

Initial results of satellite linked archival tagging in the Patagonian toothfish (Dissostichus eleginoides Smitt, 1898) around the Falkland Islands.

Judith Brown^{1,2}, Paul Brickley¹, Beth. E. Scott² and Alexander Arkhipkin¹

¹Falkland Islands Government Fisheries Department, PO Box 598, Stanley, Falkland Islands.

²University of Aberdeen, School of Biological Sciences, Tillydrone Ave, Aberdeen, UK, AB24 2TZ

Understanding the movements of Patagonian toothfish is an essential component of their fisheries management. As only one demersal longline vessel participates in this fishery in Falkland's waters, over a vast slope area, the use of conventional tags to provide data on migration and stock assessment is not viable. In contrast, archival pop-up tags have enabled the examination of toothfish movements without having to recapture tagged individuals with reasonably high success rates. A total of 16 toothfish >132cm L_T were tagged between 19/09/2007 and 7/08/2009 on the north-eastern part of the Falkland Islands' slope and northern and eastern slopes of the Burdwood Bank. The data from 9 tags that successfully released and uploaded data contradicted a hypothesis concerning the extent of migrations between their spawning and feeding grounds. Instead, the data revealed strong site fidelity, with five toothfish moving less than 50km from their release position over a 6 month period. In addition four individuals were found to move 100km or more from the south of the Burdwood Bank to the north of the bank or out towards the Scotia Ridge and one individual moved 126km north-westwards on the feeding grounds. Furthermore, our data revealed that toothfish undertake vertical migrations with movements ranging between 8 – 584m over six hourly periods. During the Austral summer three fish moved into deeper waters and one of these returned to shallower waters during the following autumn. The results of these data have made it necessary for us to re-examine the spawning behaviour of toothfish in the south Atlantic.

Keywords: Archival pop-up tags; Patagonian toothfish; spawning migration, diurnal migration, Falkland Islands.

Contact author: Judith Brown, Falkland Islands Fisheries Department, P.O.Box 598; Stanley, FIQQ 1ZZ; Falkland Islands [tel: +500-27-260, fax: +500-27-265, e-mail: jbrown@fisheries.gov.fk]

Patagonian toothfish is a deepwater long lived species that is fished commercially around the Falkland Islands. With only one demersal longliner operating in Falkland's waters and a vast slope area the number of fish that would need to be tagged and released with conventional tags would not be viable. Archival pop-up tags allow for

the examination of toothfish movements as well as giving insight into their behaviour without requiring retrieval of the tagged fish.

Tagging of toothfish with floy tags has been done around Heard Island (Williams *et al* 2002) and it was found that 734 fish remained within 28km of their release point. Four fish, however, moved much greater distance with three fish moving over 1850km to Crozet Island and one fish moving over 390km to Kerguelen.

The aim of this study was to investigate the hypothesis that toothfish migrate from their feeding grounds in the North of Falklands waters to the spawning grounds on the south and east of the Burdwood Bank and on the Scotia Ridge.

Twenty Wildlife Computers Limited Mk10 – Popup Archival Tags (PAT) were used during this study. A 63mm x 17mm flat titanium dart (made by Wildlife Computers) is used to tether the tag to the fish and this is attached to the Mk-10 by high strength clear 1mm diameter monofilament fishing line which passes through the attachment link on the tag. The attachment link is corrodible and activates either at a pre-programmed release date or when the Mk-10 determines the fish is dead (tag stationary for greater than preset time – set at 48 hours). The fishing line passes through an RD1800 release device which has a mechanical guillotine activated by water pressure (overcomes internal support and causes centre of device to snap downwards) when depths exceed 1800m which will cut the fishing line and release the tag from the tether.

Data was programmed to be summarised in histograms in 6 hourly bins and was collected in 14 predetermined bin ranges. Temperature bins were set at 0, 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 5, 6, 7, 8 and >8°C. Depth bins were set at 0, 500, 600, 700, 800, 900, 1000, 1100, 1200, 1300, 1400, 1500, 1600 and >1600m. These depth bins were selected to provide the highest resolution at the depths the fish were expected to spend most of their time.

Tagging was carried out during commercial fishing trips and experimental research trips onboard the CFL Gambler, however the vessel was asked to set specific lines for the purpose of tagging. This involved setting traditional Spanish longlines rather than the “umbrella” system as the nets were thought to damage the scales of the fish during hauling and therefore they would be less suitable for tag and release. Tagging trips were targeted in two separate areas, in the north of the Falkland Islands Outer Conservation Zone (FOCZ), and one tag on the north of Burdwood Bank, in the expected feeding grounds of toothfish (eight tags deployed in March 2008 and five in April/May 2009) and in the south of the FOCZ along the south of Burdwood Bank during the spawning season (two deployed in September 2007 and five in August 2008). The lines were set at depths between 750-1460m to prevent immediate activation of the RD1800. Only fish over 130cm L_T were tagged (to withstand the tagging procedure) and as well as the satellite tag the fish were injected with an appropriate dosage of Oxytetracycline (20mg OTC per kilo) and secondly tagged with a floy tag. The tagging procedure took on average five minutes and fish length, floy number, tag number, OTC dose, station number, release date and time, release depth and release position (from the vessels global positioning system) were noted along with any specific comments. If any whales were seen during a line being observed

with the intention of tagging, the tagging was abandoned for that line due to the risk of losing the tagged fish to predation.

Of the two tags recovered in the north on the feeding grounds one (Tag 86852) had moved only 10.9km and the other (Tag 77215) had moved 126.8km heading north westwards (Figure 1). Position data from eight fish (7 tags and one fish recaptured with only its floy tag) was obtained from fish which had been released on the south of the Burdwood Bank. Of these four had moved less than 50km from their release position (1.9, 5.4, 15.2 and 48.1km); two had moved out towards the Scotia Ridge (281.9 (Tag 77209) and 417.2km (Tag 86847) (Figure 1)) and one had moved to the north of the Burdwood Bank (129km). Using depth data, bathymetry of the area and start end positions it is possible to estimate the routes of the toothfish. Three tags were on the surface for a few days before they recorded a pop-up position, however, using surface drift patterns from the other tags it is possible to identify a likely end position and migratory route.

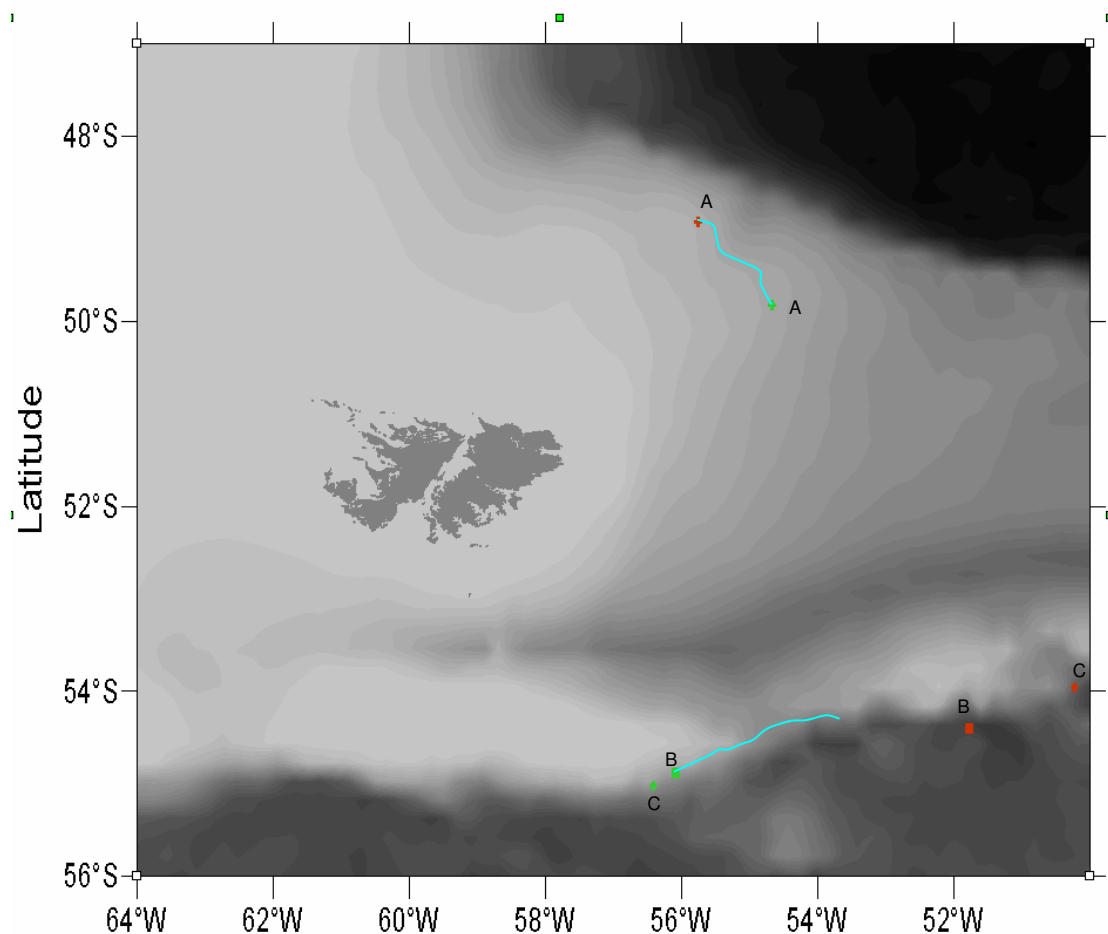


Figure 1: Deployment (green) and pop-up (red) locations of three tags. A - Tag 77215, B – Tag 77209, C - Tag 86847 (positions only). Blue lines show fish movements from depth data and bathymetry

Three different depth movement patterns appeared to exist:

The first of these is a change in the base depth. Large changes in depth, moving to deeper or shallower depths and then remaining at this new depth for some time, are most likely following the bathymetry. For example most of the fish (6 tags) appeared

to settle at a slightly deeper depth initially after tagging and then moved slightly shallower. Three fish also moved 250-400m deeper during December, with two of these moving shallower again in January.

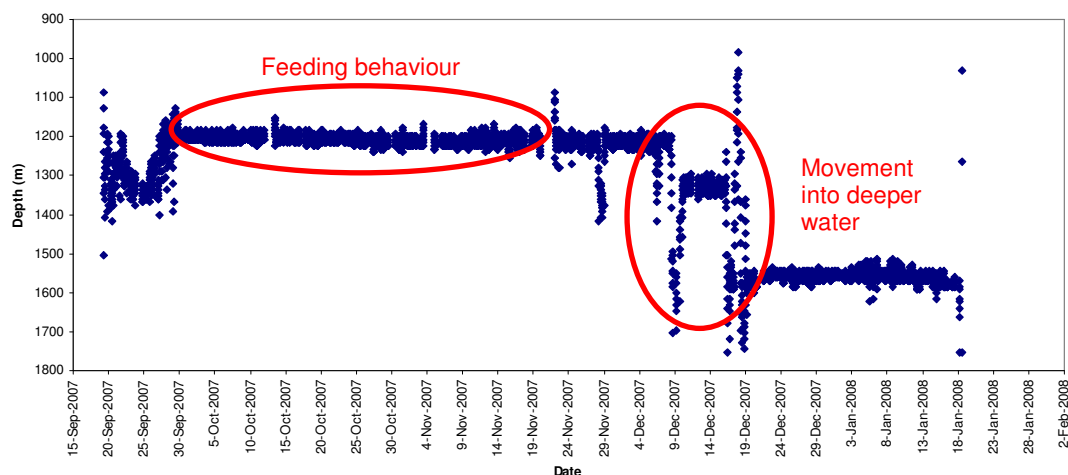


Figure 2: Depth movements of one fish tagged on Burdwood Bank

The second distinctive movement pattern was periods of relative quiescence, remaining at a constant base depth but with movements of up to 60m although generally less, over a six hour period. In three fish (but not all) this was significantly linked with lunar phase. Tag 77209 had more upwards movements during a full moon compared to a new moon and more downward movements during a new moon compared to a full moon ($p=0.014$ $F=26.9$, $p=0.014$ $F=26.4$), Tag 77209 had more downward movements than upward movements during a new moon ($p=0.028$ $F=16$) and Tag 86848 had more upwards movements during a new moon and more downward movements during a full moon ($p=0.015$ $F=25$). This type of movement is thought to be feeding behaviour. Examining links with average depth movement with fish size showed that for fish in the south (fish in the north excluded due to different bathymetry) larger fish (149-160cm) made smaller movements than smaller fish (130-140cm). La Rosa (1997) identified a difference in diet between two groups of adult toothfish around South Georgia. He found that fish 130-149cm fed mainly on squid and *Notantia* shrimp whereas toothfish 150-200cm fed on more benthic species including fish and lithodid crabs and this difference in diet could explain these differences in movements which are evident in the tagged fish.

The third type of movement was numerous large depths changes of 100-580m but returning to the base depth. These movements moved up into shallower water of 900-1200m and occurred during Feb/March (one tag), May-August (one tag) and August (two tags). This coincides with the spawning months (small spawning peak in March April and main spawning event in July/August) and occurred at shallower depths (the assumed spawning depths are 800-1000m).

Tag 86848 20-29 August 2008

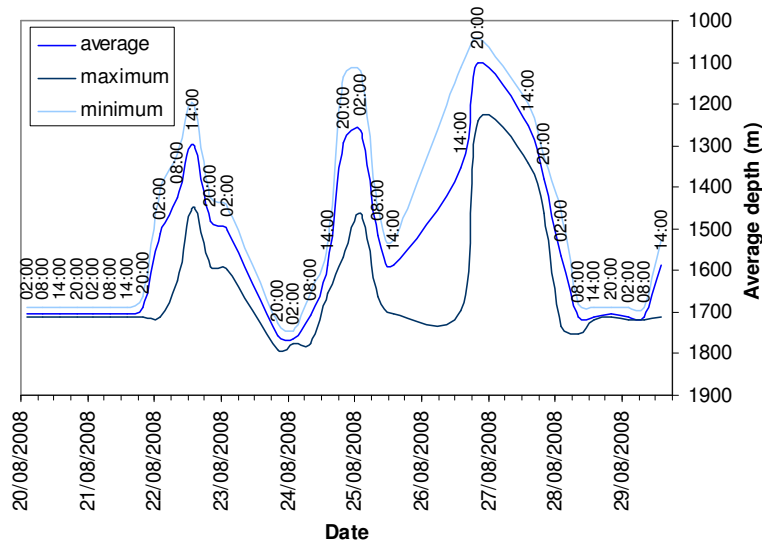


Figure 3: Observations of spawning behaviour on toothfish tagged on Burdwood Bank

The data from this study indicates there are no large scale migrations of toothfish from the north of Falkland's waters to the Burdwood Bank spawning areas or vice versa. Although maturing fish have been found in the north of the zone no spawning fish have ever been recorded in this area. Histological analysis has found toothfish undergoing skipped spawning with all the maturing oocytes in a state of reabsorption. Peaks in recruitment have also been identified occurring approximately every 4 years (Laptikhovsky & Brickle 2005), indicating spawning does not occur in all mature fish every year. Around South Georgia, Belchier & Collins (2008) found an inverse correlation between peaks in recruitment of toothfish and sea surface temperature with cold water temperatures during the summer prior to adult spawning resulting in the best recruitment. They suggested that as peaks of krill abundance have been linked to cold water temperatures (Murphy *et al* 2007) this could result in a greater amount of better quality prey becoming available to the benthic community resulting in an increased reproductive success in toothfish. Patagonian toothfish is a sub-Antarctic species so the population in the Falkland Islands is at the extent of its range. This indicates that perhaps fish in the north of the Falklands zone never experience suitable environmental conditions for spawning and perhaps only those fish that make large migrations southwards during years when temperatures are suitable will spawn. Fish on the eastern part of the Falklands zone will perhaps only spawn in years when cooler waters reach further northwards. Four more tags which were deployed in the northeast of the Falklands are due to pop-up in October which may shed more light on this. This highlights the importance for stock management of the conservation of the spawning area on Burdwood Bank during the spawning season.