Fisheries rebuilding success indicators: 2021

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November 2021

Summary

The status of Canada's marine fish and invertebrate stocks remains concerning. The results of Oceana Canada's fifth annual (2021) fisheries rebuilding success indicators reveal that overall stock status has not improved over the last five years, with still less than a third of marine fish and invertebrate stocks that can be confidently considered healthy and nearly 20 per cent that are critically depleted. Another third of the stocks are of uncertain status, primarily due to a lack of adequate information or implementation of reference points. Most of the critically depleted stocks are groundfish and flatfish located in the Atlantic Ocean. Many of these stocks have not recovered since the groundfish collapses in the mid-1990s that was due to unsustainably high harvest levels combined, in part, with unfavourable environmental conditions (ECCC, 2020). But the composition of depleted stocks has changed over the last five years, with an increasing number of invertebrate stocks now in the critical or cautious zones, including stocks of the more economically important species like snow crab and shrimp. Concerningly, there are few healthy forage fish stocks (none in the Atlantic) and no healthy shark or skate stocks. Still, there have been some improvements with other taxa, like rockfish and redfish, where favourable environmental conditions have likely facilitated large recruitment events in some stocks (e.g., redfish in Units 1 and 2; DFO, 2019e).

Climate change is expected to result in "winners" and "losers" with respect to access to future fisheries because of concerns about shifting species distributions and changing ecosystem communities driven by climate change (Boyce et al., 2021; DFO, 2019a, 2020a; Lam et al., 2016; Talloni-Álvarez et al., 2019; Wilson et al., 2020). These impacts, combined with human activities like fishing, coastal development, and resource exploitation, make the future health of our oceans highly uncertain. It has never been more urgent for Canada to accelerate the implementation of long-standing and critical policies designed to provide the best opportunity for maintaining and restoring the health of Canada's fisheries and oceans.

There has been some progress made with policy implementation over the last five years, with significant increases in the percentage of stocks with Limit Reference Points (LRPs). There is also better transparency, with nearly all stocks now included in publicly available Integrated Fisheries Management Plans (IFMPs). But the track record on keeping the public informed on the scientific basis of decisions is poor (Archibald et al., 2021b; Archibald and Rangeley, 2021c), and progress on other policy implementation has lagged. There have been no significant increases in the percentage of stocks with Upper Stock References (USRs), the point that marks the boundary between the healthy zone (where we are confident a stock is doing well) and the cautious zone (where we need to take conservation actions to rebuild it back to healthy levels). There has been little progress in the percentage of critically depleted stocks with a rebuilding plan: over 80 per cent of critical zone stocks still lack the planning framework required to promote growth. In 2017 Fisheries and Oceans Canada (DFO) made commitments to implement rebuilding plans for 19 stocks by the end of March 2021 and to make significant progress implementing other aspects of its Sustainable Fisheries Framework (i.e., reference points, harvest control rules, and Integrated Fisheries Management Plans) (CESD, 2016; DFO, 2017a, 2017b). But less than half of these commitments have been met, with most rebuilding plans delayed (Archibald et al., 2021a; Archibald and Rangeley, 2021a). This rate of progress is insufficient to make the changes

required in a reasonable timeframe. At the current rate of progress, it will take 11 more years until all stocks have an LRP, 26 more years until all have a USR and 34 more years until all critically depleted stocks are included in a rebuilding plan.[1]

To accelerate the implementation of these important tools, DFO must continue to invest resources in fisheries science. The percentage of stocks with recent stock assessments is not increasing as expected, while the percentage of stocks with uncertain status is not decreasing. While there has been improvement in the percentage of stocks with natural mortality and exploitation rate estimates, the percentage of stocks with fishing mortality estimates has stagnated at a low level. Of stocks with fishing mortality estimates, in most cases these estimates do not include all sources of fishing, meaning we are not considering all removals adequately in our management. That is why improvements to these indicators will also require better data collection. Good data provides the foundation for good management. When armed with accurate estimates of how much of each species is caught and discarded, fisheries scientists can provide fishing mortality estimates that include all sources of fishing mortality and managers will have the key information required for rigorous fisheries management and decision-making. That is why Oceana Canada is calling for the timely implementation of the national Fishery Monitoring Policy (Archibald et al., 2021c), while emphasizing that the precautionary approach means caution should be taken when scientific knowledge is uncertain and that the absence of rigorous information is not a reason to delay taking conservative measures. DFO needs to provide resources and establish timelines to implement the Fishery Monitoring Policy in all fisheries as quickly as possible. Without improved quality of data, the intentions of the new *Fisheries Act* and rebuilding regulations are compromised.

The new *Fisheries Act* is now law and includes a requirement to develop rebuilding plans for stocks at or below their LRP. The government has committed $100 million over five years to assess and rebuild fish stocks (Government of Canada, 2018; Oceana Canada, 2018b). This provides a rare opportunity for ambitious progress to create change on the water, to increase the number of stocks in the healthy zone, and to build resilience to climate change. However, the draft regulations specifying the requirements for rebuilding plans and to which stocks they will apply are still not in place, meaning they do not apply to any stocks yet. It is imperative that the government strengthen the draft regulations to require rebuilding to healthy states on scientifically determined timelines and ensure all depleted stocks are included in the first batch of stocks to be subject to them (Elmslie, 2021). Stronger and more specific rebuilding plan guidelines are needed. Rebuilding plans made with current draft content will be insufficient to promote rebuilding and are likely to result in continuation of the status quo efforts that perpetuate targeting just above the point of serious harm (i.e., LRP) and on uncertain timelines (Archibald and Rangeley, 2019c; Levesque et al., 2021). As currently written, the draft regulations fall far short of the existing laws and policies in other progressive fishing nations, where history shows strong requirements and standards can rebuild stocks to abundance (e.g., NOAA, 2021)

Recommendations — Make the Next Five Years Count

Canada has the tools to restore abundance to our oceans. But now we need to step up our efforts to use them — matching action with the urgency the situation demands. Because we simply cannot afford another five years without meaningful progress in the water.

[1] Based on the average annual increase in the percentage of index stocks with each indicator over the last five years.

Real change for Canada's fisheries will require adopting globally accepted and proven best practices. At a minimum, Canada must:

1. **Pass strong rebuilding regulations:** Canada's *Fisheries Act* now requires that DFO takes action to rebuild depleted fisheries; however, it still lacks the regulations that define how rebuilding will be accomplished. These regulations must require that rebuilding plans include scientifically estimated timelines and targets in the healthy and take into account all sources of fishing mortality.
2. **Make decisions about wild fish based on science and Indigenous Knowledge:** Fisheries management decisions must include Indigenous evidence, practice and knowledge systems and follow the best available science.
3. **Integrate ocean ecosystem considerations:** DFO must take into account the ecosystem impacts of fisheries decisions, aggressively work to rebuild depleted forage fish and address the vulnerability of species to climate change impacts.
4. **Count everything caught in a fishery** — including for recreational and bait purposes — and account for all sources of fishing in management decision-making.

To address these high-level priorities and accelerate the implementation of Canada's Sustainable Fisheries Framework, Oceana Canada calls on DFO to complete the key actions outlined in a checklist at Oceana.ca/FisheryAudit2021 within the next year. This includes fulfilling ongoing commitments or those that have been delayed from previous work plans, as well as those scheduled to be completed this fiscal year (Archibald et al., 2021a).

Background

Canada's marine fisheries are highly valuable: they are a major driver of our economy, shape our culture, and sustain our coastal communities. Canada has a fisheries policy framework in place that establishes a precautionary approach and is intended to provide a basis for an ecosystem approach to fisheries management (DFO, 2009b). But many policy instruments have not been fully implemented, putting our fisheries at risk (Archibald et al., 2021a; Baum and Fuller, 2016; CESD, 2016; Hutchings et al., 2012; Hutchings et al., 2020; Winter and Hutchings, 2020). The consistent application of these policy tools will be essential to ensure the stability of healthy fisheries and the best chance of rebuilding depleted stocks for the benefit of marine ecosystems, coastal communities, and the fishing industry.

In 2017, Oceana Canada published its first annual Fishery Audit, evaluating the status of Canada's fisheries and providing an assessment of how the government is managing them (Oceana Canada, 2017). The Fishery Audit 2017 built upon a 2016 report commissioned by Oceana Canada (Baum and Fuller, 2016) to develop indicators that measure progress toward maintaining or rebuilding fisheries to healthy levels in Canada and to track how well DFO is implementing its commitments from year to year. These indicators represent the basic and essential information required for sustainable management of our marine fish and invertebrate stocks (Archibald et al., 2020; Archibald and Rangeley, 2017, 2018, 2019b). The current report uses newly available information published over the last year to update the status of Canada's marine fish and invertebrate populations and examine changes in indicators, demonstrating the extent of progress made by DFO towards rebuilding healthy and abundant oceans.

Indicators to measure progress towards healthy fisheries in Canada
The indicators are summarized as follows:

1. **Status:** The number and percentage of stocks in the healthy, cautious, and critical health status zones and the number and percentage whose health status is uncertain (DFO, 2009a). This information is essential to determine and prioritize management actions, including determining where rebuilding plans are most needed. This indicator provides a snapshot of the overall health of Canada's marine fish and invertebrate stocks.

2. **Stocks whose health status has shifted from uncertain to certain (or vice versa):** The number of stocks whose health status was previously unknown or uncertain that can now be confidently assigned a status. This indicates how much of the reported changes are due to having better information available. As DFO continues to develop reference points and improve stock assessments, the number of stocks with an uncertain status should decline. However, sometimes assessment methods change or new information comes to light, creating situations where the reverse occurs, so this report also includes the number of stocks where the health status has become uncertain.

3. **Change in status:** The number and percentage of stocks whose health status improved, worsened, or stayed the same. This indicates how things have changed since the previous year. Over time, with the success of fisheries rebuilding efforts, more stocks should move out of the critical and cautious zones and into the healthy zone.

4. **Biomass/abundance known:** The number and percentage of stocks with biomass/abundance estimates that are no older than five years. This indicator shows how many stocks have recent estimates of abundance and how this number changes from year to year. Given the federal government's increased investment in science capacity since 2016 and the hiring of more scientists (Hutchings, 2016), this number should increase over time. Most full, peer reviewed stock assessments are now conducted on a multi-year cycle (e.g., every 2–5 years), but monitoring continues for many stocks on an annual basis. To meet the need for advice in interim years between complete assessments, scientists often provide interim-year updates on the status of the stock based on pre-identified indicators (DFO, 2016b). During interim updates, indicators are evaluated against predetermined thresholds. If the indicators cross those thresholds, pre-defined management actions may be implemented or a full assessment may be required earlier than scheduled (DFO, 2016b). For stocks not assessed recently, the present Oceana Canada report gives the number and percentage of stocks with a recent interim update, indicating whether trends in proxies for biomass/abundance are being evaluated.

5. **Sources of mortality known:** The number and percentage of stocks that have an estimate of fishing mortality, natural mortality, and total mortality, as estimated by models. Fish are removed from a population due to natural causes and fishing. In terms of fisheries management, it is most important to know the fishing mortality rate (F). Ideally, estimates will include information from all potential sources of fishing mortality: directed commercial fisheries, recreational fisheries, bait fisheries, food-social-ceremonial fisheries, and bycatch (DFO, 2009a). One or more of these sources are

often missing from fishing mortality estimates, and they may end up being included with an estimate of natural mortality.

Natural mortality (M) is the removal rate of fish from the population from causes not directly attributable to fishing. It can include disease, competition, cannibalism, old age, and predation but may also include catch that is unreported or unaccounted for. Most common stock assessment models assume natural mortality is constant and input it into the model using an informed guess. However, several approaches have been developed to estimate natural mortality within models that allow it to vary. The sum of fishing and natural mortality is termed total mortality (Z). In some mortality estimation approaches, only total mortality can be estimated. For some stocks, the data available or the most appropriate modelling approach simply does not allow for an estimation of all sources of mortality. For this reason, the present Oceana Canada report gives the number and percentage of stocks with exploitation rate index estimates.

An exploitation rate index is the proportion of the population removed by fishing. It can be expressed as a proportion of fish or biomass. It provides an indication of fishing pressure. Its calculation requires an estimate of biomass or abundance in the population. If this is unavailable, then managers should at least know how many fish are removed from the population due to fishing. To assess this, the present Oceana Canada report gives the number and percentage of stocks with landed volume reported in stock assessment documents. Combined, these indicators show what information managers are using to make decisions about fishing pressure on Canada's stocks. An increase in the number and percentage of stocks that have an estimate of fishing mortality, natural mortality, and total mortality from year to year will indicate that scientists have increased ability to estimate all sources of mortality for more stocks, due to more data and the ability to use the models required. As a result, managers will have more certainty in the outcomes of management decisions.

6. **Reference points:** The number and percentage of stocks that have health status benchmarks, such as limit reference points (LRPs) and upper stock reference points (USRs). Reference points define the stock health status zones, allowing an assessment of whether a stock is in healthy, cautious, or critical condition and providing the basis for rebuilding plan goals (DFO, 2009a). Reference points enable objective assessments of stock health and the success of management measures. With DFO's commitment to developing reference points for all major stocks (CESD, 2016; DFO, 2020f), the number of stocks with reference points should rise from year to year.

7. **Management plans in place:** The number and percentage of stocks included in an Integrated Fisheries Management Plan (IFMP), which is Canada's planning framework for the conservation and sustainable use of our fisheries (DFO, 2010). These plans outline in a single document the process by which a fishery will be managed over a given period. IFMPs are also an important tool for implementing departmental policies and the primary tool for managing stocks in the healthy and cautious zones and rebuilding stocks from the cautious to the healthy zone. A transparent, fully accessible, and detailed IFMP makes it easy to determine how a stock is managed, making it less vulnerable to bad decision-making. With DFO's commitment to develop and release IFMPs for all major stocks (CESD, 2016; DFO, 2020f), the number of stocks with IFMPs should rise from year to year.

8. **Catch monitoring:** The number and percentage of stocks with one or more of the following: at-sea observers/electronic video monitoring, dockside monitoring of landings, logbooks that record the entire catch, or electronic vessel monitoring systems (VMS) that monitor the location and time of fishing activity. When fisheries have accurate estimates of how much of each species is caught, how much is discarded, and where and when fishing is occurring, they can make informed fisheries management decisions. These indicators assess how well the fisheries on our stocks are monitored. There are many ways to monitor the catch, but at-sea observers/electronic video monitoring, dockside monitoring, and logbooks are among the most common tools. Each has some trade-offs. Dockside monitoring is a land-based program that monitors the weight and type of fish landed from a commercial fishing vessel when it returns to port. Although this is a good way to assess retained catches, it does not record species discarded at sea. At-sea observers and electronic video monitoring record the entire catch, both retained and discarded. However, 100 per cent coverage can be expensive and not necessary for all fisheries. The entire catch can also be recorded in logbooks, in which fishers record information about their catch and activities. However, it is not always a requirement to record all bycatch species, and catches identified using species guides may not be reported accurately. Electronic vessel monitoring systems allow scientists and managers to assess fishing effort in time and space using satellite technology, but this may not be feasible or required in all fisheries. By using a combination of catch monitoring tools, ideally recording the entire catch, fisheries scientists and managers will have the data required to effectively manage our fisheries.

   With the release of a national Fishery Monitoring Policy in November 2019 (DFO, 2019c), more attention is expected from DFO to determine and ensure the appropriate type and frequency of catch monitoring in all our fisheries. One of the implementation steps is ensuring there are specific and measurable fishery monitoring objectives in all IFMPs, with monitoring requirements required to achieve them outlined. To evaluate the implementation of the national Fishery Monitoring Policy, Oceana Canada reports the number and percentage of stocks with *specific and measurable* fishery monitoring objectives appearing in their IFMPs. These indicators should rise from year to year as the fisheries on these stocks evaluate and improve their catch monitoring.

9. **Critical stocks with rebuilding plans:** The number and percentage of critical-status stocks that have rebuilding plans. DFO follows a fisheries decision-making framework that incorporates the precautionary approach (PA framework) (DFO, 2009a). The precautionary approach means being cautious when scientific knowledge is uncertain and not using the absence of adequate information as a reason not to take action. According to the PA framework, all stocks within the critical zone must have rebuilding plans (DFO, 2009a). Similar to an IFMP, a rebuilding plan provides a framework for the management of a fishery, with additional requirements included to rebuild the stock out of the critical zone (DFO, 2009a, 2013), preferably to a healthy state. Ideally, all stocks in the critical zone should have rebuilding plans, and given DFO's commitments (CESD, 2016; DFO, 2020f), this indicator is expected to increase from year to year.

Methods

The initial Fishery Audit stock list (n = 194 stocks) was created for the 2017 Fishery Audit (for details on stock list creation, see Archibald and Rangeley, 2017). At the time, it was the most complete list of stocks available for Canada. It is based on marine fish and invertebrate stocks[2] included in the report commissioned by Oceana Canada in 2016 (Baum and Fuller, 2016), combined with those included in the first detailed release of the results of the DFO Sustainability Survey for Fisheries (SSF) (2015 results, released in October 2016; DFO, 2016e), with the addition of any stocks with newly available information from departmental reports that year. Oceana Canada's Fishery Audit stock list is closer to representing all marine fish and invertebrate stocks that are managed within Canada and are subject to targeted or incidental commercial fishing pressure than the SSF, which only includes major commercial stocks (DFO, 2016a),[3] but several minor stocks are still missing from the list.

There is no comprehensive list of all commercial fish stocks subject to federal management in Canada. In Oceana Canada's subsequent Fishery Audits (Oceana Canada, 2018a, 2019, 2020), efforts were made to continue to strive towards a comprehensive stock list by adding to the dataset any further stocks found in newly available information from departmental science reports, departmental work plans (DFO, 2017b, 2018b, 2019b, 2020g, 2021d), or new additions to the SSF (DFO, 2016e). However, to make comparisons from year to year, this report focuses only on stocks included in the 2017 stock list, which is now called the index stock dataset.

To update the information pertaining to the indicators, Oceana Canada reviewed DFO websites for published IFMPs and rebuilding plans and reviewed all Canadian Science Advisory Secretariat (CSAS) Science Advisory Reports, Research Documents, and Science Responses published since the last Fishery Audit (i.e., between July 2, 2020 and July 1, 2021). For stocks assessed by regional fisheries management organizations (RFMOs) and stocks jointly assessed by the U.S. and Canada, relevant websites were reviewed for newly available information. If newly available information did not result in an update to an indicator, values from 2020 were carried forward. A few minor errors found in previous records (e.g., assessment year based on publication date rather than last year of data used) were corrected when found during the 2021 update process. These minor errors did not change indicator values significantly, and annual comparisons are made using the corrected indicator dataset.

This year's report continues to use the same indicators used in past years, and during the update process, information was interpreted in the same manner. See the previous reports for further details on how indicators are evaluated for each stock (Archibald et al., 2020; Archibald and Rangeley, 2017, 2018, 2019b). Briefly, the health status of each stock was updated. In some cases, Oceana Canada was able to find this information in the documents searched, using the biomass estimates in relation to reference points. In other cases, health status was assigned based on an interpretation of data included in the documents. In determining whether a stock had a recent biomass/abundance estimate (less than or equal to five years old), the last year of data included in the assessment was used to determine how recently the estimate was made. This reduced the confusion from the long time-lapse (i.e., years) that sometimes occurs between when assessments are conducted and when the results are published

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[2] It does not include marine mammals, diadromous fish, or freshwater fish.

[3] The number of stocks included in the SSF has varied over time since the first release of stock-by-stock results in 2015 (n = 159 stocks in 2015; n = 170 stocks in 2016; n = 179 stocks in 2017; n = 177 stocks in 2018, n = 176 stocks in 2019). The most recent results (2019) of the SSF includes 176 stocks, of which 131 are marine fish and invertebrates and 45 stocks are marine mammals, diadromous fish, or freshwater fish. These stocks represent most of the landings from fisheries managed by DFO but are just part of all the stocks managed by DFO. Stocks are selected for inclusion in the survey based on their economic, cultural, or environmental importance.

(Archibald et al., 2021b). Additionally, only complete assessments (e.g., from CSAS national or regional peer review processes) with a new biomass (or proxy) estimate were accepted as an assessment; interim updates of indicators (e.g., from CSAS science response processes) were not because they are most often based on trends in survey and catch data and usually do not include biomass estimates expressed in relation to reference points (DFO, 2016b). However, the year of the most recent interim update process (i.e., CSAS science response process) was recorded for each stock. This information is used to calculate the number and percentage of stocks with an interim update since the last complete assessment, indicating whether trends in proxies for biomass/abundance are being evaluated in the absence of recent complete assessments.

In 2017, the only source of mortality included in Oceana Canada's Fishery Audit was fishing mortality. Natural and total mortality rates were added in 2018, and values were informed by the most recent stock assessment documents available for all stocks. Estimates of fishing mortality should ideally include information from all potential sources (e.g., directed commercial fisheries, recreational fisheries, bait fisheries, food-social-ceremonial fisheries, and bycatch) (DFO, 2009a). Therefore, in 2019 Oceana Canada began recording when stock assessment reports clearly indicated all sources were incorporated in the fishing mortality estimation. However, there are stocks where a lack of data or the modelling approach used by scientists simply does not allow for an estimation of fishing mortality, natural mortality, or total mortality. In such cases, Oceana Canada simply recorded whether exploitation rates, exploitation rate indices, or relative fishing mortality rates (i.e., catch/survey biomass) were estimated. Similarly, because the calculation of exploitation rate requires an estimate of biomass or abundance in the population, which is not always available, it was also noted whether the volume of landings was available in assessment reports.

The language describing reference points can be ambiguous in CSAS documents. Terms such as "calculated" or "proposed" are often used with little indication as to whether the reference points have been accepted and implemented. For the purposes of this Fishery Audit, Oceana Canada concluded that stocks had reference points if there was any indication of them having been developed but not if there was a clear indication in the reports that they were not yet accepted or implemented by managers. In the case of stocks assessed by RFMOs, if reference points exist, they often have different criteria and definitions of health status zones and reference points than DFO's PA framework. If information on these stocks included the biomass relative to a biomass limit reference point (B_{LIM}) or the biomass at maximum sustainable yield (B_{MSY}), this information was used to assign a status zone analogous to DFO's PA framework (e.g., if the currently assessed biomass was less than B_{LIM} or less than 40 per cent of B_{MSY}, the stock was assigned to the critical zone). Similarly, if there was a B_{LIM} indicated, it was considered an LRP. Additionally, for some stocks no longer subject to a directed commercial fishery, DFO appears to be developing biomass recovery targets instead of reference points. Although recovery targets should be developed to rebuild healthy populations (i.e., above an equivalent USR), DFO often, confusingly, uses definitions like those used for LRPs (i.e., 40 per cent B_{MSY}) (e.g., Swain et al., 2016). Thus, in these cases, biomass recovery targets developed by DFO were considered analogous to LRPs.

It is not unusual for more than one fishery to catch a given stock, making assessments of catch monitoring challenging. For example, different fisheries catching the same stock may have different targeted levels of at-sea observer coverage that varies by gear type and/or vessel size. Therefore, Oceana Canada established indicator values broad enough (e.g., complete coverage, varying levels of coverage, uncertain if tool is used) to allow for an amalgamation of values, but available details on targeted levels of tool use were recorded in brackets within the indicator value for each stock in the indicators spreadsheet. If there was no indication in the documents and websites searched that the use of the monitoring tool is required, "uncertain" was assigned as the indicator value. "No" was only assigned when it was clearly indicated the tool was not used. In 2019, the requirement to use electronic VMS or an automated identification system (AIS) was added to the existing three commonly used catch monitoring tools evaluated in previous reports (see Archibald and Rangeley, 2017, 2018). Further, in anticipation of the finalization and implementation of the national Fishery Monitoring Policy, the number and percentage of stocks with specific and measurable fishery monitoring objectives appearing in their IFMPs was recorded starting in 2019. To meet this requirement, objectives had to be clearly stated as fishery monitoring objectives, with the purpose stated, and details the policy suggests should be included, such as the tools, targeted coverage levels, and acceptable level of dependability to meet the objective.

In 2020, the indicators of stock status and whether a stock was recently assessed or not were explored in relation to proxies for recent landed volume and value (Archibald et al., 2020). This was done to characterize stock status in relation to these two proxies of economic importance and to determine if their economic importance influences stock assessment priorities. This analysis was not repeated in 2021, but the information required was collected and updated in 2021 and is available in the indicators spreadsheet, available online (Oceana.ca/FisheryAudit2021). Volume of reported landings for each stock was obtained from their most recent stock assessment reports. Stock assessment reports are the only location where publicly available landings data are reported by stock consistently across species and regions. Because Oceana Canada used this data as a proxy for economic importance, any estimates of unreported landings or discard mortality were excluded, as were non-Canadian landings when possible. Sometimes the volume of reported landings obtained represented a recent annual average if the most recent year was not reported by itself, and sometimes the volume found was out of date if the most recent report itself was dated. For these reasons, landed volumes reported in the spreadsheet should only be considered a proxy for recent harvest volume. Value is also not reported publicly by stock across all regions in a consistent manner. However, DFO does report annual aggregate national value data by taxa group and province on its Seafisheries Landings website (DFO 2016c). A proxy for recent landed value for each stock was estimated by multiplying the volume of reported of landings (in metric tonnes) obtained from reports by the most recent value per metric tonne of the taxa group and region to which the stock belongs in the DFO Seafisheries Landings website dataset (DFO, 2016c). The value per metric tonne was calculated by dividing the value per taxa group and region (Atlantic or Pacific) in the most recent year reported (2019 for 2021 Fishery Audit indicators spreadsheet records) by the quantities per taxa group and region in the same year. Given that the taxa level reported on the Seafisheries Landings website differ in resolution and that actual ex-vessel prices differ by quality, region, and time of year, this value should only be considered as a proxy for recent value of reported landings.

With the fifth annual update of Oceana Canada's indicators, there are now sufficient data points for most indicators to be statistically evaluated for annual trends. Annual trends in the proportion of stocks with "yes" values for indicators (or the proportion within each stock status zone) were evaluated where appropriate using chi-squared tests for trends in proportions with an alpha level of 0.05 (prop.trend.test function in the 'stats' package; R Core Team, 2019).

Results and Discussion
The 2021 index stock dataset for this Fishery Audit includes 194 marine fish and invertebrate stocks that are managed within Canada and subject to targeted or incidental commercial fishing pressure (Table 1). The complete dataset of stocks and stock-specific indicator values is available online in the indicators spreadsheet (see oceana.ca/FisheryAudit2021).[4] For a visualization of most indicators by DFO administrative region, see Appendix 1 of this document.

1. **Status:** In 2021, only 30.4 per cent (59 stocks) of Oceana Canada's marine fish and invertebrate index stocks can be confidently considered healthy. An additional 16.0 per cent (31 stocks) are in the cautious zone and 17.0 per cent (33 stocks) are in the critical zone, while the status of 36.6 per cent (71 stocks) are uncertain. Uncertain stocks are likely a mix of states, some of which are likely critical (e.g., Pacific sardine, yellowtail flounder on Georges Bank), while others are likely healthy (e.g., American lobster around Anticosti Island). With the addition of a fifth year of data, the decreasing trend in healthy stocks and increase in critical noted last year have been reversed. Over the last five years there has been little change in the overall status of the Canadian marine fish and invertebrate stocks evaluated (Figure 1, Table 1). There were no significant trends in the proportion of stocks considered healthy ($p = 0.13$ $\chi^2 = 2.32$), cautious ($p = 0.76$ $\chi^2 = 0.09$), critical ($p = 0.14$ $\chi^2 = 2.22$), or uncertain ($p = 0.93$ $\chi^2 < 0.01$) across years.

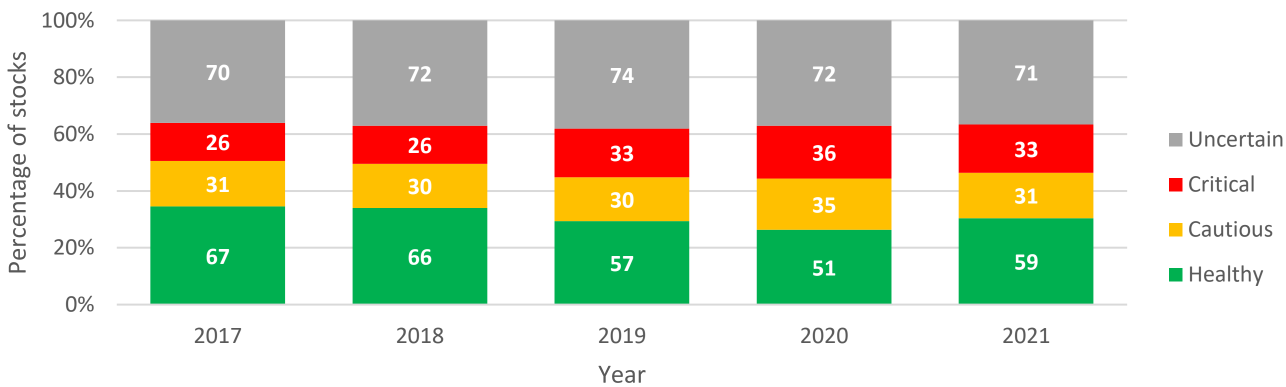


Figure 1. The percentage of Oceana Canada index stocks (n = 194 stocks) in each of the health status zones described in DFO's precautionary approach (PA) framework (DFO, 2009a) in 2017, 2018, 2019, 2020, and 2021. The number of stocks in each status zone is indicated in white font within the bars.

Most of the critically depleted stocks are groundfish (11 stocks) and flatfish (six stocks) located in the Atlantic Ocean (Figure 2), many of which have not recovered since the groundfish collapse in the mid-1990s. But there are also now many critically depleted invertebrate stocks (nine stocks) in the Pacific (Figure 3). Notable changes across the time series include no more healthy forage fish in the Atlantic and increases in the number of critical and cautious status invertebrate stocks in both the Atlantic and Pacific (Figures 2, 3). Meanwhile, there has been notable increases in the health status of rockfish and redfish in both oceans (Figures 2, 3). Within the limited number of

[4] In 2021, Oceana Canada continued its efforts to build a comprehensive stock list by adding to the dataset any additional stocks found during this update using newly available information from DFO reports, work plans, or new additions to the SSF (see Methods section). This resulted in a dataset that grew from 226 stocks in 2020 to 229 stocks. Results calculated using all stocks did not differ greatly from those using index stocks, and results using all stocks are available in Table 2.

Arctic Ocean stocks included in the dataset, as of 2021 there is reduced uncertainty in health status, with all but one now evaluated as healthy (Figure 4).

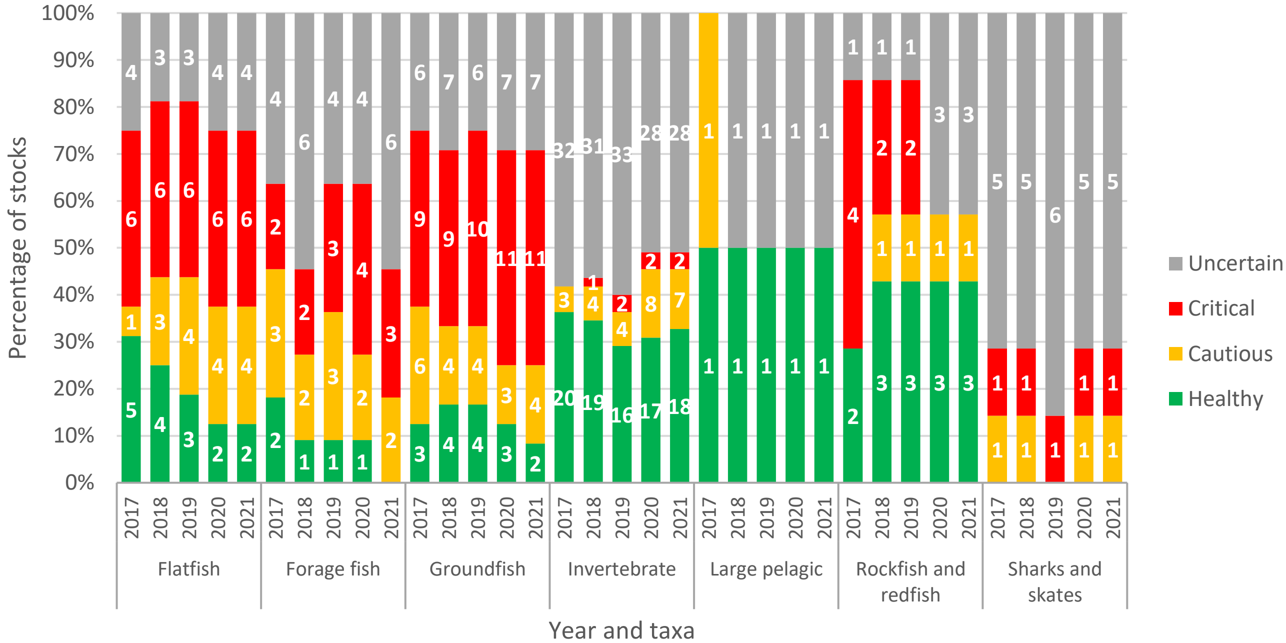


Figure 2. The percentage of Oceana Canada index stocks (n = 194) in each of the health status zones described in DFO's precautionary approach framework (DFO, 2009a), by taxa groups, in the Atlantic Ocean in 2017, 2018, 2019, 2020, and 2021. The number of stocks in each year-taxa-status combination are reported in white font within the bars.

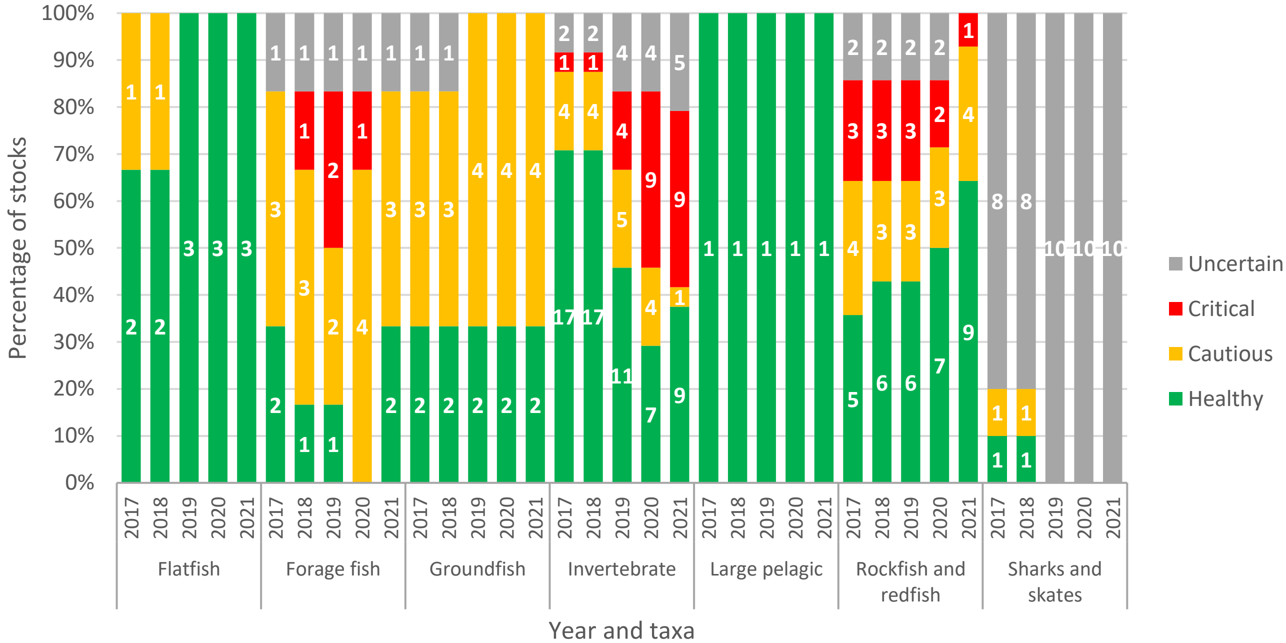


Figure 3. The percentage of Oceana Canada index stocks (n = 194) in each of the health status zones described in DFO's precautionary approach framework (DFO, 2009a), by taxa groups, in the Pacific Ocean in 2017, 2018, 2019, 2020, and 2021. The number of stocks in each year-taxa-status combination are reported in white font within the bars.

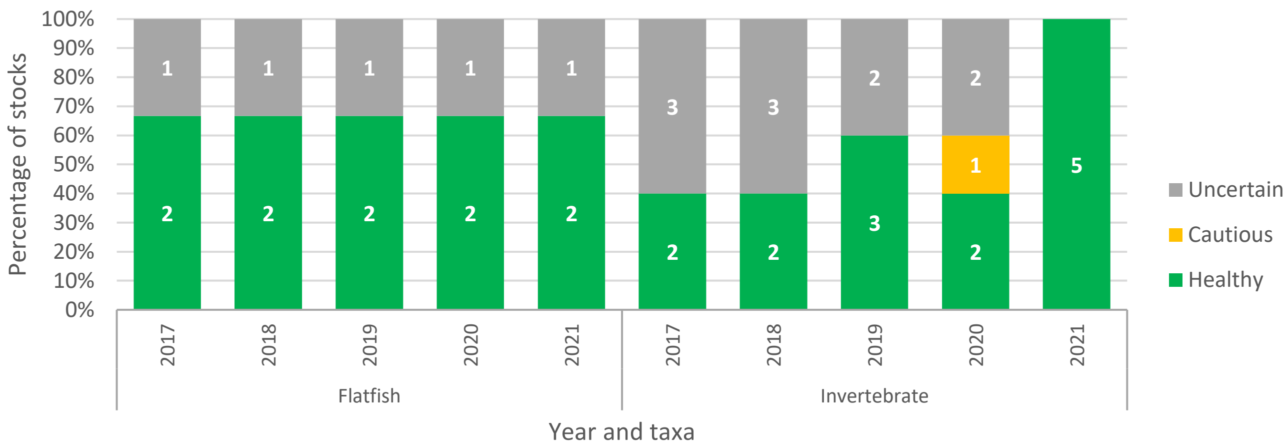


Figure 4. The percentage of Oceana Canada index stocks (n = 194) in each of the health status zones described in DFO's precautionary approach framework (DFO, 2009a), by taxa groups, in the Arctic Ocean in 2017, 2018, 2019, 2020, and 2021. The number of stocks in each year-taxa-status combination are reported in white font within the bars.

The 2021 status results reported here are slightly different from the most recent (2019) results of the DFO SSF, where 14.2 per cent (25 stocks) were critically depleted, 16.5 per cent (29 stocks) were in the cautious zone, 29.5 per cent (52 stocks) were in the healthy zone, and the status of 39.8 per cent (70 stocks) were uncertain (DFO, 2016e). These differences are likely due in part to the inclusion of additional taxa in the SSF (e.g., freshwater and diadromous fish) not included in the Oceana Canada index stock dataset, which focuses on marine fish and invertebrates that live their entire life cycle in the ocean. The differences are also likely due in part to the delay in the SSF; given it takes nearly a year to conduct and analyze the survey, results are reporting on the previous year's data and released nearly a year or more after the survey year (i.e., 2019 results were released in early 2021).

The 2021 health statuses reported here are based on information available up to and including July 1, 2021 and are therefore informed by more recent information that was not available when the 2019 SSF was completed. Additional differences likely arise from differences in stock definitions and inclusion. Oceana Canada's index stock dataset was created from a merger of stocks included in the Baum and Fuller (2016) report and the 2015 SSF (DFO, 2016e), with stock definition discrepancies decided by the unit used in the most recent CSAS report (see Archibald and Rangeley, 2017 for details). Oceana Canada's index stock dataset is closer to representing all marine fish and invertebrate stocks that are managed within Canada and are subject to targeted or incidental commercial fishing pressure than the SSF, which only includes major commercial stocks (DFO, 2016a). Therefore, although the index dataset used here includes all stocks from the SSF at the time it was first published, it also includes several stocks (47 stocks) not included in the 2019 SSF in any form. Of these stocks not overlapping with the 2019 SSF stock list, nine are in the critical zone (19.1 per cent), seven are in the cautious zone (14.9 per cent), five are in the healthy zone (10.6 per cent) and 26 are uncertain (55.3 per cent). This indicates the health of stocks that DFO considers "minor" may be worse than those it considers "major," contributing to the differences in health status reporting.

Unlike here where little change was found in in the overall status of index stocks from 2017 to 2021, the SSF dataset is showing a large decline in the percentage of what DFO considers to be healthy stocks from 49.1 per cent (78 of 159 stocks) in 2015 to 29.5% (52 of 176 stocks) in 2019. Given there was relatively little change in the percentage of stocks considered to be in the cautious (17.6 per cent in 2015 to 16.5 per cent in 2019) or critical zones (11.9 per cent in 2015 to 14.2 per cent in 2019), it seems this large change in the percentage with healthy status could be linked to the large increase in uncertain status stocks from 21.4 per cent in 2015 to 39.8 per cent in 2019. The SSF questions have changed since 2015 and have required respondents to provide more details and evidence in support of status determinations, including specification if it is based on peer reviewed evaluation or expert opinion (DFO, 2018c, 2021c). This may have resulted in respondents being more conservative in their evaluation of status. However, respondents indicated that serious harm was possible or likely for over a third of those with uncertain status (37.4 per cent or 26 of 70 stocks).

2. **Stocks whose health status has shifted from uncertain to certain (or vice versa):** In 2021, five index stocks went from having an unknown/uncertain status in 2020 to having one assigned due to new information, a similar change as in previous years (Table 1). The health status of four were assigned as healthy and one as cautious.[5] Four stocks underwent the reverse change, with

[5] Uncertain to healthy: longspine thorny head in the Pacific, northern shrimp in the Western Assessment Zone, striped shrimp in the Western Assessment Zone, and rougheye rockfish in the Pacific.
Uncertain to cautious: haddock in NAFO 4X5Y

Oceana Canada unable to determine their status with certainty (two from healthy to uncertain, one from cautious to uncertain, and one from critical to uncertain).[6] This resulted in an overall decrease in the total number stocks with uncertain status from to 72 in 2020 to 71 in 2021, the second year in a row with net declines after net increases from 2017–18 and 2018–19 (Table 1, Figure 1). While the number of uncertain status stocks in the index dataset has remained relatively stable (between a minimum of 70 stocks in 2017 and a maximum of 74 in 2019), as noted above the number of uncertain stocks in the DFO SSF has increased greatly, from 34 stocks in 2015 to 70 in 2019 (DFO, 2016e). DFO indicates uncertain status is assigned for several reasons, such as a lack of reference points, insufficient data, or fluctuations in population level that makes assigning a health status difficult (DFO, 2016d). This lack of sufficient information to reliably assess the health status of some stocks, combined with the increase in the number of stocks included in the SSF, has contributed to the high number of stocks with an uncertain status in the SSF (ECCC, 2021). Given the continued development of reference points and improved science capacity for stock assessments within the department in the last five years, the SSF data displays a change in the opposite direction than expected, while the Oceana Canada index dataset shows little net change in the ability to assign a health status for over a third of our marine fish and invertebrate stocks.

3. **Change in status:** In 2021, 10.8 per cent of index stocks (21 of 194 stocks) had a different health status as compared to 2020 (Table 1). This is a similar amount of change as in past years (Table 1), with no significant trend in the percentage of stocks changing health status from one year to the next across Fishery Audit years ($p = 1.0$, $\chi^2 < 0.01$). As outlined above, many of these changes from last year (nine stocks) were stocks that moved from uncertain to certain or the reverse. In addition, three stocks were identified as more at risk, with one stock declining from healthy levels to the cautious zone,[7] and two stocks declining from the cautious zone to the critical zone.[8] Nine stocks were identified as less at risk, with two moving from the critical zone to the cautious zone,[9] two moving from the critical zone to healthy zone,[10] and five moving from the cautious zone to healthy zone.[11]

4. **Biomass/abundance known:** In 2021, 58.2 per cent of index stocks (113 of 194 stocks) had a biomass or abundance estimate made during a full, peer reviewed assessment process within the last five years (i.e., CSAS national or regional peer review processes or RFMO equivalents). This value is similar to past years, and there was no significant trend in the proportion of stocks with recent assessments ($p=0.10$, $\chi^2 = 2.66$) (Figure 5, Table 1). As in previous years, many stocks (57) had more recent biomass estimates this year than they did last year, but most of the previous estimates were still less than five years old, resulting in little influence on the indicator.

[6] Healthy to uncertain: fall spawning Atlantic herring in NAFO 4R, haddock in NAFO 5Zjm
Cautious to uncertain: intertidal clams – depuration in the Pacific
Critical to uncertain: spring spawning Atlantic herring in NAFO 4R
[7] Healthy to cautious: Iceland and sea scallops around the Magdalen Islands (areas 20A, 20B, 20C, 20E, and 20F)
[8] Cautious to critical: Intertidal clams – North coast Haida Gwaii razor clam, snow crab in NAFO 4X
[9] Critical to cautious: snow crab in NAFO 3L – inshore, yelloweye rockfish – inside population
[10] Critical to healthy: pink shrimp in the Prince Rupert District, Pacific herring – Haida Gwaii
[11] Cautious to healthy: northern shrimp in SFA 5, Pacific herring in the Strait of Georgia, sidestripe shrimp in the Prince Rupert District, snow crab in NAFO 3LNO – offshore, striped shrimp in the Eastern Assessment Zone

Meanwhile, several stocks assessed in 2015 (i.e., six years ago) have not been reassessed since and are now considered outdated in this year's analysis. As a result, there was little net change in this indicator again in 2021.

Of the 41.8 per cent of index stocks (81 stocks) without complete assessments in the last five years, 21.0 per cent (17 stocks) have had an interim update reporting on trends in proxies for biomass/abundance within the last five years (i.e., CSAS science response processes or RFMO equivalents; CSAS, 2021). This means that 67.0 per cent of index stocks have had at least some sort of evaluation of trends in abundance or biomass indices within the last five years to support fisheries management. However, of the interim updates, only one stock had indicators evaluated against predetermined thresholds used to trigger pre-defined management actions or a full assessment earlier than scheduled, suggesting the policy is not being consistently implemented (DFO, 2016b).

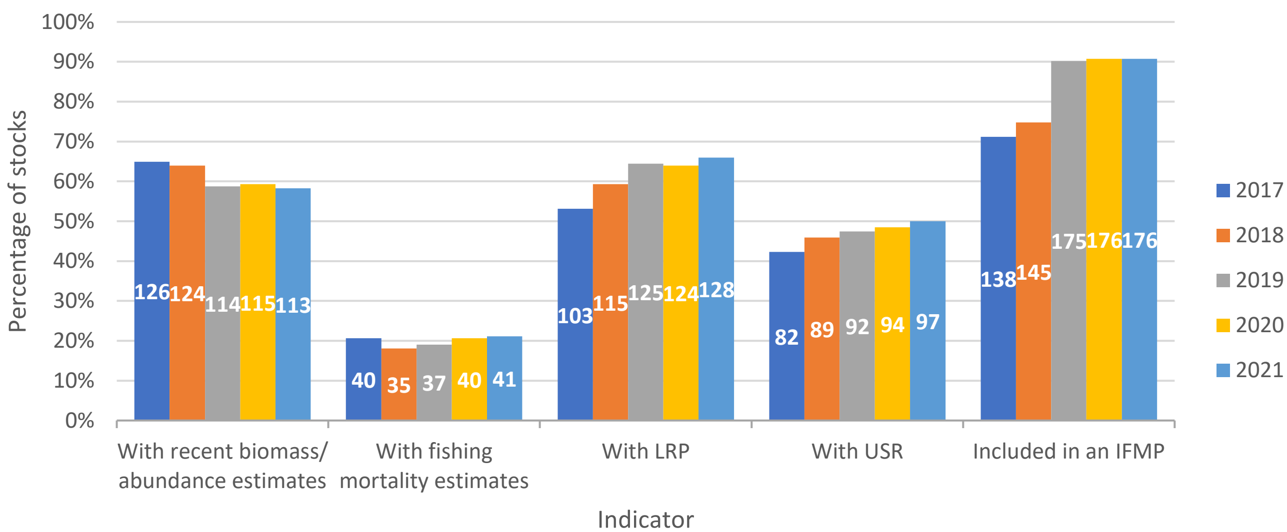


Figure 5. An assessment of how stocks perform on five indicators, based on Oceana Canada's index stock dataset (n = 194 stocks) in 2017, 2018, 2019, 2020, and 2021. The indicators included the percentage of stocks: 1) with a biomass/abundance estimate within the last five years; 2) with fishing mortality estimates; 3) with a limit reference point (LRP); 4) with an upper stock reference point (USR); and 5) included in an Integrated Fisheries Management Plan (IFMP). The number of stocks for each indicator is in white font within the bars. See the Introduction and Methods sections for further details on indicator definitions and calculations.

5. **Sources of mortality known:** In 2021, 20.6 per cent of index stocks (40 of 194 stocks) had an estimate of fishing mortality. This value is similar to past years, and there was no significant trend in the proportion of stocks with estimates of fishing mortality (p=0.82, χ^2 = 0.05). Roughly one in five stocks have sufficiently robust data or a modelling approach that allows for the estimation of fishing mortality, which is valuable in assessing whether overfishing is occurring (NMFS, 2019). Ideally, fishing mortality estimates should include all sources of fishing mortality (DFO, 2009a; Gilman et al., 2013): commercially directed, recreational, bait, food-social-ceremonial, and bycatch. Only two stocks have recent stock assessment reports that clearly indicate all

suspected sources were accounted for,[12] while 10 additional stock assessment reports clearly indicate they at least partially account for sources other than reported commercial landings (e.g., by reconstructing uncertain catch histories or by using censored-catch models that assume landings data is biased).[13]

Several approaches have been developed to estimate natural mortality within models and/or to allow it to vary (e.g., Turcotte et al., 2021). In 2021, 21.6 per cent of index stocks (42 of 194 stocks) have an estimate of natural mortality. This is the fourth year-over-year increase in this indicator since it was included in the 2018 Fishery Audit (Table 1), a significant trend ($p=0.04$, $\chi^2 = 4.21$), likely representing increased use of the new modelling approaches. In some mortality estimation approaches, only total mortality can be estimated. In 2021, 12.4 per cent of index stocks (24 of 194 stocks) have an estimate of total mortality. This is another year-over-year increase since this indicator was first included in the 2018 Fishery Audit (Table 1) and another significant trend ($p=0.04$, $\chi^2 = 4.21$) across years.

These notable improvements in the number of stocks with natural and total mortality estimates hopefully signal improvements in the ability to estimate all sources of mortality. Still, the number of stocks with fishing mortality estimates has remained relatively stable, and few of these stocks have all sources of fishing mortality incorporated in their estimation. These results indicate a lot more work is needed to ensure there is the data and ability to use the models required to estimate all sources of mortality, so there can be more confidence in management decisions.

In the absence of the data and ability to estimate fishing mortality, it important to at least have an estimate of the exploitation rate. Exploitation rate indices are the proportion of the population removed by fishing (expressed as proportion of abundance or biomass) and provide an indication of fishing pressure. In 2021, still less than half (49.0 per cent; 95 of 194 stocks) of index stocks have exploitation rates or indices reported, but this is the third year of improvement since this indicator was first included in the 2019 Fishery Audit (Table 1), and another significant trend ($p = 0.04$, $\chi2 = 4.18$). The percentage of stocks with some level of information on fishing pressure, either the more detailed information provided by fishing mortality estimates or relative information from exploitation rate indices, has increased since 2019 (2019 – 49.0%; 2020 – 55.7%; 2021 – 58.8%). But this was not a significant trend ($p = 0.05$, $\chi2 =3.75$), and in 2021 over 40% of stocks still lack this type of information on fishing pressure.

If fishing mortality or exploitation rate estimates are not possible, at a minimum, it is important to know the volume of fish landed. In 2021, most index stocks (97.9 per cent; 190 of 194 stocks) have estimates of reported landings included in their most recent stock assessment reports, essentially unchanged over the three years this indicator has been included (Table 1), with no significant trend ($p = 1.0$, $\chi2 < 0.01$).

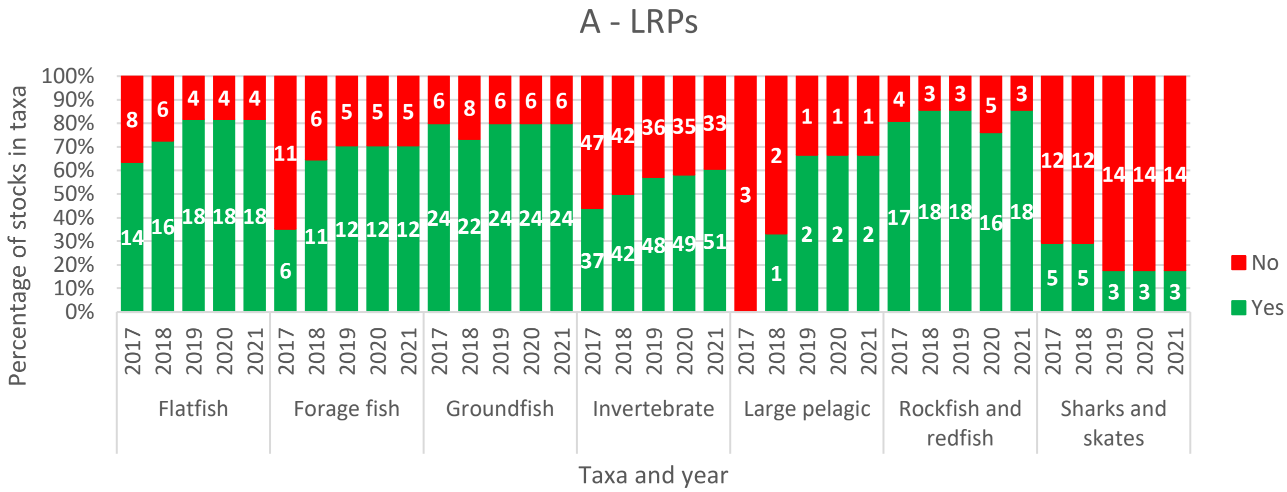
[12] Pacific halibut and winter skate in NAFO 4T

[13] American plaice in NAFO 4T, bluefin tuna in the western Atlantic, Atlantic herring in NAFO 5YZ, Atlantic mackerel in NAFO subareas 3 and 4, Atlantic cod in NAFO 2J3KL (i.e., northern cod), Atlantic cod in NAFO 3Ps, Pacific cod in the Hecate Strait (5CD), Pacific cod in the Queen Charlotte Sound (5AB), yelloweye rockfish – inside population, and the yelloweye rockfish – outside population

6. **Reference points:** In 2021, 66.0 per cent of index stocks (128 of 194 stocks) have LRPs and 50.0 per cent (97 stocks) have USRs. Although there was a slight drop in the percentage of stocks with LRPs last year, this indicator increased again this year as in earlier years (Table 1), resulting in significant increase in the percentage of stocks with LRPs since 2017 ($p = 0.005$, $\chi 2 = 7.57$). USR development has consistently increased year over year (Table 1), but at a slower rate than LRPs, resulting in no statistically significant trend in the percentage of stocks with USRs across years ($p = 0.11$, $\chi 2 = 2.34$). Without reference points, it is difficult to apply the PA framework (DFO, 2009a), assess stock health, and identify targets for rebuilding depleted stocks to healthy levels. DFO has committed to developing reference points for all major commercial fish stocks (CESD, 2016), and the results here indicate they are making some progress. But with about a third of the marine fish and invertebrate index stocks lacking LRPs and half lacking USRs, managers continue to operate without these benchmarks, and the status of many stocks remains uncertain. All index stocks in the critical and cautious zones have LRPs or their equivalent. However, over a quarter of these stocks are missing USRs (in the critical zone, 27.2 per cent or nine stocks are missing USRs; in the cautious zone, 25.8 per cent or eight stocks are missing USRs). If stocks that are not doing well lack a USR, there is no target for rebuilding them to a healthy state.

   Implementation of reference points has likely been hindered by vague and ambiguous policy language without accompanying operational guidelines for different species and data-richness scenarios, identified as important for successful policy implementation in other jurisdictions (Mace and Gabriel, 1999; Methot et al., 2014). Additionally, the ambiguity of scientists' responsibilities in policy formulation and implementation in Canada has been identified as a factor impacting compliance with the precautionary approach (Winter and Hutchings, 2020). For example, while policy is clear that LRPs are to be established by fisheries scientists, it is less clear on the role of scientists in establishing USRs and target reference points (DFO, 2009a), largely interpreted as management decisions. Progress with LRPs has shown significant improvement over the last five years, while USR development lags. Although DFO scientists have proposed USRs for several stocks, these have yet to be implemented by management (Archibald et al., 2021a; Archibald and Rangeley, 2021a).

   When reference point development is examined by taxa group it is apparent that, except for sharks and skates, most taxa groups have had proportional increases in reference point presence (Figure 6A, 6B). However, it is noteworthy that invertebrates, which include stocks of Canada's most valuable seafood species (e.g., lobster, scallops, shrimp, and snow crab) (DFO, 2016c), are still missing LRPs for about 40 per cent of index stocks, more than any other taxa group except sharks and skates. Similarly, 50 per cent of invertebrate stocks are missing USRs. When the most valuable species groups (lobster, scallops, shrimp, and snow crab) are examined for reference point presence, it is startling to find that most lobster, snow crab and scallop stocks still lack these basic components of the PA framework (Figure 7A, 7B). Although DFO has committed to developing reference points for several of these stocks and DFO scientists have proposed PA frameworks for some (e.g., snow crab in Newfoundland and Labrador), these have yet to be implemented fully by management (Archibald et al., 2021a; Archibald and Rangeley, 2021a). Meanwhile although most shrimp stocks have PA frameworks in place, the framework for some of these stocks is under revision and the process has encountered delays (e.g., northern shrimp in SFAs 4-6) (Archibald et al., 2021a; Archibald and Rangeley, 2021a).



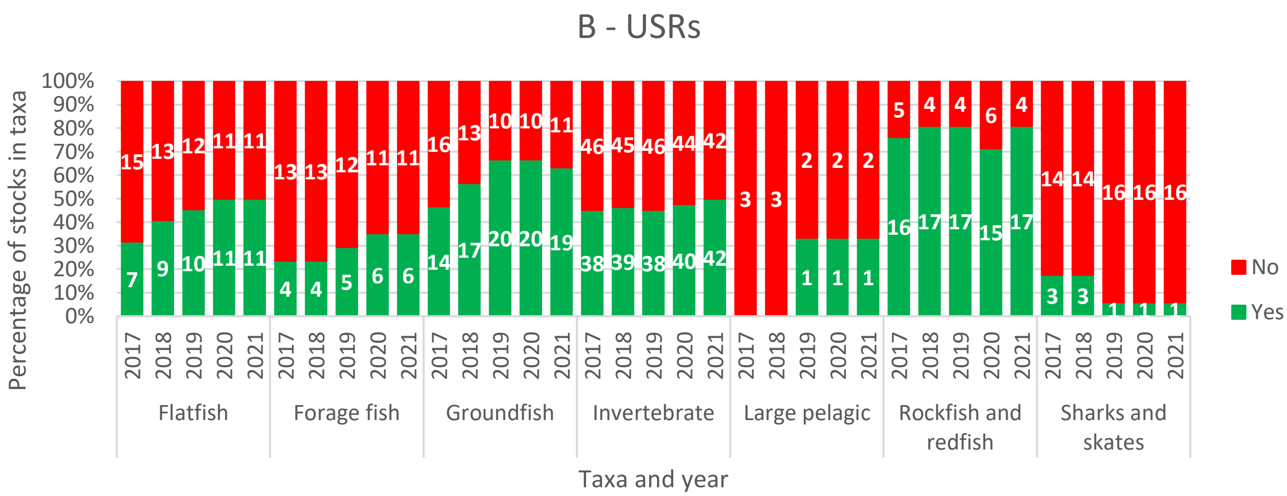


Figure 6. The percentage of Oceana Canada index stocks (n = 194) in each taxa groups with and without (A) Limit Reference Points (LRPs) or (B) Upper Stock References (USRs) in place in 2017, 2018, 2019, 2020, and 2021. The number of stocks in each year-taxa-category combination are reported in white font within the bars

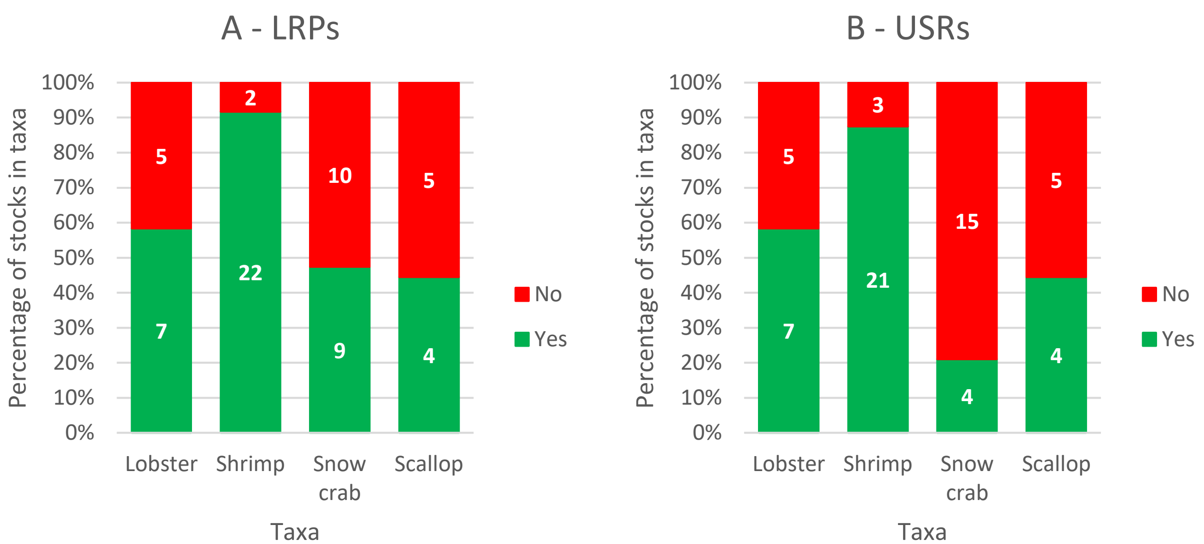


Figure 7. The percentage of Oceana Canada index stocks (n = 194) in high-value invertebrate taxa (lobster, shrimp, snow crab, and scallops) with and without (A) Limit Reference Points (LRPs) or (B) Upper Stock References (USRs) in place in 2021. The number of stocks in each taxa-category combination are reported in white font within the bars.

In addition to biomass or abundance-based reference points, the DFO PA framework also requires a removal reference for each stock status zone: the maximum acceptable removal rate for the stock, which is normally expressed in terms of fishing mortality (F) or harvest rate (DFO, 2009a). According to DFO policy, removal references are supposed to include all sources of fishing mortality from all types of fishing and must be less than or equal to the removal rate associated with maximum sustainable yield (e.g., F_{MSY}) (DFO, 2009a). However, in practice, removal references implemented appear to be serving the role of limit and target, which can increase the chances of exceeding them and also means they may not always represent unacceptable stock states associated with "overfishing" as it is recognized internationally (DFO, 2021b). The ability to use them to report on "overfishing" status is further complicated when they are only partially defined (i.e., only available for one stock status zone) (DFO, 2021b). Both situations appear to be common. When the answers defining the removal reference values are examined in the most recent (2019) results of the DFO SSF (DFO, 2016e), the inconsistent interpretation of policy requirements becomes clear. Respondents cite target and limit functions with values ranging from those based on F_{MSY}, to outlining how harvest control rules work (which may or may not involve stock status zones, and is another separate question in the SSF), to indicating that recent quota decisions by management serve as the removal reference. Meanwhile, few even have them in place, with the latest results (2019) of the DFO SSF indicating less than half of the "major" stocks have a removal reference for the healthy zone (42.6 per cent or 75 of 176 stocks), less than a third have a removal reference for the critical zone (31.2 per cent) and even fewer have one for the cautious zone (26.7 per cent) (DFO, 2016e). This low implementation rate and inconsistent application of policy regarding removal references (DFO, 2021b) — combined with the ambiguity of scientists' role in defining them (Winter and Hutchings, 2020) and Oceana Canada's findings here that few existing fishing mortality estimates include all sources of fishing removals — have led to the exclusion of removal references as an indicator in this report. DFO scientists recently noted several of these issues with the current application of removal references (DFO, 2021b). They advised that the science sector could be responsible for characterizing stock status relative to a single-limit fishing mortality rate, such as F_{MSY} or suitable proxies, which would make Canada's approach consistent with international requirements (i.e., United Nations Fish Stocks Agreement) and definitions of the term "overfishing" (DFO, 2021b; FAO, 2020; Froese and Proelss, 2012). This change, if implemented, would allow Canadians increased confidence in the biological sustainability of harvest rates and a more nuanced and meaningful evaluation of stock status. If stock status was evaluated using both science-based biomass/abundance numbers and science-based fishing mortality reference points, it would be possible to identify depleted stocks still subject to overfishing and focus management rebuilding efforts where they are needed most.

7. **Management plans in place:** In 2021, 90.7 per cent of index stocks (176 of 194 stocks) were included in an IFMP. While there was no change in this indicator since last year, in earlier years there were continual increases (Figure 5, Table 1), resulting in a significant increasing trend in the number of stocks included in IFMPs ($p < 0.001$, $\chi 2 = 39.0$). This trend is likely driven largely by the notable increase in 2019 that was due to the publication of several new multi-stock IFMPs. Since then, progress on IFMP development has been minimal, as most index stocks are already included in IFMPs. In 2021, all but two of the index stocks are now included in IFMPs that are also available online, totalling 47 unique IFMPs available publicly. Each stock should be included in an IFMP, and entire IFMPs (not just summaries) should be publicly available. If fish stocks are not included in a management plan, fisheries managers lack the framework required for conservation and sustainable use, and if those plans are not easily accessible, it is difficult for stakeholders and the public to assess how a fishery is being managed. DFO has committed to having all major commercial fish stocks included in IFMPs and making these available to the public on its website (CESD, 2016), which has resulted in the large increases in this indicator. There is still some more work to do, so it is expected that this indicator will continue to rise, if only slightly (see Archibald et al., 2021c). However, it should be noted that the IFMP-related deliverables for several stock groups in DFO's Sustainable Fisheries Framework Work Plan pertain to updating out-of-date IFMPs, which would not be reflected by this indicator as they are already included in IFMPs.

8. **Catch monitoring:** In 2021, 86.6 per cent of index stocks (168 of 194 stocks) have fisheries with some level of at-sea observer or electronic (i.e., video) monitoring required (Figure 8, Table 1). Of these 168 stocks, 42 have fisheries with 100 per cent monitoring, while 126 have fisheries with varying target monitoring levels depending on the vessel size or gear type. The presence of at-sea or electronic monitoring was uncertain in 13.4 per cent of stocks (26 stocks). This indicator has changed over the years, with a significant increasing trend in the percentage of stocks with fisheries with some level of at-sea observer or electronic (i.e., video) monitoring (Figure 8) ($p < 0.001$, $\chi 2 = 22.1$). However, this increase is likely due to increased transparency rather than changing requirements for harvesters. Increased transparency from the increase in the number of stocks in, and availability of, IFMPs has resulted in increased clarity on fishery monitoring requirements. Furthermore, in 2019, DFO published a review of catch monitoring tools in major

Canadian fisheries that provided increased clarity on targeted at-sea observer coverage levels (Beauchamp et al., 2019).

In 2021, most index stocks require the use of logbooks (96.4 per cent; 187 of 194 stocks) (Figure 8, Table 1). However, the requirement to record the entire catch (targeted species and bycatch) is clearly indicated for only 35.1 per cent of index stocks (68 of 194 stocks); 61.3 per cent (119 stocks) have fisheries where logbooks are used, but it was not clear from the materials searched whether the entire catch must be recorded. There is uncertainty about the use of logbooks for 3.6 per cent of stocks (seven stocks). This indicator has changed over the years, with a significant increasing trend in the percentage of stocks with fisheries that use logbooks (Figure 8) ($p < 0.001$, $\chi2 = 40.0$). Again, however, this increase is likely due to increased transparency rather than changing requirements for harvesters, for the same reasons noted above. This increase in transparency has resulted in more certainty about general logbook use and details recorded since 2017.

In 2021, 88.7 per cent of index stocks (172 of 194 stocks) have fisheries that require some level of dockside monitoring of landings (Figure 8, Table 1). Of these 172 stocks requiring dockside monitoring, 123 stocks have fisheries that are required to have 100 per cent of landings verified by a certified independent dockside monitor. A further 49 stocks have dockside monitoring requirements, but the level of monitoring is varied or unknown. The use of dockside monitoring in the fisheries of 11.3 per cent of stocks (22 stocks) is uncertain. This indicator has changed over the years, with a significant increasing trend in the percentage of stocks that have fisheries that require some level of dockside monitoring of landings (Figure 8) ($p < 0.001$, $\chi2 = 22.5$). Again, however, this increase is likely due to increased transparency rather than changing requirements for harvesters, for the same reasons noted above. This increase in transparency has resulted in more certainty in the general use of dockside monitoring, to whom it applies, and the levels targeted since 2017.

In 2021, 61.3 per cent of index stocks (119 of 194 stocks) have fisheries with at least some vessels requiring electronic location monitoring, all via a VMS (no fisheries are required to use AIS for fisheries management purposes at this time) (Figure 8, Table 1). About one-quarter (22.2 per cent or 43 of 194 stocks) do not require any vessels to be electronically monitored,[14] while the use of this tool is uncertain for 16.5 per cent of index stocks (32 of 194 stocks). Of the 119 stocks with some use of VMS, 73 stocks have fisheries where 100 per cent of vessels always require electronic location monitoring; 36 stocks have fisheries that use the tool for some, but not all vessels; and 10 stocks have fisheries that use the tool, but it is uncertain if it is used by all vessels or at all times. There was no significant trend in the percentage of stocks that have fisheries with at least some vessels requiring VMS ($p = 0.68$, $\chi2 = 0.17$).

[14] It should be noted that not all stocks are harvested using vessels; for example, some clam fisheries are shore-based.

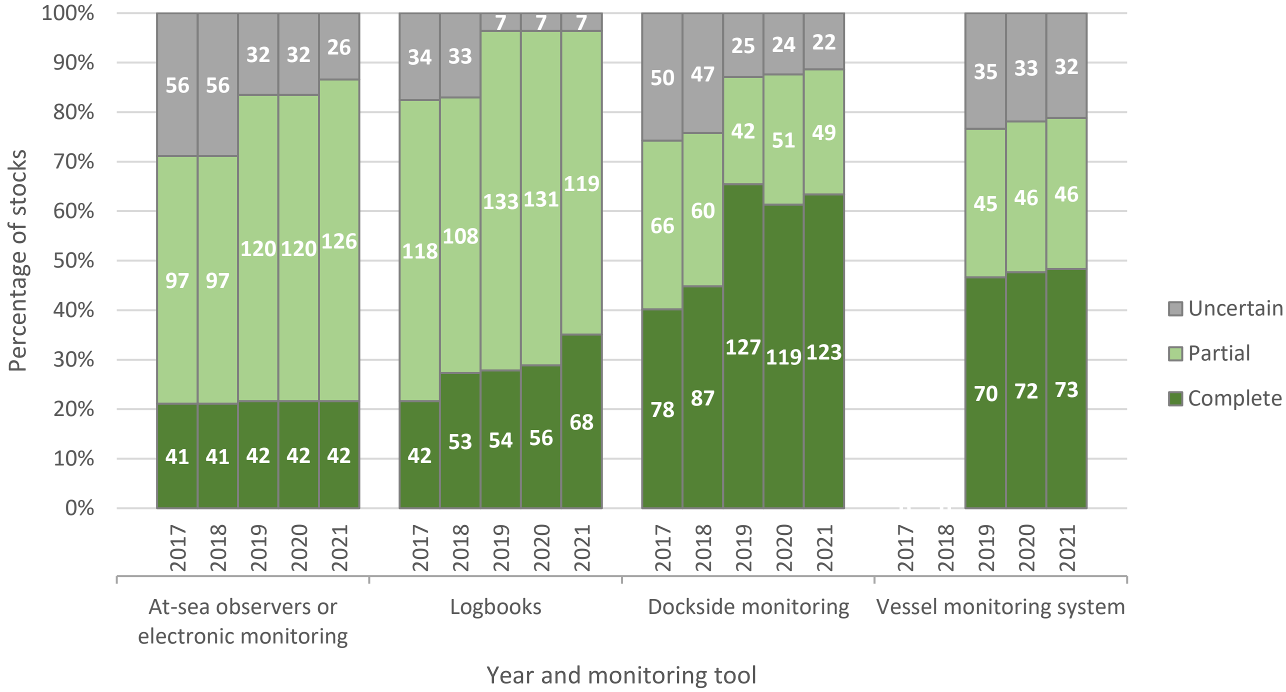


Figure 8. The percentage of stocks in Oceana Canada's index stock dataset (n = 194 stocks) in 2017, 2018, 2019, 2020, and 2021 that have requirements for the following catch monitoring tools in place: 1) at-sea observer or electronic (i.e., video) monitoring; 2) logbooks recording the entire catch (i.e., targeted species and bycatch); 3) independent dockside monitoring; 4) electronic location monitoring via Vessel Monitoring System (VMS). Note that VMS usage was not evaluated in 2017–18. The number of stocks with each level of targeted monitoring tool use is indicated in white font within the bars. "Uncertain" level was assigned when there was no indication in the documents and websites searched that the use of the monitoring tool is required. "Partial" level was assigned when it was clearly indicated the monitoring tool was required but targeted levels of tool use vary or are uncertain or, for logbooks, when it was unclear if bycatch is recorded. "Complete" level was assigned when it was clearly indicated the monitoring tool is required on 100 per cent of fishing trips or, for logbooks, when both directed catch and bycatch are recorded. It should be noted, 100 per cent coverage for at-sea observers or electronic monitoring (i.e., video monitoring) or VMS is not necessary for all fisheries.

These results are based on publicly available information from scattered sources with varying levels of detail and, as such, likely do not reflect the full extent of catch monitoring in Canada. This is reflected in the high number of stocks in the partial-use categories. Often, more than one fishery catches a given stock, making assessments of catch monitoring on that stock challenging (i.e., due to different levels of at-sea observer coverage, varying by gear type and/or vessel size). DFO scientists recently reviewed catch monitoring tools used in major Canadian fisheries, which contributed to the large increase in clarity on tool use and targeted levels for most stocks and fishery sub-units since 2019 (Beauchamp et al., 2019). However, targeted coverage levels are often not achieved, and even when they are, levels can be inadequate to assess impacts to non-target species and sensitive habitats (Benoît and Allard, 2009; CESD, 2016; Clark et al., 2015; Gavaris et al., 2010). Furthermore, the CESD audit found that DFO did not provide a clear rationale for determining targeted levels of at-sea coverage and lacked systematic controls to ensure targets are met (CESD, 2016).

DFO recently reviewed the catch monitoring programs of fisheries in Canada, acknowledging the current shortcomings, and in November 2019 finalized and released a national Fishery Monitoring Policy (DFO, 2019c) (originally intended to be released in 2017; CESD, 2016). As indicated by the department's own consultation materials, not having a national policy on catch reporting and fishery monitoring until now has led to: inconsistent monitoring and reporting requirements and no explanation for the differences; concerns about the adequacy and quality of data from fishery monitoring programs, which is needed to manage fisheries sustainably; and an absence of national goals with which to assess performance (DFO, 2018a). Furthermore, a lack of a national policy precluded the consideration of cumulative impacts across fisheries on species or the ecosystem (Archibald and Rangeley, 2019a).

The new policy includes guidance on assessing risk of fisheries to target stock health, sensitive habitats and species caught as bycatch, the risk of non-compliance with the rules, and assessing data quality and dependability (Allard and Benoît, 2019; Benoît and Allard, 2020; DFO, 2019c, 2019d). Together, these tools can be used to determine the dependability of a fishery monitoring program and inform a gap analysis for improvements that may be required to tailor monitoring requirements to the risk levels that respective fisheries pose to fish populations and the ecosystem. One requirement of the policy is for specific, measurable fishery monitoring objectives to be included in IFMPs, with monitoring requirements required to achieve them outlined. This will be an improvement over the current situation, where it was found in 2020, and again in 2021, that no stocks in the index dataset had specific and measurable fishery monitoring objectives in their IFMP, outlining the details required by the policy (see methods section). It is expected this new indicator will increase in future years as the policy is implemented and DFO determines and ensures the appropriate type and frequency of catch monitoring in all our fisheries.

This policy was developed by DFO to improve data quality used in Canada's fisheries science and management. The policy can also improve transparency and public confidence in management, while contributing to more stability and better market access for the fishing industry (Archibald et al., 2021c). Despite being released two years ago, it has yet to be fully implemented in any fishery. However, there are encouraging signs of progress more recently: this year, for the first time, implementing the policy was included in the 2021/22 Sustainable Fisheries Framework work plan, which outlines priorities for DFO (DFO, 2021d). But this addition only includes a few stocks, and none will have the policy completely implemented this year. If the policy is effectively implemented — which some experts at DFO continue to recognize and advocate for — Canada will have better science and data-driven fisheries management. It will take time to gather enough of the data required to make good use of it. Continued delays in implementation will therefore delay the benefits of this policy and make other DFO commitments harder to achieve, including the rebuilding mandate outlined in the amended *Fisheries Act*. These amendments provide an opportunity to restore the abundance of Canada's wild fisheries. Our ability to realize this potential depends on DFO accurately measuring and managing these fisheries by implementing the Fishery Monitoring Policy.

9. **Critical stocks with rebuilding plans:** In 2021, rebuilding plans are in place for 21.2 per cent of index stocks in the critical zone (seven of 33 stocks). There has been little change in this indicator

over time (Figure 9, Table 1), with no significant trend in the percentage of critical stocks included in rebuilding plans across years ($p = 0.26$, $\chi 2 = 1.26$). This is despite having a policy requirement for over a decade for rebuilding plans to be in place for critically depleted stocks (DFO, 2009a), recent commitments and work plans to develop them (CESD, 2016; DFO, 2020f), and revisions to the *Fisheries Act* to require them (Legislative Services Branch, 2019). The latter change to the law is expected to cause this indicator to rise significantly, but the regulations outlining the requirements of rebuilding plans under the new act and specifying what stocks the new law will apply to are still in development (Public Works and Government Services Canada, 2021), meaning the revised act does not apply to any stocks yet.

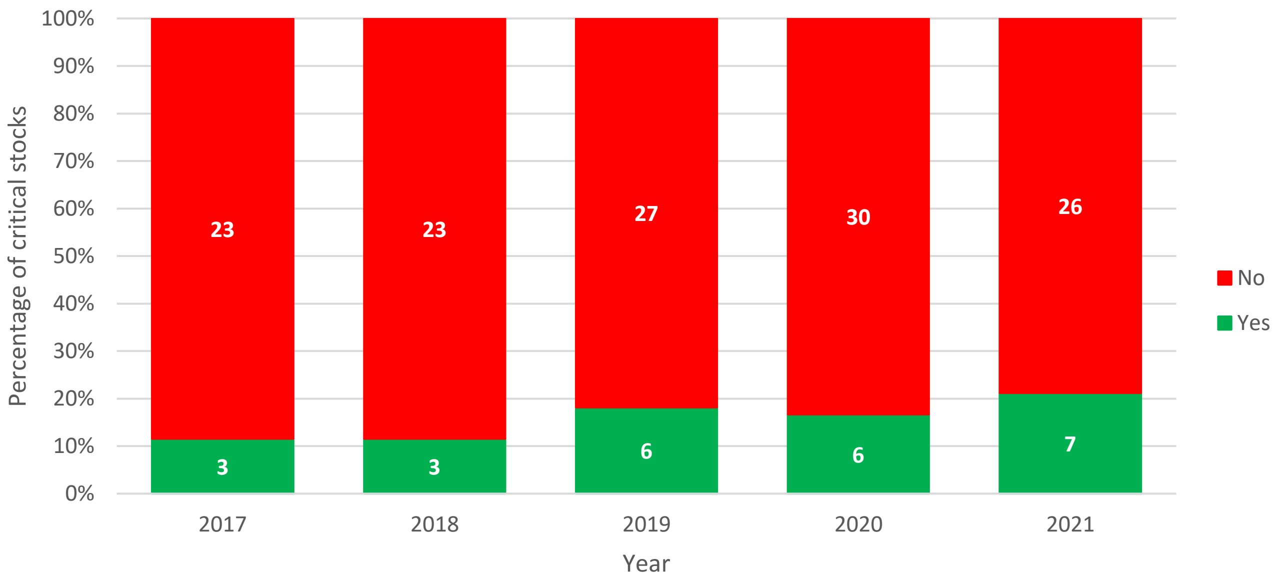


Figure 9. The percentage of Oceana Canada index stocks (n = 194 stocks) in the critical zone and included in rebuilding plans in 2017, 2018, 2019, 2020, and 2021. The number of stocks in each year-category combination is reported in white font within the bars.

There were two new rebuilding plans published for critically depleted stocks since last year, while one stock already included in a rebuilding plan is no longer evaluated as being in the critical zone,[15] resulting in a net increase of one new plan. Disappointingly, both new rebuilding plans fall short, with neither including target abundances in the healthy zone or scientifically informed timelines of how long rebuilding might take (Levesque et al., 2021). Although scientists can be reluctant to make long-term projections given increased uncertainty beyond the year-classes currently observed, without these projections managers have little information available to inform realistic expectations (Shelton et al., 2007). Without a target in the healthy zone, there is no identification of what a rebuilt stock looks like, making it challenging for the rebuilding plan to

[15] Yelloweye rockfish - inside population remains included in a rebuilding plan but was evaluated by Oceana Canada as being in the cautious zone in 2021. A recent evaluation of management procedures for the rebuilding plan (using a closed loop simulation approach similar to Management Strategy Evaluation) found that under all the reference set operating model scenarios the stock was already rebuilt above the LRP, with some indicating it was also above the USR while others still had it below (DFO, 2020b). Using a weight-of-evidence approach, a cautious zone status was assigned.

take us there. By only including reference to the LRP, not only do these plans not meet international standards (which require limit *and target* reference points)[16] and DFO policy guidance (DFO, 2013; FAO, 2020), but they also risk that the rebuilt target will be assumed to be just above “the point below which serious harm is occurring to the stock” (i.e., the LRP, plus one fish) (DFO, 2009a).

After nearly a decade in the critical zone, a rebuilding plan for Atlantic Mackerel (NAFO subareas 3 and 4) was published in November 2020 (DFO, 2020e). In addition to not including a rebuilding abundance target, this plan lacks a harvest control rule (HCR), even though a Management Strategy Evaluation (MSE) process was held to develop one. The MSE did reveal trade-offs among HCRs tested (Van Beveren et al., 2020), but the details of these trade-offs were not clearly outlined in the rebuilding plan. No HCR was selected, resulting in increased uncertainty in harvest level decisions moving forward. The MSE reiterated long-standing issues with fishery monitoring for the stock were impacting efforts at rebuilding (Van Beveren et al., 2020), and while the rebuilding plan did outline recent improvements in some areas, further improvements required to account for unreported catches were missing (e.g., monitoring of landings from bait fisheries in *all* administrative regions and the recreational fishery).

Northern cod (Atlantic cod in NAFO 2J3KL) was included in a long-awaited rebuilding plan in late December 2020 (DFO, 2020d), and Oceana Canada applauded the department for finally taking this important step towards rebuilding the stock. However, the rebuilding plan requires several improvements to ensure it effectively promotes rebuilding, as noted by several prominent fisheries scientists (Hutchings et al., 2021). In addition to inclusion of a USR to define a healthy stock status, this plan is missing other components of DFO’s PA framework, such as removal references for each stock status zone (DFO, 2009a, 2020d). Science-based removal references would allow for increased confidence that removals are truly sustainable and will promote recovery. While this plan does include an HCR, there are several issues with it that call into question its ability to promote rebuilding (Archibald and Rangeley, 2021b; Hutchings et al., 2021). The HCR does not appear to have been evaluated by fisheries scientists to ensure it promotes rebuilding and complies with the PA framework. It should be simulation-tested by DFO Science, with independent peer review to ensure that it has an acceptable robustness to uncertainty, meets performance expectations, and has a high probability of achieving management objectives.

As it currently stands, the northern cod HCR allows for catches to substantially increase while this stock is in the critical zone, contrary to the PA framework, which indicates total removals from all sources must be kept to the lowest possible levels until the stock clears the critical zone (DFO, 2009a). When stocks are in the critical zone, DFO policy indicates that removals by all human sources must be kept to the lowest possible level and that biological considerations should prevail over socio-economic considerations to facilitate rebuilding (DFO 2009a). DFO rebuilding plan guidelines reiterate that long-term sustainable fishery benefits can only be realized by emphasizing considerable restraint through the stock rebuilding phase (DFO, 2013). “Lowest possible levels” has never been defined, but the provisional harvest rule within DFO

[16] United Nations Convention on the Law of the Sea

policy for the critical zone includes a provisional removal reference or fishing mortality equal to zero, while the harvest strategy example included indicates that when a stock is in the critical zone, the harvest rate is to be reduced to zero as a result of directed fishing and other removals (e.g., bycatch) reduced at a level consistent with growth (DFO, 2009a). Yet when the most recent reported landings of critical zone stocks were investigated for this report, it was found that five still have more than 2000 t of landings, all of which still allow for directed fishing.[17] Interestingly, all these stocks are in the DFO Atlantic administrative regions, with none of the critical zone stocks in the Pacific region having such high landings. The Pacific region appears to follow the PA framework more closely, with several PA frameworks that require directed fishing to stop when a stock falls below its LRP (e.g., Pacific shrimp trawl and Pacific herring) (DFO, 2020c, 2021a).

According to the 2020/21 DFO Sustainable Fisheries Framework Work Plan, 12 other rebuilding plans were expected to be completed by the end of March 2021 (DFO, 2020g). None have been published, and with the 2021/22 work plan, deadlines were extended (Archibald and Rangeley, 2021a; DFO, 2021d). While the COVID-19 pandemic certainly impacted progress in the last year, it has now been five years since the initial work plan was created, which included 10 of the 12 stocks with delayed plans (CESD, 2016; DFO, 2017b). Rebuilding plan development is not an insignificant task, and to meet international best practices, these plans must be developed in close consultation with the rights-holders and stakeholders (DFO, 2013; Garcia, 2018; OECD, 2012), which takes time. There was a lack of progress and delays with several rebuilding plans leading up to the pandemic (Archibald et al., 2021a), likely contributing to the inability of DFO to meet its commitments.

It is imperative that the government strengthen the draft regulations outlining the requirements for rebuilding plans and ensure all depleted stocks are included in the first batch of stocks to be subject to them (Elmslie, 2021). Stronger and more specific rebuilding plan guidelines are needed, as plans made with current draft content will be insufficient in the promotion of rebuilding and are likely to result in rebuilding plans like those developed by DFO to date (see Archibald and Rangeley, 2019a). As currently written, the draft regulations will maintain the status quo and fall far short of the existing laws and policies in other progressive fishing nations, where history shows strong requirements and standards can rebuild stocks to abundance (NOAA, 2021).

Recommendations — Make the Next Five Years Count

Canada has the tools to restore abundance to our oceans. But now we need to step up our efforts to use them — matching action with the urgency the situation demands. Because we simply cannot afford another five years without meaningful progress in the water.

Real change for Canada's fisheries will require adopting globally accepted and proven best practices. At a minimum, Canada must:

[17] Critical zone stocks with > 2000 t of reported landings: Atlantic cod in NAFO 2J3KL (i.e., northern cod), Atlantic cod in NAFO 3Ps, northern shrimp in SFA 6, Atlantic mackerel in NAFO subareas 3 and 4, and Atlantic herring in NAFO 4VWX.

1. **Pass strong rebuilding regulations:** Canada's *Fisheries Act* now requires that DFO takes action to rebuild depleted fisheries; however, it still lacks the regulations that define how rebuilding will be accomplished. These regulations must require that rebuilding plans include scientifically estimated timelines and targets in the healthy and take into account all sources of fishing mortality.
2. **Make decisions about wild fish based on science and Indigenous Knowledge:** Fisheries management decisions must include Indigenous evidence, practice and knowledge systems and follow the best available science.
3. **Integrate ocean ecosystem considerations:** DFO must take into account the ecosystem impacts of fisheries decisions, aggressively work to rebuild depleted forage fish and address the vulnerability of species to climate change impacts.
   Count everything caught in a fishery — including for recreational and bait purposes — and account for all sources of fishing in management decision-making

To address these high-level priorities and accelerate the implementation of Canada's Sustainable Fisheries Framework, Oceana Canada calls on DFO to complete the key actions outlined in a checklist at Oceana.ca/FisheryAudit2021 within the next year. This includes fulfilling ongoing commitments or those that have been delayed from previous work plans, as well as those scheduled to be completed this fiscal year (Archibald et al., 2021a).

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Tables

Table 1. The percentage and number of marine fish and invertebrate[18] stocks for each indicator in the 2017, 2018, 2019, 2020, and 2021 index stock datasets (n = 194 stocks; the same stocks in each year).

Indicator	Details	2017	2018	2019	2020	2021
	Number of stocks	194	194	194	194	194
1. Status	%/# of "healthy" stocks	34.5% / 67	34.0% / 66	29.4% / 57	26.3% / 51	30.4% / 59
	%/# of "cautious" stocks	16.0% / 31	15.5% / 30	15.5% / 30	18.0% / 35	16.0% / 31
	%/# of "critical" stocks	13.4% / 26	13.4% / 26	17.0% / 33	18.6% / 36	17.0% / 33
	%/# of "uncertain" stocks	36.1% / 70	37.1% / 72	38.1% / 74	37.1% / 72	36.6% / 71
2. Stocks going from uncertain to certain status (or vice versa) in the past year	# of stocks that went from uncertain status to known status	Baseline year	4	6	6	5
	# of stocks that went from known status to uncertain status	Baseline year	6	8	4	4
3. Change in status from previous year	%/# of stocks that have changed status	Baseline year	10.8% / 21†	13.4% / 26†	13.4% / 26†	10.8% / 21†
	# of stocks whose status improved	Baseline year	5	2	5	9
	# of stocks whose status worsened	Baseline year	6	10	11	3
	%/# of stocks whose status remained the same	Baseline year	89.2% / 173	86.6% / 168	86.6% / 168	89.2% / 173
4. Biomass/abundance known	%/# of stocks with recent (≤ 5 years) biomass/abundance estimates	64.9% / 126	63.9% / 124	58.8% / 114	59.4% / 115	58.2% / 113
	%/# of stocks without recent assessments that have had interim updates of indicators since last complete assessment	Not available — new indicator	Not available — new indicator	20.0% / 16	24.1% / 19	21.0% / 17

[18] Excluding marine mammals, diadromous fish, and freshwater fish

Indicator	Details	2017	2018	2019	2020	2021
5. Sources of mortality known*	%/# of stocks with fishing mortality (F) known	20.6% / 40	18.0% / 35	19.1% / 37	20.1% / 39	20.6% / 40
	# of stocks that clearly incorporate all sources of F in their estimation	Not available — new indicator	Not available — new indicator	2	2	2
	%/# of stocks with natural mortality (M) known	Not available — new indicator	14.4% / 28	16.0% / 31	19.6% / 38	21.6% / 42
	%/# of stocks with total mortality (Z) known	Not available — new indicator	6.7% / 13	8.8% / 17	11.3% / 22	12.4% / 24
	%/# of stocks with exploitation rate known	Not available — new indicator	Not available — new indicator	38.7% / 75	45.4% / 88	49.0% / 95
	%/# of stocks with landings known	Not available — new indicator	Not available — new indicator	97.9% / 190	97.4% / 189	97.9% / 190
6. Reference points	%/# of stocks with limit reference points	53.1% / 103	59.3% / 115	64.4% / 125	63.9% / 124	66.0% / 128
	%/# of stocks with upper stock reference points	42.3% / 82	45.9% / 89	47.4% / 92	48.5% / 94	50.0% / 97
7. Management plans in place	%/# of stocks in an Integrated Fisheries Management Plan	71.1% / 138	74.7% / 145	90.2% / 175	90.7% / 176	90.7% / 176
8. Catch monitoring	%/# of stocks with at-sea/electronic monitoring	Yes — 100% 21.1% / 41	Yes — 100% 21.1% / 41	Yes — 100% 21.6% / 42	Yes — 100% 21.6% / 42	Yes — 100% 21.6% / 42
		Yes — coverage varies or level is uncertain 50.0% / 97	Yes — coverage varies or level is uncertain 50.0% / 97	Yes — coverage varies or level is uncertain 61.9% / 120	Yes — coverage varies or level is uncertain 61.9% / 120	Yes — coverage varies or level is uncertain 64.9% / 126
		Uncertain 28.9% / 56	Uncertain 28.9% / 56	Uncertain 16.5% / 32	Uncertain 16.5% / 32	Uncertain 13.4% / 26
	%/# of stocks with logbooks	Yes — and bycatch species are recorded 21.6% / 42	Yes — and bycatch species are recorded 27.3% / 53	Yes — and bycatch species are recorded 27.8% / 54	Yes — and bycatch species are recorded 28.9% / 56	Yes — and bycatch species are recorded 35.1% / 68

Indicator	Details	2017	2018	2019	2020	2021
		Yes — but unclear if bycatch species are recorded 60.8% / 118	Yes — but unclear if bycatch species are recorded 55.7% / 108	Yes — but unclear if bycatch species are recorded 68.6% / 133	Yes — but unclear if bycatch species are recorded 67.5% / 131	Yes — but unclear if bycatch species are recorded 61.3% / 119
		Uncertain 17.5% / 34	Uncertain 17.0% / 33	Uncertain 3.6% / 7	Uncertain 3.6% / 7	Uncertain 3.6% / 7
	%/# of stocks with dockside monitoring	Yes — 100% 40.2% / 78	Yes — 100% 44.8% / 87	Yes — 100% 65.5% / 127	Yes — 100% 61.3% / 119	Yes — 100% 63.4% / 123
		Yes — coverage varies or level is uncertain 34.0% / 66	Yes — coverage varies or level is uncertain 30.9% / 60	Yes — coverage varies or level is uncertain 21.6% / 42	Yes — coverage varies or level is uncertain 26.3% / 51	Yes — coverage varies or level is uncertain 25.3% / 49
		Uncertain 25.8% / 50	Uncertain 24.2% / 47	Uncertain 12.9% / 25	Uncertain 12.4% / 24	Uncertain 11.3% / 22
	%/# of stocks with electronic vessel monitoring systems (VMS)/automated identification systems (AIS)	Not available — new indicator	Not available — new indicator	Yes — 100% of vessels always 36.1% / 70	Yes — 100% of vessels always 37.1% / 72	Yes — 100% of vessels always 37.6% / 73
		Not available — new indicator	Not available — new indicator	Yes — some vessels but not all vessels 15.5% / 30	Yes — some vessels but not all vessels 19.1% / 37	Yes — some vessels but not all vessels 18.6% / 36
		Not available — new indicator	Not available — new indicator	Yes — but uncertain if all vessels or all times 7.7% / 15	Yes — but uncertain if all vessels or all times 4.6% / 9	Yes — but uncertain if all vessels or all times 5.2% / 10
		Not available — new indicator	Not available — new indicator	Uncertain 18.0% / 35	Uncertain 17.0% / 33	Uncertain 16.5% / 32
		Not available — new indicator	Not available — new indicator	No 22.7% / 44	No 22.2% / 43	No 22.2% / 43

Indicator	Details	2017	2018	2019	2020	2021
	%/# of stocks with specific catch monitoring objectives in their IFMP	Not available — new indicator	Not available — new indicator	0.0% / 0	0.0% / 0	0.0% / 0
9. Critical stocks with rebuilding plans	%/# of critical zone stocks with rebuilding plans	11.5% / 3	11.5% / 3	18.2% / 6	16.7% / 6	21.2% / 7

†This value includes those that changed status to or from uncertain.
**Sometimes it is not possible to estimate mortality with available data or models.*

Table 2. The percentage and number of marine fish and invertebrate stocks[19] for each indicator in 2017 (n = 194 stocks), 2018 (n = 214 stocks), 2019 (n = 222 stocks), 2020 (n = 226 stocks), and 2021 (n = 229 stocks) using all stocks in the dataset, including those added during the updates in addition to the index stock dataset (i.e., 2017 dataset stock list).

Indicator	Details	2017	2018	2019	2020	2021
	Number of stocks	194	214	222	226	229
1. Status	%/# of "healthy" stocks	34.5% / 67	31.8% / 68	27.5% / 61	24.8% / 56	27.9% / 64
	%/# of "cautious" stocks	16.0% / 31	14.5% / 31	14.4% / 32	16.4% / 37	15.3% / 35
	%/# of "critical" stocks	13.4% / 26	13.1% / 28	16.2% / 36	17.3% / 39	15.7% / 36
	%/# of "uncertain" stocks	36.1% / 70	40.7 % / 87	41.9 % / 93	41.6% / 94	41.0% / 94
2. Stocks going from uncertain to certain status (or vice versa) in the past year	# of stocks that went from uncertain status to known status†	Baseline year	4	7	6	6
	# of stocks that went from known status to uncertain status†	Baseline year	6	8	4	4
3. Change in status from previous year	%/# of stocks that have changed status†	Baseline year	10.8% / 21††	12.6% / 27††	11.7% / 26††	9.7% / 22††
	# of stocks whose status improved †	Baseline year	5	2	5	9
	# of stocks whose status worsened †	Baseline year	6	10	11	3
	%/# of stocks whose status remained the same†	Baseline year	89.2% / 173††	87.4% / 187††	88.3% / 196††	90.3% / 204††
4. Biomass/abundance known	%/# of stocks with recent (≤ 5 years) biomass/abundance estimates	64.9% / 126	64.0% / 137	59.5% / 132	59.7% / 135	58.5% / 134
	%/# of stocks without recent assessments that have had interim updates of indicators since last complete assessment		Not available — new indicator	18.9% / 17	22.0% / 20	18.9% / 18

[19] Excluding marine mammals, diadromous fish, and freshwater fish

Indicator	Details	2017	2018	2019	2020	2021
5. Sources of mortality known*	%/# of stocks with fishing mortality (F) known	20.6 % / 40	16.8 % / 36	18.0 % / 40	18.6% / 42	18.8% / 43
	# of stocks that clearly incorporate all sources of F in its estimation	Not available — new indicator	Not available — new indicator	2	2	2
	%/# of stocks with natural mortality (M) known	Not available — new indicator	14.0% / 30	16.7% / 37	19.5% / 44	21.4% / 49
	%/# of stocks with total mortality (Z) known	Not available — new indicator	6.1% / 13	8.1% / 18	10.6% / 24	11.8% / 27
	%/# of stocks with exploitation rate known	Not available — new indicator	Not available — new indicator	39.2% / 87	45.1% / 102	48.0% / 110
	%/# of stocks with landings known	Not available — new indicator	Not available — new indicator	96.4% / 214	96.9% / 219	97.4% / 223
6. Reference points	%/# of stocks with limit reference points	53.1% / 103	57.0% / 122	61.3% / 136	60.2% / 136	62.0% / 142
	%/# of stocks with upper stock reference points	42.3% / 82	43.0% / 92	44.1% / 98	44.7% / 101	45.4% / 104
7. Management plans in place	%/# of stocks in an Integrated Fisheries Management Plan	71.1% / 138	72.0% / 154	88.7% / 197	88.9% / 201	88.2% / 202
8. Catch monitoring	%/# of stocks with at-sea/electronic monitoring	Yes — 100% 21.1% / 41	Yes — 100% 21.0% / 45	Yes — 100% 22.1% / 49	Yes — 100% 22.1% / 50	Yes — 100% 22.8% / 50
		Yes — coverage varies or level is uncertain 50.0% / 97	Yes — coverage varies or level is uncertain 49.1% / 105	Yes — coverage varies or level is uncertain 59.9% / 133	Yes — coverage varies or level is uncertain 59.7% / 135	Yes — coverage varies or level is uncertain 62.4% / 143
		Uncertain 28.8% / 56	Uncertain 29.9% / 64	Uncertain 18.0% / 40	Uncertain 18.1% / 41	Uncertain 15.7% / 36

Indicator	Details	2017	2018	2019	2020	2021
	%/# of stocks with logbooks	Yes — and bycatch species are recorded 21.6% / 42	Yes — and bycatch species are recorded 26.6% / 57	Yes — and bycatch species are recorded 28.4% / 63	Yes — and bycatch species are recorded 30.1% / 68	Yes — and bycatch species are recorded 36.2% / 83
		Yes — but unclear if bycatch species are recorded 60.8% / 118	Yes — but unclear if bycatch species are recorded 55.6% / 119	Yes — but unclear if bycatch species are recorded 67.6% / 150	Yes — but unclear if bycatch species are recorded 65.9% / 149	Yes — but unclear if bycatch species are recorded 59.4% / 136
		Uncertain 17.5% / 34	Uncertain 17.8% / 38	Uncertain 4.1% / 9	Uncertain 4.0% / 9	Uncertain 4.4% / 10
	%/# of stocks with dockside monitoring	Yes — 100% 40.2% / 78	Yes — 100% 44.9% / 96	Yes — 100% 63.1% / 140	Yes — 100% 59.3% / 134	Yes — 100% 60.7% / 139
		Yes — coverage varies or level is uncertain 34.0% / 66	Yes — coverage varies or level is uncertain 28.5% / 61	Yes — coverage varies or level is uncertain 23.0% / 51	Yes — coverage varies or level is uncertain 27.0% / 61	Yes — coverage varies or level is uncertain 25.8% / 59
		Uncertain 25.8% / 50	Uncertain 26.6% / 57	Uncertain 14.0% / 31	Uncertain 13.7% / 31	Uncertain 13.5% / 31
	%/# of stocks with electronic vessel monitoring systems (VMS)/automated identification systems (AIS)	Not available — new indicator	Not available — new indicator	Yes — 100% of vessels always 33.8% / 75	Yes — 100% of vessels always 35.0% / 79	Yes — 100% of vessels always 35.4% / 81
		Not available — new indicator	Not available — new indicator	Yes — some vessels but not all vessels 17.6% / 39	Yes — some vessels but not all vessels 20.4% / 46	Yes — some vessels but not all vessels 19.2% / 44
		Not available — new indicator	Not available — new indicator	Yes — but uncertain if all vessels or all times 8.1% / 18	Yes — but uncertain if all vessels or all times 5.8% / 13	Yes — but uncertain if all vessels or all times 6.1% / 14

Indicator	Details	2017	2018	2019	2020	2021
		Not available — new indicator	Not available — new indicator	Uncertain 19.8% / 44	Uncertain 19.0% / 43	Uncertain 19.7% / 45
		Not available — new indicator	Not available — new indicator	No 20.7% / 46	No 19.9% / 45	No 19.7% / 45
	%/# of stocks with specific catch monitoring objectives in their IFMP	Not available — new indicator	Not available — new indicator	0.0% / 0	0.0% / 0	0.0% / 0
9. Critical stocks with rebuilding plans	%/# of critical zone stocks with rebuilding plans	11.5% / 3	10.7% / 3	16.7 % / 6	15.4% / 6	19.4% / 7

† The "all stocks" dataset changes each year as stocks are added during the update process. To calculate the percentage change from the previous year, Oceana Canada used the previous year's "all stocks dataset," excluding new stocks added during the update.
†† This value includes those that changed status to or from uncertain.
** Sometimes it is not possible to estimate mortality with available data or models.*

Appendix 1: Figures of select indicators by Fisheries and Oceans Canada (DFO) administrative regions

In addition to the National Capital Region based in Ottawa, DFO currently has seven administrative regions across the country,[20] each responsible for the management of fisheries and oceans within their jurisdiction (Figure A1):

1. Newfoundland and Labrador
2. Maritimes
3. Gulf
4. Quebec
5. Arctic
6. Ontario and Prairie
7. Pacific

The following pages provide visualizations of the Fishery Audit index dataset (n = 194 stocks) by taxa group within each DFO region (Figure A2) and select indicator values summarized by region in each year available (Figures A3 to A16).

[20] Source: DFO (2021). Regions. Fisheries and Oceans Canada. http://www.dfo-mpo.gc.ca/regions/index-eng.htm

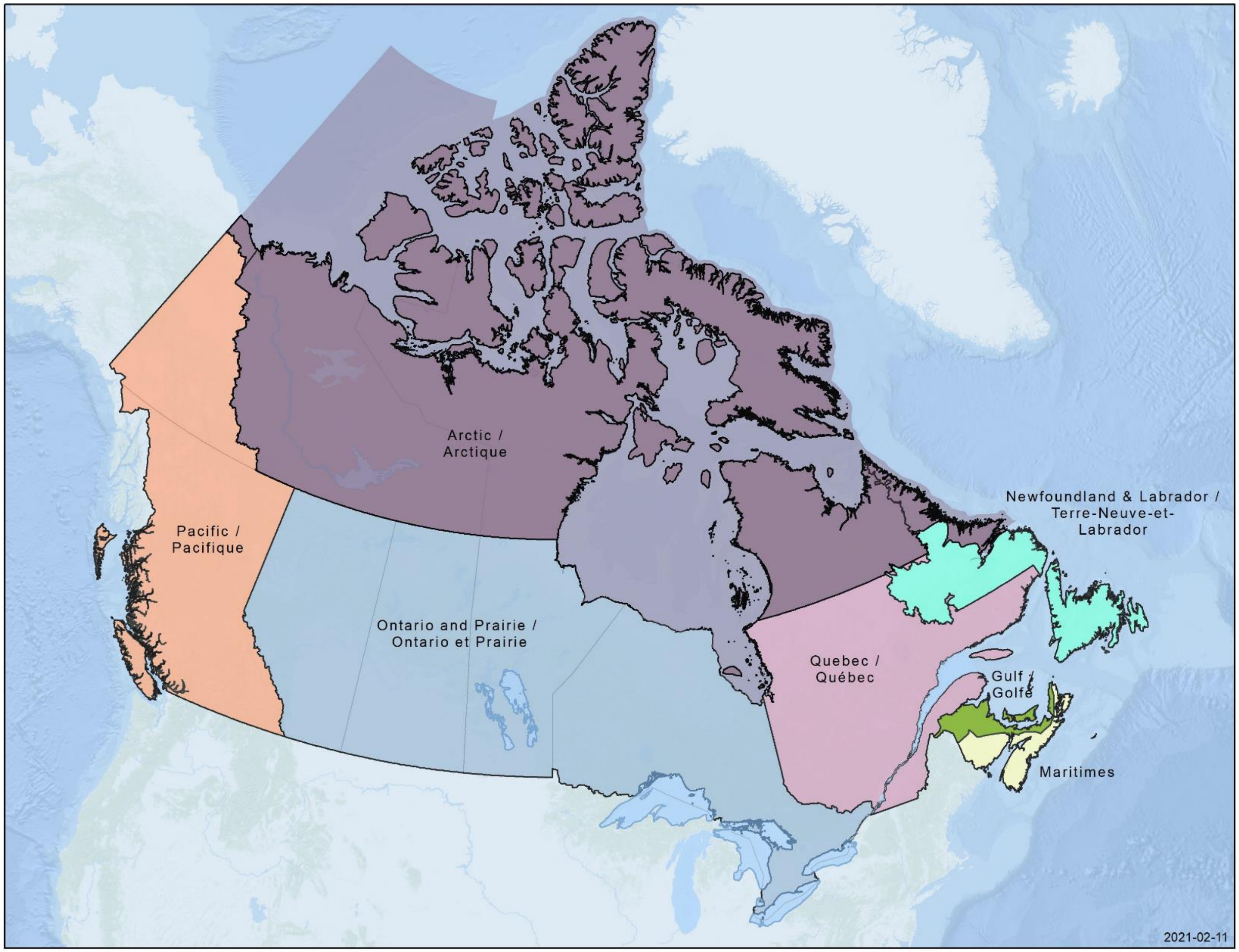

Figure A1. Map of DFO administrative regions. Modified from: https://www.dfo-mpo.gc.ca/about-notre-sujet/organisation-eng.htm

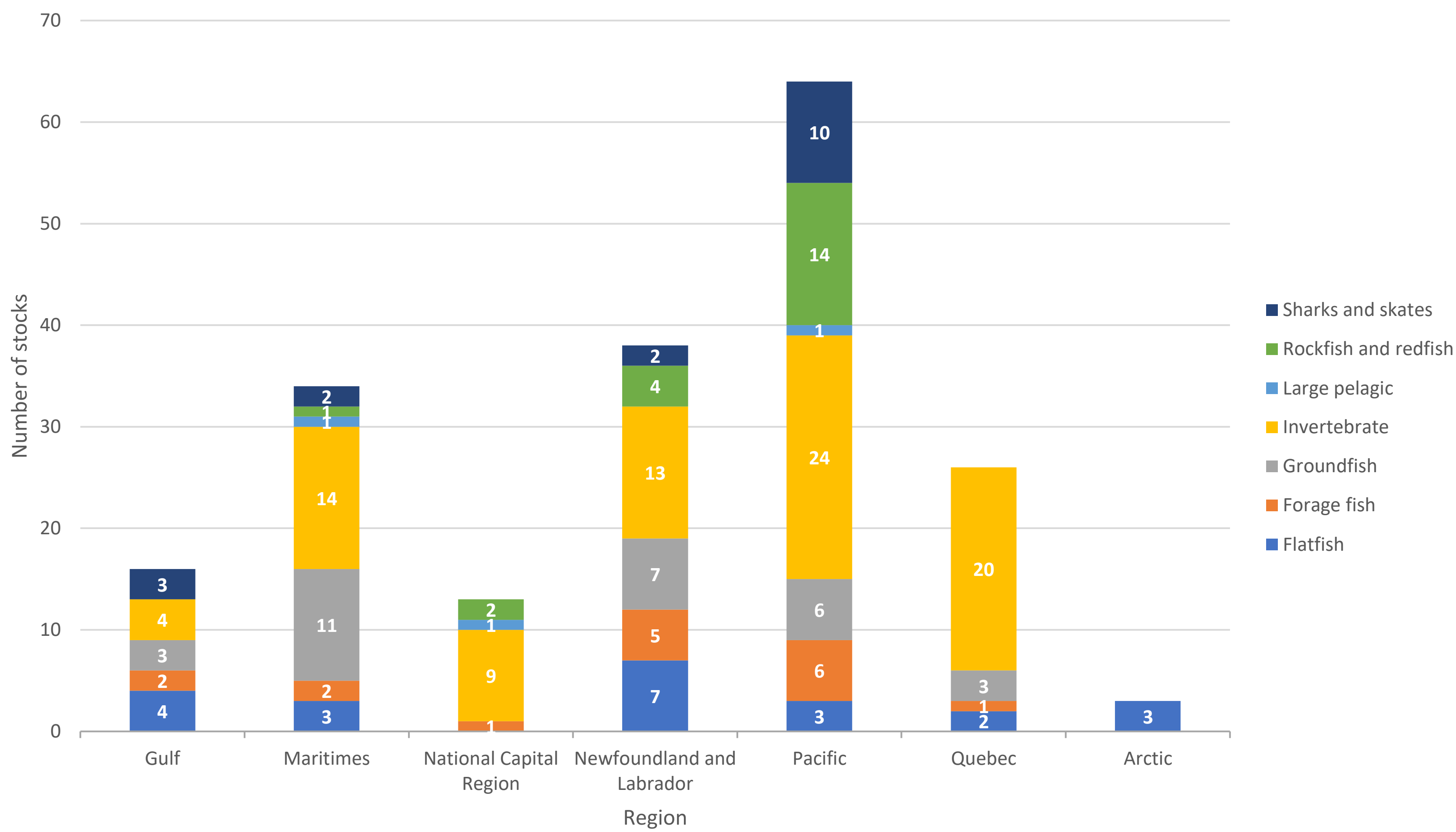

Figure A2. The number of Oceana Canada index stocks (n = 194 stocks) within each DFO administrative region and taxa group. The number of stocks in each region-taxa combination is reported in white font within the bars.

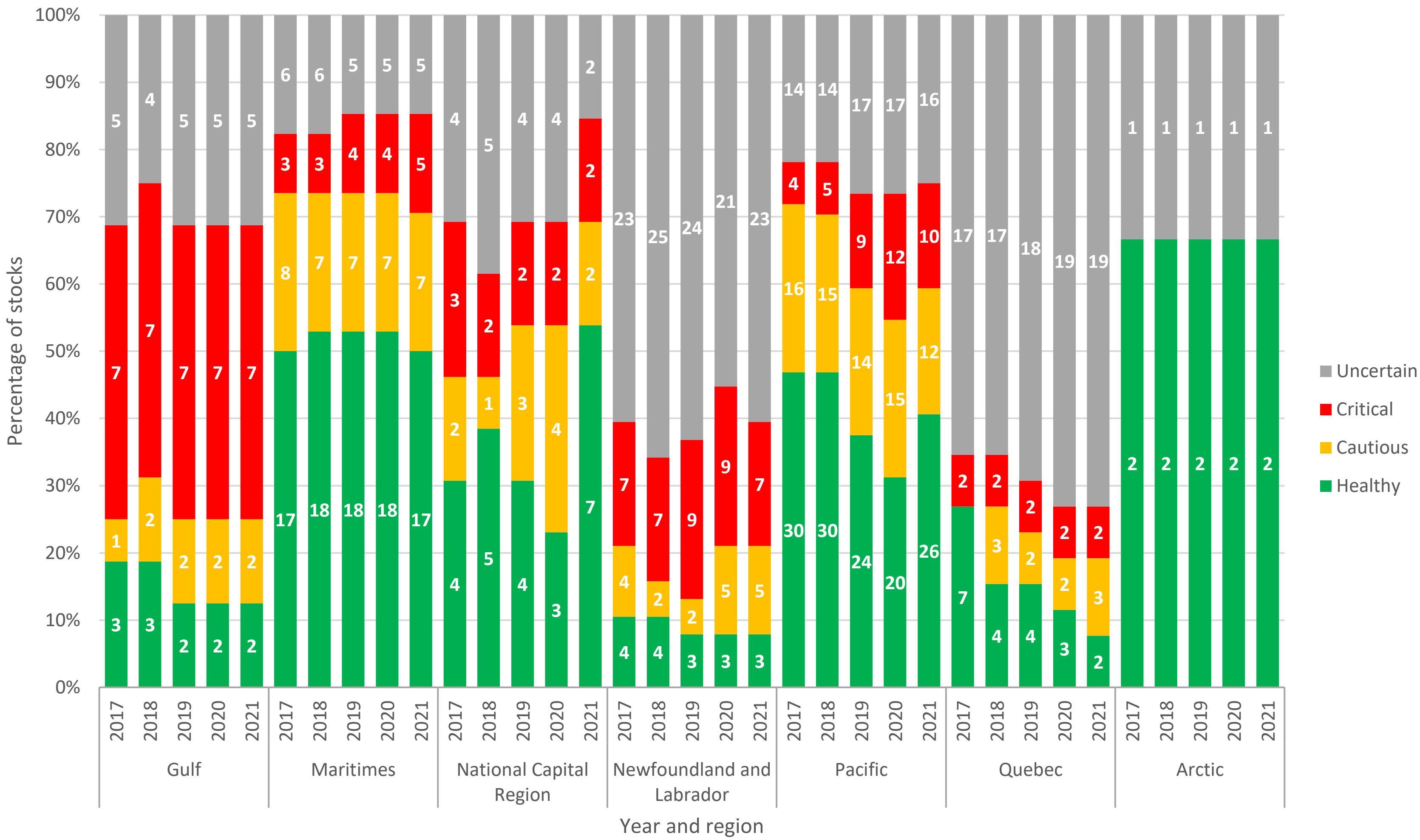

Figure A3. The percentage of Oceana Canada index stocks (n = 194 stocks) in each of DFO's precautionary approach (PA) framework health status zones in each DFO administrative region in 2017, 2018, 2019, 2020, and 2021. The number of stocks in each year-region-status combination is reported in white font within the bars.

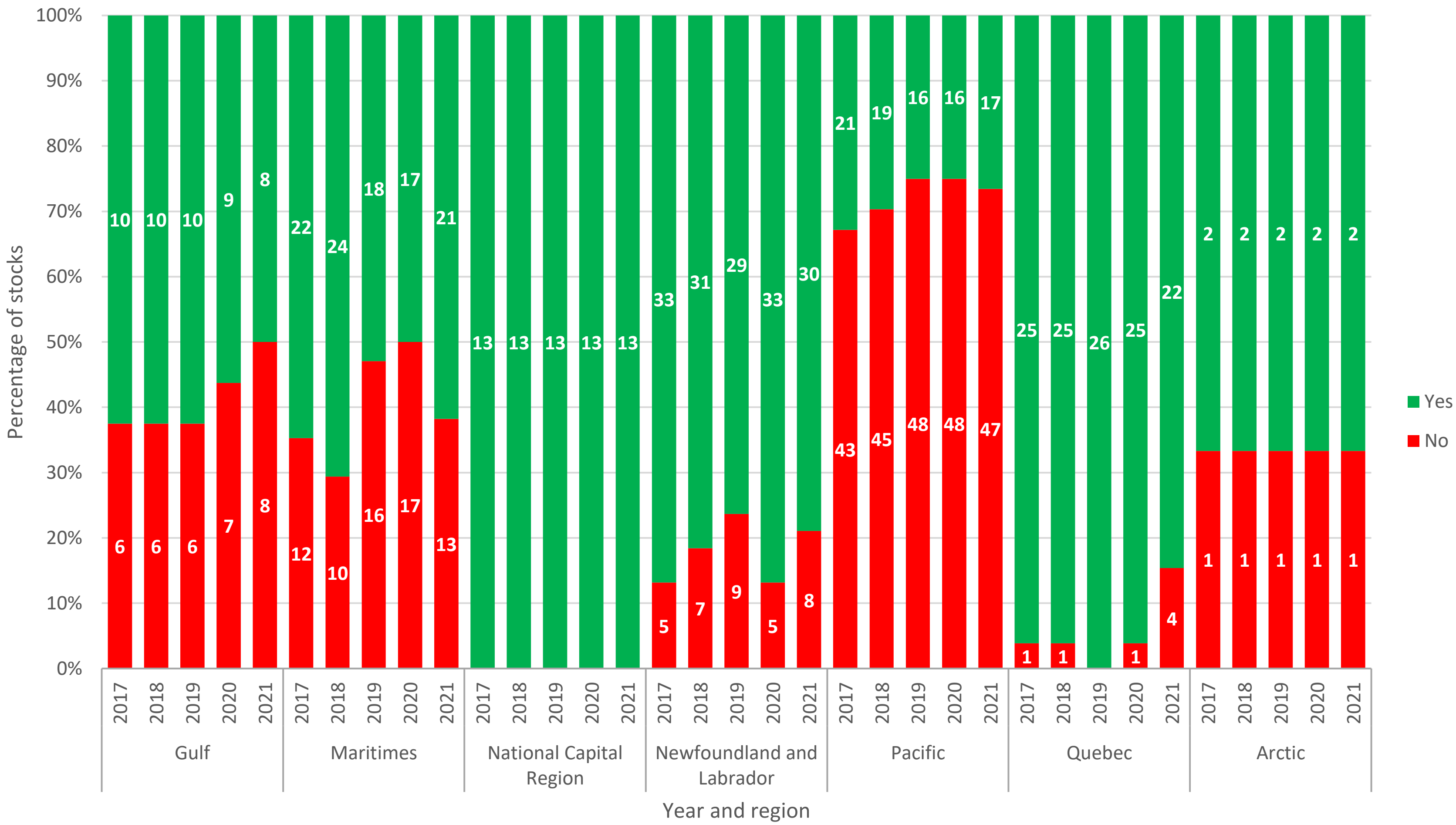

Figure A4. The percentage of Oceana Canada index stocks (n = 194 stocks) with recent (≤ 5 years old) biomass or abundance estimates in each DFO administrative region in 2017, 2018, 2019, 2020, and 2021. The number of stocks in each year-region-category combination is reported in white font within the bars.

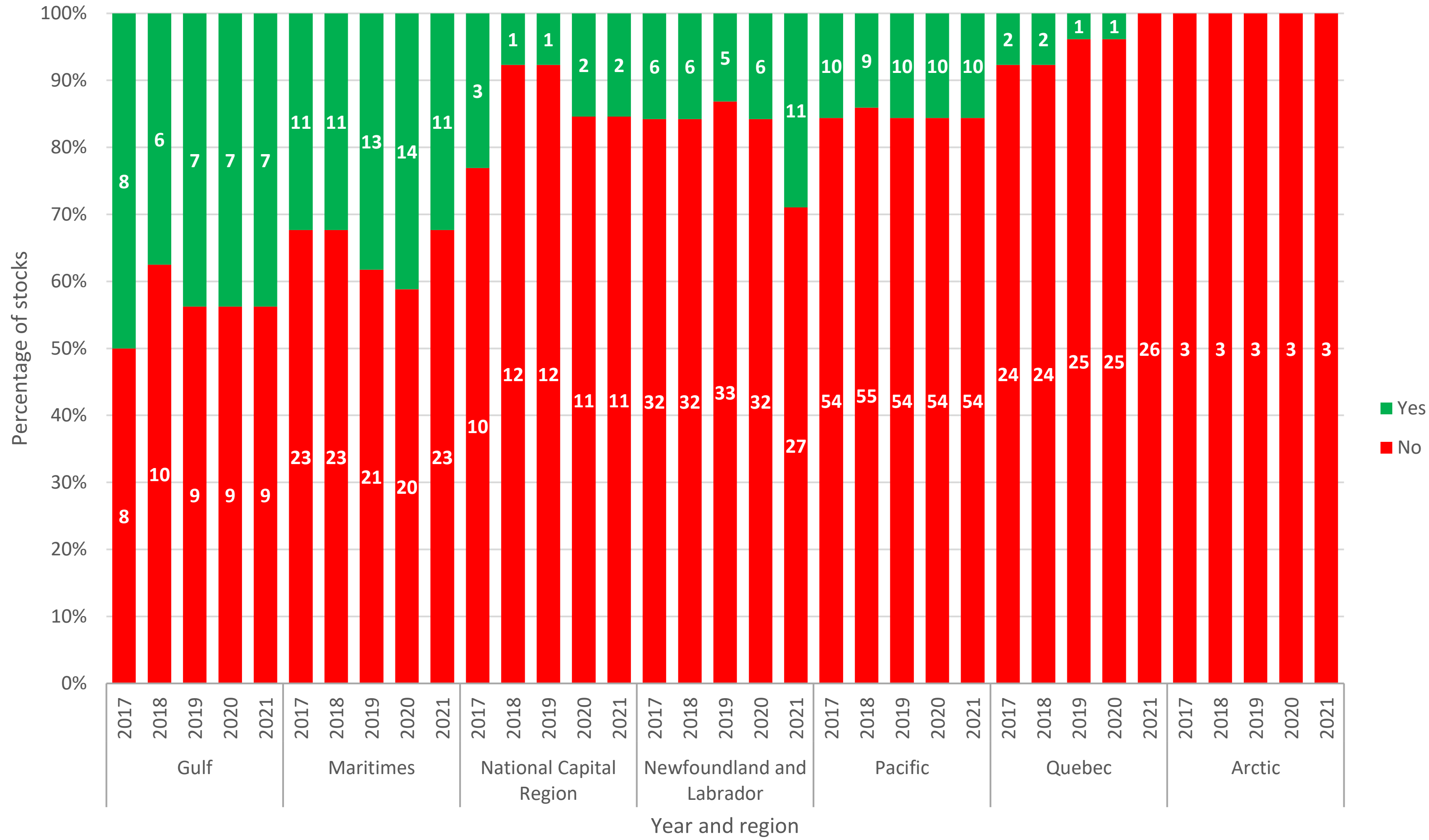

Figure A5. The percentage of Oceana Canada index stocks (n = 194 stocks) with fishing mortality (F) estimates in each DFO administrative region in 2017, 2018, 2019, 2020, and 2021. The number of stocks in each year-region-category combination is reported in white font within the bars.

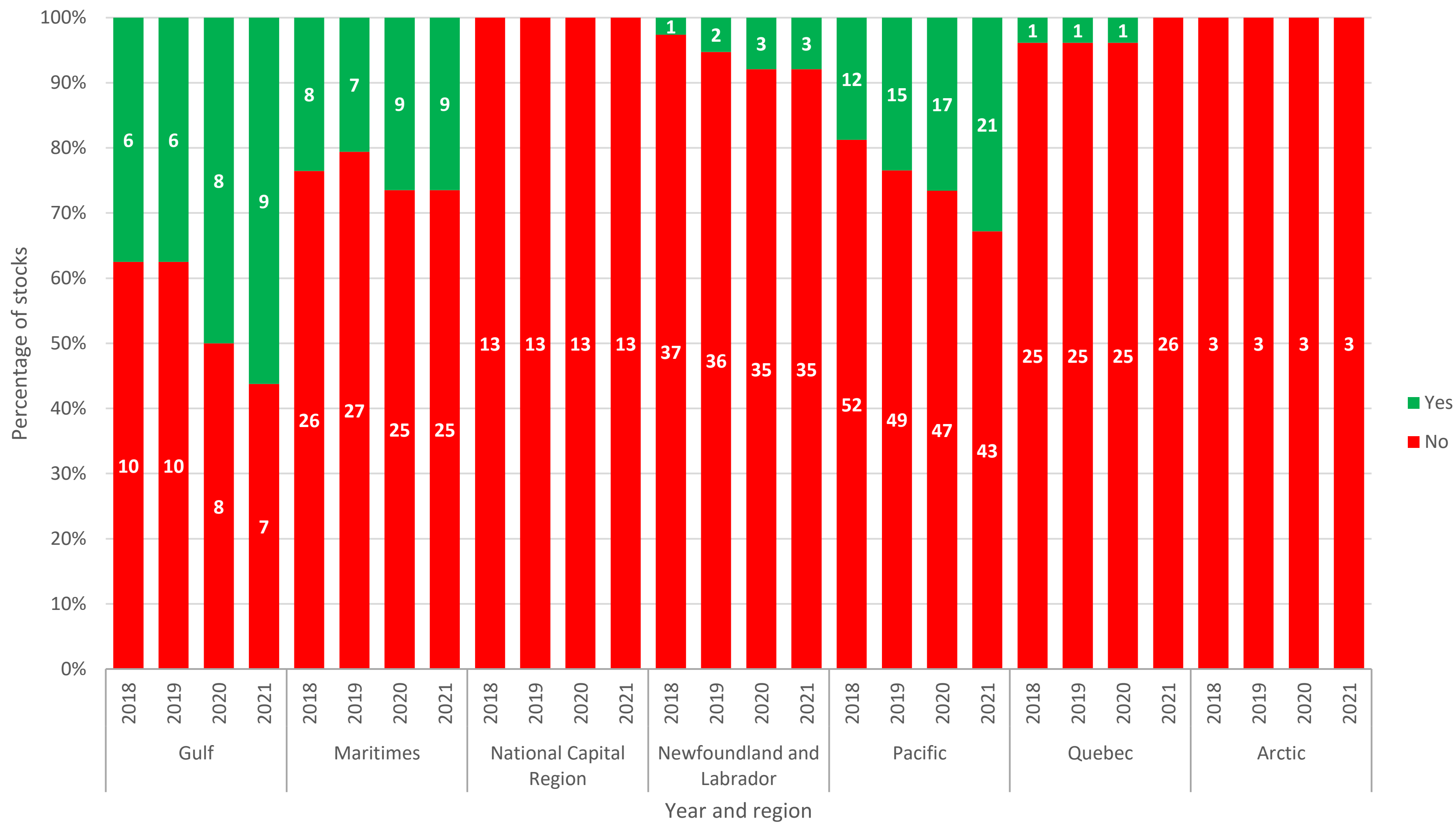

Figure A6. The percentage of Oceana Canada index stocks (n = 194 stocks) with natural mortality (M) estimates in each DFO administrative region in 2018, 2019, 2020, and 2021. The number of stocks in each year-region-category combination is reported in white font within the bars. Please note this indicator was added in 2018.

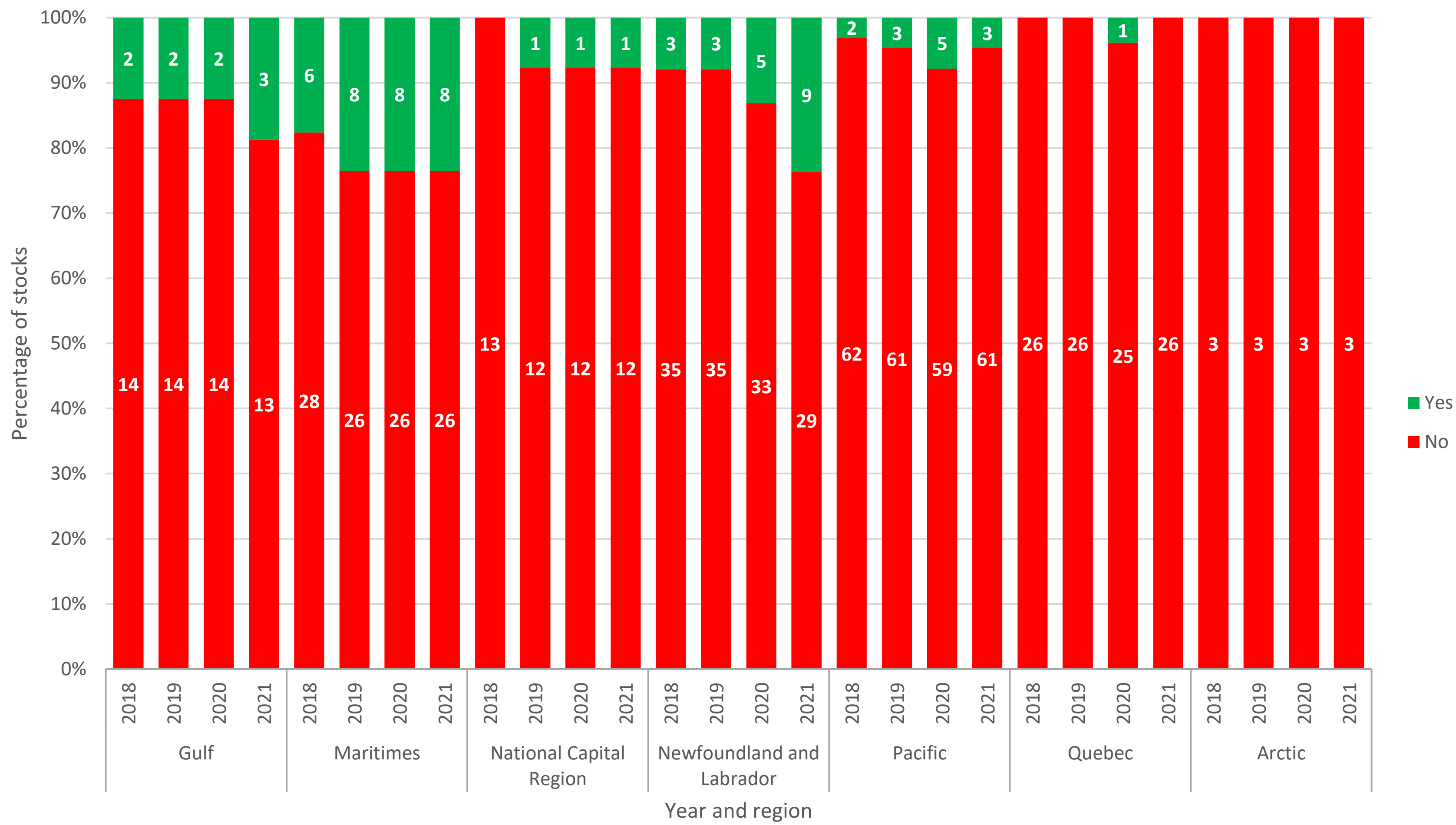

Figure A7. The percentage of Oceana Canada index stocks (n = 194 stocks) with total mortality (Z) estimates in each DFO administrative region in 2018, 2019, 2020, and 2021. The number of stocks in each year-region-category combination is reported in white font within the bars. Please note this indicator was added in 2018.

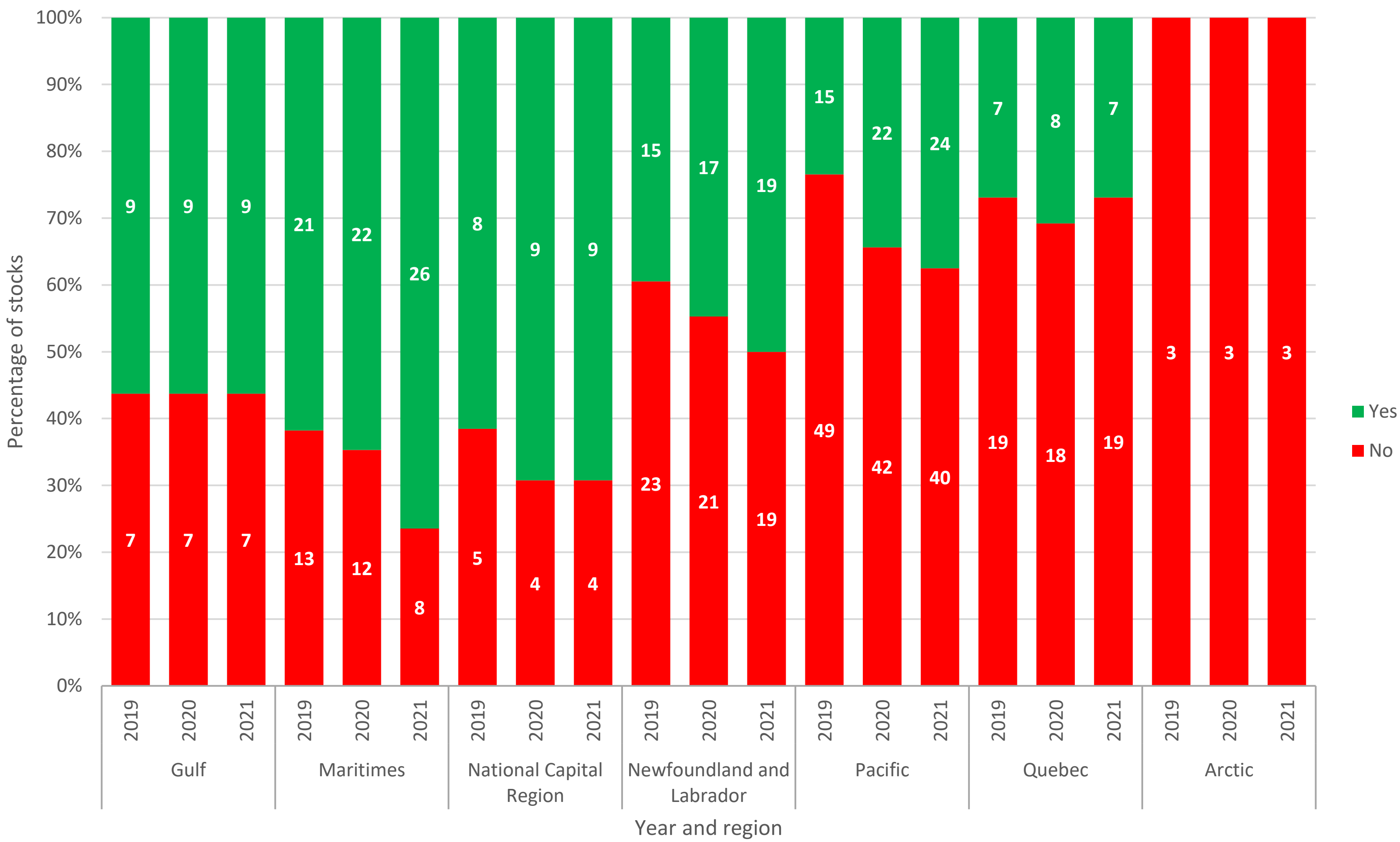

Figure A8. The percentage of Oceana Canada index stocks (n = 194 stocks) with exploitation rate estimates in each DFO administrative region in 2019, 2020, and 2021. The number of stocks in each region-category combination is reported in white font within the bars. Please note this indicator was added in 2019.

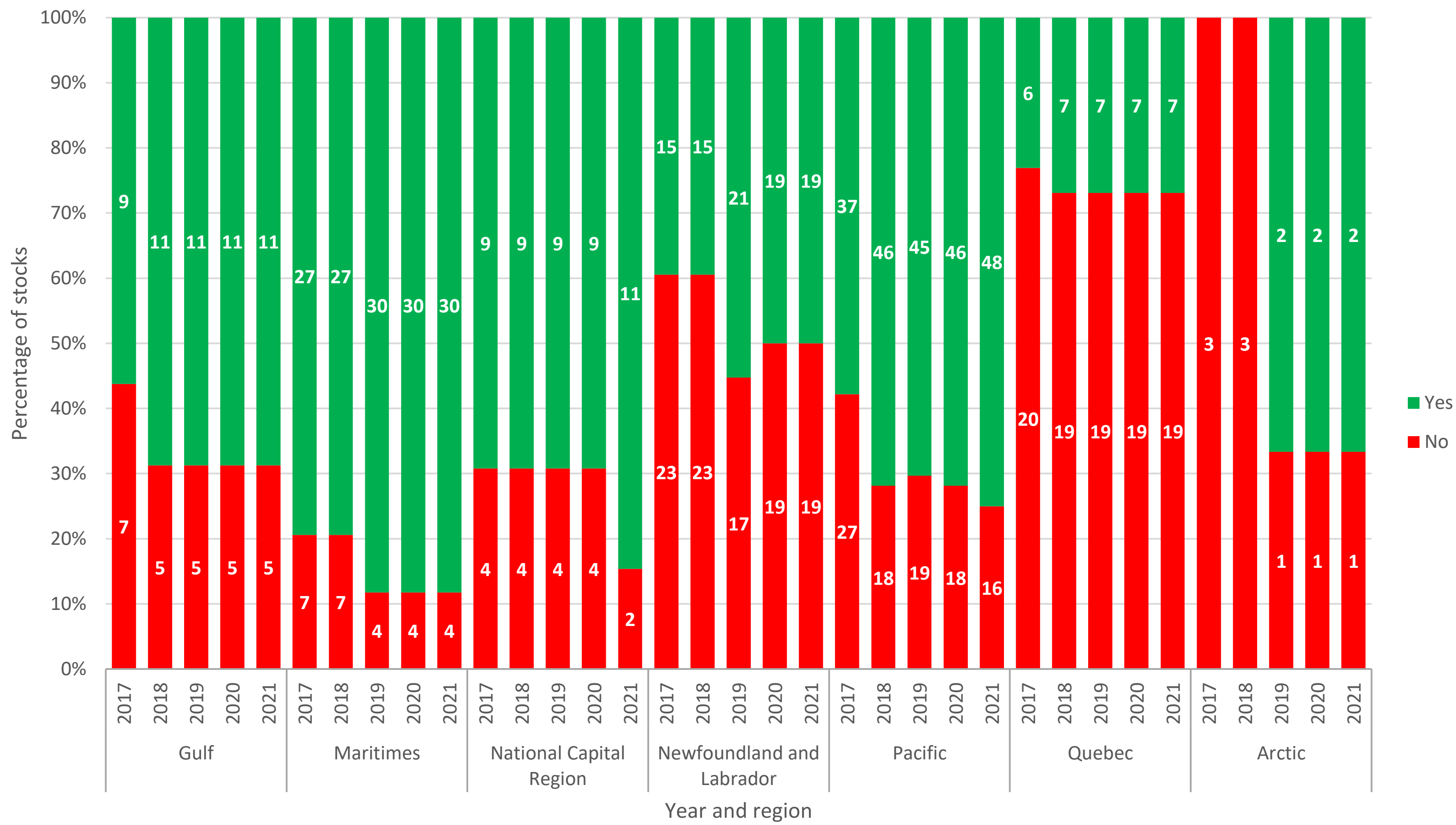

Figure A9. The percentage of Oceana Canada index stocks (n = 194 stocks) with limit reference points (LRPs) in each DFO administrative region in 2017, 2018, 2019, 2020, and 2021. The number of stocks in each year-region-category combination is reported in white font within the bars.

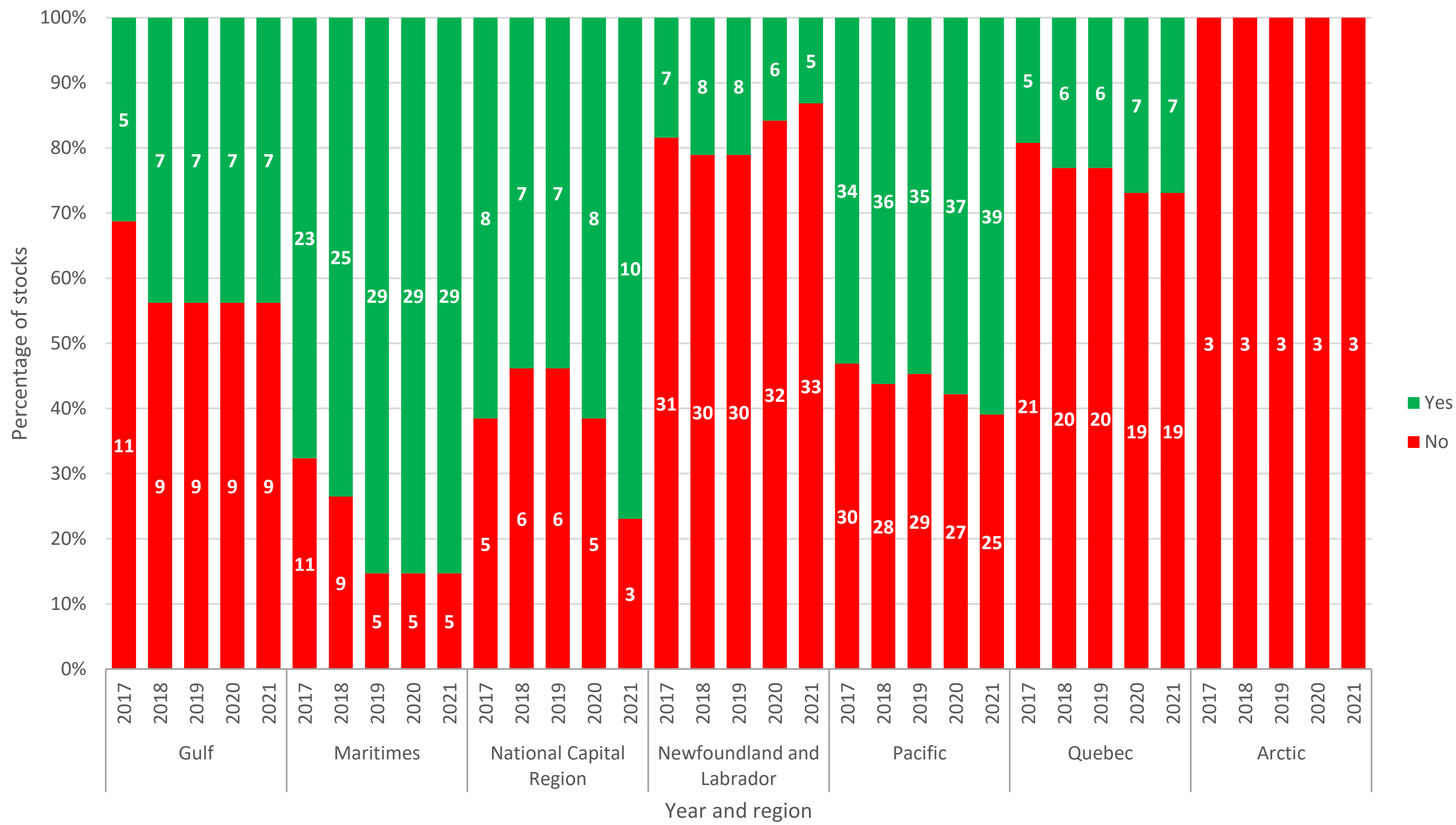

Figure A10. The percentage of Oceana Canada index stocks (n = 194 stocks) with upper stock reference points (USRs) in each DFO administrative region in 2017, 2018, 2019, 2020, and 2021. The number of stocks in each year-region-category combination is reported in white font within the bars.

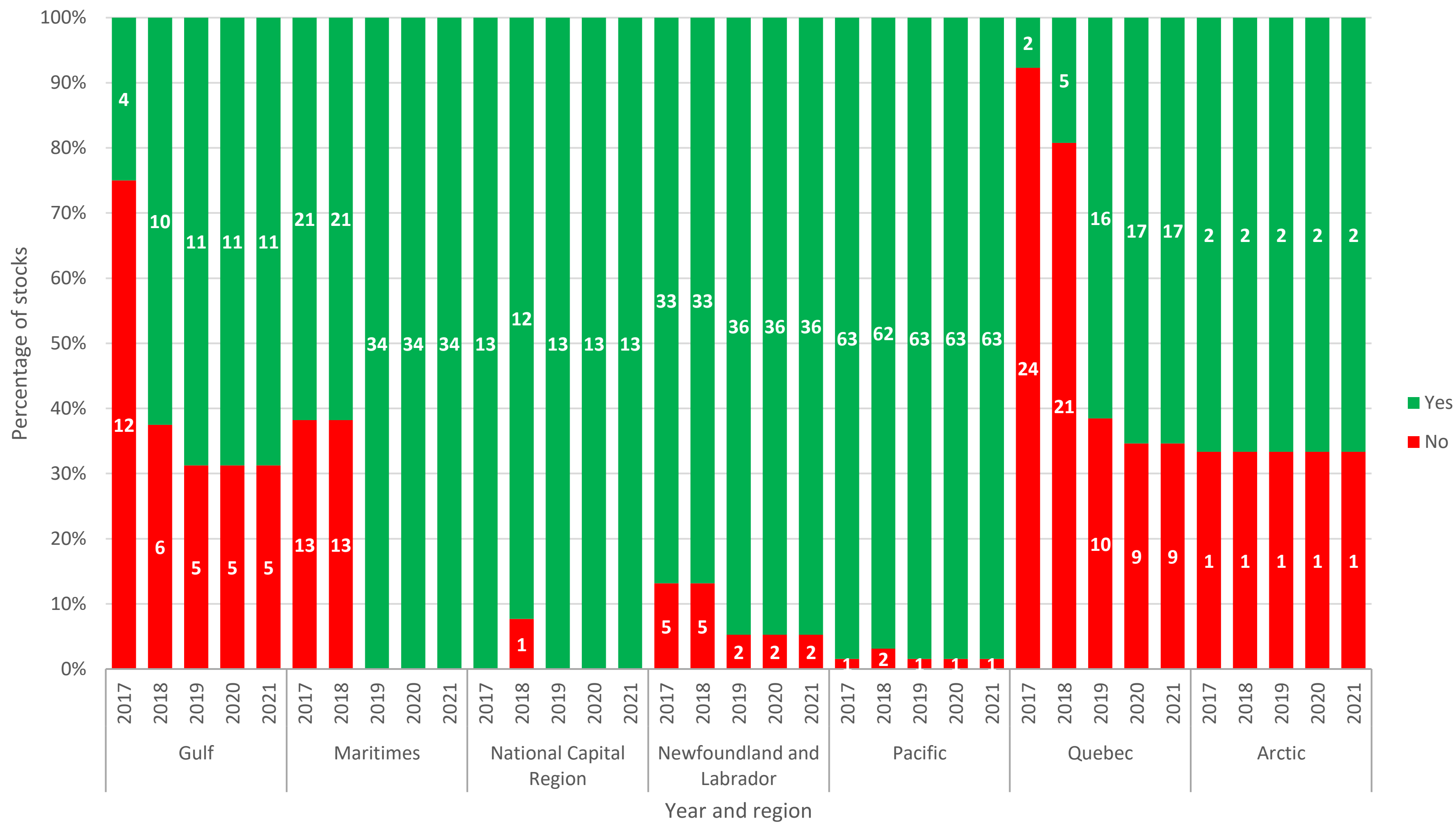

Figure A11. The percentage of Oceana Canada index stocks (n = 194 stocks) included in Integrated Fisheries Management Plans (IFMPs) in each DFO administrative region in 2017, 2018, 2019, 2020, and 2021. The number of stocks in each year-region-category combination is reported in white font within the bars.

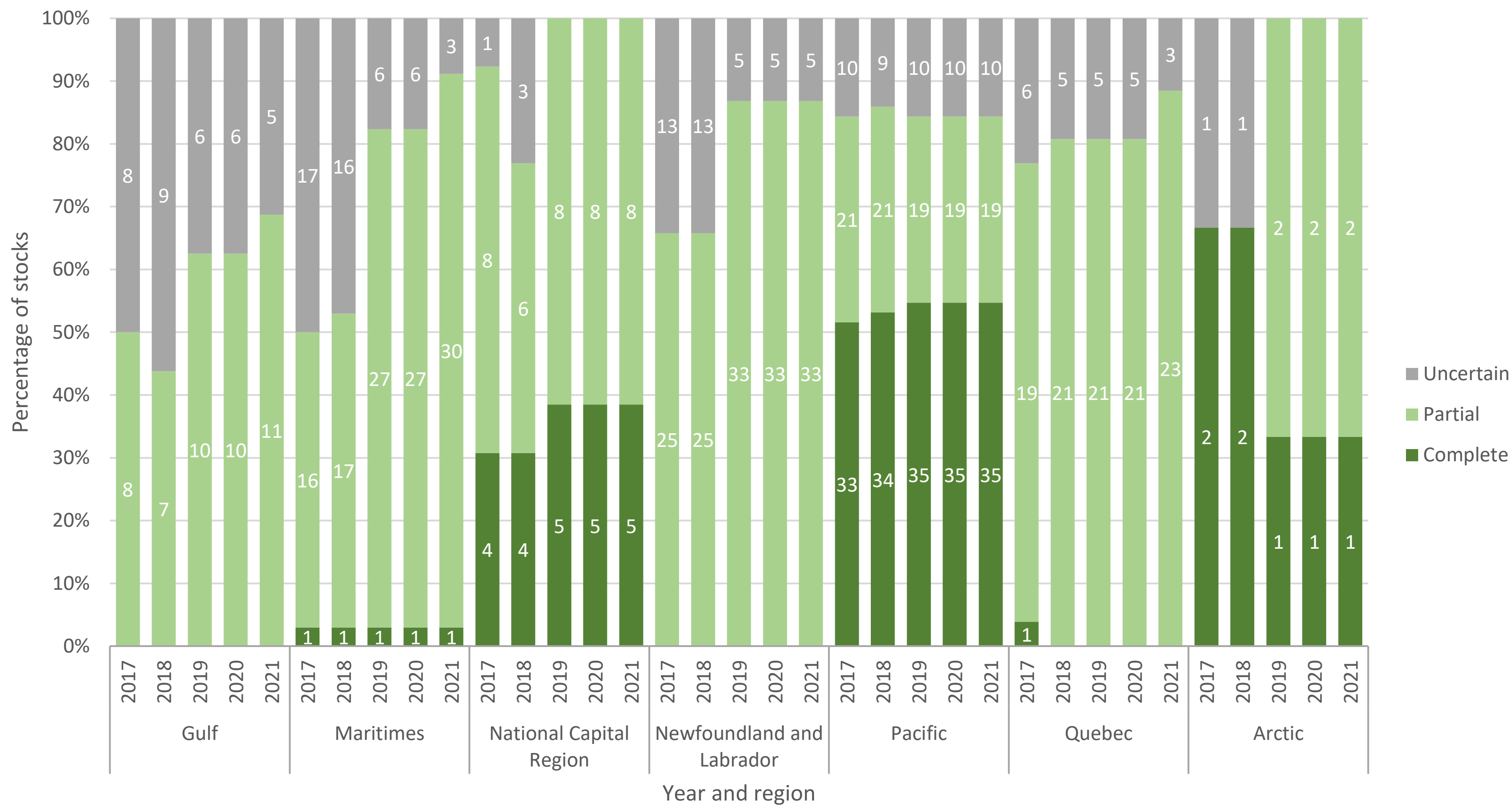

Figure A12. The percentage of Oceana Canada index stocks (n = 194 stocks) that have at-sea observer or electronic (i.e., video) monitoring in each DFO administrative region in 2017, 2018, 2019, 2020, and 2021. The number of stocks in each year-region-category combination is reported in white font within the bars. "Uncertain" was assigned when the documents and websites searched provided no indication that the use of the monitoring tool was required. "Partial" was assigned when it was clearly indicated the monitoring tool was required but levels of targeted tool use varied or were uncertain. "Complete" was assigned when it was clearly indicated the monitoring tool is required on 100 per cent of fishing trips. It should be noted, 100 per cent coverage for at-sea observers or electronic monitoring is not necessary for all fisheries.

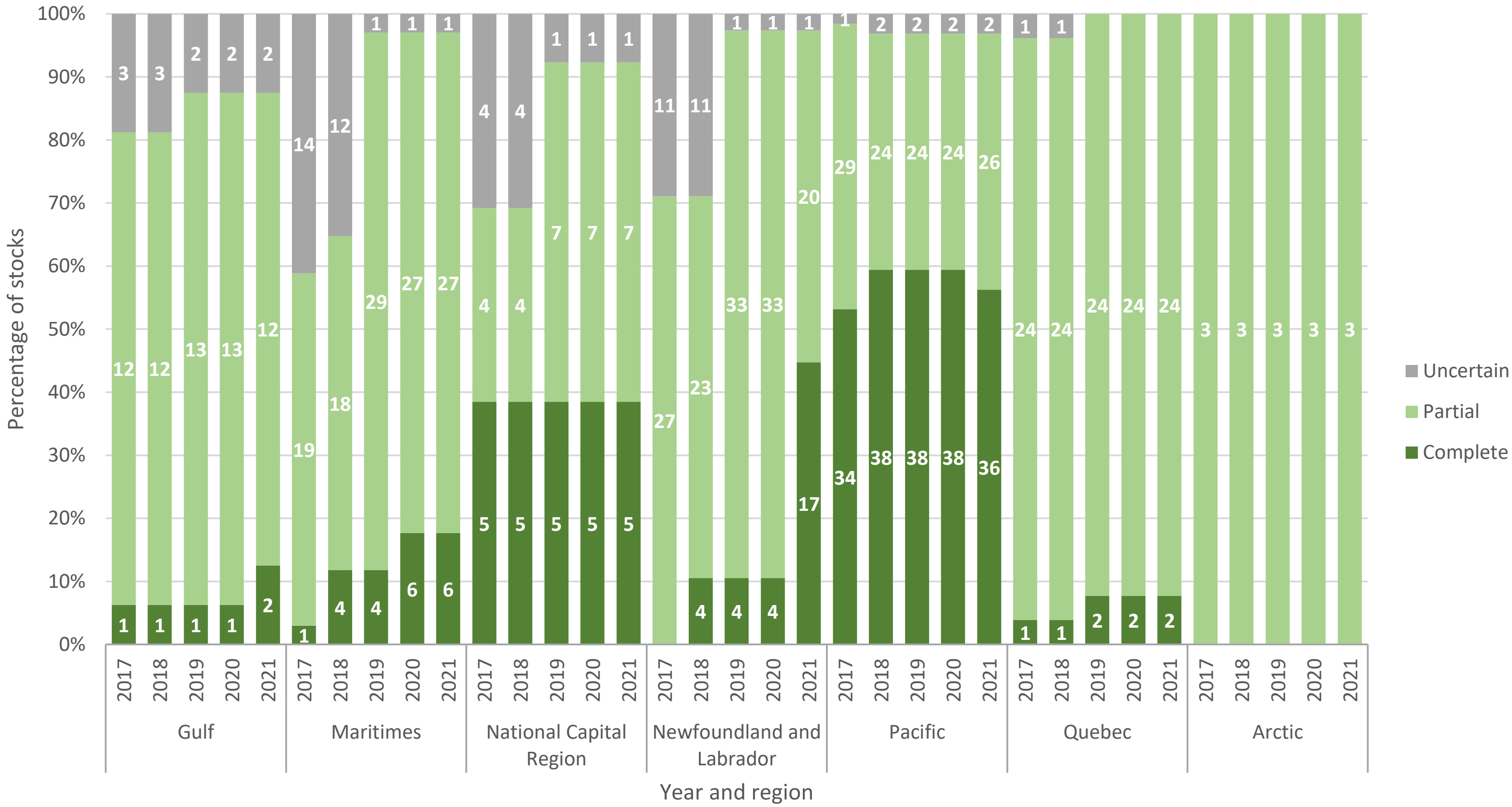

Figure A13. The percentage of Oceana Canada index stocks (n = 194 stocks) that require logbooks recording the entire catch (i.e., directed species and bycatch) in each DFO administrative region in 2017, 2018, 2019, 2020, and 2021. The number of stocks in each year-region-category combination is reported in white font within the bars. "Uncertain" was assigned when there was no indication in the documents and websites searched that the use of the monitoring tool is required. "Partial" was assigned when it was clearly indicated the monitoring tool was required but it was unclear if bycatch is recorded. "Complete" was assigned when it was clearly indicated that recording both directed catch and bycatch is required.

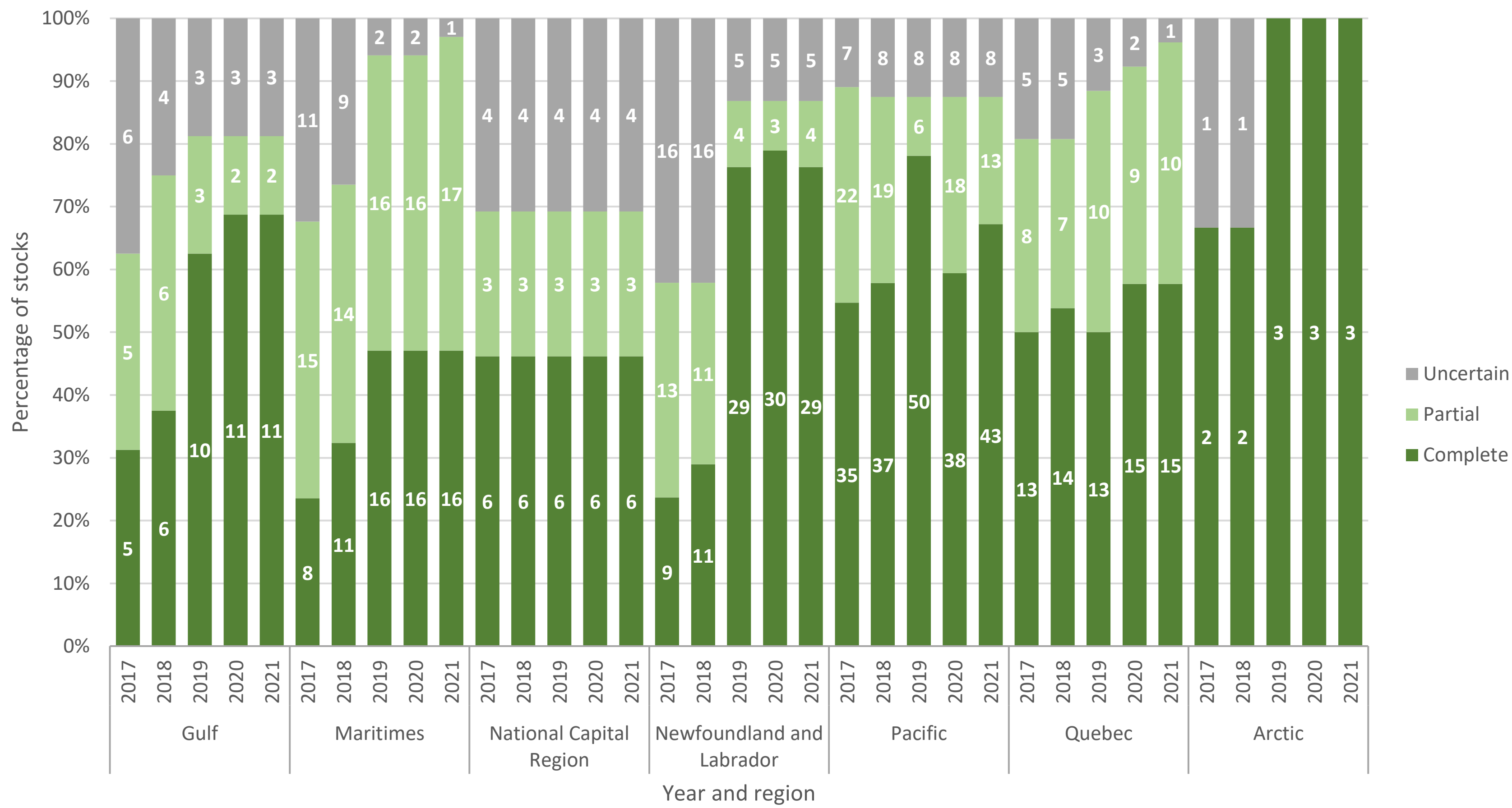

Figure A14. The percentage of Oceana Canada index stocks (n = 194 stocks) that have independent dockside monitoring in each DFO administrative region in 2017, 2018, 2019, 2020, and 2021. The number of stocks in each year-region-category combination is reported in white font within the bars. "Uncertain" was assigned when there was no indication in the documents and websites searched that the use of the monitoring tool is required. "Partial" was assigned when it was clearly indicated the monitoring tool was required but targeted levels of tool use varied or were uncertain. "Complete" was assigned when it was clearly indicated the monitoring tool is required on 100 per cent of fishing trips.

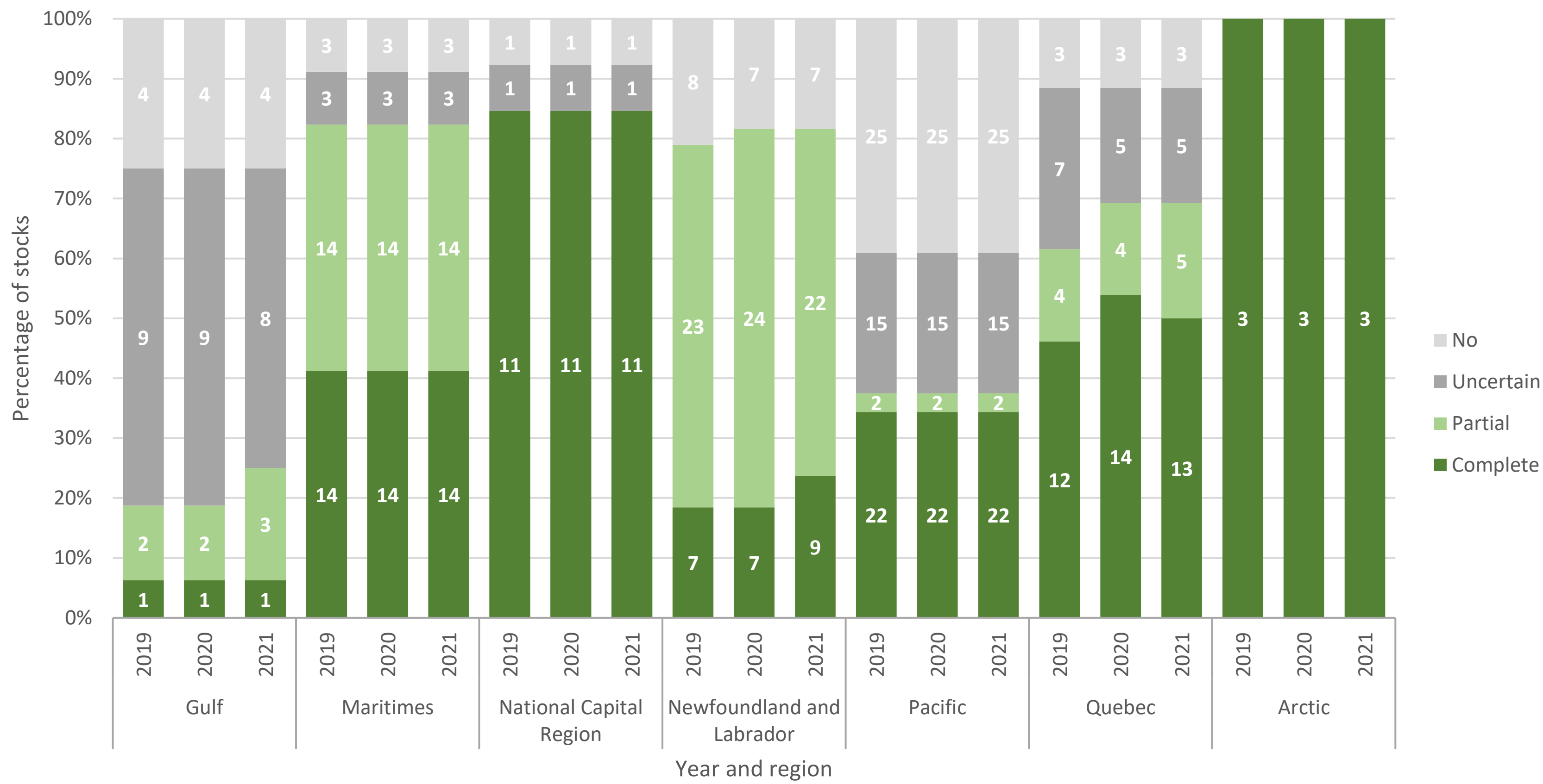

Figure A15. The percentage of Oceana Canada index stocks (n = 194 stocks) that have vessels requiring electronic location monitoring, either via vessel monitoring systems (VMS) or automated identification systems (AIS), in each DFO administrative region in 2019, 2020, and 2021. The number of stocks in each region-category combination is reported in white font within the bars. "Uncertain" was assigned when there was no indication in the documents and websites searched that the use of the monitoring tool is required. "Partial" was assigned when it was clearly indicated the monitoring tool was required but targeted levels of tool use varied or were uncertain. "Complete" was assigned when it was clearly indicated the monitoring tool is required on 100 per cent of fishing vessels and trips. "No" was assigned when it was clearly indicated VMS or AIS was not required. It should be noted, 100 per cent coverage for electronic location monitoring is not necessary for all fisheries (e.g., shore-based fisheries without vessels). Please note this indicator was added in 2019.

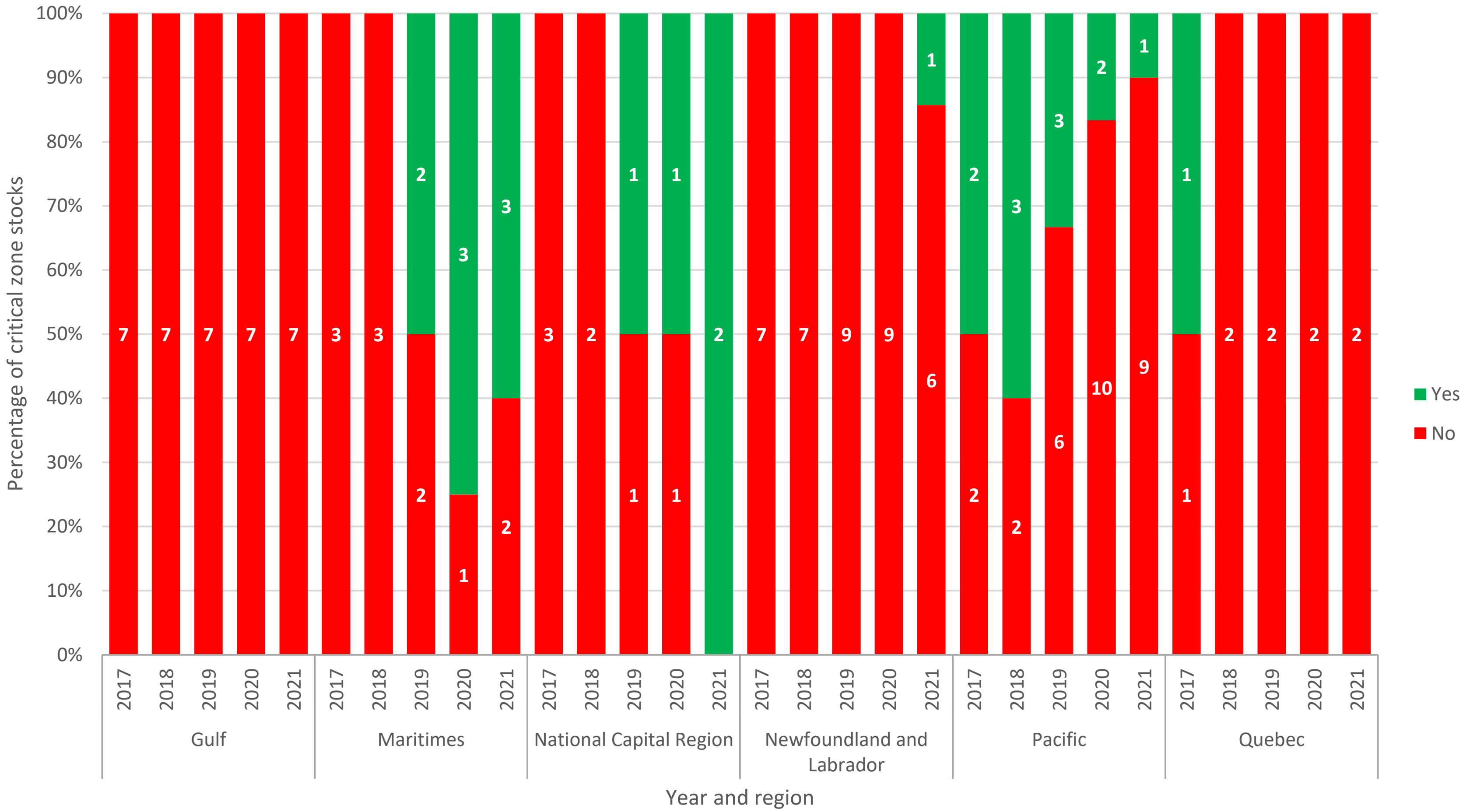

Figure A16. The percentage of Oceana Canada index stocks (n = 194 stocks) in the critical zone and included in rebuilding plans in each DFO administrative region in 2017, 2018, 2019, 2020, and 2021. The number of stocks in each year-region-category combination is reported in white font within the bars. Please note the number and composition of critical zone stocks within each region may change from year to year. Note this figure does not display rebuilding plans in place for non-critical zone stocks.