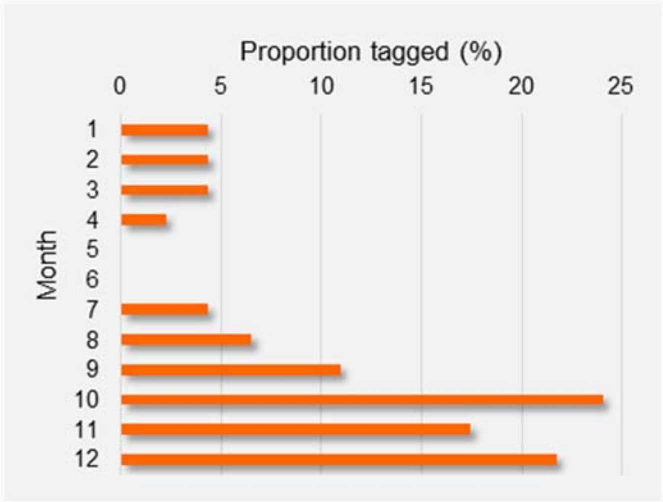



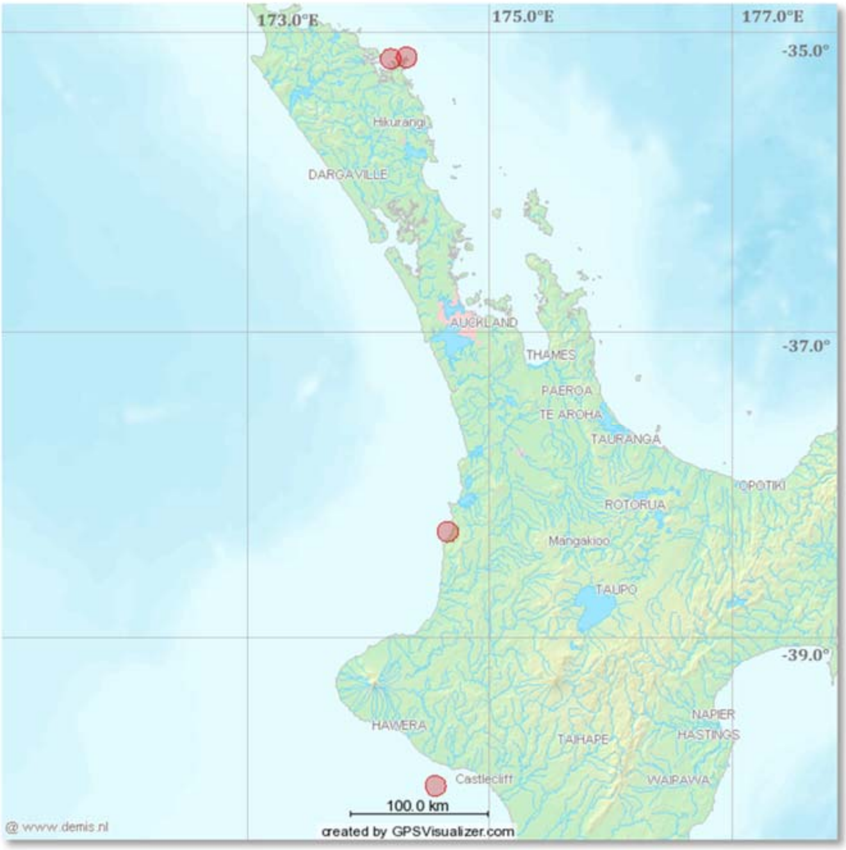

***Figure 23 a-d.***

***a)*** ***Top.*** Sevengill sharks tagged and released by year.

***b)*** ***Above left.*** Distribution of sevengill sharks tagged in New Zealand waters, 1974–2014.

***c)*** ***Above right.*** Proportion of sevengill sharks tagged by calendar month 1974–2014.

Small numbers of sevengill sharks have been tagged since 1987 mostly during winter and spring (Figure 23a and b). Generally, sevengill sharks are caught as bycatch in association with bottom fishing in the Bay of Islands. Small numbers have also been caught in Manukau Harbour as part of collection for Kelly Tarleton's Under Water World (Figure 23c). Some of these were tagged after a period in captivity.

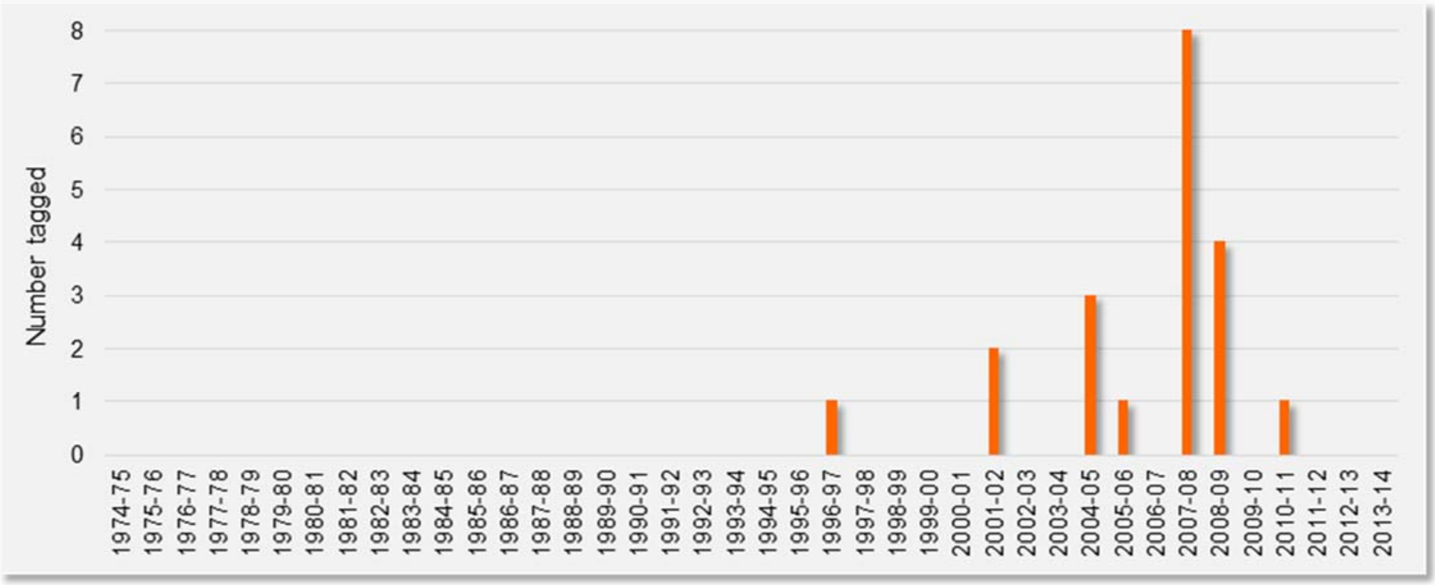



***d)*** ***Above.*** Distribution of sevengill sharks recaptured 1976–2014.

There have been two sevengill shark recaptures close to their release point in the Bay of Islands with relatively short times at liberty (Figure 23d). One shark tagged near Cape Brett was recapture by a commercial set net fisher off Waverly in the Taranaki Bight after 712 days at liberty.

### 4.4.9. WPS: Great white shark (*Carcharodon carcharias*)

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 20 | 3 | - | - | - | - |



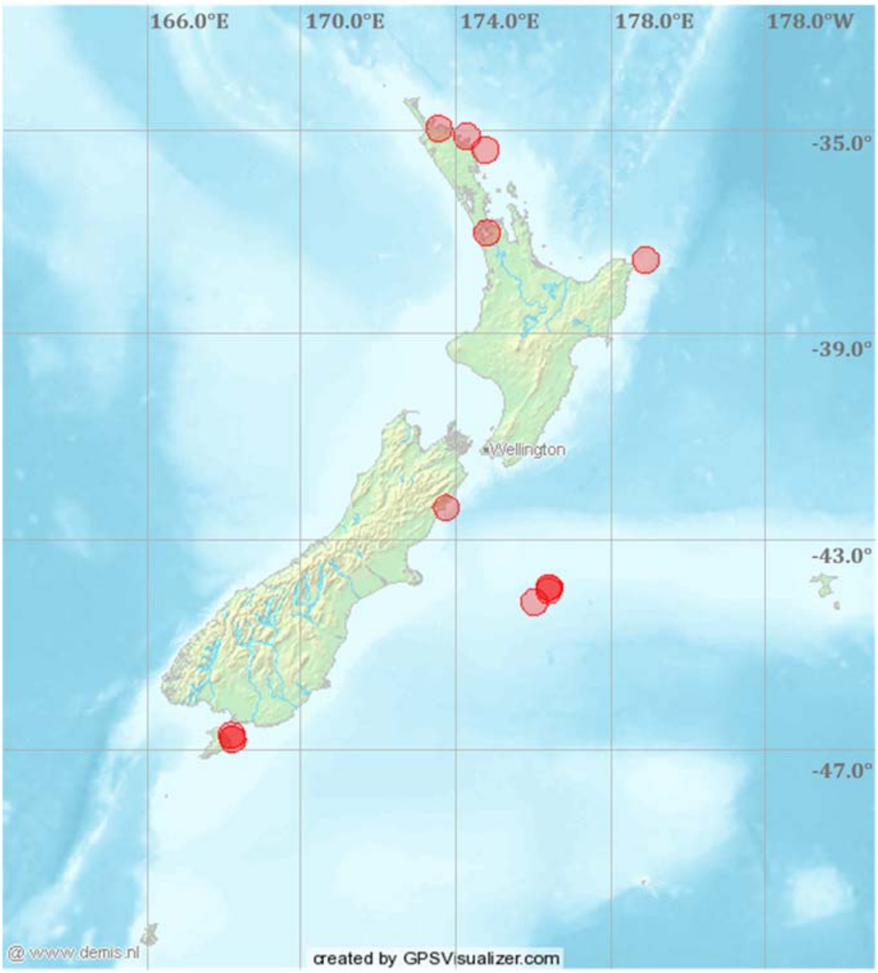



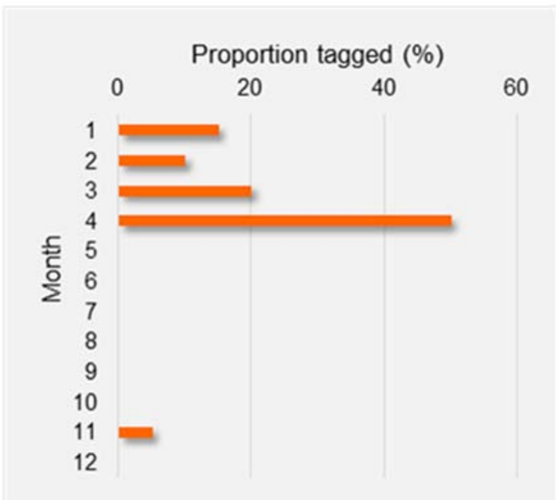

***Figure 24 a-c.***

***a)*** ***Above.*** Great white sharks tagged and released by year 1974–2014.

***b)*** ***Left.*** Distribution of great white sharks tagged in New Zealand waters, 1974–2014.

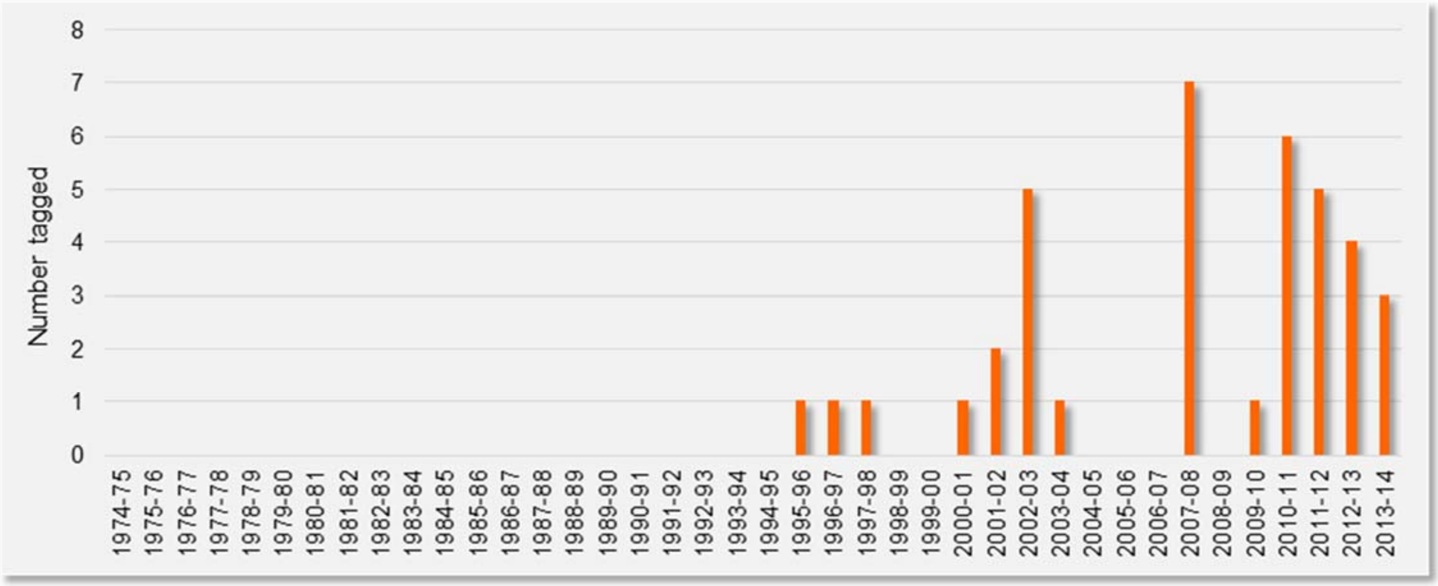
***c)*** ***Below.*** Proportion of great white sharks tagged by calendar month 1974–2014.

White sharks have been tagged since 1997 in a wide range of locations around New Zealand (Figure 24a and b). Most have been caught during summer in association with satellite tagging projects for this species (Figure 24c).



### 4.4.10. SHA: Other or unspecified shark species

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 55 | - | 2 | 3.6 | 1807 | 6.7 |



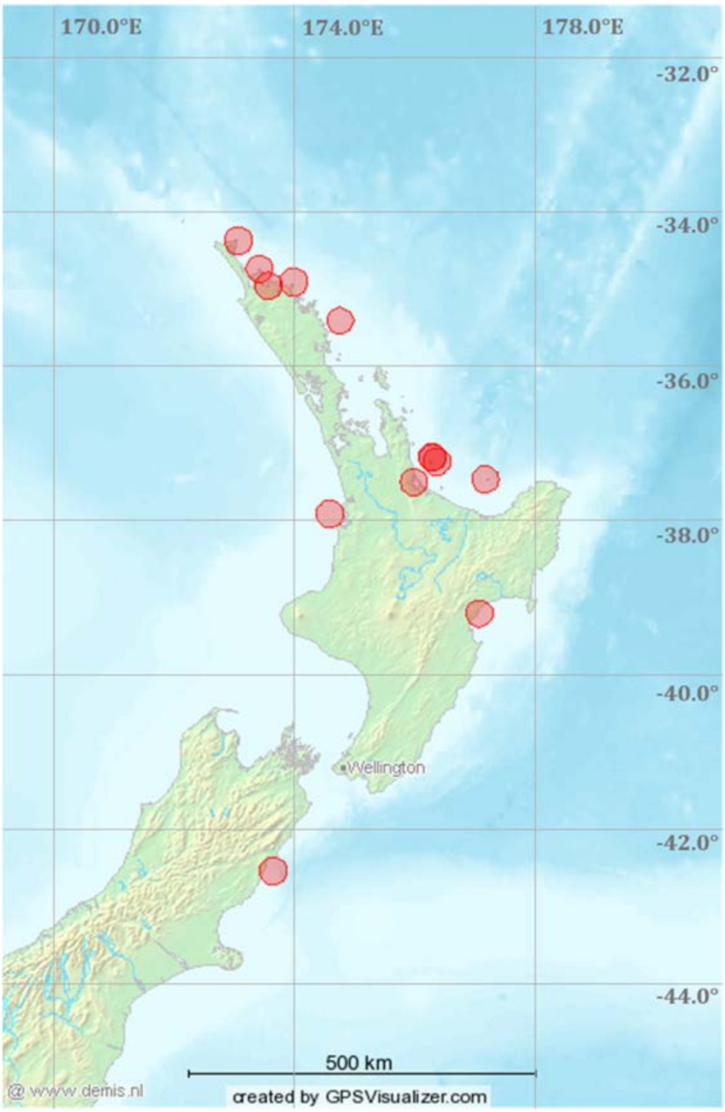



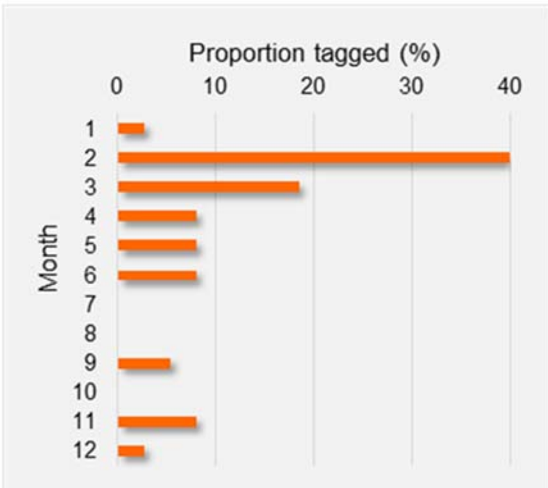

***Figure 25a-c.***

***a)*** ***Above.*** Other shark species tagged and released by year 1974–2014.

***b)*** ***Left.*** Distribution of other shark species tagged in New Zealand waters, 1974–2014.

***c)*** ***Below.*** Proportion of other shark species tagged by calendar month 1974–2014.

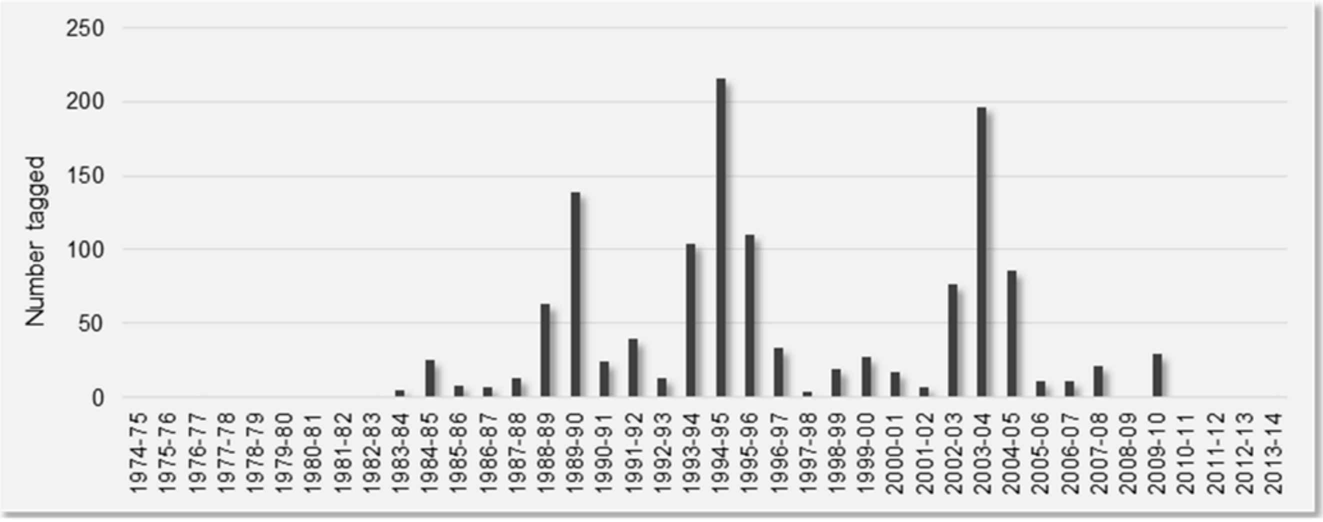
There have been 55 unidentified sharks tagged and released since 1996, mainly from the upper North Island (Figure 25a and b).

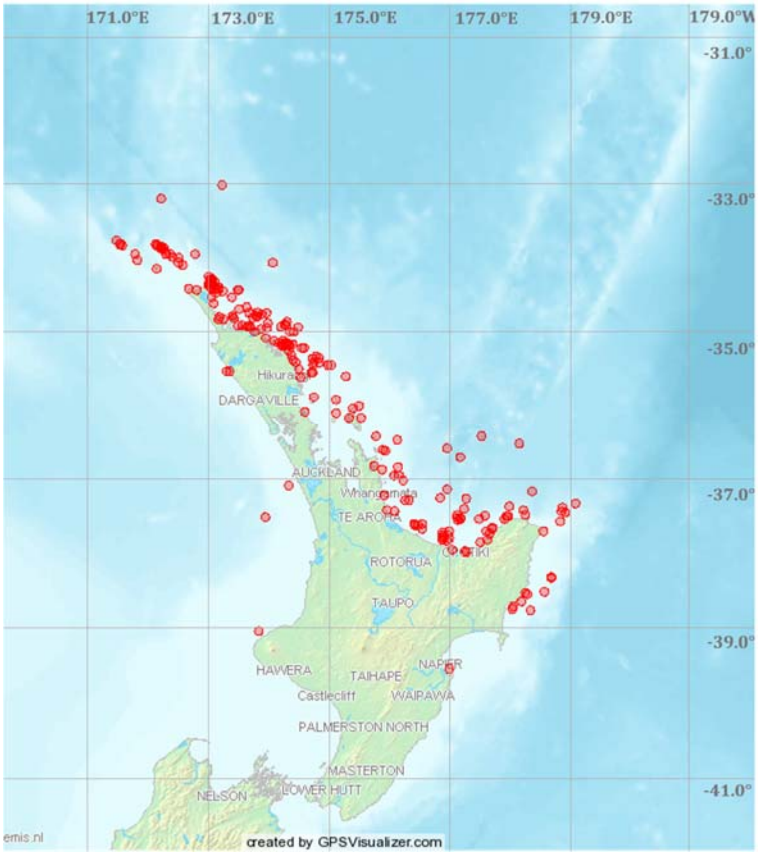


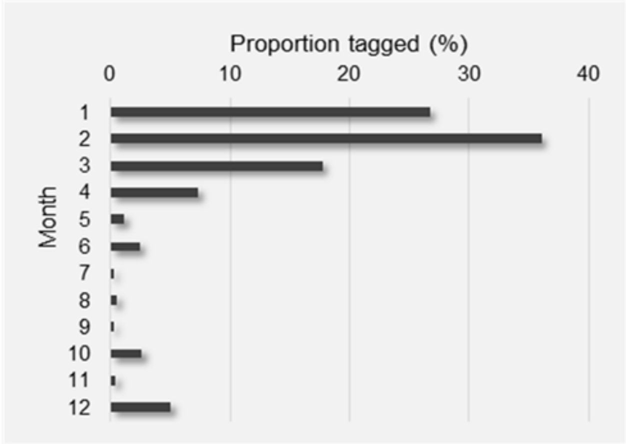
## 4.5. Tunas

### 4.5.1. YFN: Yellowfin tuna (*Thunnus albacares*)

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 1245 | 53 | 15 | 1.16 | 1170 | 1.64 |




Yellowfin tuna were added to the target species for tagging in 2001, but from 2004–05 catches declined to almost zero (Figure 26a). Releases were mainly on the north-east of the North Island, from Poverty Bay to the Three Kings Islands from January to March (Figure 26b and c). Fishers have generally tagged small fish and kept larger ones (Figure 26d).

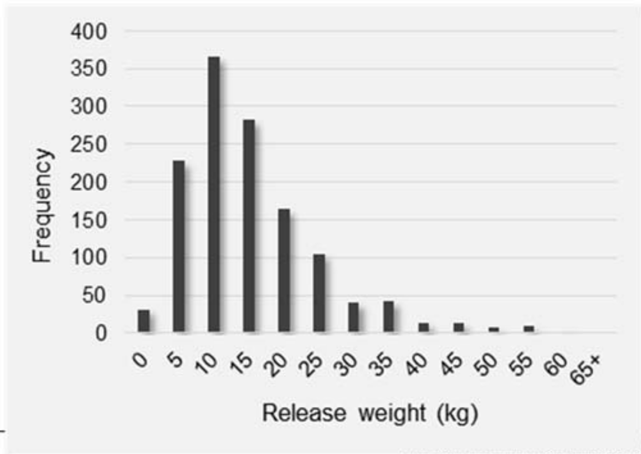


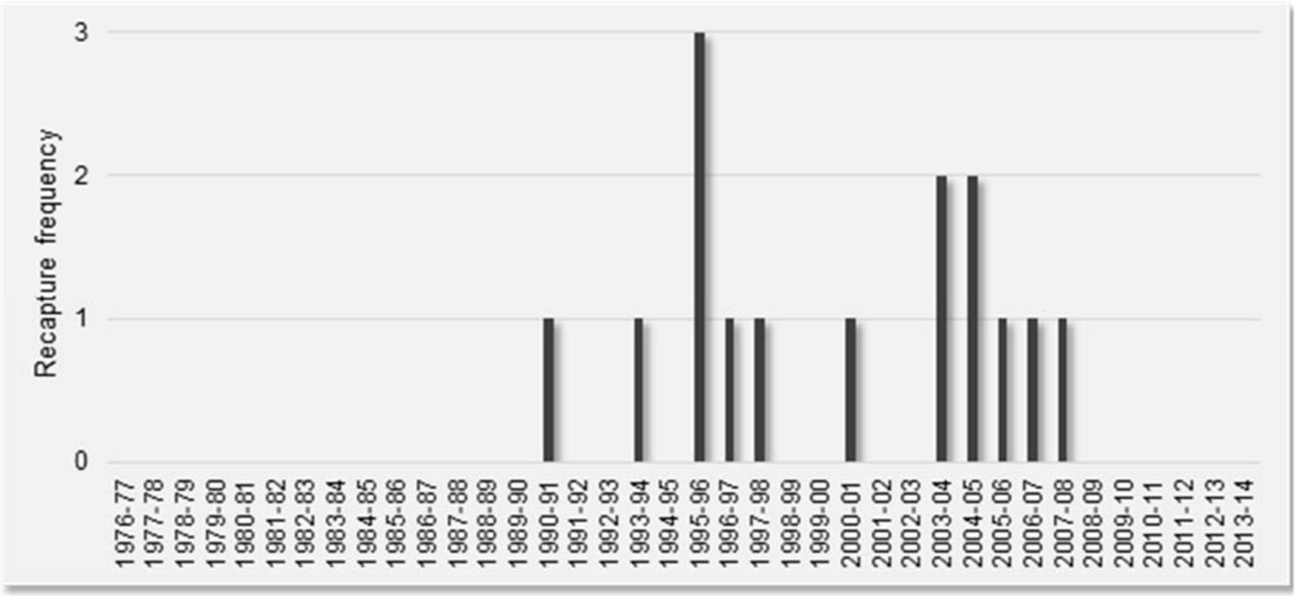

***Figure 26 a-k.***

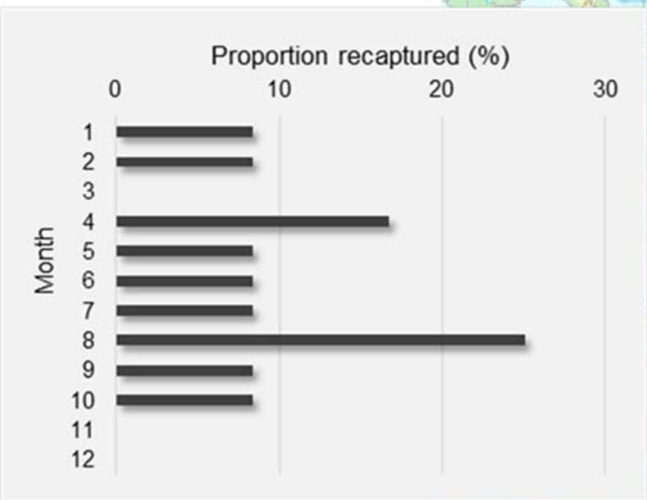
***a)*** ***Top.*** Yellowfin tuna tagged and released by year 1974–2014.

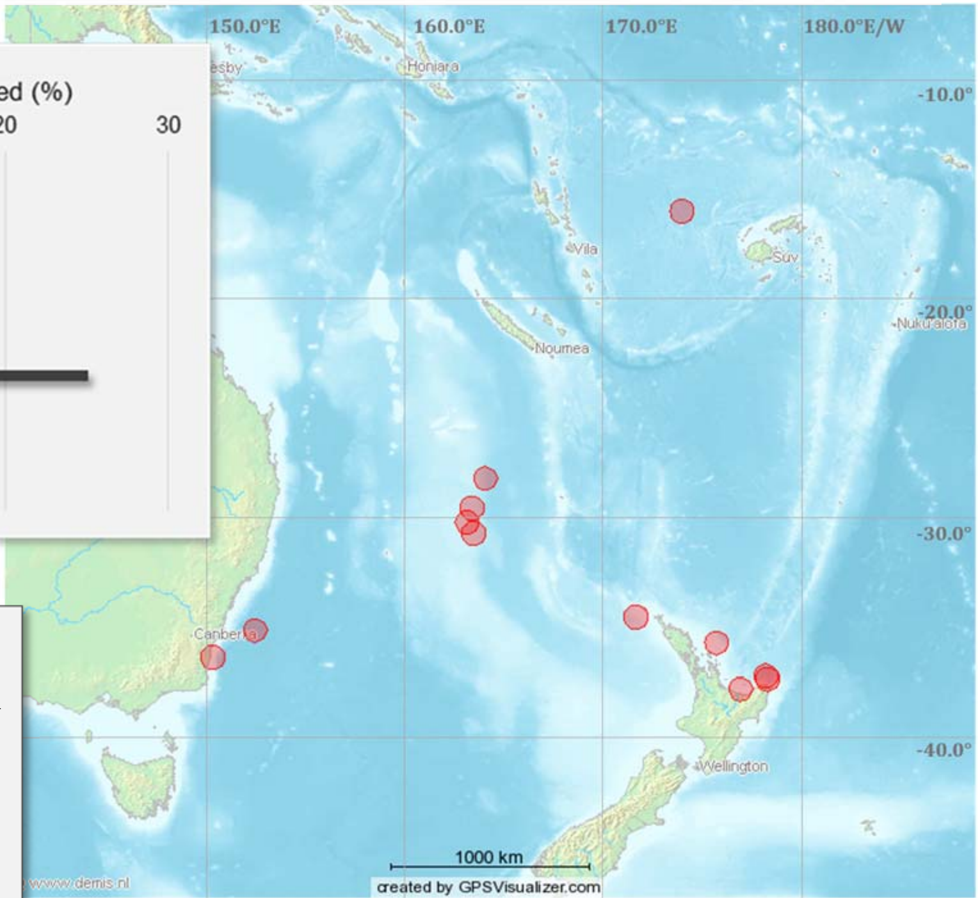
***b)*** ***Above.*** Distribution of yellowfin tuna tagged, 1974–2014.

***c)*** ***Above right.*** Proportion of yellowfin tuna tagged by calendar month 1974–2014.

***d)*** **Right.** Weight (kg) of tagged yellowfin tuna released 1974–2014.



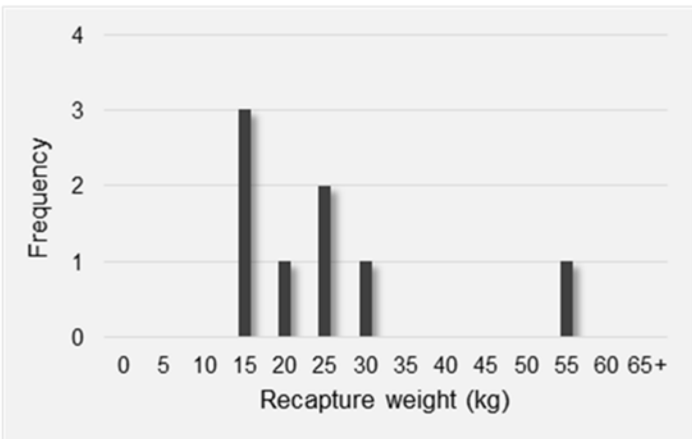

***e)*** ***Top.*** Yellowfin tuna recaptures by year.

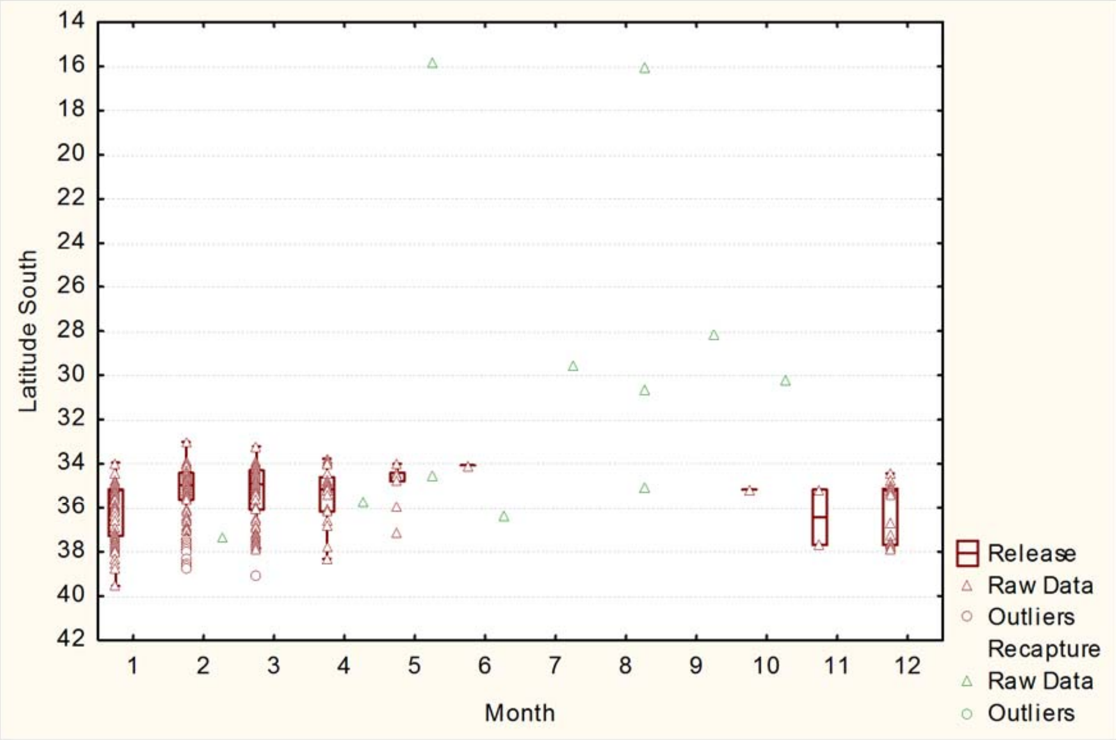
***f)*** ***Above.*** Proportion of yellowfin tuna recaptures by calendar month 1976–2014.

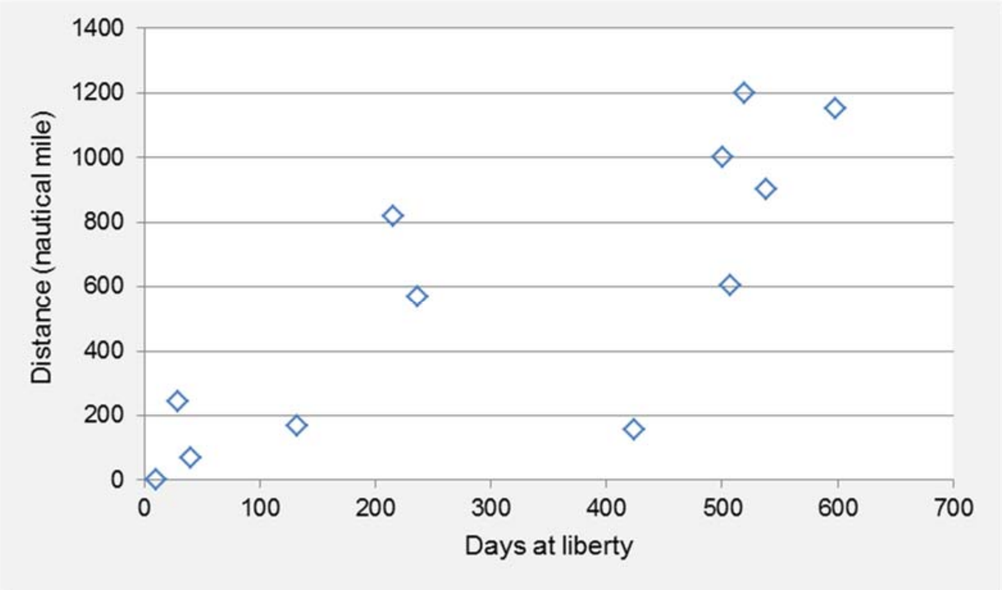
***g)*** **Right.** Distribution of yellowfin tuna recaptured 1976–2014.

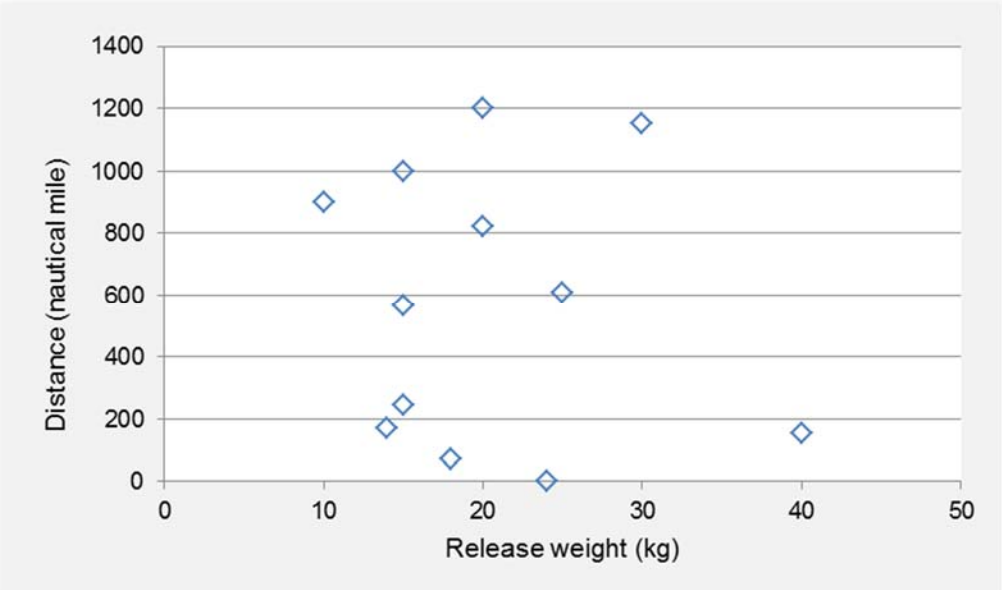
***h)*** **Below right.** Weight (kg) of yellowfin tuna recaptured.

There have been 15 yellowfin recaptures from 1991 to 2008 spread across most months (Figure 26e and f). Time at liberty ranges from 10 to 598 days with an average of 322 days (s.d.=218). Two yellowfin have been recaptured off east Australia (Figure 26g) but so far none of the thousands of yellowfin tagged by Australian anglers have been recaptured in New Zealand waters. Recapture weights are not available for all fish but reflect the size of fish released (Figure 26h).






***i)*** ***Above.*** ***Y***ellowfin tuna releases and recaptures by latitude and month.

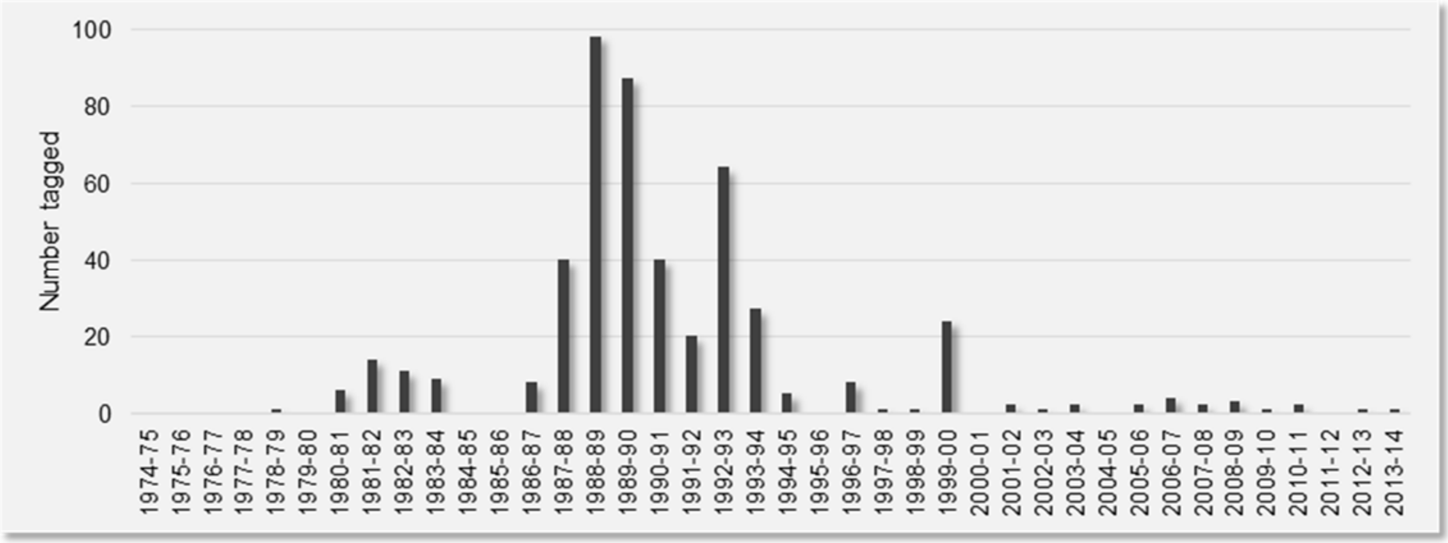
***j)*** ***Left.*** Distance moved by days at liberty for yellowfin.

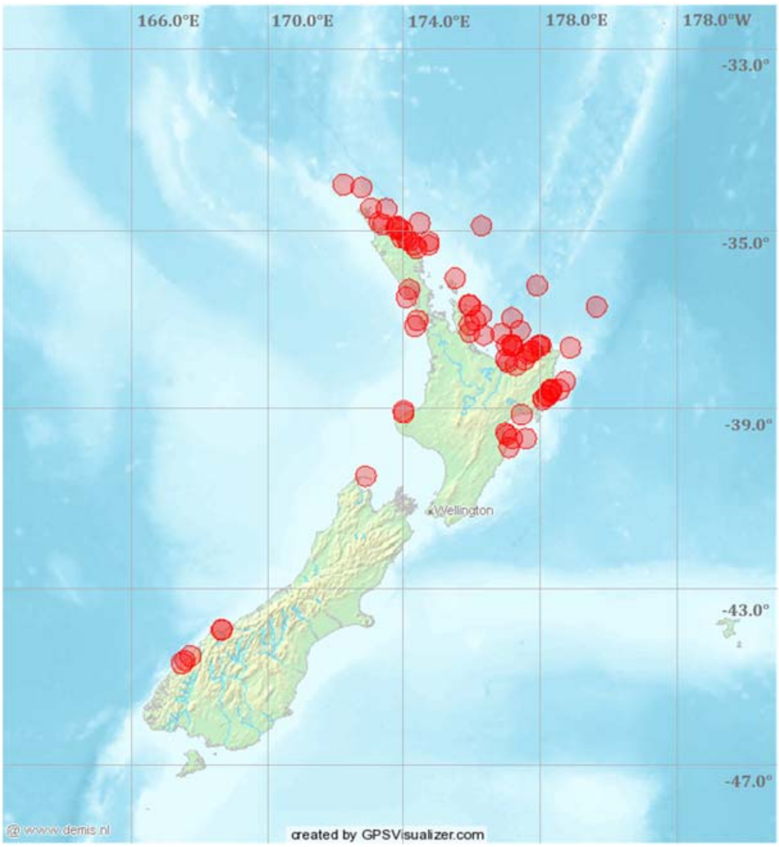
***k)*** ***Below left.*** Distance moved by release weight for yellowfin.

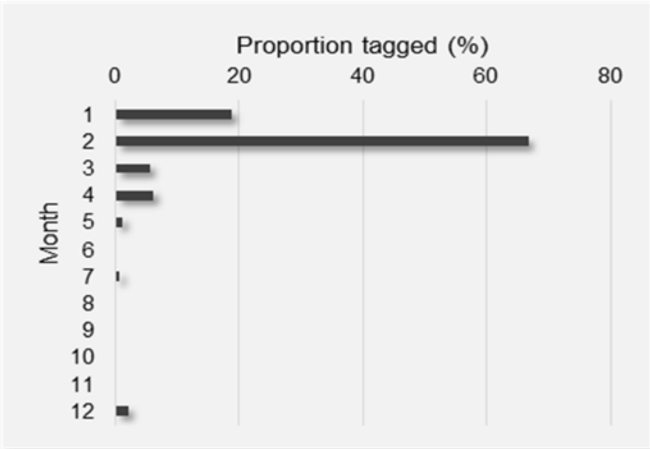
Four yellowfin have been recaptured north of Lord Howe Is. in international waters, all in different years, and all between July and October (Figure 26g and i). Yellowfin recaptures in winter months have been away from New Zealand, the fish recaptured at 35° S in August was off NSW. For the 12 recaptures with data, displacement distance tends to increase with days at liberty and there is no pattern in the plot of distance by release weight (Figure 25j). One 40 kg fish tagged in February was recaptured 14 months later in New Zealand waters (Figures 25j and k).

### 4.5.2. ALB: Albacore (*Thunnus alalunga*)

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 484 | 1 | 1 | 0.21 | 107 | 0.14 |




Recreational fishers tagged most albacore between 1988 and 1994, mainly in January and February (Figure 27a and b). Fishers were actively discouraged from tagging this species in the early 1990s. Albacore releases were spread around New Zealand and most were less than 10 kg (Figure 27c and d).

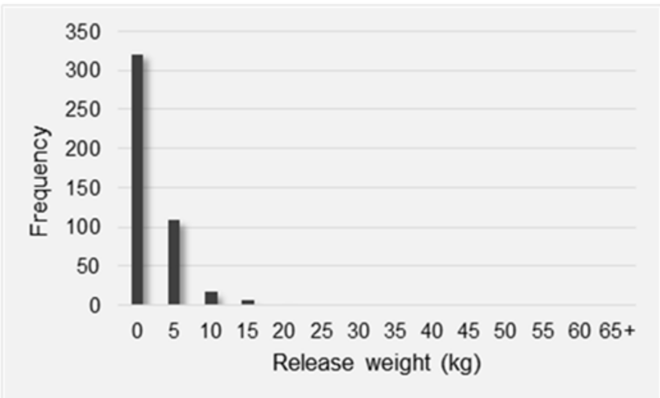
*Figure 27 a-d.*

***a)*** ***Top.*** Albacore tagged and released by year 1974–2014.

***b)*** ***Above.*** Distribution of albacore tagged, 1974–2014.

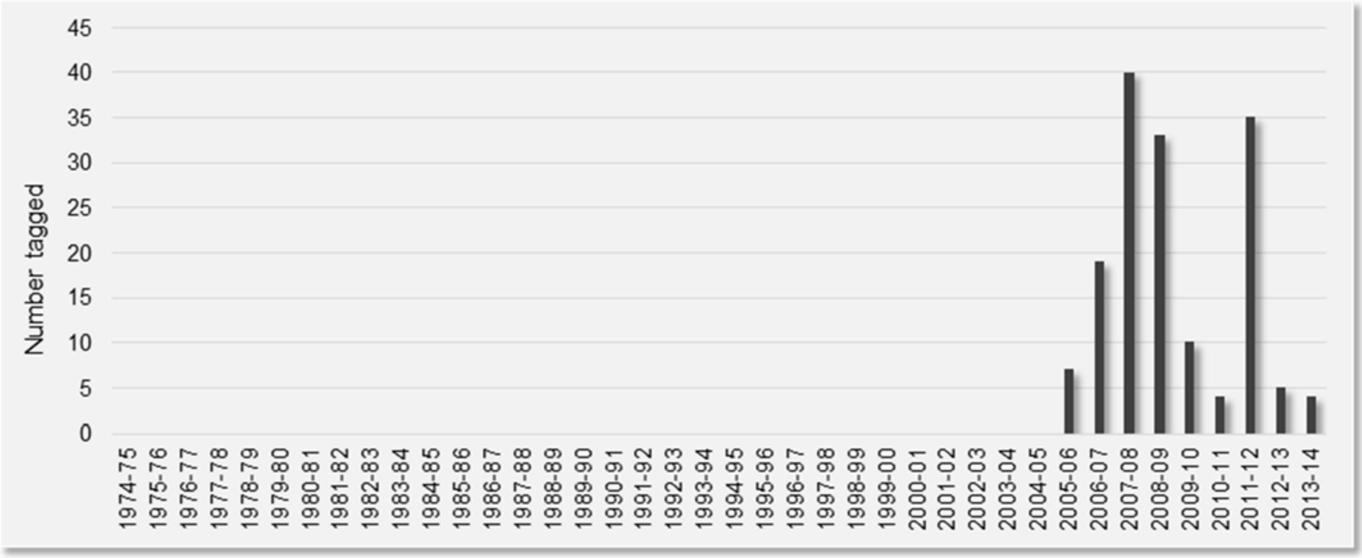
***c)*** ***Above right.*** Proportion of albacore tagged by calendar month 1974–2014.

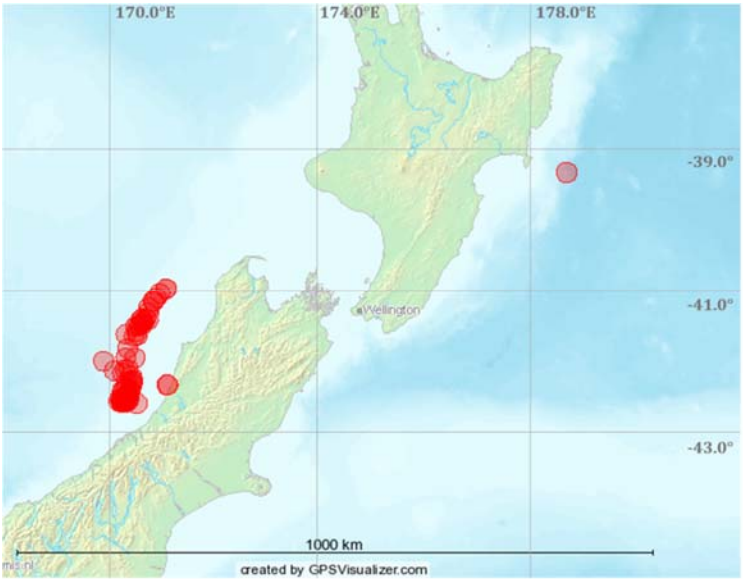
***d)*** **Right.** Weight (kg) of tagged albacore released 1974–2014.



### 4.5.3. TOR: Pacific bluefin tuna (*Thunnus orientalis*)

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 142 | - | 4 | 2.82 | 60 | 4.02 |




The recreational fishery for Pacific bluefin developed in 2005 targeting these fish on the hoki grounds and behind fishing trawlers in August and September (Figure 28a, b and c). Tag and release was an important component of this fishery as the fish were large (Figure 28d) and skippers limited the number kept per fishing party.
Four recaptures have been made all within 60 n. miles of their release point in the same or subsequent years.

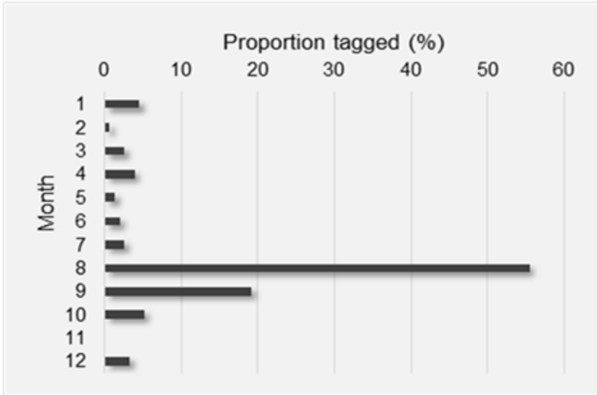


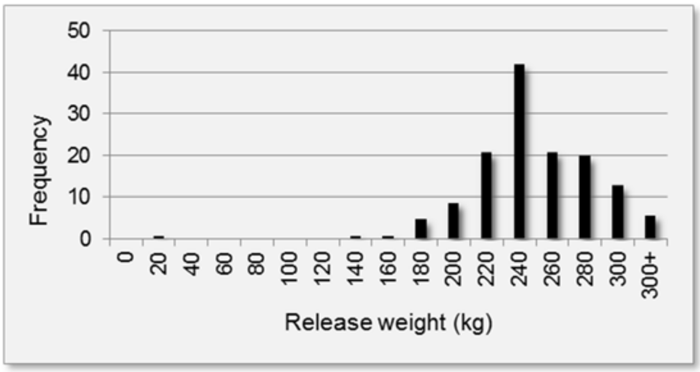

***Figure 28 a-d.***

***a)*** ***Top.*** Pacific bluefin tuna tagged and released by year.

***b)*** ***Above.*** Distribution of pacific bluefin tuna tagged.

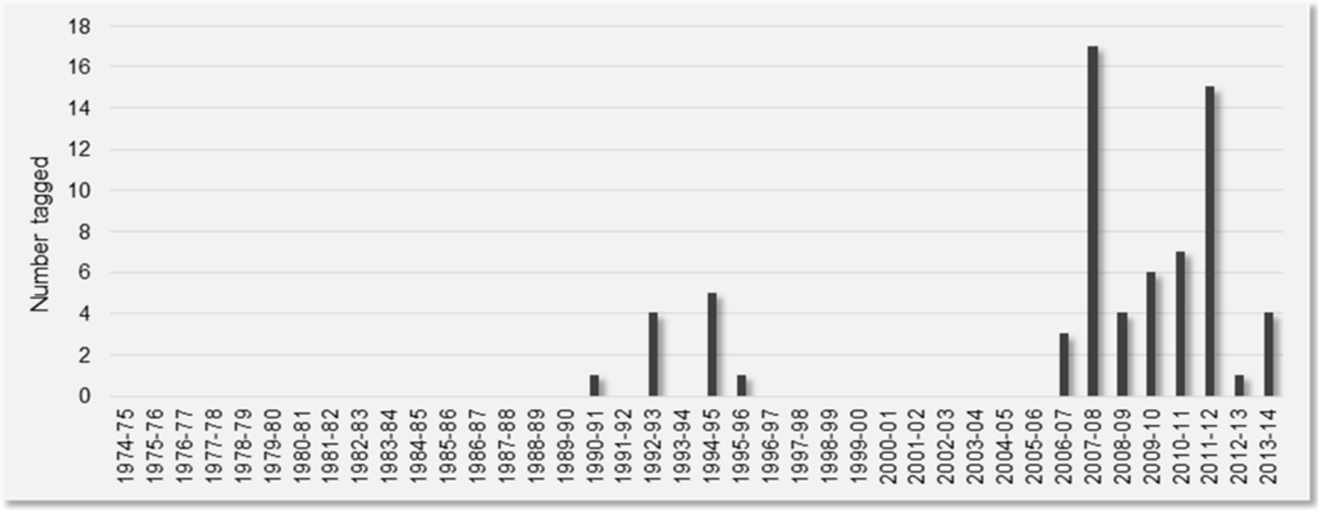
***c)*** ***Above Right.*** Proportion of pacific bluefin tuna tagged by calendar month.

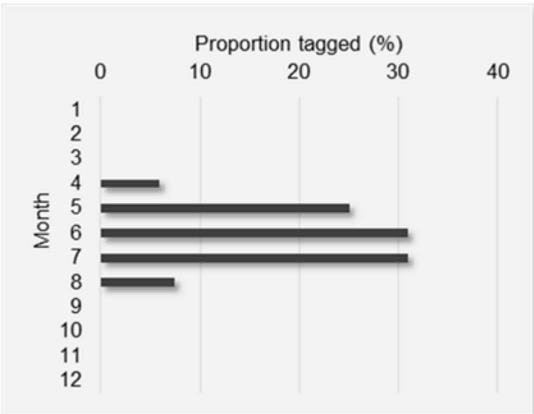
***d)*** ***Right.*** Weight (kg) of tagged pacific bluefin tuna released.



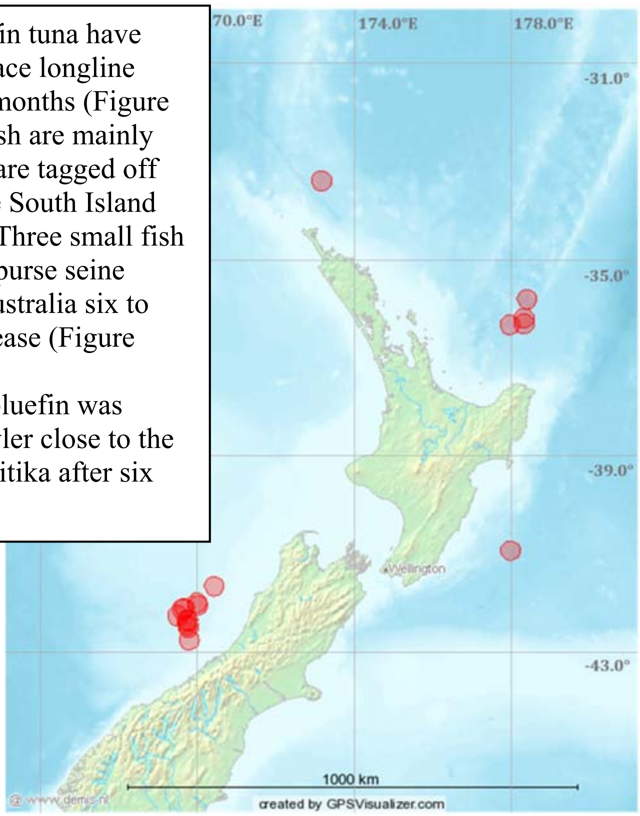
### 4.5.4. STN: Southern bluefin tuna (*Thunnus maccoyii*)

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 65 | 3 | 4 | 5.88 | 2317 | 6.04 |




Most southern bluefin tuna have been tagged by surface longline fishers over winter months (Figure 29a and b). These fish are mainly less than 30 kg and are tagged off the west coast of the South Island (Figure 29c and d). Three small fish were recaptured by purse seine vessels off South Australia six to ten months after release (Figure 29e).
A 120 kg southern bluefin was recaptured by a trawler close to the release area off Hokitika after six years at liberty.



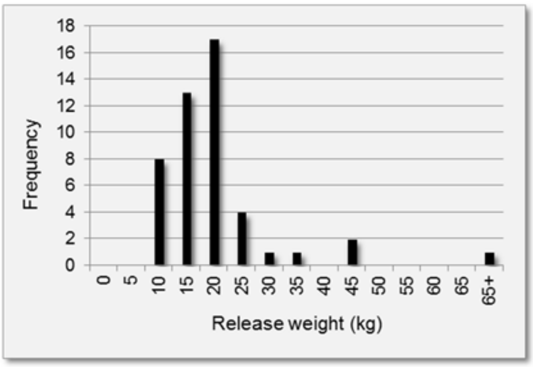




***Figure 29 a-e.***

***a)*** ***Top.*** Southern bluefin tuna tagged and released by year.

***b)*** ***Above.*** Proportion of southern bluefin tuna tagged by month.

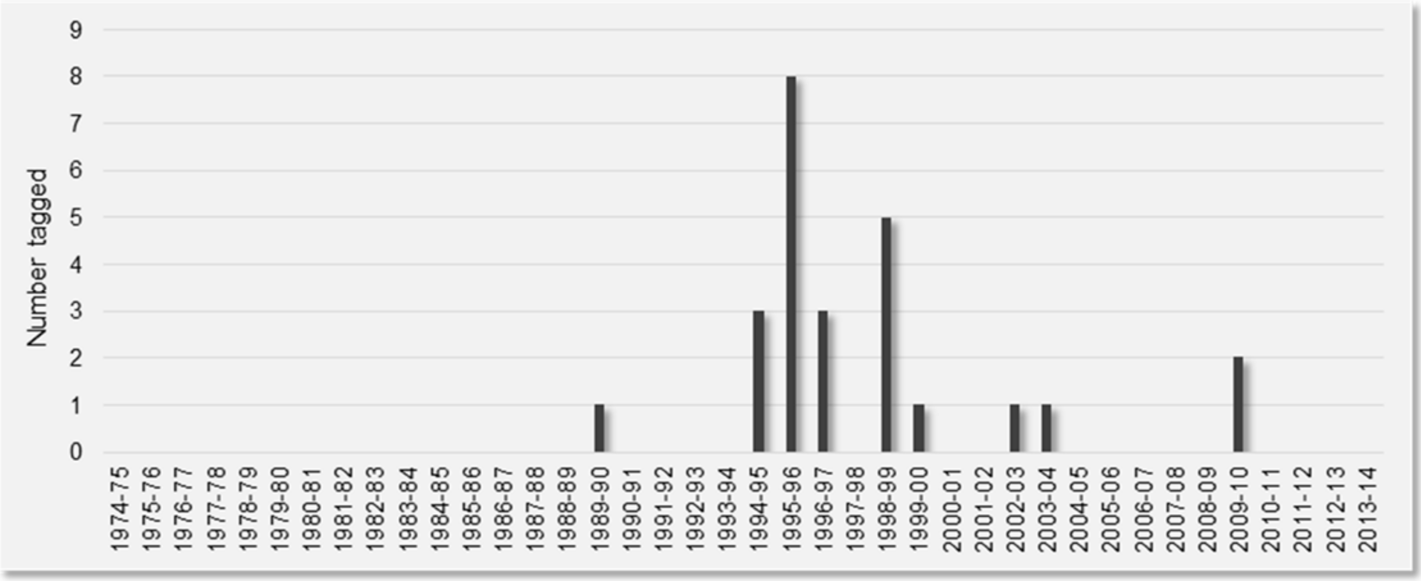
***c)*** ***Above.*** Weight (kg) of tagged southern bluefin tuna

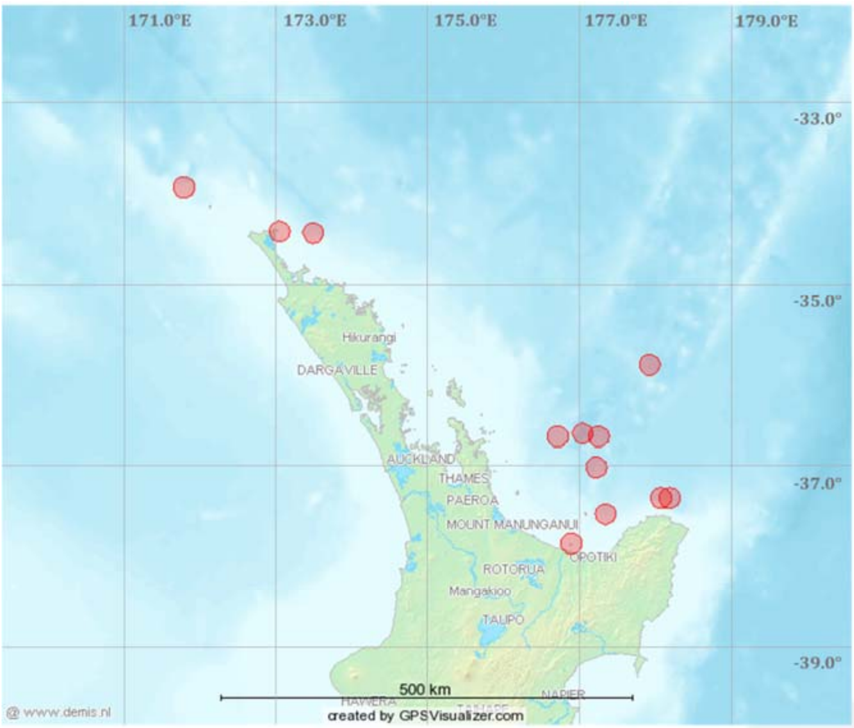
***d)*** ***Above right.*** Distribution of southern bluefin tuna tagged.

***e)*** **Right.** Distribution of southern bluefin tuna recaptured.

#### 4.5.5. BIG: Bigeye tuna (*Thunnus obesus*)

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 14 | 11 | - | - | - | - |



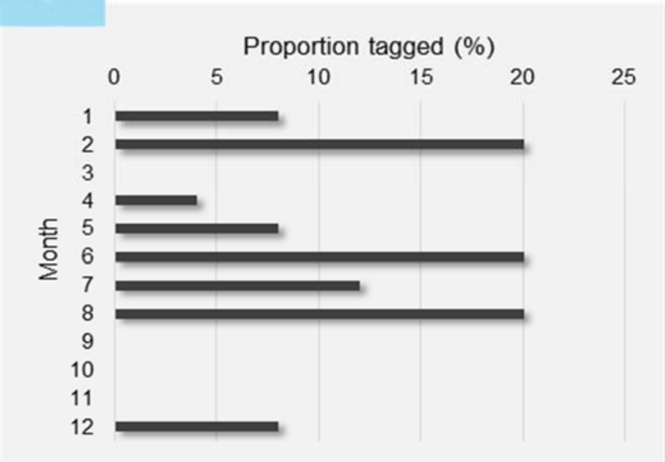

Small bigeye tuna (over 20 kg) have been tagged by commercial surface longliners in the Bay of Plenty in the late 1990s (Figure 30a and b). They have been a relatively rare catch in the recreational fishery with three tagged in the Far North. In 1995 a Fiji based surface longliner also tagged small bigeye tuna during the winter months (Figure 30c).

*Figure 30a–c.*

***a)*** ***Top.*** Bigeye tuna tagged and released by year.

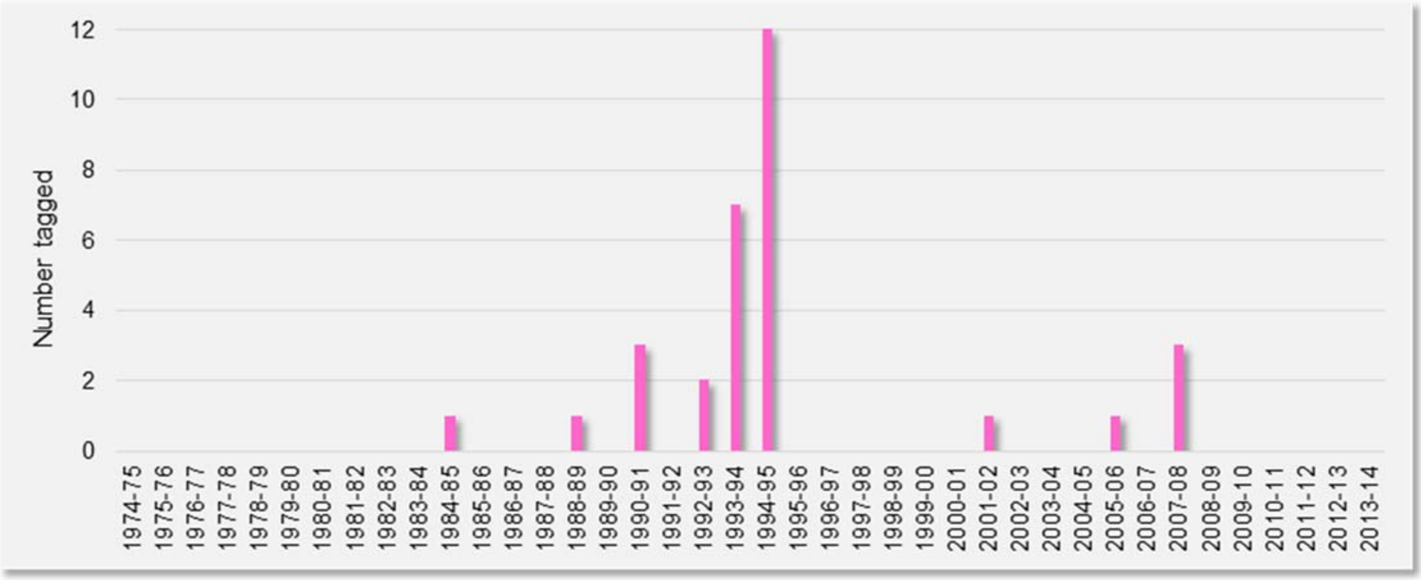
***b)*** ***Above.*** Distribution of bigeye tuna tagged.

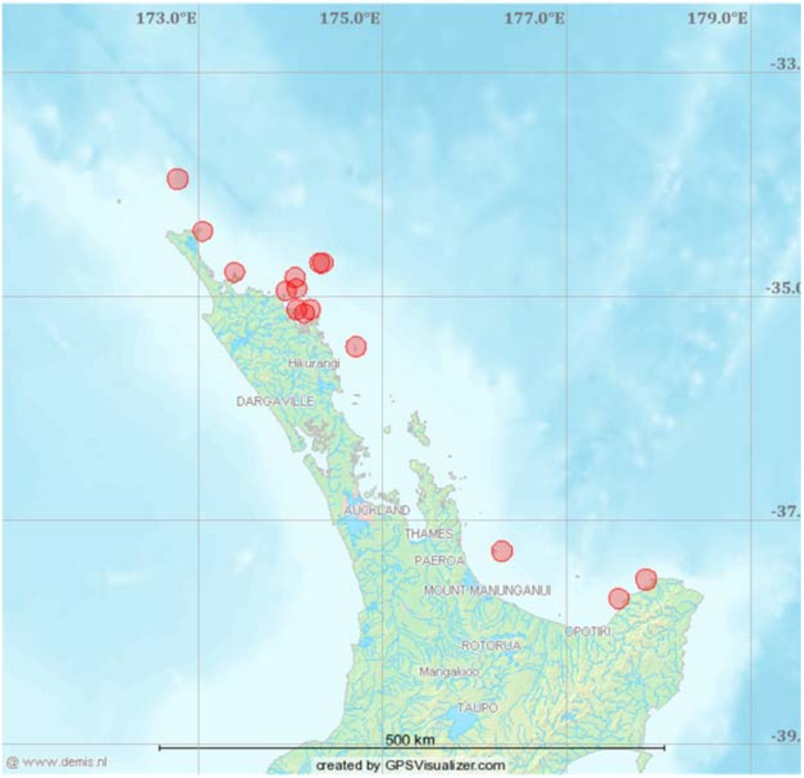
***c)*** ***Right.*** Proportion of bigeye tuna tagged by calendar month.



### 4.6. DOF: Mahimahi (Dolphinfish) *(Coryphaena hippurus)*

| Releases inside EEZ | Releases outside EEZ | Recaptures (all areas) | Recapture rate (%) | Maximum displacement (n. mile) | Maximum time at liberty (years.) |
|---|---|---|---|---|---|
| 31 | 2 | - | - | - | - |



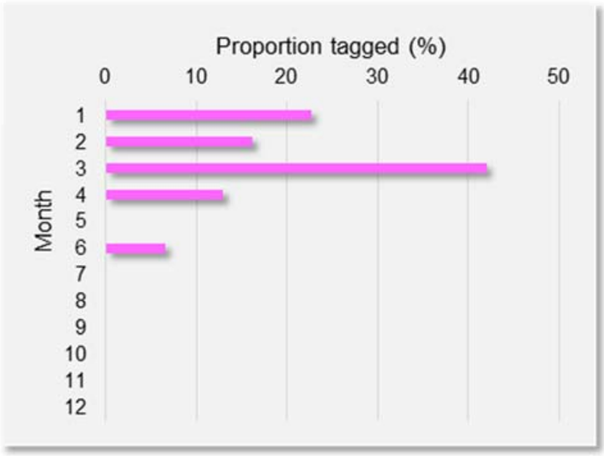

Mahimahi caught in New Zealand are generally too small for the tags used in the NZGTP. Most were tagged in the early 1990s by recreational fishers in East Northland (Figure 31a and b). These fish were estimated between 4 and 11 kg.
Mahimahi are caught in summer months in New Zealand, those tagged in June were by recreational fishers in Fiji (Figure 31c).

***Figure 31 a-c.***

***a)*** ***Top.*** Mahimahi tagged and released by year 1974-2014.

***b)*** ***Left.*** Distribution of mahimahi tagged.

***c)*** ***Below.*** Proportion of mahimahi tagged by calendar month.



## 4.7. Recapture rates by boat and area

One of the specific objectives was to review fishers' success and the probability of a tagger's fish being recaptured. The intent was to identify fishers with the best handling and tagging techniques and to help train less successful fishers. In the gamefish fishery the angler is solely responsible for playing the fish to the boat but fish handling and tagging at the boat is generally the responsibility of the crew. Recaptures by individual anglers are relatively rare events, with recaptures either zero or one. Charter boats tend to catch and tag the most fish; they have a paid deck hand and skipper trace and control the fish close to the boat, apply the tag, remove the hook to release the fish and record the details. We expect that the type of boat and skill of the crew has the greatest effect on the success of the tag and release operation, therefore we have summarised the proportion of released fish recaptured by boat rather than by angler. The species and number of tagged fish in an area will also influence the proportion of fish recaptured. Boats with more than 80 fish tagged and released (all species) were identified and the number of released and recaptures by species was compared. Boat ID was used as for privacy reasons, data identified by individual vessel are not released in MPI research reports. Note the two different scales used on the Y-axis.

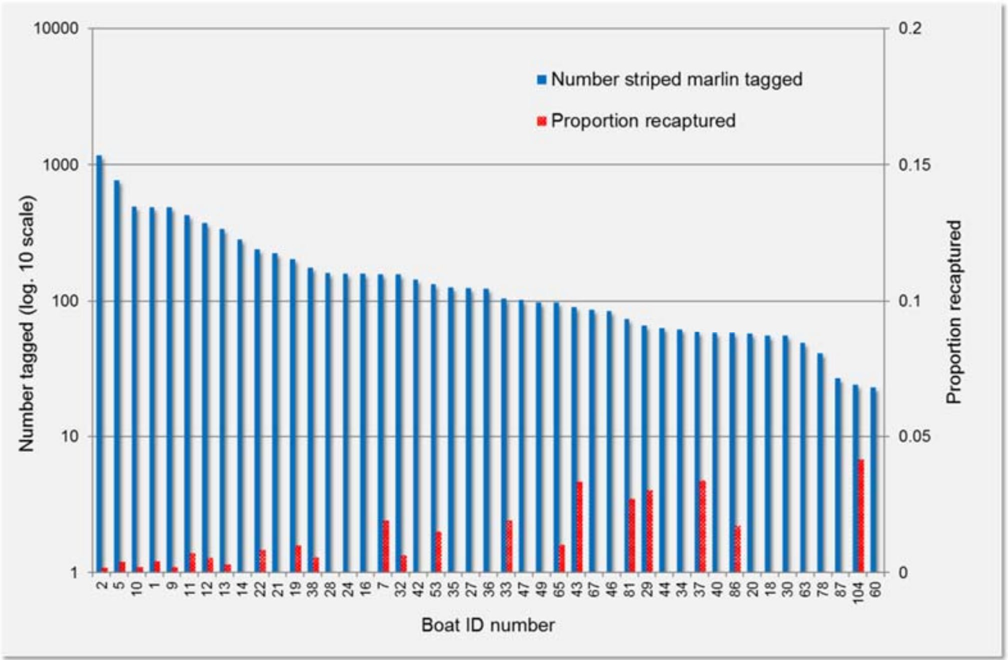



**Figure 32: Number of striped marlin tagged for boats releasing more than 20 (log scale on the left) and the proportion of striped marlin subsequently recaptured from releases by that boat (right axis).**

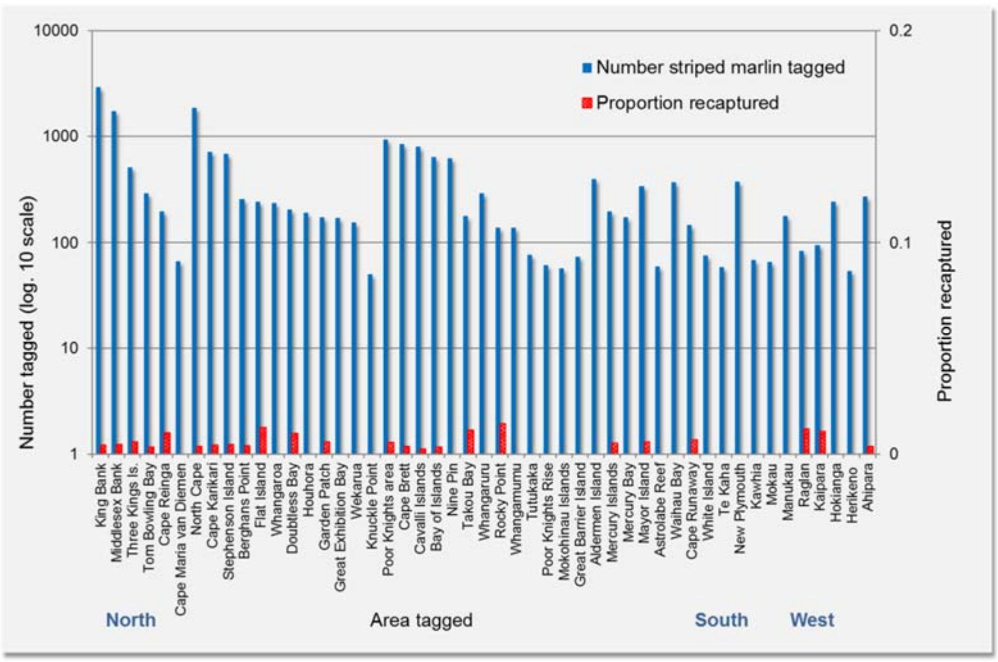



**Figure 33: Number of striped marlin tagged (log scale on the left) by area where more than 50 were released and the proportion of striped marlin subsequently recaptured from releases in that area (right axis). Areas are sorted by statistical area from north to south (left to right) and ranked by the number tagged within statistical area.**

The boats that have tagged the most striped marlin have had two or three of those fish recaptured each (Figure 32). They tend to fish in the Far North where there are often more fish and fewer boats. Some boats that have tagged fewer fish have also had 1, 2, or 3 of their fish re-caught and therefore a higher relative proportion of recaptures (Figure 32). The King Bank off the Three Kings Islands is the area with the most released fish (2,930) and the highest number of recaptures (12) giving an average proportion recaptured of 0.4% (Figure 33). Other areas appear to have higher recapture rates but these are for 1 or 2 fish from fewer releases. Overall it appears that the skill of the crew or area fished does not influence the proportion of striped marlin recaptured as much as random chance and luck.

There is some pattern to the proportion recaptured by boat for yellowtail kingfish. All the boats, with one exception, that have tagged more than 200 kingfish since 1991 have below average recapture rates (Figure 34). Rick Pollock is a long-time supporter of the tagging programme and has tagged by far the most kingfish (6,382) and has the most recaptures (507) from his charter vessel Pursuit and above average proportion of kingfish re-caught. They fish White Island and associated reefs, Ranfurly Bank, and the Three Kings area. The proportion of recaptures from White Island and Volkner rocks is clearly above average as well as the relatively small Ranagatira Reef which is even further offshore (Figure 35).

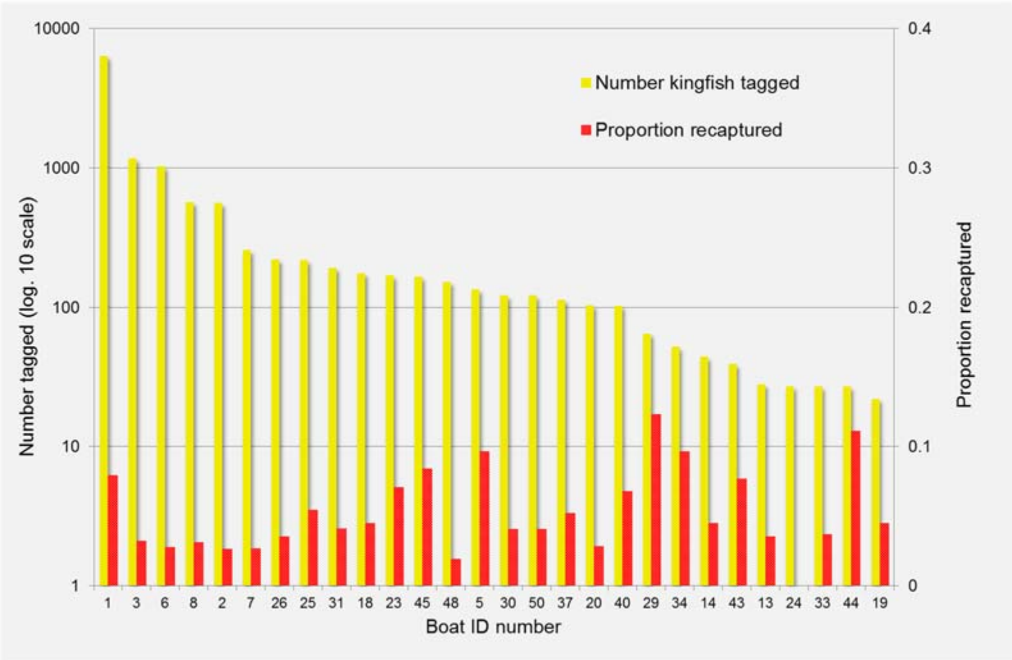



**Figure 34: Number of yellowtail kingfish tagged for boats releasing more than 20 (log scale on the left) and the proportion of kingfish subsequently recaptured from releases by that boat (right axis).**

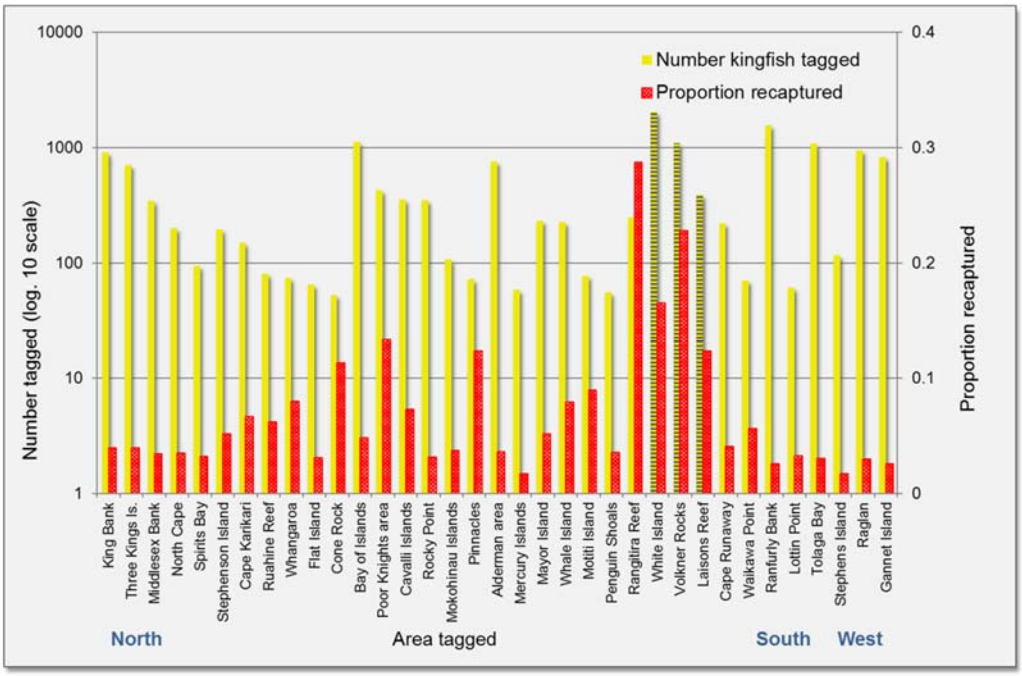



**Figure 35: Number of yellowtail kingfish tagged (log scale on the left) by area where more than 50 were released and the proportion of kingfish subsequently recaptured from releases in that area (right axis). Areas are sorted by statistical area from north to south (left to right) and White Island and associated reefs striped columns.**

The number of mako sharks tagged by the top boats is relatively consistent, probably because they are generally not a target species. The highest number tagged by a single boat in this data set is 194 makos for four recaptures. The proportion recaptured appears to increase for the boats with fewer sharks tagged. Again one or two recaptures from relatively few releases is a larger proportion for that boat (Figure 36). Mako shark recapture rate by area released does not show a consistent trend from north to south or for the west coast (Figure 37). Sport fishers know where there are concentrations of mako sharks and tend to avoid those areas to avoid losing their lures or baits to sharks.

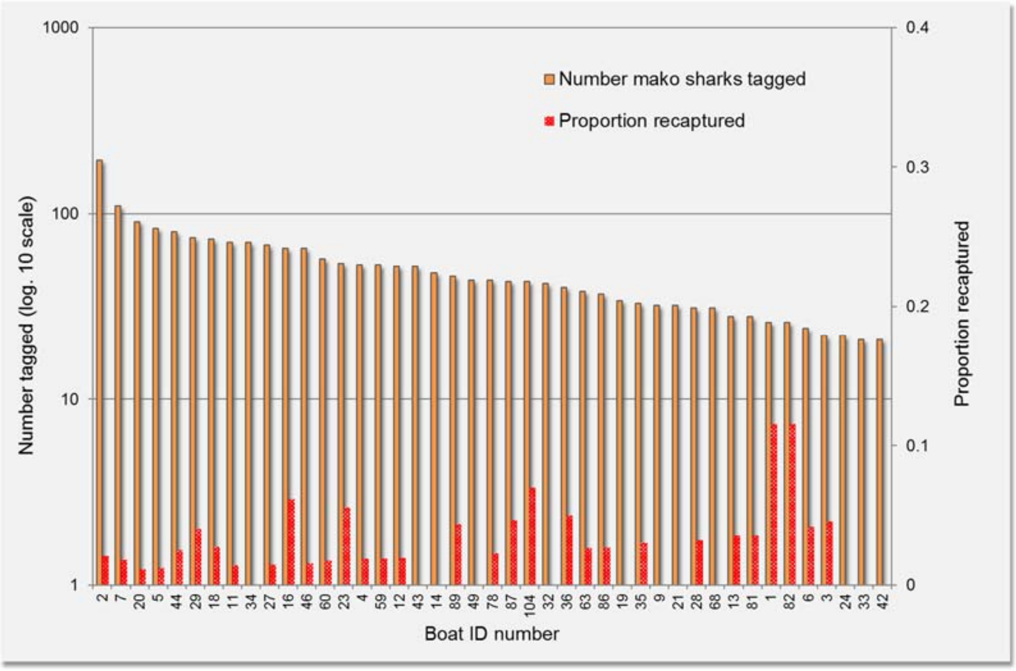



**Figure 36: Number of mako sharks tagged for boats releasing more than 20 (log scale on the left) the proportion of mako sharks subsequently recaptured from releases by that boat (right axis).**

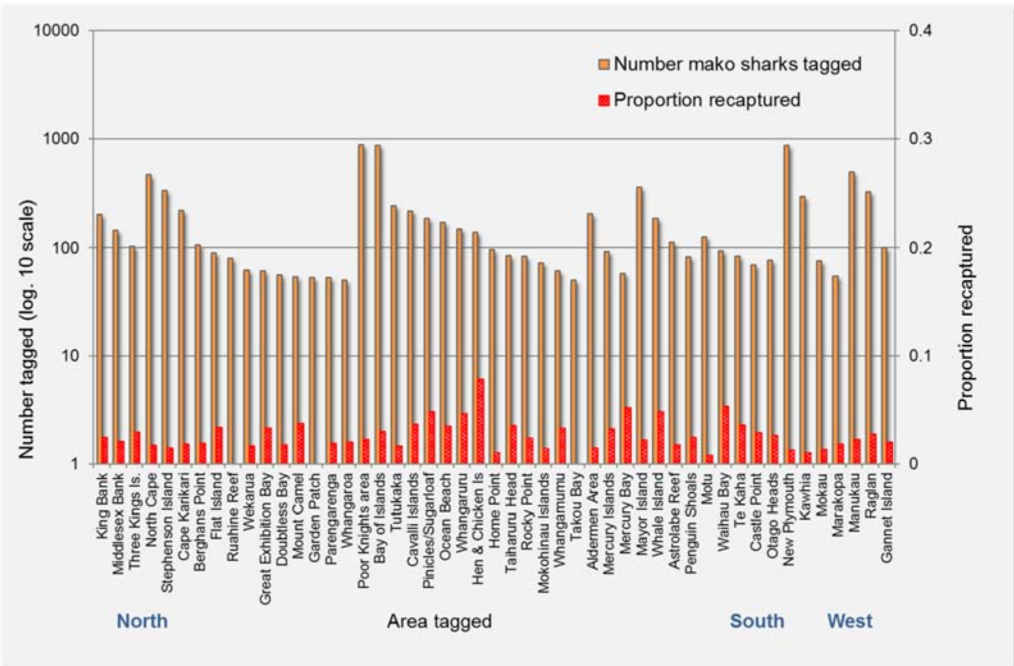



**Figure 37: Number of mako sharks tagged (log scale on the left) by area where more than 50 were released and the proportion of mako sharks subsequently recaptured from releases in that area (right axis). Areas are sorted by statistical area from north to south (left to right) and ranked by the number tagged within statistical area.**

Blue sharks are relatively common in southern waters over summer and a few fishers have targeted and tagged blue sharks. The highest number tagged in this data set is 1002 blue sharks for 15 recaptures (Figure 38). The proportion recaptured increases for the boats with fewer sharks tagged, but again recaptures are a relatively rare event and 1 or 2 recaptures affect recapture rates.

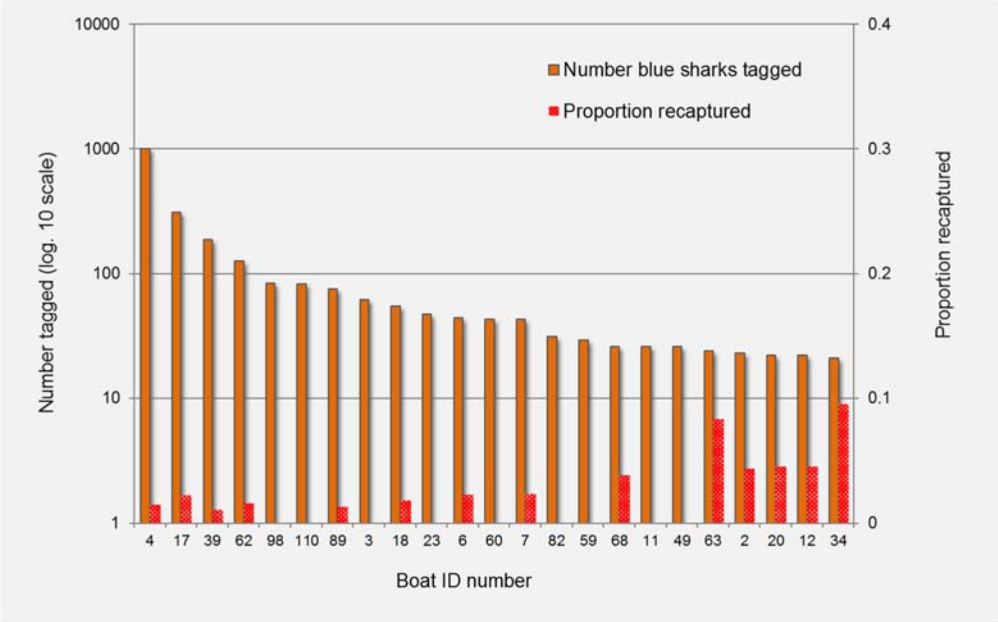



**Figure 38: Number of blue sharks tagged for boats releasing more than 20 (log scale on the left) and the proportion of blue sharks subsequently recaptured (right axis).**

## 5. DISCUSSION

It took some years for tag and release to become fully integrated into the New Zealand marine sports fishery. Anglers were accustomed to eating the relatively small numbers of striped marlin they caught annually. It was not until the government of the day recognised the importance of the recreational billfish fishery, by first restricting, then halting commercial fishing for marlin that anglers really embraced the idea of catch and release. The adoption of voluntary minimum weights for marlin by the clubs affiliated to the New Zealand Sport Fishing Council gave impetus to the drive to tag and release at least 50% of the annual recreational marlin catch. To this day, almost all clubs have adhered to the 90 kg minimum weight that was initially calculated to be the average weight of striped marlin recorded by the Bay of Islands Swordfish Club. For almost all of the last 20 years, between 50% and 65% of all marlin recorded by the NZSFC have been tagged and released. In recent years landing of pelagic sharks has been discouraged by the NZSFC and in 2012–13 94% of mako and 92% of blue sharks reported by club members were tagged and released (Holdsworth & Saul 2014).

The extent to which tag and release has been embraced is demonstrated by the fact that release numbers have been remarkably consistent since 1993–94, despite inter-seasonal variations in availability of some species and variable fishing conditions. Striped marlin are the number one tagged species and the main focus of summer fishing effort for most blue water fishers. Over the entire period from 1974–2014, 36% of all NZGTP tagged fish were billfish, with striped marlin dominant to the extent of 91% of that category. Kingfish accounted for 31% of all releases, while sharks as a group accounted for another 30%.

Tagging totals tend to be higher in warm seasons and lower in cold ones. Shark tagging in northern waters is largely for fish caught as a bycatch of trolling for marlin, or bait fishing for broadbill swordfish. During the 1990s a small number of anglers fishing off Otago established a target fishery for blue sharks, which considerably boosted shark numbers for some years.

This report provides a synthesis of release and recapture information since the inception of the NZGTP. A number of annual reports have been produced over the years providing details of releases and recaptures and trends over time (Hartill & Davies 1999, 2000, 2001, Holdsworth and Saul 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011a, 2011b, 2013, 2014). Some of these reports were published as NIWA Technical Reports and since 2003 as New Zealand Fisheries Assessment Reports. Non-technical summaries and articles in the fishing media have also been produced and circulated to clubs and participants. NZGTP data has also been reported in various peer reviewed articles and stock assessments including: A global overview of constituent-based billfish tagging programmes and their results (Ortiz et al. 2003); Striped marlin biology and fisheries (Bromhead et al. 2004); Size trends and population characteristics of striped marlin caught in the New Zealand recreational fishery (Kopf et al. 2005); Near real time satellite tracking of striped marlin movements in the Pacific Ocean (Holdsworth et al. 2009); and the two western and central Pacific stock assessments for striped marlin (Langley et al. 2006, Davies et al. 2012).

A feature of the NZGTP is the relatively low recapture rates for most species. The main exceptions – school shark, sevengill shark and yellowtail kingfish – don't have a seasonal offshore migration and are caught in New Zealand waters year round. School shark are very long-lived and at the time the QMS was established, were considered to be heavily over-fished. Although only 172 school shark have been tagged, 32 have been recaptured after periods as long as 19 years. One school shark was reported to have crossed the Tasman Sea to be recaptured off Tasmania. Only 46 sevengill shark have been tagged, and the 8.7% recapture rate comes from four tag recoveries, two of them very close to the original tag location in the Bay of Islands. Southern bluefin tuna are highly migratory and in the NZGTP there have been four recaptures from just 68 tagged fish. While the sample size is small this stock is considered to be heavily exploited and a high recapture rate would be consistent with this.

The subject of low recapture rates for billfish and in particular striped marlin has been controversial amongst angling groups. Various reasons have been proposed, including post-release mortality, tag shedding, non-reporting of tags recovered, and movement of fish into areas where fishing effort may be low. In all constituent-based tagging programmes striped marlin recaptures longer than a year at liberty are rare, regardless of the tag anchor used (Ortiz et al. 2003).

Satellite tagging of striped marlin both in New Zealand and elsewhere has clearly demonstrated that fish which are released in good condition, and that were not deeply hooked or bleeding on release, have a very high prospect of survival (Domeier et al. 2003, Holdsworth et al. 2009, Sippel et al. 2011). On the other hand, there is some evidence that points to tag shedding as a problem. Very short-term tag recoveries have shown that some tags were poorly anchored, or badly fouled with gooseneck barnacles (*Lepas anatifera*). It is very important that anglers strive to improve the quality of tag application so that tags are implanted in the dorsal muscle to the correct depth (50 mm), and where they can easily be seen if the fish is caught again.

It has been suggested that the increased use of the nylon anchor (PIMA) tags might improve the striped marlin recapture rate. This type of tag head has been shown to improve tag return rates in recreational fisheries for blue marlin and sailfish, but in the literature to date reports indicate that stainless steel anchors have a better recapture rate for striped marlin (Ortiz et al. 2003). The highest recapture rate for this species was 1.3% from the NMFS Southwest Fisheries Science Centre followed by 0.86% for the NSW Fisheries Tagging Programme, 0.52% for the New Zealand programme and 0.38% for The Billfish Foundation programme using nylon heads only (Ortiz et al. 2003). There have been 1,243 striped marlin tagged with the nylon anchor tags in the NZGTP since 2005 for one recapture to date (0.08% recapture rate) and 177 swordfish tagged for 2 recaptures (1.1% recapture rate). The Hallprint stainless steel anchor (SSD) tags most commonly used by New Zealand anglers have been highly successful in kingfish and sharks, and have also been recovered after many years from broadbill swordfish. Several crews including a leading charter skipper have been double tagging billfish with nylon and stainless steel anchors since 2007. The level of experience of skipper and crew do not result in higher recapture rates for striped marlin in the NZGTP. While all the boats with more than 300 striped marlin tagged have had at least one recapture each, their recapture rates are below the overall average. It appears that skill of the crew or area fished does not influence the proportion of striped marlin recaptured as much as random chance and luck.

Non-reporting of tags from recaptured fish by commercial fishers is often quoted by sports fishers as a reason for not tagging billfish. Whether this is based on fact or mere speculation is difficult to determine. There is anecdotal evidence that some commercial fishers do not report tags for various reasons, and yet many of the tag returns reported here do come from commercial vessels, so if there is some non-reporting it is not by any means universal. For the programme to be successful, administrators of tagging programmes must do everything in their power to encourage tags to be reported, while anglers must work to improve tag application and also ensure that every tag report card is returned to their club or the programme administrator. Every year small numbers of recaptures are invalidated because the release data is unavailable due to the tag card not being returned. Overall about 7% of recaptures have no release information indicating that more fish are tagged than recorded in the database. Generally, the gamefish clubs in New Zealand do a good job collecting tag cards when anglers return to port and sending them to the return address at MPI.

Since 1985–86, kingfish have been a major part of the NZGTP. Kingfish are tagged throughout the year with a peak in summer, when the greatest numbers of anglers are active. Recaptures are also made throughout the year with a summer peak. Despite a small number of long-distance recaptures, most kingfish are caught close to their release locations, often on multiple occasions as anglers frequently release tagged fish more than once. White Island and its associated reef structures has been the most important location for kingfish tag and release. Charter boat operators have been instrumental in measuring a high percentage of tagged kingfish prior to release and again on recapture, providing excellent growth data over many seasons. An estimate of the average annual growth of kingfish was derived from the release and recapture measurements using the GROTAG model (Francis 1988). Although there were some issues with probable measurement error the model indicates that kingfish are a fast growing species. A 50 cm fish was predicted to grow 11.5 cm in a year while a 100 cm fish would grow 4.1 cm on average (Hartill & Davies 1999).

There is evidence that kingfish form resident or semi-resident populations around offshore islands or reefs such as White Island, Rangitira Reef and the Three Kings Islands, with higher recapture rates than other areas and few tagged kingfish being recaptured away from their tagging location. On the other hand, kingfish tagged on the coast appear more mobile, with some movement between east and west coasts of the North Island.

Minimum legal size (MLS) legislation for kingfish was not brought in until 1993 when a 65 cm size limit was introduced, increasing to 75 cm in 2004. The large proportion of kingfish tagged that are less than the current Minimum Legal Size therefore is because there was no MLS until 1993. The great majority of small kingfish tagged relate to the period prior to 2004. Subsequently anglers were actively discouraged from tagging kingfish less than 75 cm, as this might encourage people to land under-sized fish bearing a tag.

The development of catch and release recreational fisheries provides the opportunity to collect some information on growth and movement of selected species through a mark and recapture programme. Recreational fishers have been asked to tag only billfish, pelagic sharks, kingfish, and large tuna. To date all but six recaptures in the NZGTP have been from the Southwest Pacific, showing regional fidelity for the main species tagged in the NZGTP. Three 20–25 kg southern bluefin have been recaptured by purse seine vessels in the Great Australian Bight, a blue shark was recaptured in the Indian Ocean southwest of Perth and another off Chile and a mako shark was recaptured near Port Lincoln, South Australia. Pacific and southern bluefin tuna have spawning grounds outside the southwestern Pacific so movement to other regions is expected. There are international tagging programmes for these species.

Some care is needed when interpreting the movement information for the NZGTP and other conventional tagging programmes. Fish are tagged wherever the recreational fishery operates and some skippers are more committed and diligent than others. Consequently, tagging is not spread across the distributional range of the species and plots of recaptures naturally tend to show movement away from these tagging “hot spots” often resembling a starburst pattern. Similarly, points of recapture are dependent on where and when effective fishing effort occurs. These are fishery dependant biases in the movement patterns observed (Pepperell 2007). The benefit of a longitudinal tagging programme for highly migratory species is that it receives recapture data from a large number of fisheries that may have shifted or changed over time, spreading effort across the region. It also gives an indication of which fisheries are interacting with fish that have been tagged and released in New Zealand, or at least which fleets are reporting recaptures.

New technology and techniques can provide more detailed insights into fish movement and population structure. Electronic archival and pop-off satellite archival tags can provide detailed information on temperature, depth and light levels and approximate tracks which are independent of fishery bias. Satellite linked radio telemetry tags can provide locations with a known accuracy of within 1 km or better and have been attached to white shark and mako shark dorsal fins and striped marlin caudal fins in New Zealand. Electronic tags and tagging programmes are expensive and the number of fish tagged in New Zealand waters has been limited. Reports on the species tagged in New Zealand include: striped marlin (Domeier 2006, Holdsworth et al. 2008, Sippel et al 2007 & 2011); broadbill swordfish (Holdsworth et al. 2007, 2010, Evans et al. 2014); Pacific bluefin and southern bluefin tuna (Holdsworth et al. 2008); white sharks (Francis et al. 2012) and porbeagle sharks (Francis et al. 2015).

Advances in genetic techniques can provide greater resolution around the genetic structure of populations of highly migratory species. This may help with interpreting the results from the NZGTP and similar programmes. What would be helpful would be to tag more billfish and collect tissue from spawning areas. There has been extensive tagging of tropical tunas by the Secretariat of the Pacific Community (SPC), but no recaptures as yet from New Zealand waters.

The ratio of stable isotopes of nitrogen and carbon can be used to infer the trophic level of fish in a population. This may change as fish grow or move from one region to another. Work is underway to map the trophic signatures found around the Pacific Ocean and projects in New Zealand are investigating patterns found in highly migratory species caught in New Zealand. These patterns will help further describe each species’ foraging ecology, trophic preferences and migratory histories.

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APPENDIX 1. New Zealand species codes and scientific names (Roberts et al. 2015)

| Species code | Common name | Scientific name |
|---|---|---|
| ALB | Albacore | *Thunnus alalunga* |
| BEM | Blue marlin | *Makaira nigricans* |
| BIG | Bigeye tuna | *Thunnus obesus* |
| BKM | Black marlin | *Istiompax indica* |
| BWH | Bronze whaler shark | *Carcharhinus brachyurus* |
| BWS | Blue shark | *Prionace glauca* |
| DOF | Mahimahi (Dolphinfish) | *Coryphaena hippurus* |
| HHS | Smooth hammerhead shark | *Sphyrna zygaena* |
| KIN | Yellowtail kingfish | *Seriola lalandi* |
| MAK | Shortfin mako shark | *Isurus oxyrinchus* |
| POS | Porbeagle shark | *Lamna nasus* |
| SAI | Sailfish | *Istiophorus platypterus* |
| SCH | School shark | *Galeorhinus galeus* |
| SEV | Broadsnout sevengill shark | *Notorynchus cepedianus* |
| SHA | Other or unspecified shark species | |
| SSF | Shortbill spearfish | *Tetrapturus angustirostris* |
| STM | Striped marlin | *Kajikia audax* |
| STN | Southern bluefin tuna | *Thunnus maccoyii* |
| SWO | Broadbill swordfish | *Xiphias gladius* |
| THR | Thresher shark | *Alopias spp.* |
| TOR | Pacific bluefin tuna | *Thunnus orientalis* |
| WPS | Great white shark | *Carcharodon carcharias* |
| YFN | Yellowfin tuna | *Thunnus albacares* |