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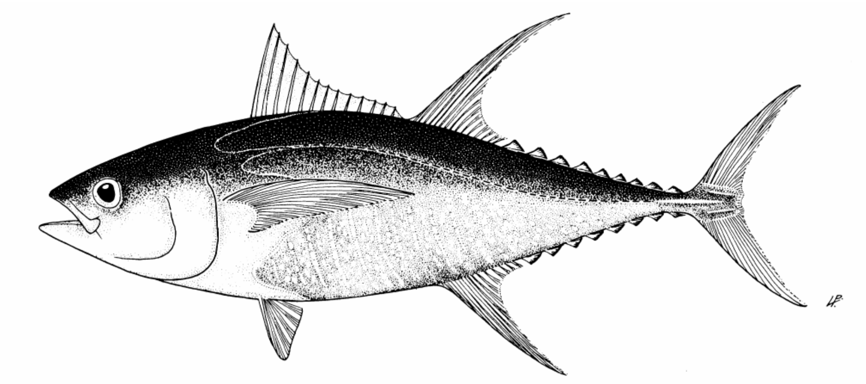
Summary of New Zealand research into tunas and tuna-related species



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Summary of recent New Zealand research into tunas and tuna-related species

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INTRODUCTION

The paper summarizes recent and on-going research into tunas and tuna-related species in New Zealand. This research is undertaken under contract to the New Zealand Ministry of Fisheries and though other funding sources.

Included below are summaries of MFish-funded papers describing:

- Growth rate, age at maturity, longevity and natural mortality rate of **Ray's bream** (*Brama* sp.)
- Growth rate, age at maturity, longevity and natural mortality rate of **moonfish** (*Lampris guttatus*)
- Age and growth of **blue shark** (*Prionace glauca*) from the New Zealand Exclusive Economic Zone
- Age, growth, maturity, longevity and natural mortality of the **shortfin mako shark** (*Isurus oxyrinchus*) in New Zealand waters
- Monitoring the length structure of New Zealand commercial landings of **albacore tuna** during the 2003−2004 fishing year
- Characterisation of **striped marlin** fisheries in New Zealand
- **Swordfish** stock structure
- Growth rate, age at maturity, longevity and natural mortality rate of **swordfish** (*Xiphias gladius*)
- New Zealand **billfish** and **gamefish** tagging, 2003–04
- The distribution of **Pacific bluefin tuna** (*Thunnus orientalis*) in the southwest Pacific Ocean, with emphasis on New Zealand waters

Non-MFish funded research to be undertaken includes (summaries are not provided here):

- Satellite tagging of striped marlin – funded by the New Zealand Marine Research Foundation
- Kopf, R. K., Davie, P. S., and Holdsworth, J. C. (2005). Size trends and population characteristics of striped marlin, *Tetrapturus audax* caught in the New Zealand recreational fishery. *New Zealand Journal of Marine and Freshwater Research 39 (5).*

Also, MFish-funded research is currently being undertaken in the following areas:

- Age, growth, maturity, longevity and natural mortality of the **porbeagle shark** (*Lamna nasus*) in New Zealand waters
- Standardized CPUE analyses for the **swordfish** longline fishery, and the longline and troll fisheries for **albacore** tuna
- Standardized CPUE for the recreational **striped marlin** fishery
- Development of shore-based sampling for **highly migratory species**
- Regional stock assessment for **swordfish** (in collaboration with CSIRO, Australia)

If you would like further details regarding any of these studies please contact Shelton Harley (Shelton.harley@fish.govt.nz).

Paul, L.J.; Francis, M.P.; Ó Maolagáin, C. (2004). Growth rate, age at maturity, longevity and natural mortality rate of Ray's bream (*Brama* sp.). *Final Research Report of Project TUN2003/01.*

There are several very similar species of Brama, and it is possible that more than one is taken in the New Zealand fishery. The most common is believed to be southern Ray's bream, *B. australis*. It is assumed that the otoliths examined in this study came from this species.

Length frequency data were obtained from observer and research trawl survey databases, and otoliths from 30–56 cm fish were selected from these same sources.

Otoliths from 252 fish were thin-sectioned and read under high magnification with transmitted light. They were difficult to interpret, showing a variety of growth patterns not characteristic of standard annual zones seen in other species. Less than half (43–49%) were scored with moderate uncertainty or better, and only 12–19% were scored as good or clear. In general, only otoliths with more than about 12 zones were clear, and most of these came from fish longer than 48 cm. This high uncertainty in the age estimates, and their status as being unvalidated, means the growth curve estimates must be interpreted with some caution, particularly for the younger age classes.

Otoliths were read blind (without knowing fish length) by one reader, and with known length by two readers. Within-reader variability (blind cf. known-length) was high but with no bias. Between-reader variability (length-known) was also high but with no bias. When fish length was known, length-at-age variability was lower and the shapes of the fitted growth curves were more plausible.

Few young fish were aged (and with low reliability). The growth curves imply rapid early growth, to about age 5, at 40–45 cm, and then slow growth to 56 cm. Maximum age was 25.

Length and age at maturity could not be adequately estimated because although gonad maturity stages were available for fish sampled from tuna longline catches and research trawl surveys, these stages do not distinguish between resting mature fish and fish that are maturing for the first time. Most of the fish above 35 cm or about 2 years old were resting or maturing, though it is not known what proportion of the latter were maturing for the first time. It appears that fish longer than about 40 cm and older than about 5 years are mature. It is surprising that although staged samples were available from winter, summer and autumn, ripe fish were virtually absent. New Zealand Ray's bream may spawn only in more northerly waters than have been sampled so far.

The natural mortality coefficient M was estimated using Hoenig's (1983) regression method, and with a Chapman-Robson estimator. Neither method provided a good estimate of M with the present data, but the most plausible estimate was in the range 0.10–0.15.

The trawl catch is estimated to be based mainly on 4 to 11 year old fish, and the bycatch in the tuna longline fishery mainly on 5 to 11 year old fish, but the relatively flat growth curve means that length is not a good predictor of age for fish over about 5 years old.

Addendum: Based on ages of recruitments of 2-3 years, the Chapman Robson estimates of Z for Ray's bream are 0.16-0.19. The Hoenig estimate of M was 0.17.

Francis, M.P.; Griggs, L., and Ó Maolagáin, C. (2004). Growth rate, age at maturity, longevity and natural mortality rate of moonfish (*Lampris guttatus*). *Final Research Report of Project TUN2003/01*.

Age and growth of moonfish (*Lampris guttatus*) in New Zealand waters was studied from counts of growth bands on cross sections of the second ray of the dorsal fin. Fin samples were collected by Ministry of Fisheries observers working on tuna longline vessels. Observers also collected maturity data, and length-frequency data were obtained from the longline observer database.

Thin sections were cut from fin rays 3.5–4 times the condyle width above the fin base. Sections were read blind (without knowing the fish length) by two readers. Readability scores were poor. Due to difficulty in interpretation, Reader 1 did a second count knowing the fish length. Age-bias plots showed that Reader 2 produced higher ages, with a mean difference of 1.4 bands between readers. This was largely due to a difference in interpretation of the first band. Interpretation was also difficult at the outer edge of rays from large fish, where there appeared to be a number of thin bands. Because of this difference between the two readers, two additional readers aged a subset of 25 sections. One of the additional readers generally agreed with Reader 1 and the other with Reader 2.

Length-at-age data did not show any marked differences between males and females. Von Bertalanffy growth curves were fitted to the age estimates of both readers individually, and also to the mean ages of the two readers. We suggest that the mean age provides the best available age estimate for our moonfish samples. However, because of differences between readers, and the unvalidated nature of our estimates, the growth curves must be interpreted with caution, especially for younger fish.

The growth curves suggest rapid early growth. The greatest age estimated in this study was 13 or 14 years depending on the reader, but this is probably an underestimate of true longevity. Using a maximum age of 14 years, Hoenig's method provides an M estimate of 0.30. If moonfish live to 20 years, this would reduce to 0.21. The Chapman-Robson estimate of Z is 0.13–0.14 for ages at recruitment of 2–4 years. However, our sample was not randomly selected and so this is probably unreliable. The best estimate of M may be around 0.20–0.25.

Most of the catch taken by the tuna longline fishery was aged 2 to 14 years, and most (71%) of the commercial catch appears to be of adult fish.

Length and age at maturity could not be accurately determined due to insufficient data, but it appears that fish longer than about 80 cm fork length are mature. The corresponding age at maturity would be 4.3 years. Sexual maturity may therefore be attained at about 4–5 years. A few spawning females were collected in the Kermadec region, and at East Cape, suggesting that moonfish spawn in northern New Zealand. Identification of the location and timing of spawning are important areas of further research and are a pre-requisite for obtaining good estimates of length and age at maturity.

Addendum: Based on ages of recruitment of 2-4 years, the Chapman Robson estimates of Z for Moonfish are 0.19-0.27. The highest value (0.27) is most sensible because full recruitment appears to be at age 4. Notwithstanding this, the numbers-at-age plot is very flat topped, and the graph does not look like the fish were randomly sampled so the estimates are not reliable.

Manning, M.J.; Francis, M.P. (2005). Age and growth of blue shark (*Prionace glauca*) from the New Zealand Exclusive Economic Zone. *New Zealand Fisheries Assessment Report 2005/26. 52 p.*

Age and growth, longevity, natural mortality, and age-at-maturity estimates for blue sharks in the New Zealand Exclusive Economic Zone (EEZ) were derived from 428 whole and X-radiographs of sectioned vertebral centra and other biological data collected from commercial and recreational catches. This study was funded by the New Zealand Ministry of Fisheries under research project TUN2002-01 Objective 1.

Vertebral reading precision was fair within-reader (IAPE = 5.99; mean c.v. = 8.47%), and compares favourably between-readers with overseas studies (IAPE = 9.02; mean c.v. = 12.76%). There was no evidence of bias within-reader; however there was some evidence of a difference in interpretation between-readers of vertebrae from older sharks.

A range of alternative growth models was fitted to the final vertebral length-at-age dataset using maximum likelihood methods. Additive and multiplicative von Bertalanffy and Schnute growth models that assumed and did not assume separate growth by sex were fitted and compared using the likelihood ratio test. Selection of an appropriate case of Schnute's model was made using Akaike's Information Criterion (AIC). The fit of a Schnute model (case 1) assuming separate parameters by sex and multiplicative normal errors was preferred among the suite of models fitted ($L_{1,\text{male}} = 65.21$, $L_{2,\text{male}} = 217.48$, $\kappa_{\text{male}} = 0.1650$, $\gamma_{\text{male}} = 0.16$, $L_{1,\text{female}} = 63.50$, $L_{2,\text{female}} = 200.60$, $\kappa_{\text{female}} = 0.2297$, $\gamma_{\text{female}} = 0.07$; asymptotes calculated from the parameter estimates are $L_{\infty,\text{male}} = 297.18$ and $L_{\infty,\text{female}} = 235.05$). Reference ages of 2 and 10 years were assumed for all Schnute models fitted.

From the fit of the preferred model, female blue sharks appear to approach a lower mean asymptotic maximum length and grow at a faster rate than males. This contradicts studies on the age and growth of blue shark from other oceans, where female sharks typically approach a larger mean asymptotic maximum size than males. This is thought to result from the presence of relatively few larger (over 250 cm FL), older female blue sharks in length-at-age dataset in this study. The data suggest that larger females are missing from the commercial catch despite anecdotal evidence to the contrary. Hence, the vertebral growth estimates produced are probably biased. Growth rates (the values of growth model rate parameters) are broadly comparable with overseas studies, however. A MULTIFAN analysis of length-frequency data was uninformative.

The oldest male and female blue sharks in the final vertebral length-at-age dataset were 22.76 and 19.73 years, respectively. From these results, it appears that male blue sharks in the New Zealand EEZ reach at least their 22nd year and females approach their 20th year. Although crude, these estimates are preferred to estimates of longevity calculated from von Bertalanffy model parameter estimates. Natural mortality estimates derived from the former using Hoenig's regression are 0.19 for male sharks and 0.21 for females. Age at maturity appears to be about 8 years for male sharks and about 7–9 years for females in the New Zealand EEZ. Blue sharks in the New Zealand EEZ appear to mature later than blue sharks from other oceans, although growth rates and longevity are roughly comparable. Blue sharks caught in the New Zealand EEZ are almost certainly part of a larger South Pacific stock, however.

Collecting, preparing, and reading vertebrae from larger (over 250 cm FL), older female blue sharks and updating the analyses presented in this study is a priority for research on this species in the New Zealand EEZ. The possible difference in interpretation in vertebrae of older sharks between-readers should also be investigated further; an inter-laboratory exchange is suggested.

Bishop, S.D.; Francis, M.P.; Duffy, C. (2004). Age, growth, maturity, longevity and natural mortality of the shortfin mako shark (*Isurus oxyrinchus*) in New Zealand waters. *Unpublished data.*

Shortfin mako sharks were aged by counting growth bands in sectioned vertebrae collected from recreational fishing competitions and the tuna longline fishery. Replicate counts were made from images taken under reflected light. No systematic ageing bias was present within or between readers and count precision was high. Growth is rapid in early years and quickly declines. Vertebral data showed that males and females grow at similar rates until age 7–9 years, after which the relative growth of males declines. Von Bertalanffy growth parameters were: male L_∞ = 302.16 cm fork length (FL), K = 0.0524 and t_0 = –9.04 years: female L_∞ = 732.41 cm FL, K = 0.0154 and t_0 = –10.79 years. MULTIFAN analysis of length-frequency data from the tuna longline fishery estimated substantially faster growth than that derived from vertebral ages. MULTIFAN growth rates were considered reliable up to age 2–3 years, and thereafter vertebral ages were more reliable. Longevity estimates based on the maximum ages from vertebral band counts were 29 and 28 years for males and females respectively. Natural mortality estimates calculated from Hoenig's (1983) equation were 0.14 for males and 0.15 for females. Ages at 50% maturity determined by probit analysis of paired age and maturity data were 6.9 years for males and 19.1 years for females. Indirect age at maturity estimates from conversion of length at maturity data were 8–9 years for males and 20–21 years for females. Median maturity in males corresponded with the age at which male growth rate declined.

The shortfin mako is a large, slow-growing, and late-maturing species with high longevity and low natural mortality. Comparison of growth curves reported here with overseas studies suggest that there are no regional differences in growth rates. Stock size and structure are unknown for this species internationally, and management should be of a precautionary nature.

Griggs, L. (2004). Monitoring the length structure of New Zealand commercial landings of albacore tuna during the 2003−2004 fishing year. ***Final Research Report for project ALB2003/01, Objective 1***

Albacore tuna caught by trolling in New Zealand waters during the 2003–04 fishing season were sampled in fish sheds to determine the length frequency composition and length-weight relationship. This season albacore were sampled from three ports, Auckland, New Plymouth and Greymouth.

Albacore sampled in the 2003−04 fishing year had a mean fork length of 64.3 cm, and ranged in size from 40−94 cm, with nearly all fish (99%) in the 52−76 cm range. Length:weight relationships were determined. Log of fork length plotted against log of green weight produced a significant linear relationship (R2=0.92).

Nearly all of the albacore sampled in the troll fishery over an eight year period from 1996−97 to 2003−04 were in the 47−81 cm size range (99%), with a mean fork length of 63.3 cm. There is considerable variability in the size composition from year to year.

Size frequency of the troll catch is compared with the New Zealand observed longline catch of albacore. Longline caught albacore are larger, with an average fork length of 80.0 cm, and most fish (99%) in the 56−104 cm size range.

Albacore caught by trolling around the New Zealand coast tend to be smaller than those caught by troll vessels from the U.S.A. fishing in the sub-tropical convergence zone, the only other surface fishery for the South Pacific albacore stock. Fish caught by longline throughout the South Pacific are all larger sub-adult and adult fish. Continued monitoring of the catch composition of juvenile albacore in the New Zealand troll fishery is a critical input to the length-based regional stock assessment of the South Pacific albacore stock. The New Zealand fishery catches up to half of the total removals of juveniles from this stock and is one of only a few target fisheries for this stock. Failure to monitor size composition in this stock would appreciably increase uncertainty of stock assessments.

Holdsworth, J.; Kopf, R.K. (2005). Characterisation of striped marlin fisheries in New Zealand. ***New Zealand Fisheries Assessment Report 2005/31*****. 63 p.**

Striped marlin (*Tetrapturus audax*) (Philippi, 1887) are found throughout the tropical and temperate Indian and Pacific Oceans. Much of what we know about the distribution, movement and possible stock status of striped marlin comes from catch records. Surface longline is the method responsible for almost all striped marlin commercial catch. Data from the Ministry of Fisheries and the Ocean Fisheries Programme (OFP) of the Secretariat of the Pacific Community (SPC) were used to describe tends in commercial longline catch, effort and CPUE for striped marlin in New Zealand fisheries waters and the wider southwest Pacific. The Japanese had the first and largest surface longline fleet and have keep records of catch and effort since first moving into the South Pacific in 1952. A relatively complete record of catch and effort for all fleets, aggregated by 5 degree square by month, for the tuna and billfish species is available as a public domain database from the SPC Ocean Fisheries Programme.

Japanese surface longline vessels start fishing around New Zealand in 1956 and their striped marlin catch and CPUE was initially high (2500 fish at 3.0 fish or more per 1000 hooks). The discovery of the lucrative southern bluefin tuna fishery shifted the focus of the Japanese fleet in New Zealand waters south. OFP data for the area around northern New Zealand (north of 35 ^{o}S) shows a declining trend in striped marlin CPUE in the 1950s and 1960s followed by lower catch rates and no clear trend.

There has been a fundamental change in the surface longline fishery in the New Zealand's EEZ partly as a result of the billfish moratorium introduced in 1987 and subsequent changes to fishing regulations which prohibit commercial fishers from landing marlin and other Istiophorid billfish. Foreign licensed distant water fishing vessels, mainly from Japan and Korea, have not fished in New Zealand waters since 1995. Four or five Japanese vessels are still chartered for a few months each year by a New Zealand company and a large number of smaller domestic surface longline vessels entered the fishery during the 1990s.

New Zealand commercial catch records commence in 1980. According to these the annual striped marlin catch was highest in 1982 at 2798 fish (275 tonnes). The recreational catch peaked in 1999 at 2368 fish (estimated 208 tonnes), with 67% of these tagged and released. The number of marlin caught in the southwest Pacific per season in the OFP database peaked at almost 80000 in 1954 but since 1964 it has fluctuating between 13000 and 40000 fish per year (annual mean 23000 sd 6500). Total longline fishing effort in the south west Pacific has been steadily increasing from around 20 million hooks per year in the 1950s to 174 million hooks in 2001.

Sea surface temperature appears to have a strong influence on striped marlin distribution. In New Zealand waters they prefer surface water temperatures of 20^{o}C to 23^{o}C, although occasionally fish are found in water down to 14^{o}C.

The highest striped marlin catch for the surface longline method is recorded in January-February while the highest recreational catch is in February and March. Longline records show that striped marlin have been caught in New Zealand waters in every month, with lowest catches in November and December and an intriguing spike in catch rates in October, particularly around the Kermadec Islands.

For many years recreational fishing clubs have kept catch records for pelagic gamefish. The Bay of Island Swordfish Club (BOISC) have made their catch records available which start 1924. These contain the date, weight and vessel name for each fish recorded. There is some evidence that the spread of surface longing into the south west Pacific Ocean had and effect on the size structure of striped marlin in the recreational fishery. Since 1960 there has been greater interannual variability in average weight and there has been a significant declining trend in mean weight from around 120 kg to 95 kg in the BOICS records. There is also a trend in the striped marlin weight distributions. The proportion of small and medium sized striped marlin (less than 100kg) has consistently increased in each decade since commercial fishing started and that trend appears to be continuing.

BOISC records show a sharp decline in the incidence of multiple striped marlin captures (more than one fish caught by one boat on a single day) in the late 1950s. If the proportion of multiple captures averaged over 20 seasons is used as a measure of relative fishing success then the recreational striped marlin fishery was nearly 3 times better in the 1940s and 1950s than it was in the 1960s and 1970s. The proportion of multiple captures has increased since 1988 (mean 30% of BOISC catch). Advances in fishing tackle, vessels and technology may contribute to this also some Bay of Islands boats started fishing the banks north of the Three Kings Islands in the late 1980s, where catch rates are generally higher than on the coast. Since then, the Three Kings fishery has become and important component of the New Zealand gamefish fishery.

Recreational striped marlin CPUE (fish per boat day averaged over the season) has been collected from east Northland charter boat skippers (excluding the Three Kings) for 27 years. CPUE has been consistently high (0.18 to 0.25 striped marlin/boat day) since the mid 1990s. It was also high in the early 1980s and more boats and fishers started targeting pelagic gamefish at that time.

Lengths of striped marlin (n = 622) caught in the New Zealand recreational fishery between 1985 to 1994 were used to calculate a length–weight conversion equation. The mean lower jaw fork length for all fish was 2373 mm (sd = 167 mm) and males (mean = 2310mm, sd = 158mm) were generally smaller than females (mean = 2417mm, sd = 163 mm).

Length at age data derived from a previous study (Davie and Hall 1990) were applied to the von Bertalanffy growth model and the following parameters were obtained: L_∞=3010 mm, K=0.22 annual, and t_0= -.04. These estimates should be treated with caution because the growth of striped marlin may not be well described by the von Bertalanffy curve and the length at age estimates are unvalidated.

Most striped marlin are tagged and released by vessels fishing off east Northland or the Three Kings Islands. Recaptures have been wide spread throughout the southwest Pacific Ocean but not beyond. The preliminary results of a project using pop-up satellite archival tags deployed on New Zealand striped marlin are discussed.

Striped marlin is the main target species for an important recreational and tourist fishery in northern New Zealand. Also they were a small but valued component of the commercial surface longline catch of foreign licensed vessels in the region until 1987. The billfish moratorium and subsequent regulations prohibit commercial fishers from landing striped marlin taken from New Zealand fisheries waters. This appears to have had a positive effect on recreational CPUE.

Smith, P. J., Diggles, B., and Kim, S. (2005). Swordfish stock structure. ***Final Research Report for Ministry of Fisheries Project SWO2002/01 Objective 1***

A preliminary trial was undertaken to determine if there are appropriate parasites in broadbill swordfish (*Xiphias gladius*) for testing residency hypotheses and stock relationships. The gills and guts of 34 swordfish, eight from New Caledonia, 10 from Queensland, and 16 from New Zealand, were examined for parasites. Three species of monogenean were found on the gills (*Tristoma adintegrum*, *Tristoma adcoccineum* and an unidentified capsalid); three species of nematode in the stomach (*Maricostula* sp., *Hysterothylacium* sp. A, and *Hysterothylacium* sp. B); two cestodes in the stomach and encysted in the mesenteries (*Pseudeubothrium* sp. and *Hepatoxylon* sp.); and one digenean in the stomach (*Hirudinella* sp.). Swordfish from New Caledonia were also examined for ectoparasites.

The parasite fauna of swordfish from the three areas was dominated by adult nematodes. The largest of the nematodes, *Maricostula* sp., showed differences in abundance among the three areas. The other two nematodes, species of *Hysterothylacium*, also showed significant differences between areas, but these adult worms may have limited application as a biological tag, reflecting short term feeding patterns of the host. Three parasites were identified that are potential markers of movement of swordfish between tropical and temperate waters. 1.) The digenean *Hirudinella* is likely to be a short lived parasite acquired in tropical areas. 2.) Larval cestodes of *Hepatoxylon* sp. are thought to be acquired in temperate areas. 3.) A pennellid copepod recorded in swordfish from New Caledonia, is likely to be acquired in tropical areas. This large ectoparasite is readily observed on whole swordfish, and presence/absence could be recorded by fishery observers, without the need for returning samples to the laboratory.

Griggs, L., Francis, M. P., and Ó Maolagáin, C. (2005). Growth rate, age at maturity, longevity and natural mortality rate of swordfish (*Xiphias gladius*). ***Final Research Report for Ministry of Fisheries Project TUN2003/01, Objective 3***

Age and growth of swordfish (*Xiphias gladius*) in New Zealand waters was studied from counts of growth bands on cross sections of the second ray of the anal fin. Fin samples were collected by Ministry of Fisheries observers working on tuna longline vessels. Observers also collected maturity data, and length-frequency data were obtained from the longline observer database.

Thin sections were cut from fin rays 1.5 times the condyle width above the fin base. Sections were read blind (without knowing the fish length) by two readers. Readability scores were poor, but slightly better than have been achieved elsewhere for swordfish. Age-bias plots showed that Reader 2 produced higher ages, with a mean difference of 0.8 bands between readers. This was largely due to a difference in interpretation of the first band. Interpretation was also difficult at the outer edge of rays from large fish, where there appeared to be a number of thin bands.

Both sexes had similar length-at-age up to about 6 years, after which there were few males. Other studies have shown that female swordfish grow larger and faster than males, with the growth curves diverging after about 3–4 years. Our results are consistent with that conclusion, but the paucity of males older than 8 years means that we could not demonstrate a significant difference between the sexes.

The greatest age estimated in this study was 15.3 years, but this probably underestimates true longevity because of the small sample size and the fact that the population has been fished. Longevity may be about 20 years in the south-western Pacific Ocean.

The best estimate of *M* using Hoenig's method may be around 0.2. The best Chapman-Robson estimate of *Z* is 0.25 (assuming full recruitment at 5 years). This suggests that *Z* is not substantially greater than *M*, and that fishing mortality is not high. This conclusion is preliminary, and needs verification.

Due to problems with the gonad staging scheme (i.e., the non-separation of immature and resting fish), and the paucity of data, it was not possible to determine length at maturity from our data. However, swordfish from eastern Australia reach 50% maturity at about 221 cm for females and 101 cm for males. These lengths correspond with ages of 9.9 years and 0.9 years respectively. Thus males mature at a very young age, and females mature at a moderate age. Based on the preliminary results from this study, swordfish appear to be moderately productive, having a moderate female age at maturity, moderate longevity, and moderate natural mortality rate (relative to other fish species). Almost all of the commercial catch of males is likely to be mature, but about two-thirds of the females, which are mainly 2–12 years old, are probably immature. Swordfish may spawn rarely in northern New Zealand waters, but most spawning likely occurs in subtropical and tropical waters further north.

Holdsworth, J.; Saul, P. (2005). New Zealand billfish and gamefish tagging, 2003–04. *New Zealand Fisheries Assessment Report 2004/00.* 30 p.

The gamefish tagging programme has been an integral part of the New Zealand marine sports fishery since the mid 1970s. The species that form the focus of the programme are striped marlin (*Tetrapturus audax*), mako shark (*Isurus oxyrinchus*), blue shark (*Prionace glauca*), yellowfin tuna (*Thunnus albacares*), and yellowtail kingfish (*Seriola lalandi)*. Worldwide there has been a growing trend toward the catch and release of large pelagic species hooked by recreational fishers. The collection of movement and, on occasion, growth information through cooperative tagging programmes with recreational fishers is a cost-effective way of collecting information on large pelagic species that are difficult to study by other means. However, in cooperative programmes, tagging may be spread over a long period and it is difficult to control the tagging event and quality of reporting.

Release and recapture data for the 2003–04 season (July to June fishing year) are summarised in this report and compared with those from previous seasons. Particular recaptures that provide growth or movement information of significance or interest are described.

This season 2419 fish were reported tagged and released and 237 late reports were added to those of previous seasons. The number of striped marlin (1019) and yellowfin tuna (186) tagged increased in 2003-04 compared to recent seasons. The number of mako and blue sharks tagged has been significantly lower than the long term average for the last two years.

A total of 52 recaptures were reported in the 2002–03 fishing season, including 32 yellowtail kingfish, 9 mako sharks, 4 striped marlin, and 2 blue sharks, 2 yellowfin tuna and one swordfish. Time at liberty ranged from one day for a kingfish at Channel Island to 3047 days (8years 4 months) for a 90 kg swordfish caught off Gisborne. Distance between release and recapture points ranged from less than 1 nautical mile, recorded for 12 kingfish, to 1330 nautical miles (2460 km) by a mako shark was recaptured off Vanuatu in October 2003.

This season data from 356 kingfish measured on release and recapture was supplied to NIWA to estimate growth.

Murray, T. (2005). The distribution of Pacific bluefin tuna (*Thunnus orientalis*) in the southwest Pacific Ocean, with emphasis on New Zealand waters. *New Zealand Fisheries Assessment Report 2005/xx*.

This report reviews information derived from catch and effort logsheets collected by the New Zealand Ministry of Fisheries and longline catch and effort data compiled by the Secretariat of the Pacific Community, Noumea, New Caledonia. These data are used to describe the distribution of Pacific bluefin (*Thunnus orientalis*) in comparison with southern bluefin tuna (*T. maccoyii*), both within the New Zealand EEZ and more broadly in the western and central Pacific Ocean. Pacific bluefin tuna, recognized as a distinct taxon from southern bluefin tuna, but previously regarded as a subspecies of bluefin tuna (*T. thynnus*), have been recognized as a minor component of tuna longline catches in the south western Pacific Ocean since the 1960s. These regular, but small catches of Pacific bluefin tuna (all by longline), began increasing dramatically with the expansion of the domestic longline fishery in New Zealand waters but apparently not elsewhere in the southwestern Pacific. Part of the reason for increasing catches of Pacific bluefin, stems from the increased ability of fishers to correctly distinguish between Pacific and southern bluefin tunas, and the decision by the Ministry of Fisheries that the two species be separated for quota monitoring purposes.

Reported catches of Pacific bluefin tuna increased exponentially from 1991 to 2002 to nearly 60 t (total landings). Catches have subsequently declined (40 t in 2003 and 54 t in 2004) due to fewer boats longlining and low market prices for all bluefin tuna species generally. Most of the catches within New Zealand waters are from FMA 1 and FMA 2, although catches are made throughout the EEZ. Although catches of Pacific bluefin tuna have been reported in all months, above average catch rates (higher than 1.07 fish per 1000 hooks) of Pacific bluefin tuna occur from April to July.

Cumulative frequency distributions of Pacific bluefin tuna catches indicate that Pacific bluefin range from the North Pacific probably as far south as 48.3º S (99.9% of all catches in the EEZ), although identity has only been confirmed genetically in Pacific bluefin caught as far south as 46.6º S. In contrast, southern bluefin appear not to be caught in New Zealand waters further north than 31.1º S.