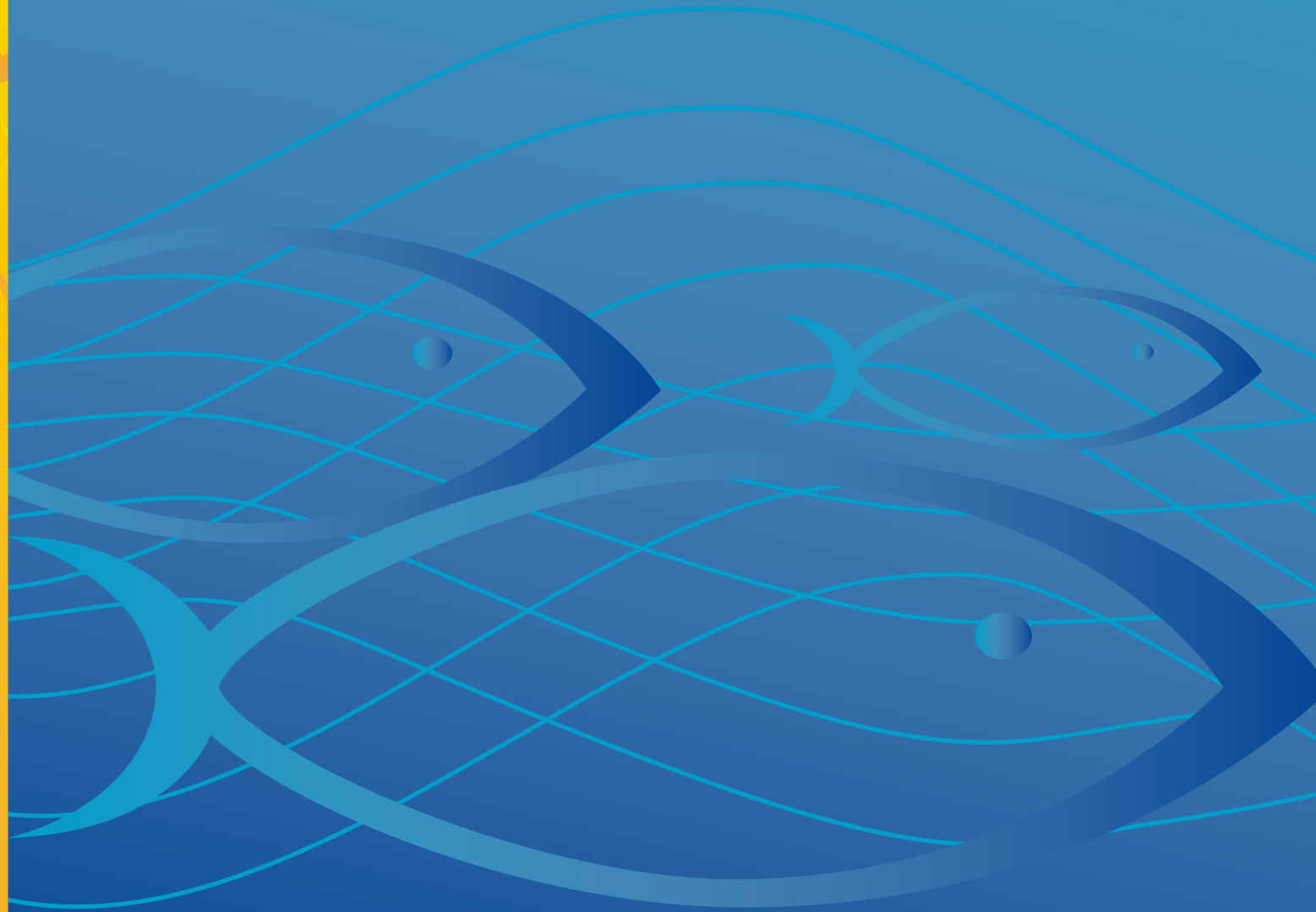




Bord Iascaigh Mhara
Irish Sea Fisheries Board

Bluefin Tuna Tagging in Irish Waters

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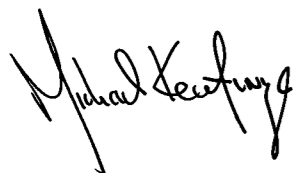
Foreword

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The content of the *Fisheries Resource Series* reflects a synergy of resources and expertise between BIM and the Irish fishing industry, national academic institutions, international partners, other state and semi-state agencies and provides a vehicle for the dissemination of the results of the Board's innovative, technical and applied research and development activities.

Technical and scientific contributions to the *Fisheries Resource Series* are invited, from internal and external sources, which primarily promote the sustainable development of the Irish sea fisheries sector and, in addition, support its diversification in the coastal regions so as to enhance the contribution of the sector to employment, income and welfare both regionally and nationally.

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Table of Contents

Summary	3
Introduction	4
Biology of bluefin tuna	5
Management and legislation	6
The recreational fishery for bluefin tuna in Ireland	6
Landings	7
Fishing methods	8
The tagging programme	10
Tagging methods	10
Tagging results	11
Geolocation	11
Depth and temperature preferences	11
Discussion	14
References	16

Summary

A recreational fishery for bluefin tuna commenced in Irish waters in September 2000 and developed in proceeding years, with 74 captures made by rod and line by the end of 2004. A satellite tagging programme was initiated by An Bord Iascaigh Mhara (BIM) and the Tuna Research and Conservation Centre (TRCC) from California, USA to promote conservation and collect information on the migratory paths and depth and temperature preferences of bluefin tuna in Irish waters.

A total of 6 bluefin tuna were tagged and released with pop-up archival transmitting tags in 2003 and 2004 and ultimately 3 of these deployments were successful. Two tags deployed off Donegal in September 2004, reported approximately 6 months later from different sides of the Atlantic Ocean, close to the Bahamas in the western Atlantic and south west of Portugal in the eastern Atlantic. A third fish tagged off Donegal in October 2004 was captured 8 months later in the Mediterranean Sea, southwest of Malta.

The results of the study support a link between bluefin tuna in Irish waters and western Atlantic waters and spawning grounds in the Mediterranean Sea.

The Irish recreational fishery has suffered a dramatic decline in captures of bluefin tuna in recent years, which may be linked to poor stock status throughout the distribution of the species.

Introduction

The first capture of a bluefin tuna (*Thunnus thynnus*) by rod and line in Irish waters, in September 2000, created a wave of excitement throughout the sea angling community. Commonly perceived as the ultimate big game fighting fish, anglers became enthralled at the prospect of catching a 'giant bluefin' in Irish waters. As the number of captures increased, so grew the interest amongst charter angling operators in taking advantage of this new opportunity, and the need to effectively manage the emerging resource. A satellite tagging programme was, therefore, initiated in order to create a culture of tag and release amongst anglers and to acquire information on migration patterns; a crucial component for the proper management and conservation of any large migratory species.

Ireland has no directed quota for bluefin tuna so recreational fishing potentially offers an alternative outlet to coastal communities seeking to benefit from the resource. Just as Irish recreational fishing for bluefin tuna was becoming established however, a sudden and dramatic decrease in captures occurred in 2005 and the fishery has not recovered since then. Although factors such as poor weather may have been partly responsible, this decline may be linked to the massive expansion of bluefin tuna ranching in the Mediterranean and commercial overfishing throughout their distribution. A multi-annual, recovery plan for bluefin tuna in the East Atlantic and Mediterranean was introduced in 2007, which will hopefully lead to a revival of the species.

This paper describes the emergence of the recreational fishery for bluefin tuna in Ireland with reference to the pioneers who made it happen, and the subsequent transatlantic collaboration between Irish and American Institutes in tracking fish movement.

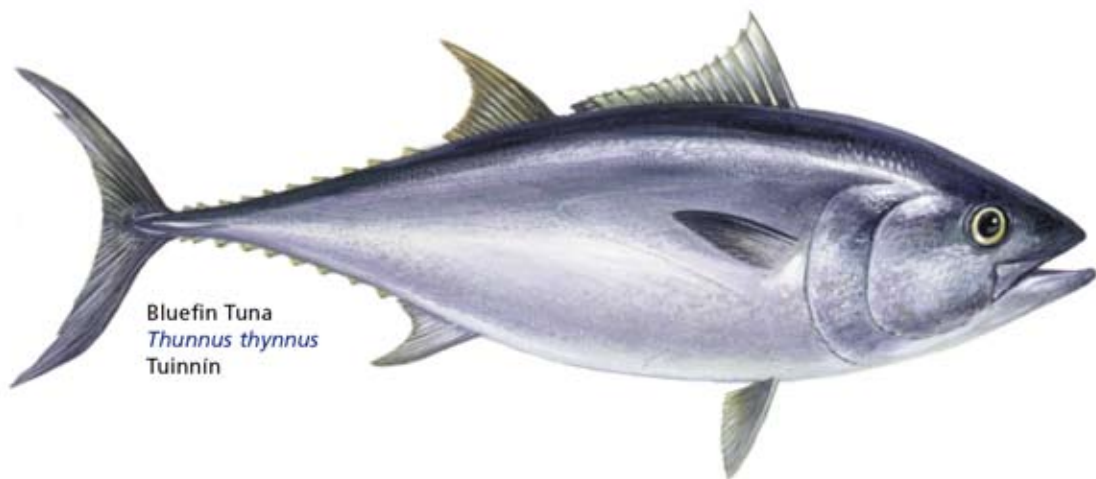


Figure 1. *Thunnus thynnus*; Northern Atlantic Bluefin Tuna

Biology of bluefin tuna

The bluefin tuna (Fig. 1) is a member of the Scombridae family that, along with other tunas, includes mackerel and bonitos. There are three species of bluefin tuna: the southern bluefin (*Thunnus maccoyii*), inhabiting the southern hemisphere, and two species in the northern hemisphere: the Atlantic northern bluefin (*Thunnus thynnus*) and the Pacific northern bluefin (*Thunnus orientalis*). The species name '*Thunnus*', comes from the Greek verb '*thunos*' which means 'to rush'; a title worthy of a fish that can swim at speeds of up to 90 km per hour.

Tunas are endothermic, a term used to describe the process by which metabolic heat can be used to elevate and maintain regional body temperatures that are warmer than the ambient sea temperature. This is one distinguishing characteristic of tuna from its ectothermic i.e. cold blooded cousins, mackerels and bonitos. This elevated temperature is produced by incessant swimming, which permits generation and conservation of heat within the dark muscle, which is used to power cruise swimming. In a tuna steak, this muscle is evident as the dense dark red flesh at the centre, next to the vertebral column. The lighter coloured muscle surrounding this flesh is used for bursts of speed. The endothermic characteristic is thought to have major influence over the migratory paths chosen by tuna. Research has shown that tuna prefer to travel in relatively warm surface waters, which assists them in maintaining their internal temperature. However, they still need to occasionally visit the colder, enriched, upwelling areas in order to feed and are therefore, more likely to be found in oceanic frontal areas.

Thunnus thynnus is the largest of the tunas, reaching a maximum size of 3 metres in length and 650kg in weight. Individuals are known to live for up to 20 years, based on data from tagging studies, but may live for longer. The dorsal side of the body is a metallic deep blue and the

lower sides and underbelly are silvery white. Distinguishing features from other tuna include a relatively long and pointed head, small eye, relatively short pectoral fins and a relatively elongate second dorsal fin.

The northern Atlantic bluefin tuna is distributed on the west side of the Atlantic from Brazil up to the Gulf of Mexico and the Caribbean Sea as far north as Canada, and on the east from Mauritania off North Africa into the Mediterranean and Black Sea and as far north as Iceland and Norway. They are known to carry out seasonal spawning migrations to the Gulf of Mexico from April to June and to the Mediterranean from June to August when water temperatures exceed 24°C. The estimated age and size, at which bluefin reach maturity on the east side of the Atlantic, is 5 years and 130cm, respectively. Fecundity is related to size and up to 30 million eggs can be produced (Block and Stevens, 2001).

Little is known about the movement patterns of bluefin in the eastern Atlantic, particularly in the north eastern Atlantic off Ireland and in higher latitudes. Seasonal migration patterns appear to vary, depending on the age of the fish, with larger fish travelling further distances in search of food. Bluefin tuna, from the Mediterranean spawning grounds, are thought to migrate into the Atlantic and travel north, towards the Bay of Biscay or south, towards the Canaries. Large bluefin tuna are found in the North East and North West Atlantic from August to November. They travel to these northerly areas in search of abundant prey species such as squid (*Loligo forbesi*, *Illex coindetti* and *Todaropsis eblanae*), sauries (*Scomberesox saurus*), herring (*Clupea harengus*), mackerel (*Scomber scombrus*) and horse mackerel (*Trachurus trachurus*). Bluefin tuna are thought to gain up to 2kg in weight, per day, during these 'fattening' trips and their flesh acquires a high lipid content, which is highly desired on the Japanese market and leads to avid pursuit by commercial fishermen.

Management and legislation

Fisheries for Atlantic bluefin tuna are currently managed by the International Commission for the Conservation of Atlantic Tunas (ICCAT) under a two stock hypothesis. These are: the eastern Atlantic Ocean and Mediterranean Sea stock, that spawns in the Mediterranean Sea and the western Atlantic Ocean stock, that spawns in the Gulf of Mexico, with a boundary line dividing the stocks at 45 W longitude. However, evidence such as the results of the present study and other research (Block *et al.*, 2005), indicates that movement across the currently assumed east-west boundary in the Atlantic, does occur and ICCAT now recognise the need to develop quantitative knowledge of mixing rates and integrate this knowledge into the assessment and evaluation process (ICCAT, 2007).

Irish recreational charter vessels targeting bluefin tuna are subject to passenger boat regulations issued by the Marine Survey Office (MSO) of the Department of Transport. These vessels fall outside the remit of regulations affecting Community fishing vessels equipped for commercial exploitation of living aquatic resources. Therefore, they are not subject to the normal quota restrictions, which affect registered fishing vessels and are technically entitled to land any species that they catch. However, they are not permitted to sell their catch. No financial gain can, therefore, legitimately be obtained from landing bluefin tuna from the recreational fishery and BIM have actively encouraged tag and release to promote conservation and avoid the wasteful practice of landing fish.

The recreational fishery for bluefin tuna in Ireland

Grant aid measures, such as BIM's Inshore Fisheries Diversification Scheme and the PESCA programme have sought to reduce the dependence of peripheral coastal communities on commercial fishing and encourage people to apply their maritime skills to other, income earning pursuits. Marine tourism and in particular sea angling, has major potential in this regard and 50 sea angling/marine tourism vessels were introduced, with State and EU assistance, between 1994 to 2004.

These vessels enabled skippers to offer safe and reliable facilities, resulting in expansion of the charter sea angling business in Ireland.

Sea angling principally occurs during the summer months, from June to September, with reef and wreck fishing for species such as pollack, ling and cod representing the core of the business. A steady influx of anglers is essential during this period, in order to generate enough income to keep the business alive during the winter months. The majority of charter skippers are operating on tight margins and are constantly seeking new outlets to attract potential customers. One such outlet is bluefin tuna angling, which, weather permitting, may extend the traditional angling season by up to two months.

Although angling by Irish boats for bluefin tuna commenced relatively recently, the species have been observed in Irish waters since the late 1970s. The Irish Specimen Fish booklet 2002 (Anon, 2003) refers to an article from the *Cork Examiner* in May 1977 that describes the unusual capture of a bluefin tuna in the Blackwater river estuary by a salmon fisherman. Shortly after this, bluefin tuna were noted in numbers in Irish waters, as a by-catch of pelagic trawlers targeting herring at the mouth of the Shannon, in the early 1980s. Donegal based pelagic trawlers also landed bluefin tuna as a by-catch at this time. Subsequently, fishermen operating in Donegal Bay during the 1990s, occasionally observed schools of bluefin tuna breaking the surface. A number of attempts by anglers to land a fish were made in vain, until Alan Glanville, from Dunmore East, landed the first rod-and-line caught bluefin tuna, in Irish waters, on the 24th September 2000, in Donegal Bay. In the following 4 years, over 70 captures were made by anglers. The estimated average weight of these fish was 218kg (480 lbs) with the largest of all, a 440kg (968 lbs) specimen caught by Adrian Molloy off Donegal in 2001 (O'Farrell and Molloy, 2006).

Donegal has been the primary location for bluefin tuna angling with a number of different fishing hot-spots identified all along the north west coast from Donegal Bay up to Malin Head. The coastline of County Mayo has been the second most successful location for bluefin tuna angling, particularly off the Bills Rocks, close to Achill Island. Fish have also been observed close to salmon cages in nearby Clew Bay. Further south, bluefin have been observed close to the islands of Inis Bofin and Inis Turk, and the Aran Islands off the coast of Galway (Fig. 2).

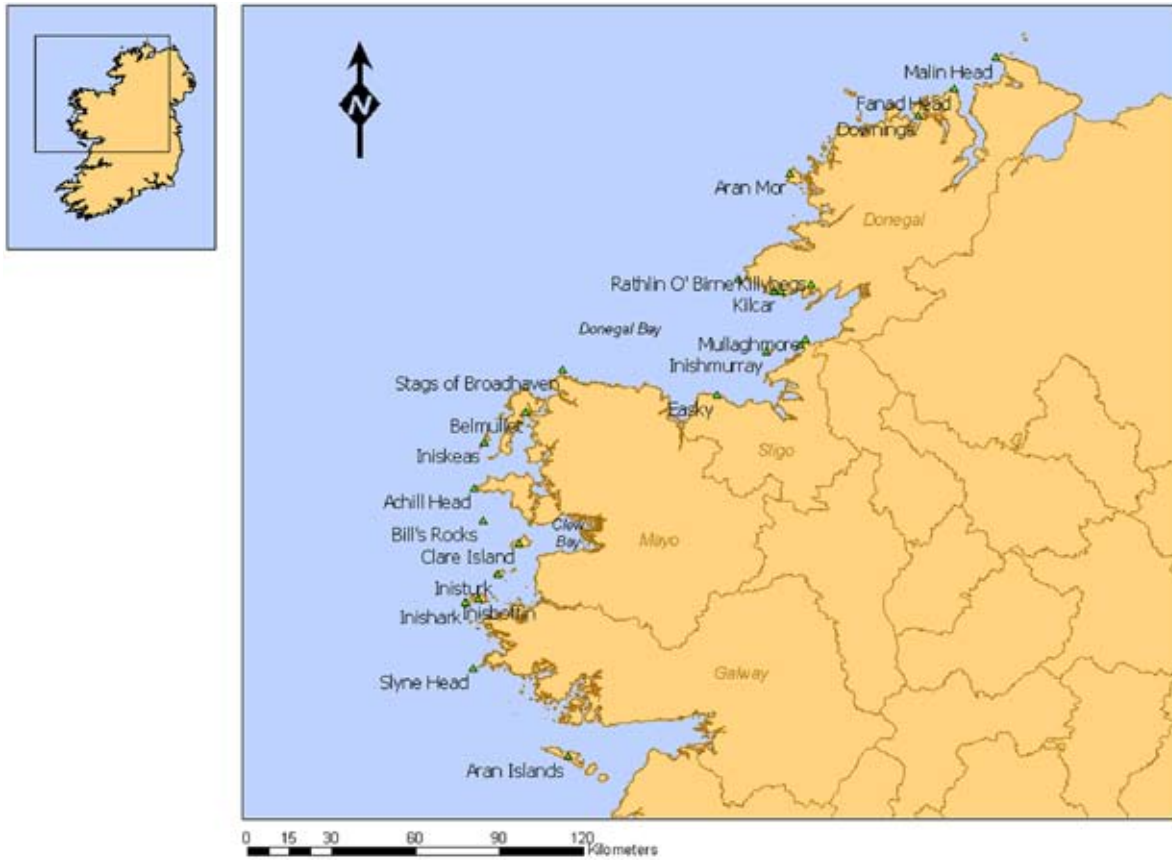


Figure 2. Map of the principal angling locations for bluefin tuna in Ireland

Landings

Data on bluefin tuna brought to boat by angling vessels have been compiled since 2000. A total of 75 fish have been caught during the period 2000 – 2007. Following the introduction of a tagging programme in 2003, the majority of fish were released alive. Landings increased from 3, in 2000, to 11 in 2001 and a peak of 25 in 2002, with 16 and 19 fish landed in 2003 and 2004, respectively. No fish were landed in 2005, however, with just one fish caught in 2006 and no fish in 2007.

The personal diary of Adrian Molly, who has fished consistently for bluefin since the recreational fishery commenced, reveals more information on the 2005 fishing season. The season was remarkable for the lack of sightings of bluefin tuna early in the season compared to previous years. Schools of fish were eventually sighted in September and October but the estimated size of the fish, 80 – 100kgs, was much smaller than the estimated average size of those observed in previous years ~250kgs. Adrian had 25 sightings of bluefin tuna for 35 days fished in 2005, which is about average when compared to previous years but no fish were landed. This compares poorly with 2004, when Adrian fished just 20 days for 12 fish landed and this catch rate further

highlights the dramatic decline in 2005 (O'Farrell and Molloy, 2006).

The weather was poor during the 2005 season. Data from the Irish marine weather buoy M4¹, which is located close to Donegal Bay reveals substantially higher wind speed and wave height values in October and November 2005 and 2006, compared to the previous 2 years (Fig. 3). This does not, however, explain the dramatic decline in numbers as bluefin tuna have often been caught in previous seasons during poor weather. For example, a total of 14 fish were caught during September 2004 when the average wind speed was higher and the wave height similar to the same period in other years. Sea temperature was slightly higher during October and November 2006 than other years, but was similar for the same period during 2005 (0 fish) and 2004 (19 fish), so it is unlikely that a change in sea temperature has contributed to the fall in landings.

Other factors, which may have affected fishing in 2005 and 2006 included an increase in private, inexperienced skippers targeting and often disturbing schools of bluefin tuna, and a high abundance of natural prey species due

¹ Marine weather buoy data provided courtesy of the Marine Institute.

to reduced fishing effort from the commercial fishing fleet. In 2007, some sporadic sightings of bluefin tuna ‘busting’ the surface were reported by angling and commercial vessels. However, charter angling vessels were discouraged from targeting bluefin tuna due to the poor fishing in preceding years and despite some lengthy spells of good weather, generally reverted to reef or wreck fishing. There is a strong likelihood that the observed decline is due to a lower abundance of bluefin tuna off the Irish coast and that this is symptomatic of poor stock status throughout the rest of the Atlantic and the Mediterranean Sea.

Fishing methods

Tagging operations were predominantly carried out onboard two charter angling vessels; the ‘Naomh Cartha’ (Fig. 4) owned by Adrian Molloy, which operated off Donegal, and the ‘Bluewater’ owned by John Brittain, which operated off Galway and Mayo. The Naomh Cartha is a 38ft, Interceptor, built in 2002 with a single 420hp engine. The ‘Bluewater’ is a 42ft, Cygnus Cyfish, built in 1996 with twin 250hp engines. Both of these vessels were fitted with transom doors and specially constructed steel ramps, which greatly assisted in taking aboard and subsequently releasing bluefin tuna.

These vessels also possessed a complete range of equipment necessary to catch, fight and bring bluefin tuna to boat. Each vessel had a fighting chair with harness and 4 x 80 or 130lb class rods and reels (Fig. 5). Both vessels also used stainless steel outriggers and downriggers for trolling lures on the surface and at various depths.

Trolling with artificial squid lure spreader bars, was the principal angling method used. In this rig, only the last in an array of squid lures, which is slightly larger than the others, contains a hook and is known as a ‘stinger’ (Fig. 6). This gear was trolled 20–40m behind the vessels, at a speed of 3–5 knots. Occasionally, other lures such as mackerel baits attached to a down rigger and trolled at various depths, were also used on occasion, but without success.

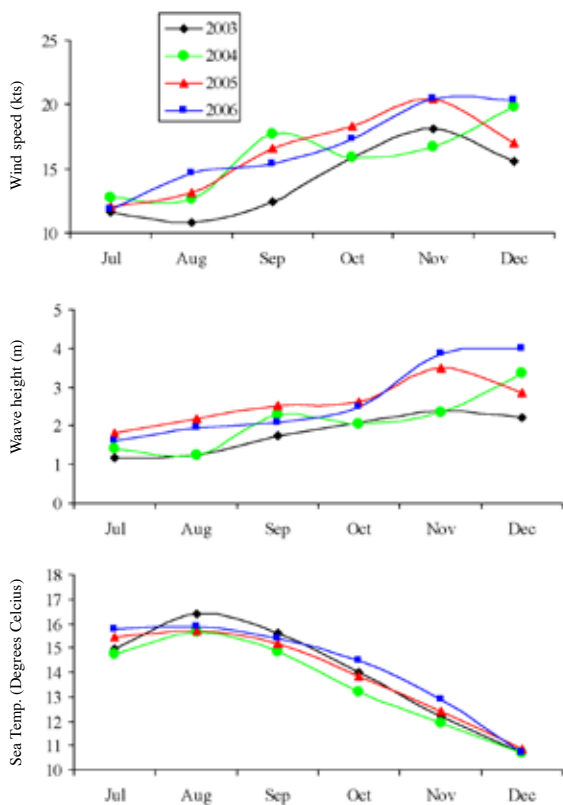


Figure 3. Average monthly wind speed, wave height and sea temperature values off Donegal from 2003 to 2006. Data provided courtesy of Marine Institute.



Figure 4. The 'Naomh Cartha' a typical Irish, charter angling vessel



Figure 5. Bluefin tuna rods and reels



Figure 6. The 'stinger' at the end of the squid spreader bar

The tagging programme

The BIM bluefin tuna tagging programme commenced, in collaboration with the Tuna Research and Conservation Center (TRCC) from Stanford University, California, USA in September 2003. The TRCC are world leaders in conducting satellite tagging programs for various species of large pelagics. The team were delighted to share their knowledge of tagging methodologies, in return for the opportunity to tag fish, for the first time, in the north eastern Atlantic.

Tagging methods



Figure 7. A PAT tag with a conventional floy tag above

Pop-up Archival Transmitting Tags (PATs) (Fig. 7) are designed to track the large scale movements and behaviour of pelagic fish and other animals. Summaries of depth, temperature and light-level data are archived in the tag, while attached to the fish. Neither the fish nor the tag needs to be retrieved in order to obtain these data. At a user-specified date and time, a pin is corroded, releasing the PAT to float to the surface and transmit summarised information via the Argos satellite system. Daily longitude of the migration track, is calculated onboard the PAT using geo-location by light level techniques. Daily latitude can be calculated from transmitted light level curves using software provided by the tag manufacturer. The results provide the migration path and depth and temperature preferences of the study animal, as well as oceanographic data, in the form of depth-temperature profiles.

In this study, light, ambient temperature and pressure parameters were measured and archived at 60 second intervals, with depth and temperature data summarized into 12 hour bins, prior to transmission. Temperature vs. depth profiles were generated with minimum and maximum temperature, at each of the eight, equally spaced depths. The tags were equipped with a pre-release program and an auto-depth correction so if the tag prematurely detached from the fish and floated to the surface, it reported to the satellite 4 days after detachment (Stokesbury *et al.*, 2007).

Fishing was predominantly carried out off Donegal and Mayo. Once a bluefin tuna was hooked and brought close to the boat, the transom door was opened and a steel ramp deployed. The fish was then pulled through the door using a customised titanium or stainless steel, lip hook and on to a vinyl covered, landing pad. A soaked blindfold was immediately placed over the eyes to calm the fish. A deck hose was then placed in the mouth to irrigate the gills with clean sea water and the hook was removed.

PATs were attached to the fish using a titanium dart. The dart was inserted approximately 10cm perpendicular to the apex of the second dorsal fin, where it anchored through bony projections and connective tissue, radiating ventrally from the fin. An additional conventional tag was inserted on the opposite side of the second dorsal fin and small fin clippings were retained and preserved for future DNA analysis. When tagging was complete, the vinyl mat was lifted with the head of the fish towards the transom door, allowing the fish to slide into the water headfirst, which assisted in reviving the fish (Fig. 8).

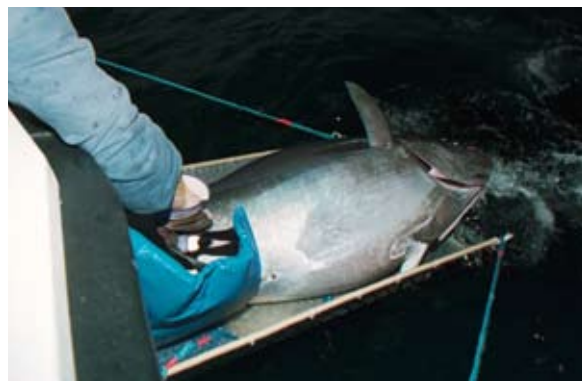


Figure 8. A tagged bluefin tuna is released off Donegal

Tagging results

A total of 6 bluefin tuna were tagged and released with PATs off the north west coast of Ireland in 2003 and 2004. In 2003, two fish (Fish 1: 221cm and Fish 2: 225cm curved fork length (CFL)) were tagged off Donegal on 20 September. These two fish were hooked by the same boat at approximately the same time and were tagged and released within 15 minutes of each other. A third fish (Fish 3: 264cm CFL) was tagged off Mayo on 15 October 2003. The tags deployed on Fish 1 and 2 reported 177 and 205 days later from opposite sides of the Atlantic Ocean. The tag on Fish 3 failed to report.

In 2004, two fish (Fish 4: 226cm and Fish 5: 230cm CFL) were tagged off Donegal on 9 October and were again hooked by the same boat, at approximately the same time and were tagged and released within 10 min of each other. A third fish in 2004 (Fish 6: 230cm CFL) was tagged off Donegal on 8 October 2004. The tag from Fish 6 was later returned by fisherman, after they caught the fish in the Mediterranean Sea on 11 June 2005. The tags from the other 2 fish, released in 2004, failed to report (Stokesbury *et al.*, 2007).

Geolocation

The tag from Fish 1 reported to Argos satellites on 15 March 2004 from the Bahamas at 25.67 N, 67.39 W, a straight-line distance of 5805km from the tagging site (Fig. 9).

Geolocation positions indicate that this fish resided in waters over the Irish shelf from tagging until 26 October. The fish then moved to off shelf waters for a period of 24 days, corroborated by multiple dives to depths deeper than 400m (Fig. 11a). The fish then returned to waters over the Irish shelf on 19 November 2003, where it remained until 18 December 2003. It then returned off shelf, until the tag reported from the Bahamas in March 2004.

The tag from Fish 2 reported on 12 April 2004 from waters off southwest Portugal, at 38.17 N, 13.33 W, a straight-line distance of 1962km from the tagging site (Fig. 9). Geolocation positions and maximum depth profile data (Fig. 11b) indicate that this fish resided in waters over the Irish shelf from tagging until 21 October, and then moved off shelf, to waters over the mid-Atlantic Ridge and back to the Eastern Atlantic Ocean. Finally, the fish resided in shelf waters, southwest of Portugal until the tag reported (Fig. 9).

Fish 6 was captured, in a purse seine, on 11 June 2005 in waters southwest of Malta, at 31.57 N, 17.42 W, a straight-line distance of 2766km from the tagging site

(Fig. 10). Geolocation positions (Fig. 10), indicate that this fish moved southwest from waters off Ireland, in October, and remained in the North Atlantic until May 2005. The fish then crossed into the Mediterranean Sea in June 2005 and was captured by a purse seine fishing vessel on 11 July 2005 (Stokesbury *et al.*, 2007).

Depth and temperature preferences

Depth and temperature data were available for Fish 1 and 2. Fish 1 spent 79.9% of its time in the top 100m of the water column, including 42.8%, in the top 5m. The fish spent 55.5% of its time in water with temperatures between 12 and 16°C (Fig. 12a). Sea surface temperatures from 12 to 26°C were recorded by the tag, while the fish crossed the mid-Atlantic and entered the waters of the Bahamas (Fig. 13a).

Fish 2 spent 84.25% of its time in the top 100m of the water column and 93.84% of its time in water with temperatures between 12 and 18°C (Fig. 12b). The temperature-depth profile, indicated that the water column was mixed and cool during the observation period, on the Irish shelf. However, when the fish moved to the mid-Atlantic Ocean, the water column became more stratified and the thermocline was deeper. Finally, off Portugal the water column was mixed and cool (Fig. 13b) (Stokesbury *et al.*, 2007).

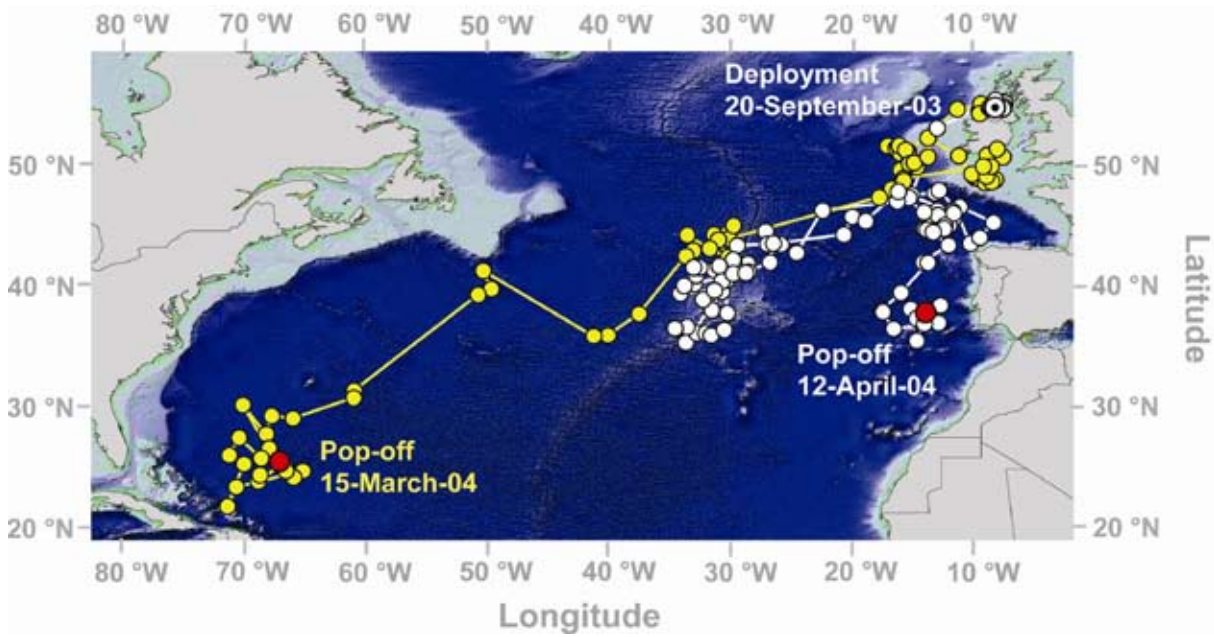


Figure 9. Location data from PAT tags deployed on 2 Atlantic bluefin tuna, off Ireland, in September 2003; (yellow circles = Fish 1, white circles = Fish 2).

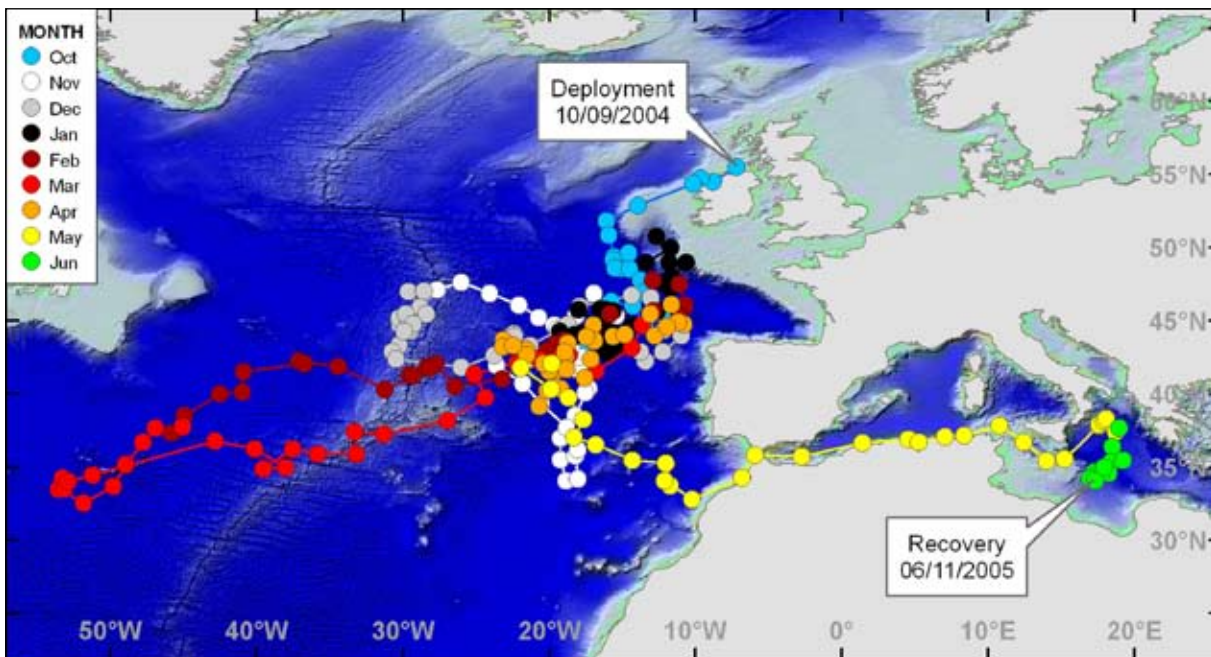


Figure 10. Location data from a PAT tag deployed on an Atlantic bluefin tuna (Fish 6), off Ireland, in October 2004 (circles are colour coded for month)

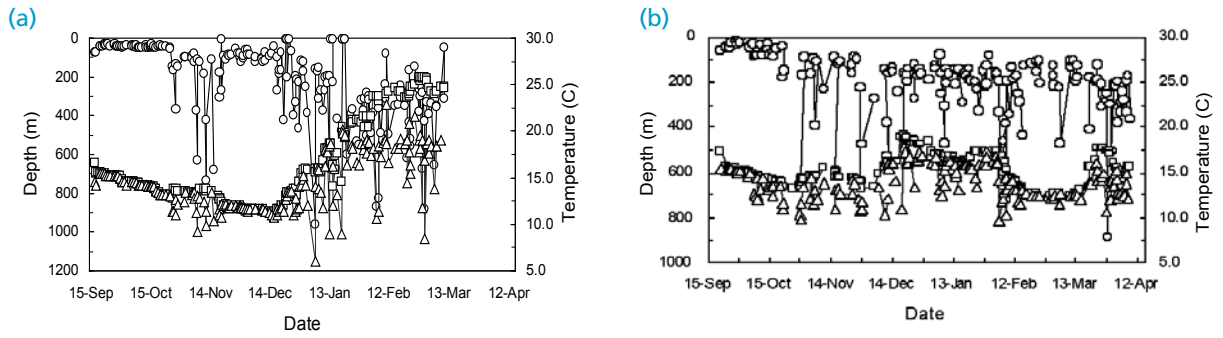


Figure 11. Maximum depth (O), maximum (□) and minimum (Δ) temperatures reported by PAT tags deployed on Atlantic bluefin tuna Fish 1 (a) and Fish 2 (b), deployed off the west coast of Ireland, in September 2003

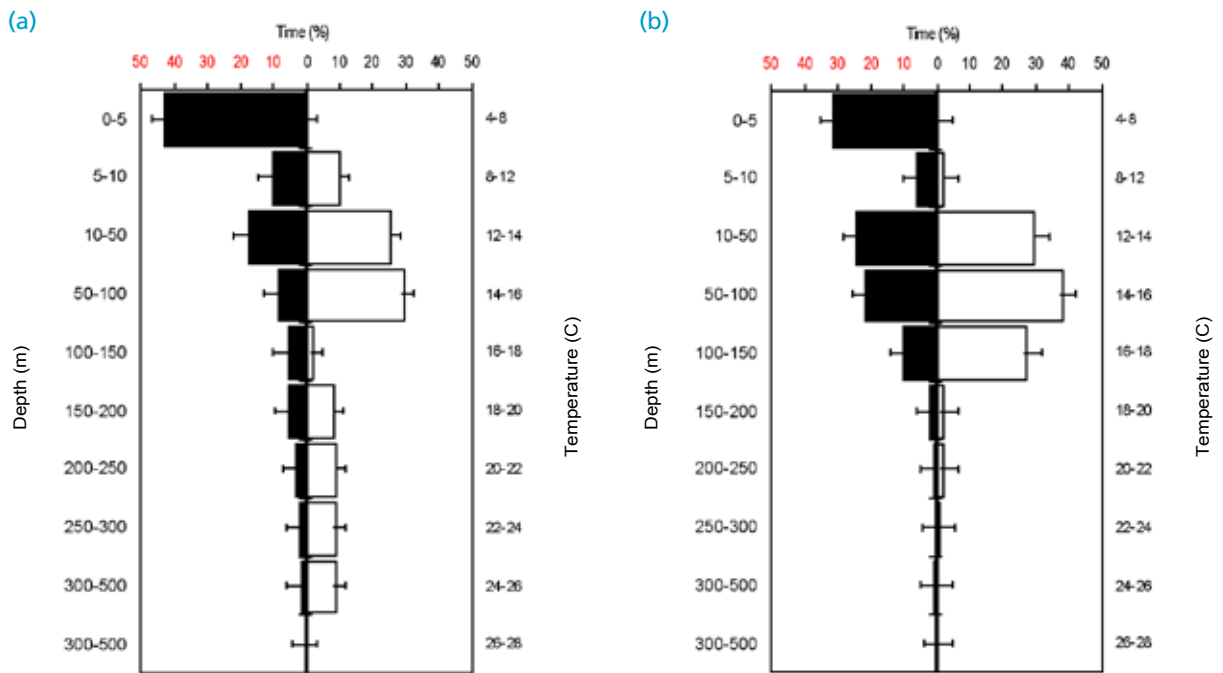


Figure 12. Time-at-depth distribution (black) and time-at-temperature distribution (white) for Fish 1 (a) and Fish 2 (b)

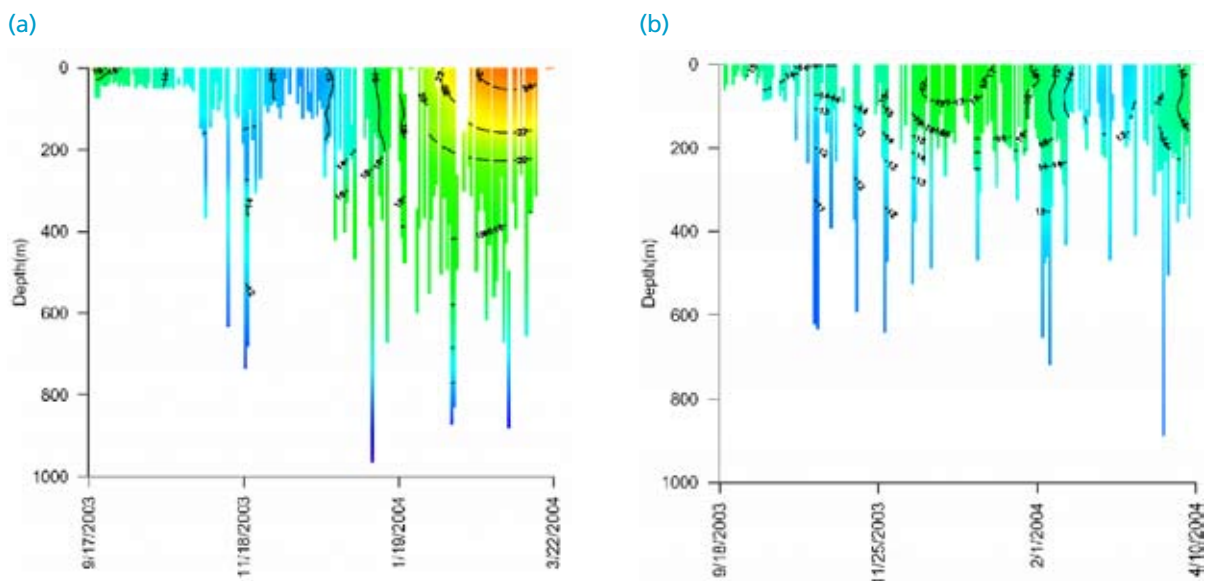


Figure 13. Water column temperature profile generated by Fish 1 (a) and Fish 2 (b)

Discussion

Bluefin tuna caught, tagged and released on feeding grounds in waters off the northwest coast of Ireland in autumn 2003 and 2004 subsequently moved to waters in the West Atlantic, East Atlantic and the Mediterranean Sea. Two fish caught and tagged at approximately the same time, in September 2003, off the northwest coast of Ireland, moved to opposite sides of the Atlantic Ocean by March and April 2004. Fish 1 travelled to the waters of the Bahamas, close to the Florida Straits, a proposed spawning ground for bluefin tuna in the northwest Atlantic Ocean and the water in this area was warm enough for a bluefin tuna to spawn ($>24^{\circ}\text{C}$) (Block *et al.*, 2001; 2005).

Fish 2 travelled to waters off southwest Portugal near the Ibero-Moroccan Bay. However, the water temperatures at the time the tag reported, were well below the accepted temperatures, in which bluefin tuna are hypothesized to spawn. The tag reported approximately 755km from the Straights of Gibraltar and this fish may have been on its way to the Mediterranean spawning ground when the tag popped up.

Fish 6 travelled to waters south west of Malta in the Mediterranean Sea in the months of May and June. This fish moved from the feeding grounds off Ireland, to the spawning grounds in the Mediterranean Sea, precisely during the time that other electronically tagged fish move into these regions from western Atlantic releases (Block *et al.*, 2001; 2005). This result suggests that, at least a component of the Irish fishery, is composed of Mediterranean spawned breeders.

In terms of depth and temperature preferences, Fish 1 and 2 spent a large portion of their time in the top 5m of the water column, which may be due to the overall thermal regime that the fish were exposed to in Irish waters. The temperatures were mostly cool and the occupancy of surface waters may be associated with the thermal tolerances of both prey and bluefin tuna.

The tuna spent the majority of their time in a relatively narrow temperature range during the period they were in east Atlantic waters. However, during the latter half of the tagging experiment, the two temperature ranges differed, as Fish 1 moved into the warmer waters of the Bahamas and Fish 2 remained in the cooler waters of the mid and eastern Atlantic Ocean.

The results of this study support a link between bluefin tuna on the feeding grounds off Ireland and the eastern Atlantic spawning grounds off Malta in the Mediterranean Sea, and a potential link with western Atlantic spawning grounds in the Bahamas. Technically, however, the tag from Fish 1 popped up slightly to the north of the putative, spawning grounds in the Bahamas. Given the small sample size, caution should be exercised in interpreting these tracks. However, they are similar to several tracks noted previously (Block *et al.* 2005), indicating that independent breeding stocks are mixing on feeding grounds and then sorting to breeding grounds (Stokesbury *et al.*, 2007). In addition, genetic analysis of fin clippings, taken during tagging, may yet help confirm the origin of these fish.

This mixing has major implications for the assessment and management of bluefin tuna stocks, which have traditionally been based on 2 distinct stocks. Despite a relatively high level of compliance with management measures, the smaller western Atlantic stock (Total allowable catch (TAC) of 2,100 t from 2007) continues to decline with countries such as the US, failing to catch its quota in the years 2004 – 2006. This trend looks set to continue. The considerably larger eastern Atlantic and Mediterranean stock is thought to be close to collapse due to the expansion of farming activities in the Mediterranean and a lack of compliance with quota regulations. Estimates of landings in recent years, based on fishing effort data, suggest annual landings of about 50,000t, which is far in excess of both the TAC (32,000t in 2006) and reported landings (estimated to be about 32,500t in 2006).

Increased evidence of mixing across the 2 stocks, suggests that the productivity of western Atlantic bluefin tuna fisheries is linked to the eastern Atlantic and Mediterranean stock and ICCAT have commenced evaluating management options to address these mixing issues (ICCAT, 2007).

A multi-annual, recovery plan for bluefin tuna in the eastern Atlantic and Mediterranean was introduced in 2007², which included the following measures: a gradual reduction in TAC to 25,500t in 2010; closed fishing seasons categorised by fishing gear; prohibition of aircraft spotting; an increase in the minimum landing size to 30kgs; increased management of recreational and sport fisheries and increased regulation regarding transshipment and caging operations. Successful implementation of these measures will, hopefully, reverse the decline in

² Council regulation (EC) No 1559/2007 of 17 December 2007 establishing a multi-annual recovery plan for bluefin tuna in the Eastern Atlantic and Mediterranean and amending Regulation (EC) No 520/2007.

spawning biomass and initiate rebuilding of the bluefin tuna stock.

The recovery rate of tag data from this study was lower than similar studies in the west Atlantic, where a recovery rate of 89% has been documented (Block *et al*, 2005). This may have been caused by black spots in the coverage of the Argos satellite system over the Mediterranean region (De Metrio *et al*, 2004). However, the study has provided important new information on the diverse migratory behaviour of bluefin tuna occurring in Irish waters, and in timely fashion given the recent decline in landings. It is hoped that new management measures will have a positive effect on bluefin stock status and that fish will, once again, be caught and released in numbers off the Irish coast.

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