

**Preliminary report on migration paths of juvenile  
southern bluefin tuna determined by acoustic tagging  
in Western Australia 2007-08**

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## Abstract

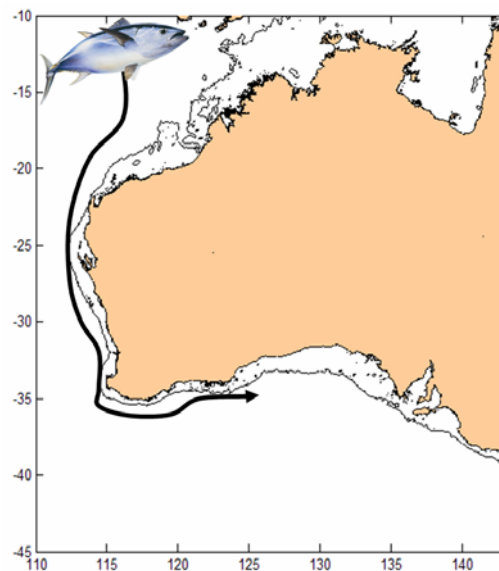
Southern bluefin tuna movements from the west coast of Australia to the south coast were studied with acoustic tags and listening stations. For the second year of this experiment, it is clear that during the summer, few tagged fish from the west coast move around to the south coast (only 1 of 73 detected after two years). Age-1 SBT present in the vicinity of the listening stations on the south coast of western Australia must arrive earlier in the season. The fraction of fish that move to the south coast is unknown, and has implications for our understanding of stock structure. Several alternate migration paths are possible, and need further consideration. Of particular importance is determining if the fraction of age-1 fish using different migration routes varies between years, and if this variation is carried forward to the fraction entering the GAB as 2-4 year old fish. At this time, a range of approaches should be considered to determine the fate of these “summer resident” west coast fish, including ongoing acoustic tagging, archival tagging, and biochemical analysis of older fish to determine past habitat use. This has implications for estimating juvenile recruitment and interannual variation in the fraction of 1-year old SBT that move to the Great Australia Bight in subsequent years.

## 要約

豪州西岸から南岸へのミナミマグロの回遊を音響タグと受信機で調べた。調査2年目として、夏季に西岸から南岸へ移動する魚はほとんどいなかった（2年間で73個体中の1個体）ことが分かった。西オーストラリア南岸の受信機周辺にいたミナミマグロ1歳魚は、時期当初から存在していたはずである。資源評価とも関連する南岸へ移動する魚の割合は不明である。回遊経路はいくつか想定され、さらなる検討を要する。特に重要なのは、1歳魚が異なる回遊経路を利用するとしたら、その割合の年変動、ならびにその後のGABの2-4歳魚との関連である。これらの西岸夏季滞在魚の動向を決定するため、実施中の音響タグやアーカイバルタグ、高齢魚の環境履歴を求める生化学分析など、とりうる手段を検討すべきである。これは加入資源の推定とその後GABへ移動するミナミマグロ1歳魚の割合の年変動へも影響を与える。

### Summary of the juvenile SBT migration path experiment in 2007-08

Juvenile southern bluefin tuna move down the west coast of Australia from the spawning grounds, and are subsequently found as age-1 fish in southern Australia during the austral summer (**Figure 1**). The fraction of age-1 fish that move around to the south coast is unknown, and has implications for stock structure, mixing rates, and population estimates, particularly if there is inter-annual variation in the fraction moving to southern Australia. The acoustic monitoring approach has shown patterns of habitat use along the south coast (Hobday et al in press), however, the fraction of fish that arrived in the southern region, and ultimately move to the Great Australia Bight (GAB) as 2-4 year olds is unknown.

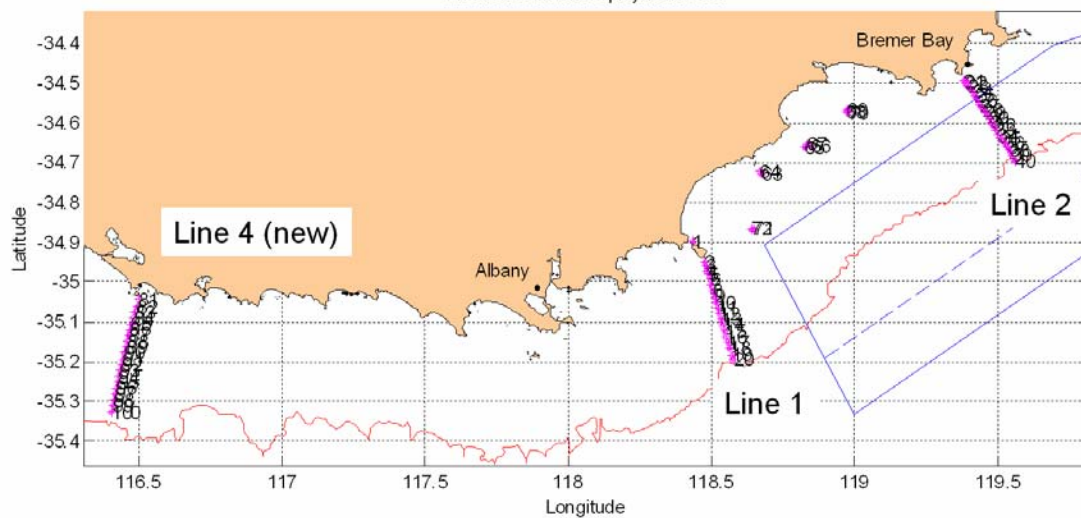


**Figure 1.** The possible migration path for age-1 southern bluefin tuna from the spawning ground into southern Australia.

### Methods

Beginning in 2006/07, age-1 and age-2 fish were acoustically tagged on the west and south coast of Australia to begin estimating the fraction that move to the south coast during the same summer. Three cross-shelf lines of listening stations were deployed along the south coast in 2006/07, and the design was modified slightly in 2007/08, with the easternmost Line 3 replaced with a western line 4 (**Figure 2**). This line was added to improve detection of fish tagged on the west coast. A total of 70 stations were used in 2007/08; in addition to the three lines of 20 stations each, 4 hotspots were also instrumented, with 2, 2,3,3 stations respectively (**Figure 2**). The hotspots

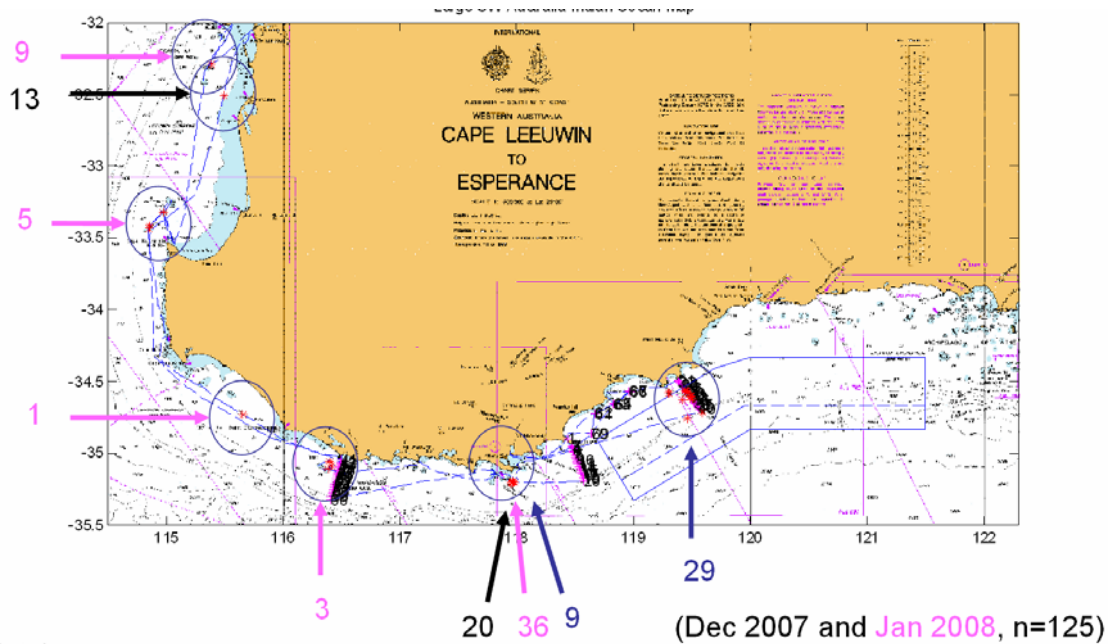
are used in analyses of inshore residency, and not discussed further in this preliminary report.



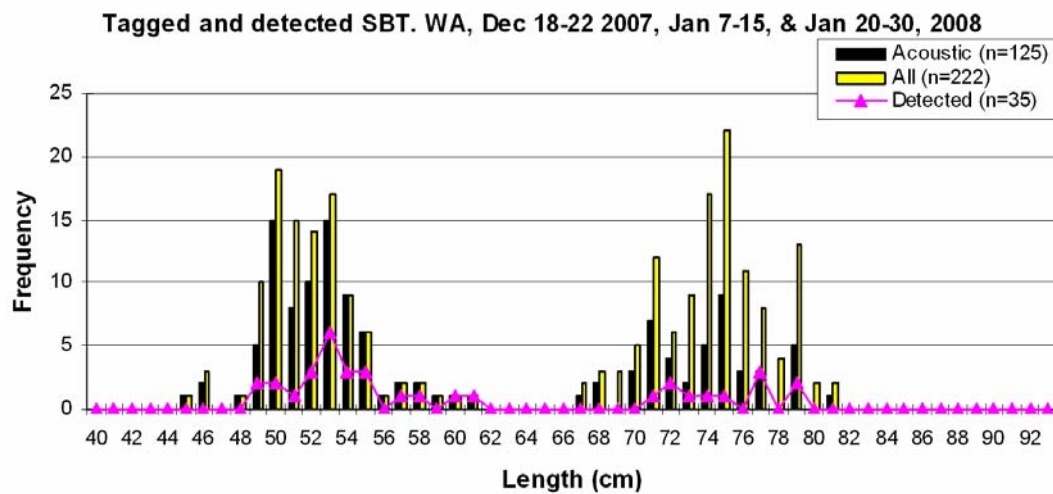
**Figure 2.** Location of acoustic listening stations in 2007/08. Line 3 (not shown) was located further to the east in 2006/07, and was not used in 2007/08, as it was replaced with Line 4.

### Results – preliminary analysis

A total of 125 fish were acoustically tagged in December 2007 and January 2008 (**Figure 3**). The three tagging periods were December 18-22 (south and west coast), January 7-15, 2008 (south and west coast), and January 21-30 (south coast). Both one and two-year old fish were tagged (**Figure 4**). The average size of the tagged one-year old fish was 52.3 cm (range 45 - 61 cm, n=80), and the two-year old fish averaged 73.9 cm (range 71 – 84 cm, n=45). A total of 27 age-1 SBT were tagged on the west coast (**Figure 3**), with an average size of 50.3 cm (range: 45 - 54 cm).



**Figure 3.** Number of tagged age-1 and age-2 SBT released at several locations in 2007/08. Colors indicate the release period. Black: December, Magenta: January-early, Blue: January-late.

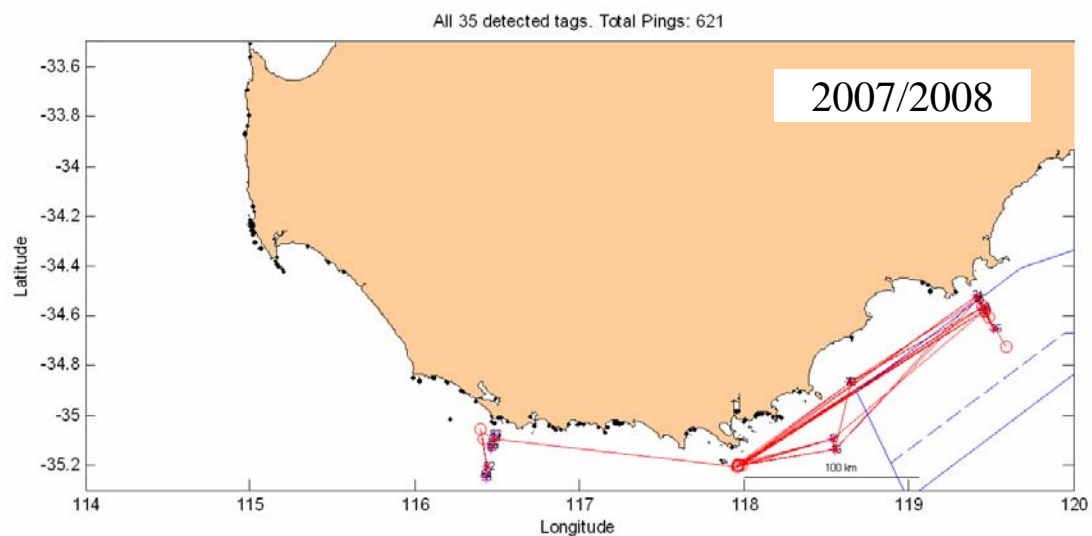


**Figure 4.** Size distribution of all SBT tagged and captured (some SBT were released without tags, as fish from a wide size range were sought). The number of fish detected at the listening stations is also indicated (current to Aug 7, 2008). Both age-1 and age-2 fish were tagged and subsequently detected.

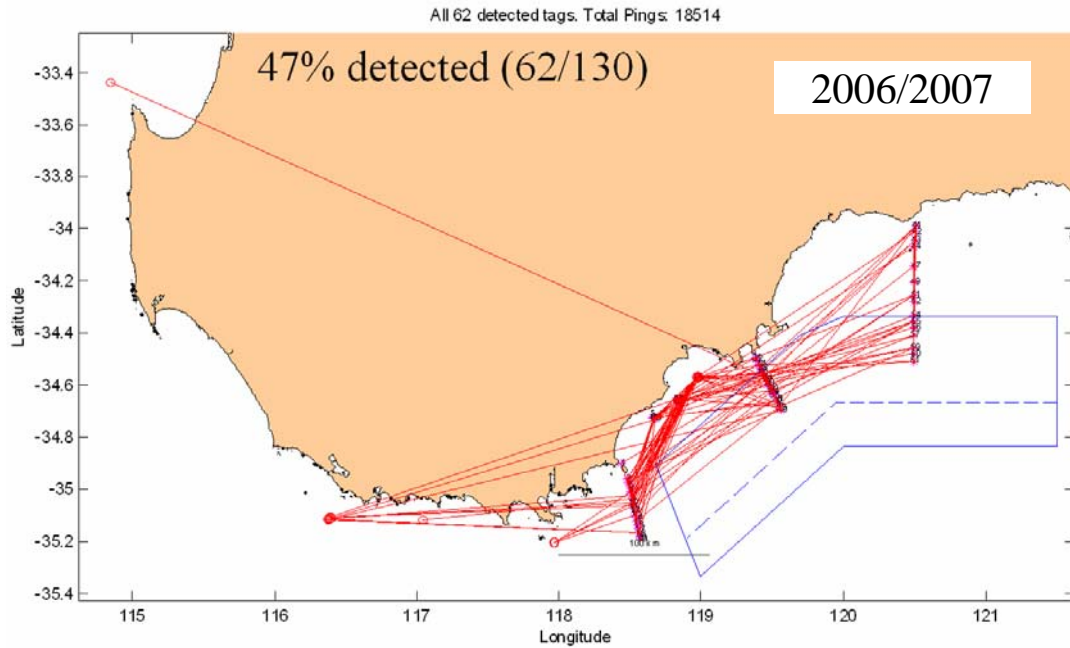
Recovery of the listening stations took place during May 28-31 2008. During this cruise, only 13 of 70 stations were recovered, the remainder had broken free, due to unanticipated corrosion of one mooring component. This component (wire fasteners) was the same specifications that had been used in previous years, and the corrosion appears to be due to a change in manufacturing quality. Thus, the majority of receivers appear to have broken free from the mooring base, and drifted away. To date

(August 7, 2008), a total of 17 stations have been recovered, as additional receivers have been washed ashore and returned. Only 15 stations have been downloaded at this time; two other stations are currently being returned to CSIRO. An extensive media (newspaper and television) effort was also completed to increase public awareness of the lost equipment. Additional recoveries may occur in the coming months. Despite these losses, some preliminary results are intriguing.

A total of 35 tagged SBT (28%) were detected on the 15 stations (**Figure 5**). No fish were detected from the west coast (n=27 tagged). Age-1 fish tagged on the south coast were detected (**Figure 4**), indicating that, as in previous years, age-1 fish do survive tagging. In 2006/07, only one of 46 fish tagged on the west coast was detected on the south coast (**Figure 5**).

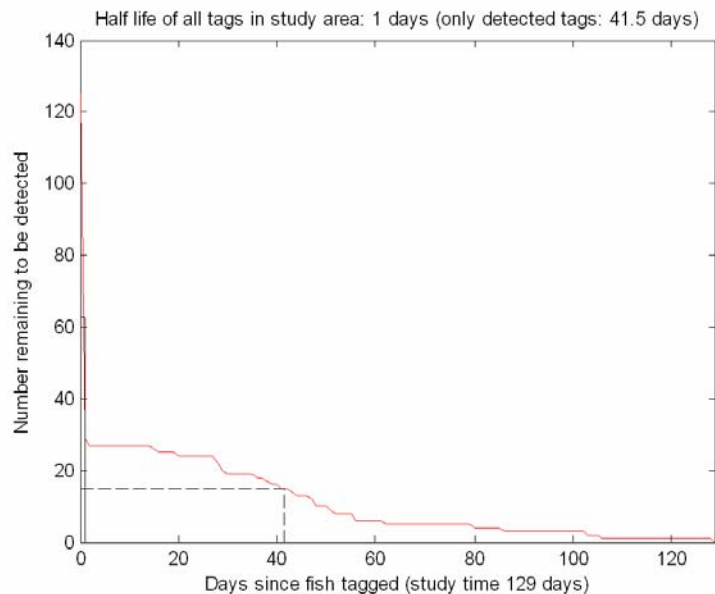


**Figure 5. Upper:** Tracks of tagged SBT from release locations (circles) to receivers for 2007/08. Data from 15 receivers is contained in this figure. **Lower:** Tracks of tagged SBT from release locations (circles) to receivers for 2006/07.



**Figure 5.** (Contd.)

Fish remained in the region of the tagging array for similar times to previous years. Fish were detected up to 129 days after tagging, and the half life (time at which only half the fish remained in the study area) was 41.5 days (**Figure 6**), compared with 39 days for 2006/07.



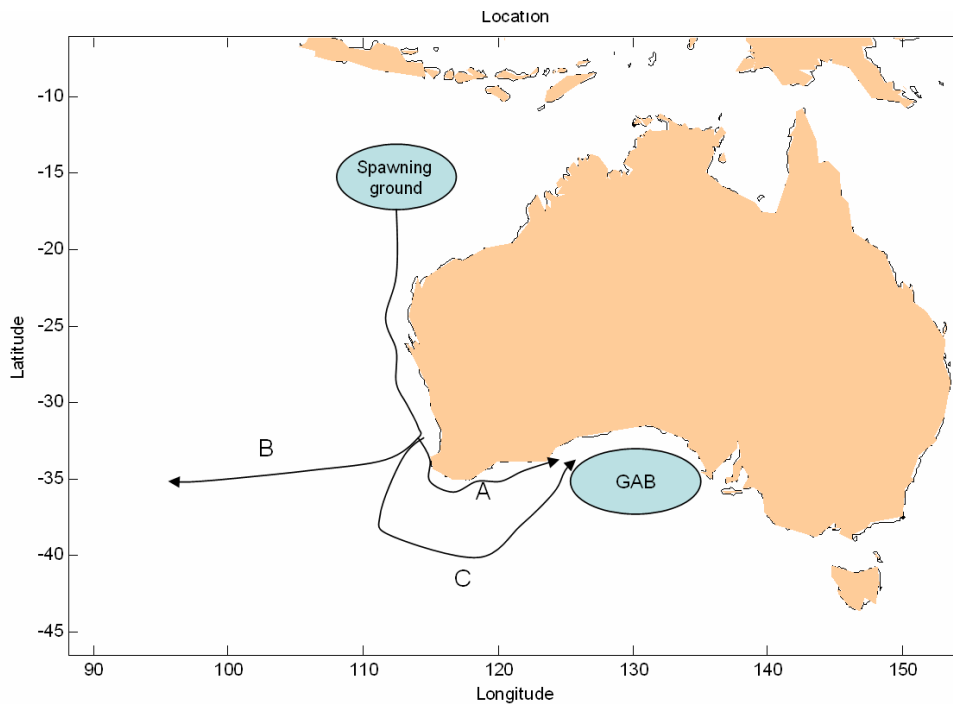
**Figure 6.** Persistence of tagged SBT in the study region. The half life is the time at which half the detected fish remained in the study region. With 35 fish detected from the recovered receivers, the half life is the time when only 17 fish remained.

**Conclusions – preliminary**

The acoustic monitoring experiment has provided valuable information on the patterns of juvenile SBT habitat use on the south coast for a number of years, and the implications of SBT habitat use for estimating abundance is discussed in Hobday et al (in press). Based on the last two years of acoustic experiments (73 fish tagged on the west coast), it now appears that from late December onwards, age-1 SBT are present on the west coast of Australia, and these fish do not move to the south coast, at least not along (or to) the inshore area where the arrays are. Age-1 SBT present on the south coast in the vicinity of the acoustic array (tagged on the south coast) must have arrived earlier in the season. We are currently considering changes in the strength of the Leeuwin Current that may explain this apparent pause in the migration during the later portion of the summer, however, a variety of other explanations may be possible. Detection rate of fish tagged on the south coast was 74% in 2006/07, and 37% in 2007/08 (despite loss of many receivers). Thus the detection of fish from the west coast is likely, if they migrated to this same region as the other age-1 fish.

With regard to the migration pathways, there are several possibilities. Two alternatives to direct migration to the GAB (**Figure 7**, pathway A) are that fish move along pathway C, and ultimately migrate to the GAB in subsequent years, or that fish move to the west, and do not appear in the GAB in subsequent years (pathway B).





**Figure 7.** Hypothetical SBT migration pathways for juvenile SBT from the spawning ground to the GAB.

Electronic tagging with two technologies, acoustic tags for fine scale location in combination with acoustic listening stations, and archival tags for basin-scale movements could be used to estimate fractions for migration pathways A, B and C (**Figure 7**). Pathways A and C can be distinguished with acoustic tags, while B can be distinguished from A+C with archival tags, and not with archival tags. These tagging techniques have been applied independently and successfully in the past. Deployment of an acoustic array in southern Western Australia could be used to detect acoustic tags released on the west coast. Support is needed to resolve this uncertainty regarding the interannual fraction of the juvenile stock that is ultimately present in the GAB.

### **Acknowledgements**

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