

French research on fisheries in the Northwest Atlantic, from its origins to the present

by

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Abstract. – This review of French research on fisheries in the Northwest Atlantic first summarizes the history of the access rights of the French fleets to the fishing grounds of this area, then the evolution of the fisheries management systems. The focus then shifts toward French fishery research from the beginning of the 20th century. Four major periods are described to characterize the objectives of this research, its implementation, and its results. The first French scientific studies of fisheries in the Davis Strait, Newfoundland, and Nova Scotia banks by fishery support vessels date back to the 19th century. These studies intensified from the middle of the 20th century with the deployment of dedicated research vessels, especially from 1970 with the establishment of a research laboratory and an oceanographic vessel in Saint-Pierre and Miquelon (SPM). These assets, a close collaboration with laboratories in Canada and the United States, and participation in the work of the regional fisheries commission (ICNAF/NAFO) enabled the teams in SPM to develop and perform innovative research. However, the delimitation in 1992 of the EEZ in Canada and around SPM and the depletion of the main fish stocks dealt a severe blow to the French fisheries in this region, causing France to review its research strategy.

Résumé. – Les recherches halieutiques françaises dans le Nord-Ouest Atlantique des origines à nos jours.

Cet article a pour objet de faire un bilan des recherches françaises sur les pêcheries dans l'Atlantique du Nord-Ouest. Il résume tout d'abord quelques points de l'historique des droits d'accès des flottes françaises aux lieux de pêche de cette zone, puis de l'évolution des systèmes de gestion des pêcheries, deux facteurs qui ont fortement joué sur la stratégie de recherche. Enfin, il présente un panorama de l'évolution des recherches halieutiques depuis le début du xx^e siècle jusqu'à nos jours. Quatre grandes périodes sont décrites pour y caractériser les objectifs de ces recherches, les moyens mis en œuvre et les résultats. Les premières observations scientifiques françaises sur les pêcheries des bancs du détroit de Davis, de Terre-Neuve et de Nouvelle-Écosse par des navires d'assistance aux pêches remontent à la fin du xix^e siècle. Elles se sont intensifiées à partir du milieu du xx^e siècle avec le déploiement de navires de recherche, et surtout à partir de 1970 avec l'implantation d'un laboratoire de recherche et d'un navire océanographique à Saint-Pierre et Miquelon. Grâce à ces moyens et une collaboration avec des laboratoires du Canada et des États-Unis ainsi qu'une insertion dans la commission régionale des pêches (ICNAF/NAFO), les équipes sur place ont développé des recherches innovantes à cette époque sur les pêcheries françaises. La délimitation en 1992 des ZEE du Canada et autour de Saint-Pierre et Miquelon et l'épuisement des principaux stocks de poissons ont porté un coup très dur aux pêches françaises dans cette région et a amené la France à revoir sa stratégie de recherche.

INTRODUCTION

According to De Loture (1949), there is evidence that Bretons and Normans have fished in the Newfoundland area since the early 16th century. Until the late 1900s, French fishing activities in the waters of the Northwest Atlantic were very important. Most French ports equipped ships to participate in the Northwest Atlantic fisheries. Some were fishing on the banks of Newfoundland and Nova Scotia or Iceland and stored salted cod (known as “green cod”) in their holds. Another segment of the French fleets settled their crew ashore during the fishing season to salt and dry the fish caught in coastal waters. Most ships went after what was then the “king of fish”, *i.e.* Atlantic cod (*Gadus morhua*, Linnaeus, 1758). After the long period of sailing boats fishing with lines, the appearance of the first French trawlers around 1904 (de La Morandière, 1966) heralded a new era of industrialization of the French cod fishery and

the gradual disappearance of salted cod in favour of frozen fillets.

Cod and other North Atlantic fish populations long seemed inexhaustible. But with the intensification of their exploitation, it became evident that human activities can deplete marine resources. Thus, towards the middle of the 19th century, the need to better understand the dynamics of exploited resources to control their anarchic exploitation became more apparent. Also, when several countries shared these fish populations, cooperation between scientists within international bodies became necessary, to pool data and knowledge and guide fisheries managers in their decision-making.

Thus, at least in certain areas, the principle of free access to living marine resources, which had hitherto largely prevailed, was replaced by “rational management,” and, later, ecosystem-based fisheries management. However, even if its contribution is critical, scientific research is not enough

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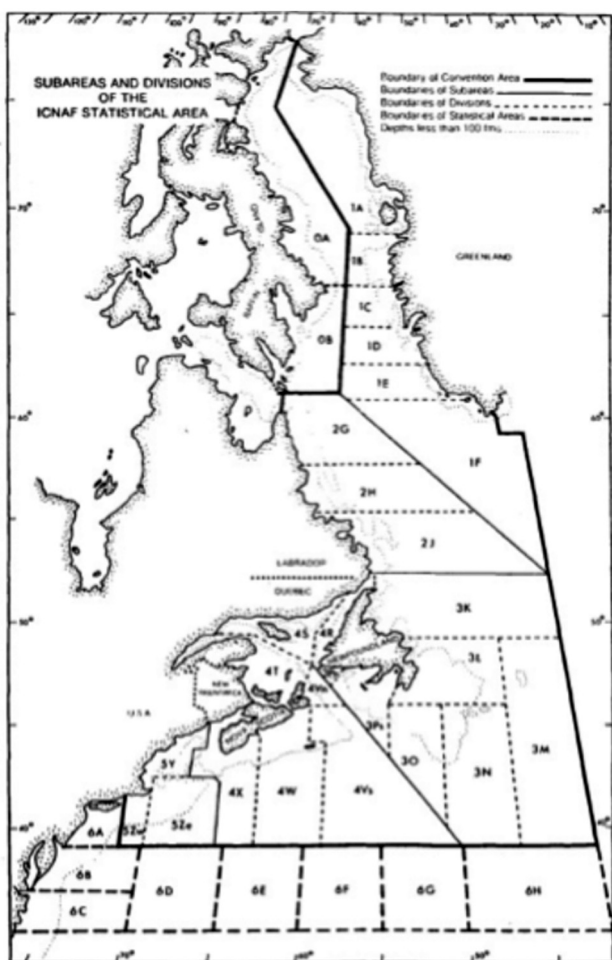


Figure 1. – Map showing the ICNAF/NAFO divisions.

to ensure the sustainable exploitation of living marine resources. As Gulland (1974) pointed out, fisheries management requires a complex mix of biological, economic, social information, and political support.

This article presents a brief review of the French fisheries research in the Northwest Atlantic (Fig. 1) after recalling the historical and legal context in which it evolved and had to adapt. Figure 2 provides the names of the main fishing banks cited in this text.

THE LONG HISTORY OF FRENCH ACCESS TO COD IN THE WESTERN NORTH ATLANTIC

The history of the French cod fishery – particularly its access to the waters off Newfoundland, Labrador, and Nova Scotia – is also the history of the conflicts between England and France over the occupation of what would later become the Atlantic Provinces of Canada. This history has been widely documented, notably by De La Morandière (1966).

French fishers had long settled each year on the shores of Newfoundland to fish, salt and dry cod during the fishing season. They considered themselves masters of Newfoundland despite the growing presence of English and Irish immigrants. But in 1713, with the Treaty of Utrecht signed between France and Great Britain, which ended the War of the Spanish Succession, England took possession of Newfoundland and Saint-Pierre and Miquelon (SPM). However, the Treaty confirmed to the French fishers the exclusive right of temporary settlement for the duration of the fishing season along the North coast of Newfoundland, the so-called French Shore (Fig. 3A).



Figure 2. – Map of the fishing grounds around Newfoundland and Nova Scotia.

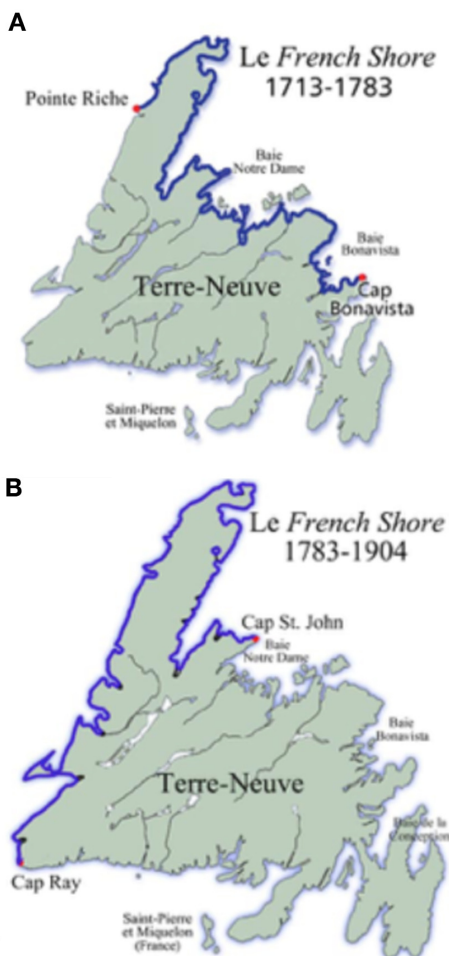


Figure 3. – Maps of the French-Shore from 1713 to 1783 (A) and from 1783 to 1904 (B) (Source: Newfoundland and Labrador Heritage Web Site: <https://www.heritage.nf.ca/>).

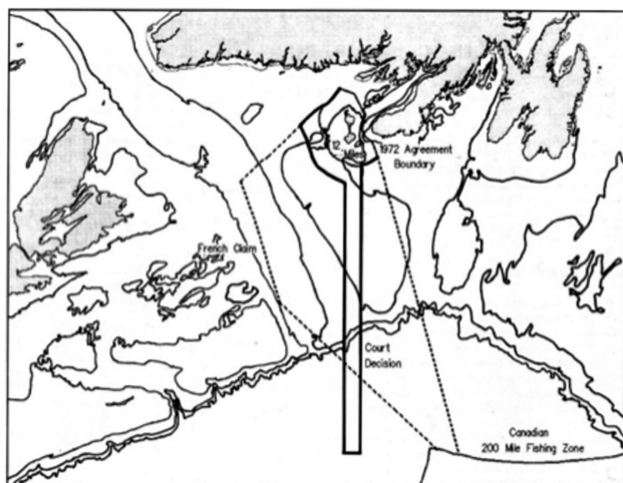


Figure 4. – Map of areas claimed by Canada and France as their Economic Exclusive Zones and the Court of Arbitration decision (from Parsons, 1993).

In 1756, hostilities between England and France resumed. The fisheries on the French Shore were suspended, as were fisheries of Cape Breton Island in 1758, in the wake of France evacuating Louisbourg. With the signing of the Treaty of Paris (1763), France lost its North American colonies. However, the Treaty returned Saint-Pierre and Miquelon to France and reaffirmed the rights of French fishers on the French Shore, in spite of the opposition of the Newfoundlanders to a continued French presence on their coast.

In 1783, following the American War of Independence – in which France was an ally of the nascent USA – and in response to claims by Newfoundlanders, the French Shore moved from the north to the west of Newfoundland (Fig. 3B). Again, access to the fishing ground varied in response to the vagaries of the French-English wars and local conflicts, but also due to increasing imposed restrictions on the French fishers (conditions of settlement, access to baitfish, species for which fishing was allowed, etc.).

Then, in 1904, as French activities on the French Shore rapidly declined in favour of fishing on offshore banks, France gave up its right to the French Shore in exchange for the concession by the United Kingdom of territories from its colonial empire. Important here is that French fishers could continue their activities along the French Shore on an equal footing with those from Newfoundland fishers, but without being able to use land bases. Thus, France put an end to the centuries-old practice of salting and drying of cod on the Newfoundland and Labrador shore. Following this agreement, the waters of the west coast of Newfoundland become one of the main fishing areas for trawlers both from the French mainland and operating from SPM.

When, in 1972, the Canada-France agreement replaced the 1904 agreement, France renounced the right of access of French fishers to the waters of the Gulf of St. Lawrence (declared a Canadian fishing zone) after 1986, except for ten trawlers of a maximum of 50 meters, registered in SPM. All French vessels had guaranteed access to other Canadian fishing zones beyond the 12-mile-limit. Coastal fishing boats based in SPM retained their rights in Newfoundland waters, with reciprocity for Canadian vessels (Parsons, 1993).

In 1977, Canada declared an exclusive 200-mile fishing zone off its coast, while France declared a 200-mile Exclusive Economic Zone (EEZ) around SPM (Parson, 1933). A dispute soon arose because Canada denied SPM any maritime space other than the 12-mile territorial sea. At the same time, based on an equidistance argument, France claimed almost all of the Saint-Pierre Bank (NAFO Sub-division 3Ps) and part of the Laurentian Channel. A “grey zone” was thus created where both Canada and France felt they had jurisdiction (Fig. 4). Differences in the interpretation of the 1972 agreement and the question of delimiting the Economic Exclusive Zones (EEZ) led to a deterioration in relations between the two countries, with episodes of serious crises

such as in 1986-89 (closure of Canadian ports and waters to French ships, recall of the French ambassador from Ottawa, etc.).

In 1992, the International Tribunal in charge of arbitrating this dispute granted France an economic zone of 12,400 km², much smaller than its initial claim of about 50,000 km² (Fig. 4). This decision came when the region's fishery resources were being severely depleted, leading the Canadian government to impose a moratorium on almost all groundfish stocks in its EEZ from 1992/1993. This suspension dealt a serious blow to the economy of SPM and precipitated the end of the French mainland fisheries in the Northwest Atlantic.

THE EVOLUTION OF FISHERIES MANAGEMENT SYSTEMS

Apart from a few isolated actions (minimum mesh size of cod traps in Newfoundland in 1919, limitation of the number of trawlers in the 1920s and 1930s, etc.), it was not until the 1940s that the first fishery management measures appeared in Canadian waters (Anderson, 1998).

The first attempts to develop and coordinate international research activities on the Northwest Atlantic fisheries date back to 1921 with the creation of what later became the North American Council on Fishery Investigations (NACFI). The Council consisted of Canada, United States, Newfoundland (then an English Dominion). France joined in 1922. In 1938, the Council was dissolved (Anderson, 1998).

In the face of increasing evidence of a reduction in the abundance of key fish stocks, several international conferences were held during the 1930s and 1940s, notably, the "1946 Overfishing Convention" that recommended trawl mesh sizes and minimum landing sizes for different species in the North Atlantic and that the size of fishing fleets should not be increased. The 1946 Overfishing Convention recognized the need to consider the East and West Atlantic separately in terms of fisheries management, which led to the creation of regional commissions on both sides of the North Atlantic (Engesæter, 2002).

In response to the ever-increasing number and power of vessels exploiting the resources in the waters off West Greenland and around Newfoundland and Labrador, which in 1949 joined Canada as the Province of Newfoundland and Labrador, a regional fisheries commission – the International Commission for the Northwest Atlantic Fisheries (ICNAF) – was created in that year. Its objective was to promote scientifically-based conservation measures to ensure maximum catches in the long term (ICNAF, 1951). ICNAF, which France joined in 1953, coordinated scientific research aimed at assessing the abundance of stocks. It also formulated management measures to regulate exploitation of these

stocks: minimum mesh sizes, minimum landing sizes of species, limits on fishing effort, access restrictions to fisheries, protected areas and, from 1971 on, a gradual introduction of Total Allowable Catch (TAC) and quotas for the main stocks.

With the 1977 extension of the EEZ to 200 miles by the countries bordering the Northwest Atlantic (Canada, Denmark for Greenland, France for SPM, and USA), a large part of the exploited resources came under national jurisdiction. In 1979, the member countries of ICNAF decided to dissolve it and to replace it with the Northwest Atlantic Fisheries Organization (NAFO). NAFO's objective is "to contribute through consultation and co-operation to the optimal use, rational management and conservation of fisheries in the Convention Area" (NAFO, 1980). In this new fisheries organization, the member countries of the European Union are part of the same, single delegation; however, since 1997, France has also been a member on behalf of SPM.

Pending a decision on the delimitation of the respective EEZ, protracted discussions took place between Canada and France to reach an agreement on the fishing rights of French vessels in Canadian waters. In 1989, the two countries signed a Procès-verbal that set French quotas for stocks in Canadian waters from 1989 to 1991 (Parsons, 1993). Following the 1992 arbitration on the delimitation of the EEZ of Canada and France, a "Procès-verbal of application of the agreement relating to reciprocal relations between France and Canada in fisheries matters of March 27, 1972" was signed between the two countries in 1994. This document specifies the conditions of fishing, monitoring, and control of fishing fleets and various administrative arrangements. It sets out the proportion of the TACs allocated to each country for the shared stocks of NAFO Subdivision 3Ps and those in Canadian waters for which France has fishing rights. A Canada-France Advisory Council now exists whose main objective is to propose measures to ensure the management and conservation of the resources concerned by the Procès-Verbal, one of these measures being the setting of TACs for certain stocks. The Council relies on a bilateral working group responsible for assessing the fish stocks to decide on these measures. The French research institute Ifremer (Institut Français de Recherche pour l'Exploitation de la Mer) participates in this working group. Its activities in the years that followed to the present were all performed within this framework.

FRENCH FISHERIES RESEARCH

Signs of the exploitation of fishery resources have been known since at least the Neolithic period and research on the biology of marine species has been carried out since antiquity. But it was not until the mid-18th century and the 19th century that the Ocean became an object of study. The great

maritime expeditions collected a considerable volume of data on the oceans' physics and biological material, while the construction of marine biology stations allowed the development of scientific knowledge of coastal areas. As part of this movement, research on major fisheries of economic interest was initiated to understand the reasons for fluctuations in abundance of stocks and their depletion for an increasing number. At the beginning of the 20th century, the scientific basis for the assessment of exploited resources was established (Ricker, 1975).

The appointment in 1862 of Victor Coste – a professor at the Collège de France and one of the pioneers of French aquaculture – as General Inspector of coastal fisheries was a first tangible sign of a desire in France to better integrate scientific data into the process of marine resource management (Chatry, 2021). However, it was not until 1918 that the Office Scientifique et Technique des Pêches Maritimes (OSTPM) was created to provide scientific and technical support to activities related to the fishing and seafood processing industries. In 1953, it became the ISTPM (Institut Scientifique et Technique des Pêches Maritimes) with broader mission. In 1984, ISTPM merged with the CNEXO (Centre National pour l'Exploration des Océans) to create Ifremer. Almost all French researches on fisheries in the Northwest Atlantic has been carried out within this institutional framework.

1886-1933: Fishing support vessels as platforms for scientific observations

As early as 1610, French warships were sent to the Banks to escort, monitor, and support fishing vessels and shore settlements (Lefort and Lemesle, 1994). In the 19th century, fisheries support vessels were taking water temperature measurements and bathymetric data, under the responsibility of a Fisheries Officer (often with the ship's medical officer's participation) to assist fishers in their search for cod concentrations. The first French research cruise in the region appears to have occurred in 1886 when Julien Thoulet, a geologist and oceanographer, joined the frigate *Clorinde* and produced, among other things, bathymetric and geological maps of various banks off Newfoundland (Rallier du Baty, 1926).

In 1922, four years after its creation, OSTPM re-launched research in this region (Rallier du Baty, 1926). Since OSTPM did not have a ship capable of carrying out distant cruises, it arranged for its scientists to join French Navy ships deployed as fishery support vessels (including the *Ville d'Ys*, Fig. 5), hospital ships, (including the *Sainte Jeanne d'Arc*), and fishing vessels. From these vessels came reports on hydrological conditions and the bathymetry of the fishing grounds. Based on these observations, OSTPM developed various hypotheses to predict the success or failure of fishing operations in the Western North Atlantic from "oceanic transgressions," *i.e.*, the periodic displacement of waters of high-latitude ori-

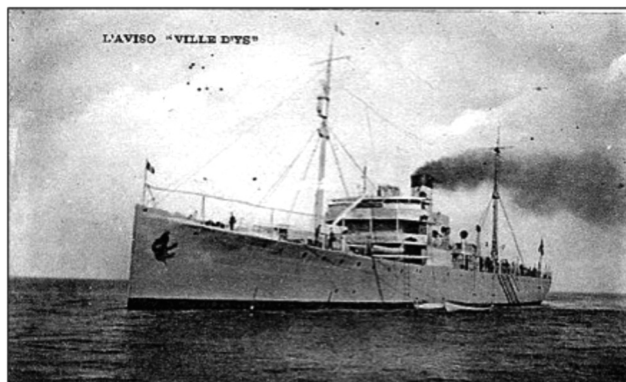


Figure 5. – The aviso *Ville d'Ys*, a stationary warship responsible for assisting French fishing vessels, was also observing hydrological conditions on the fishing Banks between the two-world war period.

gin by water originating in the tropical Atlantic (Le Danois, 1930; Le Danois and Beaugé, 1931).

These observations, continuous from 1922 to 1936, were transmitted to NACFI (Le Danois, 1926; NACFI, 1932, 1935, 1939), presented in the annual reports of OSTPM, and formed the basis of various syntheses (Rallier du Baty, 1926; Beaugé, 1933).

In 1933, a new period began for French fisheries research with the commissioning of the R/V *Président Théodore Tissier*, the research vessel of OSTPM (Le Danois, 1935).

1934-1970: fisheries research based in the French mainland

Launched in 1933, the 50 m-long R/V *Président Théodore Tissier* (Fig. 6) was designed and equipped to meet the needs of OSTPM in terms of fisheries research. Thus, it could deploy fishing and dredging gears, equipment for hydro-

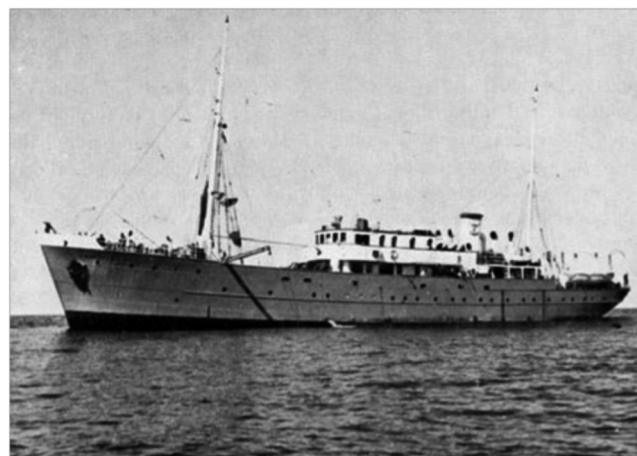


Figure 6. – The R/V *Président Théodore Tissier* of the Office Scientifique et Technique des Pêches Maritimes carried out surveys in the North West Atlantic mainly during the 1950s (source: www.le-petit-manchot.fr).

logical measurements, and plankton collectors, whose data could be analysed in onboard laboratories (Estival, 2003). In 1934, *President Théodore Tissier* carried out her first survey on Newfoundland and Nova Scotia banks and the Gulf of St. Lawrence. Her objectives remained the same as in previous years: to establish linkages between hydrological conditions (temperature, salinity) and cod abundance, as estimated by a grid of trawl stations. The ship's hydroacoustic-sounding equipment made it possible to improve the bathymetric maps that were widely used by fishermen (Beaugé, 1937).

No other cruises were carried out before the outbreak of the war in 1939, and the R/V *President Théodore Tissier* was requisitioned by the Free French Naval Forces. Thus, not until 1951 were new research surveys organized in the region of Newfoundland by OSTPM (in 1951, 1952 and 1954, according to Furnestin, 1966). In addition to the traditional sampling (hydrology, dredging, and trawling), cod were tagged. The results were used to draw some conclusions about the status of cod stocks of Labrador, Greenland, and the Grand Bank (Desbrosses, 1954). R/V *President Theodore Tissier*, which had become obsolete, was no longer able to carry out long distance cruises and it was not until the 1960 commission of a new ship, the R/V *Thalassa*, that ISTPM resumed its research in the Northwest Atlantic.

The 66 m-long R/V *Thalassa*, which could accommodate up to 18 scientists, was the first large French stern trawler with modern equipment that enabled her to meet the needs of French fisheries research. In addition to deploying hydroacoustic and navigation technology, there were improved sampling protocols: *i.e.*, fishing operations were standardized in terms of duration and fishing gear, subsampling of catches to an unbiased representation of size and age of the caught fish, etc., which allowed straightforward comparisons between stations and years (Letaconnoux *et al.*, 1967).

Between 1961 and 1970, R/V *Thalassa* carried out about ten surveys in the Northwest Atlantic, from the David Strait to Georges Bank, mainly to identify new trawlable grounds that might be of interest to French fleets, and to acquire data for hydrological and biological studies of the relationships between species distribution and environmental conditions (ISTPM, 1964; Morice *et al.*, 1967).

The expansion into new fishing grounds and the exploitation of new species were the guiding principles of these surveys. Indeed, as Parsons (1993) noted, during the 1960s to the mid-1970s, the growth of Northwest Atlantic fishing fleets was largely uncontrolled, with their overall tonnage rising from 400,000 gross register tons (GRT) in 1959 to a peak of 1,500,000 GRT in 1974. In addition, technical progress in fishing vessels (stern trawling, geo-positioning systems, etc.), fishing gears, and fish detection methods greatly increased their efficiency. However, catches from the banks off Canada (ICNAF Zones 2, 3 and 4) fell from 2,700,000 t in 1968 to 1,500,000 t in 1977 despite a sharp

increase in fishing effort, which was a clear sign of the worsening state of stocks, especially cod.

Thus, ISTPM's research was re-directed towards species that were, at the time, little or not exploited by French fleets. These included silver hake *Merluccius bilinearis* (Mitchill, 1814) (Ancellin, 1962; L'Hérrou, 1972), Atlantic herring (*Clupea harengus* Linnaeus, 1758) and lobster (*Homarus americanus*, Milne-Edwards, 1837) between the Gulf of Maine and the Laurentian Channel (Ancellin, 1962), redfish (*Sebastes* spp.; Elwertovski, 1964) and northern prawn *Pandalus borealis* (Krøyer, 1838) (Fontaine, 1970). The trawlers based in SPM were able to effectuate a transition toward previously spurned species, such as redfish, American plaice (*Hippoglossoides platessoides* (Fabricius, 1780)), haddock (*Melanogrammus aeglefinus* (Linnaeus, 1758)) and grey sole (*Glyptocephalus cynoglossus* (Linnaeus, 1758)). The French mainland trawlers equipped to mainly process cod continued to target this species, often under challenging conditions (Morice *et al.*, 1967).

1970-1991: A research center and an oceanographic vessel in Saint-Pierre and Miquelon

Unlike other countries, notably the US and the UK, which concentrate their research in a few large centers, the ISTPM had a policy of establishing regional laboratories to better align its research to local economic activities. For this reason, a new "Saint-Pierre Center" was inaugurated on April 27, 1970, which included laboratories and equipment for biological studies, along with chemical and bacteriological facilities for the quality control of fish products processed in SPM (ISTPM, 1970; Fig. 7). In 1971, the Research Center, led by Jean Morice, included 14 staff, notably a team of researchers who, under his direction, had previously worked in the ISTPM laboratory in La Rochelle. Most researchers of the initial team had participated in R/V *Thalassa's* surveys in the region and some had already started research on regional resources.



Figure 7. – The Saint-Pierre and Miquelon research center and the R/V *Cryos* in the 1970s (Photo A. Forest).

The R/V *Cryos*, a 49 m-long oceanographic trawler built in 1970, and whose ice-strengthened hull was specially designed for cold, tumultuous waters, arrived in the Archipelago in 1970. Her crew consisted of 22 members, mainly from SPM, and she could accommodate 9 scientists. Her equipment included different types of fishing gears (trawls, dredges, lines, nets, etc.), and enabled her to support biological and hydrological studies. Based in Saint-Pierre, she also carried out cruises for other French research teams in the North Atlantic.

Because the small team in St Pierre was geographically isolated, and more than 4,000 km from the French mainland, it quickly established links with research laboratories in Canada and the United States. It joined international programs such as the Atlantic salmon tagging survey in Greenland and the study of the herring pre-recruitment on Georges Bank, among others. Bilateral cooperation was developed with various neighbouring research institution, notably in Newfoundland, Nova Scotia and Quebec in Canada, and in Woods Hole in the US. An important part of this cooperation was done through ICNAF, with the recommendations of its Scientific Committee serving as a basis for the research programming of the team in Saint-Pierre.

At least at the beginning of this period and despite shortcomings in some scientific equipment (especially computing facilities), this cooperation enabled the Saint-Pierre team to implement scientific methods relatively undeveloped at ISTPM at the time (standardization of survey sampling plans, fish population dynamics, bioeconomic modelling, etc.).

Researchers from SPM worked in the Newfoundland, Labrador, Nova Scotia regions, on Georges Bank and in the Davis Strait. They covered a variety of species (Denys *et al.*, 2022), *i.e.*, cod, American plaice, redfish, yellowtail flounder, northern prawn, cephalopods, scallops, Atlantic salmon, tuna, etc. Their objectives were:

- To develop knowledge on the species exploited by French fisheries;
- To contribute to the work of ICNAF/NAFO via the assessment of stocks of interest to French fisheries;
- To provide information to the French fishing industry, and from 1977 on;
- To provide French negotiators with data on the resources of the Saint-Pierre Bank and their exploitation.

The following is a brief overview of the various research activities that were carried out during this period, all of which has been the subject of numerous scientific communications to ICNAF/NAFO. Some have been published in scientific outlets by ISTPM, and the results of surveys have been disseminated to French fishing fleets, most often directly at sea. However, many of the results were produced as unpublished reports and remain rather difficult to access.



Figure 8. – Study of the Gulf of St. Lawrence cod stock: results of a 30-minute trawl haul aboard the R/V *Cryos* in 1977 (Photo A. Forest).

– American plaice: this species was exploited by Saint-Pierre trawlers and was the subject of a major study on its fishery and biology (Minet and Poulard, 1972; Minet, 1974). This research focused on the growth, reproduction, and diet on the Saint-Pierre Bank and the Cape Breton shelf. The modelling they performed was innovative for the Saint-Pierre team and for ISTPM.

– Atlantic cod was a species mainly sought by all the French fleets in the region. From 1973, research was intensified with the setting up of surveys in the Gulf of St. Lawrence (NAFO Divisions 4R and 3Pn; Fig. 8), on the Banks off Labrador and Newfoundland (NAFO Divisions 2J-3KL), and Saint-Pierre Bank (NAFO Subdivision 3Ps). The research objectives were: to describe the demography of cod, to relate its movements and location to hydrological factors (Fig. 9), to describe the composition of the diet of cod and to transmit this information to the French trawlers (Minet and Poulard, 1973; Minet, 1981; Minet and Péroudou,



Figure 9. – Recording of a thermal profile using an expendable bathythermograph probe temperature recorder aboard the R/V *Cryos* in 1985 (Photo A. Forest).

1978). This work was supported by the tagging of 6,313 cod carried out during surveys in 1975, 1976, 1980 and 1982 (Moguedet, 1992). Also, Minet (1978) studied the dynamics of cod along the west coast of Newfoundland (NAFO divisions 4RS-3Pn) using a yield-per-recruit model that was one of the first of this type carried out at ISTPM. After 1986, the work focused on the cod stock of NAFO subdivision 3Ps, the area claimed by France as part of its EEZ. Some stock assessments were performed within the frameworks of both NAFO and the French-Canadian Advisory Committee at the end of the 1980s. Ifremer contributed to these assessments by providing data on French fisheries and at-sea surveys (see, e.g., Mabeau *et al.*, 1986; Bertrand *et al.*, 1988b).

– Cephalopods: beginning in the early 1970s, the international landings of cephalopods from the Northwest Atlantic increased sharply (Mesnil, 1977a). The small-scale fleet of SPM and some trawlers based on the French mainland began the exploitation of the northern shortfin squid, *Illex illecebrosus* (Lesueur, 1821). As early as 1972, the Saint-Pierre Center set up a research program to refine the biological param-

eters of squids and estimate their biomass, which involved conducting joint ‘ENCANO’ surveys with researchers from Woods Hole and Halifax on Georges Bank and the Nova Scotia Shelf from 1973 to 1976 and again from 1979 to 1984. The detailed analyses of size distributions and sexual maturity schedules enabled the life-cycle of two species, the northern shortfin squid and longfin inshore squid *Doryteutis pealei* (Lesueur 1821), to be elucidated (Mesnil, 1977b). In addition, for the location of trawling stations during cruises, in 1977, B. Mesnil introduced a stratified random sampling plan, similar to those used in Canada and the United States, but new to ISTPM, which allowed for a rationalization of sampling. The abundance indices obtained, supplemented by analysis of the yields of small-scale fishery from SPM and data from French trawlers, contributed to the assessment of stocks within ICNAF (Minet and Dupouy, 1980).

– Northern prawn: following the R/V *Thalassa* surveys in 1966, 1967 and 1970 on the Newfoundland Banks (Fontaine, 1970), surveys were performed in 1970 and 1971 by R/V *Cryos* on the Nova Scotia Banks (Fontaine and Paturel, 1972) and the Davis Strait in 1977 (Minet *et al.*, 1978; Dupouy *et al.*, 1981); R/V *Thalassa* also conducted in 1979 an additional survey, in cooperation with Canada and with the participation of the captain of a French trawler. Also, from 1979 to the mid-1980s, data from the French mainland fishery that had developed in Greenland waters were used to derive indices of stock abundance (Bertrand *et al.*, 1988c).

– Atlantic herring: the surveys conducted from 1972 onwards were to explore the Newfoundland and Nova Scotia shelves and Georges Bank in view of an exploitation by French fleets that would offset the collapse of herring stocks in the Northeast Atlantic. Meristic characteristics (number of fin rays, vertebrae, etc.) were used to differentiate populations (Décamps and Briand, 1973; Forest and Briand, 1975). The Saint-Pierre team also participated in an international program on the pre-recruitment of herring in ICNAF Area 5 (Minet *et al.*, 1974; Fig. 10). However, this research on herring was abandoned in 1977, as the extension of the EEZs of coastal States made it impossible to consider a redeployment of the French herring fishery to the Northwest Atlantic.

– Yellowtail flounder (*Limanda ferruginea* (Storer, 1839) was exploited by trawlers from Saint-Pierre, and research on this species provided additional data on its distribution on Georges Bank and Nova Scotia shelf and its growth on Saint-Pierre Bank (Berthomé, 1976).

– Atlantic salmon (*Salmo salar* Linnaeus, 1758): in 1972, as its contribution to an international program led by the International Council for the Exploration of the Sea (ICES) and ICNAF to tag Atlantic salmon in the waters off West Greenland, France organized a tagging survey onboard the R/V *Cryos*, with the participation of ISTPM (a researcher from the Saint-Pierre Center), the Institut National de



Figure 10. – Plankton sampling aboard the R/V *Cryos* in 1975 to study herring pre-recruitment on George's Bank as part of an ICNAF project (Photo A. Forest).

Recherche Agronomique (INRA), the Centre Océanographique de Bretagne (COB) and the Muséum national d'Histoire naturelle (MNHN) (Minet, 1973). In addition, at the end of the 1970s, experimental fishing with surface nets around SPM confirmed the presence of salmon, and extracted biological information from catch data, allowing the development of a new small-scale fishing activity (Paturel and Laborde, 1977).

– Redfish: based on various sources of data (at-sea surveys, data from the fishing industry, and the published scientific literature), Hamon (1972) synthesized knowledge on the two main species (*Sebastes mentella* Travin, 1951 and *S. norvegicus* (Ascanius, 1772)). In addition, an assessment of the Gulf of St. Lawrence stock was attempted, using for the first time in Saint-Pierre a surplus production model (Berthomé and Forest, 1976).

– Tuna: in 1975, the Center participated in a tuna survey by line surface fishing aboard the R/V *Cryos* between SPM and the Azores. The presence of albacore concentrations, *Thunnus alalunga* (Bonnaterre, 1788), in waters south of Saint-Pierre was confirmed (Aloncle *et al.*, 1977). In 1978, a new R/V *Cryos* survey showed that skipjack tuna *Katsuwonus pelamis* (Linnaeus, 1758) also frequented the region around SPM (Aloncle and Delaporte, 1979).

– Scallops: three dredging surveys on Saint-Pierre Bank (1974, 1975, 1976) confirmed the presence of Iceland scallop (*Chlamys islandica* (Müller, 1776)) and American sea scallop (*Placopecten magellanicus* (Gmelin, 1791)). Despite initially encouraging results (Fig. 11), it was not until 1986 that exploitation by vessels from SPM began (Mahé, 1993).

– In 1977, a French program of bottom trawling surveys was set up to monitor the fishery resources of the Saint-Pierre Bank, which France then claimed as part of the EEZ



Figure 11. – Results of a 10-minute dredging on the Saint-Pierre Bank Iceland scallop beds aboard the R/V *Cryos* in 1974 (Photo A. Forest).

of SPM. This program of two surveys per year carried out according to a stratified random sampling plan lasted until 1992. The data collected were used for the assessment of resources (*e.g.*, Forest *et al.*, 1979; Moguedet, 1990), environmental conditions (Forest and Poulard, 1981), and the links between abundance and environmental factors (Mauviel and Bertrand, 1987).

– Between 1977 – when EEZ were established by Canada and France – and 1992, the Saint-Pierre Center was heavily solicited to provide French negotiators with information on the state and distribution of the resources of Saint-Pierre Bank (*e.g.*, Moguedet, 1991) and on the activity of the fleets that exploited them (*e.g.*, Poulard and Battaglia, 1986; Mauviel, 1987; Bertrand *et al.*, 1988a). A bioeconomic study (Forest *et al.*, 1983) presented the economic impacts of several scenarios for the delimitation of EEZ and according to different management objectives, a type of study that was new to ISTPM.

After 1992: A new basis for Ifremer's scientific support

As provided for in the 1972 France-Canada agreement, after 1986 the French mainland fleet no longer had access to one of its main fishing areas, the eastern part of the Gulf of St. Lawrence (NAFO Divisions 4R-3Pn). Moreover, as described above, in 1992-1993, the decision of the International Tribunal on the issue of the EEZs of Canada and France and the moratorium imposed by Canada on a large part of the groundfish stocks dealt a very harsh blow to French fishing activities in the Northwest Atlantic.

Ifremer's withdrawal from SPM was in response to the decline of French fisheries in the Northwest Atlantic. The 'ENCANO' cephalopods research surveys ended in 1984, followed by the 'MORUTENE' cod surveys in 1986. The R/V *Cryos* was decommissioned in 1991 and sold to Libya, while the R/V *Thalassa* performed the last 'ERHAPS' Saint-Pierre Bank groundfish surveys in 1992. In 1994, only 3 Ifremer agents remained at the St. Pierre Center, whose premises are now devoted to various services. In July 1994, Ifremer informed the Prefect of SPM that its scientific support would consist of:

- Maintenance of an Ifremer correspondent based at Saint-Pierre and Miquelon;
- Expertise according to needs by specialists from the French mainland;
- Continuation of the scientific cooperation with Canada.

The stocks covered by the 1994 agreement are groundfish (cod, redfish, American plaice, Greenland halibut (*Reinhardtius hippoglossoides* (Walbaum, 1792)), etc.), squid, and Iceland scallop. The data collected on these French fisheries (landings, fishing effort), possibly supplemented by scientific observations, are shared within the France-Canada working group for the assessment of resources (Vigneau *et al.*, 2013).

Following the serious deterioration in the state of groundfish stocks, particularly cod, fishing activities in the Archipelago turned to other resources that had previously been underexploited or little or not targeted, such as snow crab (*Chionocetes opillio* (Fabricius, 1788)), clams, lumpfish (*Cyclopterus lumpus* Linnaeus, 1758), sea cucumber



Figure 12. – Ifremer survey in 2021 on board a professional vessel to assess the sea cucumbers abundance in Saint-Pierre and Miquelon's EEZ using a dredge equipped with an underwater camera (Photo Ifremer).

(*Cucumaria frondosa* (Gunnerus, 1767)), whelk (*Buccinum undatum* (Linnaeus, 1758)) or even Northern Sea urchin (*Strongylocentrotus droebachiensis* (Müller, 1776)) and seaweed. The evolution is quite striking, since according to the statistics of the Food and Agriculture Organization of the U.N. (FAO), between 2015 and 2019 sea cucumber landings first reached and then largely exceeded those of what was long time the “king of fish”, the Atlantic cod (see Palomares and Pauly, 2022).

Ifremer has continued to provide advice to the managers of SPM’s fisheries. Thus, the snow crab fishery, which, in SPM, began in the mid-1990s, was monitored by the catch of commercial vessels (Laurans *et al.*, 2010), supplemented by Canadian data (Laurans *et al.*, 2017).

Since the beginning of the 1990s, several surveys to estimate the pectinid (clam) stocks of the Saint-Pierre Bank have been carried out by Canadian research vessels (with the participation of Ifremer Saint-Pierre) and, on the French side, aboard an oceanographic or fishing vessel, with the support of teams from the French mainland (Foucher, 2018). Given that it is shared between the EEZs of Canada and SPM, the scallop stock is managed jointly with Canada.

Sea cucumber landings by vessels from SPM began in 2008 and increased from 2011 (Vigneau *et al.*, 2017). The assessments of sea cucumber abundance in the EEZ of SPM are done by dredging during pectinid surveys (Foucher *et al.*, 2019), or more recently, with underwater cameras (Fig. 12), and analysis of catch data. Results are used to manage the fishery via TAC, fishing period and minimum catch size. Finally, information has also been collected on the lumpfish fishery (Briand, 1995a) and the Northern sea urchin (Briand, 1995b).

CONCLUSIONS

As we have seen, French research on fisheries in the Western North Atlantic has contributed to various fields within a legal context that became increasingly complex.

From 1970 onwards, the creation of the Saint-Pierre Center, equipped with its own research vessel, made it possible to build on the research initiated by the pioneers of the late 19th and early 20th centuries and continued by the ISTPM teams on the French mainland. The Center was able to increase France’s participation in developing knowledge on the resources exploited in the Western North Atlantic. Since most of these resources were exploited by fleets of various nationalities, this research could only be done within a framework of international cooperation. ICNAF then NAFO enabled the Saint-Pierre Center to avoid scientific isolation. From 1992 onwards, following the establishment of limits to their respective EEZs, this cooperation was organized mainly between Canada and France.

French fisheries research has been directly supporting French fisheries in the region, whether in its attempts to locate “cod waters” based on their temperature (referred to as “thermometer fishing”), and in response to the degradation of the main resources (notably cod) prospecting for new fishing areas, promoting new species or supporting their exploitation.

However, the degradation of the Western North Atlantic fish stocks became a major concern and ICNAF/NAFO introduced increasingly restrictive regulations. Therefore, modelling, assessing resources and fisheries, and a better understanding of ecosystem functioning, have become essential tools to assist managers in decision-making. In particular, from 1970 to the end of the 1980s – thanks to a favourable international scientific environment and to the teams based in SPM – the ISTPM and then Ifremer were part of this evolution.

At the national level, this research has made it possible to respond to various requests for expertise, particularly during negotiations on the limits of the EEZs between Canada and France. Today, they contribute to the assessment of stocks whose exploitation is shared with Canada and provide scientific data to establish the conditions for the exploitation of resources in the EEZ of SPM.

The Saint-Pierre Center has also played its role in training researchers. Thus, several technicians from SPM recruited by ISTPM went on to study and become researchers at Ifremer or in Academia. In addition, the Center hosted young scientists who came to SPM as part of their National Service (Voluntary Technical Assistance). Many of them (including this author) were recruited by ISTPM/Ifremer.

The end of the French fishing rights east of Newfoundland in 1986, the 1992 decision on the delimitation of the Canadian and French EEZs and the moratorium on the main groundfish fisheries in Canadian waters led to a collapse of French mainland fisheries in the Northwest Atlantic and had a lasting impact on the fleet based in SPM. French research had to adapt and from 1994, onwards a new system was put in place to continue to provide scientific information to fisheries managers, thereby opening a new page of French research on fisheries in the northwest Atlantic.

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