Fisheries rebuilding success indicators: 2022

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Summary

The results of Oceana Canada's sixth annual (2022) fisheries rebuilding success indicators reveal that the overall status of Canada's marine fish and invertebrate populations has been largely stagnant over the past six years:

- Less than a third of marine fish and invertebrate stocks can be confidently considered healthy;
- One in five stocks are critically depleted; and
- One third of all stocks are classified as "uncertain" due to a lack of reference points and stock status.[1]

We expected a change in indicators by now, considering the significant investments, new policies, and updated laws devoted to fisheries and oceans management over the past six years. The fact that indicators have remained stationary suggests that more needs to be done. With threats such as climate change, overfishing, and pollution accumulating, the need to rebuild depleted fish populations has never been more urgent.

Fisheries must be managed to prioritize long-term resilience of fish populations, be based on science and Indigenous Knowledge Systems, and consider ecosystem-level structures and processes that capture the interrelationships among species. It is essential that the Canadian government engages in meaningful collaboration with rightsholders and stakeholders to implement strong plans with clear targets and timelines to rebuild depleted populations, while supporting effective fisheries monitoring to track progress and guide decision-making. Amendments to the *Fisheries Act* in 2019, and new regulations issued in 2022, require rebuilding plans for prescribed depleted fish populations under Canadian law and outline the steps for creating them (Public Works and Government Services Canada, 2022; DFO, 2022a, 2022b). In order to make a difference for marine ecosystems and coastal communities in Canada, the federal government needs to implement these measures urgently and ramp up capacity to improve performance.

Most of the long-standing critically depleted stocks are found in the Atlantic Ocean, especially groundfish and flatfish, which have not recovered from widespread collapses in the 1990s. These were caused by unsustainable high harvest levels combined with unfavourable environmental conditions (ECCC, 2020). Alarmingly, there are no healthy shark or skate species across Canadian waters. Moreover, there are no healthy forage fish stocks in the Atlantic, which are vital to ecosystem functioning. Forage fisheries are regulated by the precautionary approach (PA) (DFO, 2009a) and should align with the Policy on New Fisheries for Forage Species (DFO, 2009b). The loss of many long-lived, high trophic level species (i.e., groundfish, sharks and skates) has resulted in focussing fishing efforts on short-lived, low trophic level species (i.e., invertebrates). A growing number of invertebrate stocks, including economically important species such as snow crab and shrimp, are now classified as critical or cautious. Depleted prey populations not only creates economic risks, but and can disrupt food web

[1] Oceana Canada's complementary stock assessments indicate that the majority of these "uncertain" populations may not be in good health (Schijns, 2022).

structure and function and exacerbate biodiversity loss by preventing the recovery of depleted higher-level species.

Recovery is possible, and there have been some notable improvements with other taxa, like rockfish and redfish, where favourable environmental conditions have likely enabled large recruitment events in some stocks (e.g., redfish in Units 1 and 2; DFO, 2019e). In both bocaccio and yelloweye (inside water) rockfish populations, rebuilding plans were implemented and populations are now considered to have grown above their respective limit reference points. While this is good news, management should continue to practise the precautionary approach (DFO, 2009a) and the six principles for Science Advice for Government Effectiveness (SAGE) by setting quotas designed to maintain healthy levels and minimize the probability of stock declines. Given that the bocaccio population had declined by 97 percent only two years earlier, concerns were raised about how this year's bocaccio quota was raised 24 times higher over three years, particularly in light of climate change and a single unusual recruitment event (Whitney, 2022).

Climate change's significant impact on marine species is playing out in both direct and indirect ways. There are expected to be "winners" and "losers" when it comes to access to future fisheries, because climate change is affecting species distributions and ecosystem communities (Boyce et al., 2021; DFO, 2019a, 2020a; Lam et al., 2016; Talloni-Álvarez et al., 2019; Wilson et al., 2020). In the coming years, the effectiveness of fisheries management will be further undermined by the effects of climate change unless major changes are made to strengthen resiliency in populations by minimizing cumulative impacts, assessing those most vulnerable populations, and adapting management accordingly (Cheung et al., 2022). The effects of climate change are not currently factored into most fisheries management plans even when there is available evidence that fish populations are impacted, particularly for highly vulnerable species (Schijns and Rangeley, 2022a). These gaps hamper Canada's ability to respond to environmental change (Pepin et al., 2020) and can perpetuate poor management decisions, making it difficult to implement adaptive and risk-based decisions based on the best available information.

Over the past six years, existing policies have progressed in some key respects and lagged in others. There has been a significant increase in the percentage of stocks with limit reference points (LRPs) and improved transparency as most stocks are included in publicly available Integrated Fisheries Management Plans (IFMPs). There have been incremental increases in the percentage of stocks with upper stock references (USRs), but development of both LRPs and USRs stabilized over recent years, and nearly half of all stocks still need reference points. As well, management decisions are often made before the public has access to the scientific basis used to inform resource managers (Archibald et al., 2021b; Archibald and Rangeley, 2021c). It is clear from these analyses that the Department of Fisheries and Oceans (DFO) must mobilize investments in fisheries science to accelerate the implementation of fundamental requirements for management decision-making.

The majority of stocks in the critical zone lack rebuilding plans despite departmental commitments made in 2017 to implement 19 rebuilding plans by the end of March 2021 (DFO, 2017a). Over a year since this deadline, 13 rebuilding plans have been developed but some require major revisions, and 10 stocks experienced delays (Archibald et al., 2021a; Archibald and Rangeley, 2021a) and now have deadlines extended to 2023 (DFO, 2022d). Further departmental commitments to make significant progress implementing other aspects of DFO's Sustainable Fisheries Framework (i.e., reference points, harvest control rules, and Integrated Fisheries Management Plans) (CESD, 2016; DFO, 2017a, 2017b) fall short, with less than half of these commitments realized. Canada cannot achieve the necessary changes in a reasonable timeframe with this rate of progress.

The percentage of stocks with a recent stock assessment (within 5 years) declined, from 56.7 per cent in 2021 to 54.6 per cent in 2022 (Table 1), and the state of stocks with undefined status remained the same this year (37 per cent; Table 1). While the proportion of stocks with estimates of natural mortality have increased, the proportion of stocks with estimates of fishing mortality and exploitation rate have remained at a low level. Most estimations of fishing mortality for stocks do not consider all fishing sources, which means that managers are not fully accounting for all removals, including from bait and recreational sources. Since reliable data serves as a foundation for effective management, it is necessary to invest in further capacity to monitor and assess fish population health.

Fisheries scientists can provide fishing mortality estimates that account for all sources of fishing mortality when they are well equipped with accurate estimates of how much of each species is landed and discarded. Unreported components, such as recreational or bait fisheries, frequently contribute a significant portion of catches (Pauly, 1998; Pauly and Zeller, 2016). Oceana Canada continues to advocate for the swift implementation of the national Fishery Monitoring Policy (Archibald et al., 2021c), highlighting the precautionary approach, which dictates that caution should be exercised when scientific knowledge is unclear and that the lack of reliable data should not be used to justify postponing conservative measures. This will give managers the critical information necessary for rigorous fisheries management and decision-making. The Fishery Monitoring Policy must be implemented as soon as feasibly possible in all fisheries, which means DFO must set deadlines and allocate resources accordingly. The goals of the new *Fisheries Act* and rebuilding regulations are jeopardized in the absence of better data quality.

In 2019, the *Fisheries Act* was amended to restore protections lost under previous governments and was modernized with new provisions to require rebuilding plans for critically depleted stocks. In April 2022, the Canadian government amended the Fishery (General) Regulations. The regulations specify the requirements for rebuilding plans, including targets and timelines, and to which stocks they will apply. The first batch of stocks prescribed under the regulations includes 30 major fish stocks, nearly half of which are in the critical zone and now require a rebuilding plan to be developed within 24 months (with the possibility of a 12-month extension).

The combination of significant commitments, investments, and legal obligations provides a unique opportunity for ambitious progress to increase the number of stocks in the healthy zone and to build resilience to climate change. However, without further research to define stock status for uncertain stocks, which may include critically depleted populations, Section 70 of the Fishery (General) Regulations (referred to hereafter as the rebuilding regulations) will not apply, risking further decline towards collapse rather than providing the opportunity to recover. The government must determine the status of all stocks and ensure that all depleted stocks are included in the next batch subject to the rebuilding regulations (Elmslie, 2021). An additional challenge is that the few existing rebuilding plans for major stocks fall short of the regulations and need revisions to comply with the law. Implementing strong rebuilding plans can set a new precedent and surpass status quo efforts that perpetuate setting targets just above the point of serious harm on uncertain timelines (Archibald and Rangeley, 2019c;

Levesque et al., 2021). Only then will Canada make significant progress towards rebuilding abundance, as has been demonstrated by other progressive fishing nations who follow globally accepted standards of fisheries management (e.g., NOAA 2021).

Recommendations
As the country with the world's longest coastline and coastal communities that rely on healthy marine ecosystems, Canada has the responsibility to modernize marine resource management and waste no more time in the pursuit of restoring ocean abundance. The government needs to match their response to the urgency of the situation, by using the knowledge and tools already available to manage stocks so that there are more stocks in the healthy zone, few in the cautious zone and all stocks in the critical zone are managed under good-quality rebuilding plans.

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

1. **Implement rebuilding regulations for all depleted stocks:** Canada's *Fisheries Act* now requires that DFO takes action to rebuild depleted prescribed major fish stocks, and new rebuilding regulations now define how rebuilding will be accomplished. Because these regulations only apply to stocks prescribed in the Fish Stock Provisions (FSP) and because only one batch of stocks has been prescribed to date, all depleted stocks should be listed in upcoming batches of prescribed stocks. Specifically, DFO must:
    a. Implement eight new rebuilding plans by 2022/2023 plus three new rebuilding plans (Pacific salmon) and three revised rebuilding plans by 2023/2024 per the FSP;
    b. Prescribe remaining critical and cautious stocks in the second batch by early 2023 and implement the corresponding new rebuilding plans by 2024/2025;
    c. Assign status and develop LRPs for all uncertain stocks, using methods across the data spectrum and prioritizing development for 16 key stocks (Schijns and Rangeley, 2022b);
    d. Develop LRPs for forage fish according to the Policy on New Fisheries for Forage Species (DFO, 2009b) as a threshold to serious harm experienced by both target and ecologically dependent species (currently 5/17 forage stocks lack LRPs, 11/17 lack USRs, and the health status of 7/17 is uncertain).
2. **Make decisions about wild fish based on science and Indigenous Knowledge Systems:** To uphold its commitments to truth and reconciliation, the Canadian government must meaningfully engage with Indigenous organizations to make decisions informed by Indigenous evidence, practices, and knowledge systems, as well as the best available science. Specifically, DFO must:
    a. Reform DFO's decision-making structure to be more accountable and transparent, in ways that promote holistic forms of co-governance;
    b. Implement collaborative fisheries management agreements between the Canadian government and Indigenous organizations; and
    c. Transform fisheries management with new approaches that centre on sustainability and ecosystem management and recognize the ecological and cultural significance of fish as more than just a commodity to be extracted.
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 and habitats to climate change impacts. Specifically, DFO must:

   a. Assess vulnerability and climate risk of all populations to identify the species, location, and timelines necessary to prioritize resources that enable climate-smart management for stocks most vulnerable to climate change;
   b. Include a new section in DFO Science Advisory Reports or related documents titled "Climate Change Considerations" that explicitly summarizes available knowledge on ecosystem changes and the mechanisms for including relevant information in fisheries science and advice;
   c. Ensure that the effects of climate change are considered consistently in the science that informs fisheries management decisions through integrating environmental variability into both assessments and advice;
   d. Implement a long-term National Climate Change Adaptation Strategy that adopts Ecosystem-Based Fisheries Management Approaches and risk-based frameworks; and
   e. Implement management decisions and strategies for all forage fish that account for the role of forage fish in the ecosystem and incorporate ecosystem-based principles in line with the Policy on New Fisheries for Forage Species (DFO, 2009b).
4. **Count everything caught in a fishery** — including for recreational and bait purposes — and account for all sources of fishing in management decision-making. Specifically, DFO must:
   a. Increase the following efforts to implement the Fishery Monitoring Policy to ensure all commercial fisheries have sufficient monitoring to provide dependable estimates of fishing mortality from all sources:
      i. Provide dedicated operating resources to implement the policy over the next five years to ensure all federally-managed fish stocks and fisheries have their monitoring programs reviewed under its standards;
      ii. Advance monitoring activities identified in the Sustainable Fisheries Framework Work Plan, prioritizing stocks suspected of having issues with the quality of fishery monitoring data, and including at least five stocks for complete implementation in each DFO Region every year until the policy has been implemented for all major stocks; and
      iii. In 2022, publish an annual report to the Minister that provide performance measurements evaluating progress towards achieving the policy objectives for all major stocks, along with targets and timelines for nationwide implementation.

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 the checklist within the next year. This includes fulfilling ongoing commitments and those that have been delayed from previous work plans, as well as those scheduled to be completed this fiscal year.

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 as is stated by the *Fisheries Act* (DFO, 2009c). Many policy instruments have not been fully implemented, however, 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, 2021b). 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 (Government of Canada, 2018; Hutchings, 2016; Oceana Canada, 2018b), 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, 2020d), 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, 2020d), 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, 2020d), 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 primarily 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, 2021), 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, 2020e, 2021d, 2022d), or new additions to the SSF (DFO, 2016e, 2022e). 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, 2021 and July 1, 2022). 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

[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, n=180 stocks in 2020). The most recent results (2020) of the SSF includes 180 stocks, of which 136 are marine fish and invertebrates and 45 stocks are marine mammals, diadromous fish, or freshwater fish (DFO, 2022e). 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.

an update to an indicator, values from 2021 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 2022 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 (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 since 2020, but the information required was collected and updated in 2022 and is available in the indicators spreadsheet, available online (Oceana.ca/FisheryAudit2022). 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 (2020 for 2022 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 sixth 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 with an alpha level of 0.05 (prop.trend.test function in the "stats" package; R Core Team, 2019).

Results and Discussion

The 2022 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/FisheryAudit2022).[4] For a visualization of most indicators by DFO administrative region, see Appendix 1 of this document.

1. **Status:** In 2022, only 30.4 per cent (59 stocks) of Oceana Canada's marine fish and invertebrate index stocks can be confidently considered healthy. An additional 15.4 per cent (30 stocks) are in the cautious zone and 17.0 per cent (33 stocks) are in the critical zone, while the status of 37.1 per cent (72 stocks) is uncertain. In 2022, Oceana Canada published an analysis using data-limited assessment methods revealing that stocks with an "uncertain" status can be categorized according to the Sustainable Fisheries Framework into 30 per cent (n=30) healthy, 32 per cent (n=32) cautious, 22 per cent (n=22) critical and 15 per cent (n=15) "uncertain" (Schijns, 2022). Over the last six 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 ($p = 0.21$ $\chi^2 = 1.55$), cautious ($p = 0.94$ $\chi^2 < 0.01$), critical ($p = 0.15$ $\chi^2 = 1.90$), or uncertain ($p = 0.93$ $\chi^2 < 0.01$) across years.

[4] In 2022, 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 229 stocks in 2021 to 230 stocks in 2022. Results calculated using all stocks did not differ greatly from those using index stocks, and results using all stocks are available in Table 2.

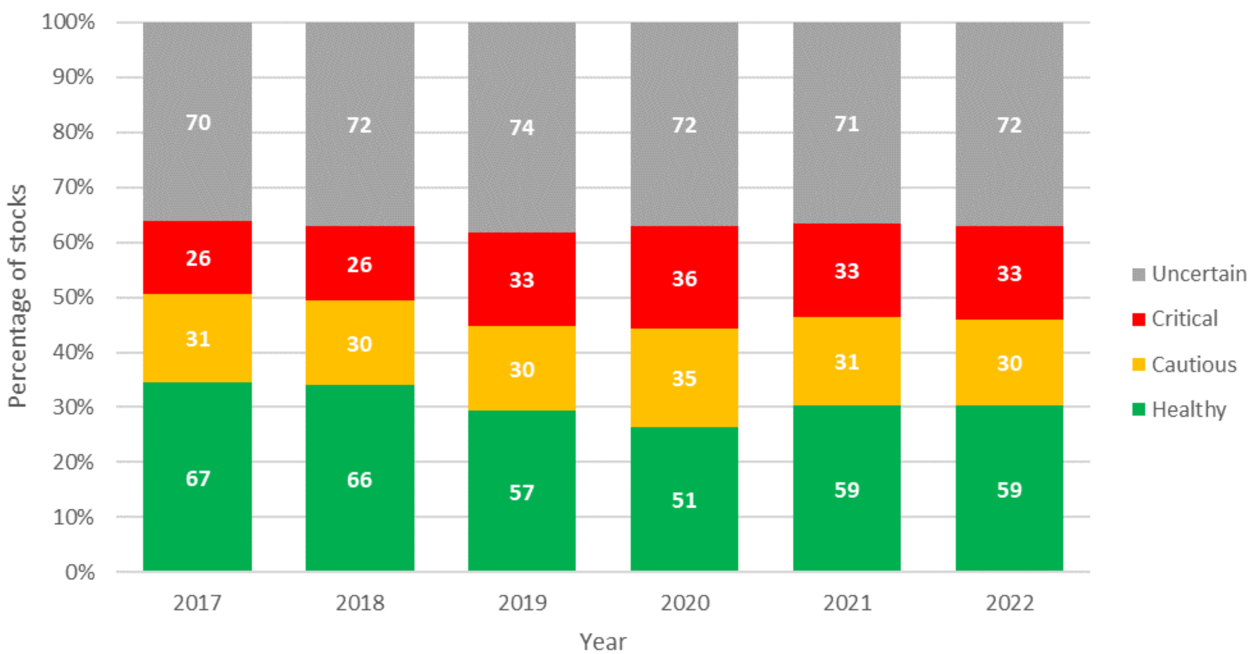

Figure 1. The percentage of Oceana Canada index stocks (n = 194 stocks) in each of the health status zones described in DFO's precautionary approach (PA) framework (DFO, 2009a) in 2017, 2018, 2019, 2020, 2021, and 2022. The number of stocks in each status zone is indicated in white font within the bars.

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 the disappearance of healthy forage fish in the Atlantic and increases in the number of invertebrate stocks with critical or cautious status in both the Atlantic and Pacific (Figures 2 and 3). Meanwhile, there have been notable improvements in the health status of rockfish and redfish in the Pacific (Figure 3). Within the limited number of Arctic Ocean stocks included in the dataset, all but one stock are evaluated as healthy (Figure 4).

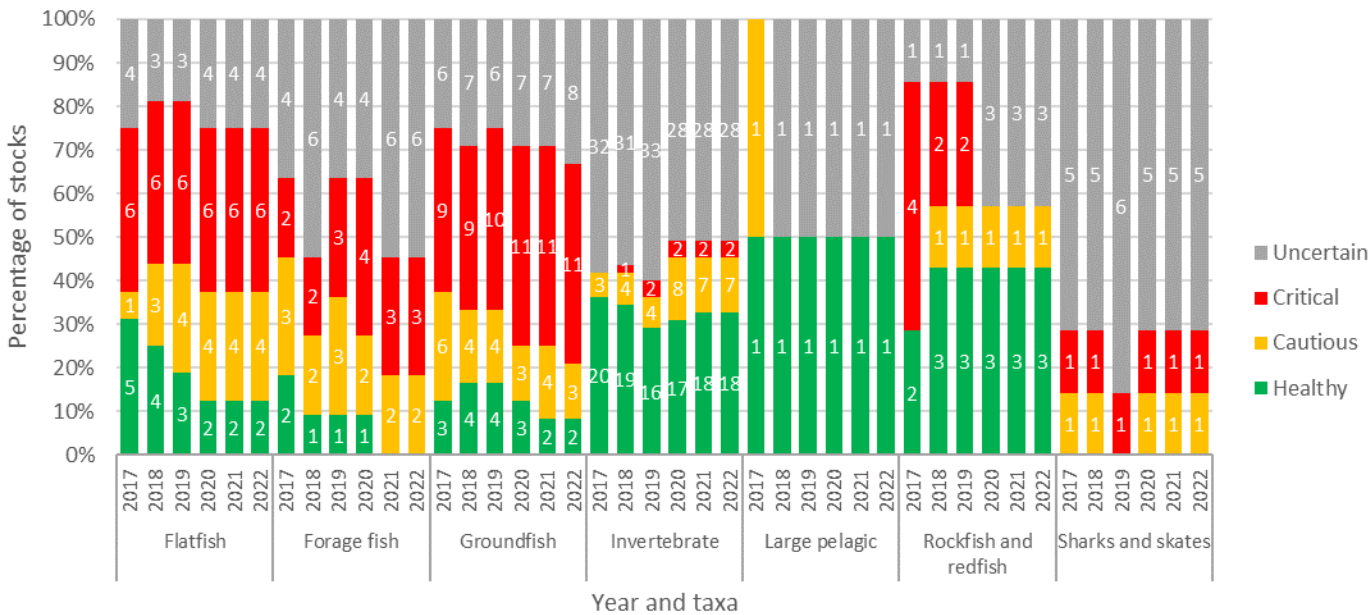

Figure 2. The percentage of Oceana Canada index stocks (n = 194) in each of the health status zones described in DFO's precautionary approach framework (DFO, 2009a), by taxa groups, in the ***Atlantic Ocean*** *in 2017, 2018, 2019, 2020, 2021, and 2022. The number of stocks in each year-taxa-status combination are reported in white font within the bars.*

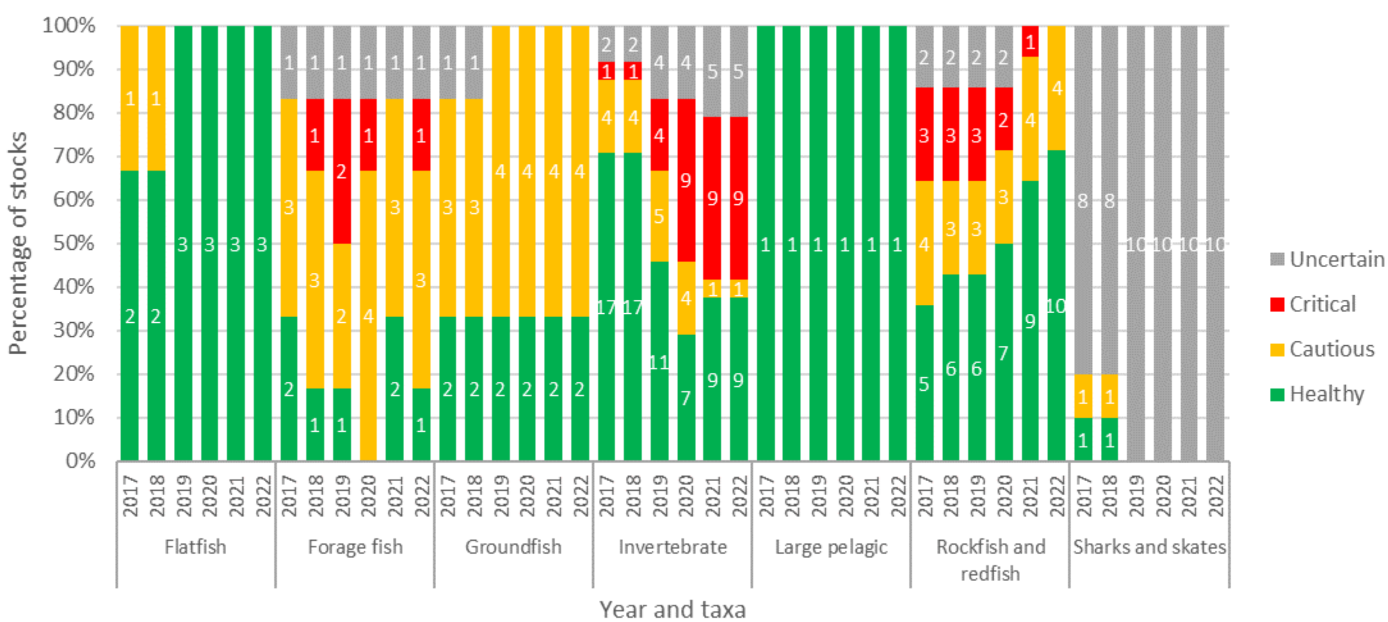

Figure 3. The percentage of Oceana Canada index stocks (n = 194) in each of the health status zones described in DFO's precautionary approach framework (DFO, 2009a), by taxa groups, in the ***Pacific Ocean*** *in 2017, 2018, 2019, 2020, 2021, and 2022. The number of stocks in each year-taxa-status combination are reported in white font within the bars.*

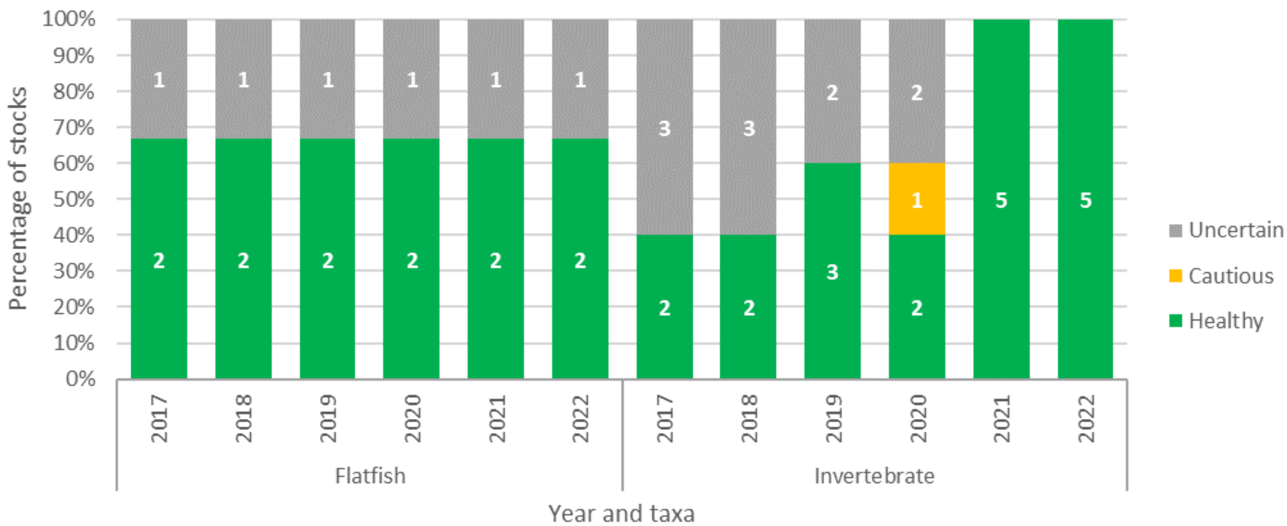

Figure 4. The percentage of Oceana Canada index stocks (n = 194) in each of the health status zones described in DFO's precautionary approach framework (DFO, 2009a), by taxa groups, in the ***Arctic Ocean*** *in 2017, 2018, 2019, 2020, 2021, and 2022. The number of stocks in each year-taxa-status combination are reported in white font within the bars.*

The 2022 status results reported here are slightly different from the most recent (2020) results of the DFO SSF, where 13.1 per cent (23 stocks) were critically depleted, 13.1 per cent (23 stocks) were in the cautious zone, 30.1 per cent (53 stocks) were in the healthy zone, and the status of 43.8 per cent (77 stocks) were uncertain (DFO, 2022e). 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., 2020 results were released in 2022).

The 2022 health statuses reported here are based on information available up to and including July 1, 2022 and are therefore informed by more recent information that was not available when the 2020 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 contains primarily economically important 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 2020 SSF in any form. Of these stocks not overlapping with the 2020 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. Further research on the ecological, cultural, and economic values of rebuilding "minor" stocks is needed, particularly in light of the new rebuilding regulations, which only apply to "major" stocks.

Unlike Oceana Canada's dataset, where little change was found in in the overall status of index stocks from 2017 to 2022, 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 30.1 per cent (53 of 176 stocks) in 2020. Given there was relatively little change in the percentage of stocks considered to be in the cautious zone (17.6 per cent in 2015 to 13.1 per cent in 2020) or critical zone (11.9 per cent in 2015 to 13.1 per cent in 2020), 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 43.8 per cent in 2020. The SSF questions have changed since 2015 and have required respondents to provide more details and evidence in support of status determinations, including specifying if it is based on peer-reviewed evaluation or expert opinion (DFO, 2018c, 2021c, 2022d). 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 stocks with uncertain status (41.6 per cent or 32 of 77 stocks).

2. **Stocks whose health status has shifted from uncertain to certain (or vice versa):** In 2022, no index stocks went from having an unknown/uncertain status in 2020 to having one assigned due to new information (Table 1). One stock underwent the reverse change (from cautious to uncertain), with Oceana Canada unable to determine their status with certainty.[5] This resulted in an overall increase in the total number stocks with uncertain status from to 71 in 2021 to 72 in 2022 (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 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 can be 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). This increase is unexpected, given the continued development of reference points and improved science capacity for stock assessments within the department in the last six years and given that the Oceana Canada index dataset shows little net change in the number of stocks with uncertain health status.

3. **Change in status:** In 2022, only 1.5 per cent of index stocks (3 of 194 stocks) had a different health status as compared to 2021 (Table 1). This is a departure from past years of the Fishery Audit (Table 1), which saw no significant trend in the percentage of stocks changing health status from one year to the next ($p = 1.0$, $\chi^2 < 0.01$). As outlined above, no stocks moved from uncertain to certain and just one stock underwent the reverse. In addition, one stock was identified as

[5] Cautious to uncertain: Haddock in 4X5Y

more at risk, declining from healthy levels to the critical zone.[6] One stock was identified as less at risk, moving from the critical zone to healthy zone.[7]

4. **Biomass/abundance known:** In 2022, 54.6 per cent of index stocks (106 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 less than past years, and there was a significant trend in the proportion of stocks with recent assessments ($p = 0.01$, $\chi^2 = 6.0$) (Figure 5, Table 1). Meanwhile, several stocks assessed in 2015 (i.e., seven 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 2022.

   Of the 45.4 per cent of index stocks (88 stocks) without complete assessments in the last five years, 27.1 per cent (23 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 66.5 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).

[6] Healthy to critical: Pacific herring in Haida Gwaii (Pacific QCI))

[7] Critical to healthy: bocaccio rockfish

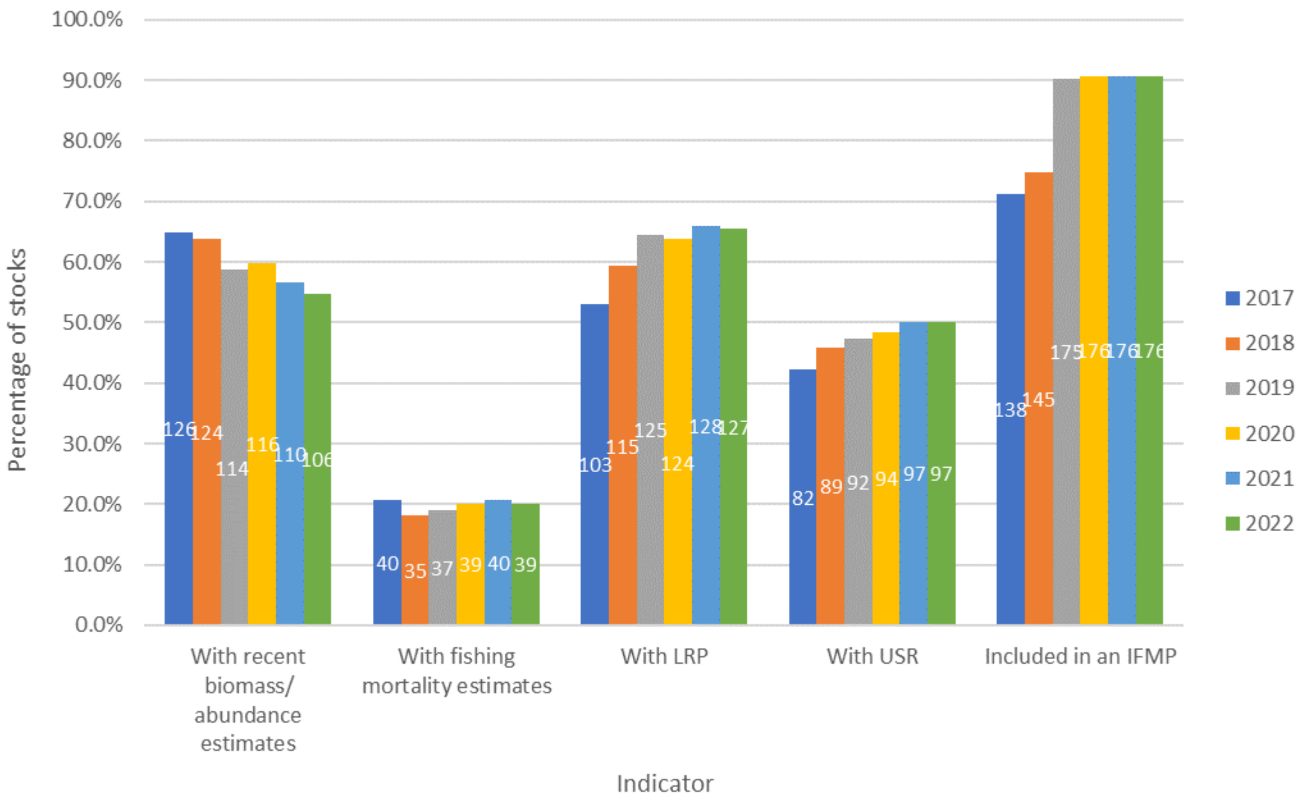

Figure 5. An assessment of how stocks perform on five indicators, based on Oceana Canada's index stock dataset (n = 194 stocks) in 2017, 2018, 2019, 2020, 2021, and 2022. The indicators included the percentage of stocks: 1) with a biomass/abundance estimate within the last five years; 2) with fishing 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 2022, 20.1 per cent of index stocks (39 of 194 stocks) had 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). This value is similar to past years, and there was no significant trend in the proportion of stocks with estimates of fishing mortality ($p = 0.80$, $\chi^2 = 0.07$). 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 three stocks have recent stock assessment reports that clearly indicate all suspected sources were accounted for,[8] while 10 additional stock assessment reports clearly indicate they at least partially account for sources

[8] Pacific halibut, winter skate in NAFO 4T, Atlantic cod in NAFO 3NO

other than reported commercial landings (e.g., by reconstructing uncertain catch histories or by using censored-catch models that assume landings data is biased).[9]

Several approaches have been developed to estimate natural mortality[10] within models and/or to allow it to vary (e.g., Turcotte et al., 2021). In 2022, 25.8 per cent of index stocks (50 of 194 stocks) have an estimate of natural mortality. Since the indicator was included in the 2018 Fishery Audit, there has been consistent improvement each year (Table 1) and a significant trend ($p = 0.002$, $\chi^2 = 9.94$), likely representing increased use of the new modelling approaches. In some mortality estimation approaches, only total mortality can be estimated. In 2022, 12.4 per cent of index stocks (24 of 194 stocks) have an estimate of total mortality. Since the indicator was first introduced in the 2018 Fishery Audit (Table 1) there has been a significant increasing trend ($p = 0.03$, $\chi^2 = 4.69$).

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. Having estimates of all sources of mortality would provide a better understanding of the environmental and fishing impacts on the population and surrounding ecosystem, enabling management decisions that are robust to uncertainties.

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 2022, the number of index stocks with exploitation rates or indices reported continues to be less than half (49.0 per cent; 95 of 194 stocks), but since this indicator was first included in the 2019 Fishery Audit (Table 1) there has been a significant trend ($p = 0.03$, $\chi2 = 4.67$).

If fishing mortality or exploitation rate estimates are not possible, it is important at a minimum to know the volume of fish landed in the commercial fishery. Oftentimes, reported landings exclude or underestimate catches from other targeted fisheries (i.e., recreational, Indigenous, bait) and non-directed activities (i.e., bycatch, discards) (Pauly, 1998). In 2022, 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 four years this indicator has been included (Table 1), with no significant trend ($p = 0.91$, $\chi2 = 0.01$).

[9] 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, yelloweye rockfish – outside population, capelin in NAFO 4RST, and white hake in NAFO 3NOPs

[10] Natural mortality (*M*) is a measure of mortality from causes other than fishing. It is calculated using empirical relationships between *M* and observable life-history characteristics. Age-structured population models (VPA and SCA) can be used to compare stationary and time-varying natural mortality parameters. In models that allow for non-stationarity in *M*, independent time series of *M* can be estimated for different age groups (e.g., Turcotte et al., 2021).

6. **Reference points:**
   Upper Stock Reference (USR) and Limit Reference Point (LRP)
   In 2022, 65.5 per cent of index stocks (127 of 194 stocks) have LRPs and 50.0 per cent (97 stocks) have USRs. The percentage of stocks with LRPs increased notably in earlier years, but the rate of improvement has slowed in recent years, and decreased slightly this year from 2021 (Table 1). Overall, there was a significant increase in the percentage of stocks with LRPs since 2017 ($p = 0.005$, $\chi2 = 7.80$). USR development has consistently increased year over year and stabilized in 2022 (Table 1) but at a slower rate than LRPs, resulting in no statistically significant trend in the percentage of stocks with USRs across years ($p = 0.08$, $\chi2 = 3.01$). 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 it is 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, 30.3 per cent or ten stocks are missing USRs; in the cautious zone, 26.7 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.

   Implementing reference points
   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). In 2021, DFO Science outlined key recommendations to support the development of rebuilding plans (DFO, 2021c), and management guidelines for writing rebuilding plans were published alongside the new regulations (DFO, 2022a). Additionally, in 2022, DFO held a workshop on "Science Advice on Guidance for Limit Reference Points under the Fish Stocks Provisions," to develop a set of best practices for estimating LRPs and stock status across the data spectrum (DFO, 2022c). The policy is clear that LRPs are to be established by fisheries scientists, and now there are guidelines on how management should use them.

   However, similar guidance is missing for USR and target reference points, making the role of scientists in establishing USRs and target reference points less clear (DFO, 2009a). Progress with LRPs has shown significant improvement over the last six 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). It is therefore necessary to develop more science-based reference points and to provide additional guidelines for how to interpret them to maintain stocks in the healthy zone.

   Reference points by taxonomic group

When reference point development is examined by taxa group, it is apparent that most taxa groups except sharks and skates have had proportional increases in reference point presence (Figure 6A, 6B). However, there has not been much change over recent years (2020-2022): the invertebrate group has an additional two LRPs and three USRs, but rockfish and redfish have lost both LRP and USR information for index stocks and groundfish lost an USR. 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 39.2 per cent of index stocks, more than any other taxa group except sharks and skates. Similarly, 48.8 per cent of invertebrate stocks are missing USRs. Benthic invertebrate populations are frequently spatially complex and more susceptible than most marine fish species to spatially or quality-based serial depletions against which generic reference points based on dynamic pool models offer little protection (Smith et al., 2012). As well, there is commonly uncertainty regarding the degree of overlap between management and assessment units. In such cases, refining spatially based limits and targets for fisheries may be more appropriate. Spatial approaches and methods for addressing scale mismatch between units are under development.

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).

A

B)

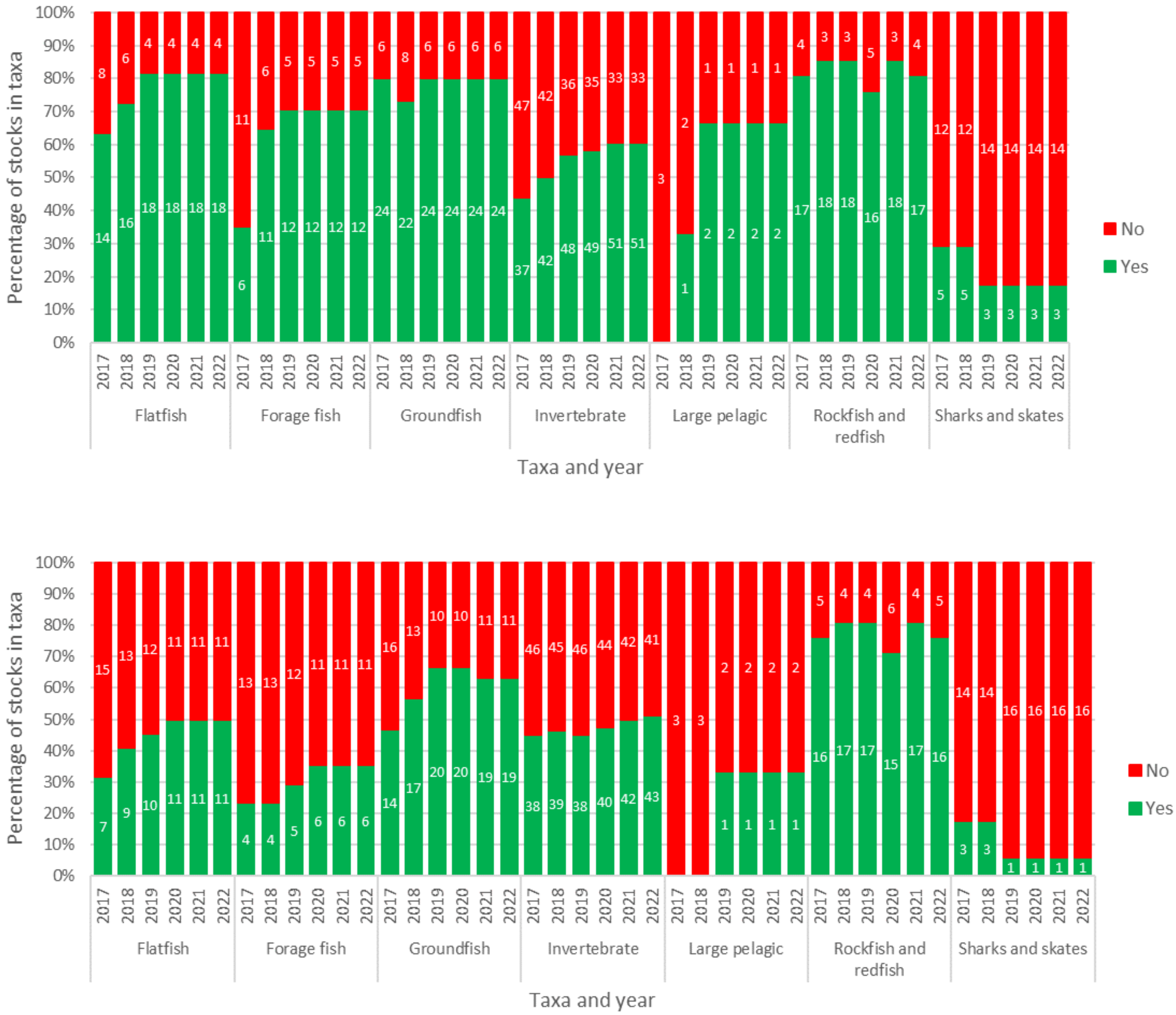

Figure 6. The percentage of Oceana Canada index stocks (n = 194) in each taxa groups with and without (A) Limit Reference Points (LRPs) and (B) Upper Stock References (USRs) in place in 2017, 2018, 2019, 2020, 2021, and 2022. The number of stocks in each year-taxa-category combination are reported in white font within the bars.

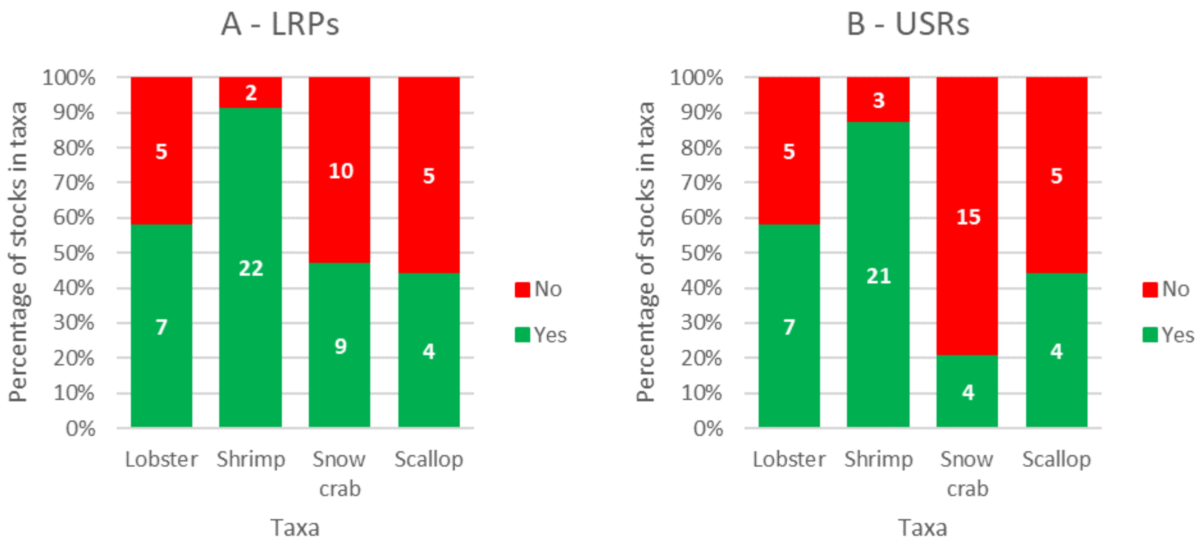

Figure 7. The percentage of Oceana Canada index stocks (n = 194) in high-value invertebrate taxa (lobster, shrimp, snow crab, and scallops) with and without (A) Limit Reference Points (LRPs) and (B) Upper Stock References (USRs) in place in 2022. The number of stocks in each taxa-category combination are reported in white font within the bars.

Removal Reference

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 means they may not always represent unacceptable stock states associated with "overfishing" as it is recognized internationally (DFO, 2021a). 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, 2021a). Both situations appear to be common. When the answers defining the removal reference values are examined in the most recent (2020) results of the DFO SSF (DFO, 2022e), the inconsistent interpretation of policy requirements becomes clear. Some respondents cite target and limit functions with values based on F_{MSY}; some outline how harvest control rules work (which may or may not involve stock status zones, a separate question in the SSF); and some indicate that recent quota decisions by management serve as the removal reference. Meanwhile, few stocks even have them in place, with the latest results (2020) of the DFO SSF indicating less than half of the "major" stocks have a removal reference for the healthy zone (40.9 per cent or 72 of 176 stocks), less than a third have a removal reference for the critical zone (30.6 per cent) and even fewer have one for the cautious zone (26.7 per cent) (DFO, 2022e).

This low implementation rate and inconsistent application of policy regarding removal references (DFO, 2021a) — 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, 2021a). 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, 2021a; FAO, 2020; Froese and Proelss, 2012). Furthermore, when reporting fishing mortality status relative to the removal reference, the probability, or qualitative likelihood, that fishing mortality is greater than the removal reference should be included (DFO, 2021c). 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 2022, 90.7 per cent of index stocks (176 of 194 stocks) were included in an IFMP. While there was no change in this indicator over recent years (2020–2022), 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 since 2017 ($p < 0.001$, $\chi 2 = 45.9$). This trend is likely driven largely by the notable increase in 2019 that was due to the publication of several new multi-stock IFMPs. However, there are numerous IFMPs that include multiple species with different life histories and sensitivities that have not been assessed. Since 2019, progress on IFMP development has been minimal, as most index stocks are already included in IFMPs.

   In 2022, 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:**
   At-sea observer or electronic monitoring

In 2022, 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, albeit unchanged from 2021, has changed over the past six 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) ($p < 0.001$, $\chi 2 = 26.9$). 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 IFMPs and the availability of those 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 further documentation on targeted at-sea observer coverage levels (Beauchamp et al., 2019).

Logbooks

In 2022, most index stocks require the use of logbooks (96.9 per cent; 188 of 194 stocks) (Figure 8, Table 1). However, the requirement to record the entire catch (targeted species and bycatch) is clearly indicated for only 38.7 per cent of index stocks (75 of 194 stocks); 58.2 per cent (113 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 3.1 per cent of stocks (six 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) ($p < 0.001$, $\chi 2 = 47.1$). 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.

Dockside monitoring

In 2022, 89.1 per cent of index stocks (173 of 194 stocks) have fisheries that require some level of dockside monitoring of landings (Figure 8, Table 1). Of these 173 stocks requiring dockside monitoring, 125 stocks have fisheries that are required to have 100 per cent of landings verified by a certified independent dockside monitor. A further 48 stocks have dockside monitoring requirements, but the level of monitoring is varied or unknown. The use of dockside monitoring in the fisheries of 10.8 per cent of stocks (21 stocks) is uncertain. This indicator has changed over the past six 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) ($p < 0.001$, $\chi 2 = 26.4$). 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.

Vessel monitoring system

In 2022, 61.9 per cent of index stocks (120 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 (21.6 per cent or 42 of 194 stocks) do not require any vessels to be electronically monitored,[11] while the use of this tool is uncertain for 16.5 per cent of index stocks (32 of 194 stocks). Of the 120 stocks with some use of VMS, 74 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 ($p = 0.60$, $\chi 2 = 0.28$).

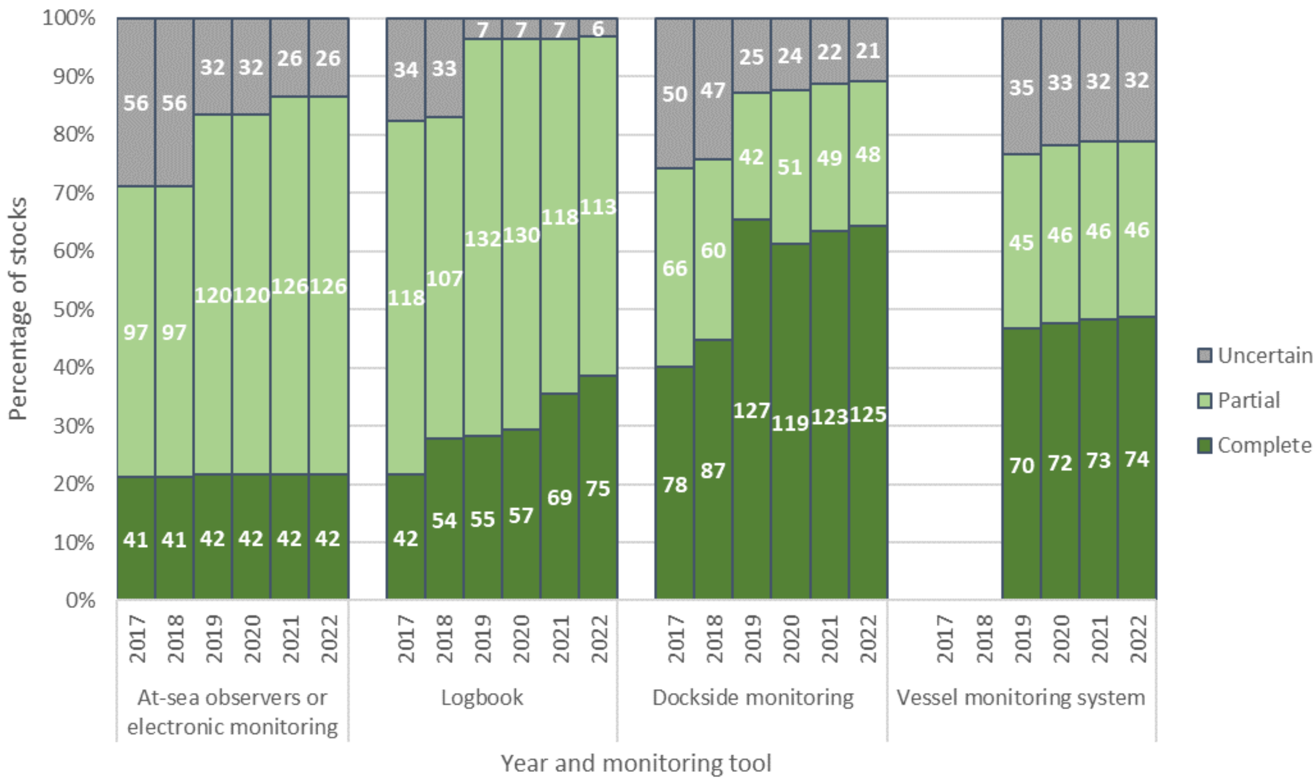

Figure 8. The percentage of stocks in Oceana Canada's index stock dataset (n = 194 stocks) in 2017, 2018, 2019, 2020, 2021, and 2022 that have requirements for the following catch monitoring tools in place: 1) at-sea observer or electronic (i.e., video) monitoring; 2) logbooks recording the entire catch (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

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

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 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 on a draft national fishery monitoring policy (DFO, 2018a), not having a national policy on catch reporting and fishery monitoring until now has led to:

- Inconsistent monitoring and reporting requirements with no explanation for the differences;
- Concerns about the adequacy and quality of data from fishery monitoring programs; and
- An absence of national goals with which to assess performance.

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 and species caught as bycatch; the risk of non-compliance with the rules; and 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 and measurable fishery monitoring objectives to be included in IFMPs, along with the monitoring necessary to achieve them. This would be an improvement over the current situation, in which no stocks in the index dataset have specific and measurable fishery monitoring objectives in their IFMP (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 three years ago, it has yet to be fully implemented in any fishery. However, there are encouraging signs of progress over the past two years, as the policy is now included in the Sustainable Fisheries Framework work plan, which outlines priorities for DFO (DFO, 2021b) but only includes a few stocks. In the 2022/23 Sustainable Fisheries Framework work plan, most activities are expected to be completed by the end of the 2022/2023 fiscal year (DFO, 2022d). If the policy is effectively implemented, 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 2022, rebuilding plans are in place for 18.2 per cent of index stocks in the critical zone (six of 33 stocks) and for 6.2 per cent of all index stocks (12 of 194 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 ($p = 0.15$, $\chi 2 = 2.07$). This is despite a policy requirement for well 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, 2020d), 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, as the first batch of stocks was prescribed under the Fish Stock Provisions in April 2022 and consists of 16 stocks (including three Pacific salmon management units) that are below LRPs and require rebuilding plans to be developed within 24 months.

   Since the first batch was prescribed, two stocks in the Pacific are now considered to have grown above their respective LRPs (bocaccio rockfish and yelloweye rockfish, inside waters). Bocaccio rockfish growth is attributed to a large recruitment event while yelloweye's change in stock status is due to an updated model structuring choice. Given how rapidly stocks can move out of the critical zone, they should continue to be managed with precaution to ensure that their growth was not simply a short-term fluctuation and that the populations maintain full health for the long-term future. Three critical stocks in the first batch (Atlantic cod in 2J3KL, Atlantic mackerel, northern shrimp in SFA 6) have existing rebuilding plans (DFO, 2018d; 2020b; 2020c). However, the plans are insufficient in that they don't meet international standards (which require limit *and target* reference points)[12] and even DFO's own policy guidance (DFO, 2013; FAO, 2020). For example, they lack target abundances in the healthy zone or scientifically informed timelines of how long rebuilding might take (Levesque et al., 2021; Hutchings et al., 2021). The existing plans will need to be revised to comply with the rebuilding regulations. Therefore, by April 2024 a net increase of 11 new rebuilding plans is expected.

   According to the 2021/22 DFO Sustainable Fisheries Framework Work Plan, eight rebuilding plans were expected to be completed by the end of March 2022 (DFO, 2021b). None have been published on time, and with the 2022/23 work plan, all deadlines were extended following listing under the Fish Stock Provisions to either 2022/2023 or 2023/2024. While the COVID-19 pandemic certainly impacted progress in the past two years, it has now been six years since the initial work plan was created (CESD, 2016; DFO, 2017b). Rebuilding plan development is a significant workload commitment, 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

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

rebuilding plans leading up to the pandemic (Archibald et al., 2021a), likely contributing to DFO's inability to meet its prior commitments. An additional cause of delay may have been the process of reviewing, finalizing and approving the new rebuilding plan regulations.

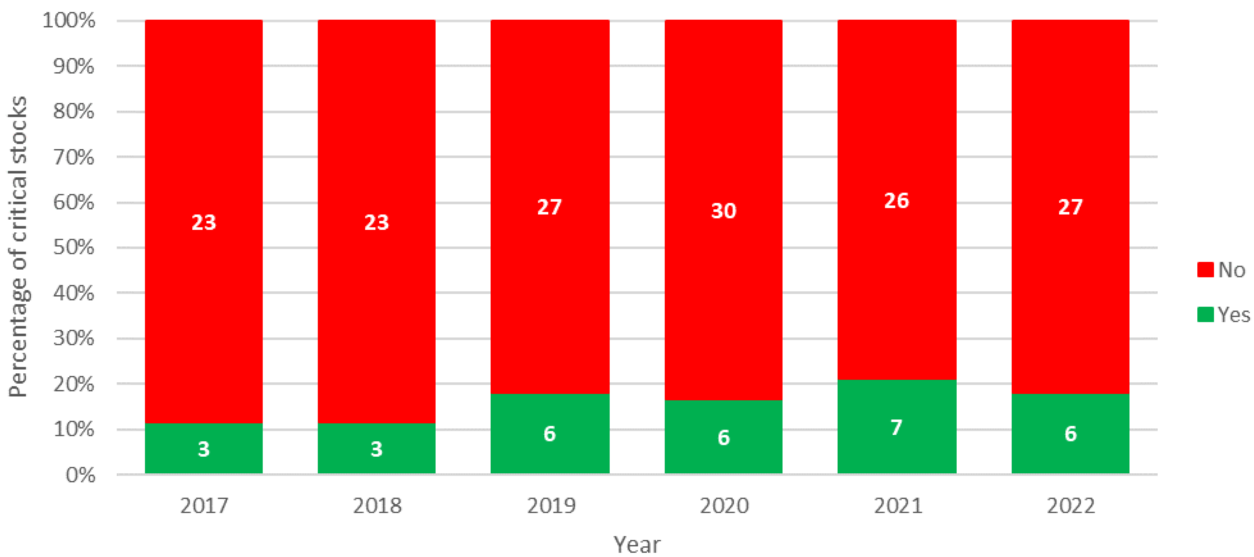

Figure 9. The percentage of Oceana Canada index stocks (n = 194 stocks) in the critical zone and included in rebuilding plans in 2017, 2018, 2019, 2020, 2021, and 2022. The number of stocks in each year-category combination is reported in white font within the bars.

This year, only one new rebuilding plan was published. The rebuilding plan for witch flounder in NAFO area 2J3KL[13] was initially included in a previous year's fiscal year workplan for development, with a deadline for completion by end of 2020/2021. In July 2022, the plan was completed. The plan was developed in consultation with rights-holders and stakeholders, and it includes abundance targets in the healthy zone, interim milestones associated with growth to the mid-cautious zone, a schedule for periodic review, and harvest strategies and decision rules that halt fishing while the stock is below the LRP. However, the plan as it stands is missing key components (Schijns and Rangeley, 2022c), including those in DFO's existing rebuilding plan guidelines (DFO, 2021c), and fails to meet the full legal requirements and intent of the *Fisheries Act* rebuilding regulations (Public Works and Government Services Canada, 2021).

The plan lacks an analytical population assessment model and biomass projections needed to determine timeframes to achieve short- and long-term objectives. Without these projections, managers have little information available to inform realistic expectations (Shelton et al., 2007). This missing analysis also precludes the ability to estimate the probability of at least 75 per cent

[13] Witch flounder in NAFO area 2J3KL is not included in the Fishery Audit index stock list (n=194) since it was a 2018 addition from the departmental workplan. It is therefore not included in the total number of critical stocks with rebuilding plans. However, it is included in the comprehensive stock list (n=230), and the values are available in Table 2.

that the target abundance will be met within the timeframe. In addition, there are no simulations of catch scenarios by DFO science with independent peer review to ensure that it has an acceptable robustness to uncertainty, meets performance expectations, has a high probability of achieving management objectives, and conforms to DFO policy.

Since this stock is not yet prescribed under the Fish Stock Provisions, it is not legally required to contain all components of the rebuilding regulations. However, it is expected that all critically depleted stocks will be prescribed in future batches. Once the stock is prescribed, DFO will have 24 months to address the missing requirements and revise the plan. It is therefore more effective to create a robust rebuilding plan that complies with the regulations today, avoiding the need for future revisions.

Recommendations

In the year ahead, Oceana Canada calls on DFO to leverage the knowledge and policy tools already available to deliver on commitments and implement real change on the water. This means:

1. **Prescribe all remaining stocks in the critical and cautious zones** to the Fish Stocks provisions in the *Fisheries Act* and make management decisions that are consistent with the rebuilding regulations.
2. **Meaningfully engage with Indigenous communities and organizations** to make decisions about wild fish that are informed by Indigenous Knowledge Systems, as well as the best available science.
3. **Integrate ecosystem impacts into fisheries decisions,** prioritizing rebuilding depleted forage fish and addressing vulnerabilities to climate change.
4. **Count everything caught in a fishery** — including for recreational and bait purposes — and make decisions that account for all sources of fishing mortality.

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/FisheryAudit2022 within the next year. This includes fulfilling ongoing commitments or those that have been delayed from previous work plans (Archibald et al., 2021a).

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Tables

Table 1. The percentage and number of marine fish and invertebrate[14] stocks for each indicator in the 2017, 2018, 2019, 2020, 2021, and 2022 index stock datasets (n = 194 stocks; the same stocks in each year).

Indicator	Details	2017	2018	2019	2020	2021	2022
	Number of stocks	194	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	30.4% / 59
	%/# of "cautious" stocks	16.0% / 31	15.5% / 30	15.5% / 30	18.0% / 35	16.0% / 31	15.5% / 30
	%/# of "critical" stocks	13.4% / 26	13.4% / 26	17.0% / 33	18.6% / 36	17.0% / 33	17.0% / 33
	%/# of "uncertain" stocks	36.1% / 70	37.1% / 72	38.1% / 74	37.1% / 72	36.6% / 71	37.1% / 72
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	0
	# of stocks that went from known status to uncertain status	Baseline year	6	8	4	4	1
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†	1.5% / 3†
	# of stocks whose status improved	Baseline year	5	2	5	9	1
	# of stocks whose status worsened	Baseline year	6	10	11	3	1
	%/# of stocks whose status remained the same	Baseline year	89.2% / 173	86.6% / 168	86.6% / 168	89.2% / 173	98.5% / 191
4. Biomass/abundance known	%/# of stocks with recent (≤ 5 years) biomass/abundance estimates	64.9% / 126	63.9% / 124	58.8% / 114	59.8% / 116	56.7% / 110	54.6% / 106
	%/# of stocks without recent assessments that have had interim updates of indicators since their last complete assessment	Not available — new indicator	Not available — new indicator	22.5% / 18	25.6% / 20	25.0% / 21	27.1% / 23

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

Indicator	Details	2017	2018	2019	2020	2021	2022
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	20.1% / 39
	# of stocks that clearly incorporate all sources of F in their estimation	Not available – new indicator	Not available – new indicator	2	2	2	3
	%/# of stocks with natural mortality (M) known	Not available – new indicator	14.4% / 28	16.0% / 31	19.6% / 38	21.6% / 42	25.8% / 50
	%/# of stocks with total mortality (Z) known	Not available – new indicator	6.7% / 13	8.8% / 17	11.3% / 22	12.4% / 24	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	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	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	65.5% / 127
	%/# of stocks with upper stock reference points	42.3% / 82	45.9% / 89	47.4% / 92	48.5% / 94	50.0% / 97	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	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 – 100% 21.6% / 42

Indicator	Details	2017	2018	2019	2020	2021	2022
		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	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	Uncertain 13.4% / 26
	%/# of stocks with logbooks	Yes — and bycatch species are recorded 21.6% / 42	Yes — and bycatch species are recorded 27.8% / 54	Yes — and bycatch species are recorded 28.4% / 55	Yes — and bycatch species are recorded 29.4% / 57	Yes — and bycatch species are recorded 35.6% / 69	Yes — and bycatch species are recorded 38.7% / 75
		Yes — but unclear if bycatch species are recorded 60.8% / 118	Yes — but unclear if bycatch species are recorded 55.2% / 107	Yes — but unclear if bycatch species are recorded 68.0% / 132	Yes — but unclear if bycatch species are recorded 67.0% / 130	Yes — but unclear if bycatch species are recorded 60.8% / 118	Yes — but unclear if bycatch species are recorded 58.2% / 113
		Uncertain 17.5% / 34	Uncertain 17.0% / 33	Uncertain 3.6% / 7	Uncertain 3.6% / 7	Uncertain 3.6% / 7	Uncertain 3.1% / 6
	%/# 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 — 100% 64.4% / 125
		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	Yes — coverage varies or level is uncertain 24.7% / 48
		Uncertain 25.8% / 50	Uncertain 24.2% / 47	Uncertain 12.9% / 25	Uncertain 12.4% / 24	Uncertain 11.3% / 22	Uncertain 10.8% / 21
	%/# of stocks with electronic vessel monitoring systems	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	Yes — 100% of vessels always 38.1% / 74

Indicator	Details	2017	2018	2019	2020	2021	2022
	(VMS)/automated identification systems (AIS)	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	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	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	Uncertain 16.5% / 32
		Not available — new indicator	Not available — new indicator	No 22.7% / 44	No 22.2% / 43	No 22.2% / 43	No 21.6% / 42
	%/# 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	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	18.2% / 6

† 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[15] for each indicator in 2017 (n = 194 stocks), 2018 (n = 214 stocks), 2019 (n = 222 stocks), 2020 (n = 226 stocks), 2021 (n = 229 stocks), and 2022 (n=230) 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	2022
	Number of stocks	194	214	222	226	229	230
1. Status	%/# of “healthy” stocks	34.5% / 67	31.8% / 68	27.5% / 61	24.8% / 56	27.9% / 64	27.8% / 64
	%/# of “cautious” stocks	16.0% / 31	14.5% / 31	14.4% / 32	16.4% / 37	15.3% / 35	14.8% / 34
	%/# of “critical” stocks	13.4% / 26	13.1% / 28	16.2% / 36	17.3% / 39	15.7% / 36	15.7% / 36
	%/# of “uncertain” stocks	36.1% / 70	40.7 % / 87	41.9 % / 93	41.6% / 94	41.0% / 94	41.7% / 96
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	0
	# of stocks that went from known status to uncertain status†	Baseline year	6	8	4	4	1
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††	1.3% / 3††
	# of stocks whose status improved †	Baseline year	5	2	5	9	1
	# of stocks whose status worsened †	Baseline year	6	10	11	3	1
	%/# of stocks whose status remained the same†	Baseline year	89.2% / 173††	87.4% / 187††	88.3% / 196††	90.3% / 204††	98.7% / 228††
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	56.8% / 130	54.3% / 125
	%/# of stocks without recent assessments that have had interim updates of indicators since their last complete assessment	Not available – new indicator	Not available – new indicator	21.1% / 19	22.0% / 20	22.2% / 22	23.8% / 25

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

Indicator	Details	2017	2018	2019	2020	2021	2022
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	18.7% / 43
	# of stocks that clearly incorporate all sources of F in its estimation	Not available – new indicator	Not available – new indicator	2	2	2	4
	%/# of stocks with natural mortality (M) known	Not available – new indicator	14.5% / 31	17.1% / 38	19.9% / 45	21.8% / 50	25.7% / 59
	%/# of stocks with total mortality (Z) known	Not available – new indicator	6.1% / 13	8.1% / 18	10.6% / 24	11.8% / 27	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	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	97.4% / 224
6. Reference points	%/# of stocks with limit reference points	53.1% / 103	57.0% / 122	61.3% / 136	60.2% / 136	62.0% / 142	61.3% / 141
	%/# of stocks with upper stock reference points	42.3% / 82	43.0% / 92	44.1% / 98	44.7% / 101	45.4% / 104	45.2% / 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	87.8% / 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% 21.8% / 50	Yes – 100% 21.7% / 50

Indicator	Details	2017	2018	2019	2020	2021	2022
		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	Yes — coverage varies or level is uncertain 62.2% / 143
		Uncertain 28.9% / 56	Uncertain 29.9% / 64	Uncertain 18.0% / 40	Uncertain 18.1% / 41	Uncertain 15.7% / 36	Uncertain 16.1% / 37
	%/# of stocks with logbooks	Yes — and bycatch species are recorded 21.6% / 42	Yes — and bycatch species are recorded 27.1% / 58	Yes — and bycatch species are recorded 28.8% / 64	Yes — and bycatch species are recorded 30.5% / 69	Yes — and bycatch species are recorded 36.2% / 83	Yes — and bycatch species are recorded 38.7% / 89
		Yes — but unclear if bycatch species are recorded 60.8% / 118	Yes — but unclear if bycatch species are recorded 55.1% / 118	Yes — but unclear if bycatch species are recorded 67.1% / 149	Yes — but unclear if bycatch species are recorded 65.5% / 148	Yes — but unclear if bycatch species are recorded 59.4% / 136	Yes — but unclear if bycatch species are recorded 57.0% / 131
		Uncertain 17.5% / 34	Uncertain 17.8% / 38	Uncertain 4.1% / 9	Uncertain 4.0% / 9	Uncertain 4.4% / 10	Uncertain 4.3% / 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 — 100% 61.3% / 141
		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	Yes — coverage varies or level is uncertain 25.2% / 58
		Uncertain 25.8% / 50	Uncertain 26.6% / 57	Uncertain 14.0% / 31	Uncertain 13.7% / 31	Uncertain 13.5% / 31	Uncertain 13.5% / 31
	%/# of stocks with electronic vessel monitoring systems	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	Yes — 100% of vessels always 35.7% / 82

Indicator	Details	2017	2018	2019	2020	2021	2022
	(VMS)/automated identification systems (AIS)	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	Yes — some vessels but not all vessels 19.1% / 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	Yes — but uncertain if all vessels or all times 6.1% / 14
		Not available — new indicator	Not available — new indicator	Uncertain 19.8% / 44	Uncertain 19.0% / 43	Uncertain 19.7% / 45	Uncertain 19.6% / 45
		Not available — new indicator	Not available — new indicator	No 20.7% / 46	No 19.9% / 45	No 19.7% / 45	No 19.6% / 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	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	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,[16] 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).

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

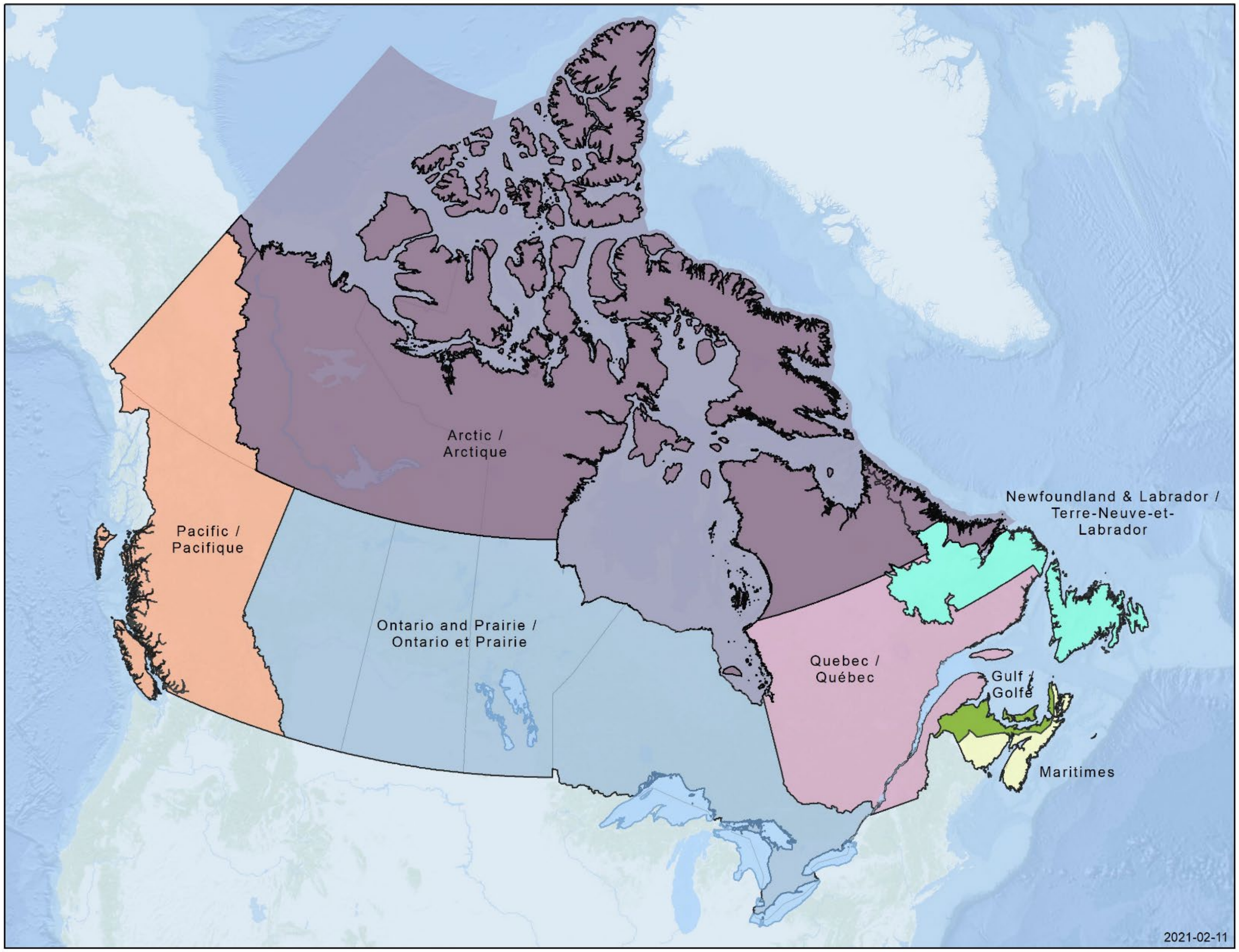

Figure A1. Map of DFO administrative regions. Modified from: [*https://www.dfo-mpo.gc.ca/about-notre-sujet/organisation-eng.htm*](https://www.dfo-mpo.gc.ca/about-notre-sujet/organisation-eng.htm)

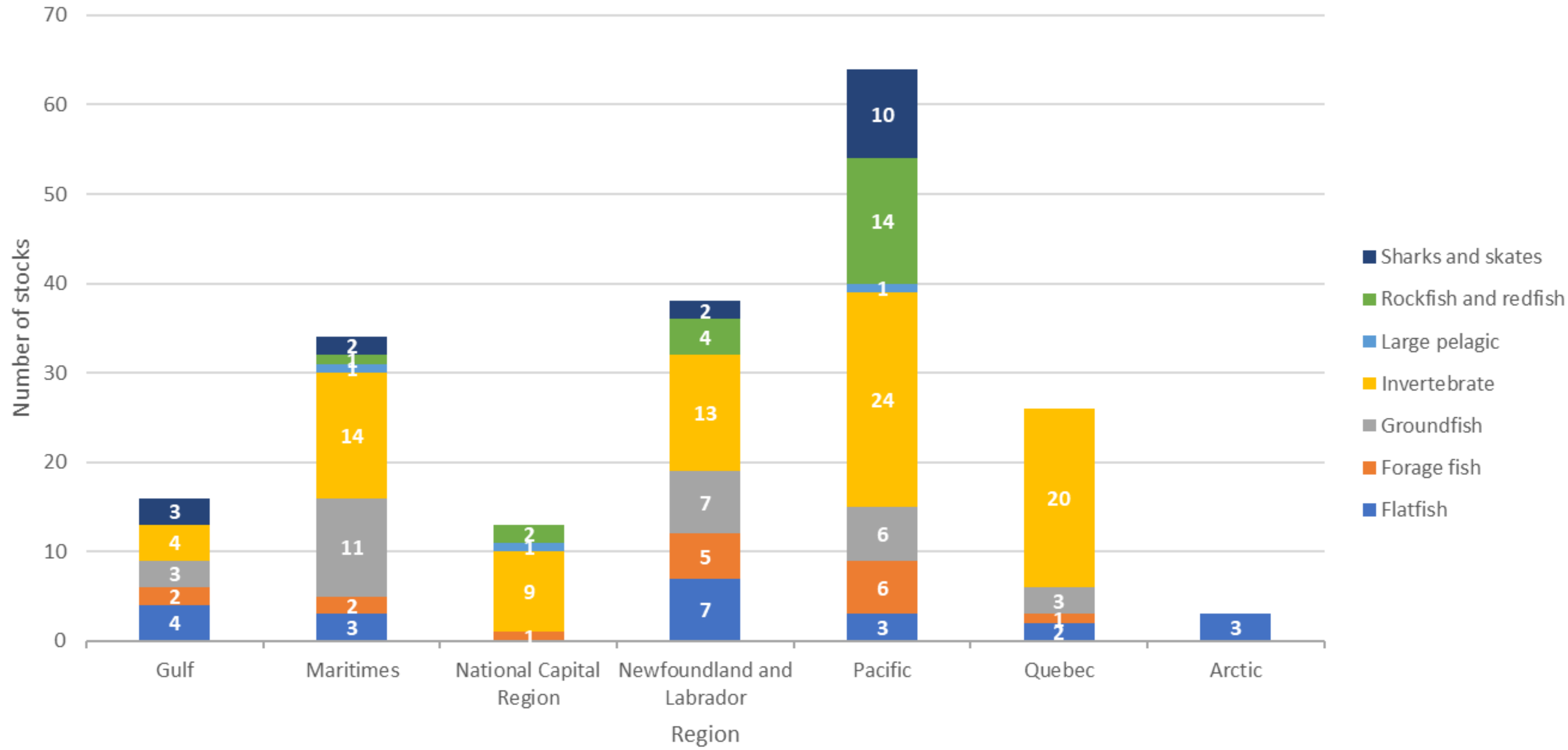

Figure A2. The number of Oceana Canada index stocks (n = 194 stocks) within each DFO administrative region and taxa group. The number of stocks in each region-taxa combination is reported in white font within the bars.

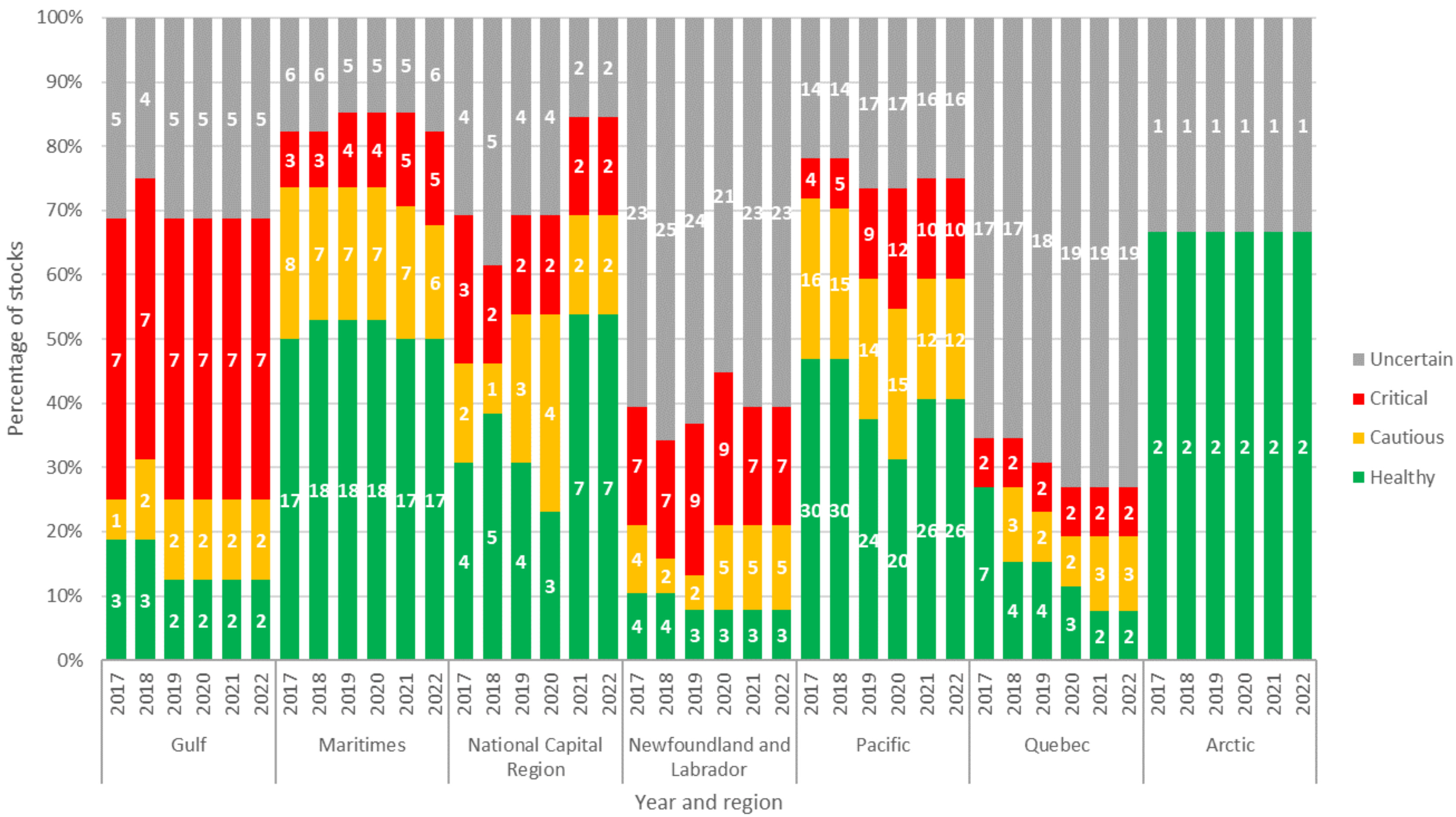

Figure A3. The percentage of Oceana Canada index stocks (n = 194 stocks) in each of DFO's health status zones defined under the precautionary approach (PA) framework in each DFO administrative region in 2017, 2018, 2019, 2020, 2021, and 2022. The number of stocks in each year-region-status combination is reported in white font within the bars.

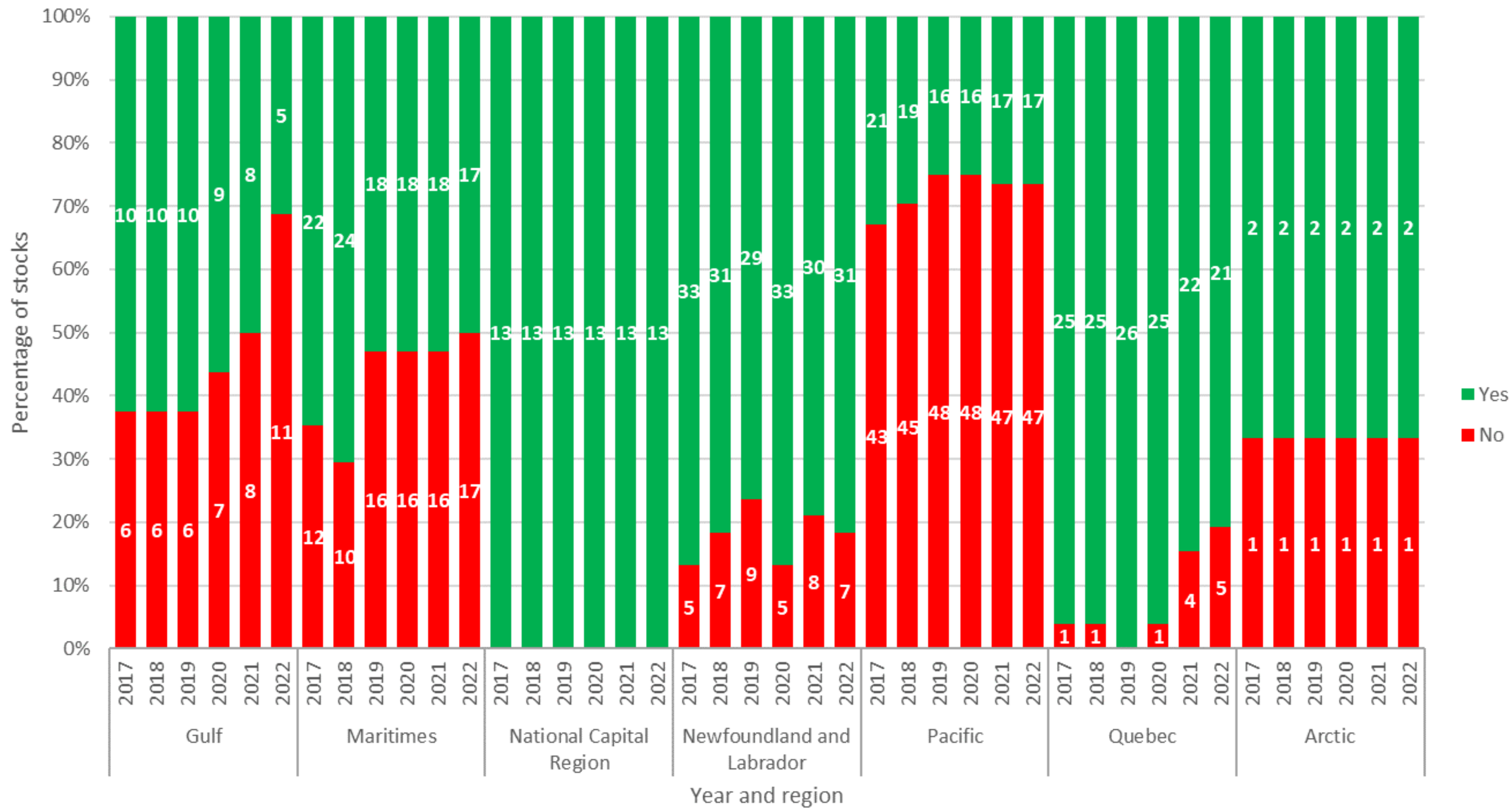

Figure A4. The percentage of Oceana Canada index stocks (n = 194 stocks) with recent (≤ 5 years old) biomass or abundance estimates in each DFO administrative region in 2017, 2018, 2019, 2020, 2021, and 2022. The number of stocks in each year-region-category combination is reported in white font within the bars.

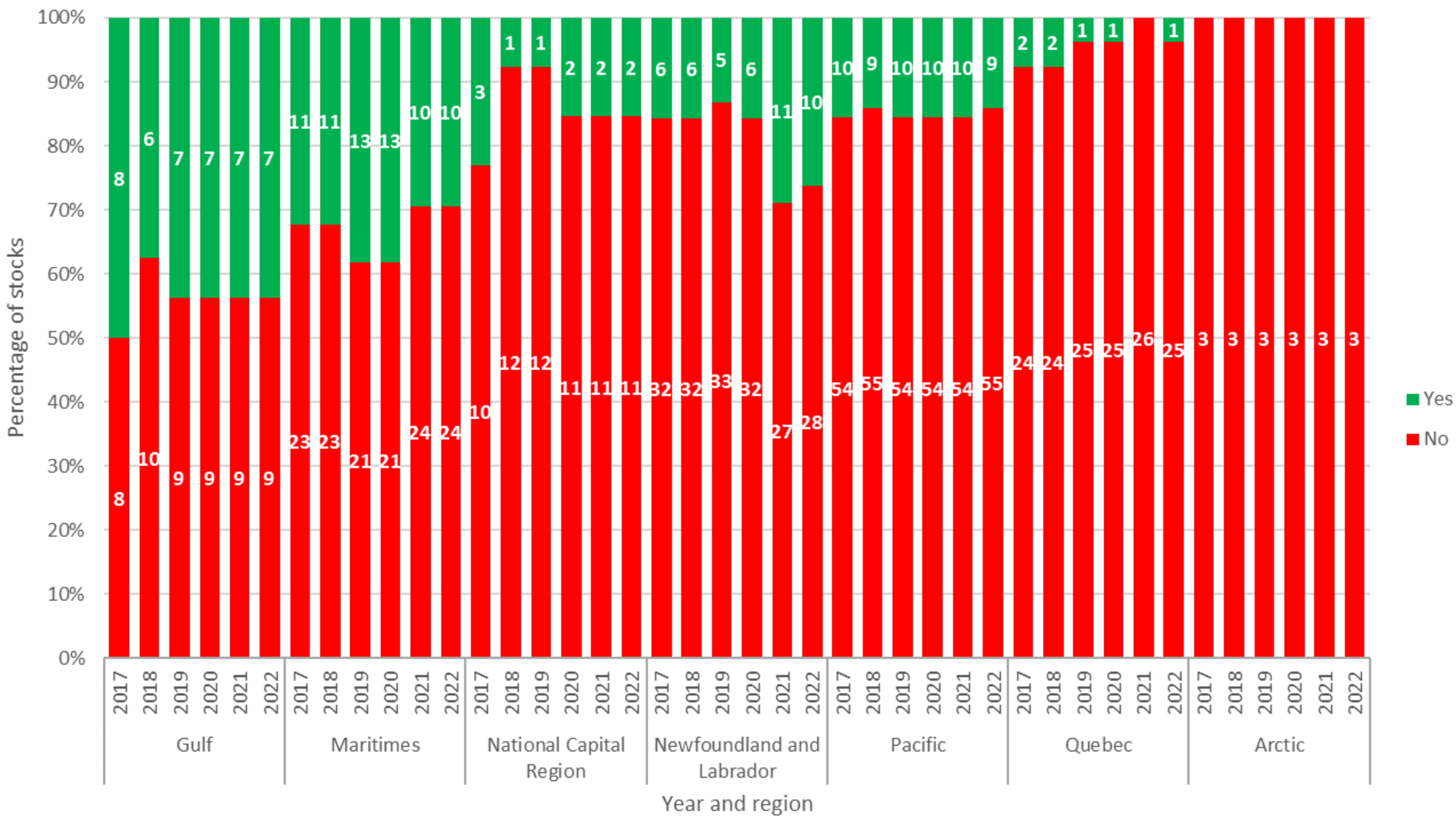

Figure A5. The percentage of Oceana Canada index stocks (n = 194 stocks) with fishing mortality (F) estimates in each DFO administrative region in 2017, 2018, 2019, 2020, 2021, and 2022. The number of stocks in each year-region-category combination is reported in white font within the bars.

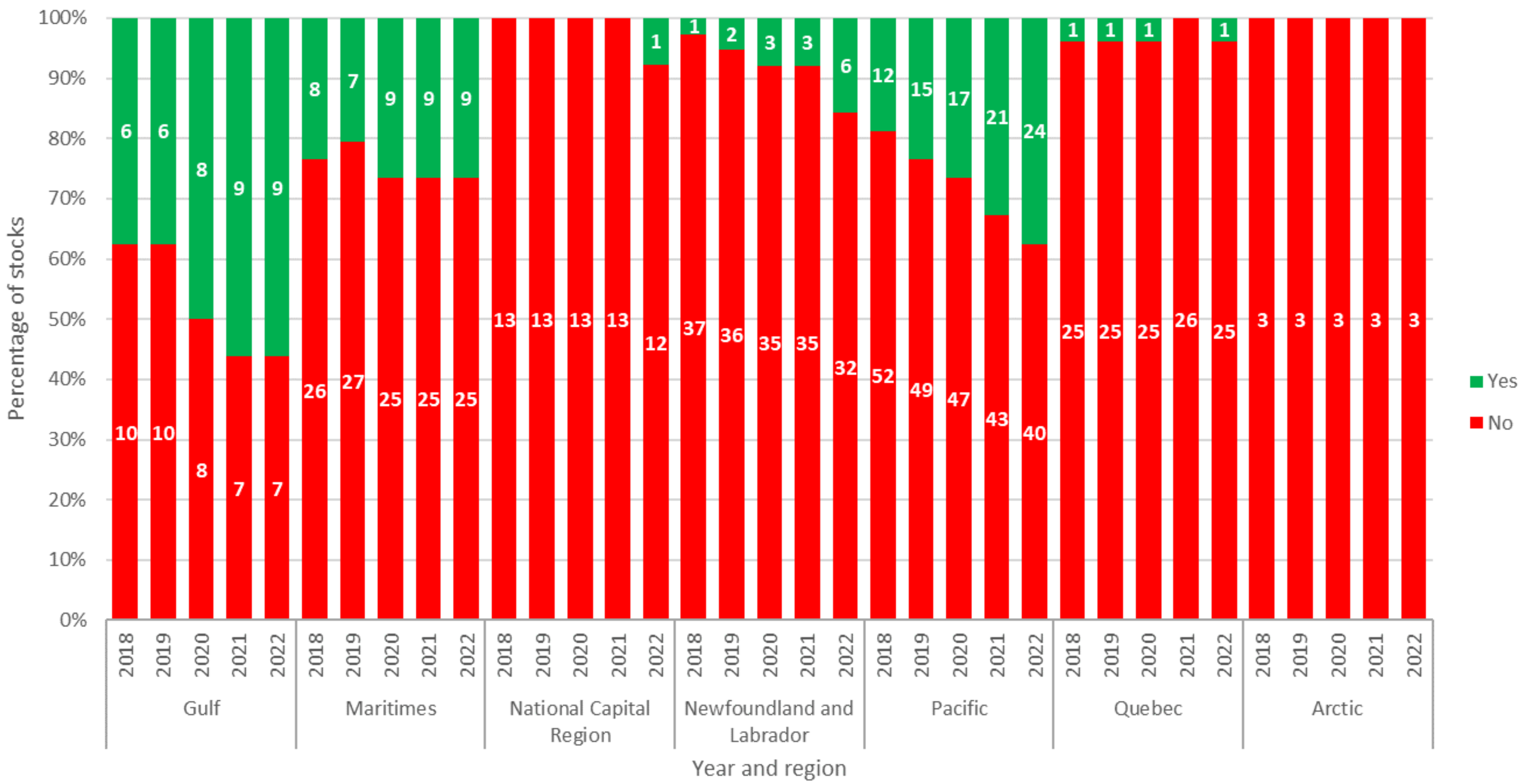

Figure A6. The percentage of Oceana Canada index stocks (n = 194 stocks) with natural mortality (M) estimates in each DFO administrative region in 2018, 2019, 2020, 2021, and 2022. The number of stocks in each year-region-category combination is reported in white font within the bars. Please note this indicator was added in 2018.

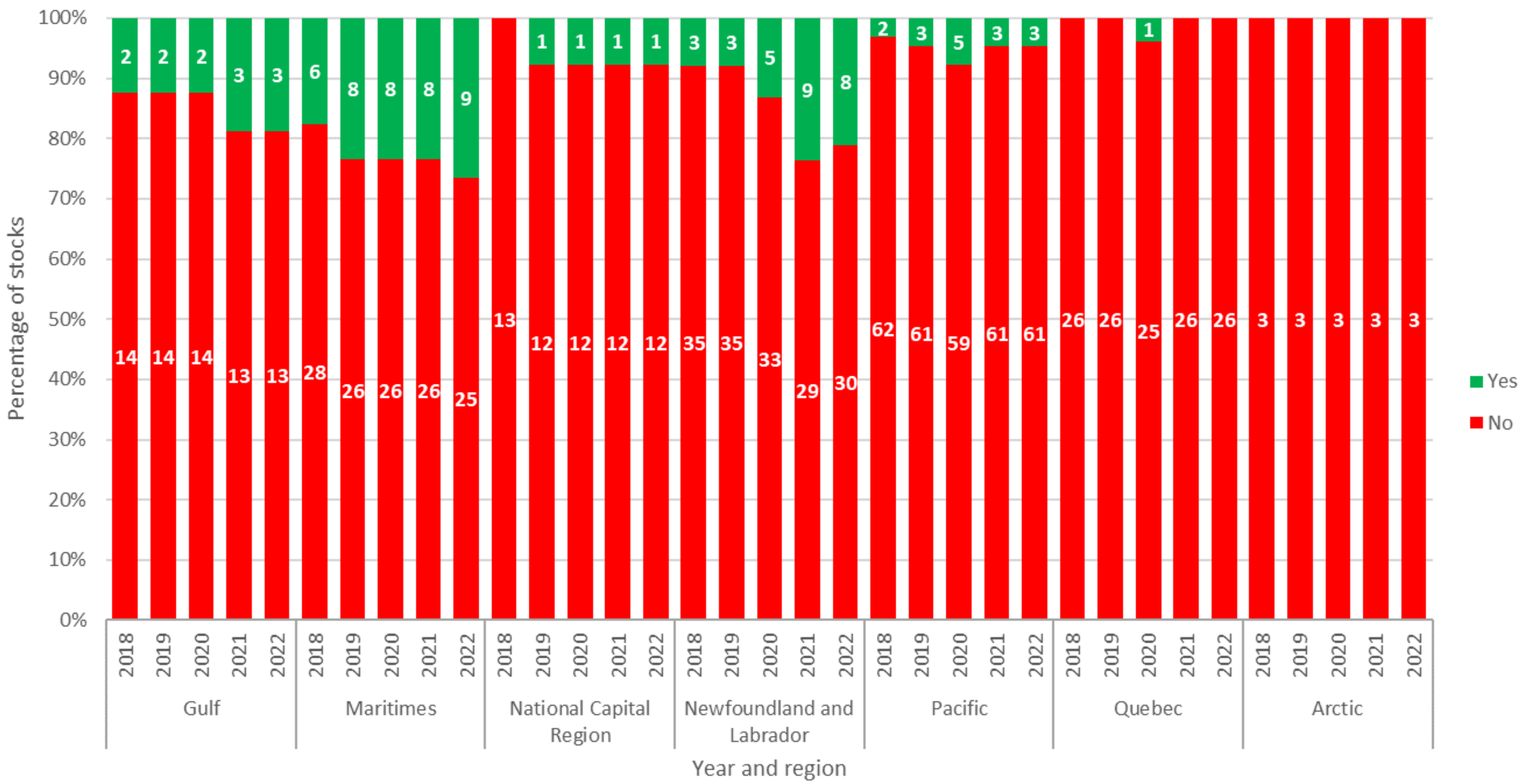

Figure A7. The percentage of Oceana Canada index stocks (n = 194 stocks) with total mortality (Z) estimates in each DFO administrative region in 2018, 2019, 2020, 2021, and 2022. The number of stocks in each year-region-category combination is reported in white font within the bars. Please note this indicator was added in 2018.

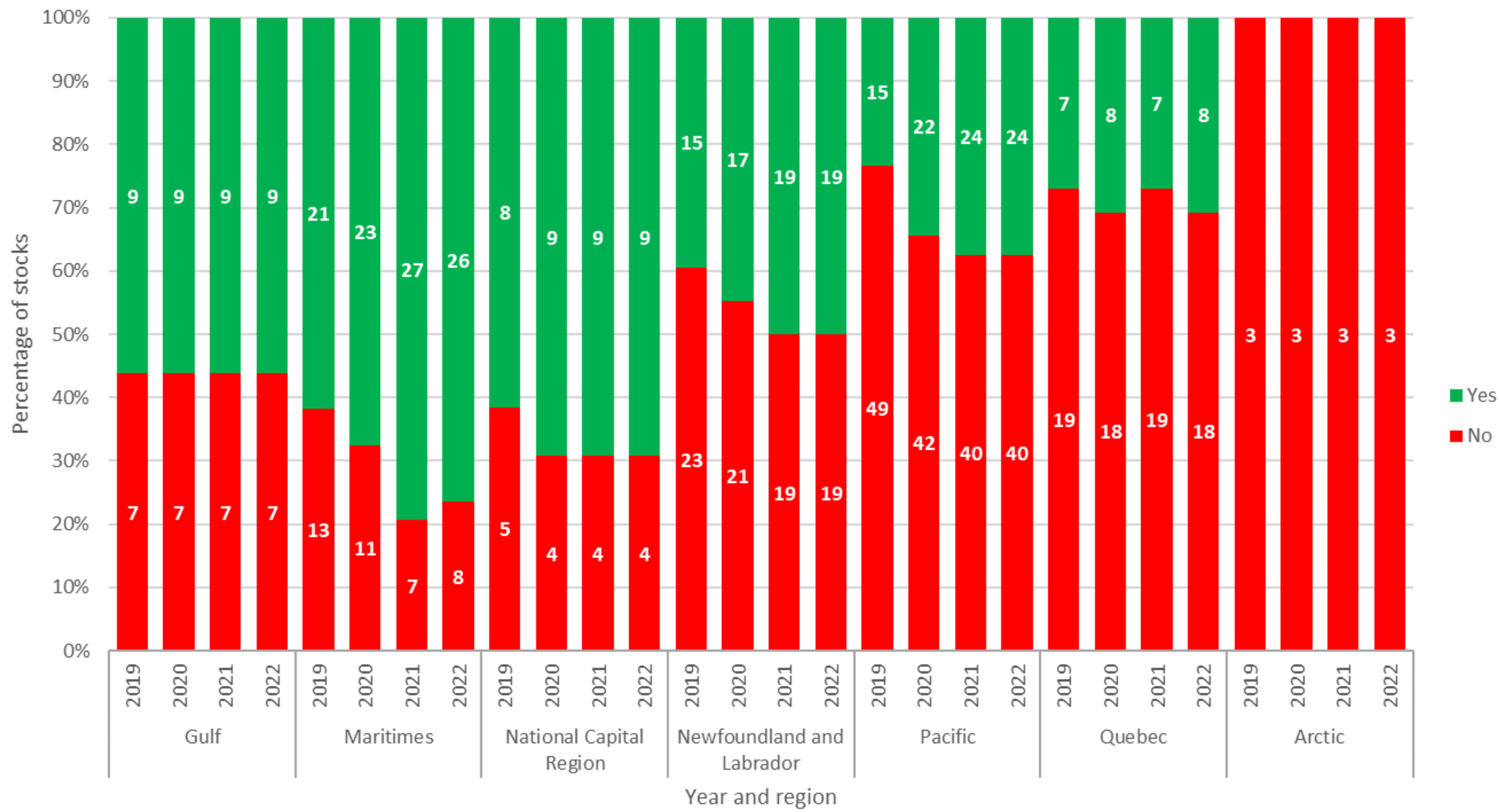

Figure A8. The percentage of Oceana Canada index stocks (n = 194 stocks) with exploitation rate estimates in each DFO administrative region in 2019, 2020, 2021, and 2022. The number of stocks in each region-category combination is reported in white font within the bars. Please note this indicator was added in 2019.

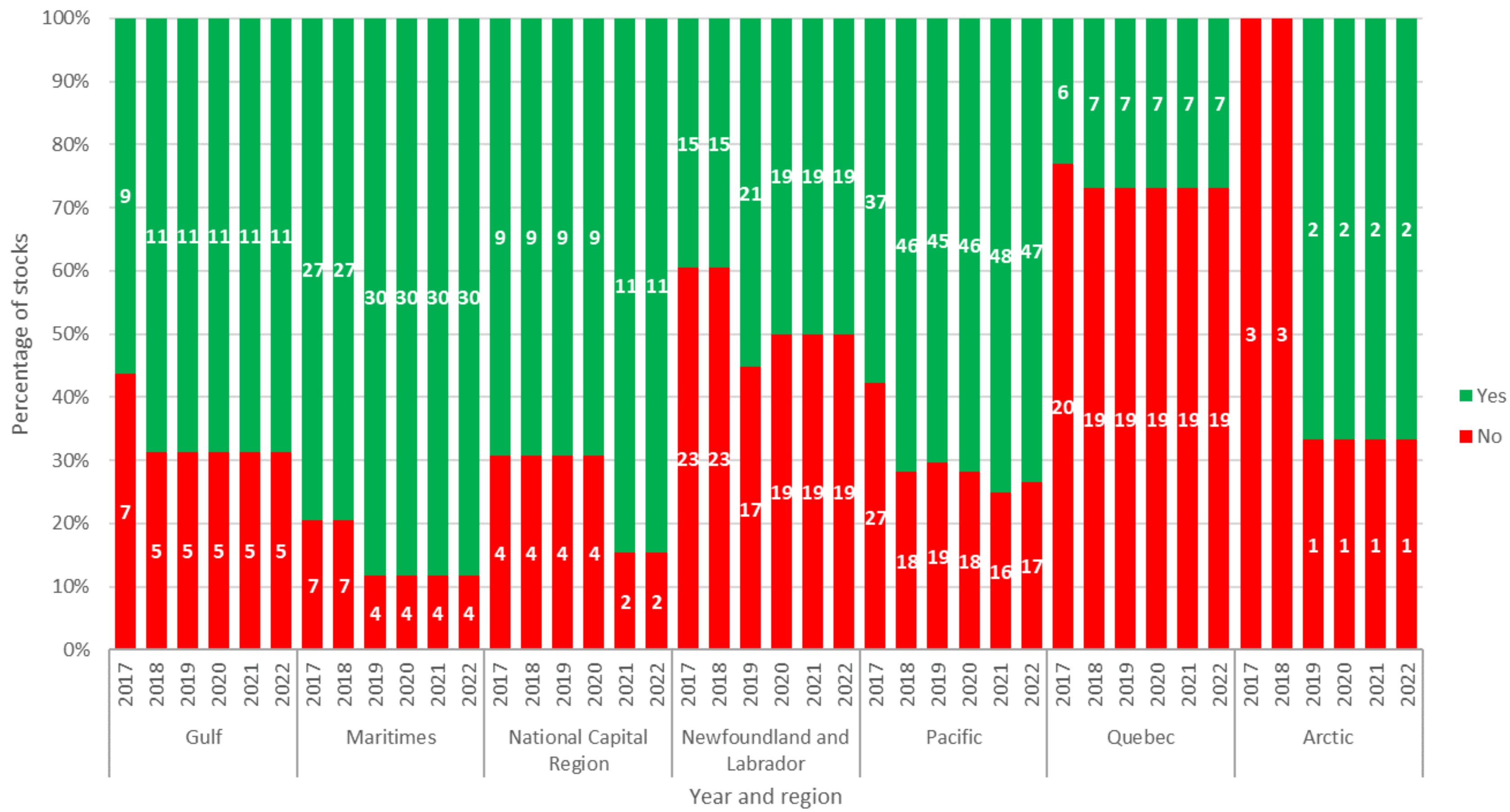

Figure A9. The percentage of Oceana Canada index stocks (n = 194 stocks) with limit reference points (LRPs) in each DFO administrative region in 2017, 2018, 2019, 2020, 2021, and 2022. The number of stocks in each year-region-category combination is reported in white font within the bars.

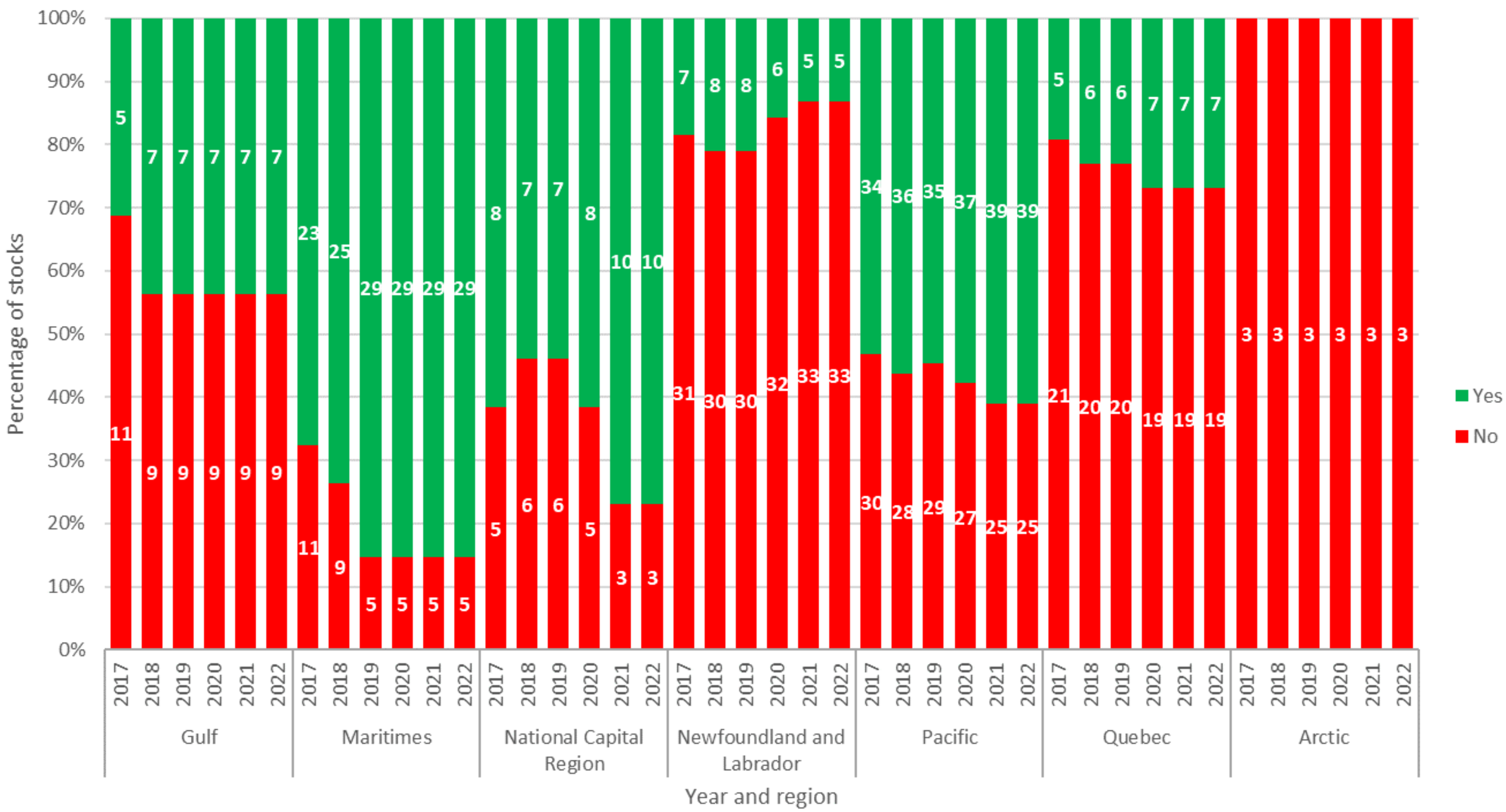

Figure A10. The percentage of Oceana Canada index stocks (n = 194 stocks) with upper stock reference points (USRs) in each DFO administrative region in 2017, 2018, 2019, 2020, 2021, and 2022. The number of stocks in each year-region-category combination is reported in white font within the bars.

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, 2021, and 2022. The number of stocks in each year-region-category combination is reported in white font within the bars.

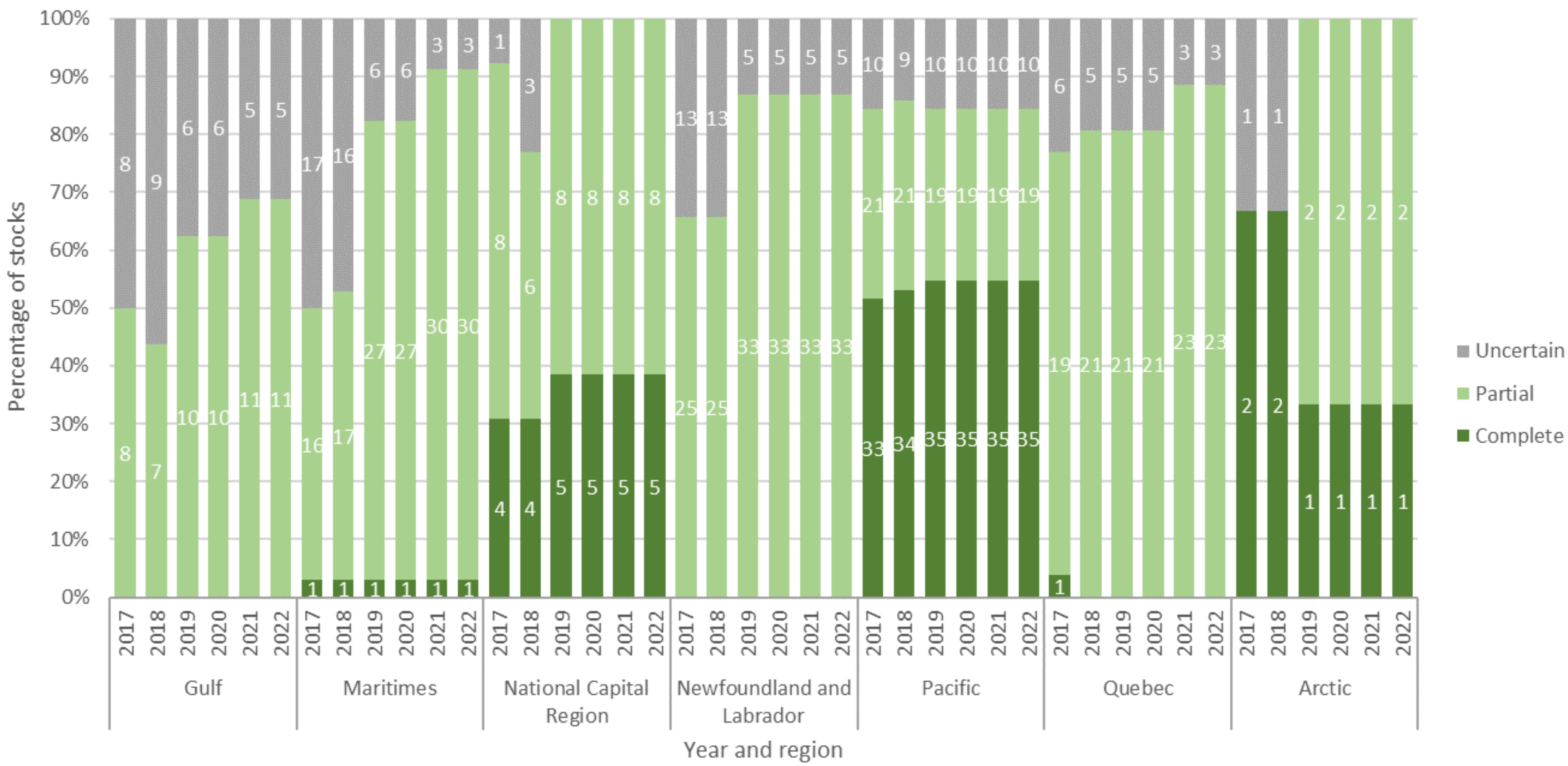

Figure A12. The percentage of Oceana Canada index stocks (n = 194 stocks) that have at-sea observer or electronic (i.e., video) monitoring in each DFO administrative region in 2017, 2018, 2019, 2020, 2021, and 2022. The number of stocks in each year-region-category combination is reported in white font 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.

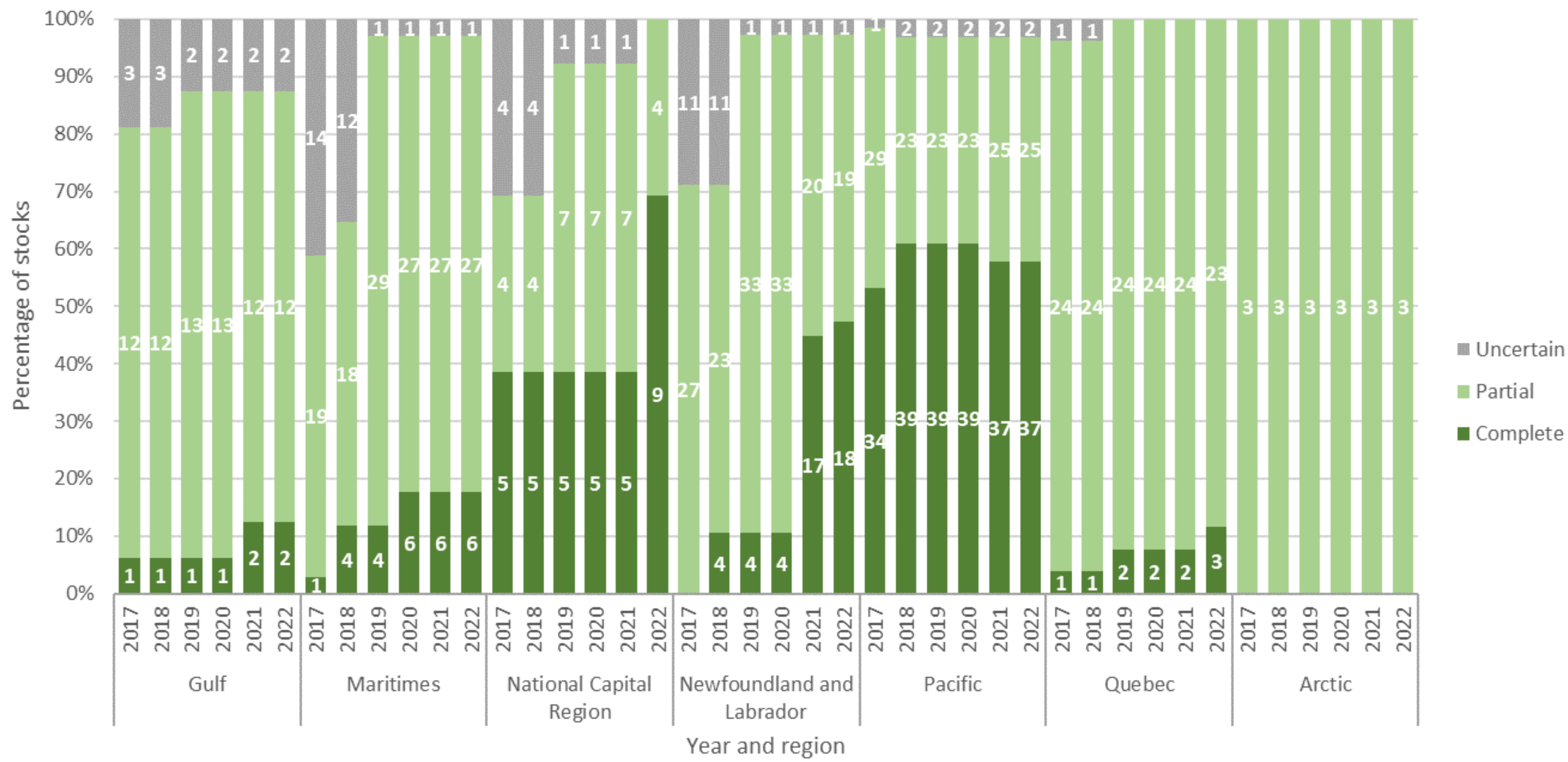

Figure A13. The percentage of Oceana Canada index stocks (n = 194 stocks) that require logbooks recording the entire catch (i.e., directed species and bycatch) in each DFO administrative region in 2017, 2018, 2019, 2020, 2021, and 2022. The number of stocks in each year-region-category combination is 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.

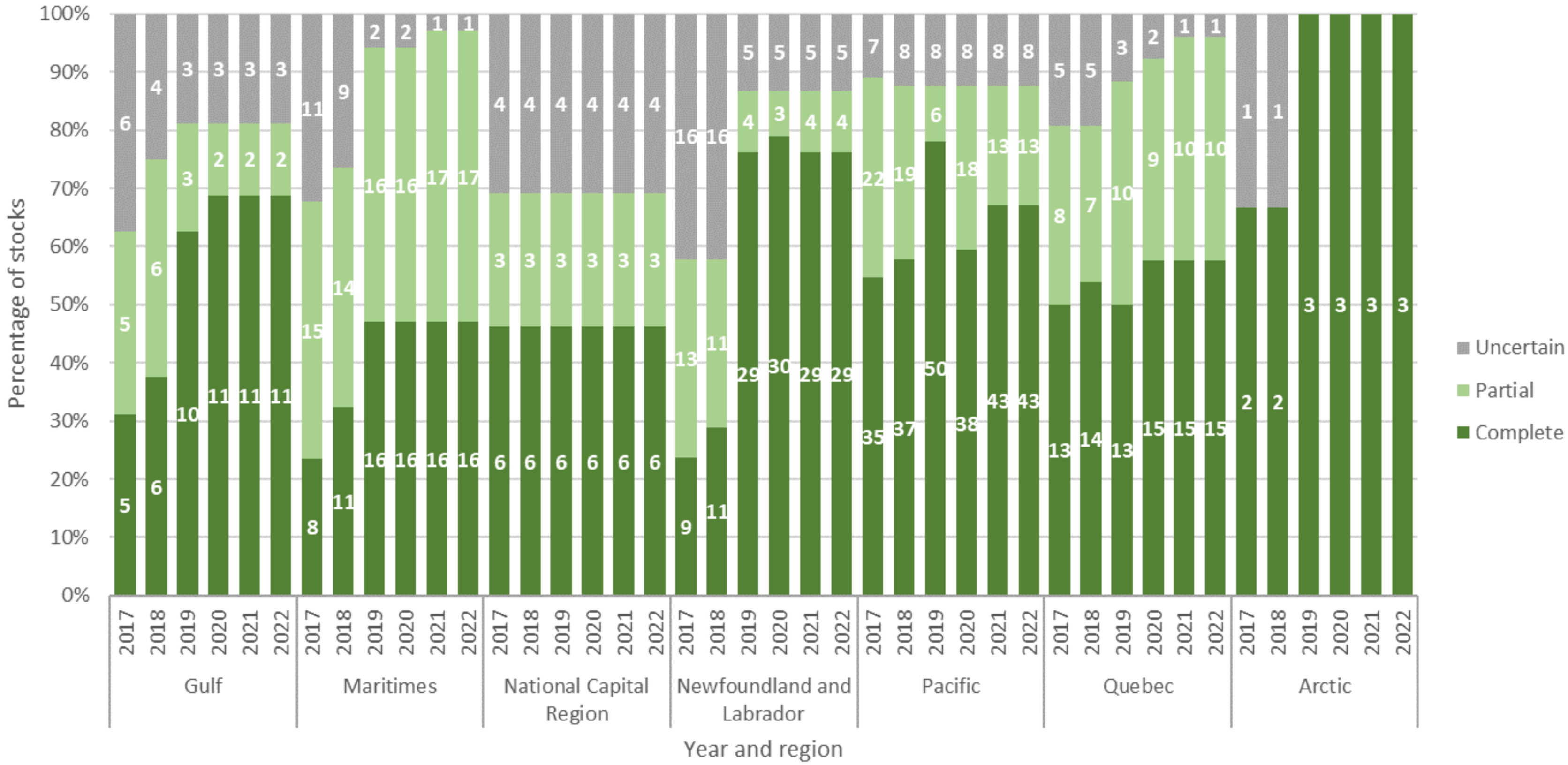

Figure A14. The percentage of Oceana Canada index stocks (n = 194 stocks) that have independent dockside monitoring in each DFO administrative region in 2017, 2018, 2019, 2020, 2021, and 2022. The number of stocks in each year-region-category combination is reported in white font within the bars. "Uncertain" 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.

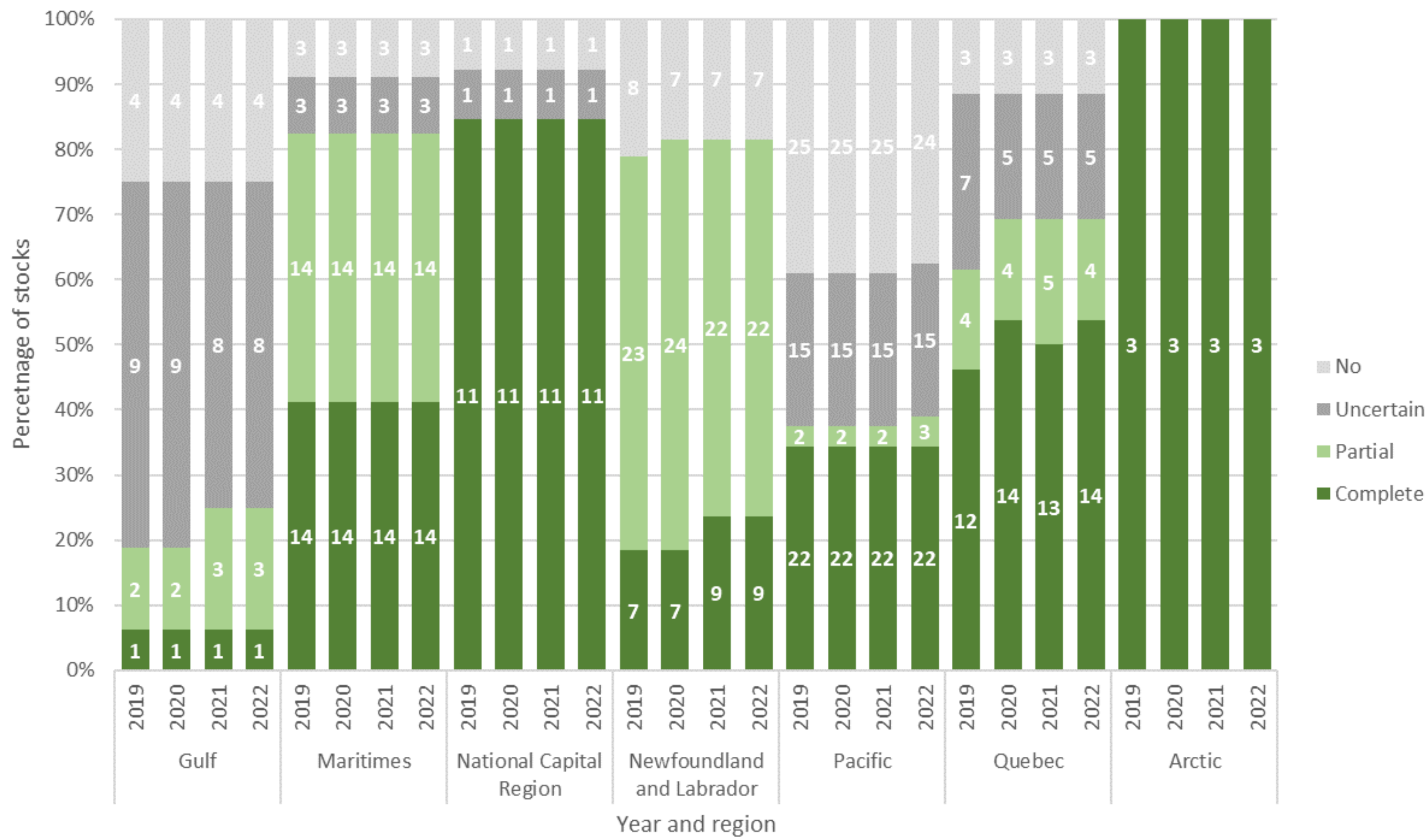

Figure A15. The percentage of Oceana Canada index stocks (n = 194 stocks) that have vessels requiring electronic location monitoring, either via vessel monitoring systems (VMS) or automated identification systems (AIS), in each DFO administrative region in 2019, 2020, 2021, and 2022. The number of stocks 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, 2021, and 2022. 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 stocks that are no longer in the critical zone.