



## UPDATE OF INDICATORS OF THE SAGUENAY FJORD WINTER RECREATIONAL GROUND FISH FISHERY

### Context

This update summarizes the analysis of the most recent data obtained from the Saguenay Fjord winter recreational fishery monitoring program. Fisheries Management would like an update of the indicators to determine if the management measures in place should be adjusted for future fishing seasons. The recreational fishery is currently managed through a fishing season and daily catch limits. No fishery-independent data were available for this update.

This Science Response Report results from the regional peer review meeting of November 16, 2023, on the Update of Indicators of the Saguenay Fjord Winter Recreational Groundfish Fishery.

### Background

The Saguenay Fjord is a unique environment, as it has the rare characteristic of being intracontinental (i.e. it does not empty directly into the ocean). The upper sill at the mouth of the fjord restricts the exchange of water with the St. Lawrence Estuary (Figure 1), making it a relatively isolated environment, and traps cold, saline water from the St. Lawrence Estuary at depth, while warmer, fresh water from tributary rivers and Lac Saint-Jean flows on the surface. These conditions create a complex ecosystem that supports a wide range of biodiversity, including many species of groundfish. These features have been investigated and documented since the mid-20th century, leading to recognition of the site's richness and uniqueness. These efforts were instrumental in justifying the protection of part of the fjord by establishing the Saguenay–St. Lawrence Marine Park (SSLMP) in 1998.

Sixty species of fish are found in the Saguenay Fjord, a number of which are harvested in the winter recreational fishery (also known as ice fishing). The main groundfish species caught in the Saguenay winter recreational fishery are redbfish (*Sebastes* spp.), Atlantic cod (*Gadus morhua*), Greenland cod (*Gadus ogac*) and Greenland halibut (*Reinhardtius hippoglossoides*), also known as turbot. According to Sévigny et al. (2009), the individuals of the species that occur in the Saguenay Fjord are linked to the populations of the Estuary and Gulf of Saint-Lawrence (EGSL), and do not represent isolated populations. Sirois et al. (2009) reported that the recruitment of redbfish and Atlantic cod is not dependent on local larval production, and that exchanges between the Saguenay Fjord and the St. Lawrence Estuary occur passively through larval and egg advection, or actively through the migration of juveniles and adults. Based on phenotypic differences, Sévigny et al. (2009) suggested that once migration into the Saguenay Fjord is complete, individuals of these species spend the majority of their lives in its waters. Therefore, the probability of recruitment of groundfish present in the fjord would not be impacted by the fishery operating there. Although these populations are not genetically dissimilar from those in the St. Lawrence, they remain important components of a unique ecosystem.

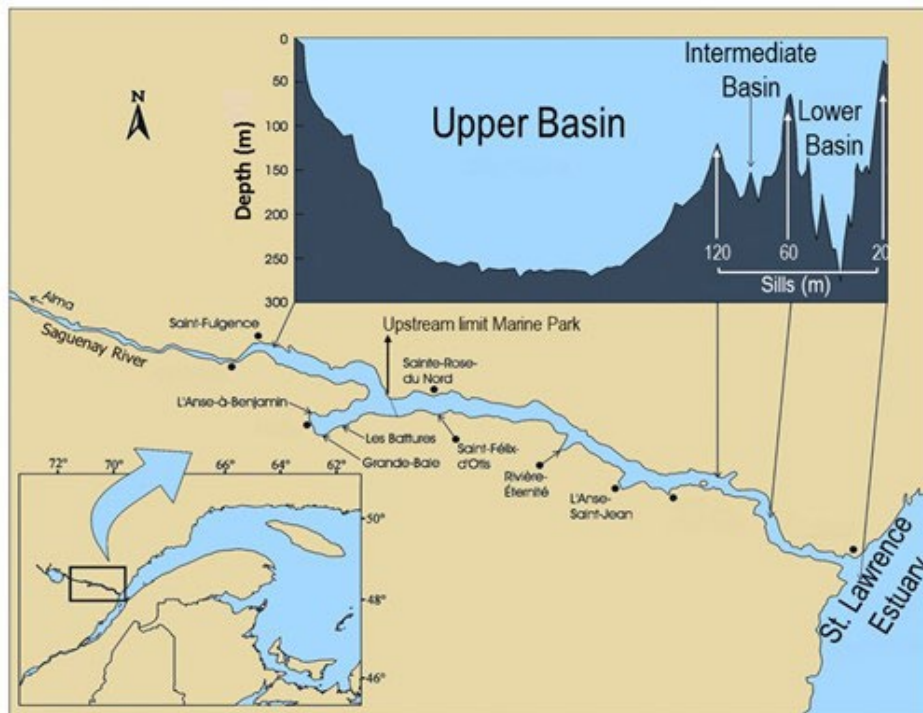


Figure 1. Bathymetric map and profile of the Saguenay. The main winter recreational fishing sites are identified, as well as the upstream boundary of the Saguenay–St. Lawrence Marine Park (SSLMP).

Since 1995, DFO has been coordinating the monitoring program of the groundfish fishery in the Saguenay Fjord in response to the concerns of several stakeholders about resource conservation and the sustainable development of this fishery. This monitoring program is delivered in collaboration with the Société des établissements de plein air du Québec and Parks Canada, which co-manage the SSLMP, and Contact Nature and various Saguenay fishers' associations and committees. The program's success relies on the substantial contribution of each of the partners, who are responsible for gathering and inputting information from each of the villages under their jurisdiction.

### Description of the fishery

The winter recreational fishery took off in the early 1980s and is concentrated at eight sites, four of which are located within the boundaries of the SSLMP (Figure 1). The activity occurs mainly in cabins set up in fishing villages on the pack ice. Saguenay's La Baie area includes the villages of L'Anse-à-Benjamin, Grande-Baie and Les Battures, which has been closed since 2013 as a result of ice cover problems. The other villages are associated with the municipalities of Saint-Fulgence, L'Anse-Saint-Jean, Rivière-Éternité, Saint-Félix-d'Otis and Sainte-Rose-du-Nord. The latter four sites are located within the boundaries of the SSLMP.

Fishing villages generally include two areas where cabins are set up: a pelagic fish area near shore, where smelt (*Osmerus mordax*) is the main catch, and a groundfish area further out in deeper waters, where the species discussed in this report are caught.

No licence is required for this fishery and only line fishing is permitted. Rods, tip-ups and rollers are used. There is no restriction on the number of lines and hooks used. Under the existing regulations, it is prohibited to sell, barter and waste fish, and it is mandatory to release crustaceans, molluscs, Atlantic halibut (*Hippoglossus hippoglossus*), wolffish, sharks and

skates. During the 2022 and 2023 fishing seasons, DFO issued a scientific fishing licence for Atlantic halibut to the *Comité de bassin de la baie des Ha! Ha!*, which was responsible for coordinating scientific fishing activities, including identifying participants who would be permitted to retain catches over 85 cm for research purposes. The results of this work are not available for this Science Response.

Conservation measures implemented since the monitoring program first began (Table 1) focus primarily on two aspects: 1) the daily groundfish catch limit and 2) the length of the fishing season. The first management measures in 1995 combined a daily limit of 25 groundfish and a season length of more than 100 days. The daily bag limit of five groundfish has been in effect since 2004. In 2005, the fishing season was set to begin in mid-January and end with the start of icebreaking operations on the Saguenay in mid-March (the exact dates vary from one year to another).

Table 1. Changes in management measures for the Saguenay Fjord winter recreational groundfish fishery.

Year	Daily Limit	Maximum Season Length
1995 to 1996	25	> 100 days
1997 to 1998	25 (5 cod, pollock, haddock, 1 Atlantic halibut)	> 100 days
1999 to 2002	25 (5 cod, pollock, haddock, 0 Atlantic halibut)	> 100 days
2003	15	> 100 days
2004	5	> 100 days
2005 to 2010	5	60 days
2011 to 2016	5	44 days
2017 to 2018	5	51 days
2019 to 2023	5	58 days

## Analysis and Response

### Monitoring of fishing activities

The winter recreational fishery monitoring program has three components. A detailed description of the monitoring program is available in Gauthier (2018) and Gauthier et al. (2020).

The first component (since 1996) records fishing activities by interviewing recreational fishers at the different sites. The annual sampling plan involves visiting each site 20 times, on weekdays and weekends throughout the entire fishing season. On each of these visits, samplers aim to interview 15 randomly selected fishers. On average, 1,200 fishers are interviewed annually, each providing information on their catches (species, number) and fishing effort (number of lines, hooks per line and hours fished). Samplers estimate site frequentation by counting active fishers at the time of their visits. Owing to the public health measures implemented for the COVID-19 pandemic, no sampling was conducted in 2021.

The second component (since 1996) focuses on collecting biological data on the different species caught, such as size and weight. These data are collected by samplers and fishers recruited in each site. Information on an average of 930 fish per year has been compiled over the past decade. Owing to the public health measures implemented for the COVID-19 pandemic, no biological data were collected in 2021.

Quebec Region

A third component (since 2015), consists of logbooks completed by recreational fishers who fish inside and outside of fishing villages. Fishing activities conducted outside of villages are poorly represented in Component 1 of the monitoring program. Since 2015, between 15 and 29 logbooks have been filled out every year, for an average of about 450 fishing activities per year. Since this type of approach does not require samplers to be in proximity to fishers, it could be maintained in 2021 without violating the public health measures in place for the COVID-19 pandemic.

From 2000 to 2018, a gillnet scientific survey was carried out in April by DFO in the Saguenay Fjord (Gauthier et al. 2019). Following the discontinuation of this survey, no fishery-independent data are available for this update.

Fishing effort

Fishing effort is calculated from the number of fishers present at a site and the length of the fishing season. The number of fishers is assessed by samplers in the first component of the monitoring program. Since a sampler’s assessment represents a snapshot of the presence of fishers at a site, it underestimates the actual number of daily visits, as some fishers may have already left the site, while others will arrive later in the day. The length of the fishing season is approximated on the basis of the first and last sampling dates identified in the first component, and this value is applied to all sites, regardless of any specific local characteristics.

The estimated average frequentation for 1996–2023 is 26,000 fisher-days per season (Figure 2A). Despite substantial fluctuations in annual frequentation, the long-term trend shows stability for the whole Saguenay region. Fishing effort is concentrated mainly at the Baie des Ha! Ha! sites, which accounted for about 65% of effort at the start of monitoring, rising to 91% in 2010 and then dropping to recent values of around 75% (Figure 2B).

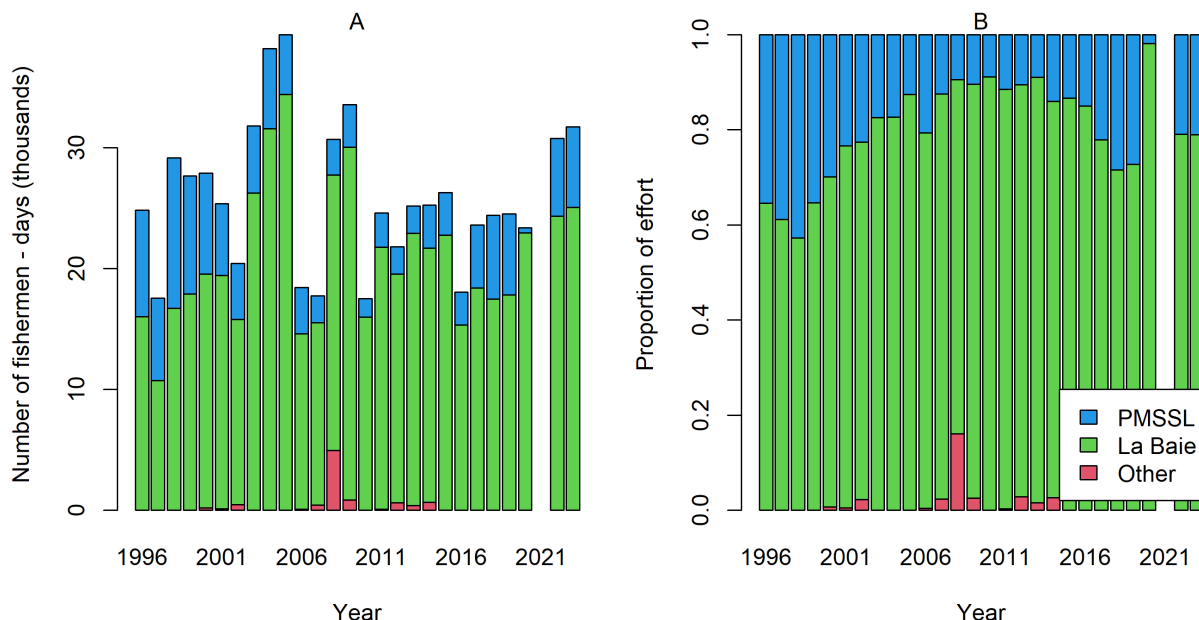


Figure 2. Annual frequentation of the recreational groundfish fishery by area (A) and proportion of the fishing effort between La Baie, the SSLMP and other areas (B).

The calculation of the total fishing effort is expected to be subject to multiple biases which relate to several factors, including the sampler’s experience with estimating crowds, the sampler’s

knowledge of fishing patterns specific to the site visited and the difficulty of assessing whether fishers are present in cabins not visited, as well as the ice cover and the opening and closing dates, which vary by site.

**Catch description**

In addition to the main species retained in the winter fishery (redfish, cod, Greenland cod and Greenland halibut), catches of Atlantic halibut, eelpouts and skates have also been reported and could represent a non-negligible portion of the catch retained, depending on the period.

Total catches (Figure 3A) are calculated based on the estimated annual frequentation at the different sites and the catch rates observed in the first component of the monitoring program (see section on Fishing success). Catches calculated for the last two years show an increasing trend and are among the high values in the historical series, in contrast with the downward trend observed from 1996 to 2017. More than 90% of the groundfish caught in 2022 and 2023 were redfish (Figure 3B). Catch levels from logbooks (third component of the monitoring program, Figure 4A) are consistent with the trajectory of total catches. The catch composition also indicates a prevalence of redfish (Figure 4B).

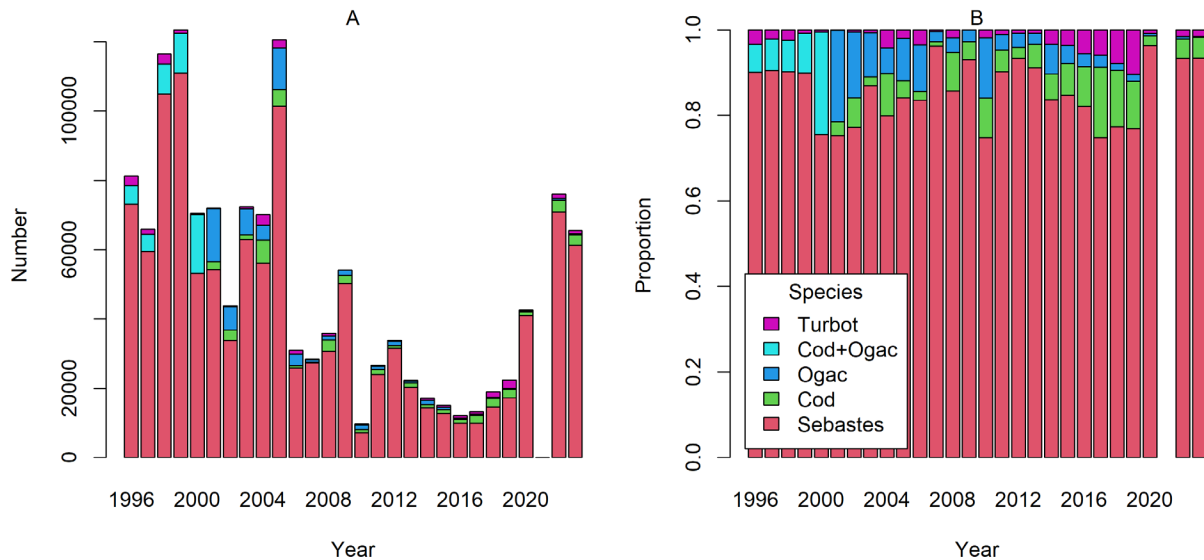


Figure 3. Number A) and proportion (B) of the total annual catch, estimated for the main groundfish species harvested in the Saguenay Fjord winter recreational fishery. No data were available for 2021.

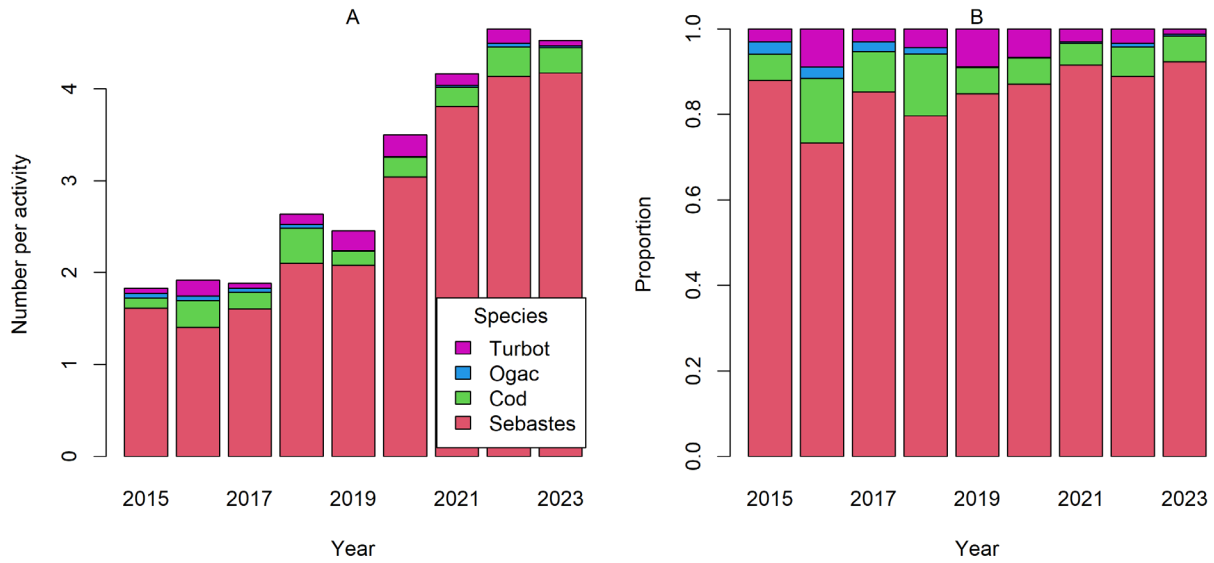


Figure 4. Average number of groundfish caught per activity monitored (A) and contribution of the main species to the catch (B), from logbook data (third component of the monitoring program).

The size frequency distributions obtained in the second component of the monitoring program allow us to visualize the arrival of new cohorts and track their growth over the years. The presumed trajectory of some of these cohorts is presented in Figure 5. For redfish (Figure 5A), and to a lesser extent cod (Figure 5B), these growth trajectories correspond to strong cohorts observed in the Gulf of St. Lawrence (GSL). These observations suggest a strong link between the resource available to the Saguenay recreational fishery and the status of commercially harvested stocks in the ESGL.

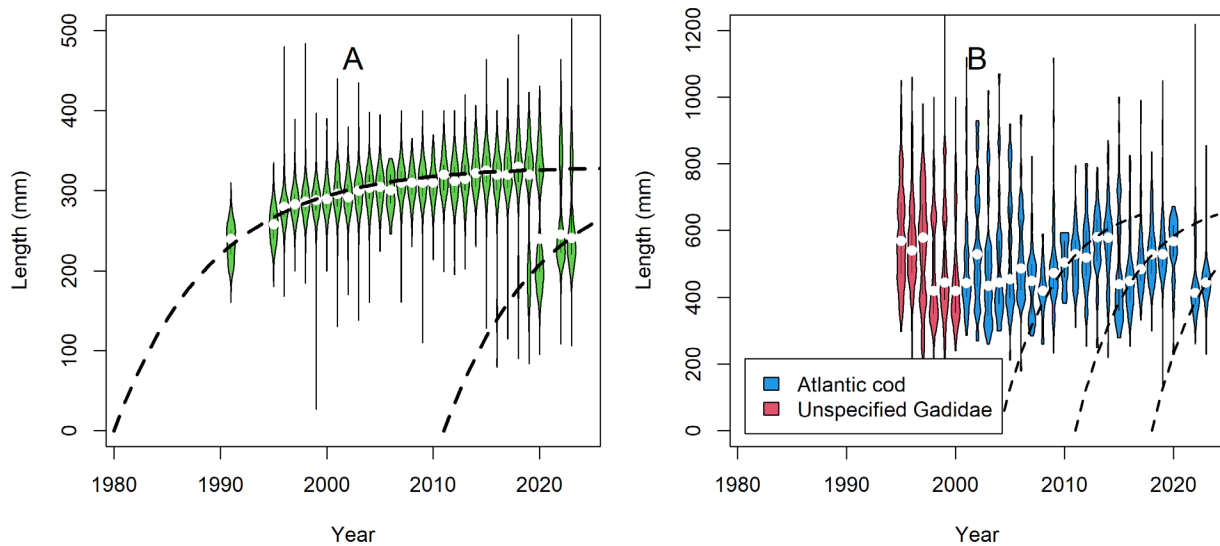


Figure 5. Size frequency distributions of redfish (A) and cod (B) sampled from the Saguenay Fjord winter recreational groundfish fishery. The presumed growth of some cohorts is shown as a dotted line. The violin plots represent the probability density of different lengths of fish measured. The white dots indicate the median, while the black vertical lines indicate the interquartile range.

Catches of redfish observed between 1996 and 2019 (Figure 3A) were supported by a cohort of redfish born circa 1980, which alone accounted for over 75% of catches, all species combined,

from the Saguenay recreational groundfish fishery (Figure 3B). Other redfish cohorts, born circa 2011, also appeared in the catches and account for the majority of catches in 2022 and 2023. The appearance and development of these cohorts in the EGSL are well documented (Bourdages et al. 2023; Senay et al. 2023), with the cohort from circa 2011 being described as “the most abundant ever observed in the northern Gulf of St. Lawrence” (Senay et al. 2023.) Although the abundance of recent cohorts in the Saguenay has yet to be determined, the possibility that they could sustain a recreational fishery for several more years, as was the case for the previous cohort, has not been ruled out. Other groundfish species seem to be benefiting from the more regular arrival of new cohorts.

### **Fishing success**

Data from the first and third component of the fishery monitoring program were standardized to take into account any variability caused by factors such as the site of the activity and the date on which it took place (weekday or weekend). The use of echo sounders and whether fishers choose to carry out the activity in a fishing village or outside these villages are also considered with respect to the logbook data (third component of the monitoring program). This standardization makes it possible to identify yearly trends in catch rates, expressed in number of fish per unit effort.

Catch rates for redfish, Atlantic cod and Greenland halibut have been high in recent years (Figure 6), while catch rates for Greenland cod remain low. Under certain conditions, variations in a species' catch rate may be correlated with variations in its abundance. With respect to the monitoring data for the Saguenay recreational fishery, at least two conditions suggest that the results should be interpreted with caution. First, fishing effort is highly concentrated at a few sites, and little is known about the distribution and movements of the resource within the Saguenay Fjord. Uneven distribution of the resource, fidelity of individuals to certain sites and reduced movements of fish are examples of factors that could bias the interpretation. Second, changes in fishing patterns may alter the performance obtained for one standard unit of effort. In other words, under similar conditions, fishing efficiency may increase over time. Some of these changes are related to a gradual increase in the experience of many participants, an increase in the use of fishing aids such as echo sounders and a decrease in the use of unattended fishing gear, which is potentially less efficient. Nonetheless, the changes in fishing success for redfish and cod point to variations that are consistent with the arrival of new cohorts. This suggests that these indicators reflect changes in abundance and are effective tools for monitoring the status of the resource.

Redfish stocks in the Saguenay and the EGSL appear to be on similar trajectories, showing a decline between 1995 and 2015, followed by a recent increase linked to the arrival of new high abundance cohorts (Senay et al. 2023). A comparison of cod and Greenland halibut stocks in the Saguenay and the ESGSL paints a more nuanced picture. Indicators show that cod and Greenland halibut levels in the Saguenay are among the highest observed, while in the ESGSL, these stocks are at all-time lows or have been declining for several years (Bourdages et al. 2023). Low abundances in the EGSL could cause future recruitment to decline in the Saguenay.

### **Conclusions**

The results of the monitoring indicators for the winter recreational groundfish fishery have been positive over the two last years. The activity remains popular, with over 30,000 fisher-days recorded along with increasing catches, over 90% of which consist of redfish. Daily catches are also trending upward for redfish, Atlantic cod and Greenland halibut, reaching some of the highest levels of fishing success since 1996. Daily logbook catches average more than four

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groundfish per fishing day, out of a daily quota of five fish. The redfish and cod cohorts already present in the Saguenay are expected to support the recreational groundfish fishery over the coming years.

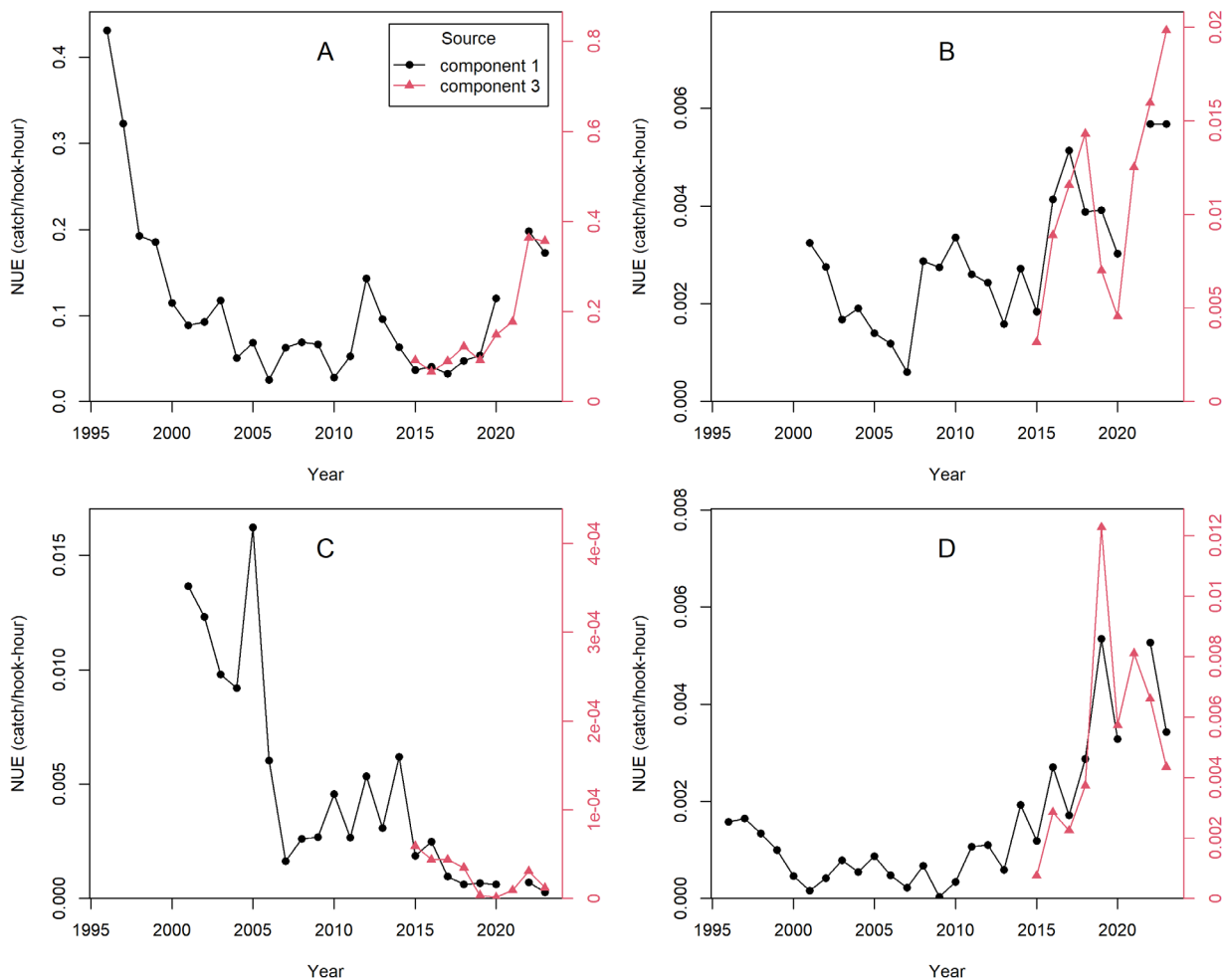


Figure 6. Standardized annual catch rates in number per unit effort for redfish (A), Atlantic cod (B), Greenland cod (C) and Greenland halibut (D), based on data from Component 1 of the monitoring program. For each species, two sources of information are presented at different scales: Component 1 data are in black on the left side of the graph and Component 3 data are in red on the right.



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