Tagging of Atlantic bluefin tuna (*Thunnus thynnus*) with pop-up satellite archival tags (PSAT) in Norway during 2024

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Bergen, Norway, 5th February 2025

Final project report prepared for the International Commission for the Conservation of Atlantic Tunas (ICCAT) / Grand Bluefin Year Programme (GBYP) 2024 – Phase 14. GBYP e-tagging program 2024.

This project is co-funded by the European Union

Executive summary

Atlantic bluefin tunas (BFT) have reoccurred in increasing numbers along the coast of Norway during the last decade. To study the behavior, migration and general ecology of BFT returning to their historical productive feeding grounds in Norwegian waters, the Institute of Marine Research (IMR) in Norway continued its tagging program of BFT along the coast of Norway in collaboration with the International Commission for the Conservation of Atlantic Tunas (ICCAT) between the 1st of September and 6th of November 2024. Like in previous years, the major aims were to collect genetic samples of BFT and tag these with both pop-up satellite archival tags (PSATs) and conventional tags as far north as possible. Tagging was performed on-board a specially designed tagging vessel with an aluminum ramp to pull the fish on board. In total, six BFT ranging from 240 cm to 293 cm (CFL) in length were tagged with PSATs and conventional tags, and genetic samples were collected. All BFT were caught from the IMR research vessel using rod-and-line and spreader bars as lures. The results of this project contribute to the understanding of the behavior, migration and ecology of this highly migratory species at its historical feeding grounds far north in the northeast Atlantic Ocean.

1. Introduction

Atlantic bluefin tunas (BFT) have returned to Norwegian waters in large numbers during the last decade (Nøttestad et al., 2020). To study the behavior, migration and ecology of BFT in Norwegian waters, the Institute of Marine Research (IMR) in Norway has been conducting electronic tagging programs as part of the Grand Bluefin Year Programme (GBYP) during the past years (Ferter et al., 2024).

Like in previous years, the International Commission for the Conservation of Atlantic Tunas (ICCAT) provided pop-up satellite tags (PSATs) to be deployed in the Mediterranean Sea and North Atlantic Ocean targeting eastern stock individuals as part of ongoing CPCs national electronic tagging programs (ICCAT GBYP CIRCULAR #G-00515/2024). Through a Memorandum of Understanding (MoU), IMR agreed to deploy five PSATs provided by ICCAT as part of the GBYP 2024 Phase 14 e-tagging activities. In addition, IMR had six self-financed PSATs available, and the results of these additional tags will be shared with ICCAT GBYP. Although both fishing and tagging were planned to be mainly performed from a research vessel owned by IMR, this study greatly benefited from collaboration with recreational BFT fishers in terms of knowledge sharing and helping to catch BFT for electronic tagging.

To study the behavior of individuals feeding at the northernmost distribution limit of the species, the aim of this project was to extend previous tagging campaigns by collecting genetic samples of BFT and tag the fish with PSATs and conventional tags during their feeding period as far north as possible in Norwegian waters.

2. Materials and Methods

All procedures followed the handling and tagging protocols in 2021 (Ferter et al., 2021).

Study area and period

The field study was conducted north of 60°N between Bømlo and Ålesund in western Norway between the 1st of September and 6th of November 2024 (Figure 1). This area was chosen because of many observations of feeding BFT during the study period, and because most of both recreational and commercial catches were taken within this area during this year's season. Moreover, like in previous years, the aim of this study was to deploy the PSATs as far north as possible in Norwegian waters. A total number of 18 effective fishing days were conducted from IMR's tagging vessel. All experimental procedures were approved by the Norwegian Food Safety Authority (FOTS ID 30799) and the Norwegian Directorate of Fisheries.

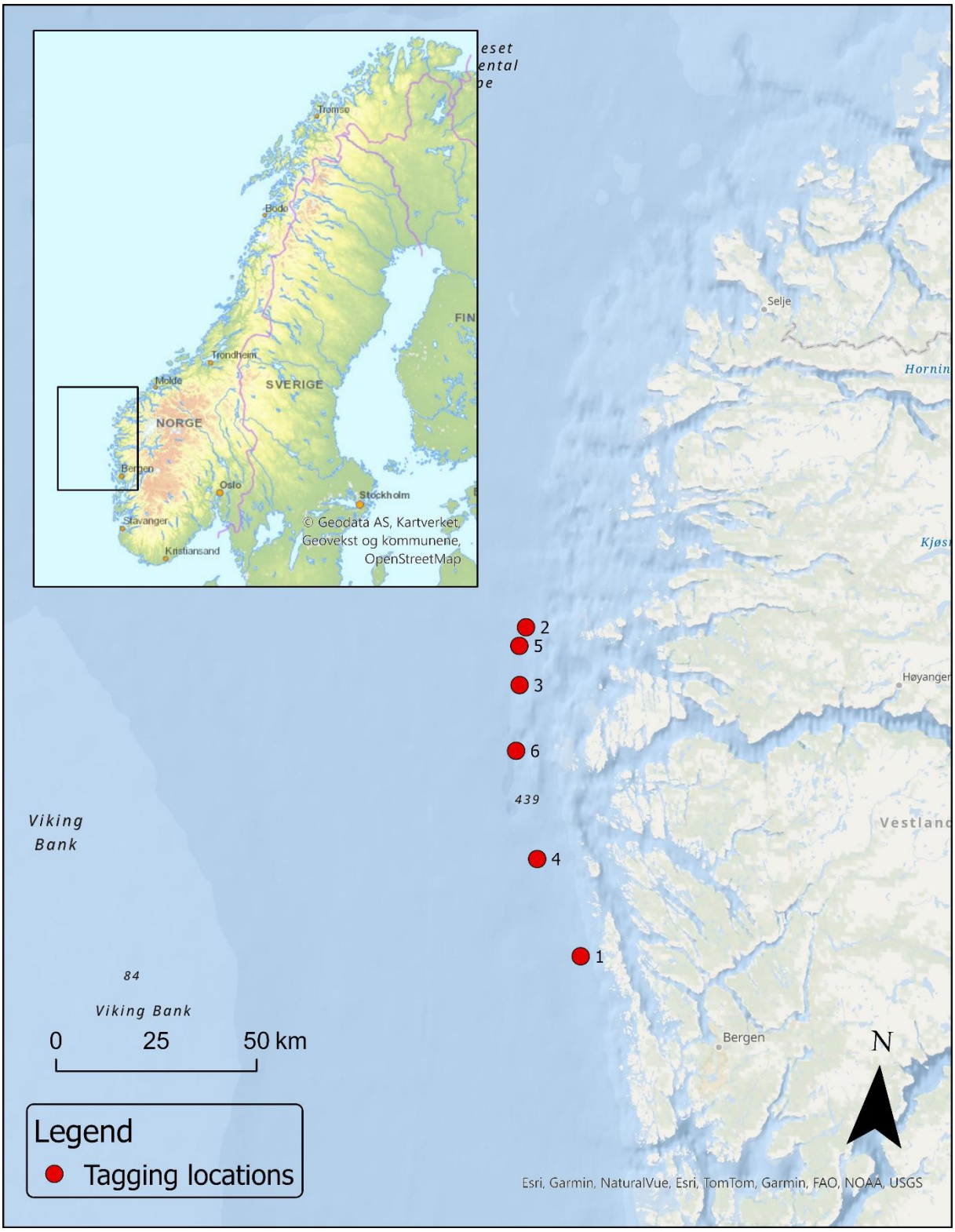

Figure 1: Map of the study area. The red dots indicate the tagging and release locations of the six tagged BFT in this study. Numbers next to the dots indicate fish ID.

Fishing equipment and methods

All fish were caught from the research vessel (Table 1) using fishing rods in the 130 lbs range, and reels of at least size 80. All fish were fought stand-up using a fighting belt (Black Magic XL wide Equalizer gimbal and harness system). Spreader bars with multicoloured squids and 500 lb. leader and >450 lb. swivels were used as fishing method on all fishing days. To keep fighting time to a minimum, the boat was used to overtake the fish as fast as possible after the first initial run. This made it possible to pull up the head of the fish from straight above, hampering the swimming of the fish and cutting angling duration to a minimum.

Tagging protocol

Once the BFT was close to the boat, a large, barbless hook with a rope was placed between the tip of the tongue and the lower jaw of the BFT. The fish was then towed behind the boat (in 2 - 3 knots) for up to 10 minutes. Afterwards, the fish was pulled into the boat on a 108-cm wide, custom-built aluminum ramp and placed on a 6 cm think foam mattress which was covered with a smooth tarpaulin. The eyes of the fish were then covered with a towel to minimize stress, and a hose with high-volume but low-pressure continuous seawater supply was placed into the mouth of the fish to irrigate the gills. The fish were tagged with one PSAT (MiniPat-348, Wildlife Computers or PSATFLEX, LOTEK, 365 days deployment duration, constant pressure release after three days) fitted with two monofilament anchors (one of them fitted to the base of the PSAT and the other one as a loop) and titanium darts next to the second dorsal fin (Wilson et al., 2015). In addition, a conventional spaghetti tag was placed close to the second dorsal fin following the instructions in the ICCAT-GBYP tagging manual (Cort et al., 2010). During tagging, the curved fork length (CFL) of the fish was measured and a fin clip was taken for genetic analysis. The fin clip was stored in > 99.0 % ethanol at 4˚C. The genetic samples were sent to AZTI for further analysis, and to be included in the GBYP tissue bank. After tagging, the fish was released on a thin rope which was pulled through the same hole as the large, barbless hook, and towed behind the boat (in 2 - 3 knots) for a short time until the fish showed strong swimming activity.

3. Results

A total number of six BFT were tagged with both PSATs and conventional spaghetti tags during the 18 fishing days (table 1). All fish were tagged north of 60°N (figure 1, table 1). The size of the fish ranged from 240 cm to 293 cm (CFL).

Table 1: Overview of the six BFT tagged along the coast of Norway in 2024.

Date	ID	Boat	Release time	Release position	CFL [cm]	Angling duration [min]	PSAT ID	Conventional
04.09.24	1	Tagging boat	17:55	60.57, 4.68	240	15	23P2734	BYP032072
07.09.24	2	Tagging boat	15:24	61.30, 4.33	270	25	23P2735	BYP032053
08.09.24	3	Tagging boat	14:30	61.17, 4.32	265	15	23P2737	BYP032051
08.09.24	4	Tagging boat	19:10	60.78, 4.45	249	12	23P2738	n/a
20.09.24	5	Tagging boat	13:10	61.26, 4.30	293	18	L330-4902*	BYP032059
20.09.24	6	Tagging boat	17:55	61.02, 4.32	248	11	L330-4903*	BYP032052

* ICCAT GBYP PSAT

To date, four of the tags have not reported, indicating that they are still attached to the fish, and that these fish survived. However, ID 3 died immediately after tagging as indicated by constant pressure recordings for three days. ID 5 detached prematurely for unknown reasons north of the Canary Islands (position: 29.410; -16.429) on 2nd of December.

4. Discussion and concluding remarks

The 2024 tagging campaign was a continuation of previous electronic tagging of BFT in Norwegian waters (Ferter et al., 2024). The number of tagged fish was lower than in previous years despite 18 days of fishing effort. In total, 42 fish have been tagged with PSATs in Norwegian waters since 2020. Apart from one post-release mortality and one early detachment, all 2024-tags are still attached to the BFT, indicating that the improved tagging protocol, i.e. on-board tagging with double anchoring, is an effective method. This is backed up by the fact that several of the tags from previous tagging projects stayed on for an entire year of deployment (Ferter et al., 2024). As all fish in this year's study were tagged north of 60°N, the results of this study will further increase our knowledge on the behavior and migration of BFT at the northernmost border of its distribution range, and fill important knowledge gaps (Nøttestad et al., 2017; Horton et al., 2020; Nøttestad et al., 2020).

Pulling the fish on board for tagging makes it possible to place the tag accurately as desired. Results from all tagging years demonstrate high retention rates of the tag and high survival rates (see also Stokesbury et al., 2011). Towing the fish on a thin rope after tagging until the fish showed strong swimming activity was a further improvement compared to previous tagging campaigns. However, in 2023 and 2024, we experienced higher post-release mortality (3 out of 17 tagged fish) compared to previous years, which might be linked to later tagging in the season, particularly in 2023. At that point, the BFT had fed on high-caloric prey such as mackerel for several weeks in Norwegian waters, which significantly increased their weight and presumably fat content. This may potentially have made them less resilient to stress

later in the season compared to earlier in the season. The increasing age and size of tagged individuals may also have played a role.

Overall, the experiences and knowledge gained from this year's study have laid the foundation for future successful electronic tagging studies of BFT in Norwegian waters. Further tagging efforts are required to further improve our understanding of the large-scale and long-term migration pattern and behavior of BFT in its northernmost distribution area.

5. Acknowledgements

This work has been carried out under the ICCAT Atlantic-Wide Research Programme for Bluefin Tuna (GBYP), which is funded by the European Union, several ICCAT CPCs, the ICCAT Secretariat, and other entities (see https://www.iccat.int/gbyp/en/overview.asp). The content of this paper does not necessarily reflect ICCAT's point of view or that of any of the other sponsors, who carry no responsibility. In addition, it does not indicate the Commission's future policy in this area. Further funding was provided by the Institute of Marine Research in Norway through the Norwegian Sea program (Project 15698 – "Vandring, utbredelse og økologi av makrellstørje"). Five of the PSATs and the conventional tags, in addition to other tagging equipment, were provided by ICCAT-GBYP. The tagging pole to set the conventional tags was provided by Anthony Mendillo Jr.. The authors are grateful to all the voluntary anglers and commercial fishers that supported the project by reporting sightings of BFT and developing fishing methods. We are also grateful for the help we have received from the Norwegian Directorate of Fisheries, e.g. providing vessel time for this project. The authors are also thankful to the staff of the Institute of Marine Research, especially Gunnar Didriksen for his work efforts in the field.

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