

**Patagonian Toothfish Tag-recapture
Program Update Report: June 2016 –
July 2020**



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1. Introduction

The Falkland Islands Patagonian toothfish longline fishery was certified as compliant with the Marine Stewardship Council (MSC) Fisheries Standard on 06 March 2014, and recertified in November 2018, effective until 04 November 2023. With the original certification came the voluntary 'condition' of enhancing the current knowledge on stock discrimination for toothfish in the south western Atlantic. The stock discrimination condition was addressed in collaboration with the Falkland Islands Fisheries Department (FIFD) through several methods recommended by an independent review from the National Institute of Water and Atmospheric Research Ltd (NIWA, New Zealand) of stock discrimination tools (Parker, 2015). Based on these recommendations, a tag-recapture program was launched in June 2016. The primary aims of the program were to improve our understanding of the movement patterns of toothfish within the region; and to quantify the amount of exchange taking place between adults on the northern and eastern slope, and the spawning grounds on the Burdwood Bank. Based on this, an objective of tagging 3000 Patagonian toothfish over the subsequent 3 year time period, ending December 2019 was devised.

The aim of this report is to provide an update on the status of the tag-recapture program during the first phase of implementation. An overview will be provided on the preliminary results achieved during both the tagging (quantities, areas and length distribution of tagged fish) and recapture (quantities, movements and times at liberty) components of the program. Given that the initial aim of tagging 3000 fish during the preliminary 3 year time period has been achieved; this review will be used to provide recommendations on the development of protocols and guidelines for the next medium term (3 to 4 year) phase of the tag-recapture program.

2. Materials and methods

2.1. *Tag deployment*

Tag and release work was undertaken by scientific staff onboard the licensed longliners CFL Gambler and CFL Hunter during research surveys and commercial fishing operations between June 2016 and July 2020. Four research surveys (Pulsed tagging Cruises) took place during the study period which involved the specific objective of tagging large numbers of toothfish across the study area during a limited time period. The original tagging protocol was developed during an initial survey in June 2016 (Randhawa and Lee, 2016) and has

since been refined and updated during subsequent surveys in June/July 2017 (Randhawa *et al.*, 2017), February 2018 (Farrugia and Keningale, 2018) and November 2018 (Farrugia *et al.*, 2018). In addition to the pulsed tagging surveys, Scientific Fisheries Observers have been tasked with the objective to tag an average of 25 toothfish per week during their trips onboard the longliner.

Fish used for tagging were carefully measured to the nearest cm (total length TL) on purpose-made PVC stretchers and tagged using external dart tags (Floy tag & Manufacturing inc, USA). Fish were tagged in the dorsal musculature below the posterior dorsal fin spines and the barb of the tag was locked behind a pterygiophore. Care was taken while handling each fish. All fish were examined for suitability prior to selection and release to minimise mortality.

3. Results and discussion

3.1. Tagging

A total of 3541 toothfish have been tagged since the inception of the tagging program in June 2016. The majority of these took place during research surveys (84.6%) compared to the deployment of tags by observers (15.4%; Table 1). Numbers of toothfish tagged steadily increased over the first three years of the program, however in the absences of research surveys these numbers have declined over 2019 and 2020. Nearly 70% of the total toothfish tagged took place during 2018 alone, the majority of which was undertaken during the two research surveys in June (n = 1161) and November (n = 828), respectively. Despite the overall decline in numbers of toothfish tagged since 2018, the numbers tagged by scientific fisheries observers has remained stable.

Table 1: Numbers of toothfish tagged and released during pulsed tagging surveys and by Scientific Fisheries Observers according to year.

Year	Survey	Observers	Total
2016	407	34	441
2017	600	87	687
2018*	1989	203	2192
2019	0	127	127
2020	0	94	94
Total	2996	545	3541

Tagged toothfish were distributed evenly across the study area (Figure 1). The greatest quantity of fish (n=1588) were tagged along the eastern slope (-50° to -53.5° S) extending into the Falklands Trough to the south east of the Falkland Islands. An additional 903 fish were tagged on the slope to the north east of the Falkland Islands (-50° to -48° S). A total of 1044 toothfish were tagged across the slope waters of the Burdwood Bank (-50° to -55.5° S) which is considered the only spawning area for toothfish in Falkland Islands' waters. The length frequency distribution of tagged toothfish was fairly uniform throughout the three areas (Figure 2). Fish tagged along the eastern slope had a modal length of 98-99 cm and ranged from 57 to 167 cm TL (mean = 100.89 cm). To the north east, tagged fish ranged from 57 to 160 cm (mean = 100.29 cm) with a modal length of 99 cm. Fish tagged on the Burdwood Bank were slightly smaller overall with a modal length of 93 cm, ranging between 55 and 160 cm.

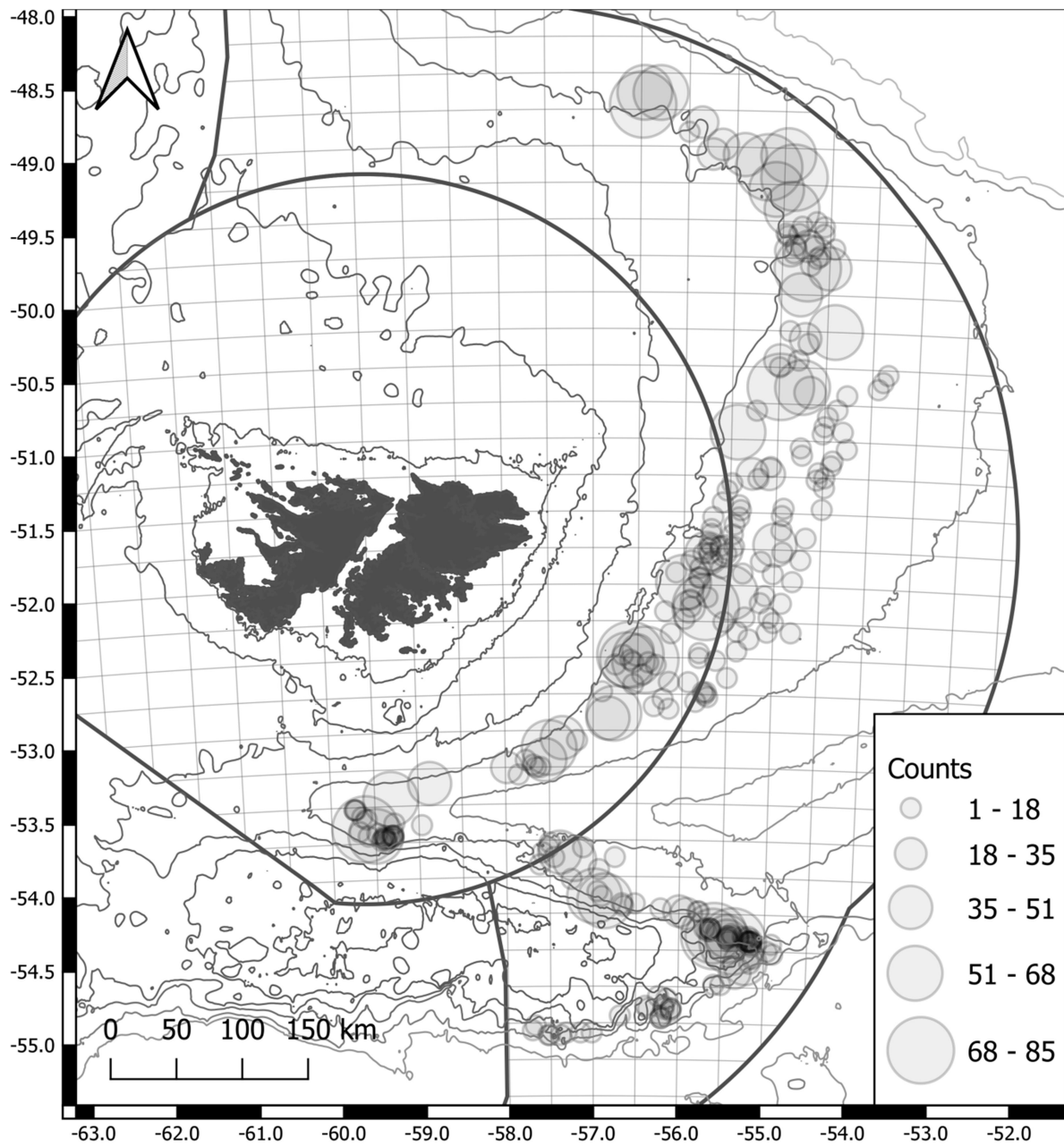


Figure 1: Distribution of toothfish tagged around the Falkland Islands between June 2016 and June 2020.

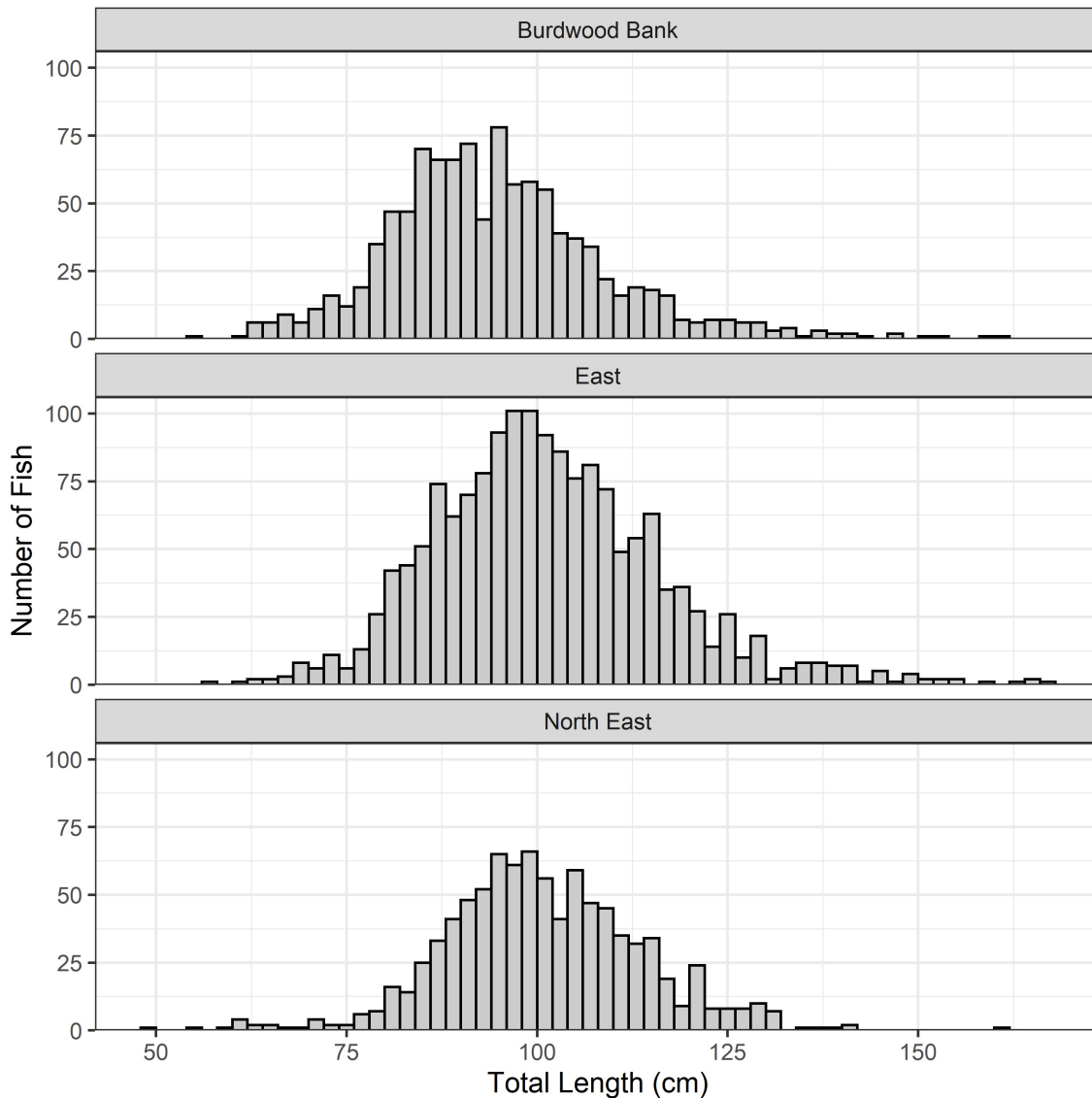


Figure 2: Length distribution of fish tagged and released on the Burdwood Bank, and the slope to the east and north east of the Falkland Islands.

3.2. Recaptures

A total of 133 toothfish have been recaptured since the inception of the tagging program in the Falkland Islands, indicating a recapture rate of 3.76%. Of the recaptures, length data was recorded for 125 toothfish. The modal length of recaptured fish was 106 cm (mean = 107.86 cm) and ranged from 78 to 152 cm (Figure 3). Time at liberty ranged from 22 to 1339 days (0.06 - 3.67 years) with an average of 526.06 days (1.44 years).

Due to the life-history characteristics of the species and the presence of shallow depth contours, movement distances are likely to be significantly greater than those measured in preliminary results. Overall the average (straight line) distance travelled by recaptured

toothfish was 87.66 km, ranging from one fish that was recaptured in the exact same location as tagging, to an individual undertaking a 1263.25 km migration. Movement patterns of recaptured toothfish remained consistent irrespective of the number of years spent at liberty (0-1, 1-2, 2-3, or 3-4 years between tagging and recapture). Overall, 40% of the recaptured toothfish were recaptured within 10km, and 75% from within 40 km of the location of tagging. Just over 15% of the recaptured fish, although still largely remaining within the general area within which they were tagged, had recorded movements of between 40 and 200 km. (ie. Fish tagged and recaptured on the Burdwood Bank, eastern, or north eastern slope). A relatively small number of toothfish (10%), were observed undertaking large scale movement patterns into different areas of the Falkland Islands or regions of the south western Atlantic waters. Large-scale movements included five toothfish migrations from the eastern or northern slope to the Burdwood Bank, four fish that were tagged on the Burdwood Bank that were recaptured on the Scotia Shelf, and five individuals that were recaptured in waters of southern Chile. Of significance is that none of these large scale movement patterns have been observed occurring in a northerly direction, possibly indicative of single direction migratory behaviour into their southern spawning areas.

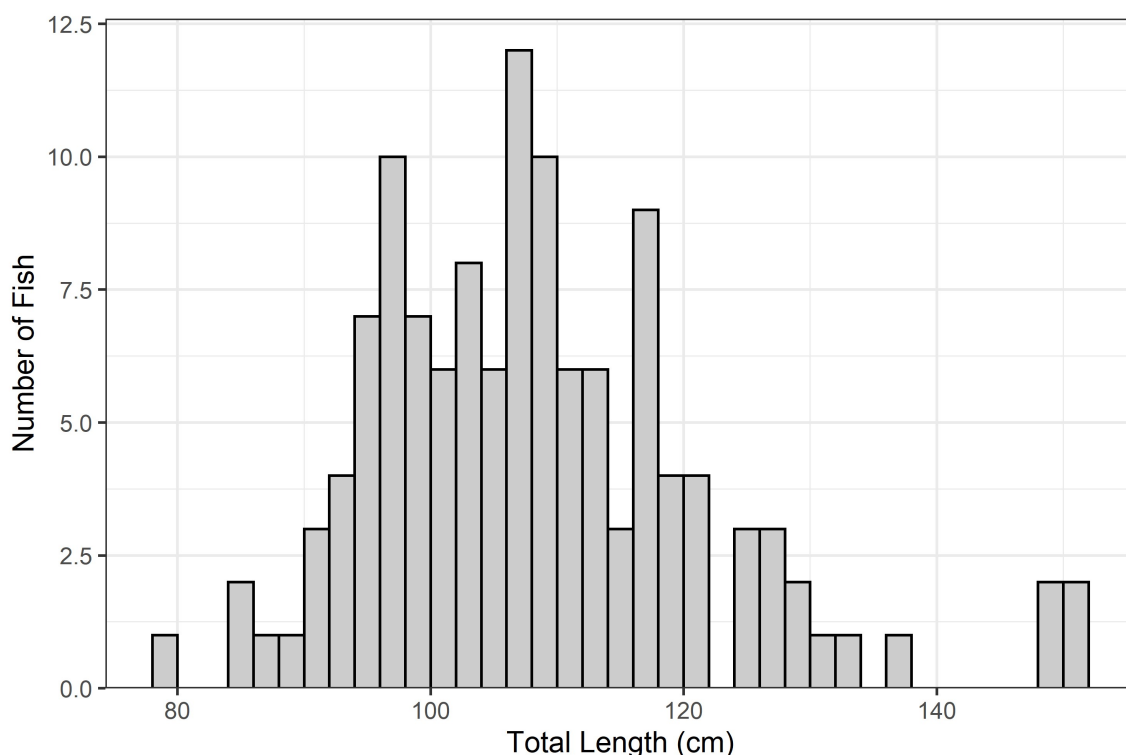


Figure 3: Length distribution of recaptured toothfish from across the study period (n = 133).

Of the 133 recaptured toothfish, 59 (44.36%) were captured within the first year of being tagged (Figure 4). The majority of these fish were recaptured within close proximity to the

area within which they were tagged with 39% having recorded movements of less than 10km, 60% less than 20km and 75% of less than 40km. Just over 15% of the recaptured fish, although still largely remaining within the general area within which they were tagged, had recorded movement patterns of between 65 and 200 km. The remaining 10% of the fish undertook largescale movement patterns. These larger scale migrations involved a single fish migrating from the eastern shelf to the Burdwood Bank (297 km), and two fish undertaking migrations from the Burdwood Bank across to the Scotia Shelf (161.5 km and 375 km). Three individuals were recorded having undertaken migration of well over 1000 km, having been tagged in the Falklands Trough, the eastern slope and the north eastern slope of the Falkland Islands, and recaptured in southern Chilean waters.

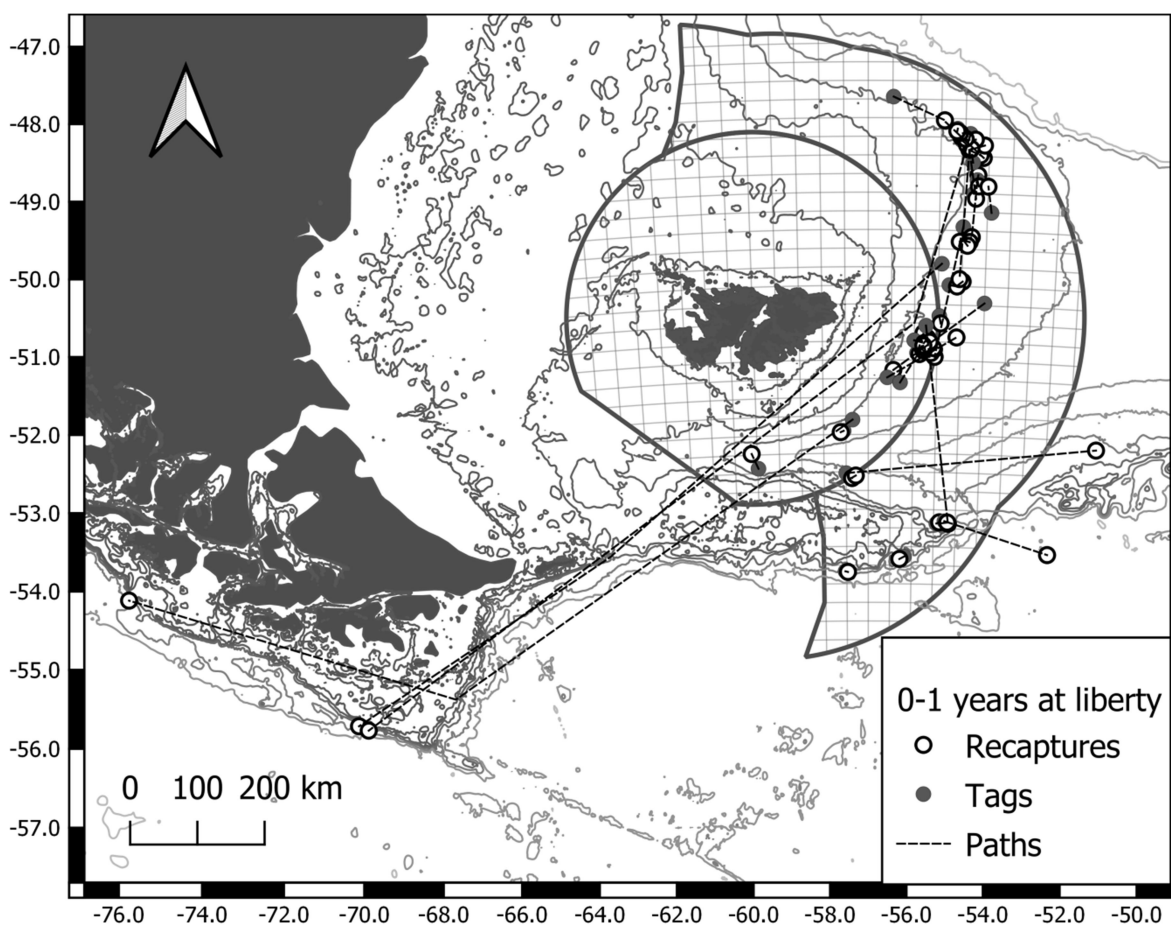


Figure 4: Map displaying the location of tagging, recapture and the most direct path between these two points for recaptured toothfish that had been at liberty for less than one year ($n = 59$). The straight line path was adjusted for two of the toothfish recaptured off southern Chile to prevent movement taking place across land.

A total of 32 individuals were recaptured after spending between one and two years at liberty (Figure 5). The patterns for these individuals were similar to those at liberty for 0-1 years

with 47% recording movements of less than 10 km, 59% less than 20 km and 84% of the toothfish being recaptured within 40 km of their tagging locations. Medium scale movements of between 57 and 105 km were observed for two individuals recaptured within the same general location on the slope to the east of the Falkland Islands. Three of the recaptured toothfish (9.4%) displayed larger scale migration patterns with distances travelled of at least 270 and 380 km. Two of these fish that were tagged in the same location on the north eastern slope of the Burdwood Bank were recaptured 270 km away on the northern edge of the Scotia Shelf. A single toothfish that was tagged on the slope to the east of the Falkland Islands was recaptured in January 2020 on the southern slope edge of the Burdwood Bank, 630 m deeper compared to the location of tagging. This particular individual had a total length of 149 cm, making it the largest toothfish recaptured during the program thus far.

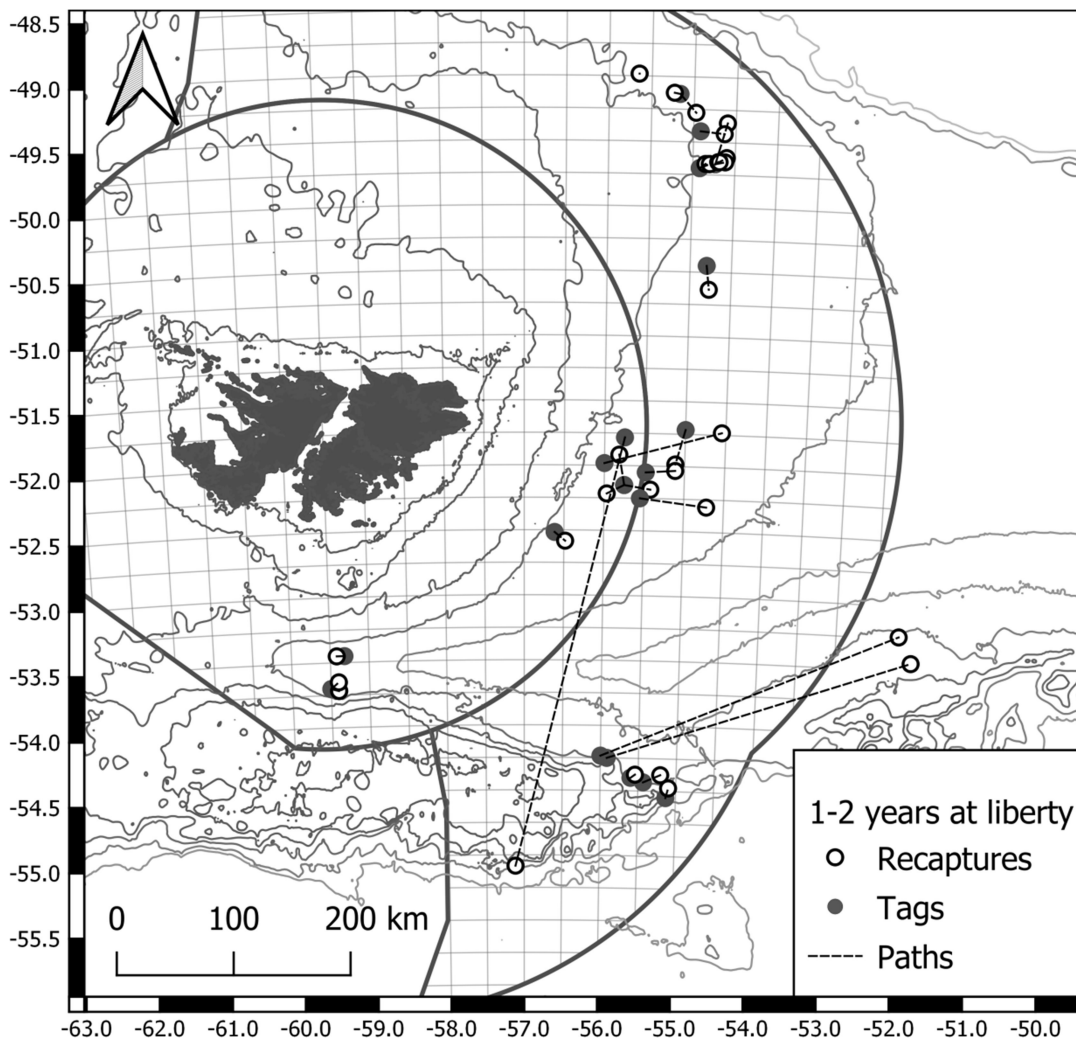


Figure 5: Map displaying the location of tagging, recapture and the most direct path between these two points for recaptured toothfish that had been at liberty for between one and two years ($n = 32$).

The patterns of movement for toothfish that had been recaptured between two and three years after being tagged ($n = 32$) continued to follow the trends depicted above, with 48% and 68% of individuals not having moved by distances greater than 10km and 40km respectively (Figure 6). A further six individuals travelled greater distances of between 40 and 160 km, with recapture locations being recorded within the same general region as which the fish were tagged. Four individuals (12.5%) were observed undertaking large scale migration patterns into different regional areas compared to where they were tagged. Two toothfish of 110 and 111 cm TL that were tagged on the slope to the north and south east of the Falkland Islands were recaptured 164 and 595 km away on the eastern edge of the Burdwood Bank. A further two toothfish of 109 and 118 cm TL that were tagged on the slope to the east of the Falkland Islands were recaptured 894 and 1021 km away off the southern tip of Chile.

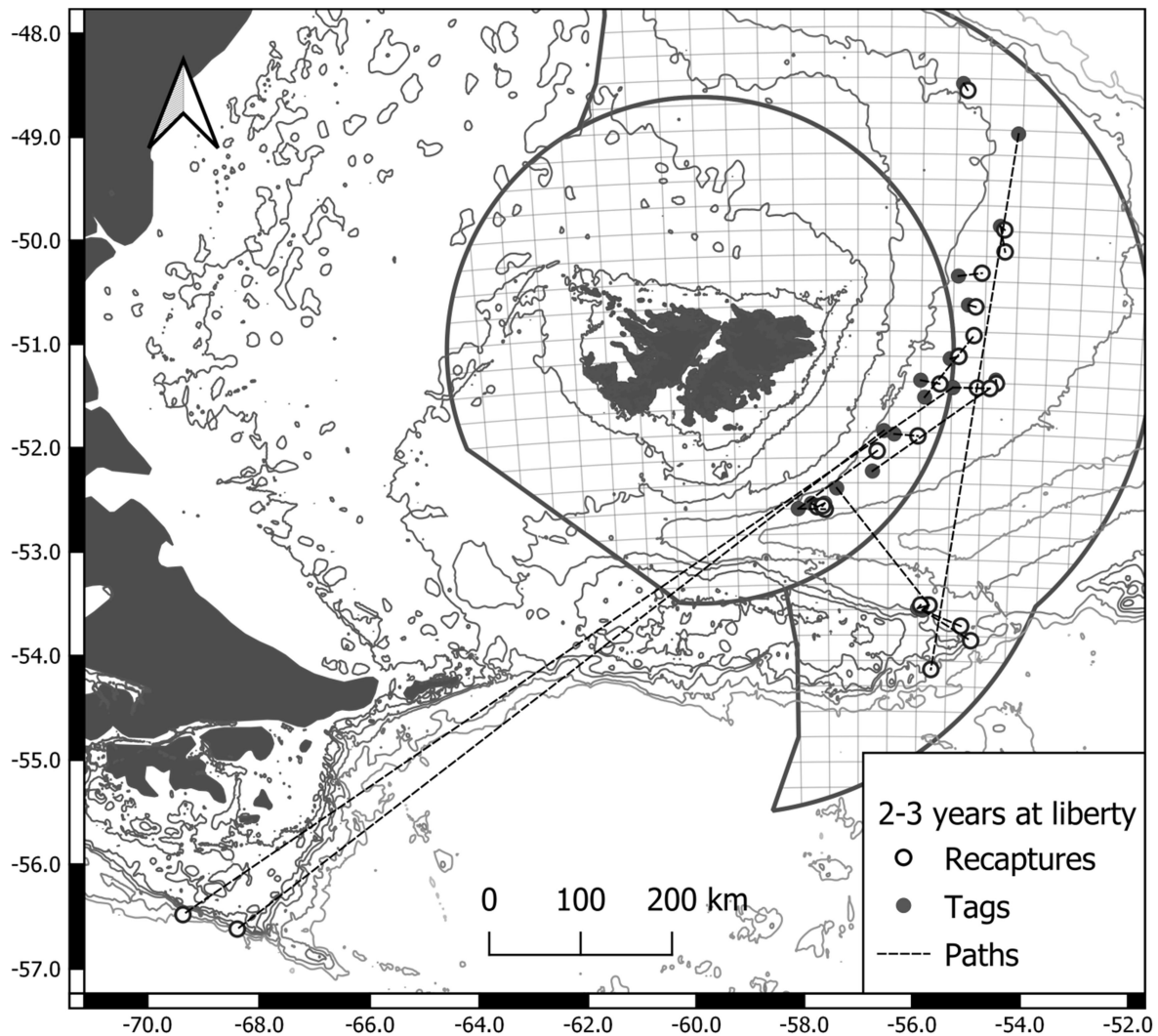


Figure 6: Map displaying the location of tagging, recapture and the most direct path between these two points for recaptured toothfish that had been at liberty for between two and three years ($n = 32$).

A total of 10 toothfish were recaptured that had been at liberty for greater than three years. Of these, 70% were recaptured within 40 km of the location of tagging. A further two individuals showed medium scale movements of up to 65 km, yet remaining in the same general location as tagging to the east of the Falkland Islands (Figure 7). A single toothfish of 113 cm undertook a large-scale migration of 620 km from the tagging location on the north-eastern slope to the southern slope edge of the Burdwood Bank.

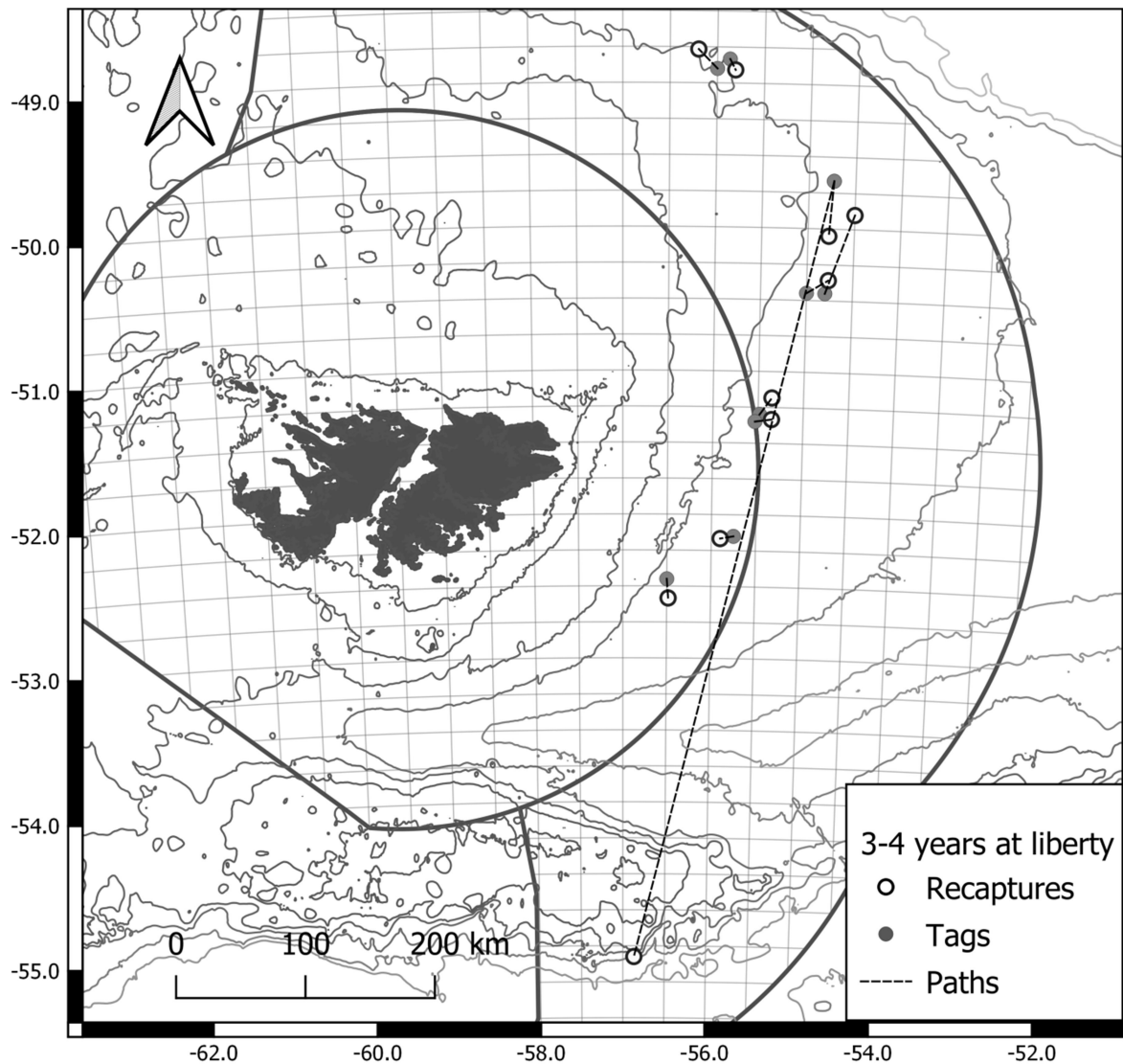


Figure 7: Map displaying the location of tagging, recapture and the most direct path between these two points for recaptured toothfish that had been at liberty for more between three and four years.

4. Recommendations

The toothfish tagging program was initiated in June 2016, with the initial objective for the deployment of 3000 tagged toothfish. The current set of guidelines and protocols for the program that were developed and refined over the study period have been shown to be effective, providing a high quality data set. Recapture rates have remained high during the course of the program and consistent patterns are beginning to emerge from the data. Once analysed these may provide valuable insights into the stock structure and movement patterns of Patagonian toothfish in the south western Atlantic. The success of the program during the first phase of implementation has largely been reliant on an initial large number of

toothfish being tagged during annual research surveys. During the second phase of the program, the need for a transfer of effort towards the observer program is reflected in the following recommendations.

4.1. *Revision of medium term objectives*

It is advised to revise the medium term objective to a tagging target of between 700 and 1000 toothfish per year over the next medium term (3-4 year) study period. This will lead to the deployment of a further 2000 to 3000 tags prior to the MSC recertification period on 04 November 2023.

4.2. *Scientific Fisheries Observers: Protocols*

According to the current protocols, Scientific Fisheries Observers are required to tag fish during the first 15 min of at least one line per day with the intention of tagging 25 fish per week. It is intended for this protocol to continue during the next phase of the program.

4.3. *Scientific Fisheries Observers: Monitoring*

Numbers of toothfish tagged by scientific fisheries observers at sea has been low during the first phase of the tag-recapture program. It is therefore recommended that a discussion forum should be set up amongst the relevant scientific staff of the FIFD to (1) identify why so few tags are being deployed during fisheries observer trips and; (2) devise and implement a strategy to ensure that the updated objectives can subsequently be achieved. This will be through:

- The review, update and consolidation of protocols for FIFD staff being tasked with tagging fish at sea.
- A review and upgrade of the tagging equipment to ensure that fisheries observers can achieve their objectives independently and with confidence at sea.
- Ensuring that FIFD staff has been adequately trained to independently undertake the required protocols with confidence while at sea.
- The development of procedures to monitor the numbers of toothfish being tagged by observers during a trip on a weekly basis, so that any issues can be identified and resolved on a short-term basis.

4.4. *Research surveys*

It is recommended that a pulsed tagging protocol should be included as an objective on further research surveys undertaken on the CFL Hunter. While the bulk of annual tagging effort should be transferring over to the Scientific Fisheries Observers, a secondary objective of tagging 400 toothfish per year on any research survey should be used to fill in gaps and ensure that the overall tagging objective can be achieved.

4.5. *Scientific Fisheries Observers: targeted trips*

In the absence of research surveys during a given year, it may be a requirement for observers to undertake focused tagging trips to address shortfalls in tagged toothfish numbers during a given year. Any such trips will be undertaken in consultation with CFL prior to protocol development and implementation.

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