NSW DPI Game Fish Tagging Program

Report 2010-2011

Pepperell Research

Marine Science & Recreational Fisheries

Recreational Fishing Trusts

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2010/2011

Introduction

The NSW DPI Game Fish Tagging Program of Australia is the largest saltwater tagging program of its kind in the world and has been in operation since 1973. It is used to obtain information on the biology, distribution, movement, growth and exploitation of billfish, tunas, sharks and sport fish and encourages game fishers to participate in the management of the fishery. The program is implemented using funds from the NSW Recreational Fishing Trust.

Total fish tagged

The number of fish tagged during the 2010/2011 tagging year was down from previous years. A total of 11,210 fish were tagged for the year and 77 recaptures were recorded. Figure 1 shows the number of fish tagged (and recaptured) on the program throughout its history, and indicates that the number of fish tagged in 2010/2011 was lower than in any of the previous six seasons.

The numbers of fish tagged each year has fluctuated, although followed steady growth to the mid 1980s, in nearly every year since then, the total tagged has exceeded 10,000 (Figure 1). Total numbers of fish tagged each year vary depending on the availability of different species of fish at different times and locations. This year, as outlined further in the report, the principal reasons for a lower number of tag-and-releases were significant reductions in the number of black marlin and sailfish tagged, compared with the previous year, reflecting the non appearance of juvenile black marlin on the east coast during the season, and a lower number of sailfish tagged off Dampier, WA, following a record season last year.

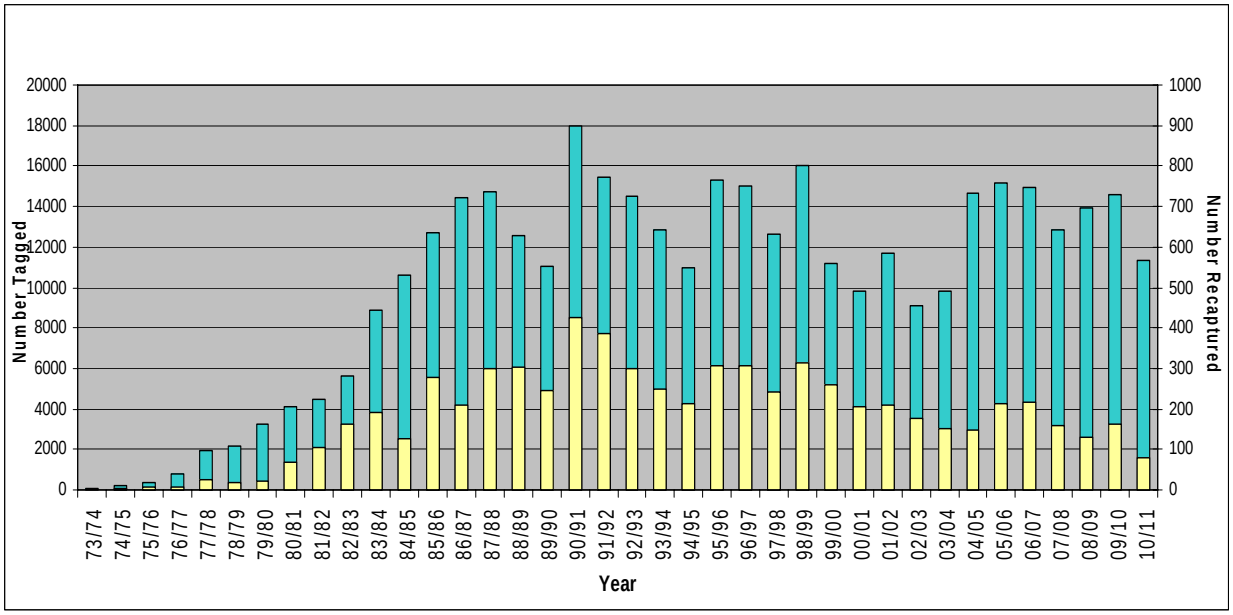


Figure 1. Numbers of fish tagged and recaptured by year, to 2010/2011.

The Program overall

Over the history of the program, the grand total of fish tagged and recaptured, as at the end of June 2011, stood at 387,795 and 6,933 respectively, continuing the program's status as one of the largest of its kind in the world (Table 1). This table summarises taggings and recaptures of the top 25 species (or species groups) tagged, with all others lumped as 'all other species'.

The species tagged in the greatest numbers continues to be black marlin (over 51,000 tagged, and representing 13.4% of all releases) followed by yellowfin tuna, yellowtail kingfish, sailfish and mahi mahi (dolphinfish).

Table 1. Total numbers of fish tagged and recaptured: 1974-2011

Species	No. Tagged	No. Recap	% Recap
BLACK MARLIN	51735	401	0.78
YELLOWFIN TUNA	36727	682	1.86
YELLOWTAIL KINGFISH	34023	2159	6.35
SAILFISH	26520	285	1.07
MAHI MAHI	22844	207	0.91
STRIPED MARLIN	20623	182	0.88
ALBACORE	20001	160	0.80
MACKEREL TUNA	19878	60	0.30
STRIPED TUNA	19735	68	0.34
SOUTHERN BLUEFIN TUNA	14094	114	0.81
BONITO	13206	219	1.66
WHALER SHARKS	11707	244	2.08
AUSTRALIAN SALMON	9490	609	6.42
SPANISH MACKEREL	8149	76	0.93
SILVER TREVALLY	6899	196	2.84
MAKO SHARK	6776	158	2.33
BLUE MARLIN	6231	19	0.30
HAMMERHEAD SHARK	5177	55	1.06
LONGTAIL TUNA	4703	59	1.25
BLUE SHARK	4309	74	1.72
TAILOR	4030	122	3.03
TREVALLY	3332	31	0.93
BARRACUDA	3047	5	0.16
QUEENFISH	2927	10	0.34
GIANT TREVALLY	2490	34	1.37
ALL OTHER SPECIES	27944	594	2.13
TOTAL	**386597**	**6823**	**1.64**

Grouping the main species together, Figure 2 shows that tunas remain the group tagged in the largest numbers (132,317 tagged, or 35% of the total) followed by billfish (105,579, or 27% of all fish tagged). Total numbers of sharks and rays (31,115 tagged) only represent 8% of the total species.

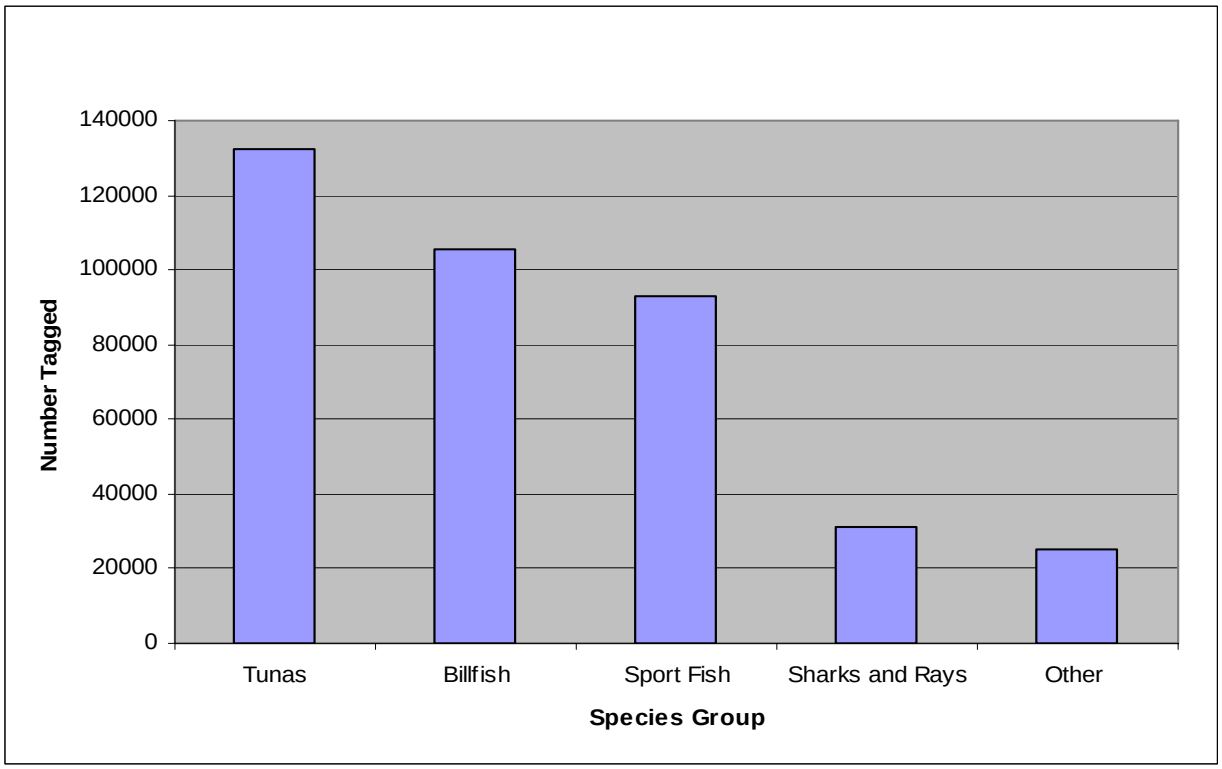


Figure 2. Total numbers of fish tagged as species groupings, 1974-2011

Summary for 2010/2011

Table 2. Numbers of fish tagged and recaptured in 2010/2011

Species	Tagged	Recaptured
SOUTHERN BLUEFIN TUNA	3366	4
BLACK MARLIN	1092	10
SAILFISH	1025	17
STRIPED MARLIN	969	7
ALBACORE	621	
WHALER SHARK	423	1
BLUE MARLIN	396	2
SPANISH MACKEREL	374	4
STRIPED TUNA	341	1
MACKEREL TUNA	328	
MAHI MAHI	293	2
YELLOWFIN TUNA	272	2
MAKO SHARK	259	7
YELLOWTAIL KINGFISH	259	6
LONGTAIL TUNA	102	1
AUSTRALIAN SALMON	97	4
BLUE SHARK	92	1
BARRACUDA	85	
QUEENFISH	83	
HAMMERHEAD SHARK	71	
SNAPPER	61	
COBIA	55	1
SPOTTED MACKEREL	53	
SHARK MACKEREL	44	
TIGER SHARK	42	
WAHOO	40	
EAGLE RAY	39	
BLACKTIP SHARK	32	
GIANT TREVALLY	32	1
BONITO	28	2
RAINBOW RUNNER	28	
SHORTBILL SPEARFISH	26	
GUMMY SHARK	21	2
GOLD SPOT TREVALLY	20	
GOLDEN TREVALLY	20	
SAMSON FISH	19	
BROAD BAR MACKEREL	17	
BRONZE WHALER	16	
BULL SHARK	11	
MISCELLANEOUS	9	1
SILVER TREVALLY	9	
TREVALLY	9	
AMBERJACK	5	
SCHOOL MACKEREL	5	
SCHOOL SHARK	5	
BIGEYE TUNA	4	
MULLOWAY	4	1
WHITETIP SHARK	3	
BARRAMUNDI	2	
SWORDFISH	2	
THRESHER SHARK	1	
Total	**11210**	**77**

Table 2 shows that, in 2010/2011, the species tagged in by far the highest numbers was southern bluefin tuna (SBT), with 3,336 releases. This is the third year in succession that SBT have topped the tagging list, and again sets a new record for the number of this species tagged in any year. Such has been the recent increase in taggings of SBT that the total number tagged over the past five years (10,985) represents 77.9% of the total tagged for the entire 38 years of the program.

As indicated in previous reports, the real-time detection and quantification of such marked changes in either fishing practices of the recreational sector, or availability of fish, would be all but impossible in the absence of the tagging program.

Figure 3 shows a comparison of species or species groups tagged over the past three years. As noted, this shows the remarkable increase in numbers of southern bluefin tuna tagged for the third year running. Tagging of blue marlin, albacore and whaler sharks were slightly up on last year, but numbers of black marlin tagged were well down on the last two seasons (but about the same as in 2007/08). Of particular note was the record low number of yellowfin tuna tagged – less than half the numbers tagged in the previous two seasons, which were themselves, historically low numbers tagged for the program.

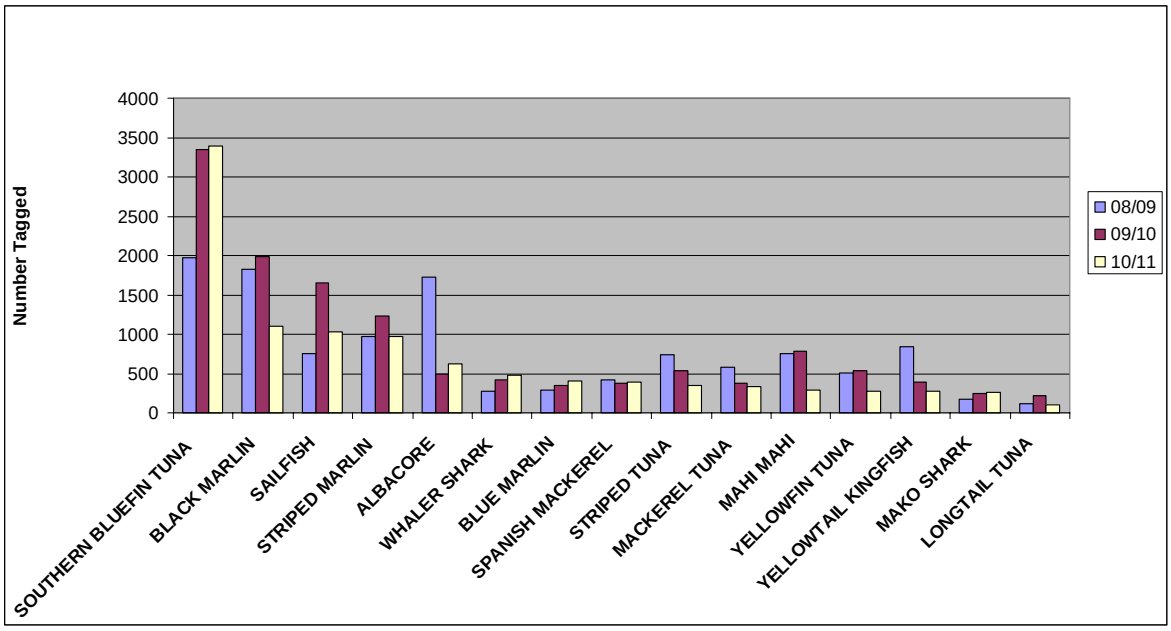


Figure 3. Numbers of main species and species groups tagged in 2010/2011 and the previous two years.

Combining the species into groups, Figure 4a shows that, in 2010/2011 billfish constituted 31% of all fish tagged, which is a fairly typical figure in recent years. With the dominance of southern bluefin tuna this year, the proportion of tuna species tagged was somewhat higher than in recent years.

Figure 4b shows the proportions of species groups tagged over the entire history of the tagging program, Comparing this with this year's data indicates that the proportions of billfish and tuna tagged have increased over historic figures while the proportions of sportfish tagged has decreased considerably. The proportion of sharks tagged has remained the same.

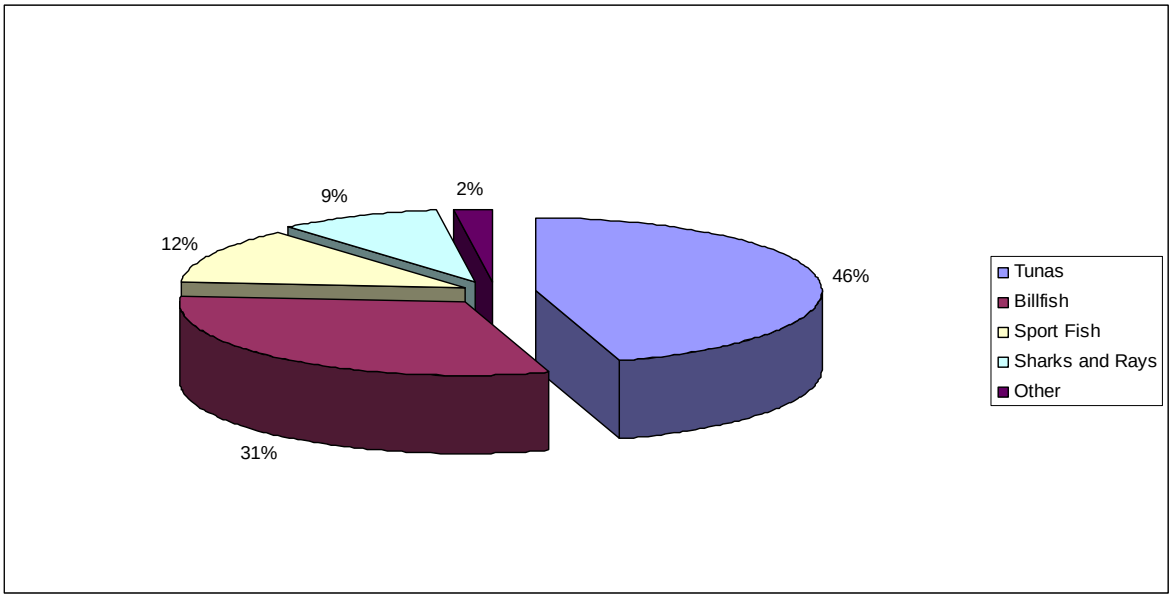


Figure 4a. Species groups tagged in 2010/2011

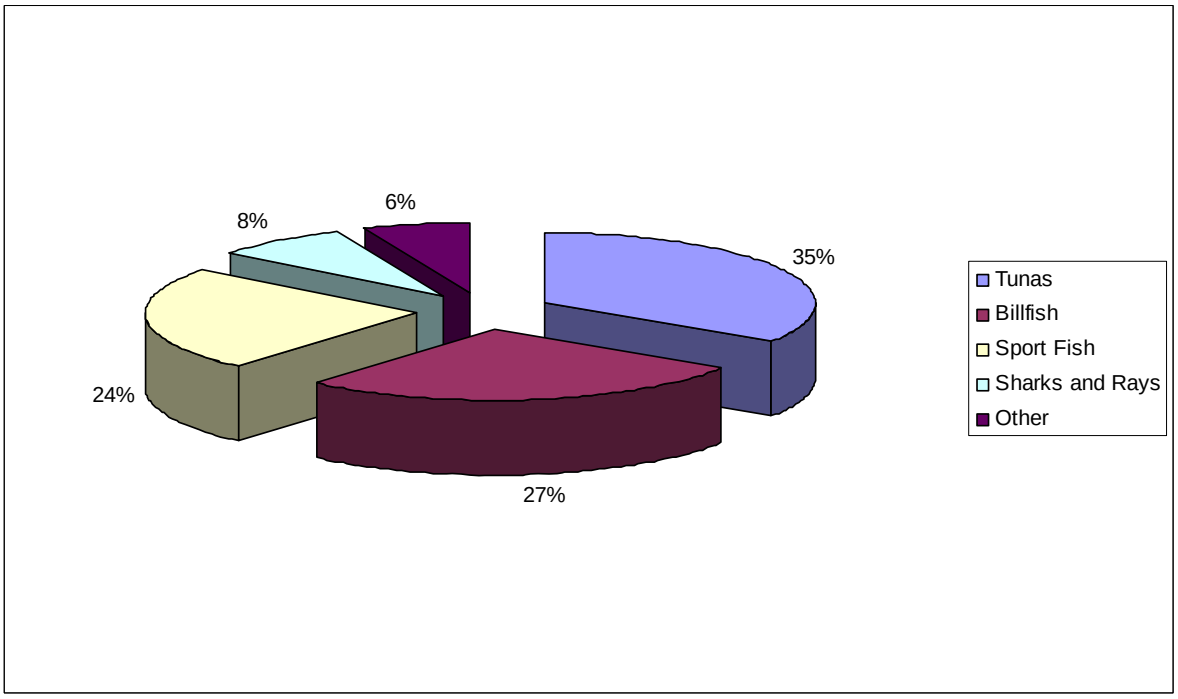


Figure 4b. Species groups tagged 1973-2011

Regarding the relative proportions of recaptured species groups, Figures 4c and 4d show that recaptures during the last season were dominated by billfish, whereas historically, the greatest proportion of recaptures have been the sport fish. Sport fish as a group consist of mahi mahi, yellowtail kingfish, samsonfish, amberjack, rainbow runner, almaco jack, cobia, barracuda sp., threadfin salmon, queenfish and Australian salmon. Much of this change however, is associated with the program more recently focussing on the tagging of the billfish, tunas and sharks.

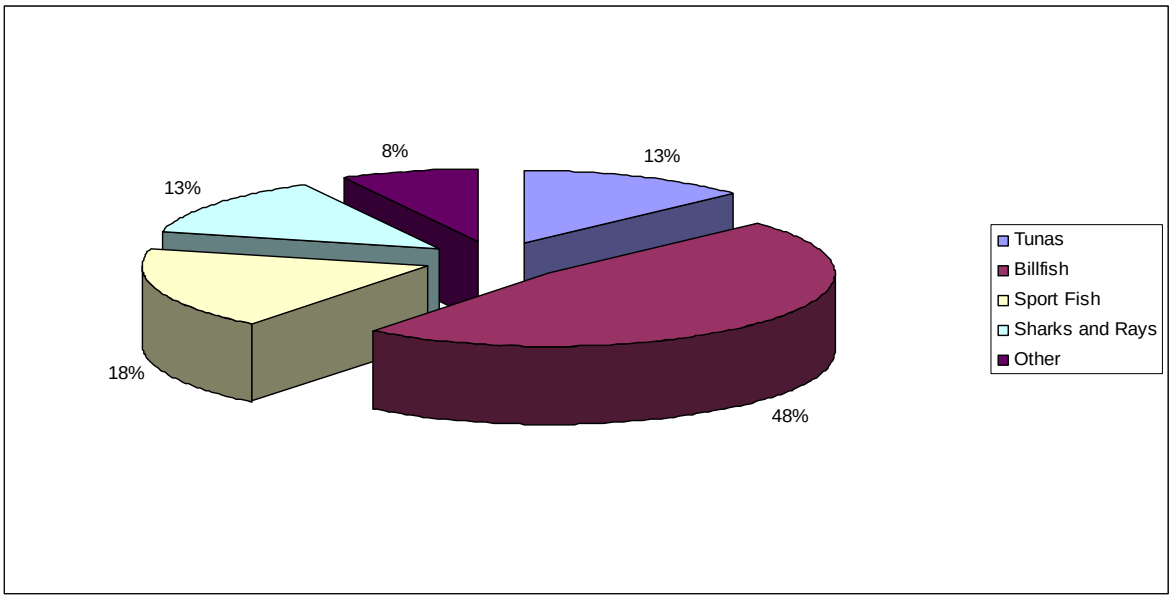


Figure 4c. Species groups recaptured in 2010/2011

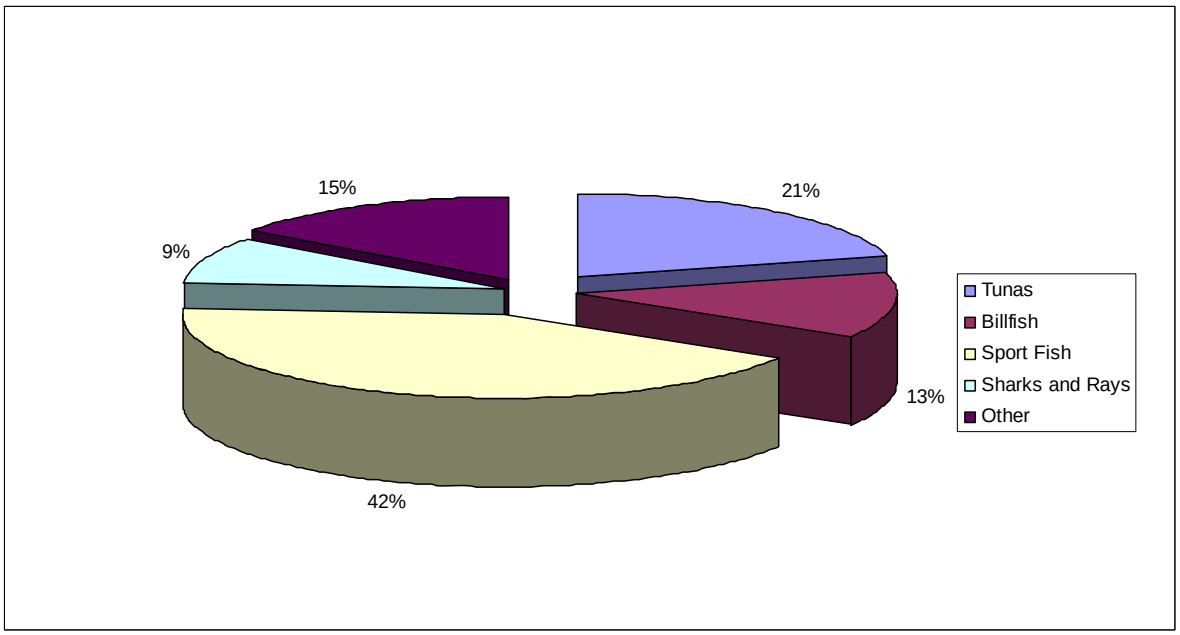


Figure 4d. Species groups recaptured 1973-2011

Recapture highlights

All of the recaptures recorded in 2010/2011 are listed in Appendix I. Following are just some of the highlights of these recaptures. These tend to emphasise some of the longer times at liberty, or longer distances moved by tagged fish, and as such, are often exceptions to the rule. In fact, many fish are recaptured relatively close to their points of release, often within relatively short times and it is important to realise that the information gained from these recaptures is just as important to our understanding of the movements and growth of game fish as longer term, longer distance recaptures.

Black marlin

2010/2010 was a moderate year for reports of recaptured black marlin. This year, 10 black marlin recaptures were reported to the program, 7 of which were released and recaptured off Dampier, Western Australia. Despite five of these being at liberty for periods of 272 to 370 days, the maximum distance recorded by any of these 7 fish was only 21 nautical miles.

The most interesting recapture recorded was a black marlin recaptured in Sri Lanka. The report received was that a 'koppara fish' had been caught bearing a NSW DPI tag.

'Koppara' is the local Sri Lankan name for marlin. It was reported to have been caught on hook and line by a commercial fisherman 30 nm SE of Hambanthota, on the southeast coast of Sri Lanka, on his boat *Dewmi* on 08/09/2010. The koppara measured 200cm and weighed 40kg.

This fish was originally tagged as a black marlin from the boat *Azura* fishing off Exmouth on 24/03/2010. It was first caught on a lure using 60kg line and was estimated to be 25kg in weight. The black marlin had been at liberty for 168 days and had travelled a straight-line distance of 2529 NM north-west from its release point.

Interestingly, this is the second black marlin to have been recaptured off India/Sri Lanka after having been released off the Exmouth Coast and there are a number of other similarities between the recaptured fish. Both black marlin were originally tagged by boats participating in the Exmouth GFC Gamex Tournment held every year in March. The first recapture was a similar sized black marlin (estimated to be 30kg) released in 2008 and later recaptured after a similar time at liberty (in August 2008) at a location approximately 350 nm further north by a commercial fisher operating out of Pondicherry, South India.

The second furthest distance moved by a recaptured black marlin during 2010/2011 was by another juvenile fish tagged off Mooloolaba Qld in March 2010. The fish was estimated at 35 kg and was subsequently recaptured 129 days later off Woodlark Island, Papua New Guinea, a distance of 1,000 nm from its release location. At recapture, the fish weighed 51 kg.

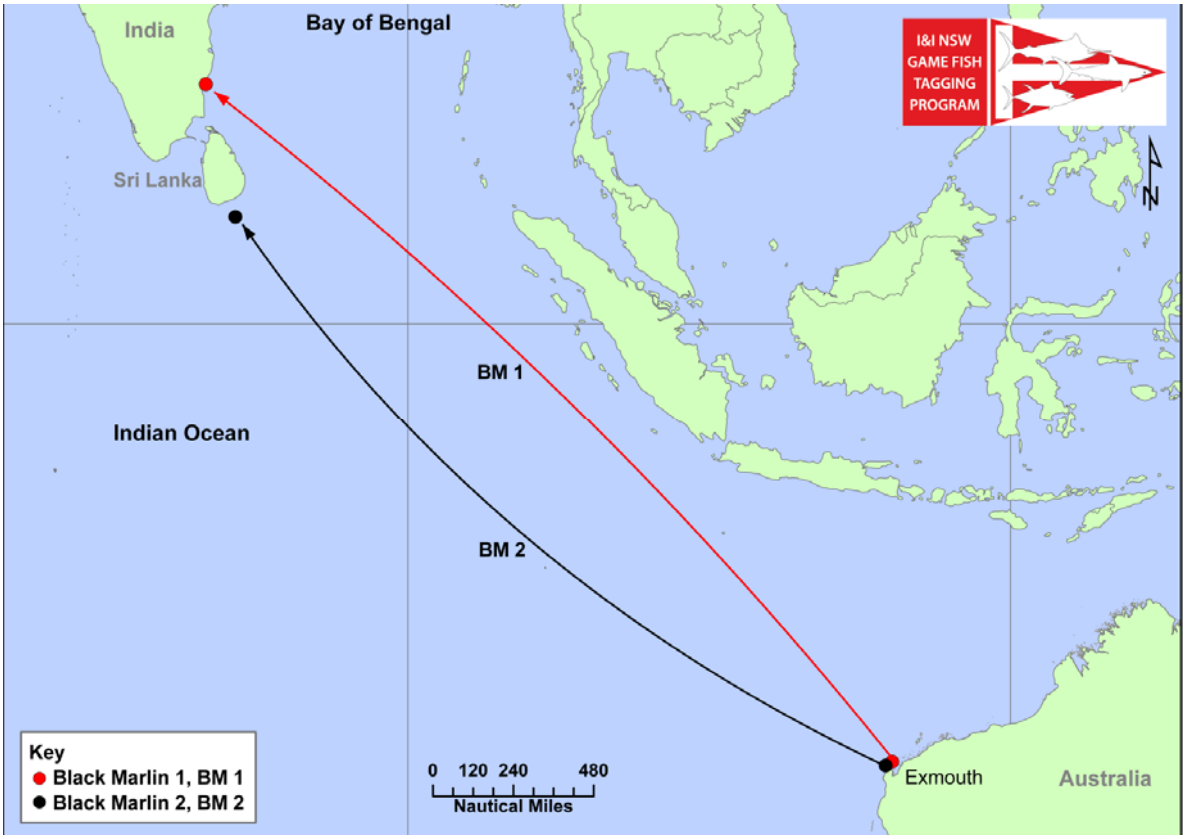


Figure 5. Two long distance movements by tagged black marlin, both tagged off Exmouth, Western Australia.

Sailfish

There were 16 sailfish recaptured during 2010/2011. Eleven of those had been tagged off Dampier WA, one off Exmouth WA and four off Mooloolaba Queensland. Not one of these fish had moved an apparent distance from its release point of more than 9 nm, even though nine of them had been at liberty for more than 120 days, and five of the Dampier fish had been at liberty for periods of 363 to 442 days. This lack of apparent movement for sailfish tagged off several locations on both the east and west coasts strongly suggests some kind of site attachment, or at least a tendency to 'home' to the same location on an annual basis (the technical term for this kind of cyclic behaviour is 'philopatry', meaning 'love of the homeland'.

Striped marlin

Port Stephens, NSW, scored the most striped marlin tags along the east coast during 2010/2011 and this was the location of three of seven recaptures reported to the program during the season. Most of the recaptured fish had been at liberty for short periods of time, from 10 to 90 days and the distances moved between recaptures ranged from 2 to 162 nm. The exception was a striped marlin that was recaptured off Moreton Island, Qld, by a commercial longliner. This fish was

originally released off Swansea Canyons NSW in February 2011 and recaptured in September some 384 nm north north-east after being at liberty for 202 days.

Another striped marlin tagged off Batemans Bay in January 2010 by Batemans Bay GFC boat *Kaos* was recaptured in April off Jervis Bay by visiting Victorian boat Dream *Catcher* while a striped marlin tagged off Ulladulla Canyons in mid-January by Shoalhaven GFC boat *Dads Boat* was recaptured off Port Stephens in April by charter-boat *Flying Fisher*.
A striped marlin tagged off the Jervis Bay Canyons in February by Jervis Bay GFC boat *Escape*, was recaptured off "The Banks", just 10 days later and 18 nm NW from it's release location.
Lastly, a striped marlin tagged at the "Car Park" off Port Stephens in February by Lake Macquarie GFC boat *Ningaloo* was recaptured in the same area 15 days later by the *Strikezone* team.
These examples of relatively short-term recaptures of striped marlin (ie, within a year of release) and quite short distances moved are typical of many other recaptures for this species logged over the course of the Tagging Program. This adds weight to the probability that striped marlin are not nearly as mobile as the other two marlin species, blue and black, leading to the existence of distinct, discrete populations of striped marlin in the Pacific.

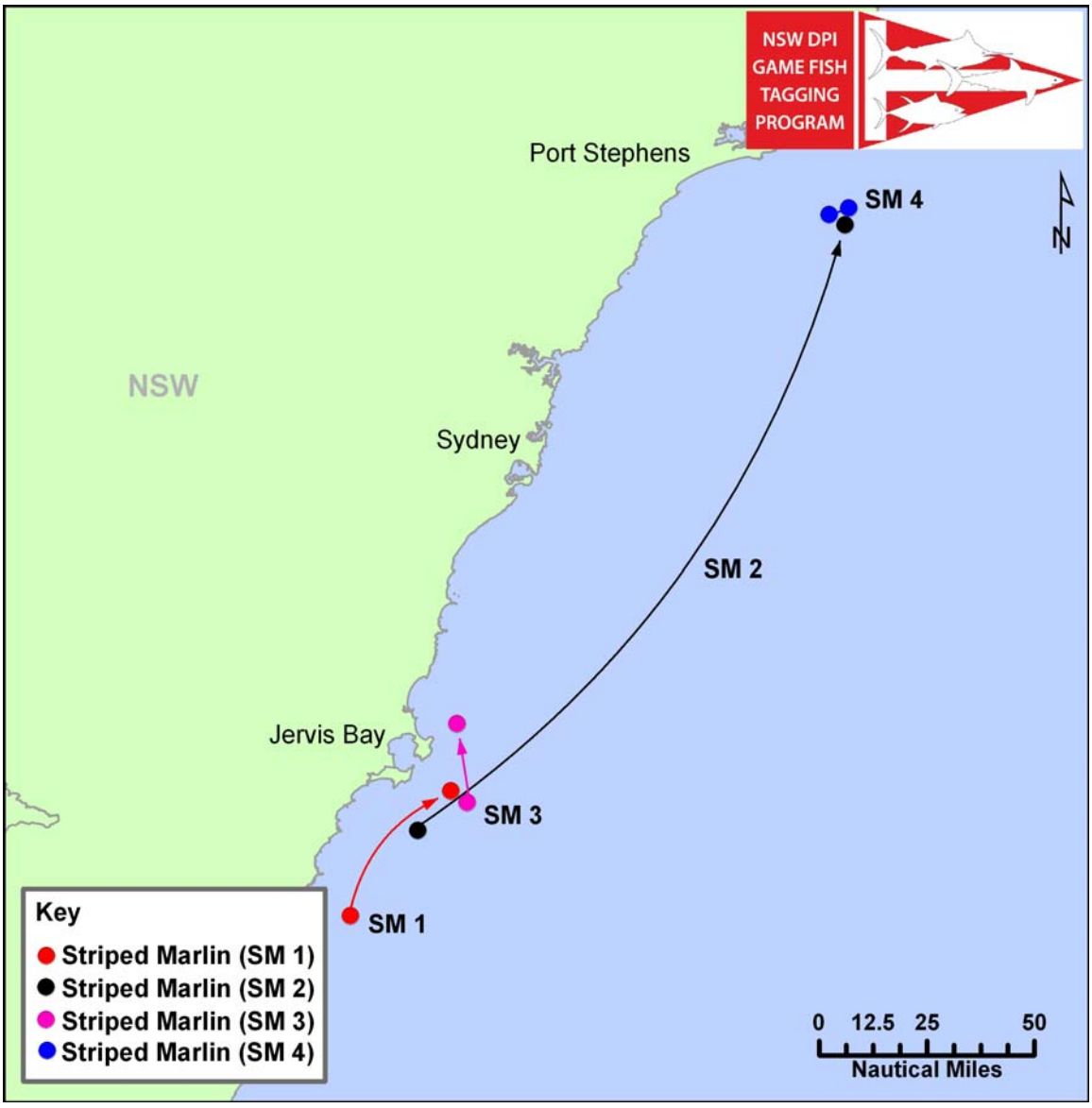


Figure 6. The mid-season movements of four of the striped marlin recaptured in 2010/2011

Yellowtail Kingfish

There have been far more yellowtail kingfish recaptured on the Tagging Program than any other species. Nevertheless, some recaptures from time to time are worthy of mention. This year, two small kingfish that had been tagged off Mowarry Point on the far south coast of NSW were recaptured in southern Queensland. The first, estimated at only 1.1kg, was released in January 2006 and was recaptured by a spearfisher at Hutchinson Shoals, off Moreton Island, in October 2010 after being at liberty for 4 years 9 months. It weighed 8.05kg at recapture. The second fish was estimated at 2.4kg and was released on Christmas Eve 2007. This fish was recaptured off Mooloolaba on the Sunshine Coast, in September 2009 after being at liberty for 2 years 10 months. It weighed 12.5kg at recapture. Although such recaptures happen occasionally, movements of kingfish over such distances are the exception to the rule. This is shown by two of the other recaptures this year of kingfish that were at liberty for lengthy periods but showed little movement. One was tagged off Green Cape, near the NSW/VIC border and recaptured just 3nm away 680 days later, while the other was tagged off the Gold Coast and recaptured 11nm away after 881 days of liberty.

Mako Sharks

During 2010/2011, seven mako shark recaptures were reported. Four of those had been at liberty for relatively short periods (5 to 69 days) and had moved relatively short distances during that time (38 to 88 nautical miles). Another, at liberty for 71 days, had moved from Port Macdonnell in South Australia to Cape Liptrap in Victoria, a distance of 243 nautical miles. The longest distance recorded for a mako this year was 439 nautical miles, by a shark tagged off St Helens Tasmania in January 2009 and one year 8 months later at Stanwell Park canyons NSW.

Interestingly the mako shark that had travelled the least apparent distance had also spent more than a year at liberty. That shark was tagged from the boat *Lockout* of Botany Bay GFC fishing south of Sydney in September 2009 using a circle hook rigged bonito. It was recaptured in November 2010 from the boat *Razorback* fishing east of Botany Bay. The shark had therefore moved an apparent straight-line distance of only 14 nautical miles over the period of 420 days, however it is highly likely that the fish had made a much more significant movement over the time period. .

A mako shark holds the record for the longest time at liberty for all species tagged under the NSW DPI Game Fish Tagging Program. The record-breaking mako was first tagged off Port Macquarie, NSW in September 1987 and was recaptured in August 1999 off Port Hacking, NSW after covering a straight-line distance of 174 nautical miles. The fish was estimated at 15 kg when first tagged and weighed 101 kg when recaptured, almost 12 years later. This demonstrates well the relatively slow growth rate of mako sharks and is apparently within normal growth ranges for this species.

On recapture of the record mako, it was reported that only 15mm of the tag was still showing from the fish as it's relative growth over that time had been considerable. Interestingly there was also another tag in the fish. Unfortunately, we don't have the details on that release, however from our deductions (by looking at the tag number details for the tag before and the tag after) it was likely to have been tagged in 1999 by a boat fishing out of Sydney.

Spanish mackerel

There have been just under 8150 Spanish mackerel tagged throughout the history of the Program and by the end of the 2010/2011 season 76 recaptures had been reported.

This year a Spanish mackerel tagged off Hayman Island, QLD in November 2008 was recaptured 954 days (2 years 7 months) later off Bowen, just 27 nautical miles from where it was released. Another Spanish mackerel originally released off Magnetic Island, QLD, by Townsville GFC boat, *Hallucination,* on 26 April 2008, was recaptured on 10 August 2010 off Fitzroy Island. The fish had travelled a straight-line distance of 132 nautical miles north–northwest. That fish had been at liberty for a total of 837 days (2 years and 4 months). These two fish represent the sixth and seventh longest times at liberty for Spanish mackerel tagged under the program.

The record time between tagging and recapture for Spanish mackerel was for a fish released off Mackay, QLD and recaptured 203 nautical miles WNW off Rib Reef, recording after 1,945 days (5 years and 120 days) at liberty. And the furthest distance travelled by a Spanish mackerel under the program was by a fish released off Cape Bowling Green, QLD and recaptured 88 days later at Sunshine Reef, 532 nautical miles west-northwest.

Southern bluefin tuna

Despite a record tagging year for southern bluefin tuna, only four recaptures were reported during 2010/2011. Two were short term, short distance recaptures, one tagged and recaptured at Rottnest Island WA after two weeks at liberty, the other recaptured only two days after tagging 31 nautical miles from its release location off Montague Island NSW.

In contrast, a southern bluefin tuna released off Kangaroo Island SA was recaptured by a Taiwanese commercial boat fishing the Indian Ocean more than 1,270 nautical miles from the Western Australia coastline. The fish was originally released at an estimated weight of 20kg from the GFC of South Australia vessel *Raptor* and was recaptured at a cleaned weight of 21kg by the longliner. It had travelled a minimum straight-line distance of 2,305 nautical miles in its 508 days at liberty. This recapture is the 10th longest distance travelled by a tagged southern bluefin tuna from of a total of 114 recaptured fish.

Blue marlin

Only 19 blue marlin have so far been recaptured and reported since the beginning of the Game FishTagging Program. With over 6,000 blue marlin tagged, this represents a recapture rate of just 0.3%, lower than any of the other billfish tagged. Some suggest this points to low survival rate after release, but satellite tagging studies have shown that blue marlin actually have excellent survival, especially when caught on lures – the method by which the great majority of tagged blue marlin are caught. One possible reason for apparent low recapture rates for blue marlin is the species tendency to disperse rapidly over very large distances, thereby reducing the chances of short term recaptures and increasing the likelihood of non-reporting of recaptured fish by distant fishing activities. That said, one of the two recaptures of blue marlin during 2010/2011 was of a fish tagged and recaptured at the same place, albeit, with a year between release and recapture.

On 24 October 2009 while fishing in a tournament in Vava'u, Tonga, Michael Gordon-Jones of New Zealand tagged & released his first blue marlin on the local charter boat, Hakuna Matata. The fish was caught on a lure near a local FAD and was estimated to be 95kg.
Michael returned to Vava'u in 2010 to fish the same tournament onboard Reel Addiction with Captain Steve Campbell. On 25 October 2010 he tagged his second blue marlin fishing the South Bank area. On closer inspection, the fish was found to already have a tag in place. On reporting the tag number it was found that the recaptured fish remarkably was found to be the same blue marlin tagged by Michael 1 year and 1 day before!
The fish was found only 19 nautical miles south west of where it was first tagged and was re-released with a new tag.

The second blue marlin recapture was more typical. That fish was tagged off Madang PNG in December 2009 and recaptured six and a half months later in the Gulf of Tomini, Indonesia,1,600 nautical miles from its release point.

Yellowfin tuna

During the course of the Game Fish Tagging Program, over 36,000 yellowfin tuna have been tagged and 682 recaptures reported. This great effort has revealed much about the movements and growth rates of this key species in our region. This year, only two recaptures of yellowfin were recorded, one of which was particularly significant. This was a yellowfin tuna, first released off Durras, near Batemans Bay on the south coast of NSW and recaptured off Wari Island, off the easternmost tip of Papua New Guinea (PNG). When tagged from the boat *Wicked One* on 27 May 2007, the tuna was estimated to be 70cm long. The fish was recaptured 3 years 5 months later by a commercial longline vessel operating out of Port Moresby, PNG, on 28 October 2010. On recapture, the fish was reported to be 125cm long and weighed 32 kg. It had travelled a straight-line distance of 1462 nautical miles north from its release point. Out of the 682 reported recaptures of yellowfin tuna, this fish comes in as the 12th longest distance recapture.

The record straight-line distance for a yellowfin tuna tagged on the NSW DPI Program was 3957 nautical miles – by a fish tagged off Ulladulla, NSW and recaptured in the mid Pacific off Caroline Island, part of the Republic of Kiribati.

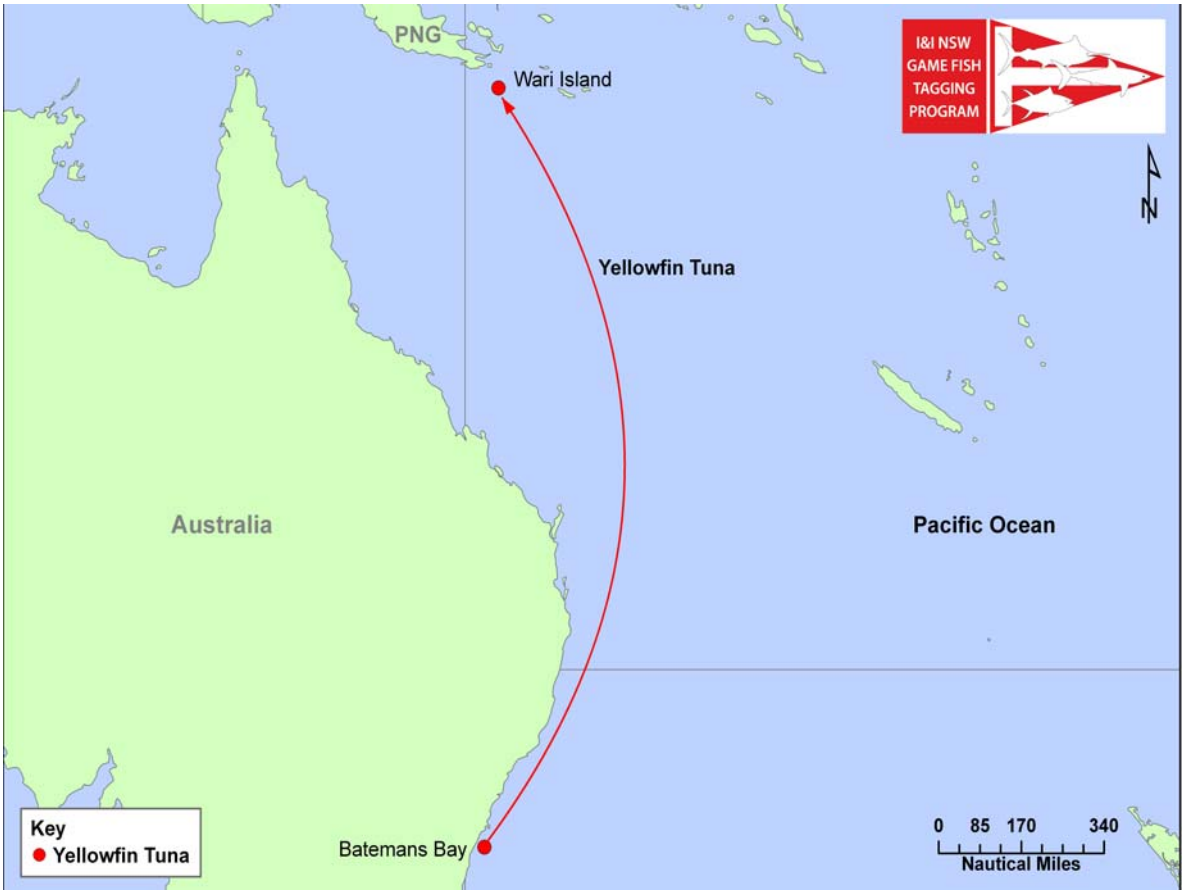


Figure 7. The movement of a yellowfin tuna tagged off Batemans Bay and recaptured off Wari Island after 3 years 5 months at liberty.

Blue shark

A blue shark tagged by Newcastle and Port Stephens GFC Boat Rackem Up during the NSW Interclub competition in February 2010 was recaptured in October, showing a southern movement of 88 nautical miles. The fish was estimated to be approximately 70kg on release and 75kg on recapture, 280 days later. Other blue sharks tagged on the Program in the past have shown a tendency to move over very long distances, into the Pacific and Indian oceans – more so than any other shark species tagged.

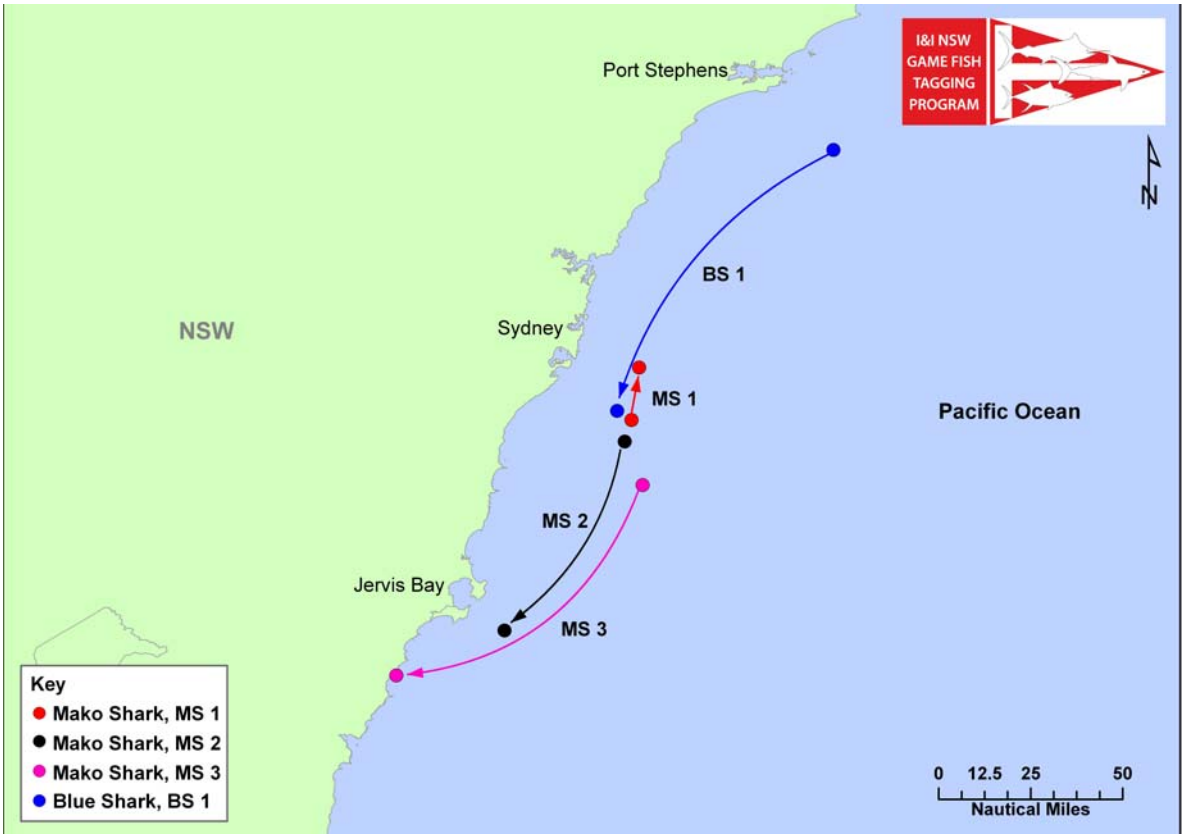
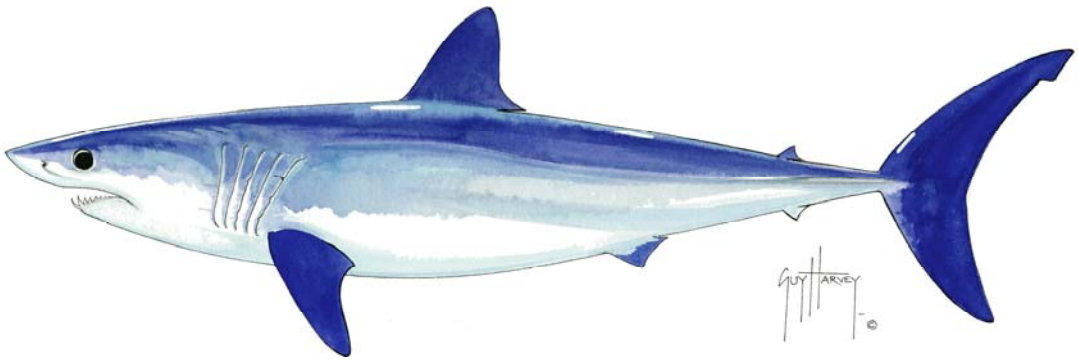


Figure 8. The movements of three mako sharks and a blue shark recaptured in the 2010-2011 season.

Focus on: Shortfin Mako Shark (*Isurus oxyrinchus*)



The following summary of the biology of the shortfin mako shark has been adapted from the book, 'Fishes of the Open Ocean' by Julian Pepperell (UNSW Press).

The mako sharks belong to the mackerel shark family, Lamnidae, the members of which (white, porbeagle, salmon and mako sharks) are widely regarded as the most 'advanced' of all species of sharks in the world. Apart from their similar peak 'design' in body form, they all share a very unusual feature: they are to some extent warm-blooded. In fact, their internal biology in some ways is closer to that of mammals than fish, proving that these sharks have certainly evolved to a high degree, even though their external body shape may have changed little over the ages.

Identification

Not many anglers realize that there are actually two species of mako shark, both with worldwide distribution. By far the most common species is the shortfin mako, *Isurus oxyrinchus*, which almost certainly accounts for 99% of all angler encounters with makos. The closely related longfin mako, *Isurus paucus*, is much rarer and more confined to the open ocean. As its name suggests, the longfin has very long pectoral (side) fins – at least as long as the head (measured from the tip of the snout to the last gill slit) whereas the pectorals of the shortfin mako are shorter than the head length. The longfin has a somewhat blunter snout than the shortfin, and also has a larger eye, although these latter two features are not obvious without a shortfin alongside for comparison.

Even though makos are distinctive sharks, they can still be confused with their three closest relatives – the porbeagle, salmon shark and white shark. The main feature separating the white shark from the mako is the teeth. Whites have triangular, finely serrated teeth in both jaws, whereas the mako's teeth are dagger shaped, and curve inwards. Porbeagle and salmon shark teeth are not serrated, but have two cusps at the base of each, which the mako lacks. There is a white patch on the rear free trailing edge of the porbeagle shark, while the mako's is uniformly coloured. Lastly, the salmon shark can be separated from the makos by a whitish patch which extends from the belly to above the base of the pectoral fin.

The extended pectoral fins of the longfin mako point to an oceanic, current-gliding existence, much like the blue shark, while the large eye indicates that the longfin is probably a deep-water hunter. Apart from these speculations, virtually nothing is known about the biology of the longfin.

The shortfin mako has a truly worldwide distribution, extending from the tropics into temperate waters in all three major oceans. The lower limit of temperature tolerance for makos is usually quoted as 16°C, although off the north-eastern United States, large ones are sometimes encountered in waters as cool as 11 or 12°C.

Geographic range

Mako sharks are generally described as tropical to temperate sharks, which, for anglers, is a little

confusing since makos are rarely caught in surface waters in the tropics. The reason for this description is that Japanese longline fleets historically captured makos throughout the tropics, and mapped this distribution. However, longline hooks fish well below the surface where temperatures are considerable lower than at the surface. Like many other pelagic species which prefer cooler waters, mako sharks simply spend most of their time below the thermocline in the tropics to avoid the hot, surface layer.

Movements

Large numbers of mako sharks have been tagged by recreational anglers in several locations around the world, resulting in some very interesting information on their movements. The main tagging has occurred off New Zealand, the eastern United States and south-eastern Australia. From such tagging in each area, some lengthy movements of makos have been recorded, but the overall results suggest some site fidelity and structuring of stocks within both the Atlantic and the Pacific oceans.

By far the greatest number of mako sharks have been tagged off New Zealand. A total of 13,091 makos had been tagged by the end of the 2010/2011 season and 336 recaptures had been reported. The furthest distance moved to date by a New Zealand tagged mako has been to the Marquesas Islands, near Tahiti, a distance of 3,000 nautical miles (5,500 km) after 162 days of liberty. Eleven makos tagged in New Zealand have been recaptured in Australian waters. Two of these had been at liberty for over two years, but one had made the trans-Tasman crossing in only 36 days, at a minimum rate of travel of 27 nautical miles (50 km) per day. An interesting finding from the New Zealand program is that around 15% of all recaptured makos have been caught well to the north in Fijian waters, nearly all by longline vessels. This cluster of recaptures seems to indicate a seasonal movement of makos into warmer, tropical waters during the southern winter, although other recaptures show that not all makos undertake this journey.

As noted in this report, the NSW DPI Game Fish Tagging Program has seen over 6,770 makos tagged, virtually all off New South Wales, and a total of 158 recaptures have been recorded. Movements of makos tagged on that program have been predominantly coastal, but some long distance displacements have been recorded. Makos tagged off south-eastern Australia have been recaptured in the Coral Sea, while international movements have been recorded to New Zealand and some Pacific Islands. The record distance moved so far was 2,577 nautical miles (4,755 km) by a mako tagged off south-eastern Australia and recaptured in the Philippines 585 days later.

Several features of the movements of makos are evident from both tagging programs, and from a smaller amount of tagging off the eastern United States. Significantly, there has been very little movement of fish between northern and southern hemispheres in either the Atlantic or Pacific oceans, and there has been very little movement recorded from the western Pacific or from the western Atlantic into the eastern sides of either ocean. This is so marked in the Atlantic (a much smaller basin than the Pacific) that it is theorized that the mid-Atlantic ridge must form some kind of barrier to the movement of makos across that ocean.

These results all suggest that the populations of mako sharks in both the Pacific and the Atlantic form discrete stocks, both north and south of the equator, and east and west in both oceans. Recent genetic studies on makos conducted by Australian scientists, also indicate discrete stocks of makos, with sharks around Australia and New Zealand being a separate group to those from the northern Pacific, eastern Pacific and the Atlantic oceans..

Growth and size

The growth rate of mako sharks has been estimated in a number of studies, mostly by counting concentric rings visible in vertebrae. In the eastern US, detailed examination of vertebrae collected throughout the year has shown that it is likely that two rings are laid down each year. However, a more recent study from South Africa, based on a single shark which had absorbed radio isotopes when very small, suggested that only one ring is laid down annually. If two rings per year are laid down, then studies indicate that makos grow quickly in their first few years, from about 70 cm (4 kg) at birth to about 180 cm (60-80 kg) by the end of their third year. As well, big

makos would not be particularly old – a 320 kg female being estimated at about 10 years old. Of course, if one ring is laid down each year, then these estimated ages would be doubled.

As with many species of shark, the maximum size to which makos grow is somewhat evasive. The all-tackle world record shortfin mako weighed 553.8kg (1,221 pounds) and was caught off Massachusetts USA in 2001. This surpassed the previous record of 505 kg (1,115 pounds) taken off the island of Mauritius in the Indian Ocean in 1995. Two other thousand pounders appear in the IGFA charts; one weighing 1,080 pounds (490 kg) caught off New York in 1979, and a 1,075 pounder (488 kg) caught off Spain in 1997. The largest recorded Australian mako, caught off New South Wales in 1991, weighed 467kg (1,027 pounds) while in New Zealand, the apparent 'home' of the mako, the all-tackle record which has stood since 1970 weighed 481.26kg (1,059 pounds). These are official records, but there is little doubt that there have been larger makos caught and verified. The largest appears to be one taken off Massachusetts USA in July 1999, which weighed 1,324 pounds (602 kg). This particular fish was caught on rod and reel but not claimed as a record for technical reasons. The largest longfin mako measured 4.17 metres. It was caught off Florida in 1984.

Reproduction

The mako sharks, like the other lamnids (mackerel sharks), are ovoviparous, meaning that the eggs hatch inside the mother well before birth. The developing young then eat other eggs as they are produced by their mother, their abdomens becoming incredibly distended as a result. (This behaviour is technically known as oophagy, or 'egg eating'). This reproductive strategy sounds quite bizarre, but biologically, it makes perfect sense. It means that the young who win the race within the uterus can grow to a much larger size before birth than would be the case if each embryo developed from the yolk of one egg. This is reflected in the size at which baby shortfin makos are born – about 4 kg – much larger than the newly born tiger or blue sharks which are not oophagous.

Pregnant mako sharks have not been scientifically examined very often. For a long time, this meant that there was considerable uncertainty about the size at first maturity of makos, where they pupped, the numbers of pups they produced, and the size of the pups at birth. Fortunately, a study in the US collected data from around the world on any reliable observations of these sorts of variables and summarized all of the data. For 30 pregnant mako sharks recorded, the number of pups found ranged between 4 and 28 with an average of 12.5. (The authors make the point that some of the counts of near full term embryonic makos are thought to be on the low side because of the possibility of a portion of the litter being aborted during capture).

The average number of pups, at 12.5, is somewhat higher than the shortfin mako's close relatives. The longfin mako apparently gives birth to an average of four young, great whites, 8.9 and the porbeagle, 4. These numbers are based on very small sample sizes, but they do give an indication that the shortfin mako is the most fecund of the lamnid sharks.

The size (fork length) at first maturity of female makos has been estimated at between 2.7 and 2.9 metres, which, based on the ageing studies mentioned above, would equate to an age of 6 to 8 years (for two vertebral rings per year) or 12 to 16 years (for one vertebral ring per year).

Fisheries

Mako sharks are considered to be good to eat and are targeted by some commercial fisheries around the world. It is not unusual to see mako on the menu in American seafood restaurants, and Spanish longline fleets in the eastern Atlantic specifically target mako and thresher sharks, both of which are caught in relatively large numbers. Throughout the Pacific, the longline fleets of many countries also target mako (including longfin) and it is estimated the total catch is quite significant.

Tagging Tips

How to tag large game fish

- Once the angler brings the fish within range, the fish should be traced and led alongside the boat so that it presents a broad tagging target. It is usually best to keep the boat moving slowly forwards to enable better control of the fish.
- Once the fish is in position for tagging, the person handling the tag pole should take position behind the person tracing the fish to allow for a clear tag shot.
- An attempt to apply the tag should only be made if the fish is calm or subdued. The tag should be placed towards the middle of the fish, well above the lateral line towards the dorsal fin.
- For billfish and most sportfish, the fish should be tagged with a firm, well-aimed stroke—simply place the tag against the fish's flank and push. Do not stab. Sharks will require a firm jab in order to penetrate their tough skin.
- Once the tag has been placed, remove the hook if possible (a de-hooker can facilitate this) or cut the trace close to the fish's mouth.
- Revive any fish that appear to be exhausted or are struggling to remain upright in the water. A commonly used approach for billfish is to hold the fish firmly by its submerged bill whilst the boat moves forwards at 2 to 3 knots. This ensures a good flow of water over the fish's gills. The fish should only be released when it shows strong signs of life and displays improved skin colour, which may take several minutes or more. Exercise caution, especially in rough weather. Alternatively, use a snooter. This is a safe and effective tool for reviving billfish.
- Fill out the tag card immediately and return to NSW DPI (or your fishing club recorder) as soon as possible, otherwise tagging is of no value.

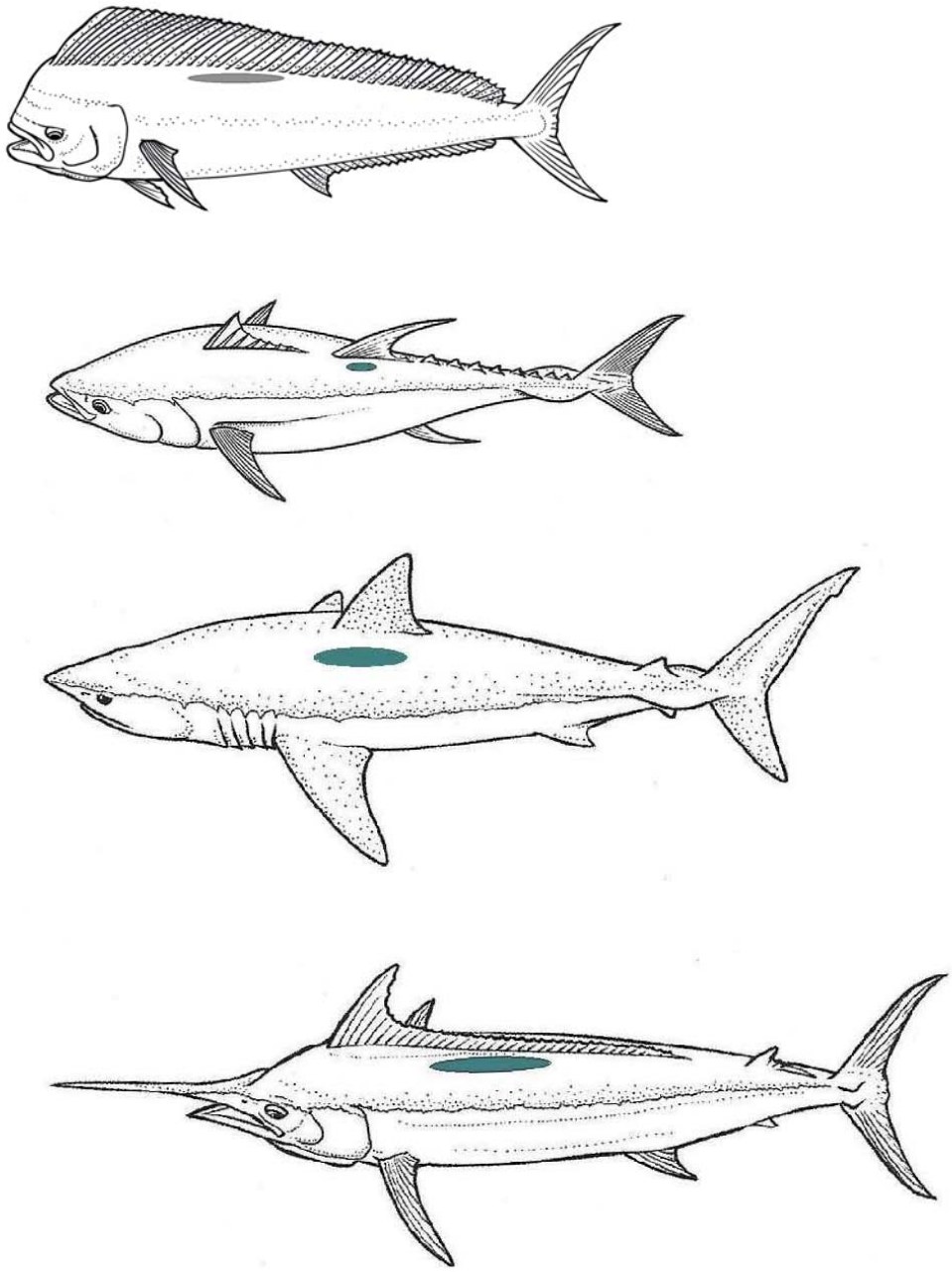
How to tag small game/sport fish

Smaller pelagic species may be removed from the water before tagging. This enables improved accuracy of tagging and may simplify hook removal. Often holding the fish on its back will lessen its 'flapping'. Try to prevent the fish damaging itself on hard, hot, or dry surfaces. A wet foam mat or similar is ideal (or a wet towel will suffice) for on-boat tagging. Where possible, try to place the tag at an angle of at least 45° to reduce water friction on the tag.

Tagging and improved survival tips

- Elect one crew member as the person in charge of the tagging equipment, to ensure that:
    - the number of the tag in position on the tag pole matches that on the tag card
    - details of the tagging are promptly recorded on the card
    - the card is handed to the fishing club recorder or mailed to NSW DPI as soon as possible
- Use non-offset circle hooks whenever possible when using live or dead baits. These hooks minimise deep hooking, foul hooking and bleeding and promote the survival of tagged fish.
- Keep your tag cards in an orderly bundle. This will help to ensure that tags do not become loose and fall out of their corresponding tag card
- Load your tagging pole with a tag before you hook a fish to ensure that it is attached properly and is readily available whenever you wish to tag a fish.
- Check the length of your billfish tag applicator 75mm is the optimal length for most billfish —this ensures that the tag is placed at the correct depth and reduces the risk of the tag being shed by the fish.
- Do not attempt to tag very active fish, especially if the fish is jumping at the side of the boat. Poor tag placement can injure fish or result in the tag being shed. The recommended tagging area is shown below. It is better to release the fish without tagging, if accurate tag placement is not possible.

Recommended tagging areas



Estimating the size of tagged fish

This may be done by estimating the weight of the fish or by measuring the fish when it is in, or alongside the boat. If the fish is less than a metre in length it may be carefully brought on board and measured using a standard measuring tape. However, larger fish should remain in the water.

If you estimate the size of the fish (especially fish weight), get a consensus from all the crew immediately after release, and record immediately (first impressions are always best!).

For measuring length of fish in the water, it is best to rig up a simple tape measure. It helps if it is flexible, and at least 4 metres long. Attach a tennis ball to the zero end and when a fish is

alongside, or being held at the back of the boat, float the tennis ball to the tail fork and get a measurement to the fish's snout, or to the tip of the lower jaw for billfish. For billfish, it is important that the recorded measurement should state where the fish was measured from and to (ie lower jaw to tail fork length or total length - tip of bill to end of tail).

Reporting a previously tagged fish

If an earlier tag is noticed on a fish, should the tag be retrieved and the fish re-tagged, or should the fish be kept for scientific examination? Unfortunately, there is no clearcut answer, but generally speaking, if the tag looks very fresh (ie, bright yellow or orange with no growth) then it is probably a very recent tag and the fish can be returned after first either recording the tag number, or better, cutting off the tag and putting another into the fish. If the fish is small enough to measure, then this should be done, ideally from the tip of the snout to the fork in the tail (or if a billfish, from the tip of the lower jaw to the tail fork). Alternatively, if the tag is fairly obviously an old one, usually identified by being faded and covered with at least some growth, then the best advice is to keep the fish, if possible, for later scientific examination. It should be wrapped in plastic and frozen, and a call made to NSW DPI Cronulla, or your local Fisheries Department, for advice. Very useful information can be gathered from inspection of recaptured fish, including more accurate growth rates, condition of released fish and effectiveness of different types of tags and tagging sites.

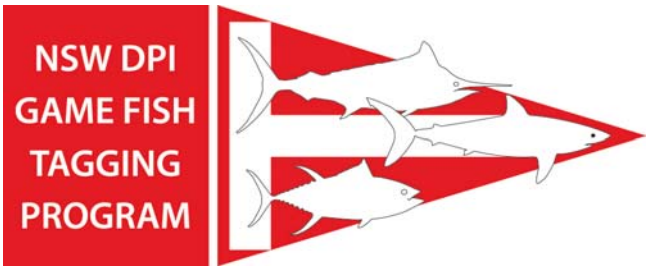
One other point regarding reporting recaptures of tagged fish should be kept in mind. In these days of nearly 100% release of billfish, previously tagged fish are quite often caught and re-released without being able to retrieve the earlier tag. If you do hook and release a fish which has a previous tag in place, you should definitely record the details (even though the tag number is unknown) and report the incident to NSW DPI (Fisheries) at Cronulla as a genuine recapture. In this way, better statistics on actual recapture rates of billfish will be able to be maintained.

Contact the program

If you would like to contact the game fish tagging program either to obtain further information on the program, tags, or to report a recapture directly, call
+61(0)2 4424 7421 or email game fish.tagging@dpi.nsw.gov.au.

Acknowledgements

The NSW DPI Game Fish Tagging Program is implemented using funds from the NSW Recreational Fishing Trust. We also acknowledge the thousands of anglers, club officials, captains and crew who participate in the Program. Without this continued effort, our knowledge of the biology of pelagic fish would be much the poorer.



Appendix I: All Recaptures of Tagged Fish Reported in 2010/2011

Release Species	ReleaseDate	Release Locality	Days at Liberty	Distance (NM)	Direction
Amberjack	13/06/2009	Southport	456	49	NW
Amberjack	20/08/2009	Frederick Reefs	324	0	S
Australian Salmon	15/05/2010	Outer Harbour (SA)	186	0	S
Australian Salmon	3/08/2007	Catherine Hill Bay	1283	24	SSW
Black Marlin	9/03/2010	Mooloolaba (9 NM NE)	129	1000	NW
Black Marlin	24/03/2010	Exmouth	168	2529	WNW
Black Marlin	9/08/2009	Dampier	355	16	NW
Black Marlin	3/08/2009	Dampier Archipelago	370	8	SSE
Black Marlin	30/07/2010	Dampier	65	4	NE
Black Marlin	25/09/2010	Dampier	11	1	SW
Black Marlin	14/02/2010	Port Stephens	362	10	S
Black Marlin	9/03/2011	Dampier	309	21	SW
Black Marlin	24/03/2011	Dampier	272	19	SE
Black Marlin	31/07/2010	Dampier	309	21	SW
Blue Marlin	24/10/2009	Tonga (middle FAD)	366	19	SW
Blue Marlin	20/12/2009	Bagabag Island (PNG)	193	1601	NW
Blue Shark	28/02/2010	Port Stephens	280	88	SSW
Bonito	28/03/2010	Sydney Heads	150	117	NNE
Bonito	27/03/2010	Forster	239	103	NE
Cobia	15/07/2009	Caloundra (wide)	362	1	N
Gummy Shark	4/10/2009	Cape Jervis (SA)	400	53	SE
Gummy Shark	18/02/2009	Port Macdonnell (SA)	707	145	NW
Longtail Tuna	11/04/2011	Tomaree Head (NSW)	11	8	NNE
Mahi Mahi	16/01/2011	Gold Coast	49	419	SSW
Mahi Mahi	18/03/2010	Sydney Shelf	224	872	NNE
Mako Shark	20/09/2009	Stanwell Park Canyons	420	14	NE
Mako Shark	19/09/2010	Wollongong (wide)	69	58	SSW
Mako Shark	2/01/2011	Cape Schanck (VIC)	13	88	W
Mako Shark	5/12/2010	Shellharbour (east)	65	53	SW
Mako Shark	25/01/2011	Inverloch (VIC)	5	38	NW
Mako Shark	7/01/2011	Port Macdonnell (SA)	71	243	SE
Mako Shark	24/01/2009	St Helens (TAS)	602	439	NNE
Miscellaneous	5/01/2011	Botany Bay	110	0	N
Mulloway	10/10/2010	Port Augusta (SA)	219	0	N
Sailfish	30/07/2010	Dampier	59	9	NNE
Sailfish	10/08/2009	Dampier	363	7	SSE
Sailfish	26/09/2010	Dampier	2	2	NNE
Sailfish	5/06/2010	Dampier	120	4	NE
Sailfish	13/04/2010	Mooloolaba (wide)	175	5	SE
Sailfish	16/08/2009	Dampier	415	3	ESE
Sailfish	29/08/2009	Dampier	400	5	ESE
Sailfish	29/09/2010	Mooloolaba (8 Nm NE)	18	2	N
Sailfish	1/10/2010	Mooloolaba (10 Nm NE)	23	1	NW
Sailfish	15/08/2009	Dampier	379	2	E
Sailfish	8/08/2010	Dampier	21	8	SE
Sailfish	7/08/2009	Dampier	442	4	E
Sailfish	10/09/2010	Dampier	19	1	W
Sailfish	23/03/2010	Exmouth	193	7	NNW
Sailfish	1/10/2010	Mooloolaba (10 NM NE)	16	2	W
Sailfish	6/06/2010	Dampier	155	7	WNW

Release Species	ReleaseDate	Release Locality	Days at Liberty	Distance (NM)	Direction
Sth Bluefin Tuna	26/02/2009	West Bay (Kangaroo Is)	508	2305	SW
Sth Bluefin Tuna	13/11/2010	Rottnest Island	14	2	ESE
Sth Bluefin Tuna	10/04/2010	Neptune Islands (SA)	320	111	WNW
Sth Bluefin Tuna	26/06/2011	Montague Island (wide)	2	31	SW
Spanish Mackerel	26/04/2008	Magnetic Island	837	132	NNW
Spanish Mackerel	17/08/2010	Mackay (Parker Reef)	29	0	E
Spanish Mackerel	21/11/2010	Fraser Island	133	210	S
Spanish Mackerel	9/11/2008	Hayman Island	952	27	W
Striped Marlin	28/02/2010	Swansea Canyons	202	384	NNE
Striped Marlin	5/02/2011	Jervis Bay Canyons	10	18	NW
Striped Marlin	5/02/2011	Port Stephens (wide)	15	2	WSW
Striped Marlin	7/01/2011	Batemans Bay (wide)	86	34	NNE
Striped Marlin	8/02/2011	Port Stephens (wide)	18	2	S
Striped Marlin	14/01/2011	Ulladulla Canyons	90	162	NNE
Whaler Shark	31/12/2010	Lord Howe Island	141	1	SE
Yellowfin Tuna	27/05/2007	Durras	1250	1462	N
Yellowfin Tuna	3/04/2010	Lae PNG	393	201	N
Yellowtail Kingfish	24/12/2007	Mowarry Point	1007	649	NE
Yellowtail Kingfish	22/01/2006	Mowarry Point	1718	637	NNE
Yellowtail Kingfish	26/11/2010	Toothbrush Island	32	2	S
Yellowtail Kingfish	18/04/2009	Green Cape	680	3	NNW
Yellowtail Kingfish	27/03/2011	Mowarry Point	23	0	N
Yellowtail Kingfish	2/11/2008	Gold Coast	881	11	SE

Appendix II: NSW DPI Game Fish Tagging Program Top Taggers for 2010/2011

Top taggers 2010/ 2011 season

NSW DPI would like to recognise the boats and anglers that have provided exceptional contributions to the program over the past season. These boats and anglers can be seen in the table below with the numbers of fish that they tagged over the 2010 - 2011 season. We will continue to develop these end of season summaries and acknowledge the strong supporters of the tagging program in future years.

Species	Top boat	Runner up boat
Billfish combined	96 - *The Wench* (WA) King Bay GFC and Nickol Bay SFC	94 - *Flying Fisher* (NSW) Central Coast GFC and Haven Fishing Charters
Blue Marlin (International)	41 - *Reel Addiction* (Tonga) Vava'u SFC and Reel Addiction charters.	14 - *Talio* (PNG) Madang GFC and Reel Fish Charters
Blue Marlin (Australia)	17 - *Mistress* (QLD) Gold Coast GFC and Mistress Sportfishing Charters	5 - *Foreign Exchange* (NSW), *Mahi Mahi II* (WA), *Wicked Weasel* (NSW) and *Rosanna* (NSW)
Black Marlin	52 - *Flying Fisher* (NSW) Central Coast GFC and Haven Fishing Charters	46 - *The Wench* (WA) King Bay GFC and Nickol Bay SFC
Striped Marlin	50 – *Sniper* (NSW) Jervis Bay GFC	36 – *Mr Hooker* (NSW) Bermagui BGAC
Sailfish	50 - *The Wench* (WA) King Bay GFC and Nickol Bay SFC	26 - *Last Cast* (QLD) Townsville GFC and Fish's Fly & Sportfishing, Weipa
Shortbill Spearfish	2 - *Bill Collector* (NSW) Canberra GFC and Tantrum (NSW) Sydney GFC	1 – 20 boats (NSW & QLD)
Swordfish	1 – *Hotshot* (NSW) Bermagui BGAC	-
Shark combined	93 - *Tantrum* (NSW) Sydney GFC	41 – *Gloriana* (NSW) Lake Macquarie GFC
Mako Shark	22 – *Greyhounder* (NSW) Wollongong GFC	12 – *Khe Sahn* (NSW) Wollongong GFC
Blue Shark	10 – *Sarah Jane* (NSW) Bermagui BGAC	9 – *Panlicker* (ACT) Canberra GFC

Tiger Shark	6 – *The Big Boat* (WA) Nickol Bay GFC	4 – *Greyhounder* (NSW), *Blue Stuff* (WA) and *Tourettes* (WA)
Whaler Shark	84 - *Tantrum* (NSW) Sydney GFC	41 – *Gloriana* (NSW) Lake Macquarie GFC
Hammerhead Shark	15 – *Care Factor* (NSW) Port Macquarie GFC	4 – *Tourettes* (WA) Nickol Bay GFC
Thresher Shark	1 – *Live Action* (NSW) Jervis Bay GFC	-
Tuna combined	342 – *Zero Six* (SA) Port MacDonnell OAC	272 – *No Alibi* (SA) Port MacDonnell OAC
Yellowfin Tuna	19 – *Seaborn* (NSW) Solitary Islands GFC	8 - *Angie 2* (NSW) Jervis Bay GFC
Southern Bluefin Tuna	340 - *Zero Six* (SA) Port MacDonnell OAC	261 **-** *No Alibi* (SA) Port MacDonnell OAC
Bigeye Tuna	2 – *Zuri* (QLD) Townsville GFC	1 – *Trophy* (WA) and Marquis (NSW)
Albacore Tuna	55 - *Mr Hooker* (NSW) Bermagui BGAC	34 – *Wild One*(TAS) St Helens GFC
Longtail Tuna	11 – *Wind Down* (NT) Groote Eylandt G&SFC	9 – *Reel Addict* (NT) Groote Eylandt G&SFC

Species	**Top individual**	**Runner up individual**
Billfish, Shark and Tuna	154 – Max Barrett (SA) Port MacDonnell OAC	144 – Dave Malcolm (SA) Port MacDonnell OAC
Billfish combined	51 - Scott MacGowann (WA) King Bay GFC	40 - Bart Portelli (NSW) Sydney GFC
Shark combined	32 - Gil Rabinowitz (NSW) Sydney GFC	21- Jono Livingstone (NSW) Lake Macquarie GFC
Tuna combined	154 – Max Barrett (SA) Port MacDonnell OAC	144 – Dave Malcolm (SA) Port MacDonnell OAC