DISTRIBUTION, CATCHES AND RESEARCH ON ATLANTIC BLUEFIN TUNA (THUNNUS THYNNUS) IN THE NORWEGIAN EXCLUSIVE ECONOMIC ZONE

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Utbredelse, fangster og forskning av makrellstørje (Thunnus thynnus) i norsk økonomisk sone

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FISKERIDIREKTORATET

Summary (English):

Norway was historically one of the largest fishing nations on large, adult Atlantic bluefin tuna (ABFT) (*Thunnus thynnus*) in the world, peaking 15 000 tons of catches and involving up to 470 fishing vessels annually in Norwegian exclusive economic zone (EEZ) during the 1950's and early 1960's. This created broad and lively fishing activity on ABFT along the extensive Norwegian coastline during summer and autumn.

Highly productive waters stretching >20 000 km along the Norwegian coastline and offshore in the vast and deep Norwegian Sea ecosystem, contain annually some 12-16 million tons of pelagic schooling fish. This represents abundant preferred prey species, which attract the largest and oldest ABFT top predators to rapidly migrate from the Mediterranean Sea spawning areas, and forage extensively on these prey species for extended periods each year, within the northernmost feeding habitats of the species.

ABFT have shown a substantial increase in relative abundance during the last decade since the documented comeback in Norwegian EEZ in 2012. ABFT have been recorded from ~58°N in the North Sea and Skagerrak to Arctic waters at 76.3°N close to Svalbard, representing 1800 km straight line distance from south to north within Norwegian EEZ. Furthermore, ABFT are at present foraging on schooling fish species such as Northeast Atlantic (NEA) mackerel (*Scomber scombrus*), from late June until late December. Most ABFT have been recorded between mid-August and mid-October each year. Furthermore, individuals electronically tagged in Norway spent on average 68 days foraging in these waters, representing a significant zonal attachment within Norwegian EEZ.

ABFT's exceptional increase the last decade in relative abundance, extensive geographical distribution, and long period present within Norwegian EEZ, clearly document that these waters are important northerly migration routes and feeding areas for particularly older (10+ years) and larger (150-400+ kg) individuals of ABFT in the Northeast Atlantic.

After the recurrence of ABFT in Norway, most large adult fish entering Norwegian waters belong to the Northeast Atlantic and Mediterranean bluefin tuna stock, based on state-of-the-art genetic origin analyses and top-notch electronic PSAT tagging studies.

There is, consequently, a need for wise and long-term sustainable management of this important branch of ABFT, consisting of the largest and oldest individuals. There is a need to reduce the likelihood that these large individuals with high fecundity may be decimated due to selective fishing pressure, particularly in the Mediterranean Sea.

The Institute of Marine Research (IMR) in Norway has invested substantial resources and infrastructure, including coastal and oceanic surveys, and dedicated national and international collaborative research on ABFT. In this report we also summarize a wide range of inter-connected research activities conducted on ABFT in Norway during the last decade.

Summary (Norwegian):

Norge var historisk sett en av de største fiskerinasjonene på stor, voksen atlantisk makrellstørje (ABFT) (*Thunnus thynnus*) i verden, med en årlig topp på 15 000 tonn fangster og opptil 470 involverte fiskefartøy i norsk økonomisk sone (EEZ) på 1950-tallet og begynnelsen av 1960-tallet. Dette skapte et betydelig, livlig og økonomisk innbringende fiske på ABFT om sommeren og høsten langs den vidstrakte norskekysten.

De produktive farvannene som strekker seg >20 000 km langs norskekysten og utenfor kysten i det enorme og dype økosystemet i Norskehavet, inneholder årlig om lag 12-16 millioner tonn pelagisk stimfisk som makrell, sild og kolmule. Dette representerer rikelig med foretrukne byttedyrarter, som tiltrekker seg de største og eldste individene av ABFT. Etter en rask vandring fra gyteområdene i Middelhavet, beiter ABFT på disse byttedyrartene innenfor de nordligste beiteområdene til arten i lengre perioder om høsten hvert år.

ABFT har vist en betydelig økning i relativ mengde i løpet av det siste tiåret siden det dokumenterte comebacket i norsk økonomisk sone i 2012. ABFT er registrert fra ~58°N i Nordsjøen og Skagerrak til arktiske farvann ved 76,3°N nær Svalbard, noe som tilsvarer 1800 km rett linjeavstand fra sør til nord innenfor norsk økonomisk sone. Videre oppsøker ABFT stimfiskarter, som nordøstatlantisk makrell (Scomber scombrus), fra slutten av juni til slutten av desember. De fleste ABFT har blitt registrert mellom midten av august og midten av oktober hvert år. Videre tilbrakte individer som ble elektronisk merket i Norge i gjennomsnitt 68 dager på å lete etter mat i disse farvannene, noe som representerer en betydelig sonetilhørighet innenfor norsk økonomisk sone. ABFTs eksepsjonelle økning det siste tiåret i relativ overflod, utstrakt geografisk utbredelse og lang periode innenfor norsk farvann, dokumenterer tydelig at disse farvannene er viktige nordlige migrasjonsruter og beiteområder for spesielt eldre (10+ år) og større (150-400+ kg) individer av ABFT i Nordøst-Atlanteren.

Basert på toppmoderne genetiske opprinnelsesanalyser og førsteklasses elektroniske PSAT - satellittmerkingsstudier ser vi at de fleste individene som besøker norske farvann tilhører bestanden av ABFT i Nordøst-Atlanteren og Middelhavet.

Det er derfor behov for en klok og langsiktig bærekraftig forvaltning av denne viktige grenen av ABFT, som består av

de største og eldste individene. Det er behov for å redusere sannsynligheten for at disse store individene med høy fruktbarhet og reproduksjonspotensiale kan bli desimert på grunn av selektivt fiskepress, spesielt i Middelhavet.

Havforskningsinstituttet (HI) i Norge har investert betydelige ressurser og infrastruktur, inkludert kyst- og havundersøkelser, og dedikert nasjonalt og internasjonalt forskningssamarbeid på ABFT. I denne rapporten oppsummerer vi også et bredt spekter av sammenkoblede forskningsaktiviteter utført på ABFT i Norge det siste tiåret.

Content

1 - Background

Atlantic bluefin tuna (ABFT; *Thunnus thynnus*) is a large, endothermic and highly migratory species (Block et al. 1997), which occupies a wide range of habitats in the North Atlantic Ocean and adjacent seas (Fromentin and Powers 2005)]. ABFT is managed as a mixed stock (i.e. western and eastern) based on a management strategy evaluation (MSE) approach adopted by the International Commission for the Conservation of Atlantic Tunas (ICCAT) in 2022 (ICCAT 2022). ABFT has probably been migrating to and feeding along the Norwegian coastline for thousands of years (Nielsen and Persson 2020), and frequency of haplotypes using ancient DNA from ABFT has remained similar through time for up to 5000 years (Falkeid et al. 2025). Norway was one of the largest fishing nations on ABFT in the Northeast Atlantic (Nøttestad and Norman 2004; ICCAT 2014). ABFT catches and observations in Norway occurs at the northernmost distribution area of the species. During the 1950's and early 1960's substantial catches reaching 15 000 tons were taken along the Norwegian coast, involving up to 470 coastal vessels (Tangen 1999; Cort and Nøttestad 2007; Appendix 1). This abundance of fish created a lot of ABFT fishing activity, optimism, and economic income along the coast of Norway (Tangen 1999; Nøttestad et al. 2017a; Karlsen 2022). International overfishing of both juvenile and adult fish in combination with poor recruitment, has led the Atlantic bluefin tuna stock to be decimated, and the species practically disappeared from Norwegian waters (Cort and Nøttestad 2007; Cort and Abuenza 2015).

After several decades of absence, ABFT had a comeback from 2012 and largely increased biomasses, observations and distribution in space and time within Norwegian waters the following years (Nøttestad et al. 2017a; Nøttestad et al. 2020). The eastern ABFT stock has recovered following strict management measures for many years and is at present sustainably harvested with high abundance and extensive spatial distribution. A whole range of management measures were executed to reduce the extensive overfishing, including significantly reduced total allowable catches (TACs), increased minimum landing size, fishing closures in space and time both in the Mediterranean Sea and in the North Atlantic Ocean, systematic international control regime both at sea and in landing ports, as well as establishing individual catch certificates to prevent IUU fishing in the recent decade (ICCAT 2023; Bjørndal 2023). This documented increase in abundance and distribution of ABFT in Norwegian waters, may also have profound effects on predator-prey interactions, as ABFT are now targeting major schooling fish species, such as mackerel and herring, which sustain highly valuable fisheries in Norway (Nøttestad et al. 2017a; Nøttestad et al. 2020, Ferter et al. 2024). Consequently, the comeback and significant increase in abundance and distribution of ABFT in Norwegian waters during the last decade (Nøttestad et al. 2020; Boge et al. in prep) may indeed have increased the natural mortality (N) of pelagic planktivorous fish species in general and mackerel in particular (Nøttestad et al. in prep).

ABFT is managed by the International Commission for the Conservation of Atlantic Tunas (ICCAT), established in Rio de Janeiro, Brazil, 31. May 1966. Norway became a full member of ICCAT in 2004. We have worked dedicated and long-term strategically during the last two decades, to provide historical and present time scientific data, results, and new valuable knowledge on ABFT from Norway to ICCAT. The major objective is to contribute and improve the stock assessment and advice for sustainable management of ABFT in general, and ABFT knowledge and ecosystem understanding in Norway in particular.

This report summarizes both fishery dependent and fishery independent data sources and results on ABFT during the last decade from 2012 to 2024, including commercial and recreational catches taken within the Norwegian Exclusive Economic Zone (EEZ). We also present updated available data and results on ABFT relative abundance, spatiotemporal distribution, biology, ecology, migration, and feeding behaviour in Norwegian waters, as well as management related aspects of the largest tuna species in the world.

2 - Material and methods

The material and methods used in this updated summarized report on ABFT originate from a wide range of scientific approaches and methodologies originating from peer reviewed publications and reports, depending on the objectives in question. The first distinction is between fishery dependent and fishery independent data sources and methodologies. All commercial and recreational catches and bycatches of ABFT represent fishery dependent data, whereas visual observations, electronic tagging as well as scientific surveys and experiments represent fishery independent data. Since science on tuna species in general and Atlantic bluefin tuna in particular literally had to start from scratch again in Norway, due to the absence of the ABFT for decades, a whole range of scientific studies needed to be initiated after the comeback in 2012. Both methods and expertise had to be acquired across important fields of science at the Institute of Marine Research as well as international research institutions involved in the scientific committee on research and statistcs (SCRS) in ICCAT. The most important methods are related to collect basic and fundamental biological data concerning weight, length, and age distribution of ABFT in Norwegian waters in accordance with established ICCAT material and methods. In addition, we also apply state-of-the-art tagging methodology for long-term and high-resolution migration studies of ABFT, and modern acoustic methods using multibeam sonars for study ABFT school size, structure, as well as behaviour and ecology in Norwegian waters. A stomach sampling program on ABFT in Norwegian waters will be initiated in 2025.

3 - Results

3.1 - Distribution

3.1.1 - Abundance and distribution of ABFT in Norway 2012-2024

We have collected, systematized, and standardized data on observations and sightings from ABFT after the documented comeback of this top predator in Norwegian waters since 2012. There has been a substantial increase in observations of ABFT in Norwegian EEZ from 2012 onwards as clearly shown in **Figure 1**. It is worth noting that there are uncertainties related to the observation effort between years, which could influence the results. Nevertheless, the overall development remains the same, with a large increase in ABFT sightings and observations within Norwegian EEZ during the last decade, followed by an indication of stabilization of observations during the last few years.

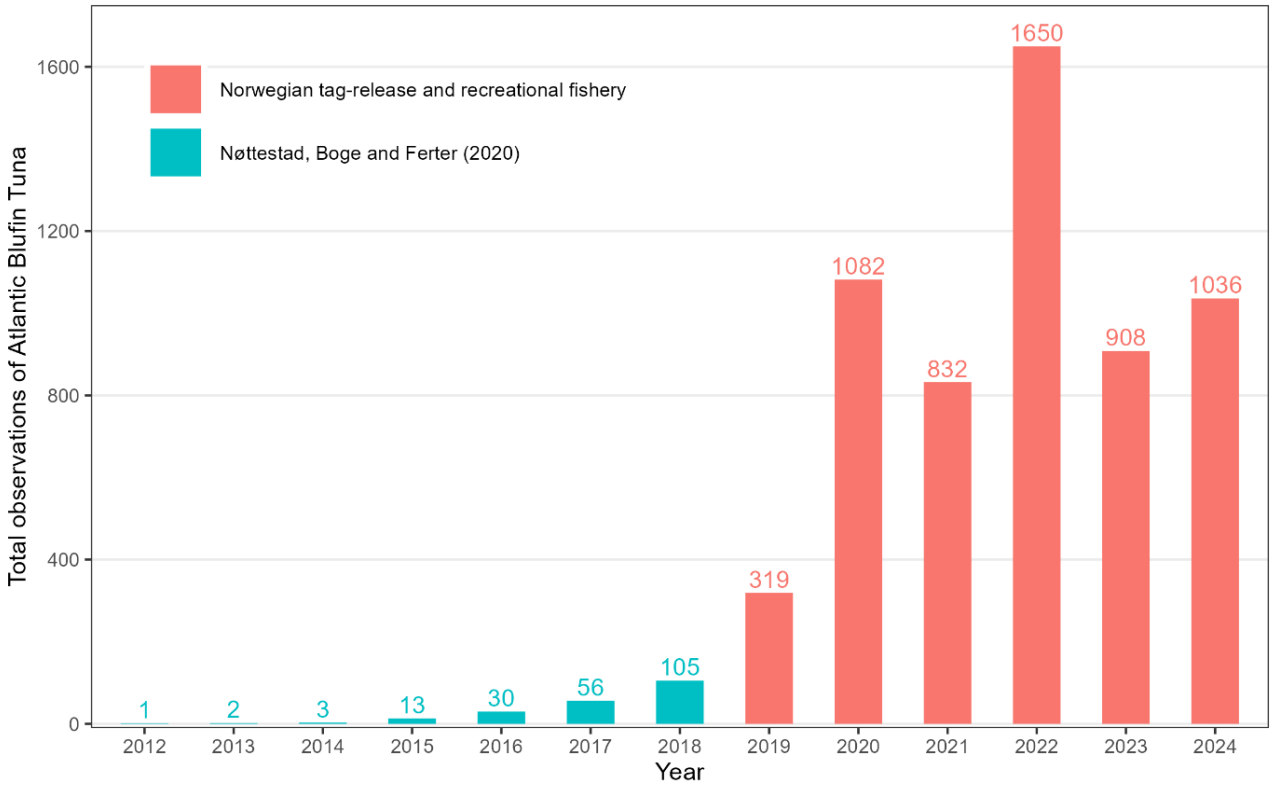

Figure 1: A substantial development in total observations of ABFT in Norwegian Exclusive Economic Zone (EEZ) from 2012 to 2024. Data from 2012-2018 are reproduced from Nøttestad et al. (2020), whereas data from 2019 to 2024 are obtained from the Norwegian tag-release and recreational fishery on ABFT (Boge et al. in prep).

The documentation of the comeback and reestablishment of ABFT in Norway has previously been published (Nøttestad et al. 2020). A continuous and sharp increase in ABFT observations in Norwegian waters have been made during the last decade. The annual amounts of observations are based on a conservative method of counting. Both commercial and recreational fishermen experienced bad weather conditions in both 2021, 2023 and 2024 compared to the other years, which may have influenced the reduced number of sightings, compared to in 2020 and 2022. Considerably more favourable weather conditions for both sightings of and fishing on

ABFT in Norwegian waters were found in 2020 and 2022.

Results available from Nøttestad et al. (2020), did not have any catch data and research data available during the last years from 2019 to 2024. Citizen science including systematic and standardized observations of ABFT have been conducted in Norway for the period 2019-2024.

Geographical positions on catches and sightings of ABFT have also been documented from 2012-2024. Results reveal that ABFT have been recorded all the way from Skagerrak and the North Sea at ~58°N to Svalbard at ~76°N in the Norwegian EEZ (Figure 2).

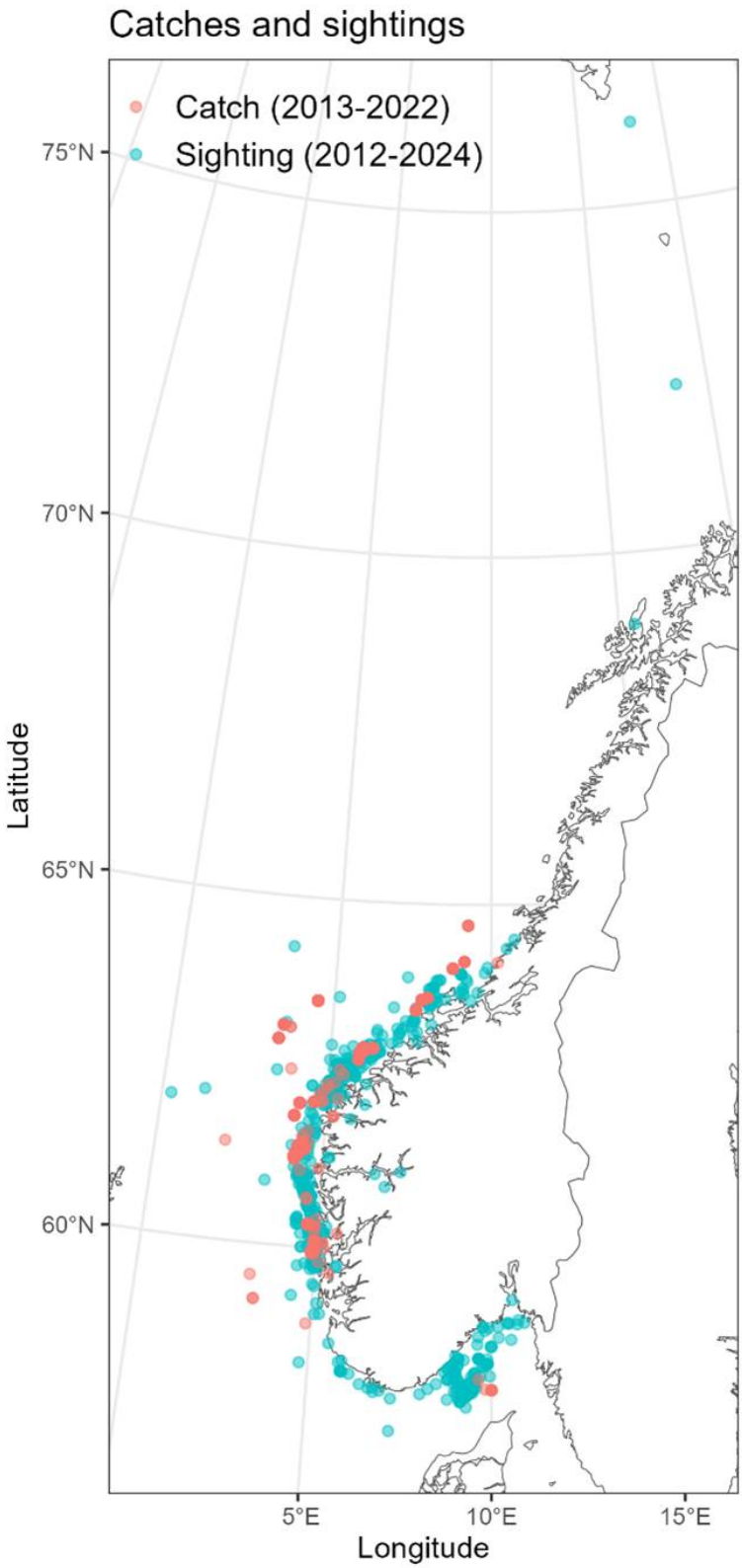

Figure 2 : Map showing overall distribution of commercial catches (from 2013-2022) and sightings (from 2012 to 2024) of Atlantic bluefin tuna (ABFT) stretching from <58°N to >76°N within Norwegian territorial waters after the comeback.

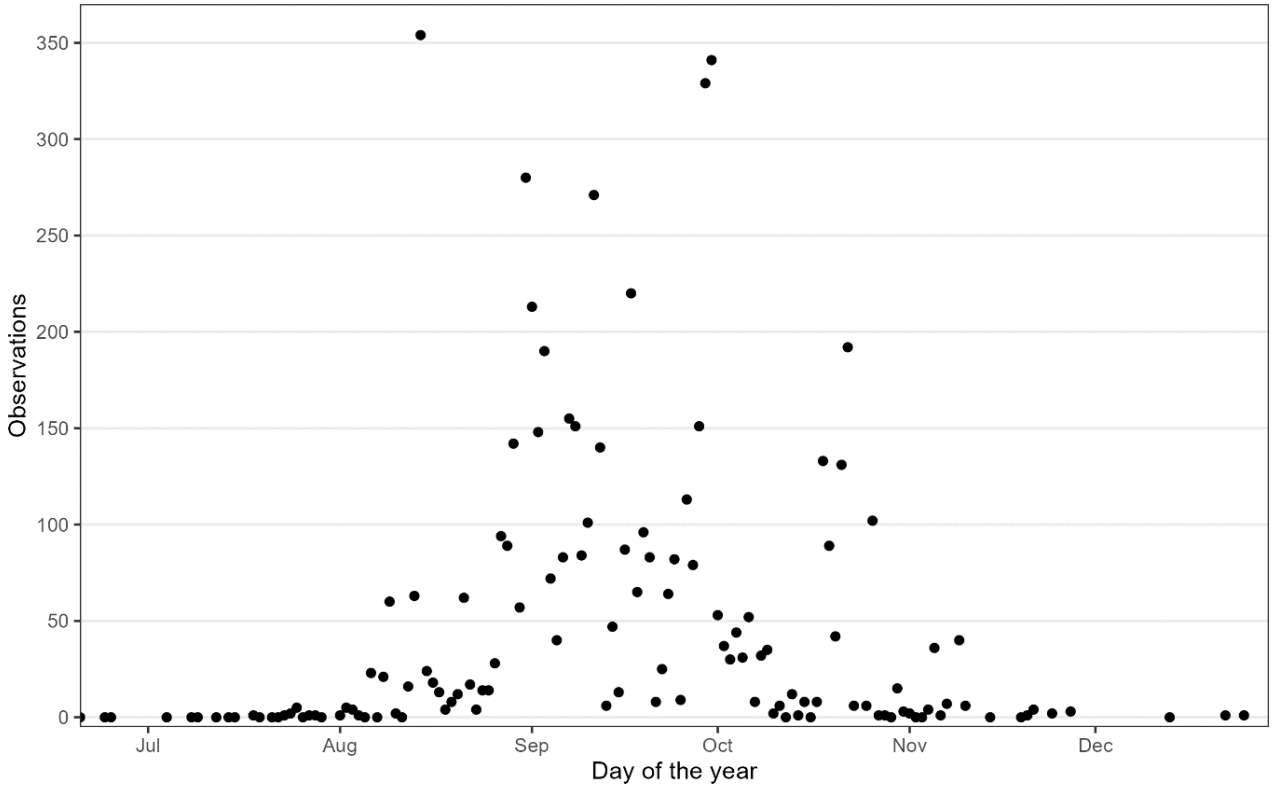

Figure 3 : Number of observations of ABFT documented from late June to late December in Norwegian waters from 2012 to 2024. Most observations have been recorded annually between mid-August and mid-October.

Observations of ABFT have been made between June and December but the vast amount are recorded between mid-August and mid- October (**Figure 3**), which are in line with detailed annual migration data from satellite tagging of numerous adult individuals (Ferter et al. 2024). Even though the majority of ABFT enter the Norwegian EEZ in August and leave in October each year, ABFT has, nevertheless, been observed in the very narrow Nærøyfjord as late as 25th of December in 2018, about 200 km inside Sognefjord: Norway's longest and deepest fjord. On the 22nd of September 2024, a school of approximately 10 individuals was observed feeding on sprat (*Sprattus sprattus*) outside Lærdal, also far into the extensive Sognefjord.

3.1.2 - Ecological effects of ABFT returning to Norwegian waters

Highly productive waters stretching >20 000 km along the Norwegian coastline and offshore in the vast and deep Norwegian Sea ecosystem, contain some 12-16 million tons of pelagic schooling fish such as Northeast Atlantic (NEA) mackerel (*Scomber scombrus*), Norwegian spring-spawning (NSS) herring (*Clupea harengus*) and blue whiting (*Micromesistius poutassou)* (**Figure 4**). High prey concentrations attract the largest and oldest Atlantic bluefin tuna to rapidly migrate from the Mediterranean Sea spawning areas, and forage extensively on these prey species for extended periods each year, within the northernmost feeding habitats of the species (Ferter et al. 2024).

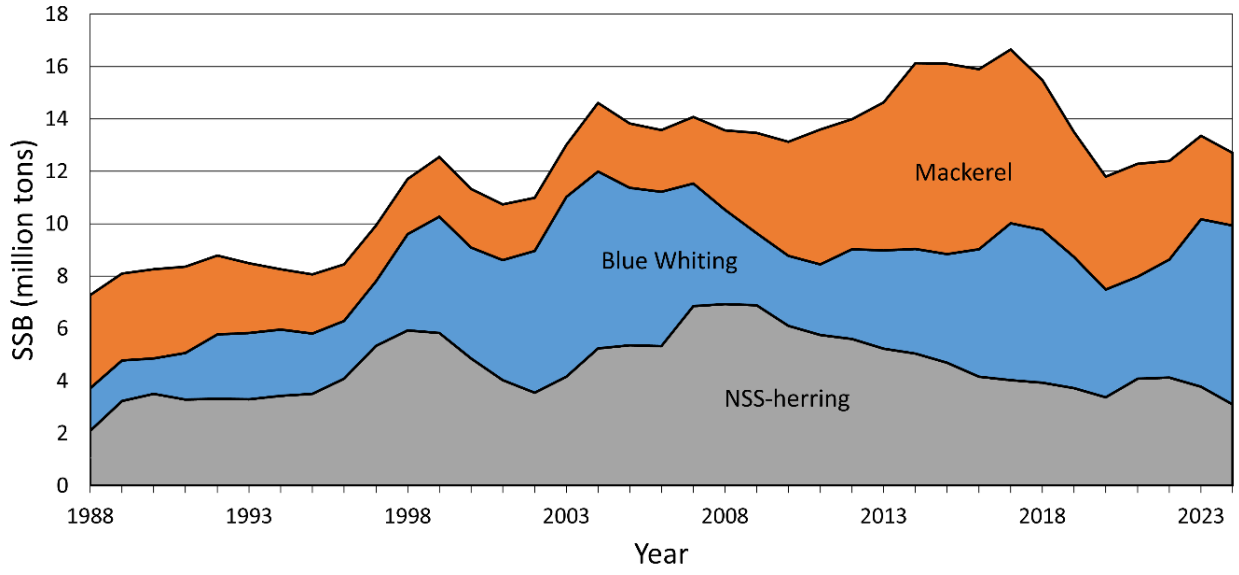

Figure 4 : Estimated Spawning Stock Biomass (SSB) for some of the most important fish stocks in the Norwegian EEZ for the time-period 1988-2024 (ICES 2024b). Total biomass decreased during the period 2017-2020, but since then continued to increase at a steady rate. From 2023 to 2024 the biomass of Northeast Atlantic mackerel (Scomber scombrus), blue whiting (Micromesistius poutassou) and NSS herring (Clupea harengus) in the Northeast Atlantic all decreased. Total biomass is estimated to constitute short of 13 million tons in 2024.

The increased abundance and spatiotemporal distribution of ABFT foraging in the Norwegian EEZ during the last decade, has also increased the natural mortality (N) through predation on targeted prey species such as mackerel and herring. These predator-prey interactions on commercially important pelagic fish species are difficult to quantify, but nevertheless, must have influenced the spawning stock biomasses (SSB) of mackerel and herring. Furthermore, the behaviour of these abundant pelagic schooling species may have changed, due to this new and highly effective top predator specifically hunting and foraging on these schooling prey species in several marine ecosystems in the Northeast Atlantic.

3.1.3 - ABFT entering Atlantic salmon farming net pens in Norway

The Norwegian Directorate of Fisheries also contributes to facilitate and assist on various research areas on ABFT as well as collaborate with the Institute of Marine Research in conducting research on ABFT. One peculiar and unexpected development in Norway is related to ABFT entering farming net pens along the coast of Norway and within fjords (**Figure 5**). Note that data on incidents regarding ABFT in the aquaculture industry is based on information reported by aquaculture localities and will for this reason be associated with a degree of uncertainty.

An increasing number of ABFT weighing up to 370 kg and caught as far north as >66°N, literally catching themselves inside Atlantic salmon farms along the coast of Norway (**Figure 5a).** There has been an increasing number of ABFT entering farming net pens in Norway after the recursion of ABFT from 2015 onwards (**Figure 5b**). Number of incidents have been increasing from 1 incident in 2015 to 8 incidents in 2023, which also strongly indicate that an increasing number of ABFT is now present and feeding in Norwegian waters compared to a decade ago (**Figure 5b**).

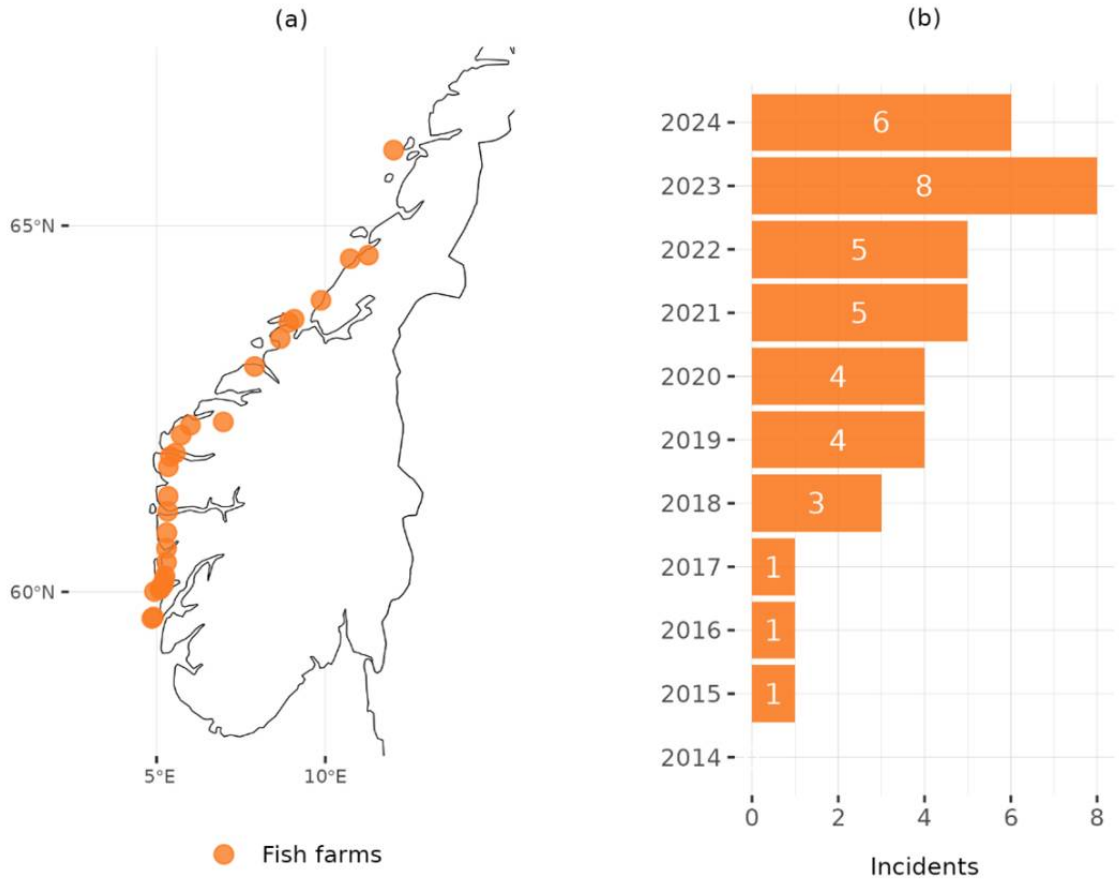

Figure 5 : (a) Fish farms with reported incidents involving Atlantic bluefin tuna (ABFT) in the period from 2014 to 2024 (Norwegian Directorate of Fisheries 2024 b). Incidents are especially prevalent on the western coast of Norway. (b) Number of incidents of ABFT being caught in fish farms reported per year. The number of incidents has been increasing every year since 2017, with 2023 and 2024 being the years with the most reported occurrences on record.

3.2 - Catches

3.2.1 - Development of ABFT fishery in Norwegian waters 2013-2024

The spatial development of ABFT catches and bycatches from 2015-2024, after the comeback in Norwegian territorial waters in 2013, are shown in **Figure 6a**. Furthermore, the temporal development of ABFT catches and bycatches, after the comeback in Norwegian territorial waters from 2013-2024, are shown in **Figure 6b.** No catches nor bycatches were reported in 2014. We document a rapid increase and development in catches and bycatches of ABFT in Norway, as well as rapidly increased migration to and geographical distribution within Norwegian Economic Exclusive Zone (EEZ) during the last decade.

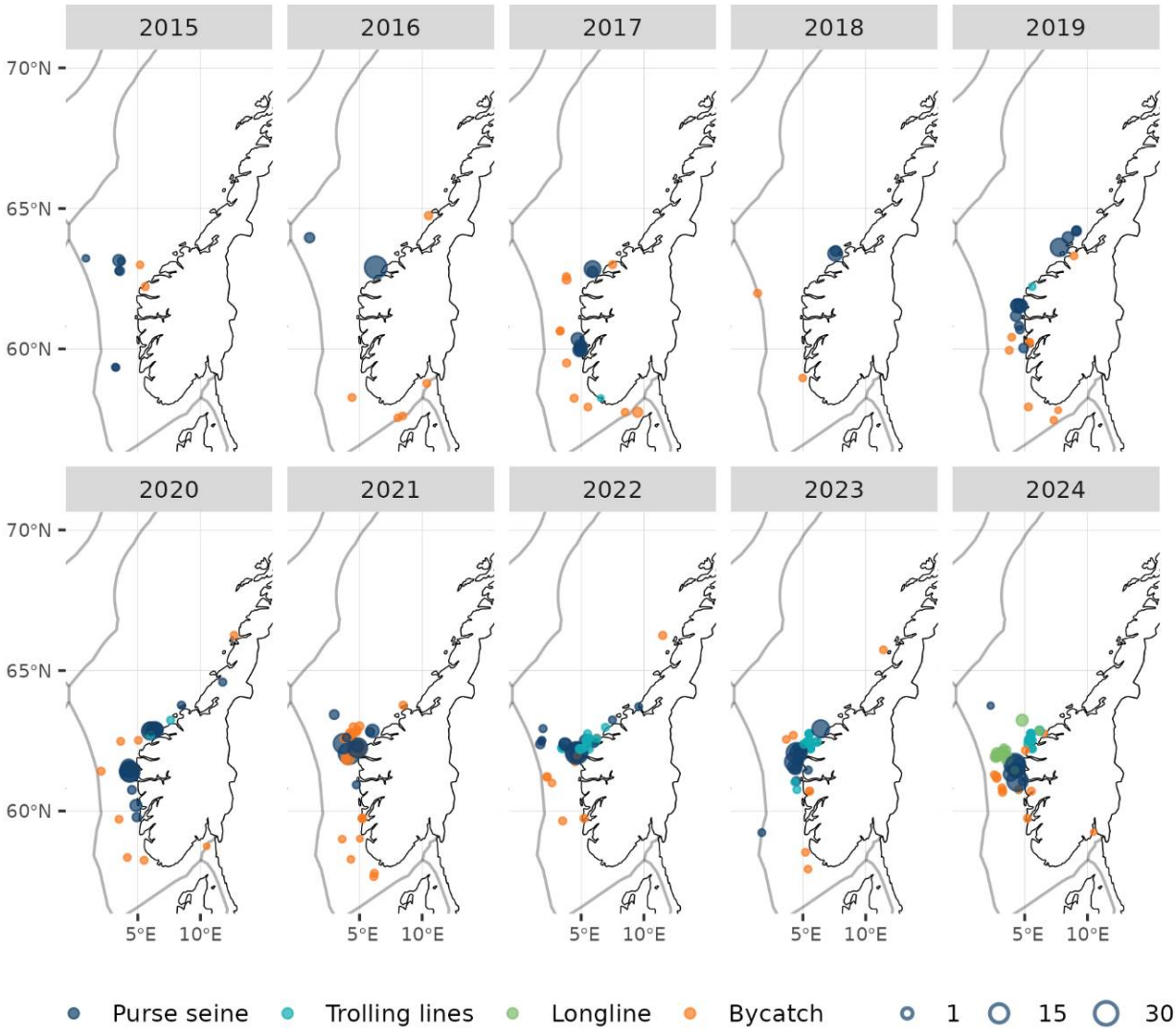

Figure 6a: Commercial catches (tons) of Atlantic bluefin tuna (ABFT) in the Norwegian EEZ from 2015 to 2024. Data compiled from the Register of Electronic Catch and Activity Reporting (ERS) from the Norwegian Directorate of Fisheries (2025a). Catches from the Register of Landings are supplied for vessels that have not reported ERS-messages. Most of the catches in the "Trolling lines" category are done by trolling and bait fishing. Most bycatches are ABFT caught with pelagic trawl.

There has also been a significant increase in spatial distribution (**Figure 6a**) and larger overall catches of ABFT taken in Norwegian waters during the last decade (**Figure 6b**). Catches in tons taken by different fishing gears of ABFT from Norwegian vessels in the period 2013-2024 are presented in **Figure 6b** .

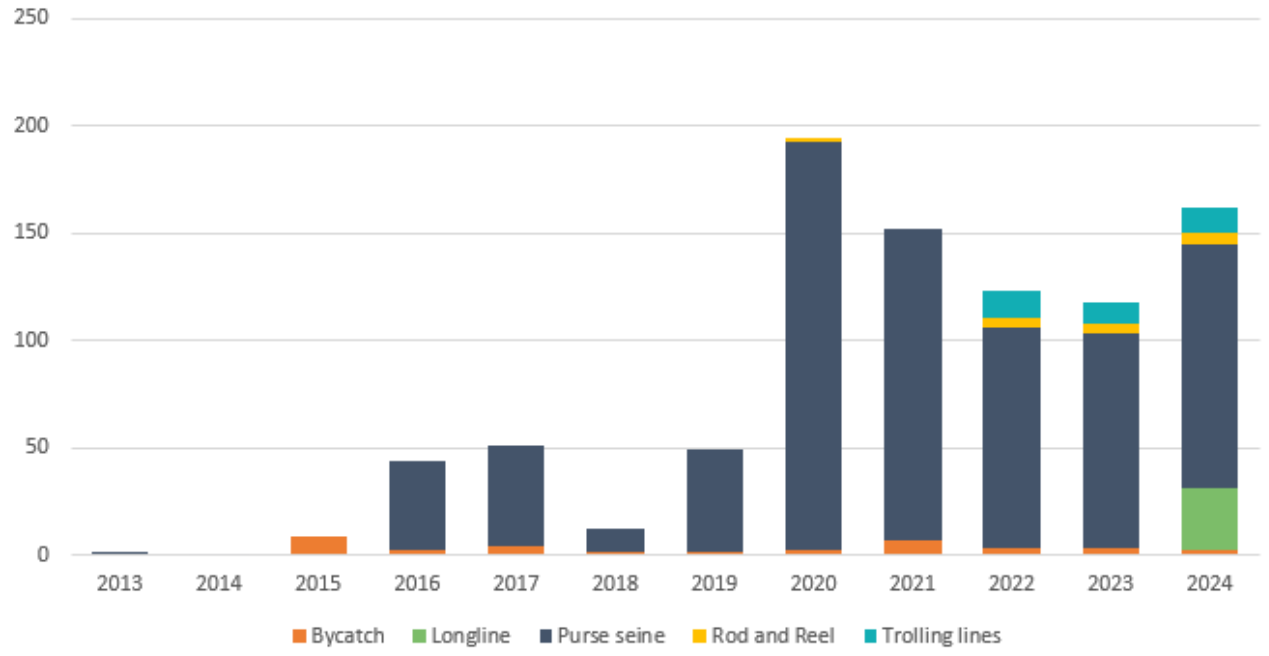

Figure 6b: Commercial catches (tons) of Atlantic bluefin tuna (ABFT) in the Norwegian EEZ in 2013 and from 2015 to 2024. Temporal development of ABFT catches and bycatches.

Below is a short summary of the ABFT fishery statistics in Norwegian waters annually reported to the Standing Committee of Research and Statistics (SCRS) in ICCAT after the ABFT comeback in Norway from 2013 onwards (ICCAT 2014-2024):

2013: Considering the critical stock situation for bluefin tuna, Norway adopted 3 May 2007 a prohibition for that year for Norwegian vessels to fish and land bluefin tuna in Norway's territorial waters, in the Norwegian Economic Zone and in international waters. A new regulation adopted 19 December 2007 provides for the same prohibition. This regulation remained in force in 2013. In addition to the prohibition to fish and land bluefin tuna, the regulation stipulates that in case of incidental by-catches of bluefin tuna in fisheries for other species, all ABFT fit for survival shall be immediately released back to the sea, whereas dead or dying bluefin tuna shall be landed. Any willful or negligent contravention of these provisions is subject to penalty in accordance with Norwegian law. Norway caught one specimen of Atlantic bluefin tuna (*Thunnus thynnus*) as by-catch in small-pelagic fisheries within Norwegian EEZ in 2013.

2015: The prohibition, for Norwegian vessels to fish and land bluefin tuna in Norway's territorial waters, was lifted in 2014 due to the improved state and recovery of the stock from the low levels in recent years. Norway licensed one purse seiner and one long-liner to fish for bluefin tuna in the Northeast Atlantic in 2015. The vessels had nil catches. However, a total of 41 specimens of bluefin tuna with a total weight 8 289 kilo were caught as bycatch by Norwegian vessels in 2015. 6 384 kilos of the total were caught by purse seiners in the Norwegian Economic Zone, 1 274 kilos were caught in the Norwegian Economic Zone and in EU waters by pelagic trawls and 667 kilos were caught by pelagic trawls on the high seas in the Northeast Atlantic.

2016 : Following ICCAT Recommendation 14-04 Norway continued a limited exploratory fishery for bluefin tuna in 2016. The bluefin tuna quota allocated to Norway was 43,71 tonnes. One purse seiner was licensed for a targeted fishery with an individual vessel quota of 32 tonnes. The remaining 11,71 tonnes were set aside to cover incidental bycatch of dead or dying bluefin tuna caught in other fisheries. An observer from ICCAT's

regional observer program was onboard the purse seiner vessel during the fishery. The purse seine vessel caught 39,64 tonnes in one single haul. Furthermore, 4,156 tonnes of bluefin tuna were taken as bycatch in non-ICCAT fisheries in 2016. Hence, a total of 43,796 tonnes of bluefin tuna were caught by Norway in 2016. Norway has forwarded the relevant reports from both the targeted fishery and the incidental bycatches to ICCAT.

2017: Only one Norwegian vessel, a purse seiner, was authorized to fish for bluefin tuna in 2017. This vessel caught a total of 46,44 tonnes in eight hauls, giving an average of 5,8 tonnes for each haul. Furthermore, 4,423 tonnes of bluefin tuna were taken as bycatch in non-ICCAT fisheries in 2017. Hence, a total of 50,863 tonnes of bluefin tuna was caught by Norway in 2017.

2018: The Norwegian fishing season in 2018 was characterized by very poor weather conditions which made it difficult to conduct a fishery for bluefin tuna. Two Norwegian vessels, both purse seiners, were authorized to fish for bluefin tuna in 2018. One of the vessels caught a total of 7,8 tonnes in one haul. The other vessel caught a total of 2,6 tonnes in one haul. The two Norwegian vessels caught a total of 10,4 tonnes in two hauls, [giving an average of 5.2 tonnes for each haul]. Furthermore, 699 kilos of bluefin tuna were taken as bycatch in non-ICCAT fisheries in 2018. Hence, a total of 11.1 tonnes of bluefin tuna was caught by Norway in 2018.

2019: The Norwegian fishing season in 2019 was characterized by overall poor weather and wind conditions which made it difficult to conduct a fishery for bluefin tuna. Eight Norwegian vessels, four purse seiners and four longliners, were authorized to fish for bluefin tuna in 2019. Three of the four purse seiners caught a total of 232 bluefin tuna, with a combined weight of 48,3 tonnes. The longliner caught only one tuna, with a weight of 168 kilos. Furthermore, 2106 kilos of bluefin tuna were taken as bycatch in non-ICCAT fisheries in 2019. Hence, a total of 50,5 tonnes of bluefin tuna was caught by Norway in 2019.

2020: The Norwegian fishing season in 2020 was characterized by Convid-19 which made it difficult to conduct a fishery for bluefin tuna. Eleven Norwegian vessels, eight purse seiners and three longliners, were authorised to fish for bluefin tuna in 2020. The purse seine vessel caught 189 tonnes, and one of the longliners caught 0,5 tonnes. In addition to these 1,8 tonnes of bluefin tuna was caught in the recreational fishery, and 2,6 tonnes was caught as bycatch. Altogether 194 tonnes of the Norwegian bluefin tuna quota were caught in 2020.

2021: The Norwegian fishing season in 2021 was characterized by Covid-19 which made it difficult to conduct a fishery for bluefin tuna. Eleven Norwegian vessels, eight purse seiners and three longliners, were authorised to fish for bluefin tuna in 2021. The purse seine vessels caught 145 tonnes. In addition to these 2,5 tonnes of bluefin tuna was caught in the recreational fishery, and 6,8 tonnes was caught as bycatch. Altogether 154 tonnes of the Norwegian bluefin tuna quota were caught in 2021.

2022: A total of 18 Norwegian vessels, including seven purse seiners and 11 small-scale vessels, were authorised to fish for bluefin tuna in 2022. Three Norwegian purse seine vessels participated in the fisheries, and they caught 102,3 tonnes, while three of the small-scale vessels caught fish equivalent to a weight of 13,1 tonnes. In addition to this, 48 fishing teams participated in the recreational fisheries, landing a total of 18 tunas with a combined weight of 4,3 tonnes. As many as 33 of these teams were also a part of the catch – and release project, a total of 11 ABFT tagged and released with PSAT tags. In 2022 3,4 tonnes were caught as bycatch. Altogether 123 tonnes of the Norwegian bluefin tuna quota were caught in 2022.

2023: In 2023, 28 Norwegian fishing vessels were permitted to fish for bluefin tuna. Among them, seven were purse seine vessels, while the remaining 21 were small-scale coastal vessels. Three purse seiners were engaged in the commercial fishery, while one purse seiner participated in the live storage pilot project. A total of 11 ABFT were tagged and released with PSAT tags. The purse seine vessels collectively caught 100,4 tonnes,

while the small-scale coastal vessels caught 10,1 tonnes. Additionally, 46 fishing teams partook in the recreational fishery, landing a total of 14 tunas weighing 4,4 tonnes. Furthermore, 3 tonnes were caught incidentally as bycatch. Overall, 118 tonnes of the bluefin tuna quota were caught in 2023.

2024: In 2024, a total of 8 Norwegian vessels were authorized to target bluefin tuna. These included seven purse seiners, one longliner, and 24 small-scale coastal boats. Of the seven purse-seine vessels, four participated in commercial fishing, catching 113,8 tonnes in total. The small-scale coastal vessels landed 10,9 tonnes. Additionally, 79 fishing teams took part in the recreational fishery, landing 17 tunas with a combined weight of 5,3 tonnes. A further 3,2 tonnes were captured incidentally as bycatch. Altogether, 161 tonnes of bluefin tuna were harvested under the Norwegian quota in 2024. A total of 6 ABFT were tagged and released with PSAT tags.

Numbers of vessels in different vessel groups authorized to fish for ABFT have increased substantially during the last years (**Figure 7**). Number of vessels per vessel group authorized to participate in the Norwegian bluefin tuna fishery is shown from 2015 to 2023 in **Figure 7** .

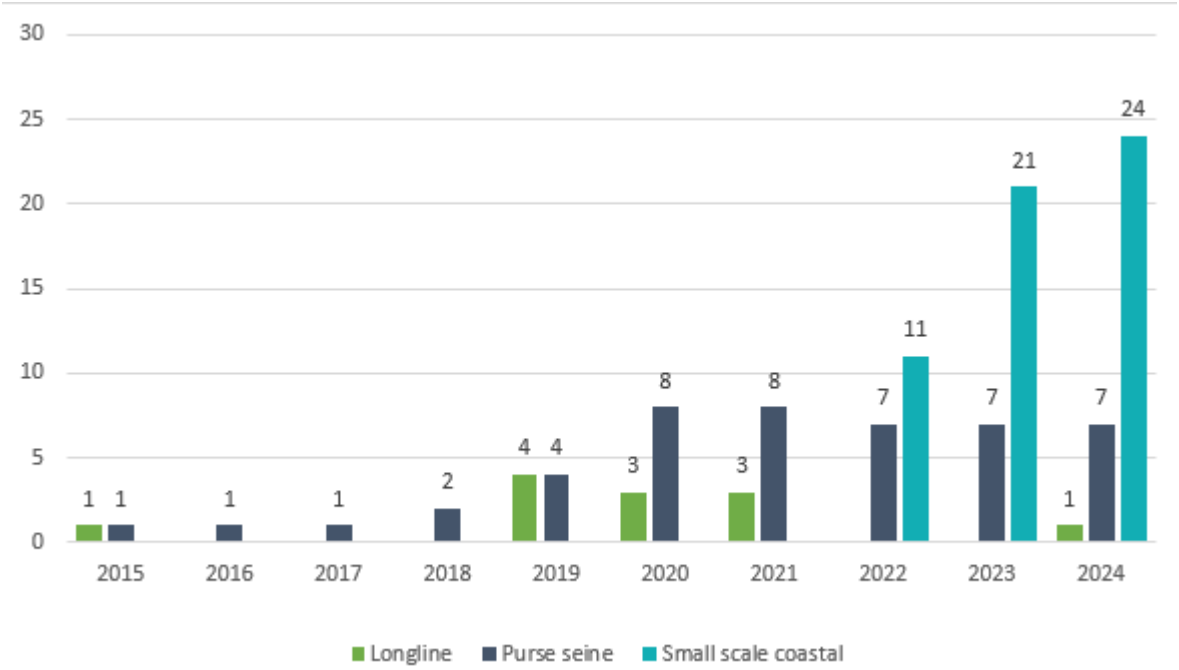

Figure 7: Number of vessels per vessel group authorized to participate in the Norwegian bluefin tuna fishery since the reopening of the Norwegian bluefin tuna fishery in 2014.

Table 1 provides an overview of the purse seine effort in the Norwegian bluefin tuna fishery for the years 2015 to 2024. The effort is measured as number of sets, and as fishing days. The numbers in the table show that catch per effort for the years 2021-2024 has been more consistent and at a higher level than previous years.

Table 1: Catch per unit effort from the Norwegian purse seine fishery for the years 2015-2024. Data compiled from the Register of Landings, the Register of Electronic Catch and Activity Reporting (ERS) from the Norwegian Directorate of Fisheries (2024a)

Year	Gear	N sets	N Fishing days	Catch per set	Catch per fishing day (tons)
2015	PS	4	4,32	0	0
2016	PS	1	84,2	41,74	0,5
2017	PS	37	24,28	1,27	1,94
2018	PS	16	17,82	0,66	0,59
2019	PS	44	67,32	1,08	0,71
2020	PS	72	67,72	2,63	2,8
2021	PS	27	32,74	5,36	4,42
2022	PS	31	18,51	3,3	5,53
2023	PS	28	31,26	3,58	3,21
2024	PS	12	12,70	9,49	8,96

3.3 - Research activities on ABFT in Norwegian waters

Norway has conducted extensive data collection of staggering ~ 270 000 individual ABFT provided to ICCAT's database, as well as contributing to ABFT research during the last ~100 years. The Institute of Marine Research conducts annually a wide range of dedicated national and international studies and projects on ABFT, including close collaboration through the ICCAT's Atlantic-Wide Research programme on Bluefin tuna (GBYP) during the last decade (phases 5-13). Research activities range from biological sampling, satellite tagging, acoustic multibeam sonars surveys, standardized sightings of ABFT, to live short-term storage of ABFT in net pens.

Research activities conducted in Norway range different sectors of science on ABFT such as:

- Spatial and temporal catch statistics and research of ABFT
- Biological, ecological, and genetic data sampling
- Visual observations and sightings of ABFT
- Satellite and conventional tagging of ABFT
- Multibeam sonar studies on ABFT abundance and behaviour
- Live storage experiments on ABFT in Norwegian waters
- Development of ABFT penetrating Atlantic salmon farming net pens in Norway
- Management related research such as MSE development on ABFT in ICCAT
- Contaminant studies on ABFT
- Economic value of the recreational fishery of ABFT
- Using game theory to reveal the success of present ABFT management in ICCAT.

3.3.1 - Scientific collaboration and MOU between IMR and ICCAT

The institute of Marine Research (IMR) in Norway has accredited a long and well-established reputation in the field of fisheries and marine sciences. IMR considers international collaboration important to improve strategical research areas to generate the best scientific advice for ameliorating the stocks evaluation and supports the management decisions aiming at ensuring the sustainability of ABFT fishery resources. IMR also recognizes that significant synergies could result from the collaboration between institutions such as ICCAT and IMR in the field of bluefin tuna research. Consequently, they have agreed in signing several MOUs over the years to define the conditions under which this specific collaboration in the field of BFT electronic and conventional tagging of bluefin tuna as well as biological sampling of bluefin tuna.

The aim of this MOU is to facilitate the cooperation between the Parties in the field of bluefin tuna research in the ICCAT Convention area, including:

- Electronic and conventional tagging of bluefin tuna
- Biological sampling of bluefin tuna

Its immediate objective is to improve the knowledge of the ABFT spatial patterns.

The added value of the collaboration aims to achieve the following outcomes and results:

- Development of unique expertise and knowledge
- Minimizing operational costs of the respective research activities
- Generation of data directly applicable to the modelling of BFT stocks dynamics
- Production of sound scientific publications, including high ranked scientific papers

3.3.2 - Biological sampling and studies of ABFT in Norwegian waters

The main objective of the Atlantic-Wide Research programme on Bluefin tuna (GBYP) is to enhance our knowledge about Atlantic bluefin tuna population structure, mixing, and growth, as well as to develop methodologies that integrate the current knowledge for effective stock management. Norway puts a lot of effort into obtaining biological, ecological and genetic samples and data from all individual Atlantic bluefin tuna caught in directed fisheries and as bycatch in other fisheries (non-ICCAT fisheries) and in the recreational rod and reel fishery for ABFT conducted in Norwegian waters. Samples were taken from Norwegian purse seine vessels. Samples have also been taken from bycatches in other fisheries as well as samples from the rod and reel fishery in Norway.

Figure 8: Pelagic fish technicians Adam Custer, Ørjan Sørensen and Christine Djønne at the Institute of Marine Research (IMR) in Norway taking out tiny otoliths, from a huge head of Atlantic bluefin tuna (ABFT) caught in western Norway. Otoliths (ear bones) are taken out to determine the age of individuals. (Photo: Erlend Astad Lorentzen, IMR).

IMR has contributed systematically to the GBYP in ICCAT with thousands of samples for several years after the comeback of ABFT in 2012, providing valuable measurements and samples for further analyses on e.g. weight, length, age, condition, genetic origin on whether they belong to the eastern ABFT or western ABFT stock.

Altogether 2808 biological samples of ABFT caught in Norwegian waters have been taken on ABFT in GBYP Phases 5-13 from 2015 to 2023 (Table 2), including 498 otoliths and 1351 spines for age reading (Figures 9a, b), and 1456 muscle samples for genetic origin analyses (ICCAT 2020-2024).

Figure 9 a: Spines from the dorsal fin of Atlantic bluefin tuna (ABFT) sampled in Norway, ready to be prepared for age determination of ABFT (Photo: Leif Nøttestad, IMR)

Table 2. Overview of numbers of biological samples taken on otoliths, spines and muscle samples for genetic analysis to the Atlantic-Wide Research programme on Bluefin tuna (GBYP). Norway has contributed all years to GBYP from Phase 5 (2015) to Phase 14 (2024).

Year	GBYP Phase	N samples	Otoliths	Spines	Muscle samples for genetics
2015	5	26			24
2016	6	202		190	180
2017	7	243		233	239
2018	8	64	23	59	62
2019	9	183	24	163	162
2020	10	400	163	356	400
2021	11	180	123	171	180
2022	12	79	65	63	78
2023	13	131	100	116	131
2024	14	101	79	99	101
Total		**2909**	**577**	**1450**	**1557**

3.3.3 - Satellite and conventional tagging of ABFT in Norway

IMR has been collaborating with ICCAT-GBYP and several international institutions including Stanford University, USA, in tagging activities, and has conducted dedicated field studies on pop-up satellite tags (PSATs) and conventional tagging from recreational tag-and-release fishery on ABFT in Norway since 2019. In total, 79 ABFT have been tagged with conventional tags by the recreational tag-and-release fishery between Skagerrak (southern Norway) and 64° N. which is the northernmost e-tagging of ABFT in the world (Ferter et al. 2020, 2021; 2022, 2023, 2024a; Ferter et al. 2024b). PSAT data can be used to reconstruct the annual migrations of ABFT as well as to investigate the spatiotemporal diving behaviour of the tagged individuals. IMR was extremely successful in the tagging with the large majority of tags staying on the fish for one year, yielding detailed information on the annual migration behaviour (Ferter et al. 2024a).

Table 3: Number of satellite tags and conventional tags deployed by IMR and recreational fishers in Norway between 2018 and 2024.

Year	Satellite pop-up tags	Conventional tags
2018	2	0
2019	0	4
2020	5	9
2021	9	8
2022	11	25
2023	11	15
2024	6	12
Total	**44**	**79**

(Ferter et al. 2024) obtained 16 full-year migrations, which differed between individuals. A total number of 13 tags were physically recovered, which provided 4699 days of archival depth and temperature data. ABFT occupied waters from the Arctic Circle in Norwegian waters to as far south as Cabo Verde, Africa, and occupied depths down to 1190 m and temperatures ranging from 0.5 to 27.8°C. ABFT spent on average, 68 days in Norwegian waters during their annual migrations, (Ferter et al. 2024). All ABFT with full-year deployments returned to Norwegian waters. ABFT displayed high site-fidelity and dynamic vertical diving behaviours that varied between hotspots and seasons. These spatiotemporal data provide important ecological knowledge for sustainable management and the conservation of the recently recovered eastern ABFT stock (Ferter et al. 2024).

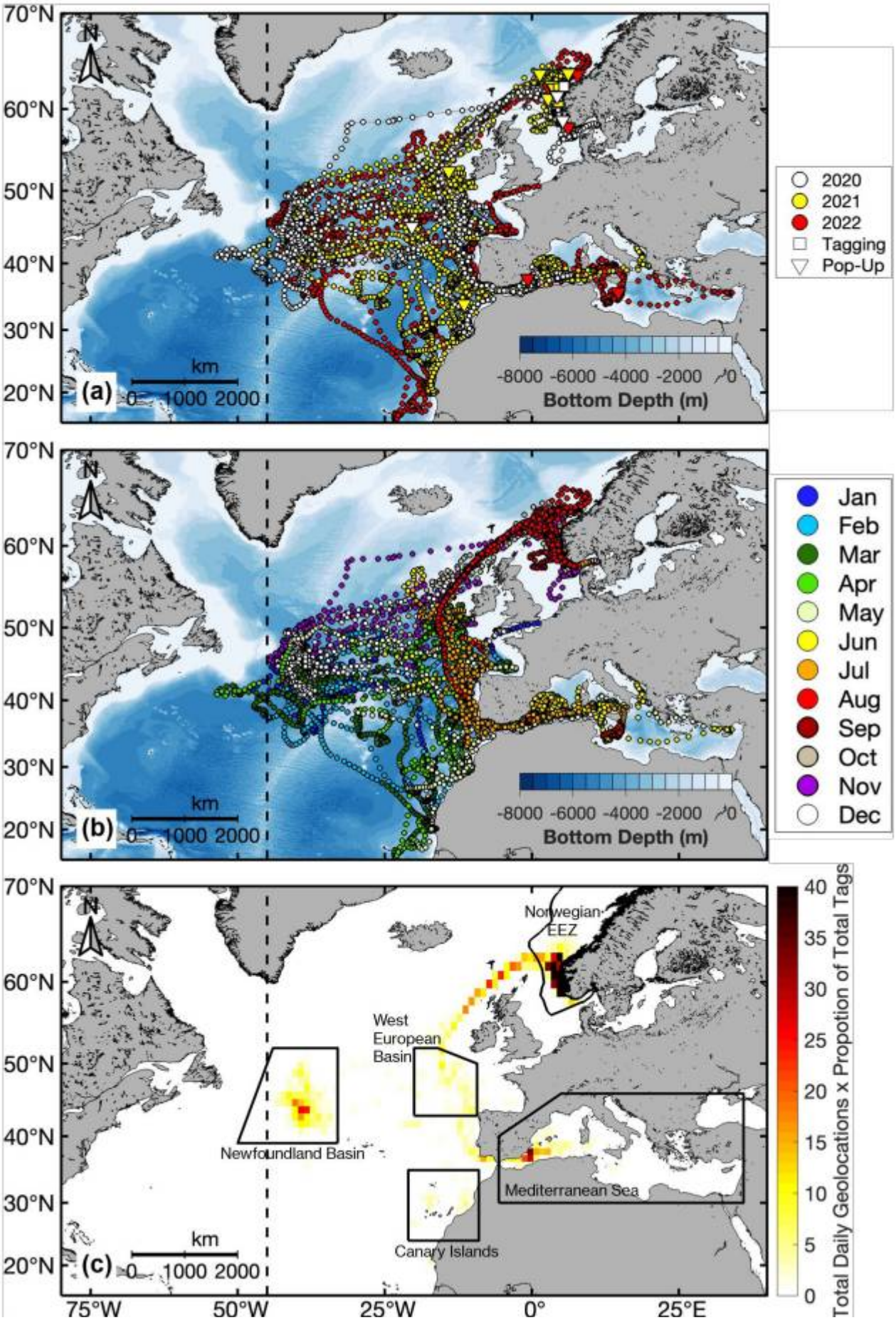
70°N
60°N
50°N
40°N
30°N
20°N
N
km
0 1000 2000
(a)
-8000 -6000 -4000 -2000 0
Bottom Depth (m)
2020
2021
2022
Tagging
Pop-Up
(b)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(c)
Norwegian EEZ
West European Basin
Newfoundland Basin
Mediterranean Sea
Canary Islands
75°W
50°W
25°W
0°
25°E
Total Daily Geolocations x Propotion of Total Tags
40
35
30
25
20
15
10
5
0

Figure 10: Tracks of electronically tagged Atlantic bluefin tuna (n = 19) released off Norway, with daily geolocations (circles) coloured by (a) deployment year and (b) month. Tagging (square) and pop-up (inverted triangle) positions are also shown in (a). (c) Number of daily geolocations within 1° × 1° latitude and longitude bins standardized by the proportion of tags in each bin. Boundaries of hotspots are outlined in solid black in (c). The ICCAT management line at the 45°W meridian is also shown (dashed black line). (Reproduced from Ferter et al. 2024)

As an endothermic fish species, ABFT can thrive in sea temperatures ranging from -1°C to + 30°C , and oceanic water masses exceeding 1200 m depths (Block et al. 2001; ICCAT 2022) . ABFT can utilize metabolic heat to elevate and maintain regional body temperatures that are warmer than the ambient seawater temperature. Consequently, ABFT are physiologically very robust and adaptive to environmental variability, changes in ocean temperatures and may even improve habitat suitability in subpolar habitats (Block et al. 2001, Muhling et al. 2016) In general, Atlantic bluefin tuna tolerates the widest range of environmental conditions among the tuna species (Arrizabalaga et. al. 2015).

Figure 10 d: Satellite tagging with PSAT tags on large Atlantic bluefin tuna (ABFT) on the west coast of Norway. (Photo: Erlend Astad Lorentzen, IMR).

3.3.4 - Biomass estimation and distribution of ABFT with multibeam sonars

Norway conducted dedicated acoustic sonar field studies and experiments in combination with visual observations, both in 2020 and 2021 to obtain quantitative information on school size, distribution, and behaviour of ABFT in Norwegian waters (Peña et al. 2022; Peña et al in prep). A major objective will be to develop and at some stage potentially establish a fishery independent index on abundance from sonar mapping, biological sampling, and visual observations of adult ABFT within Norwegian waters.

Historically, Norwegian fishermen used visual sights of surfacing individuals and shoals when fishing for ABFT using purse seine in the last century. Since 2016 a combination of visual observations and fisheries sonar have been used by Norwegian fishermen. However, no updated experience using sonar technology for observing ABFT was available at IMR, after its return to Norwegian waters.

In the Mediterranean Sea, fisheries sonar is the main tool used for searching and inspection of ABFT schools during commercial fishing. In 2021, a collaboration initiative was established between IMR and Polytechnic University of Valencia and the fishing company Balfegó. This cooperation had focus on transfer of knowledge in sonar use from the Mediterranean Sea to Norwegian waters, and the use of sonar for single school biomass estimation.

During 2021 a methodological survey onboard the chartered fishing vessel “M. Ytterstad” indicated that an omnidirectional medium frequency sonar was the best sonar for detecting and inspecting the ABFT schools in Norwegian waters during feeding (Figure 1**1**) and migration (Figure 12). This is a type of sonar that most fishing vessels have and would thereby be a practical monitoring tool for future scientific surveys. We also identified and described optimal sonar settings for detecting ABFT and identifying school characteristics that can be used to distinguish ABFT from other species. The research revealed that it was possible to identify schools of ABFT based on the sonar signature and swimming speed at a range up to 800 m from the fishing vessel. It also became clear that visual monitoring provides useful extra information but is inefficient in monitoring the stock in a routine survey as daylight, good weather conditions and fish close to surface are required. Multibeam hull mounted sonars with higher frequency and resolution showed good results for counting individuals in schools (Figure 12). The combination of both median and long-range sonars can allow for suitable data for abundance index of ABFT when used in a systematic survey design.

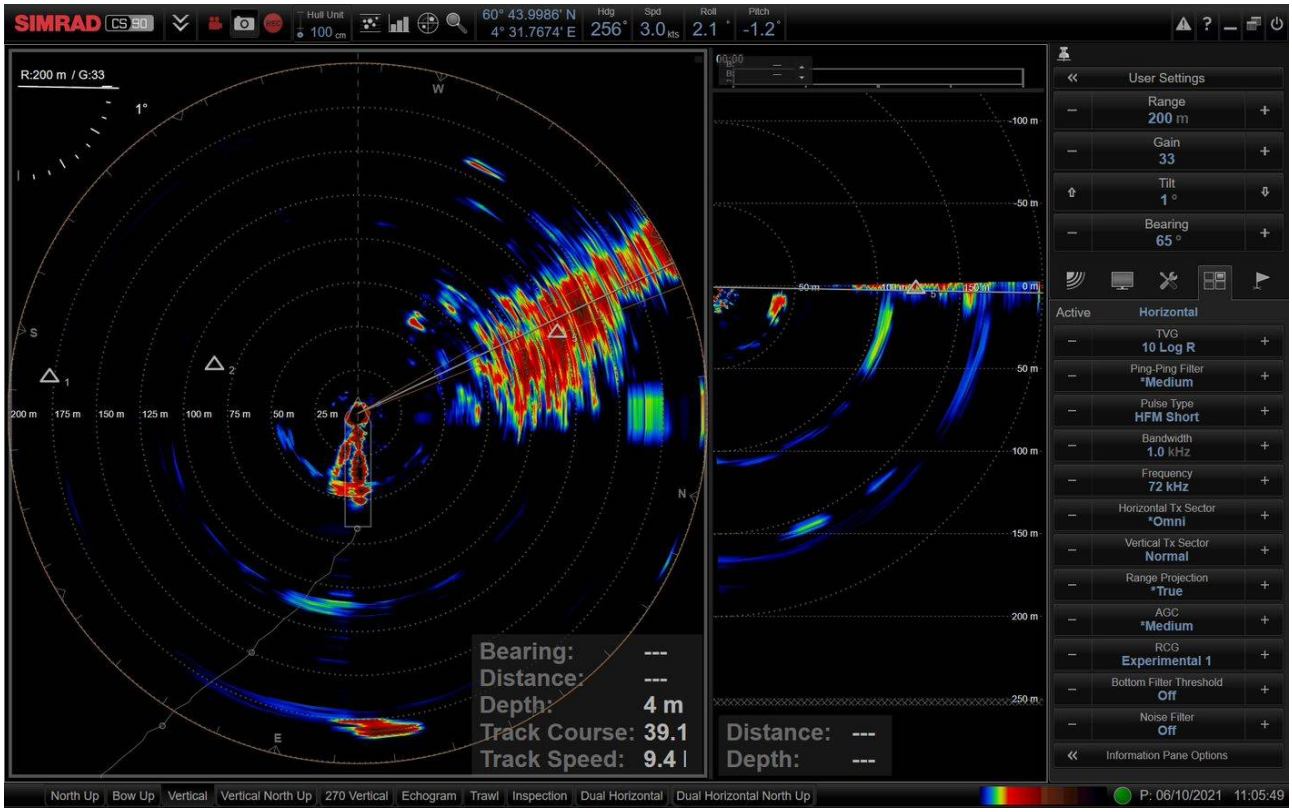

Figure 11 : Horizontal and vertical multibeam sonar display of Atlantic bluefin tuna feeding in western Norway during autumn. The sonar picture reveals a large number (> 100) of ABFT feeding aggregations swimming with slow speed of about 1 knot in the upper 10 m water of the water column in western Norway during autumn.

Furthermore, using broadband echosounders we also obtained the broadband frequency spectrum (from 55 to 250 kHz) from single bluefin tuna. This novel information will allow us to compute fish size and in situ target strength (TS), which can be used for more accurate estimates of single school biomass, very useful in ABFT catching operations in Norway.

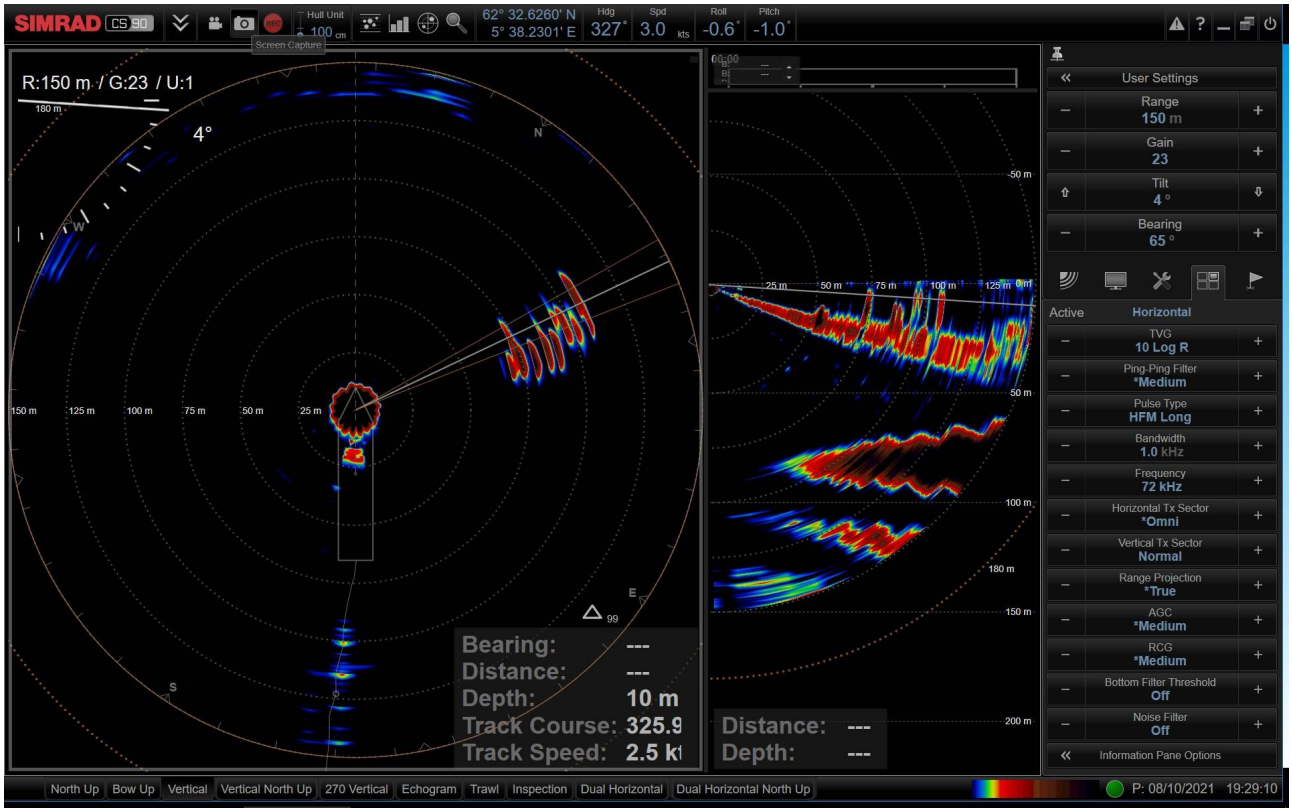

Figure 12: Sonar picture showing a migrating shoal of Atlantic bluefin tuna (ABFT) in western Norway. The characteristics were small number of individuals ranging from 5 to 50 fish, swimming 5-50 m below the surface, high swimming speed (4-7 knots) and soldier formation.

In connection with the project evaluating the transfer live ABFT from purse seine to net pens in Norwegian waters in 2022 and 2023, fish measurements using a short-range pole mounted multibeam sonar have been obtained during the catch process. This sonar was used to inspect the purse seine after the net closing period to quantify how many fish were caught inside. This information was used to confirm that fish was caught and decide if fish needed to be released to avoid excess of fish for the transfer experiments.

One scientific publication focusing on multi-beam sonar recordings of ABFT in Norwegian waters is in preparation and planned to be submitted during 2025 (Peña et al. in prep). In addition, cooperation with ABFT live transfer project and with Spanish counterparts in the Mediterranean Sea is still ongoing in 2025.

3.3.5 - Short-term live storage of ABFT in Norway

Technological development and innovation related to establishing short-term live storage of Atlantic bluefin tuna have been conducted in Norway during the last five years (2020-2024). A review of the objectives, preliminary results, opportunities and challenges of short-term live storage in Norway are summarized in a recent publication in Marine Policy (Sistiaga et al. 2025). Despite the increasing availability of the resource and industry interest in harvesting ABFT, low profitability has led to the assigned Norwegian quota not been fully utilized in recent years. One potential solution is short-term live storage so that the market can be supplied on demand. A pilot project was established in 2020 to address knowledge gaps related to ABFT live-storage in Norway.

The project has five focus areas:

i. *Fish identification and catch control:* Accurate quantification of BFT during the pre-capture, capture and post-capture phases is important to ensure catch volumes are suitable for live storage.

ii. *Fish capture:* During the capture process, fish can get entangled in the large meshes of the seine with serious consequences for fish welfare and quality as well as for crew HSE conditions.

iii. *Fish transfer:* Compliance with ICCAT transfer rules requires video verification of tuna transfers. The size and specific characteristics of the channels need to be optimized.

iv. *Welfare and quality:* Monitoring fish in different phases of the capture process is necessary to fully evaluate welfare.

v. *Live-storage monitoring:* To ensure good meat quality, the welfare of fish stored in cages should be regularly monitored.

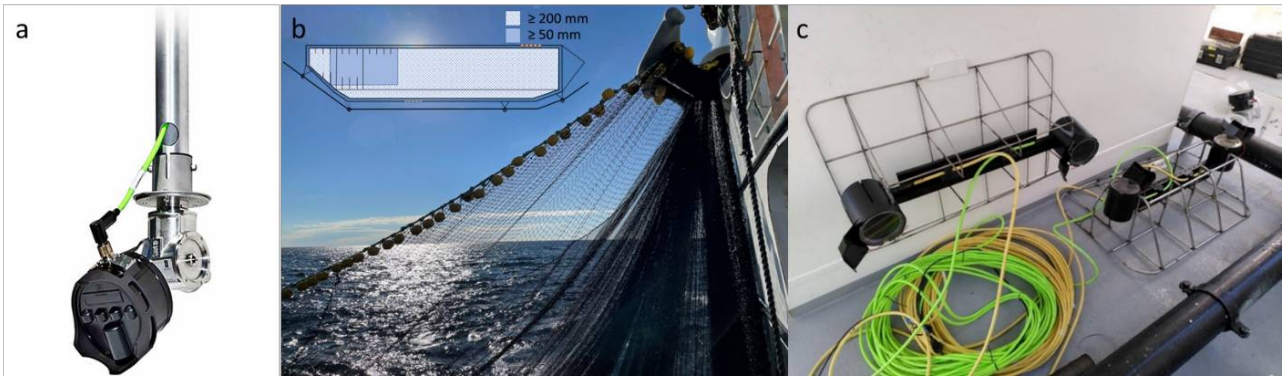

Figure 13 : a) Multibeam high frequency sonar, b) small mesh panel and c) stereo camera prototype tested during the 2023 trials.

Following the progress from the work carried out in sea trials between 2020 - 2022 (Sistiaga et al. 2021 ab; 2022), the work conducted in 2023 (Sistiaga et al., 2023) for the development of live storage of ABFT in Norway had the following goals:

- Test high frequency sonar for identification and counting of ABFT ind. (**Figure** 13 **a**).
- Test a small-mesh panel to avoid entangling fish during seine retrieval (**F igure 13b**).
- Test ABFT transfer channel and transfer cage.
- Test different optical solutions to count and monitor fish during transfers (**Figure 13c**).
- Evaluate fish welfare and quality during and after capture, and during live storage.

During the 14-day sea trials in 2023, three purse seine casts were performed. A total of 28 fish were caught. Twenty-six fish were successfully transferred into a transfer cage. Fish from Cast 3 were subsequently transferred successfully into an inshore storage cage and kept alive for 10 days (Figure 14). Pre-capture, capture, transfer, and storage operations were monitored using various optical and hydroacoustic methods. Fish welfare was assessed using behavioural monitoring and physiological sampling. Meat quality was also recorded.

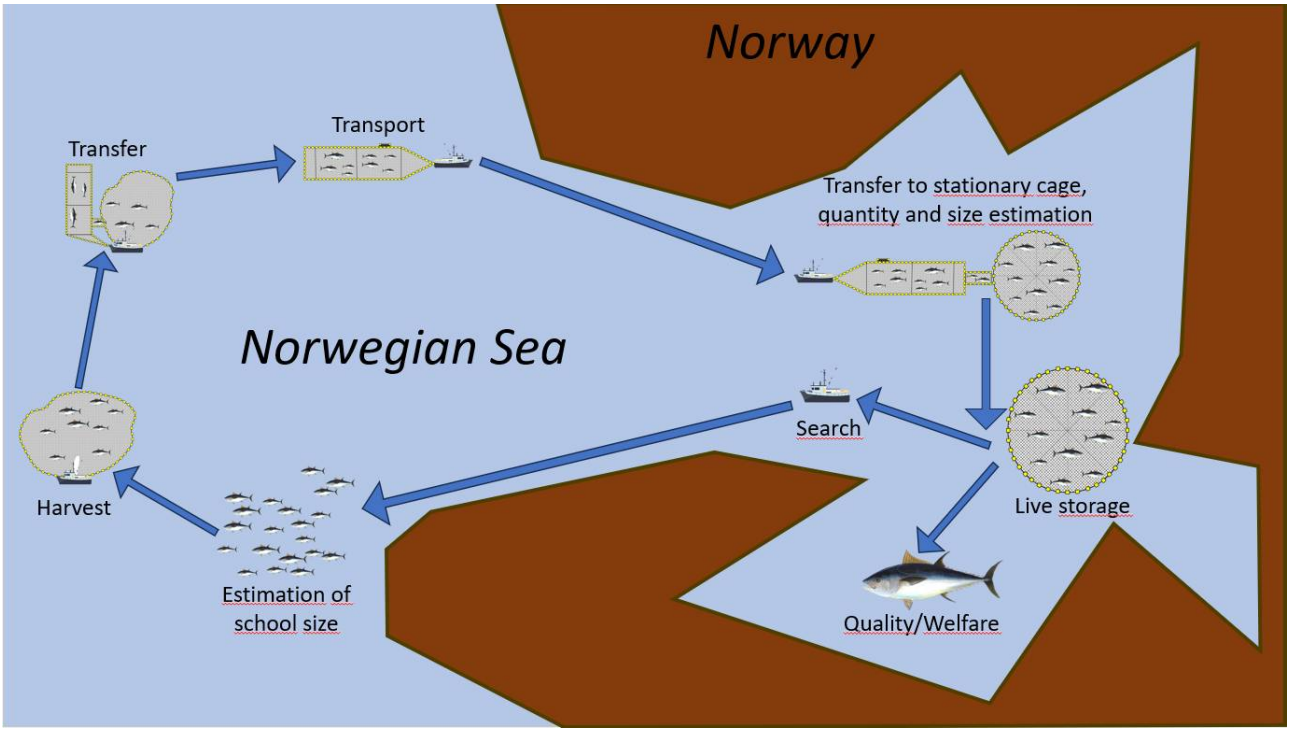

Figure 14: Illustration of the different phases in the procedure applied to store live EABFT during the 2023 trials.

The high frequency sonar was able to discriminate individual fish targets both inside the seine and the towing cage, but quantification was not reliable (**Figure 15a**). Furthermore, reliable quantification of the number of fish during transfer could not be achieved using either the stereo-camera or other camera systems that were tested. The towing cage functioned satisfactorily and allowed tuna to exhibit loose shoaling behaviour during transport (Figure 15**b**). Accurate estimates of biomass were gathered from the cage using the stereo-camera (Figure 15**c**).

Fish from the final cast were transported inshore and successfully transferred to a 15 m holding cage using a transfer channel identical to that used at sea (Figure 15 **d**). Behaviour and environmental conditions inside the static cage were consistent with good welfare throughout the 10-day holding period.

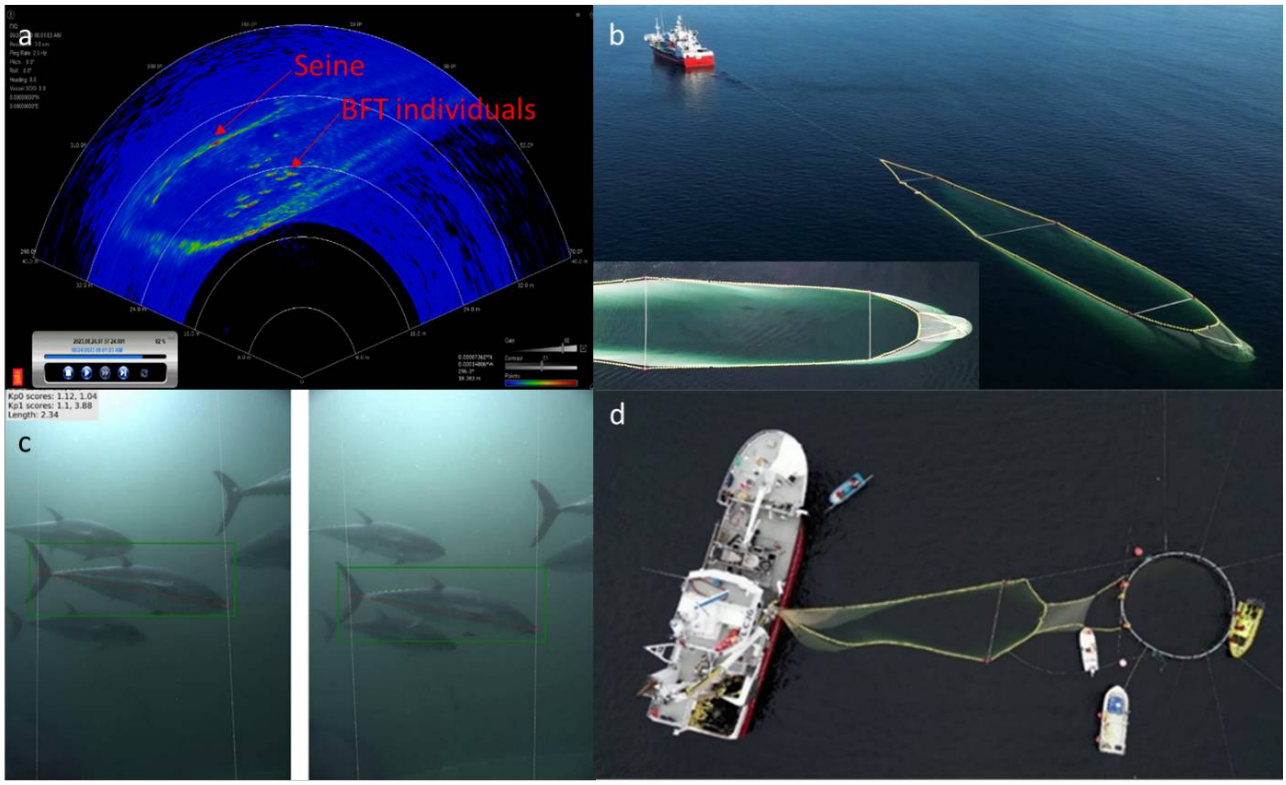

Figure 15: Images from the 2023 trials. a) Aerial of a tuna transport operation, b) image from the multibeam high frequency sonar during a retrieving operation, c) simultaneous images from the cameras in the stereo camera system and the corresponding tuna measurement, and d) aerial of the ABFT transfer from the transport cage to the static cage (Sistiaga et al. 2025).

Multiple fish transfers and subsequent inshore storage is unprecedented in Norway and represent an important breakthrough for the ABFT live storage industry. However, several challenges remain to be solved. These are mainly related to: i) capture efficiency; ii) transfer efficiency into cages; iii) observation and monitoring methods for regulatory compliance; iv) fish welfare and quality including slaughtering; and v) marketing.

In 2024, the pilot project was not conducted, revealing key learning points. The most pressing issue is securing a license to euthanize the fish in a manner that secures both the quality of the meat and fish welfare. The project has been postponed by one year to allow adequate testing of necessary methods. However, our researchers have made significant progress in developing mechanisms and methods for the project to go forward in 2025. The project activities in 2024 focused on the following: Fish identification and catch control, with both acoustic and optical systems, including stereo cameras for the transfer operation; Fish capture where the purse seine net has been modified to address challenges identified in 2023; Fish transfer with rebuilt transfer channel and a “curtain system” installed in the channel to enable more controlled opening and closing, facilitating compliance with the ICCAT transfer regulations; Fish welfare and quality including safe and humane slaughtering of caged tuna; and live storage where the project has established collaboration with partners in the salmon aquaculture industry who have equipment and know-how regarding large-scale storage.

3.3.6 - Research on ABFT walfare during capture, handling and slaughter

New multi-disciplinary research project WelTuna, led by IMR and funded by the Norwegian Research Council (NRC), was initiated in 2024. The project goal is to promote ethical capture & slaughter, sustainability and catch quality in an Atlantic bluefin tuna rod & line fishery by developing animal welfare conscious capture and handling practices. Safe and humane slaughtering of caged tuna is the most important challenge for the upscaling of BFT

live storage at the moment. There is work in progress to obtain the necessary dispensations from regulatory bodies, i.e. he Norwegian Food Safety Authority, and to acquire the required equipment, i.e. diver operated explosive harpoons.

3.3.7 - Management related research on ABFT in Norway

Norway, represented by the Institute of Marine Research (IMR) in close collaboration with the Norwegian Directorate of Fisheries, has actively contributed from the development to final decision making on the Management Strategy Evaluation (MSE) process for Atlantic bluefin tuna, including both the eastern and western ABFT stock. (Nøttestad et al. 2020b). This complex mixed stock MSE was adopted by consensus at the ICCAT Commission meeting in November 2022 (ICCAT 2023). The adoption of the Management Plan (MP) represents a foundational change in how bluefin tuna will be managed. This approach links eastern and western area Total Allowable Catch (TAC's) under one management framework, providing joint management advice. The MP frees the assessment process from having to provide annual TAC advice and allows the stock assessment process to return to its traditional strengths which are to provide a determination of relative stock status (ICCAT 2023; 2024).

Furthermore, a fruitful collaboration has also been conducted on other research areas, such as Catch Per Unit Effort (CPUE) analyses based on commercial purse seine fishing on ABFT in Norway (Nøttestad et al. 2020c; Mjørlund et al in prep). These analyses have direct consequences for the Norwegian fishery, since Norway is the only CPC in ICCAT, which can fish our annual total allowable catch (TAC) with significantly more fishing vessels, due to lower documented CPUE compared to ABFT purse seine fishing in the Mediterranean Sea.

Science and analyses on cooperative game theory related to the international management of ABFT in ICCAT, has also been conducted very recently in Norway (Bjørndal 2023). Game theory examines decision-making in situations where the decisions of several actors produce the outcome. Consequently, each actor's decision depends upon the other actors' decisions. The study analyzed how cooperation has been achieved as well as the stability of the current cooperative management regime (Bjørndal 2023). The main conclusion from this study is that the present management of ABFT in ICCAT is very successful and furthermore brings hope for the management of high seas fisheries worldwide (Bjørndal 2023).

3.3.8 - Additional research activities and projects on ABFT

3.3.8.1 - Economic value of recreational fishery for ABFT

A recent study looked at the fishing effort and economic value of the new recreational fishery for ABFT in Norwegian waters (Fleming, 2021). A total number of 24 fishing teams investigated, set out for 176 fishing trips, which lasted for a combined total of 1641 hours. The economic value of the recreational fishing for ABFT, including buying suitable fishing boat, was estimated to more than 40 million NOK. The recreational fishing on ABFT has grown rapidly in Norway the last few years from 2020-2024. .

3.3.8.2 - Contaminants in ABFT caught in Norway

Due to its large size and high trophic level position as a top predator, the presence of high concentrations of certain contaminants are expected, including mercury and dioxins and PCBs. Hence, comparisons were conducted of concentrations found in ABFT caught in Norwegian waters with the established maximum levels in Europe (Commission Regulation 2023/19) and Norway (FOR-2015-07-03-870). Samples were mostly obtained from fish caught by recreational tuna fishers, in addition to some samples from commercial landings. The size and high variation in fat content makes representative sampling of ABFT fillet challenging. To develop an optimized sampling procedure, a Master thesis was initiated investigating the distribution of fat, metals and persistent organic pollutants in the fillet of ABFT (Øyan, 2021). Large variation was found in the concentrations of the measured contaminants between the different samples analyzed of the fillets. Mercury concentrations

were highest in the lean parts of the fillet, while dioxins and PCBs accumulated mainly in the fatty parts of the fillet, mostly located in the belly region. As the number of samples was limited, more samples are analyzed to get reliable estimates of the concentrations of different contaminants, as well as nutrients, in ABFT caught in Norwegian waters.

With a high mercury content and importance as seafood, ABFT is an ideal model organism to study Hg detoxification in marine fish. Samples of 13 different organ tissues were taken from nine individuals and measured for total mercury and selenium, mercury species (methylmercury, inorganic mercury), selenium species (selenomethionine), stable mercury isotope signatures and presence of particulate mercury and selenium. The results provided evidence that *in vivo* demethylation of the highly toxic methylmercury and biomineralization to inert HgSe particles is commonly happening in marine fish, as previously only reported for marine mammals and waterbirds (Wiech et al., 2024).

The occurrence and species composition of parasitic nematodes has also recently been studied in the viscera of adult Atlantic bluefin tuna caught off western Norway (Bao-Dominguez et al. in prep).

4 - Financial contributions from Norway to ICCAT GBYP

The Norwegian Institute of Marine Research has every year contributed with 190 000 Euro to the Atlantic-Wide Research Programme for Bluefin Tuna (GBYP). This amount represents a considerably larger contribution from Norway than what has been annually requested from ICCAT. Norway believes that dedicated international collaborative and well-coordinated science on commercially exploited fish species with clear-cut objectives is vital and a prerequisite for long-term sustainable management of Atlantic bluefin tuna. Norway as a full member of ICCAT since 2004, strongly support the existing GBYP in ICCAT.

5 - Conclusions

- ABFT have shown a substantial increase in relative abundance during the last decade since the comeback in Norwegian EEZ in 2012 (Nøttestad et al. 2020).
- ABFT have been recorded from 57.6°N in the North Sea to Arctic waters at 76.3°N close to Svalbard, representing a straight distance of ~1800 km (Nøttestad et al. 2020).
- ABFT have been present in Norwegian EEZ from late June until late December, whereas the large majority of ABFT are present each year from August and October (Nøttestad et al. 2020; Ferter et al. 2024).
- ABFT tagged with PSAT satellite tags spent on average 68 days in Norwegian waters during their annual feeding migrations (Ferter et al. 2024)
- ABFT in Norwegian waters predominantly belong to the Northeast Atlantic and Mediterranean bluefin tuna stock (eastern ABFT), based on genetic data analyses (Rodríguez-Ezpeleta et al. 2019) and detailed 365 days migration to known spawning grounds in the Med from fish tagged off western Norway (Ferter et al. 2024).
- The commercial, recreational and rod and reel fishery on ABFT in Norwegian waters have increased from a single Norwegian purse seine vessel targeting ABFT in 2016 to 8 purse seine vessels, 1 long-line vessel, 24 small-scale vessels and 79 recreational fishing teams in 2024 (Directorate of Fisheries, 2024).
- The TAC on ABFT for Norway in ICCAT has increased from 34 tons in 2014 to 384 tons in 2024, whereas the total annual catches of ABFT in Norwegian waters have not been exhausted during the last few years (Directorate of Fisheries, 2024).
- Given the recent recovery of ABFT and reemergence on feeding areas in Nordic waters, ICCAT management should use the spatiotemporal data to manage these important ABFT (Ferter et al. 2024).
- Large ABFT now foraging in increasing numbers within Norwegian waters, should be managed wisely and long-term sustainable by ICCAT in the years to come, so that ABFT do that disappear, once again, from these highly important feeding areas in Norway.
- Increased abundance and spatiotemporal distribution of ABFT foraging in Norwegian EEZ during the last decade, have increased the natural mortality (N) through predation on targeted prey species such as mackerel and herring. These predator-prey interactions on commercially important pelagic fish species are difficult to quantify, but nevertheless, have influenced the spawning stock biomasses (SSB) of mackerel and herring.

The comeback of ABFT in Norway, after decades of absence, has certainly been challenging in many aspects for scientists, fishermen and managers alike. We all practically started from scratch on how to conduct research and gain new knowledge, how to fish and how to manage the world’s largest tuna in Norwegian waters. Nevertheless, the last decade has certainly created a lot of new and valuable data, results, as well as innovative solutions as a foundation to provide new knowledge and reliable advice for future long-term sustainable management of Atlantic bluefin tuna and a viable future fishery of ABFT in Norway.

6 - Acknowledgements

We thank the commercial and recreational fishermen involved in the Atlantic bluefin tuna fishery, sightings, and scientific assistance in Norwegian waters during the last decade from 2012-2024. We also provide our gratitude to the Norwegian Ministry of Trade, Industry and Fisheries, Directorate of Fisheries, Norwegian Coastguard, Institute of Marine Research, the Norwegian Research Council and The International Commission for the Conservation of Atlantic Tunas **(**ICCAT), for their financial and/or practical support on Atlantic bluefin tuna research in Norwegian Exclusive Economic Zone (EEZ) during the last decade.

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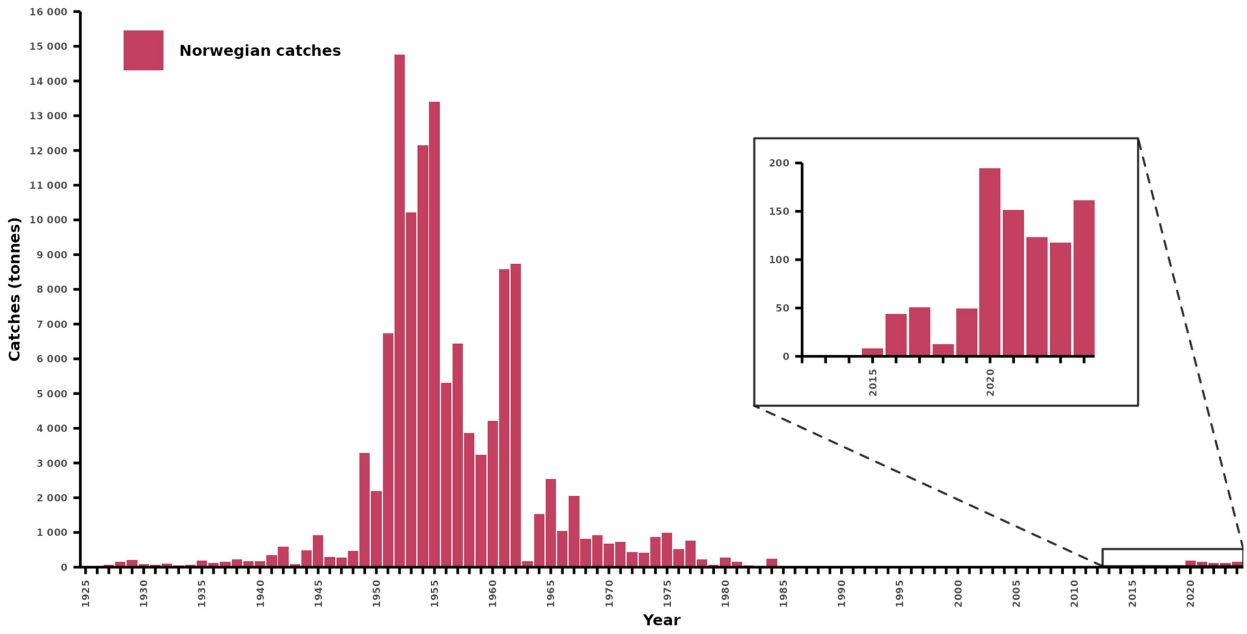
8 - Appendix: Norwegian catches of Atlantic bluefin tuna 1925-2024



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