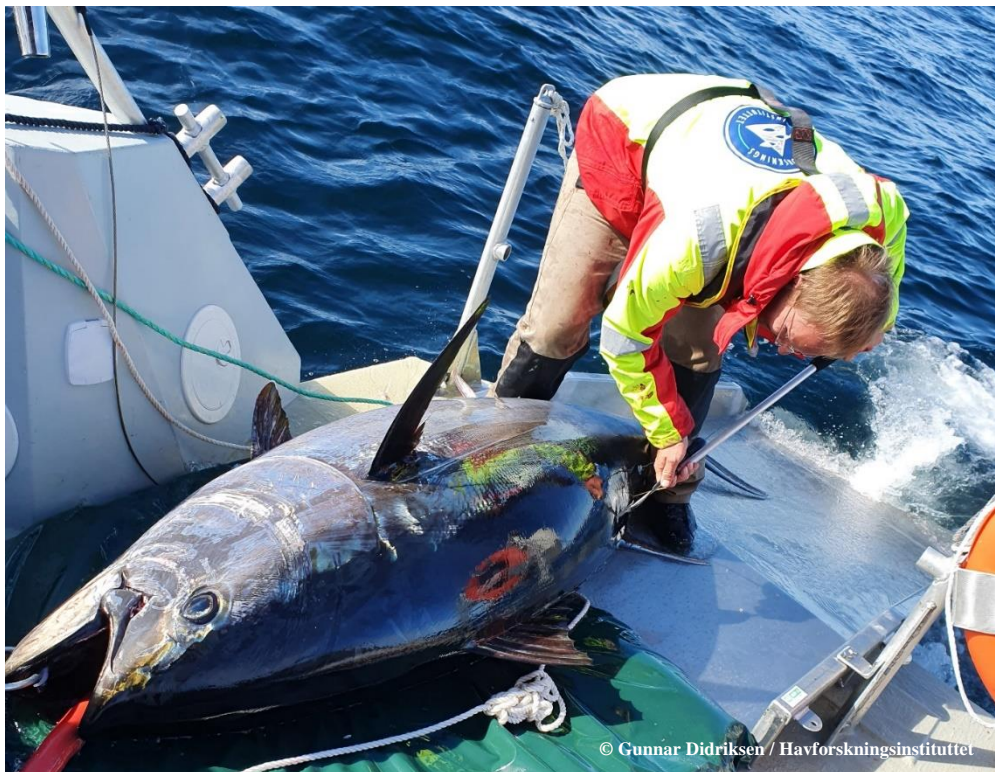


# Tagging of Atlantic bluefin tuna (*Thunnus thynnus*) with pop-up satellite archival tags (PSAT) in Norway during 2020

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## **Executive summary**

Atlantic bluefin tunas (BFT) have reoccurred in increasing numbers along the coast of Norway during the last years. To study the behavior, migration and general ecology of BFT returning to Norwegian waters, the Institute of Marine Research 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 31<sup>st</sup> of August and 29<sup>th</sup> of September 2020. The major aims were to collect genetic samples of five BFTs 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. All but one BFT were caught from the tagging vessel using rod-and-line and spreader bars as lures. One individual was transferred from a collaborating recreational fishing boat to the tagging vessel. In total, five BFT individuals ranging from 244 cm to 266 cm (CFL) in length were tagged with PSATs and conventional tags, and genetic samples were collected. After more than two months after deployment, none of the tags has reported any signals. This indicates that all tagged fish survived, and that the tagging protocol, including on-board tagging and double anchoring of the PSATs with titanium darts, works well. The results of this project contribute to the understanding of the migration and ecology of this highly migratory species at the northernmost border of its natural distribution range 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 initiated a tagging program as part of the Grand Bluefin Year Programme (GBYP) 2018 – Phase 8 (Ferber et al., 2019) in 2018. During the last years, several electronic tagging studies of BFT have been initiated in the North-East Atlantic region (Horton et al., 2020), but little is known about the behavior of individuals foraging at the northernmost distribution limit of the species.

This year, the International Commission for the Conservation of Atlantic Tunas (ICCAT) provided 22 pop-up satellite tags (PSATs) to be deployed in the North Atlantic as part of ongoing CPCs national electronic tagging programs (ICCAT GBYP CIRCULAR # 0510/2020). Norway had already put aside a national quota of 5 tons for recreational harvest of BFT, and a quota of 1 ton for incidental mortality during recreational tag-and-release fishing in 2020. The aim of this study was to deploy five of these PSATs provided by ICCAT as part of the GBYP 2020 – Phase 10, taking advantage of synergies with the ongoing recreational fishery in Norway. Although both fishing and tagging were planned to be mainly performed from a research vessel owned by IMR, this study could greatly benefit from collaboration with recreational BFT fishers in terms of knowledge sharing and helping to catch BFT for electronic tagging.

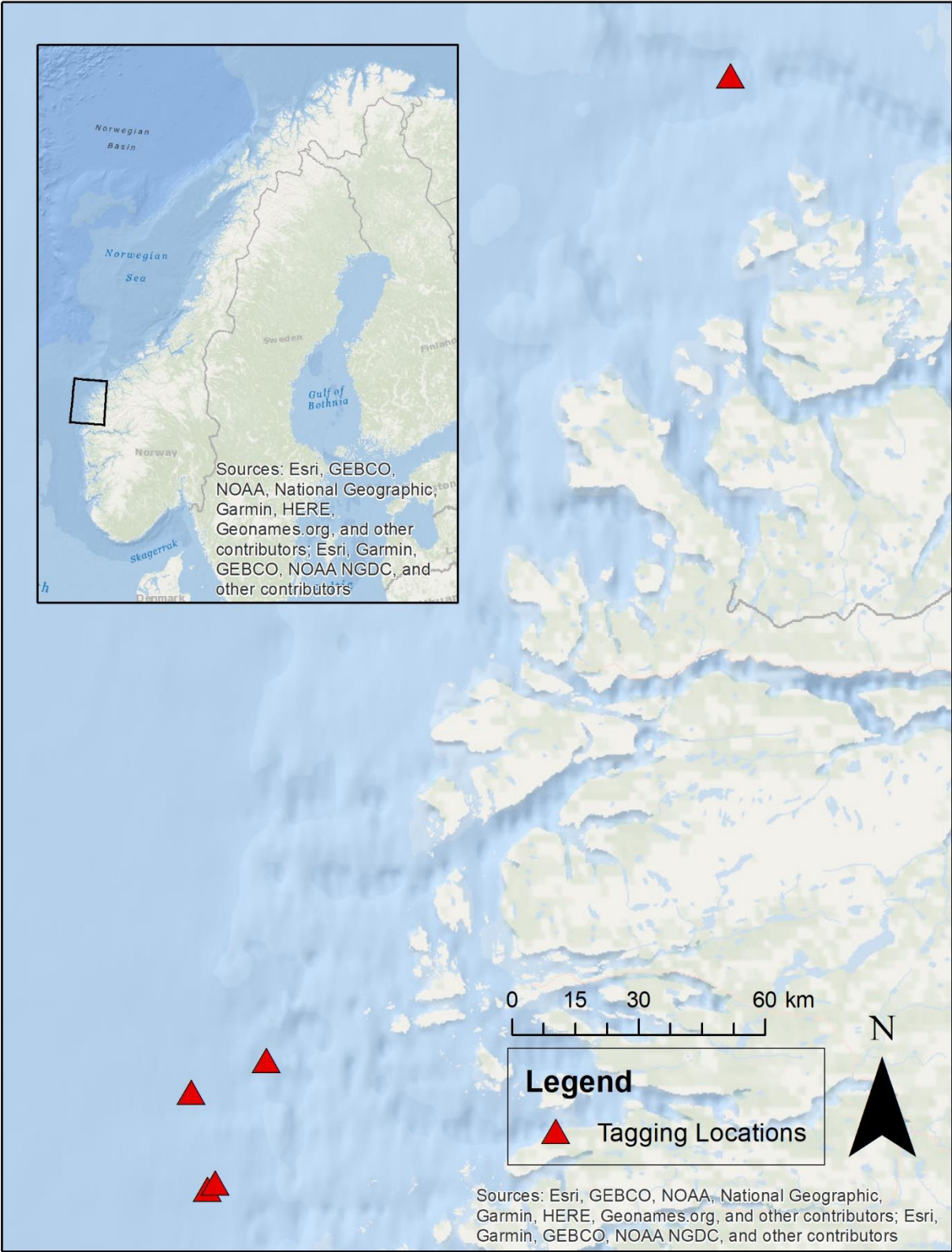
To study the behavior of individuals feeding at the northernmost distribution limit of the species, the aim of this project was to collect genetic samples of five BFTs and tag these fish with PSATs and conventional tags during their feeding period as far north as possible in Norwegian waters.

## 2. Materials and Methods

### *Study area and period*

The field study was conducted north of 61°N between Florø and Ålesund in western Norway between the 31<sup>st</sup> of August and 29<sup>th</sup> of September 2020 (see 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, the aim of this study was to deploy the PSATs as far north as possible. Totally, 14 effective fishing days were conducted. Surface water temperatures ranged between 15° C and 16.5° C (measured with a conventional echosounder). All experimental procedures were

approved by the Norwegian Food Safety Authority (FOTS ID 24394) and the Norwegian Directorate of Fisheries.



**Figure 1:** Map of the study area. The red triangles indicate the tagging and release locations of the five tagged BFTs in this study.

### *Fishing equipment and fishing methods*

All except one fish were caught from the research vessel using fishing rods in the 130 lbs-unlimited range, and reels of size 80. All fish were fought stand-up using a fighting belt (Black Magic XL wide Equalizer gimbal and harness system). One fish (ID 3) was caught by a recreational fishing boat and fought from a rod holder mounted to the boat. Spreader bars 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 (table 1).

### *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 (figure 2). The fish was then towed behind the boat (in 2 - 3 knots) for approximately five minutes, while an aluminum landing ramp was lowered into the water (figure 3). Once the landing ramp was in place, the fish was pulled into the boat and placed on a 6 cm thick foam mattress which was covered with a smooth tarpaulin. The eyes of the fish (except for ID 1) 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, 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 (figure 4). 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.

After tagging, the fish was released immediately back into the water without any further treatments. This was decided, as the first fish which was supposed to be tagged and released in this study encountered the boat propeller, as it swam forward during towing after tagging. Since all fish were in very good condition after tagging, further restitution after tagging was judged not necessary and therefore removed from the tagging protocol.





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**Figure 2:** Hook placement between the lower jaw and the tip of the tongue to secure the fish on a rope.



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**Figure 3:** The research vessel “Emmy Egidius” which was used in this study to catch and tag the BFTs. The red circle indicates the movable aluminum landing ramp which was used to pull the BFT on board for tagging. During fishing, the ramp was lifted on board, and it was lowered into the water during tagging.



**Figure 4:** All BFTs in this study were tagged on-board with one PSAT and a conventional spaghetti tag close to the second dorsal fin.

### 3. Results

During the 14 fishing days, five BFTs were tagged with both PSATs and conventional spaghetti tags (table 1). All fish were tagged north of 61°N (figure 1). The size of the fish ranged from 244 cm to 266 cm (CFL). Four fish were caught from the research vessel and one fish (ID 3) was transferred from a recreational fishing boat to the research vessel. Except for one fish, the fighting time was 60 minutes or less.

**Table 1:** Overview of the five BFTs tagged along the coast of Norway in 2020.

Date	ID	Boat	Release time	Release position	CFL [cm]	Angling duration [min]	PSAT ID	Conventional
31.08.20	1	Tagging boat	14:35	N62°30.7 E5°27.5	252	100	20P1207	BYP031126
19.09.20	2	Tagging boat	18:00	N61°29.5 E4°18.4	244	15	20P1161	BYP031127
28.09.20	3	Recreational boat	09:00	N61°31.5 E4°28.0	250	60	20P1200	BYP031135
29.09.20	4	Tagging boat	13:45	N61°23.6 E4°20.4	266	25	20P1160	BYP031131
29.09.20	5	Tagging boat	15:20	N61°23.6 E4°20.4	250	20	20P1191	BYP031138

None of the fish had any substantial physical damage, but one fish (ID 3) had some light bleeding from the tongue after the landing hook had been removed, and one fish (ID 5) showed some light bleeding from the gills before landing. The bleeding of the second fish stopped while the fish was towed behind the boat prior to tagging. All tagged fish swam away actively after release, and after more than two months at liberty, none of the tags has reported.

#### 4. Discussion and concluding remarks

The results of this study will improve our knowledge of the long-distance migration, behavior and general ecology of BFT at the northernmost border of its distribution range (Nøttestad et al., 2017). This is the first time that BFTs have been tagged with PSATs north of 61°N, which will fill important knowledge gaps (Horton et al., 2020; Nøttestad et al., 2020). Moreover, the improved tagging protocol, i.e. on-board tagging with double anchoring, has proven to be effective. All five tagged fish survived post-release, and there has not been any tag loss after two months at liberty. High survival of rod-and-line caught fish has been demonstrated in earlier studies (Stokesbury et al., 2011), but correct handling both during capture and on-board handling is essential to secure high survival.

As in previous years, rod-and-reel angling has been shown to be a suitable method for capturing BFT for tagging purposes in Norwegian waters. In fact, angling durations, which can be a serious stressor during capture (Hoolihan et al., 2011), were as short as 15 minutes in this study. To achieve these short angling durations, both strong equipment, experienced anglers, and maybe most important, active use of the boat during the fight were essential. A key to achieve short capture durations is to overtake the fish as fast as possible after the first run, which enables the angler to exert force from above rather than from the side of the fish. This makes it possible to lift the head of the fish upwards, forcing the fish to swim towards the surface. Keeping capture and handling stress to a minimum is necessary, both to reduce the potential for post-release mortality (Cooke and Suski, 2005) and to minimize impacts on post-release behavior (Hoolihan et al., 2011). The angling duration of the first fish was 100 minutes. This was because two fish were hooked at the same time. The first fish was landed after less than one hour, but as mentioned earlier, it got injured by the boat propeller during restitution after tagging, because the fish swam forward into the propeller. After euthanasia of that fish, the second fish was landed successfully and released in pristine condition.

While on-board tagging may pose some increased risk to harm the fish compared to tagging next to the boat, it has been proven to be an effective method if done correctly. Once the BFTs were pulled on-board, they were very calm, making exact placement of the tags possible. Two fish showed some stronger movements while on board, which was probably the result of the water hose being inserted too far into the mouth, triggering a gulping reflex (Davis, 2010). Restitution after tagging was removed from this year's tagging protocol due to the increased risk of injury during restitution, and as all fish swam away actively. However, if a fish is very exhausted or the tagging takes longer than expected, restitution after tagging may



be necessary. In that case, a release hook may be used so that the fish does not have to be retrieved all the way to the boat after restitution.

All in all, the experiences and knowledge gained from this year's study have laid the foundation for future electronic tagging studies in Norwegian waters. Further tagging efforts are required to fully understand the migration and behavior of BFT at its northern distribution limit. Tagging activities in Norwegian waters for 2021 have already been funded, and the aim is to tag a larger number of individuals next year.

## **5. Acknowledgements**

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