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South Pacific Albacore Tagging Project: 2009 Summary Report

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Executive Summary

The first albacore tagging cruise for the EU-funded SCIFISH project was completed in early 2009. The main objective of the cruise was to tag albacore with conventional tags in an effort to obtain information on exploitation rates and movement. The cruise also provided the opportunity to conduct an experiment to validate the age of albacore derived from hard parts such as otoliths and spines. A New Zealand commercial troll fishing vessel was chartered to fish the west coast of the south island of New Zealand between January and March 2009. Overall, a total of 2766 albacore were tagged and released with 1457 of these fish also receiving an injection of oxytetracycline (OTC) for the age validation experiment.

There have been no recaptures of tagged albacore to date, but based on previous albacore tagging projects, the likelihood of any recaptures within a month or two after tagging is extremely low. Most tagged albacore would be expected to be recaptured between one and four years after being released, with the majority captured by the longline fisheries.

The second albacore tagging cruise for the SCIFISH project is scheduled for 2010. For this second cruise, albacore will be tagged in the subtropical front, east of New Zealand in an effort to spread the tagging effort across the south Pacific and to facilitate the mixing of tagged fish within the entire population. Albacore caught during this cruise will be tagged with conventional tags, and all tagged fish will receive an injection of OTC. A small number of pop-up satellite archival tags, which are capable of providing more detailed information on movement patterns, will be tested on some larger albacore captured during this cruise. In addition, the suitability of a genetic tagging method (genetag) will be explored by testing the effectiveness of different hook types for collecting genetic samples.

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1 Introduction

A significant fishery for south Pacific albacore has operated since the 1950's, with the majority of the historic catch taken by foreign longline fishing fleets such and Taiwan, Japan and Korea. Since the early 1990's, albacore have become an increasingly important species for the domestic longline fleets of Pacific Island Countries and Territories (PICT), which now account for nearly half the annual harvest (Langley 2006). The overall annual harvest of albacore has increased steadily from around 30,000 t in the 1990's to between 60,000 and 70,000 t in recent years (Hoyle et al. 2008). The majority of this harvest is caught by longlining, with a small proportion taken by troll fishing.

The most recent assessment of the south Pacific albacore stock (Hoyle et al. 2008) indicates that the stock size of albacore and the Maximum Sustainable Yield (MSY) is lower than predicted in previous assessments (Langley and Hampton 2005, 2006), but that the albacore stock is most likely currently not over-fished and current levels of catch are sustainable. However, the assessment also highlighted that there was still evidence of bias within the assessment, and considerable uncertainty about current levels of fishing mortality. Given the uncertainty in the results of the assessment and the less optimistic implications of the results than in previous assessments, Hoyle et al. (2008) strongly suggested that efforts to improve the model should be considered a high priority. In particular, independent estimates of fishing mortality (F) obtained from tagging studies were considered to be important for refining future assessments. In addition, further information on movement patterns and independent estimates of growth from tagging studies would also assist in refining future assessments (Hoyle et al. 2008).

Given the importance of albacore to the longline fisheries of PICTs, and the uncertainty in stock assessments, there have been increasing demands for more research to be directed at the species. In response, the Secretariat of the Pacific Community (SPC) Oceanic Fisheries Program (OFP) developed a project for south Pacific albacore in consultation with the Forum Fisheries Agency (FFA) Secretariat and member countries, which was funded by the 9th European Development Fund (Overseas Countries and Territories component). The project has a three year time frame and is designed around the need to reduce uncertainty in stock assessments and to provide better management advice both at the regional and national levels.

As part of this project, the OFP designed a tagging study with the overall objective to provide contemporary data for refining our knowledge of albacore movements, exploitation rates and population biology. The specific aims of the first year of tagging for the Albacore Tagging Project (ATP) were to:

1. Tag approximately 3000 albacore from the New Zealand surface troll fishery with conventional dart tags,

2. Inject approximately 1000 of these tagged albacore with oxytetracycline as part of an age validation experiment, and

3. Collect biological samples (otoliths, gonads and stomachs) from a subsample of retained albacore to support associated research on age, growth, reproductive biology and trophic ecology of albacore.

This report provides a summary of the first year (2009) of albacore tagging activities and some considerations for future albacore tagging efforts.

2 Methods

2.1. Tagging Cruises

Tagging albacore at tropical and sub-tropical latitudes (15°S - 25°S) is problematic, as albacore typically occupy deep habitats in these regions, are often in poor condition when brought to the surface, and are unlikely to survive once released. Tagging juvenile albacore, which can be captured near the surface at higher latitudes (30°S - 45°S), is more effective, as survival is likely to be much higher. In the south Pacific, surface troll fisheries exist around the coastlines of New Zealand, and in the high seas area east of New Zealand in the Subtropical Front (STF). For the first year of this project, albacore were tagged in the New Zealand troll fishery due to the large costs associated with chartering a suitable vessel to fish the high seas east of New Zealand. Albacore tagged at these latitudes, however, are expected to migrate into the sub-tropical longline fisheries over the next few years.

Tagging of south Pacific albacore occurred off the west coast of the south island of New Zealand between Cape Farewell in the north and Jackson's Bay in the south. A total of eight cruises of between four and nine days were completely between 12th January 2009 and 20th March 2009 (Table 1). A 74 ft commercial albacore troll vessel, the *F.V. Genesis*, was chartered as the tagging vessel throughout this period. The first cruise departed from Nelson, but all subsequent cruises departed from either Westport or Greymouth on the west coast of the south island. Two scientists were on board for each cruise, with at least one scientist from SPC. An observer from the New Zealand Ministry of Fisheries acted as a tagging technician on four cruises.

Table 1. Summary of 2009 albacore tagging cruises on board *FV Genesis*

Cruise No.	Dates	Departure Port	Cruise Leader	Tagging technician
1	12-Jan – 17-Jan	Nelson	Ashley Williams (SPC)	Sifa Fukofuka (SPC)
2	20-Jan – 26-Jan	Westport	Ashley Williams (SPC)	Steve Temple (MFish)
3	28-Jan – 01-Feb	Westport	Ashley Williams (SPC)	Steve Temple (MFish)
4	04-Feb – 12-Feb	Westport	Bruno Leroy (SPC)	Steve Temple (MFish)
5	16-Feb – 19-Feb	Westport	Sifa Fukofuka (SPC)	Michael Manning (SPC)
6	24-Feb – 01-Mar	Greymouth	Ashley Williams (SPC)	Brian Kumasi (SPC)
7	02-Mar – 09-Mar	Westport	Ashley Williams (SPC)	Brian Kumasi (SPC)
8	13-Mar – 20-Mar	Westport	Ashley Williams (SPC)	Steve Temple (MFish)

2.2. Fishing and Tagging Methods

Albacore were captured using typical commercial troll fishing gear that consisted of up to 22 fishing lines rigged with rubber skirted lures and barbless double hooks. The lures were trolled behind the vessel at speeds between 5 and 7 knots. Each line was connected via a rubber 'bungee' to one of four poles that extended off the port and starboard sides of the vessel or to the stern of the vessel, which provided some stretch in the line when a fish struck the lure. All fish were retrieved by hand to minimise the damage to fish that may occur if automatic hydraulic retrievers were used. Fishing commenced at first light before sunrise each day and ceased on darkness after sunset each day.

Albacore are rarely seen at the surface, so the general fishing area was chosen using a combination of historic fishing effort data for the vessel, current information communicated from other fishing vessels, bathymetry charts and sea surface temperature (SST) charts. Specific schools were usually located by fish striking the lures or visualised on an echo sounder. Once a school was located, the vessel would troll upwind and downwind across the school until the fish were no longer striking the lures. The vessel would then steam away to locate another school. The date, start and end fishing time, SST, troll speed, and location (latitude, longitude) was recorded for each school of albacore encountered.

The troll fishing gear used to catch albacore inevitably causes some damage to the fish, which may range from very minor mouth damage to significant head damage likely to be fatal. Consequently, every albacore that was landed was initially inspected to determine whether it was suitable for tagging or not. Albacore with injuries suspected to be fatal (e.g. gill, eye or significant palate damage) were not tagged, but were retained by the vessel for later sale. For the first five cruises, all albacore with minor injuries that were considered to have a good chance of survival were tagged. For the final three cruises, some of the albacore with more significant injuries were also tagged in an effort to provide some information on the effects of these injuries on survival.

The fork length of all albacore considered suitable for tagging was measured to the nearest cm (rounded down) on one of two purpose-built tagging cradles. Albacore were then tagged using conventional plastic tip 140 mm PDAT Hallprint™ dart tags. The tag was inserted using a stainless steel applicator just below the second dorsal fin at an oblique angle to anchor the barb between the pterygiophores. Each tag was inscribed with a unique five-digit number, contact details and reward amount for returning tags. Albacore were returned to the water head first as soon as possible after tagging. The tag number, fork length, condition of fish, and tagging quality was recorded on electronic voice recorders, later transcribed onto hard copy and entered into a database.

2.3. Oxytetracycline Experiment

The most reliable method for estimating the age of fish is by counting the number of increments in hard parts (otoliths, spines or vertebrae). However, this method is only reliable when the periodicity (e.g. daily, annual) in which the increments are deposited is known. For south Pacific albacore, this periodicity has not been validated, but is critically important to ensure accurate age estimates for parameter estimation and stock assessments. The most effective method to validate the periodicity of increment formation in hard parts is by an experiment involving the mark-recapture of chemically-tagged (e.g. oxytetracycline) fish (Campana 2001).

During this tagging cruise, a large proportion of tagged albacore also received an injection of oxytetracycline (OTC). One of the tagging cradles was designated solely for injecting albacore with OTC. These albacore received an approximate dosage of 25-50 mg/kg body weight of Oxytetra LA (200 mg/ml). The dosages varied due to the difficulties in administering precise doses to different sized albacore within a short time period. The OTC was administered using a 40 mm 18-gauge needle in an automatic syringe connected via a UV-resistant tubing to a 100ml bottle of Oxytetra which was kept in an insulated holder. OTC was injected deeply within the muscle tissue under the first dorsal fin. Fish injected with OTC received a white conventional tag with "keep whole fish" inscribed. All other fish that did not receive an OTC injection were tagged with a yellow conventional tag.

2.4. Hook Type Experiment

It became apparent during the initial cruises that a large proportion of fish landed were significantly injured and were not suitable for tagging. It was hypothesised that many of the significant injuries may be the consequence of using double, rather than single, hooks. Therefore, a short experiment was conducted to examine the effects of single and double hooks on the capture and condition of albacore.

Single hooks were made simply by cutting off one hook from each double hook. Single hooks were placed on five lines on the starboard side of the vessel, while double hooks were kept on the equivalent five lines on the port side of the vessel. These 10 lines were monitored closely over a period of six days during the second and third cruises. For each line, the number fish that struck the lure but were subsequently dropped (Dropped), number of fish that were landed with significant injuries that could not be tagged (Retained), and the number of fish landed that had minor or no injuries and were tagged (Tagged) was recorded. A Chi-square contingency test was used to analyse these data and determine whether using single hooks resulted in a greater proportion of tagged fish than using double hooks.

2.5. Tag Recovery Procedures

Considerable efforts have been made to publicise the project and establish tag recovery procedures in New Zealand. Further efforts will be made in other locations where tag recoveries are likely to occur in the following years. Tagging posters have been produced that provide information to finders on what information to collect, where to send the tags and the rewards that will be paid. Posters and letters were sent to industry and Government contacts in New Zealand and Australia, and published in key industry magazines in New Zealand. A Tag Recovery Officer has been appointed in New Zealand and Australia, to publicise the project, collect tags, extract otoliths from OTC injected albacore, pay rewards, and arrange for the tags, recovery data and otoliths to be sent to SPC. Rewards for reported recapture of tagged fish include 100USD for fish with a white conventional tag (injected with OTC), including provision of the whole fish, and 20USD for fish with a yellow conventional tag.

2.6. Tag Seeding

Current analyses of albacore tagging data in the south Pacific assume particular tag reporting rates for different fishing fleets, but there are currently no data to inform these assumptions. To provide some information on tag reporting rates for the New Zealand seafood processors, 20 albacore were seeded with tags during cruises 6 through 8. It was not possible obtain information on tag reporting rates of the fishers themselves, as it is not possible to seed fish with tags prior to fishers handling the fish on board. Therefore, the fish were tagged onboard after capture and prior to stacking in the ice holds. A total of 14 albacore were tag seeded on board the *FV Genesis* and a further 6 albacore on board the *FV Miss Otago* between 26th February and 19th March 2009. The fish ranged in size from 53cm to 72cm FL.

2.7. Biological Sampling

A suite of biological samples, including otoliths, gonads, stomachs, livers and muscle tissue, were collected during most cruises from albacore that were significantly injured and not tagged and released. These samples were collected to support associated research projects that are examining the age, growth, reproductive biology and the trophic structure of albacore. Priority was given to the size of fish from which samples were collected to fill existing gaps from previous sampling and to cover a large size range.

The lipid content of some albacore was measured using an electronic Fatmeter. The lipid content of fish is related to the water content of the sample, so by measuring the water content using a micro strip sensor on the Fatmeter, the amount of lipids can be inferred by conversion with the appropriate calibration. Calibration for albacore was built in to the device but muscle samples were collected for refining the calibration in the lab.

3 Results

3.1. Cruise Tracks

Albacore were tagged and released over a wide area along much of the west coast of the south island of New Zealand during the eight cruises (Fig. 1). However, most of the fishing and tagging effort was focussed in the areas north-west of Westport to Greymouth. The cruise tracks demonstrate that most tagging occurred parallel to the coastline, although albacore were tagged further offshore north of Westport than south of Greymouth.

3.2. Tag Releases

3.2.1. Release Numbers

A total of 2766 albacore were tagged and released between 12th January and 20th March 2009 (Table 2). More albacore were tagged during the last three cruises, when additional albacore with more serious injuries were also tagged, than during earlier cruises. The proportion of albacore that received an injection of OTC varied between cruises, but overall more than half (53%) of tagged albacore also received an injection of OTC.

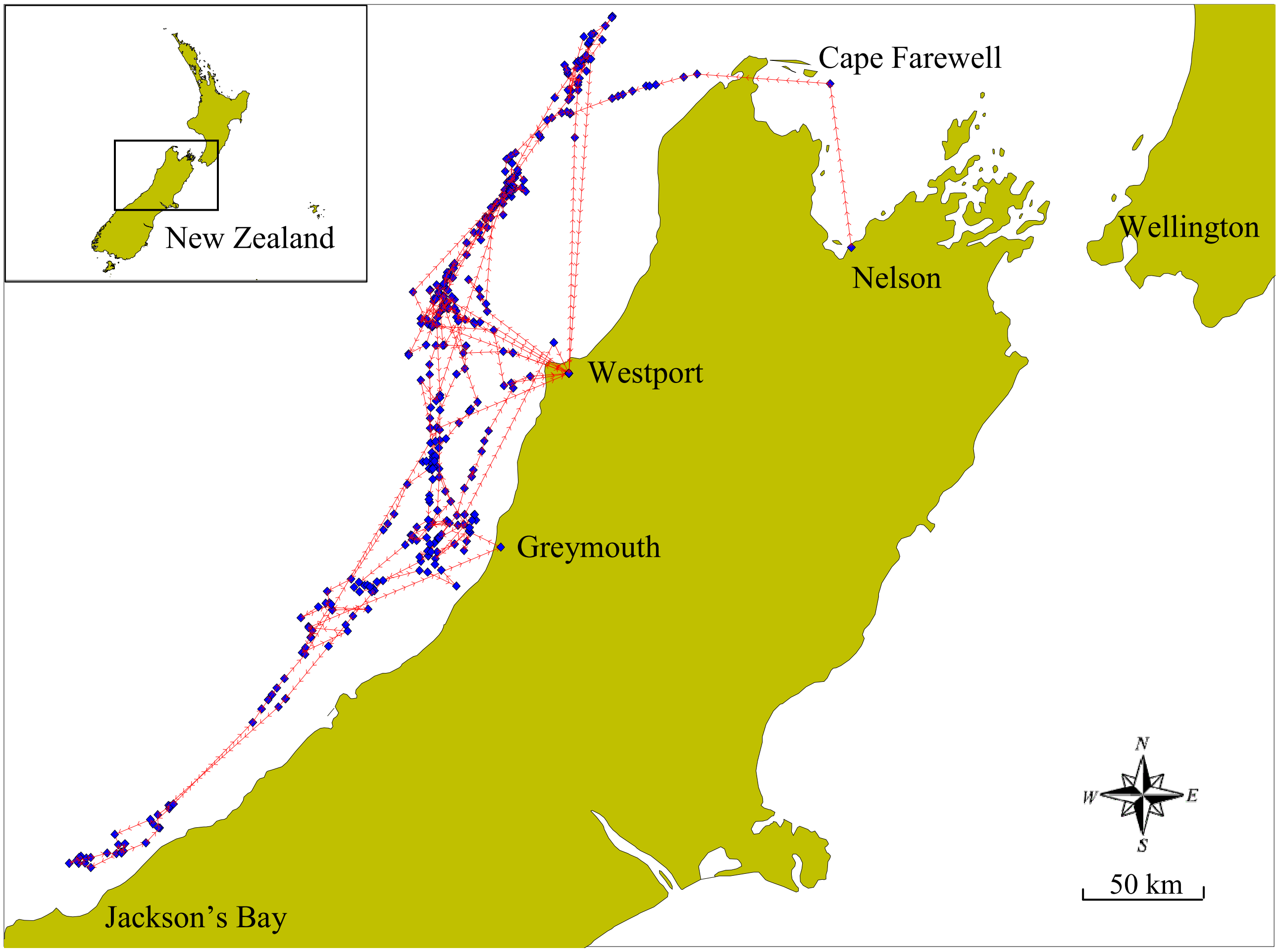

Fig. 1. Cruise tracks of FV Genesis (red line) during the Albacore Tagging Project (ATP) off the west coast of New Zealand between 12th January and 20th March 2009 with tagged school positions shown (blue diamonds).

Table 2. Number of albacore tagged during the eight cruises in 2009.

Cruise no.	Dates	Conventional tagged	OTC injected	Total tagged
1	12-Jan – 17-Jan	157	93	250
2	20-Jan – 26-Jan	143	220	363
3	28-Jan – 01-Feb	53	98	151
4	04-Feb – 12-Feb	121	163	284
5	16-Feb – 19-Feb	143	0	143
6	24-Feb – 01-Mar	187	170	357
7	02-Mar – 09-Mar	254	301	555
8	13-Mar – 20-Mar	251	412	663
	Total	**1309**	**1457**	**2766**

3.2.2. Spatial Distribution of Releases

Similar to the cruise track, most albacore were tagged from north-west of Westport to west of Greymouth (Fig. 2). The distribution of OTC injected albacore was relatively evenly spread across the tagging area, with approximately 40-60% of tagged albacore receiving an injection of OTC in most locations. There were no albacore injected with OTC in one location between Greymouth and Jackson's Bay, but the overall number of tagged albacore at this location was very small.

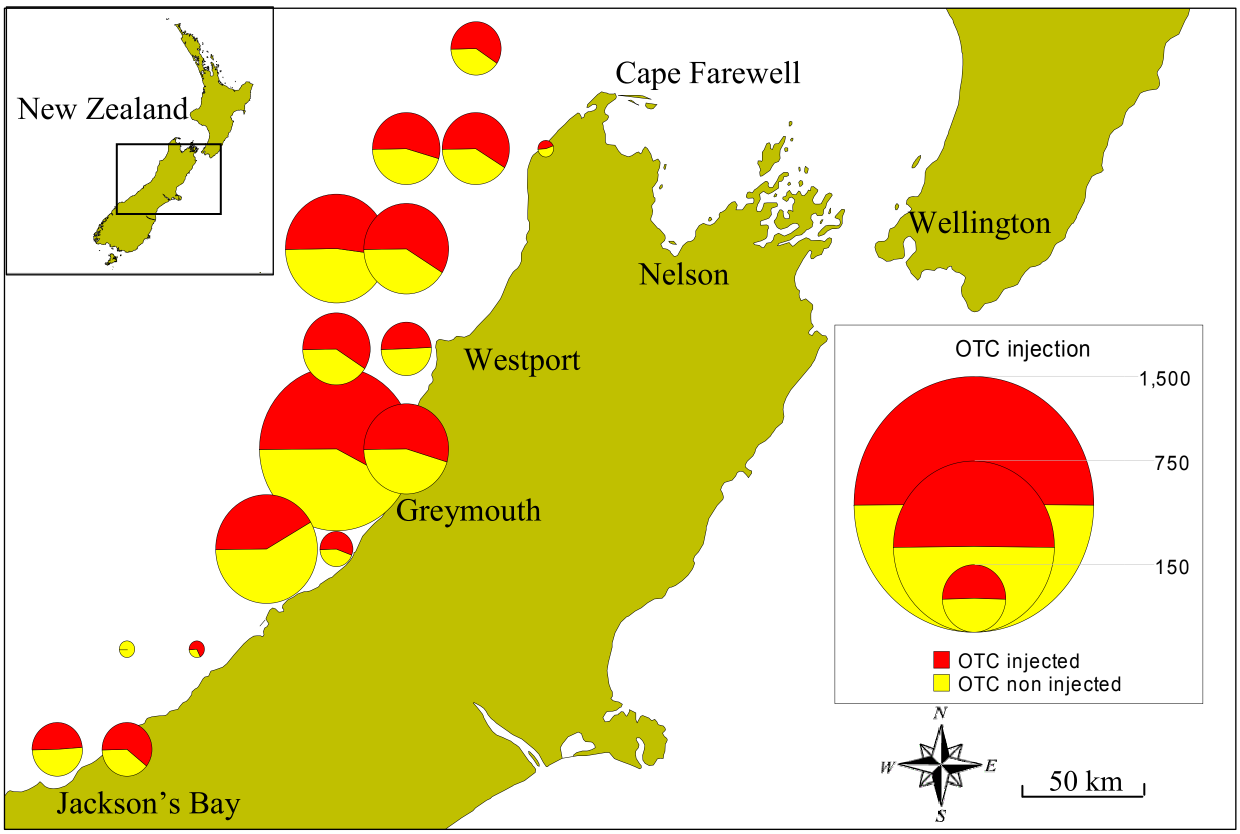

Fig. 2. Number of albacore tagged by 0.5 x 0.5° grids. Pie graphs indicate proportion of tagged albacore injected (red) or not injected (yellow) with oxytetracycline.

3.2.3. Releases by Sea Surface Temperature

Tagged albacore were caught within a relatively restricted sea surface temperature (SST) range (Fig. 3). No albacore were caught at temperatures less than 16°C or greater than 20.6°C. More than half (53%) of the albacore tagged were caught at a SST between 18 and 19°C, while 85% were caught between 17 and 19°C. This suggests that juvenile albacore have a restricted preferential SST range.

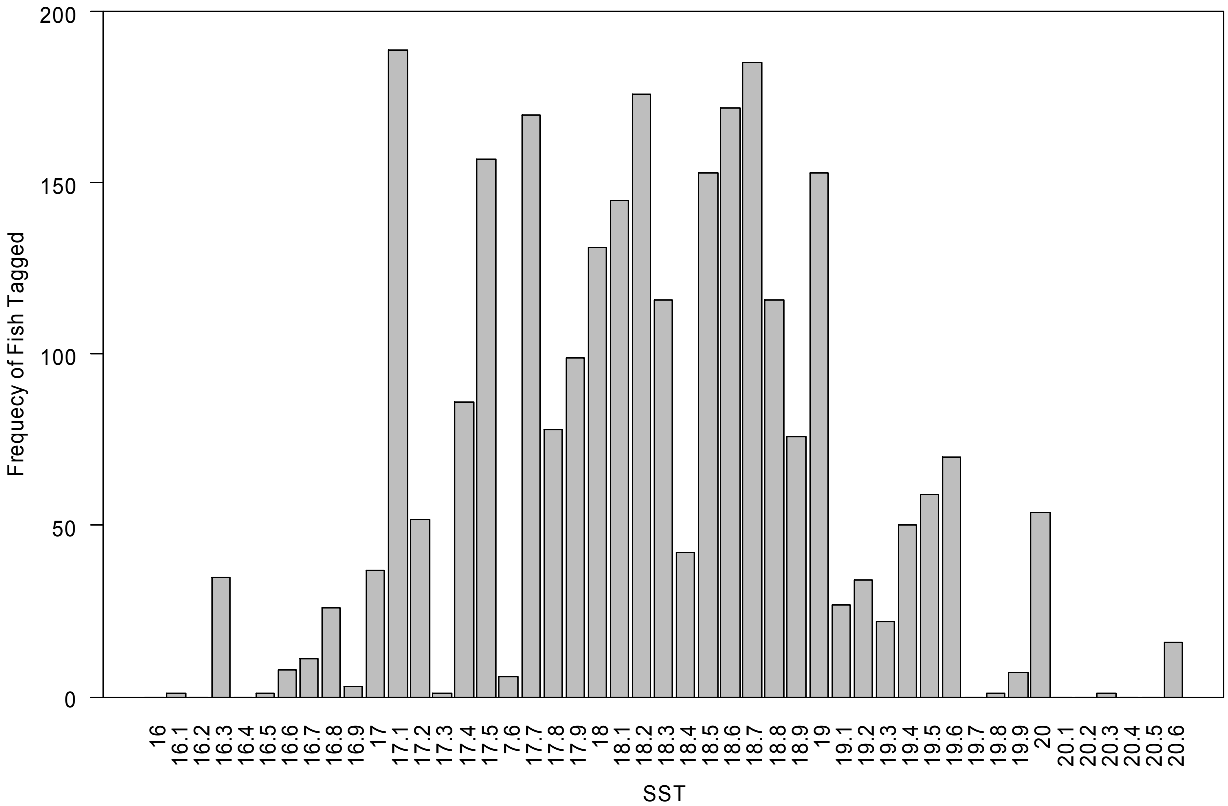

Fig. 3. Number of albacore tagged by sea surface temperature (SST, C°).

3.2.4. Length Frequency Distributions of Releases

The smallest and largest albacore that was tagged across all cruises was 44 cm and 100 cm FL, respectively (Fig. 4). There were three distinct modes in the length frequency distribution of tagged albacore at around 50, 60 and 70 cm FL. These modes most likely correspond to the 1, 2 and 3yo cohorts. Interestingly, the 60 and 70 cm modes dominated, while the 50 cm mode was very weak, for the first six cruises (Fig. 5). In contrast, the 50 and 60 cm modes dominated cruises 7 and 8, during which the 70 cm mode was much weaker. This is most likely due to the large number of small albacore encountered in a relatively small area west of Greymouth that was fished during cruises 7 and 8, and demonstrates the trend for albacore to travel in schools of similar sized fish.

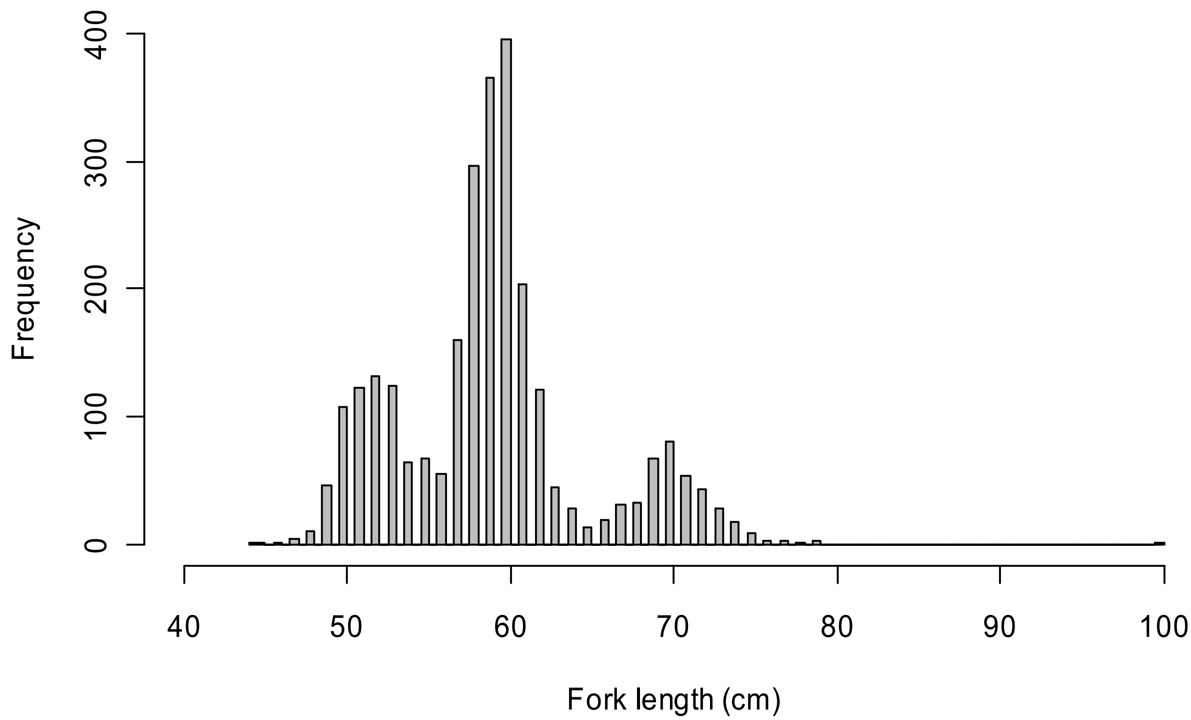

Fig. 4. Length frequency distribution of albacore tagged and released across all tagging cruises in 2009.

3.2.5. Tagging Rates

Many albacore were damaged in some way by the fishing gear. As a result, the tagging rates (% of fish landed that were tagged and released) were quite low (approx. 34%) for the first five cruises (Fig. 6), as only fish with minor or no injuries were tagged. The higher tagging rate for the first cruise is due to a learning process, whereby the taggers spent the first few days developing protocols for assessing and categorising the injuries to fish. For cruises 6 through 8, fish with moderate injuries were also tagged, including those with cuts on the palate (but with no obvious and significant eye damage), minor eye damage, injuries from being dropped on deck, or were on the hooks for an excessive amount of time before being retrieved. Consequently, the tagging rates for cruises 6 through 8 were higher (approx. 66%) than for previous cruises (Fig. 6). This approximate 2-fold increase in tagging rates was mainly due to the tagging of fish with minor palate damage or mouth damage during cruises 6 through 8 (Table 3).

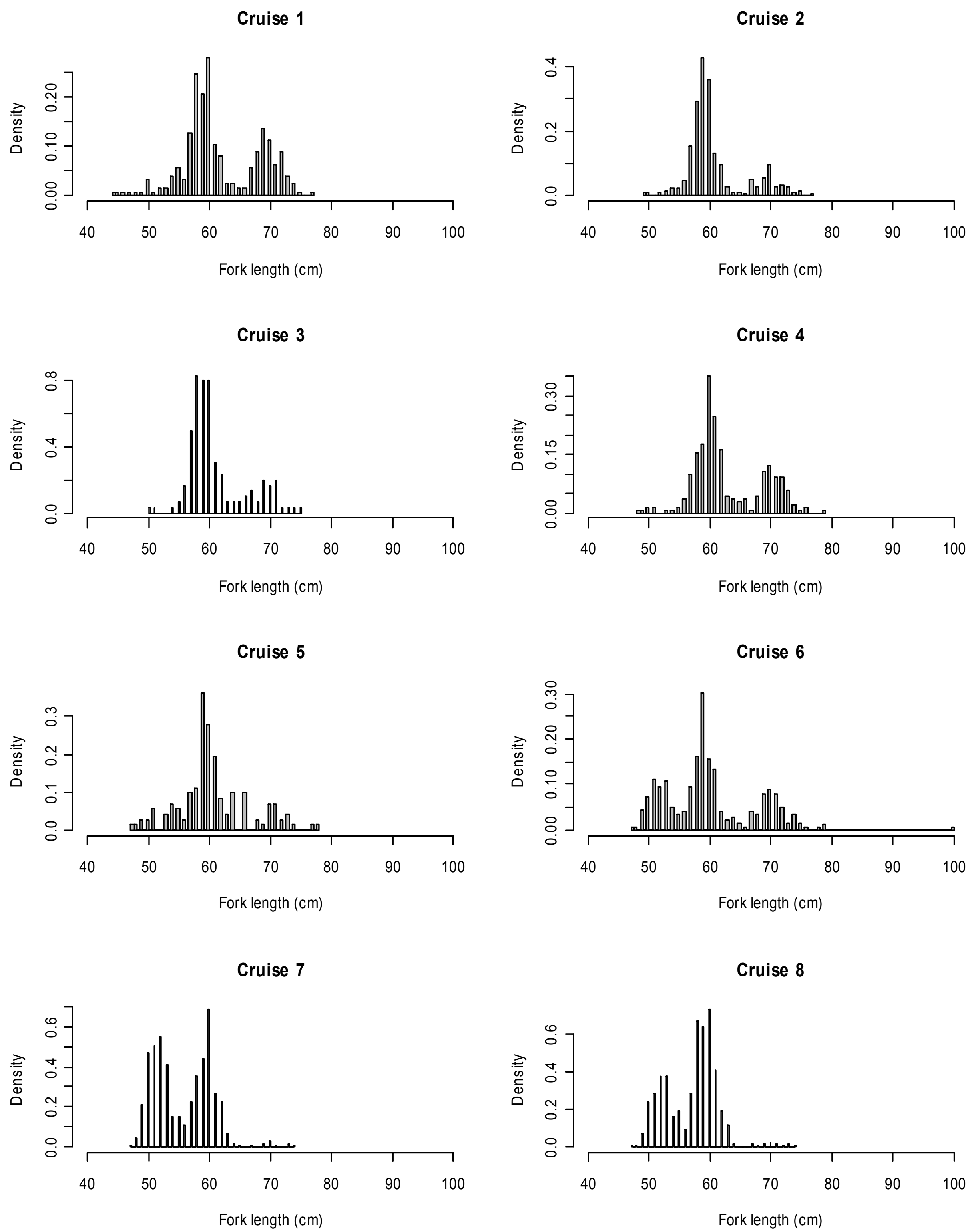

Fig. 5. Length frequency distributions of tagged albacore for each of eight cruises.

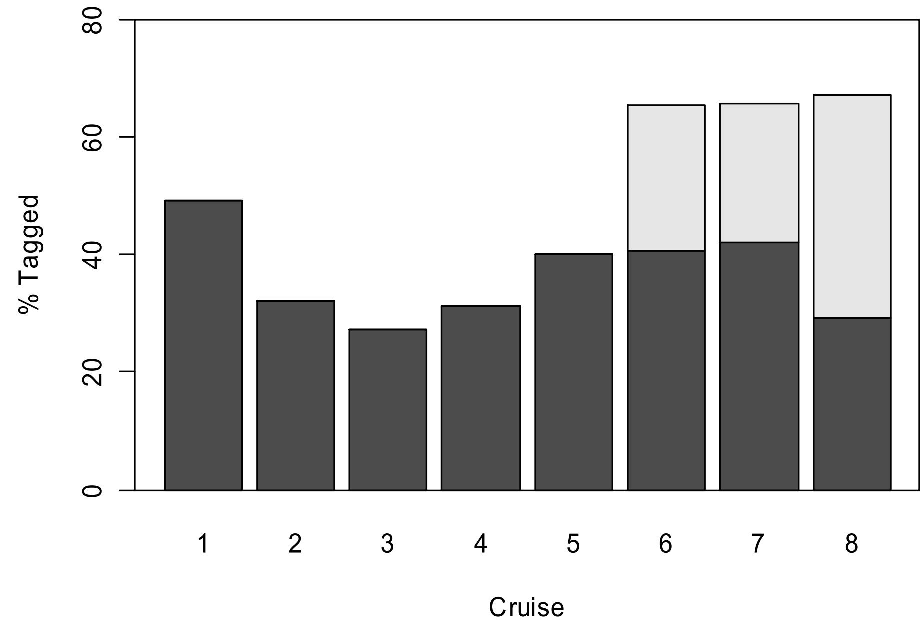

Fig. 6. Percentage of fish landed that were tagged for each cruise. Dark grey bars indicate the percentage of albacore with minor or no injuries, while light grey bars indicate the percentage of albacore with more significant injuries that were tagged during cruises 6 through 8.

Table 3. Number of albacore tagged and released in each condition category.

	Cruise number									
Fish Condition	1	2	3	4	5	6	7	8	Total	% of Total
Bleeding	17	33	13	47	5		1		116	4.2%
Dropped on deck	1	1				1	1		4	0.1%
Eye damage	1	1				4	1	11	18	0.7%
Good	209	296	105	151	111	72	144	199	1287	46.5%
Hit side of boat		1			2		1		4	0.1%
Long time on hook[1]						3	4		7	0.3%
Minor palate damage[1]						187	305	310	802	29.0%
Mouth damage	22	31	32	86	25	90	96	141	523	18.9%
Unknown			1				2	2	5	0.2%

[1] Albacore with these conditions were only tagged during cruises 6 through 8.

3.3. Hook Type Experiment

The number of fish dropped, retained or tagged varied considerably between single and double hooks (Table 4). The proportion of fish that struck the lure but were subsequently dropped was substantially higher for single hooks than for double hooks, while substantially more fish were retained from double hooks than for single hooks. This was not an unexpected result, as it was considered that double hooks would retain fish on the hooks better than single hooks, but are likely to cause more damage. The proportion of fish that struck the lure that were subsequently tagged was greater for single hooks (30%) than for double hooks (25%), but the difference was not statistically significant ($\chi^2 = 2.79$, p=0.09). That is, using single hooks does not result in a significantly greater proportion of tagged fish than using double hooks. Consequently, double hooks we used for the remainder of the cruises.

Table 4. Proportion of albacore that struck the lure that were dropped, retained or tagged using single and double hooks.

Hook Type	Proportion Dropped	Proportion Retained	Proportion Tagged
Single Hook	0.45	0.25	0.30
Double Hook	0.17	0.59	0.25

3.4. Tag Recoveries

There have been no reports of recaptured tagged albacore from the 2009 cruises to date.

3.5. Tag Seeding

A total of four tags from the 20 tag-seeded albacore have been officially reported to date (Table 5). Interestingly, these four tags were reported as being captured by a different vessel than they were tagged on. Furthermore, there was some error (positive and negative) in the reported lengths of two of these albacore at recapture.

Table 4. Summary details of reported recaptures of tag-seeded albacore

Date tagged	Vessel tagged	Fork length tagged	Date recapture	Vessel recapture	Fork length recapture
4/03/2009	Genesis	70	17/03/2009	Sea Legend	67
9/03/2009	Miss Otago	61	17/03/2009	Sea Legend	61
15/03/2009	Genesis	63	22/03/2009	Nordic	70
16/03/2009	Genesis	53	21/03/2009	Nordic	54

3.6. Biological Sampling

Samples of otoliths, gonads and stomachs were collected from a total of 67 albacore during cruises 1 through 7, while muscle and liver tissue, was collected from 61 of these fish (Table 5). No samples were collected during cruise 8. Biological samples were collected from albacore across a wide length range from 47 cm FL to 90 cm FL (Fig. 7). The fat content of 147 albacore was recorded from cruises 4, 6 and 7.

Table 5. Number of biological samples and fatmeter readings taken from albacore during cruises 1 through 7. No samples were collected from cruise 8.

Cruise	No. Otoliths	No. Gonads	No. Stomach	No. Muscle	No. Liver	Fatmeter
1	8	8	8	2	2	
2	18	18	18	18	18	
3	8	8	8	8	8	
4	5	5	5	5	5	124
5	1	1	1	1	1	
6	18	18	18	18	18	13
7	9	9	9	9	9	10
Total	**67**	**67**	**67**	**61**	**61**	**147**

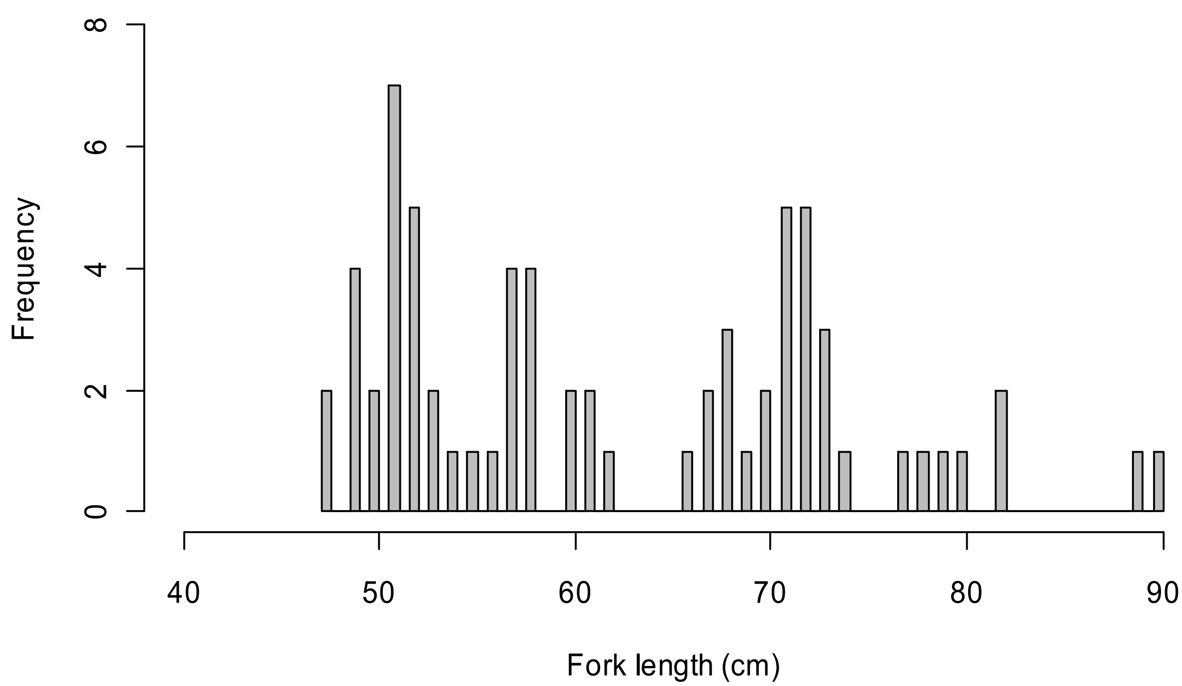

Fig. 7. Length frequency distribution of albacore from which biological samples were taken during cruises 1 through 7 of the ATP project.

4 Conclusions

Overall, the 2009 albacore tagging cruises were successful in achieving the intended objectives. Although the initial target of 3000 tagged albacore was not quite reached, the 2766 albacore tagged can be considered a good outcome considering the very low catch rates experienced by all fishing vessels in the 2009 season compared to catch rates in recent years. The number of albacore tagged in the 2009 season also compares very well with previous tagging efforts in the same region which have managed to tag around 2750 albacore over 6 seasons between 1986 and 1992 (Labelle 1993). Furthermore, the rationale behind setting the target as high as 3000 tagged albacore was to attract interest from vessels with higher catch rates for the charter. The expectation was that a total of no more than 1500 tagged albacore was more likely, based on previous tagging efforts in New Zealand.

The 1457 albacore injected with OTC was more than anticipated (1000), which increases the probability of returns of OTC-injected albacore and will strengthen the results from the age validation experiment. The number of albacore from which biological samples were collected was quite low relative to the number of landed albacore that were not tagged and released. This was mainly due to the ongoing priority to tag fish, rather than to collect biological samples, and the frequent poor weather that created excessive vessel movement for extracting biological samples.

The absence of recaptured tagged albacore to date was not unexpected. Based on previous albacore tagging projects, the likelihood of any recaptures within a month or two after tagging is extremely low (Labelle 1993). Most tagged albacore would be expected to be recaptured between one and four years after being released (Labelle 1993, Bertignac et al. 1996, Langley and Hampton 2005) and potentially some recaptures after 10 or more years (Langley and Hampton 2005).

The results from the tag seeding experiment suggest that tag reporting rates for seafood processors are likely to be substantially less than 100%, although only a small number of fish were tagged. It is likely, however, that the large majority of recaptures will be identified by the fishers themselves, as they handle each fish individually several times before offloading. It is unclear whether fishers are more or less likely to report a tagged fish than a processor. Therefore, uncertainty remains in the tag reporting rates for south Pacific albacore. Furthermore, the errors in length measurements of recaptured fish suggest that using tag recapture data to provide an independent estimate of growth may introduce significant error or biases.

The larger proportion of albacore tagged during the last three cruises, which included fish with moderate injuries, may provide some useful information for future albacore tagging. Currently, there is no information for albacore on the effects of various injuries on the probability of recapture. Based on a preliminary analysis, S. Hoyle (unpublished data) demonstrated for tropical tunas that some particular conditions (e.g. eye damage) resulted in decreased probability of recapture, assumed to be due to increased mortality. This information was used as a basis to inform the tagging protocols for albacore in this project, but information gained from this tagging project may provide the first species-specific information for albacore.

The hook type experiment also provided some useful information for future albacore tagging using troll fishing gear. It was initially thought that using single hooks would result in fewer injuries to albacore and, therefore, a greater number of fish could be tagged. We were unable to detect a statistically significant difference in the number of fished tagged from using double or single hooks. Furthermore, it should be noted that the higher proportion of dropped fish on single hooks may result in higher mortality of fish that are not landed.

5 Considerations for Albacore Tagging in 2010

5.1. General Approach

The current plans for the SCIFISH Albacore Tagging Project are to conventionally tag albacore to the east of New Zealand in the Subtropical Front (STF) during the 2010 albacore season. The STF is a near circum-global area of converging subtropical and subantarctic water masses. In the south western Pacific Ocean, the STF is typically located between approximately 35° and 45°S (Orsi et al. 1995). The area east of New Zealand in the STF was selected as a location to spread the tagging effort across the south Pacific and to facilitate the mixing of tagged fish within the entire population. The distance east of New Zealand that this tagging occurs, however, needs to be considered carefully, as the further east activities are undertaken, the greater the required vessel capacity and consequently charter costs.

Historic recapture rates for albacore tagged in the STF (mainly within the area bounded by 35°S - 47°S and 170°W - 130°W) during the late 1980's and early 1990's were very low (~1.4%, Bertignac 1996, Langley and Hampton 2005). However, there has been a substantial increase in the size of the south Pacific albacore fishery since this time, particularly the longline fisheries of PICTs (Hoyle et al. 2008), which may result in higher recapture rates of recently tagged albacore than were experienced previously. In the north Pacific, where the albacore fisheries are somewhat larger than in the south Pacific, the recapture rates have been approximately 5.5% (Bertignac et al. 1999). Consequently, we should not expect recapture rates for south Pacific albacore to exceed 5%, even with the recent increase in effort. Based on the total number of tagged albacore during this project (2766), we might expect to see between 38 (1.4%) and 138 (5%) recaptures.

It seems reasonable to expect to tag a similar number of albacore per day to the east of New Zealand in the STF as was tagged on the west coast of New Zealand, but ultimately it would depend on catch rates. Previous albacore tagging projects in the STF in the 1990's have reported landing a similar number (0-337) of albacore per day as was experienced on the west coast of New Zealand (1-266). Therefore, it is likely that up to 3000 albacore could be tagged during a 50 day cruise to the east of New Zealand in the STF, which is likely to yield an additional 42 (1.4%) to 150 (5%) recaptures.

At temperate latitudes (35°S – 45°S), much larger albacore are caught using surface longline gear than trolling (Griggs 2004). Consequently, future tagging activities could involve the use of both gear types thereby allowing a larger size range of individuals to be tagged. Tagged albacore in larger size classes would enter the longline fishery earlier than those in smaller size classes. Assuming minimal tag-induced mortality, the tagging of larger size classes would also increase the size of the sample entering the longline fishery, as tag loss due to natural mortality would be reduced.

Using surface longlines to catch larger albacore would have the additional benefit of providing the opportunity to collect biological samples from larger fish than are available from trolling. The size at maturity for albacore is currently thought to be around 80-85 cm FL (Farley and Clear 2008). The majority of the catch from the subtropical longline fleets is >80 cm FL, and from the temperate troll fisheries is <80 cm FL. Therefore, it has been difficult to obtain a single sample of albacore across the size range at maturity from one fishery and, consequently, it has been difficult to obtain a reliable estimate of size at maturity (Farley and Clear 2008). Using the combination of trolling and surface longlining techniques provides the unique opportunity to sample albacore across this size range.

5.2. Tagging Methods

5.2.1. Conventional tagging

Despite the low recapture rates of conventionally tagged south Pacific albacore, there remains some value in increasing the number of tagged albacore that have been released and spreading the releases over a broader area and across a larger range of sizes. Therefore, in 2010, albacore captured by trolling or surface longlining will be tagged with conventional tags using the same approach used in 2009. During the 2010 cruises, however, *all* albacore that are tagged with conventional tags will receive an injection of OTC. This will greatly increase the number of released albacore that have been marked with OTC and increases the probability that a greater range of ages can be validated.

5.2.2. Satellite Pop-up Archival Tags

Recent technological advances have seen the miniaturisation of satellite pop-up archival tags (PSAT). The new generation PSATs are now suitable to use on tuna as small as 80 cm FL. There are several potential advantages of tagging albacore with PSATs. Firstly, there is no need to recapture the tagged fish to obtain information on fish movements. This is particularly relevant to albacore, as recapture rates are typically very low. Secondly, PSATs provide detailed information on the fine scale movements, which is currently lacking for south Pacific albacore. Finally, PSATs would provide information to help resolve important questions raised by several PICTs about the potential residency of albacore within PICT EEZs and the nature of the assumed annual north-south migrations.

Tagging adult south Pacific albacore (>80 cm FL) has been briefly attempted during two studies around Samoa with conventional tags (T. Lewis unpublished data) and American Samoa with PSATs (Domokos et al. 2007). Both of these studies used relatively deep-set longline techniques to land albacore. None of the albacore tagged by Lewis (unpublished data) were recaptured, and of the 6 albacore tagged by Domokos et al., none survived more than 16 days. These results indicate the high mortality of adult albacore caught in deep water using longlines.

An alternative location to capture and tag adult albacore with PSATs is in the STF (~40°S, ~175°E – 180°E) where they are found closer to the surface. In this region, the size of albacore caught by surface longlines (mean = 80 cm, 99th percentile = 56 – 104 cm FL) is significant larger than those caught by trolling (mean = 63 cm, 99^{th} percentile = 47 – 81 cm) (Griggs 2004). These larger fish turn up to the east of New Zealand between about April and July (after the west coast troll season) and many are likely to be suitable for tagging with PSATs as they are caught relatively close to the surface (15-40m depth) and may not suffer the same injuries as those fish caught from deep-set longlines.

Funding is currently being sought to cover the cost of purchasing approximately 20 Microwave Telemetry miniature X-Tag PSATs. Dependant on the success of acquiring this funding, the suitability of PSATs for tagging albacore will be tested during the 2010 cruises. Larger albacore (>80 cm FL) caught by surface longlining to the east of New Zealand in the STF will be selected for tagging with PSATs. During the initial stages of tagging, 10 large albacore will be released with PSATs. Some of these tags will be programmed to release after a short period of time (days to weeks) to assess the success of attachment and release of the tags. If this initial phase is successful, a further 10 PSATs will be deployed nearer the end of the cruise. These tags will be programmed for longer attachment to provide a longer period of movement history.

5.2.3. Genetag

Genetag is a method of tagging fish that is analogous to conventional tagging. Genetagging involves collecting a small tissue sample from each fish using specialised hollow-pointed hooks that allow a sample to be taken when the fish strikes the hook or lure. Each tissue sample is then analysed and used as a unique tag for each fish. Tissue samples are then taken from fish that are landed by the fisheries when returning to port and are analysed to find matches to the 'tagged' fish. Genetag is potentially a much more powerful technique than conventional tagging for estimating exploitation rates (and movements), as it avoids any assumptions about tag reporting rates, tag induced mortality and tag shedding, all of which are major uncertainties for south Pacific albacore. The technique works best when fish are unloaded to a small number of ports, as is the case for south Pacific albacore, where genetic samples can be taken from a significant proportion of the catch.

A preliminary assessment of the application of the genetag approach will be conducted during the 2010 albacore tagging cruise. A range of different style genetag (biopsy) hooks will be tested on troll lines and longlines to determine the most suitable and efficient hook type for each fishing method. A small number of genetic samples will also be retained for evaluation of genetic loci for south pacific albacore and to assess the sample type and quality obtained from genetic tissue samples. This preliminary assessment will provide the groundwork to support and provide guidance for future applications of gentagging for albacore.

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