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Review of catch monitoring tools used in Canadian fisheries

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

Fisheries and Oceans Canada (DFO) uses a variety of catch monitoring tools to support fisheries management efforts. These tools include fisher pre-departure and pre-arrival notifications, commercial sales slips, fisher questionnaires, effort monitoring, creel surveys, logbooks, dockside monitoring, at-sea observers, and electronic monitoring systems with video. The purpose of this report is to provide an overview of these tools in the typical contexts in which they are employed to monitor catch and to highlight their strengths and weaknesses in providing dependable catch data. The report also provides a compilation of the monitoring tools and details on their implementation (e.g., intended coverage levels) for Canada’s major fisheries managed by DFO.

DFO is currently developing a national fishery monitoring policy to ensure that DFO has timely and accessible fishery-dependent information of sufficient quality to manage fisheries sustainably. This report provides information to support the implementation of this policy once it is finalized.

INTRODUCTION

Catch monitoring provides information on catch and other details related to fishing activities. This is undertaken by Fisheries and Oceans Canada (DFO) staff, fishers, fish buyers, or designated third-party individuals. Data from catch monitoring are used primarily to support fisheries management efforts and as critical input to resource assessments, but can also be used for other purposes such as enforcement activities and directed scientific research. Resource managers use the collected data to make ongoing management decisions, for within-season management actions, for longer-term fisheries planning, and for national and international reporting on landings. Scientists use the collected data for directed research and to feed into stock assessments that provide an evaluation of the stock status and the risks to conservation of different management options. Fishery officers use the collected data to carry out compliance and enforcement activities. Dependable data is therefore necessary to support these efforts and contribute to the long-term sustainable management of fisheries.

In addition to having different uses, the various catch monitoring tools also provide information that differs in content, scope, resolution and data quality. For example, some tools only report on retained catch, with varying degrees of accuracy and precision, while others report on both retained and non-retained catch. Data can be collected using a variety of techniques and may be reported by resource users or independently collected. Resource user-dependent catch monitoring tools include fisher pre-departure and pre-arrival notifications, fisher questionnaires, creel surveys, and logbooks. Third-party (i.e., independent-observer) catch monitoring tools include dockside monitoring, at-sea observers, effort monitoring, and electronic monitoring systems with video. Each of these tools has benefits and limitations that impact the quality of the inferences drawn (i.e., their bias and variability) from the data they provide and the dependability of these inferences (i.e., the likelihood of drawing correct conclusions based on the data) (for additional details on quality and dependability in the fishery monitoring context see Allard and Benoît 2019).

SCOPE

The scope of this report is national and it applies to common catch monitoring tools used in Canadian commercial, recreational, and Indigenous fisheries licensed and/or managed by DFO under the *Fisheries Act*. In this report, it is assumed that personnel are trained appropriately and equipment is functioning. The benefits and limitations of the various tools are discussed as they relate to the quality of the data they produce. Quality control or quality assurance of catch data is beyond the scope of this report. While other factors are important when choosing a monitoring tool, such as cost, feasibility, etc., these are beyond the scope of this report.

The monitoring tools are discussed in the contexts in which they are generally applied. The principal factors affecting the quality of the data provided by the various monitoring tools are discussed. This information should allow for a better evaluation of data quality for specific contexts as well as the identification of strategies to improve monitoring programs. While the information presented and discussed herein should cover the majority of Canadian fisheries, a detailed discussion of catch monitoring programs across the diverse range of fisheries, each with its own biological and operational characteristics, is beyond the scope of this report.

GLOSSARY

Indigenous, in relation to a fishery (Food, Social and Ceremonial): fish is harvested by an Indigenous organization or any of its members for the purpose of using the fish as food, for social or ceremonial purposes, or for purposes set out in a land claims agreement entered into with the Indigenous organization. (Fisheries Act, Subsection 2(1))

Bycatch: a) retained catch that includes species, and specimens of the target species, such as specimens of a particular sex, size or condition, that the fisher is not licensed to direct for but may or must retain; and, b) all non-retained catch, including catch released from gear and entanglements, whether alive, injured or dead, and whether of the target species or the non-target species. (DFO, 2013)

Commercial, in relation to a fishery: fish is harvested under the authority of a license for the purpose of sale, trade, or barter. (Fisheries Act, Subsection 2(1))

Dependability (referring to inferences drawn from data): Dependability is taken here to mean the ability of the parameter estimation process (e.g., estimating total landings of a species) to reach the objectives for which it is intended (e.g., determining whether a quota has been reached). The statistical characteristics that affect dependability are the variance and bias of the estimator.

Fishery: includes the area, locality, place or station in or on which a pound, seine, net, weir or other fishing appliance is used, set, placed or located, and the area, tract or stretch of water in or from which fish may be taken by the said pound, seine, net, weir or other fishing appliance, and also the pound, seine, net, weir, or other fishing appliance used in connection therewith. (Fisheries Act, Subsection 2(1))

Fishing: means fishing for, catching or attempting to catch fish by any method. (Fisheries Act, Subsection 2(1))

Fishing activity: a unit of fishing that involves the deployment, retrieval and emptying of the fishing gear at a chosen fishing site. When nets, pots or traps are strung together, these are considered a single fishing activity.

Fishing trip: one or more fishing activities, along with travel to and from fishing grounds and the selection of fishing sites, which begins when a fishing vessel leaves the port and ends when the vessel returns to port to offload its catch.

Non-retained catch: consists of any species or specimens that are not retained for use and that are returned to the water. The returned catch may be alive, injured or dead. This includes catch brought on board and thrown back, catch released from gear before it is brought on board (such as catch released from a purse seine before the seine is fully pursed), and catch that becomes visibly entangled in fishing gear, such as entangled whales, birds and sea turtles. This does not include catch that escaped the fishing gear, that was removed by predators and scavengers, or that dropped out dead from the gear. (DFO, 2013)

Quality (referring to inferences drawn from data): the validity of the estimate of the parameter. The quality of the estimation will depend on its accuracy (converse: bias) and its precision (converse: variability).

Recreational, in relation to a fishery: fish is harvested under the authority of a licence for personal use of the fish or for sport. (Fisheries act, Subsection 2(1))

Retained catch: the portion of the catch that is retained for use. This includes landed catch as well as catch that is used in some way but not landed, such as catch that is used for bait. (DFO, 2013)

Species at Risk Act listed species: species listed on the List of Wildlife Species at Risk as set out in Schedule 1. A species at risk means an extirpated, endangered, or threatened species or a species of special concern. (Species at Risk Act)

Target catch: retained catch that consists of the species that the fisher is licensed to direct for, in other words, the target species of the fishery. In a multispecies fishery, this includes any species that the licence holder is licensed to direct for on a given fishing trip regardless of whether the licence holder did so or not. (DFO, 2013)

Third-party monitoring: monitoring performed by a person or group besides those primarily involved in the fishing.

SURVEY OF CANADIAN FISHERY MONITORING

Fishery managers and stock assessment scientists were approached to provide information on the current use of fishery monitoring tools in Canada's major fisheries. The responses were collated to provide an overview of the different types of tools used in Canadian fisheries and the range of targeted coverage associated with each tool. Appendix 1 summarizes the responses that were received and is neither an official listing of all of Canada's fisheries nor is it meant to be an official source of the listed fishery's monitoring tools or coverage levels. It is presented here solely to help with putting each of the described tools in the context of Canadian fisheries.

CENSUS AND SAMPLING

Complete coverage (i.e. 100% coverage; a census) of a fishery provides the most comprehensive and highest quality data from a tool compared to an otherwise identical case in which coverage is below 100% (i.e., a survey). For catch monitoring, this would, for example, include complete coverage of all fleets, trips, and all activities within each trip. However, often this level of coverage is not attained and a sample is obtained instead. Survey sampling is the process of selecting a subset of elements from a target population to conduct a survey. This information is then used to draw inferences about the population as a whole.

In order to obtain a dependable estimation of catch when survey coverage is less than 100%, a properly designed and implemented survey is required. Data quality is reduced if it cannot be expanded accurately to the fishery. To ensure dependable inference of a fishery's catch, it is necessary that the sampled trips be statistically exchangeable by design (e.g., sampling that is random, stratified random, systematic or proportional to size), or conditionally exchangeable using post-stratification (e.g., Rago et al. 2005) or via a model (e.g., modelling bycatch as a function of habitat and target species catch; e.g., Cosandey-Godin et al. 2015) (for an overview of sampling designs for catch monitoring see Cotter and Pilling 2007). Failure to meet this condition is often called a deployment effect, that is the trips sampled are not statistically representative of activities in the fleet (Benoît and Allard 2009; Faunce and Barbeaux 2011). (Note that in Allard and Benoît 2019 this concept is refined and the terms unintended sampling clustering, stratification, and irregular selection probabilities are used to describe what are collectively termed deployment effects here.) Deployment effects may occur due to difficulties such as incomplete knowledge of the population of trips or operational limitations. For example, global or local (e.g., in isolated locations) gluts in demand for observers that cannot be met by the companies, inability (e.g., lack of space) or refusal of vessels to accommodate an observer, or perceived lack of safety by the observer or observer company. A deployment effect may result in a biased inference for catch. The magnitude of the bias will be a function of the extent to which sampled trips are unrepresentative of all trips. Furthermore, a deployment effect may result in an incorrect characterization of precision if the properties of sampled vessels are correlated in regards to catch such that there is pseudo replication. This lack of independence among observations, unless accounted for, typically results in an underestimate of true sampling variance. See Allard and Benoît 2019 for a detailed discussion of the expected impacts of deployment effects.

CATCH MONITORING TOOLS

RESOURCE USER-DEPENDENT CATCH MONITORING TOOLS

Resource user-dependent catch monitoring is performed by a person or group involved in the fishing. Therefore, this type of monitoring is limited by additional potential biases and inaccurate reporting. This can be intentional (e.g., underreporting discards or intentional misreporting of the area of catch) or unintentional (e.g., oversight or incorrect identification of a species). Although there can be limitations to using resource user-dependent catch monitoring tools, they remain extremely useful. While it may be preferable to have all catch monitoring done through a third party (ideally one that is trained and certified), this is extremely difficult in practice, if not impossible, as it would require extensive resources. Resource user-dependent tools therefore remain necessary for catch monitoring. Furthermore, some of the issues identified here can be countered or reduced through the careful design and application of these tools. For example, independent verification can increase the quality of the data and statistical techniques can, in some cases, identify biased reporting.

FISHER PRE-DEPARTURE AND PRE-ARRIVAL NOTIFICATIONS

Fisher pre-departure and pre-arrival notifications (also referred to as hailing-in/hailing out) refer to communication between a commercial fishing vessel and a third-party monitoring company, fishery managers, or enforcement officials prior to commencing a fishing trip and at the end of a fishing trip (often prior to reaching port). Managers may require fishers to communicate before leaving port, before returning to port, at the end of a fishing day, or all three. A main purpose of the tool is to assist in planning further monitoring and enforcement activities. Fisher pre-departure notifications are typically provided within a mandated pre-departure timeframe to allow observer companies to plan deployment of at-sea observers (Palmer et al. 2016). These systems have been shown to significantly increase the randomness of observer deployments (Benoît and Allard 2009). Fisher pre-arrival notifications are typically provided to dockside monitoring companies to allow them to plan their dockside verification activities; this could be to plan the arrival of dockside monitors or to plan the requested sampling scheme if coverage is not 100%. In some fisheries, fisher pre-arrival notifications are used to report daily catches on multi-day (extended) trips, which allow area or individual quotas to be closely regulated. Information conveyed in fisher pre-arrival notifications can include location, intended targeted species, and approximate amounts of catch. However, these notifications usually provide limited information on catch, only reporting approximate amounts and usually only focused on target species or species which the vessel has a licence to land. Fisher notifications are therefore not usually used as a sole source of reporting catch, but rather in conjunction with other catch monitoring tools. Fisher notifications account for individual fishing trips and can therefore provide a measure of fishing effort and could be used to verify compliance with mandatory logbook reporting. This is a resource user-dependent monitoring tool and the quality of the information reported can be limited by biased or imprecise reporting as described above.

COMMERCIAL SALES SLIPS

Commercial sales slips report on fish that are sold at the first point of sale. Commercial fishers are responsible for ensuring that what they harvest is reported and sales slips are a common method of doing this. They are a relatively common tool with most DFO regions (Central and Arctic, Newfoundland and Labrador, Pacific, Quebec, and Gulf regions) still using sales slips and requiring them to be submitted as part of their licence conditions (Appendix 1). However, catches that are retained for personal use, private sales (e.g., restaurant), or sold to other fishers (e.g., for bait) are often not accounted for through sales slips. Therefore, the information they provide could be underestimated. This is a resource user-dependent monitoring tool and the information reported can be limited by biased or imprecise reporting as described previously. For example, there may be deliberate misreporting via commercial sales slips to hide catch or to inflate it (Bijsterveld et al. 2002). Factors that motivate hiding catch include underreporting revenue for tax purposes or to allow for continued fishing in fisheries with catch limits. Factors that motivate inflating catch include anticipation of the imposition of catch shares based on historical individual catches. This tool does not provide any information on non-retained catch. Electronic submissions of sales slips are also used which reduces opportunities for data entry errors and provides the timely transmission of information.

FISHER QUESTIONNAIRE

Fisher questionnaires are another tool used to obtain information on fisheries. These questionnaires may be by mail, telephone, or electronic (e-mail or web/application based platform). Fisher questionnaires are often used in recreational fisheries to determine estimates of catch. This is the most common tool used in the Pacific Region of Canada to cover recreational fishing; no other region in Canada reported using recreational fishery questionnaires (Appendix 1). They are also used in commercial fisheries either during or post-season. For recreational licence holders, questionnaires are usually randomly distributed to a subset of the licensees to solicit their responses. In commercial fisheries, active licence holders that sold fish in the target season typically form the population from which participants are selected (e.g., McDermid et al. 2016). Questionnaires often collect information on the amount of effort directed at specific species (type and amount of gear used and the number of fishing units undertaken), the number/weight of species caught, and geographic regions that were targeted. Advantages of questionnaires include a lack of face-to-face bias (for example, tailoring responses based on the interviewer's reaction), more time for responses, and the ability to ask more complex questions. This is a resource user-dependent monitoring tool and the information reported can be limited by biased or imprecise reporting as described previously. Additional disadvantages include relying on recalls and non-responses, both of which can lead to increased variability. When recalls are biased toward unusual events such as large catches, or if non-responses are intentional, then bias could be introduced. Fishers may assume that they do not have to respond if they did not catch anything, generating a non-response bias. It is also not possible to clarify questions in mail or electronic questionnaires. Furthermore, unless the consistent interpretation of questions by respondents is validated, for example by using focus groups, clear-sounding questions may result in divergent answers due to misunderstanding of the questions' intent. Therefore, the quality of data provided by fisher questionnaires can be negatively affected by the lack of clarity and specificity in the questions, the elapsed time between the questionnaire and the events that are meant to be recalled, and response bias and error.

EFFORT SURVEYS

Effort surveys may be done using aerial or on water counts which can be used to provide an estimate of total effort. Fishing effort is generally estimated from a count of buoys or anglers, vessels, or rods actively fishing throughout an area, providing an instantaneous effort count. This type of effort monitoring does not provide direct information on catch. However, the effort estimate can be used with other tools that provide an estimate of catch per unit effort (e.g., creel surveys, fisher questionnaires) to provide an estimate of total catch.

In practice, full randomization of the effort monitoring can be impractical or even impossible which impacts the quality of the estimate. Factors that can make randomization a challenge include darkness, aircraft availability, accessibility and weather. For example, aircraft may have to follow a non-randomized flight path or may not be able to fly during some poor weather conditions. Poor weather conditions or poor visibility may also bias the estimate.

CREEL SURVEYS

A creel survey is a tool used to obtain information on a fishery, often by interview in the field. This tool is most often used in recreational fisheries to estimate the total catch and effort to support sustainable management. Fishery technicians may interview anglers and collect information that can include location of fishing, species and amount of fish caught and released, time spent fishing, and number of anglers and lines. Fish may also be measured, weighed, and have biological materials collected. Generally, anglers are surveyed after fishing trips and this information is used to estimate total catch and effort. The information is also used to provide data on daily activity patterns. Creel surveys can report on all types of catch, both retained and non-retained. However, reporting on non-retained catch relies on the angler's recall and the angler's ability to correctly identify fish species. A recent survey of Canadian fisheries managed by DFO highlights that this tool is not widely used (Appendix 1). However, creel surveys are much more common in recreational fisheries managed by the provinces, which are not included in this report.

Using complementary surveys is a common technique for estimating catch in creel surveys with one survey to estimate catch per unit effort or catch rate, and a second to estimate total effort. These surveys can then be used together to produce an estimator for the total catch. One advantage to this method, which uses independent estimators, is that surveys can be optimally designed for what is being estimated. This is advantageous since designs that are best for estimating catch rate may not be best for estimating total effort. Fishing effort is generally estimated from effort monitoring programs (e.g., effort surveys described above). Anglers are generally surveyed to determine catch rate.

Creel surveys are often conducted over very large areas for an extended period of time. Creel survey coverage is most often less than 100% and inadequate survey design may lead to large sampling errors and high uncertainty of results. Often many assumptions need to be made to estimate total catch, which decreases the quality of the data. For example, the assumption of a constant catch rate over the duration of a fishing trip may not be suitable for some fisheries, such as a gill net fishery where net saturation can result in a declining catch rate. Alternatively, the assumption that fishing in one area is independent from fishing in another area may be violated. In other situations, the survey may not be implemented as designed. For example, when there is difficulty or inability to estimate effort during poor weather conditions or poor visibility which may bias the estimate. While obtaining a dependable estimate of total catch from creel surveys is difficult, it is one of the few tools used to estimate catch from recreational fisheries.

LOGBOOKS

Logbooks are the fisher's account of catch and other fishing related details. Logbooks vary greatly from fishery to fishery, but can include information on total catch by species, discarded catch by species, fishing effort and location, gear used, protected species interactions, and much more. Therefore, this catch monitoring tool can provide information on retained catch (target and non-target) and non-retained catch (target species, uncommon or rare species, and Species at Risk Act listed species). This is the most common tool used throughout Canada with most fisheries requiring logbooks to be completed and submitted. A recent survey covering many Canadian commercial fisheries indicated that only a few fisheries do not currently have logbooks as part of their monitoring tools (Appendix 1); all of those that reported using logbooks required 100% coverage. Logbooks are also required in a few recreation fisheries.

Logbooks are submitted either electronically or in paper form. Paper logbooks require the manual input of data, typically by DFO or a third-party service provider, which introduces additional opportunities for data entry errors. Fishers can be required to submit these logbooks at different times, such as when they complete a fishing trip or at the end of the season. Generally, the quality of the data is considered to be greater the earlier this information is submitted, reducing the need to recall information and enhancing the efficiency of corrective actions in cases where logbook reporting is deficient. Electronic logbooks can be submitted in close to real-time and have reduced resources required to input the data thus improving the data quality compared to paper logbooks under similar fishery scenarios.

This monitoring tool is resource user-dependent and therefore can be limited by biased or inaccurate reporting. Compared to records by at-sea observers, reports in logbooks often underreport catch amounts, overreport the frequency of zero catches and report a smaller diversity of species (e.g., Allen et al. 2002; Walsh et al. 2002; Bremner et al. 2009). There may be regulatory or economic incentives to misreport. These may include catch limits, prohibitions on catching certain species, capture of charismatic species, a desire to hide prime fishing locations or fear of enforcement actions (e.g., Stanley 1992; Metuzals et al. 2005; Rijnsdorp et al. 2007). For example, there is some evidence that misidentification of species may be deliberate to avoid or delay fishery closures (Faunce 2011) or that discards may be misreported for strategic reasons such as multispecies quotas (Branch et al. 2006). There may also be disincentives to report such as the time or effort required to complete the logbooks. In some fisheries, logbook completeness is not strictly enforced and missing data may introduce additional error or bias.

Quantification of catches reported in logbooks is typically based on a visual assessment and can therefore lack precision as a result of measurement error. This monitoring tool also relies on the fisher's ability to correctly identify taxa in the catch and therefore there may be a heightened degree of misidentification for uncommon or cryptic species. Finally, the quality of the data reported in logbooks depends on having clear, accurate, and specific instructions for completing each of the fields.

Independent verification of logbooks can minimize many of the limitations and increase the quality of the data from this tool. Independent measures of fishing activities, such as fisher pre-departure or pre-arrival notifications and data from fishery enforcement overflights, can be used to ensure that logbook reporting requirements are being met. This information could also be used to post-stratify the data obtained from logbooks according to sectors in the fishery (e.g., different fishing districts or vessel classes) to correct for structural gaps or inequities in reporting when producing fishery-wide estimates (e.g., if reporting rates differ between sectors in a fishery). Boarding by fishery officers can be used to verify the accuracy of catch records in the logbooks. Similarly, catch records in logbooks and catch records provided by third-party at-sea observers can be compared to evaluate the quality of the data; however, the presence of observers can produce an invigilation effect (i.e. the act of observing ensures correct behavior) such that there is a high degree of compliance with logbook reporting requirements only when an observer is present (e.g., Benoît and Allard 2009). Strong concordance between observer and logbook records should therefore not be taken as a measure of the quality of logbook data for all fishing trips, including those without an observer. However, this is not the case for comparisons of logbook entries and data from electronic monitoring with video where strong concordance between the two methods can be taken as a measure of quality because the nature of video monitoring is such that there is an invigilation effect at all times (e.g., Stanley et al. 2009, 2015; Further details provided below).

DOCKSIDE MONITORING

Dockside monitoring programs provide third-party verification of fish landings, data collection, and often data entry. Dockside monitoring companies, either private companies or not-for-profit corporations, and the dockside observers they employ are designated by the Department to perform the duties related to the Dockside Monitoring Program, as indicated in the Fishery (General) Regulations and are qualified according to the Canadian General Standards Board (CGSB) Program Manual and the Dockside Monitoring Program Policy and Procedures. This ensures that each organization has a quality assurance system in place that ensures the integrity of the information and allows companies to consistently provide timely, accurate, and independent dockside monitoring services (DFO 2009). This includes proper documentation and training, established procedures and reporting standards, quality control, accountability, and internal audit. Dockside monitoring programs are commonly used in commercial fisheries across Canada. A recent survey of Canadian commercial fisheries indicated 132 of 180 responding fisheries have at least some dockside monitoring of landings as one of their monitoring tools (Appendix 1).

Dockside monitoring is used exclusively in commercial fisheries. These are different from weigh-stations used in recreational fishing derbies, which are not considered here. In many fisheries, dockside monitoring is the Department's primary source of verified landing information. This tool only reports on retained catch; information on non-retained catch is not reported. The data collected can include species identification, size, and weight and information on fishing activity. Catches are weighed and/or counted at the wharf providing a direct and typically accurate measurement. This is in contrast to catches recorded by at-sea observers which are often based on a visual estimation of catch weight (see below). However the condition of landed fish may vary, thereby requiring ad-hoc corrections to obtain the best estimate of the catch amount which can result in adjustment error. For example fish may be landed whole, heads-off or dressed (eviscerated), and may be mixed with ice. Ultimately the value sought is in whole or round weight equivalent. The required corrections are meant to be unbiased but do result in some error in estimated landed amounts. Measurements of individual fish lengths made by dockside monitors can be used to detect illegal length-dependent discarding (high-grading) when they are compared with measurements made by at-sea observers given that illegal activities are unlikely to occur in the presence of an observer (e.g., Allard and Chouinard 1997).

Dockside monitoring programs in Canada have been implemented as censuses in certain fisheries and surveys in others. Pre-arrival notification systems are often used in conjunction with dockside monitoring surveys. Nonetheless, such surveys may experience deployment effects. For example, deployment effects may occur due to the remoteness of certain ports that limits the ability of monitors to observe landings.

AT-SEA OBSERVERS

At-sea observer programs (ASOP) place designated third-party observers aboard fishing vessels to monitor/verify fishing activities, collect scientific and fishing data, and monitor fisher compliance with fishing regulations and licence conditions (Kulka and Waldron 1983). Karp and McElderry (1999) provide a detailed review of ASOP in North America, including objectives, structure and procedures. Similar to dockside monitoring programs, ASOP companies and the at-sea observers they employ are designated by the Department to perform the duties related to the At-Sea Observer Program, as indicated in the Fishery (General) Regulations and are qualified according to the CGSB Program Manual and the At-Sea Observer Program Policy and Procedures (see Canadian General Standards Board, 2012 and Corporation Designation Policy and Procedures, DFO 2014). The GCSB qualification program aims to ensure that ASOP companies have quality management systems and adequate quality management practices in place. This includes proper documentation and training, established procedures and reporting standards, quality control, accountability, and internal audit. Audits are carried out by CGSB to ensure that the companies conform to the recognized standard.

ASOP are used to varying degrees in commercial fisheries across Canada. A recent survey of Canadian commercial fisheries highlights how the requirement to use this tool varies between regions for similar stocks and species. The target coverage (or intended coverage) can vary substantially from as little as 2.5% to 100% in fisheries where observer coverage is a condition of licence (Appendix 1).

An ASOP can be used for a variety of objectives. One objective is monitoring of catch. On one hand, the composition of the catch may be monitored for in-season fishery management objectives such as triggering small fish protocols, soft-shell restrictions, sex-ratio cut-offs, or closures due to captures of species of concern. On the other hand, composition of catch may be monitored to meet post-season objectives such as quantifying the catches of different species (e.g., discards) and quantifying the demographic composition of catch for scientific purposes. There may also be monitoring of the fishing activity for enforcement objectives. For example, it can be used as a method of monitoring compliance in the fleet, and as a penalty for fishers that are known to be non-compliant to fishing regulations and to ensure they become compliant.

This tool reports on all components of catch that are brought to the vessel when the observer is present. This includes retained catch and non-retained catch, of which some species may be uncommon, rare or of conservation concern. While retained catch is quantified, observer reports are not typically used to estimate landings. However, these reports are one of the main sources of information used to quantify non-retained catch. This tool is typically used in commercial fisheries but is also used in recreational fisheries such as the recreational cod charter boat fishery in the southern Gulf of St. Lawrence.

Fishing trips are the basic sampling unit for ASOP. In some instances, all trips carry an observer (a census or 100% coverage) whereas in other instances observers are deployed on a subset of trips. Trips may vary in length from one day to many. Observers are meant to report on catch characteristics for all fishing activities in a day or a subset of activities on vessels that operate longer than the contracted hours of the observer. The latter case results in a hierarchy of sampling; each step involves estimation and therefore contributes to uncertainty in the estimates (e.g., Tamsett et al. 1999; Rochet et al. 2002). Furthermore, observers may quantify characteristics of the catch by subsampling and often catch amounts are estimated rather than measured directly, resulting in measurement error. Results obtained from the observer may be communicated to a coordinating office on a regular basis using electronic transmission or reported at the completion of the trip. Fisher pre-departure notifications are often used to select trips on which to deploy an observer when targeted coverage of the fleet is below 100% (e.g., Benoît and Allard 2009; Palmer et al. 2016).

An advantage of ASOP with respect to catch monitoring is that it is one of the few tools that provide a direct measurement of discarded catch provided by a third party, which, in principle, should result in more accurate reporting of the catch. In addition, for in-season fishery management actions, this is the only third-party tool that provides near instantaneous reporting on catch characteristics that may result in management actions. Examples of in-season management actions include limits on the incidental catch of non-target species, size limits for target catch and changes in sex ratios in some decapod crustacean fisheries. Presence of an observer also means that biological sampling of the catch may be undertaken for demographic characteristics such as lengths, collecting of aging material, sex, shell condition, etc.

When coverage is 100% of both trips and activities within trips, any uncertainty with respect to catch is related to subsampling of catch. Biases with respect to catch composition are likely to be very rare and limited to cases where the subsampling design is inappropriate or where sampling and reporting protocols are not followed. In programs where target coverage is below 100% of trips, a properly designed and implemented deployment scheme is required for dependable estimation of catch to avoid a deployment effect. For characteristics of catch that are only reliably inferred from observer data (e.g., discards), it will typically be impossible to quantify the magnitude of bias and degree to which variance is underestimated in instances where there are deployment effects.

On trips with fishing activities that operate longer than the contracted hours of the observer, a subset of the activities is often used to estimate catch. If the data from the subset of activities cannot be expanded accurately to the total activities within trips, then the quality of the data is affected. For example, fishing activity or catch characteristics of a trip may be different during the day compared to the night and estimates may be biased if observers are only present during the day. Additionally, many of the same limitations and biases described above for coverage below 100% of trips also apply to coverage below 100% of activities within trips which can bias the estimates of catch (e.g., observer effect – see below).

A key challenge in observer programs with less than 100% coverage is meeting the dual goals of monitoring for enforcement and monitoring for representative catch. These two objectives have conflicting ideal sampling schemes (discussed in Benoît and Allard 2009). On one hand, effective enforcement monitoring should be targeted to the vessels most likely to be in non-compliance (Furlong and Martin 2000). On the other hand, effective representative catch monitoring should employ a scheme that allows proper inference to the population (Cotter and Pilling 2007).

Violation of the assumption of statistical exchangeability may also result from a change in behaviour of the fishing crew when an observer is present, commonly referred to as an observer effect (Harris 1998; Benoît and Allard 2009; Faunce and Barbeaux 2011). Factors that can motivate an observer effect include the desire to avoid divulging prime fishing locations, shortening of trips to disembark the observer or to reduce the cost of the observer, fishing in areas where the likelihood of capturing restricted bycatch is lower than in an area that would otherwise be fished should an observer not be present, the capture of discards that would otherwise not be reported in logbooks, and using fishing practices that would not typically be used should an observer not be present. All else being equal, this will result in biased inference for catch commensurate to the degree to which the change in behaviour alters the characteristics of the catch. There is strong evidence that fishers can alter their fishing patterns to modify the amount and species composition of catches when there are incentives to do so, which there often are (e.g., Branch and Hilborn 2008). While it is sometimes possible to test statistically for an observer effect and to estimate its magnitude by comparing observer reports of retained catch and landings (e.g., Allard and Chouinard 1997; Liggins et al. 1997; Benoît and Allard 2009; Faunce and Barbeaux 2011), this is clearly not possible for discarded catch. Quantifying the magnitude of observer effects on discards is therefore not possible with existing technology and methods. However, it may be possible to infer whether an observer effect on discards is likely. This can be achieved by testing for an effect on retained catch (amount and size composition) and by comparing the spatial location and effort of fishing activities associated with an observer and not, provided that statistical power of those tests was sufficiently high.

Indeed the mandatory use of vessel monitoring systems may act as a deterrent for observer effects caused by changes in fishing patterns when an observer is present.

A number of studies have undertaken simulations to show how variation in catch and bycatch estimates changes as observer coverage increases from small percentages to 100% (e.g., Dorn et al. 1997b cited in Karp and McElderry 1999; NMFS 2004; Babcock et al. 2003). The objective is typically to determine coverage levels that are optimal with respect to statistical precision of the estimators and cost. The results of these simulations follow the theoretical patterns expected for a finite population estimator: standard error decreases asymptotically as coverage levels tend to 100%. However, none of these simulations have accounted for deployment and observer effects which can affect both standard error and bias in ways that are difficult to predict. For example, while the magnitude of bias resulting from observer effects is likely to decline monotonically as coverage levels increase, and reach zero at 100% coverage, the exact shape of this relationship and the magnitude of resulting bias are not known. Simulations that ignore deployment and observer effects are therefore likely to provide misleading results for planning observer coverage levels unless these effects are believed to be small because of the procedures that are in place (e.g., mandatory fisher pre-departure notifications) and lack of incentives (or presence of strong disincentives) to modify behaviours when an observer is present.

ELECTRONIC MONITORING SYSTEMS WITH VIDEO

Electronic monitoring systems with video use digital video-recording devices and global positioning systems (GPS) to record fishing operations and catch composition which can later be analyzed. These systems can provide independent electronic catch data and a comprehensive record of fishing activity that can be stored long-term. This allows the data to be audited or referenced at a later date to verify accuracy or clarify discrepancies if desired. In Canada, electronic monitoring with video is currently only being required in the Pacific Region's groundfish and Dungeness Crab fisheries (Appendix 1), though there are pilot projects in other fisheries across Canada.

Electronic monitoring systems with video are used in commercial fisheries. They collect data in a consistent manner and can provide data on both retained and non-retained catch. However, accurate and reliable catch data can be difficult or impossible to obtain in some instances. For example, data are difficult to capture in high volume fisheries where fish do not necessarily pass through restricted locations that are easy to record (e.g., conveyor belt) and in fisheries with species that are similar in form and colour. Electronic monitoring systems with video can provide data on the count and/or size (e.g., length) of fish but cannot directly provide data on the weight of catch, though this can be estimated from counts and sizes. Other issues that can affect data quality include changes to fishing behaviour to ensure catch is captured on video, image quality that affects species identification, image quality that varies as a function of sea conditions or weather, and inadequate camera coverage.

Data from electronic monitoring systems with video can require a lot of time to process and review and therefore an audit approach is typically used, where a predefined subset of video data is reviewed. An advantage of electronic monitoring with video is that it normally provides complete coverage of sampled trips. It is therefore possible to employ optimal sampling strategies when selecting part of the video for detailed analysis, thereby ensuring efficient and unbiased sampling of the available images. Furthermore, electronic monitoring with video allows for optimization of sampling efforts to different parts of the sampling hierarchy (e.g., vessels within the fleet, trips within vessels, and fishing sets within trips), such as to maximize precision for a given subsampling effort. In contrast, such optimization is more problematic in at-sea observer surveys given constraints on the number of available observers and the fact that once an observer is deployed they only sample at one level of this hierarchy (sets within trips).

If all vessels in a fishery are equipped with electronic monitoring with video and the quality of the recorded images is good throughout or if images of poor quality are randomized across available trips, then catch estimates will be unbiased provided an appropriate subsampling strategy is employed. Furthermore, the amount of subsampling required to achieve desired levels of precision can be modified iteratively during the image analysis given that the population of sampled images is available. This could, in principle, be applied to reach target levels of precision in the quantification of catches for certain species. However, if certain vessels or trips do not have electronic monitoring with video, or if the occurrence of poor images varies systematically with some factor that affects catch (e.g., vessel, time of day) then derived estimates of catch may be biased. This is similar to a deployment effect.

A benefit of an electronic monitoring system with video when it is deployed on all vessels in a fishery is that it has an invigilation effect. At the time of fishing, fishers do not know which segments of video will be reviewed to quantify catch. This creates a strong disincentive to deviate from normal fishing practices. All else being equal, observer effects are therefore not expected. However, if fishers are able to alter the video monitoring records, for example by temporarily obscuring the camera view, then observer effects can be considered likely. As with at-sea observer programs, the magnitude of the bias caused by such observer effects will be proportional to both the frequency of these alterations and the degree to which catch differs between regular and altered fishing sets. Another benefit of electronic monitoring systems with video and its inherent invigilation effect is that the accuracy of logbook reporting is also likely to improve when the agreement between logbooks and video is assessed (further described in the Combining Tools section).

FISHING LOCATION AND CATCH COMPOSITION

Fishery monitoring for both compliance and research applications often requires the collection of data for variables in addition to catch, either for ongoing management of the fishery or as an integral part of the assessment-management process. Most notable are data on the spatial locations at which fishing activities occur, whether or not there is catch, and data on the biological or demographic composition of the catch.

FISHING LOCATION

Data on the spatial location of fishing activities are necessary when spatial approaches are used for the management or assessment of fisheries. Spatial management includes the use of closed areas for conservation reasons or to avoid conflicts among fishery sectors or with other industries. Spatial management may also be used to designate fishing areas, in which fishing effort or catch limits are set for specific areas. Information on the spatial location of fishing activities is also used for scientific purposes, including for the standardization of catch-per-unit effort indices for stock assessments, attributing catch to specific assessment/population units, and for evaluations of ecosystem effects of fishing. Fishery monitoring tools that report on fishing locations differ with respect to the spatial resolution (precision), possible inherent bias, and the timeliness of the output data. Management applications in which fishing outside of a permitted area can result in a high likelihood of conflict or ecological harm (e.g., sensitive benthic area closures) may require real-time and highly accurate spatially resolved data to ensure rapid intervention by DFO. Such data are only available from vessel monitoring systems or perhaps ongoing reporting by at-sea observers. In contrast, other applications that are based on catch accounting in large spatial units for quota reconciliation or stock assessment purposes may require less timely and lower resolution data.

The following briefly reviews the timeliness, potential resolution (i.e., precision), and accuracy of fishing location data as provided by the main fishery monitoring tools.

Vessel monitoring systems

A vessel monitoring system (VMS) is a satellite based, near real-time, positional tracking system used to monitor the location of vessels and movement. DFO uses VMS to improve its ability to monitor vessel positions and compliance with current fisheries regulations (such as closed areas) and to guide enforcement activities. VMS provides the latitude, longitude, date and time of vessel locations and, depending on the type of unit, course and speed. There are algorithms available which use these data to partition movement patterns into different components for a fishing trip: steaming, fishing, gear deployment/retrieval, rest (Murawski et al. 2005). In general, vessel speed and course are inferred from averages calculated from successive positions. This method has been shown to be highly accurate (up to 99%) however in some cases it can lead to misclassification of activities and therefore inaccuracies in the estimations of effort (Mills et al. 2007). The data are received in near real-time at pre-determined time intervals and are stored in a centralized database which enables DFO to review and analyze past and current geographical positions of vessels. Unlike most of the other tools discussed in this report, VMS does not provide direct information on catch. However, VMS can be used successfully to validate logbook or other user-reported data on the position, timing, and/or effort of fishing trips (Palmer and Wigley 2009). VMS data also provides a record of vessel trips which can be used to estimate total effort. VMS is increasingly being used in commercial fisheries across Canada, with all regions reporting some commercial fisheries using the monitoring tool. When used, it is usually required on 100% of the vessels prosecuting a fishery (Appendix 1). However, there is less consistency in the type of fishing activity or target species requiring VMS, and implementation of this tool appears to be done on a case-by-case basis.

Logbooks

Logbooks are often used as a self-reported method for the locations of fishing activities. Historically, logbook position data are known to be of low precision and may represent the average location of numerous activities as opposed to activity specific positions (e.g., Palmer and Wigley 2009). In certain circumstances, there may be incentives to misreport such as to not reveal favoured fishing areas, or when harvest activities are occurring in or near prohibited/restricted areas. To the extent that there is a high compliance with completing and returning logbooks, the spatial information for the fleet will be complete. As described in the Logbooks section of Catch Monitoring Tools above, fishers can be required to submit these logbooks at different times, such as when they complete their fishing trip or at the end of the season. Therefore, in situations where timely location data is needed, such as for in-season management measures, the timeliness of logbook information may not be sufficient.

At-sea observers

Information on the location of fishing activity obtained from at-sea observers is likely to be highly accurate because they are generally taken from GPS. In some instances, the information may be transmitted near real time from ship to shore communication by the observer or may be reported only after the trip when the observer delivers their trip report. Assuming that at-sea observers are functioning independently while on-board the vessels and have access to reliable GPS data, their reporting of location of fishing activity should be highly dependable. Poor locational information should be restricted to recorder error, missed recording, and equipment malfunctioning. If observed trips are not spatially representative of the fishery (a deployment effect) or if fishers alter their fishing location in the presence of an observer (observer effect), the observed positions will not reflect those of the fishery.

Fisher questionnaires and creel surveys

Information on the location of fishing activities obtained from fisher questionnaires and creel surveys is usually of low precision. In fisher questionnaires, there may be questions about the general fishing locations that may provide an indication of broad scale fishing location, but precision is low. For creel surveys, information on location of where the survey is undertaken or questions about specific bodies of water visited that day may be recorded, also providing information with low precision. Generally, information is not reported until after the fishing activity has occurred, a delay that may be many days or even months. Timeliness of obtaining the information can also depend on the method used, with, for example, questionnaires by mail taking longer than electronic questionnaires or in-person surveys. Accuracy is limited to the fisher's recall of fishing locations. Information may be biased by intentional non-responses and the need for fisher's to rely on recall which may be biased towards their most successful outings. In most cases, spatial location obtained from fisher questionnaires and creel surveys is less dependable than the tools previously discussed in this section.

BIOLOGICAL OR DEMOGRAPHIC COMPOSITION OF CATCH

Information on the demographic composition of catches is required for in-season fishery management approaches that aim to avoid (or target) particular subsets of targeted or incidentally captured populations, or certain stocks within stock complexes captured in a mixed fishery. Examples of such approaches include:

- spatial sectors of the southern Gulf of St. Lawrence snow crab fishery that are closed as the percentage of soft-shelled crab in the catches exceeds a particular threshold;
- DNA sampling in salmon for in-season management; and
- many groundfish fisheries that employ small fish protocols (size limits) that result in temporary fishery closures when a high proportion of small fish are captured.

These management measures are often put in place to limit the fishing mortality on a particular segment of a population that may have little commercial value (e.g., soft-shelled snow crab) or when mortality disproportionately affects stock productivity (e.g., undersized fish). Alternatively, the catches obtained in some fisheries contain a mixture of stocks or cryptic species which are difficult to attribute to a particular stock. Determining the removals by stock is required to ensure that those removals are in line with the biological productivity of the respective stocks.

Generally, finer examination, often involving sub-sampling, is used to determine the composition of the catch for regulatory or management purposes. This is typically undertaken by a third party, such as at sea-observers or dockside monitors, or by DFO. In-season management measures based on macroscopic traits such as animal length, shell condition, or sex may create an incentive for discarding if there is the potential for fishery closures when particular catch composition thresholds are attained. If such incentives occur, then catch composition determined at sea, prior to or in the absence of discarding (given an observer invigilation effect), is likely to differ from the composition determined at the point of landing, after possible discarding (Allard and Chouinard 1997). However, if the amount of at-sea coverage is small and fishers are able to avoid unwanted catches when an observer is present (i.e., an observer effect; Branch and Hilborn 2008), then the demographic composition of catch measured by observers may not be representative of the composition in the broader fishery (i.e., there is a bias). As observer coverage increases, the magnitude of this bias is expected to decrease monotonically, but not necessarily linearly.

Genetic data has also been used to get accurate estimates of stock composition for in-season management. Microsatellite DNA-based stock identification has been used in the management of mixed stock fisheries to protect weak stocks. For example, genetic analysis of catch provides an in-season estimate of West Coast Vancouver Island (WCVI) Chinook caught and has resulted in fishery closures when the catch of WCVI Chinook met its predetermined mortality allowance (Winther and Beacham 2009).

Catch composition can also be monitored for scientific purposes, particularly when the stock assessment approaches are length or age-based. This sampling is typically undertaken by at-sea observers, or when catches are landed by dockside monitors or DFO personnel, though in some instances self-sampling may be involved. Data needs for scientific purposes are not addressed in this report which instead focusses on data collection for fishery monitoring purposes.

COMBINING TOOLS

Each of the catch monitoring tools discussed in this report has advantages and disadvantages which impact the quality of the data they provide. Combining tools can be a powerful way to maximize advantages and minimize disadvantages (Stanley et al., 2015). Tools may be combined to improve estimates, for verification, or for planning purposes.

For example, if there is complete coverage of a fishery using electronic monitoring with video, its invigilation effect would likely increase the accuracy of other catch monitoring tools when used together. This is most likely when there is either a disincentive for inaccurate reporting (possible charges for discrepancies between electronic monitoring with video and logbook records) or an incentive for accurate reporting. Tying the degree of image subsampling required (a cost to the fisher) inversely to the accuracy of logbooks creates such an incentive (Stanley et al. 2009, 2011). The use of video monitoring and observer coverage as a penalty creates a strong incentive for fishers to fish normally (Furlong and Martin 2000). For example, in the British Columbia groundfish hook-and-line and trap fishery, 100% at-sea monitoring is required however electronic monitoring with video coupled with an audit system is used to defray costs and to eliminate the need for an at-sea monitor on every vessel. These fisheries use electronic monitoring systems with video in audits of logbook data on effort, catch, and catch disposition (Stebbins et al. 2009). In these audits, a randomly selected 10% of the fishing events on the vessels have their videos independently monitored. A low level of agreement between the logbooks and videos can lead to additional audits that are directly funded by the responsible fishermen. Using the electronic monitoring system with video as a cross-reference of data against logbooks improves the level of confidence in catch data reported in logbooks, as the high costs of funding additional audits encourage honest reporting (Zollett et al. 2011).

Fisher pre-departure and pre-arrival notifications are frequently used for planning related to other monitoring tools which can improve the quality of the data obtained. For example, fisher pre-departure notifications can allow observer companies to plan deployment of at-sea observers which may reduce observer effects. As another example, fisher pre-arrival notifications can allow dockside monitoring companies to plan their dockside verification activities which may improve the sampling scheme employed.

Combining the use of at-sea observers with dockside monitoring may be used for verification and could highlight potential issues. For example, using dockside monitoring and at-sea observers may allow for detection of possible high-grading, where less valuable fish are discarded at sea to limit landings to more valuable fish. Fish measurements made by at-sea observers can be compared to those made by dockside monitors. Discrepancies may suggest that high-grading is occurring, which may warrant additional monitoring if this is a concern.

There are many ways tools can be combined, which cannot all be discussed in this report. Using complementary tools can increase the accuracy and precision of fisheries estimates, as some examples in this report have highlighted. Where tools are used together, the dependability of the information needs to be evaluated jointly.

PERSPECTIVES

This report provides an overview of the type and use of fishery monitoring tools in Canadian fishery monitoring programs. The characteristics of the different tools are described in general terms, as are the expected impacts on the quality of the data they produce and the dependability of the inferences that are drawn. A companion report provides a detailed assessment framework for the quality and dependability of fishery monitoring programs (Allard and Benoît 2019). It elaborates on the statistical properties of fishery monitoring censuses and surveys, as well as operational factors that affect the bias and variability of inferences made from fishery monitoring data, such as deployment and observer effects. The two reports are intended to jointly serve as the basis for the evaluation of existing monitoring programs, and the planning of new or altered programs in the future, as part of the forthcoming fishery monitoring policy. The present report provides options for catch monitoring, including associated limitations and considerations, while Allard and Benoît (2019) provide a means of quantifying whether and how existing or planned programs meet operational objectives in light of these limitations and considerations. The reports are therefore complementary.

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APPENDICES

Table A1. Survey of Canadian fishery monitoring in the Central and Arctic Region. Note: this table is a summary of responses received and is neither an official listing of all of Canada's fisheries nor is it meant to be an official source of the listed fishery's monitoring tools or coverage levels. (VMS = vessel monitoring system, ASOP = at-sea observer program)

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online/paper survey	Purchase slips	Hail-in	Hail-out	Comments
Greenland Halibut – NAFO 0A	--	100%	100%	--	100%	100% (in Canada)	--	--	--	Yes		Yes	--
Greenland Halibut – NAFO 0B	--	100%	100%	--	100%Mobile gear, 20%Fixed gear	100% (in Canada)	--	--	--	Yes		Yes	--

Table A2. *Survey of Canadian fishery monitoring in the Gulf Region. Note: this table is a summary of responses received and is neither an official listing of all of Canada's fisheries nor is it meant to be an official source of the listed fishery's monitoring tools or coverage levels. (VMS = vessel monitoring system, ASOP = at-sea observer program)*

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online / paper survey	Purchase slips	Hail -in	Hail -out	Comments
Herring 4T (Fall Spawner)	Fixed gear / Gillnet	--	--	--	--	100%	--	--	--	Yes	Yes	No	--
Herring 4T (Fall Spawner)	Mobile gear	100%	100%	--	20%	100%	--	--	--	Yes	Yes	Yes	--
Herring 4T (Spring Spawner)	Fixed gear	--	--	--	--	100%	--	--	--	Yes	Yes	No	--
Lobster - Prince Edward Island trap Fishery	Trap	100%	--	--	0% *	--	--	--	--	--	--	--	Science ASOP run by Province of PEI; no set coverage
Lobster Southern Gulf - LFA 23,24,25,26A, 26B	Trap	100%	--	--	--	--	--	--	--	Yes	No	No	--
Plaice (American), Southern Gulf of St. Lawrence - 4T	Mobile gear	100%	--	--	25%	100%	--	--	--	Yes	Yes	No	--
Rock crab 23, 24, 25, 26A	Trap	100%	--	--	--	100%	--	--	--	Yes	No	No	--

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online / paper survey	Purchase slips	Hail -in	Hail -out	Comments
Scallop - South Gulf of St. Lawrence (SFA 21a, b, c, 22-24)	Drag	100%	--	--	--	--	--	--	--	Yes	No	No	Recreational Scallop Report sent to DFO
Snow Crab - CFA 12, 12E, 12F, 19	Trap	100%	100%	--	20%	100%	--	--	--	Yes	Yes	No	--
Winter & Witch Flounders 4RST	Mobile gear	100%	--	--	5 - 25%	100%	--	--	--	Yes	Yes	No	--

Table A3. Survey of Canadian fishery monitoring in the Maritimes Region. Note: this table is a summary of responses received and is neither an official listing of all of Canada's fisheries nor is it meant to be an official source of the listed fishery's monitoring tools or coverage levels. (VMS = vessel monitoring system, ASOP = at-sea observer program)

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online / paper survey	Purchase slips	Hail -in	Hail -out	Comments
Atlantic Bluefin Tuna	Rod and reel/ trolling & Offshore /pelagic longline	100%	--	--	5%	100%	--	--	--	No	Yes	Yes	--
Atlantic Bluefin Tuna	Trap	100%	--	--	--	100%	--	--	--	No	Yes	Yes	--

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online / paper survey	Purchase slips	Hail -in	Hail -out	Comments
Atlantic Canada Dogfish – 4VWNX -5	Fixed gear <45' (longline)	100%	Most *	--	5 - 10%	25% most areas; (except 100% 4VTn)	--	--	--	No	Yes	Yes	VMS: required for fixed gear <45'; required for all except handline-only vessels **or** vessels restricted to 35'.
Atlantic Cod - 5Zjm	Fixed gear <65' (longline, gillnet)	100%	100 %	--	25%, (100% in June)	100%	--	--	--	No	Yes	yes	--
Atlantic Cod - 4X5Y	Fixed gear <45' (Longline, gillnet, handline)	100%	Most *	--	5 - 10%	25%; 100% if ≥ 150lbs Atlantic halibut	--	--	--	No	Yes	Yes	VMS as for Dogfish;
Atlantic Halibut 3NOPs4VWX +5	Fixed gear <45' (longline)	100%	Most *	--	5 -10%	most*	--	--	--	No	Yes	Yes	VMS as for Dogfish; DMC: 100% for 4TVn; 100% in 4VsW if ≥500lbs of Halibut onboard; 100% in 4X5Y if ≥ Halibut is onboard; all other trips 25%

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online / paper survey	Purchase slips	Hail -in	Hail -out	Comments
Atlantic Halibut 3NOPs4VWX +5	Fixed Gear 45'-65' (longline)	100%	100 %	--	5 - 10%	100%	--	--	--	No	Yes	yes	--
Atlantic Halibut 3NOPs4VWX +5	Fixed Gear > 65' (longline)	100%	100 %	--	10 - 20%	100%	--	--	--	No	Yes	Yes	Hail-outs are required 24h in advance in NL Region, prior to departure in MAR;
Eel (Large)	--	100%	N/A	N/A	N/A	--	--	--	--	No	No	No	VMS/ASOP - N/A, not a non-vessel-based fishery
Elvers	--	100%	N/A	N/A	N/A	Yes; variable*	--	--	--	No	Yes	Yes	VMS/ASOP - N/A, not a non-vessel-based fishery. DMP: 100% sold from holding facilities; each licence has 3 monitored offloads (river - holding facility)
Flounders 4VW	Groundfish Mobile Gear	100%	100 %	--	5 - 10%	100%	--	--	--	No	yes	Yes	--

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online / paper survey	Purchase slips	Hail -in	Hail -out	Comments
Gaspereau	Gill nets, trap nets, dip nets	100%	--	--	--	--	--	--	--	No	No	No	--
Haddock 4X5Y	Fixed Gear <45' (longline)	100%	Most *	--	5 - 10%	25%; 100% if ≥ 150lbs Atlantic halibut	--	--	--	No	Yes	Yes	VMS as for Dogfish; DMC requirements - 25%; 100% if ≥ 150lb Atlantic Halibut is onboard
Haddock 4X5Y	Groundfish Mobile Gear	100%	100 %	--	5 - 10%	100%	--	--	--	No	Yes	Yes	observer coverage targets are 5-10% at minimum, temporarily at 33% due to concerns about Pollock bycatch
Haddock 5Zjm	Fixed Gear <45' (longline)	100%	100 %	--	Min 25%; (100% in June)	100%	--	--	--	No	Yes	Yes	--

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online / paper survey	Purchase slips	Hail -in	Hail -out	Comments
Haddock 5Zjm	Groundfish Mobile Gear	100%	100 %	--	Min 25% (in CHP), usually 50-100% Winter & Summer	100%	--	--	--	No	Yes	Yes	--
Herring 4VWX	Purse Seine	100%	100 %	--	5%	100%	--	--	--	No	Yes	Yes	VMS: 15 min reporting from Oct 1-Oct 14, hourly reporting rest of the year
Herring 4VWX	Gillnet	100%	--	--	--	20%; (100% if roe present)	--	--	--	No	Yes	Yes	--
Herring 4VWX	Weir, Trapnet	100%	N/A	N/A	N/A	20%*	--	--	--	No	Yes	Yes	VMS, at-sea observers - N/A, this is a non-vessel-based fishery; DMP 20% of weir catch that is landed by herring carrier

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online / paper survey	Purchase slips	Hail -in	Hail -out	Comments
Herring 5Y, 5Z (weirs)	Weir	100%	N/A	N/A	N/A	10%*	--	--	--	No	Yes	Yes	VMS, at-sea observers - N/A, this is a non-vessel-based fishery; DMP 10% of weir catch that is landed by herring carrier
Lobster - Inshore LFA 28, 29, 30, 33, 34, 35-38	Trap	100%	--	--	--	--	--	--	--	No	no	no	Re column N: base-line at-sea sampling related to bycatch monitoring conducted in LFAs 29 & 30
Lobster - Inshore LFA 38B (Grey Zone)	Trap	100%	100 %	--	--	20%	--	--	--	No	Yes	yes	--
Lobster - Inshore LFAs 27, 31A, 31B, 32	Trap	100%	--	--	Variabl e*	--	--	--	--	No	no	no	ASOP: industry-funded science technicians conduct at-sea observation s

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online / paper survey	Purchase slips	Hail -in	Hail -out	Comments
Lobster - Offshore LFA 41	Trap	100%	100 %	--	6 trips	100%	--	--	--	No	Yes	yes	--
Pollock 4X5 (West Comp. 4Xopqrs5 + Eastern Comp. 4Xmn)	Fixed Gear <45' (gillnet, handline)	100%	Most *	--	5 - 10%	25%; 100% if ≥ 150lbs Atl halibut	--	--	--	No	yes	Yes	VMS as for Dogfish; DMC requirement s - 25%; 100% if ≥ 150lb Atlantic Halibut is onboard
Pollock 4X5 (West Comp. 4Xopqrs5 + Eastern Comp. 4Xmn)	Fixed Gear 45'-65' (gillnet) + Groundfis h MG	100%	100 %	--	5 - 10%	100%	--	--	--	No	yes	Yes	for groundfish mobile gear fishery observer coverage target is temporarily set to 33%
Redfish Unit 2	Groundfis h Mobile Gear	100%	100 %	--	5 - 20%	100%	--	--	--	No	Yes	Yes	--
Redfish Unit 3	Groundfis h Mobile Gear	100%	100 %	--	10 - 20%	100%	--	--	--	No	Yes	yes	--
Sea Scallop - Inshore SFA 28 (Bay of Fundy)	Drag	100%	100 %	--	--	100% and 20%*	--	--	--	No	Yes	Yes	Full Bay fleet - 100%; Upper Bay fleet 100%; Mid Bay fleet 20%

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online / paper survey	Purchase slips	Hail -in	Hail -out	Comments
Sea Scallop - Inshore SFA 29W	Drag	100%	100 %	--	1 sea day per active vessel	100%	--	--	--	No	Yes	Yes	--
Sea Scallop - Offshore SFA 26 German, Browns	Drag	100%	100 %	--	1 trip per year per bank	100%	--	--	--	No	Yes	Yes	--
Sea Scallop - Offshore SFA 27, Georges	Drag	100%	100 %	--	2 trips per month	100%	--	--	--	No	Yes	Yes	--
Shrimp (Scotian Shelf) - SFA 13-15	Mobile	100%	100 %	--	1 per area (3 trips per season)	100%	--	--	--	No	Yes	yes	--
Shrimp (Scotian Shelf) - SFA 13-15	Trap	100%	--	--	1 per area	20%	--	--	--	No	Yes	yes	--
Silver Hake 4VWX	Groundfish Mobile Gear	100%	100 %	--	5 - 10%	100%	--	--	--	No	Yes	Yes	--
Snow Crab (Scotian Shelf) 4X, ENS-S	Trap	100%	100 %	--	5%	100%	--	--	--	No	Yes	Yes	--
Snow Crab (Scotian Shelf) ENS-N	Trap	100%	--	--	5%	100%	--	--	--	No	Yes	Yes	--

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online / paper survey	Purchase slips	Hail -in	Hail -out	Comments
Surf Clam - Banquereau & Grand Bank	Dredge	100%	100 %	--	~10%*	100%	--	--	--	No	No	No	ASOP deployed "as required"; recently about 10% of trips
Swordfish (Atlantic)	Harpoon	100%	--	--	5%	100%	--	--	--	No	Yes	Yes	--
Swordfish (Atlantic)	Longline	100%	100 %	--	5%	100%	--	--	--	No	Yes	Yes	--
Winter Flounder 4X5Y	Groundfish Mobile Gear	100%	100 %	--	5 - 10%	100%	--	--	--	No	Yes	Yes	--

Table A4. Survey of Canadian fishery monitoring in the Pacific Region. Note: this table is a summary of responses received and is neither an official listing of all of Canada's fisheries nor is it meant to be an official source of the listed fishery's monitoring tools or coverage levels. (VMS = vessel monitoring system, ASOP = at-sea observer program)

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online/paper survey	Purchase slips	Hail -in	Hail -out	Comments
Clam, Geoduck	Dive	100%	--	--	--	100%	--	--	--	Yes	Yes	Yes	--
Clam, Intertidal (Manila, Littleneck, Butter and Razor clams)	Rake	--	--	--	--	--	--	--	--	Yes	No	No	--
Dungeness Crab - CMA A, B, E, G, H, I, J	Trap	100%	100 % when no ASOP	100%	100% (when no EM)	--	--	--	--	Yes	Yes	Yes	Red Rock and King crabs can be retained
Dogfish	Groundfish Trawl - Option A	100%	100 %	--	100%	100%	--	--	--	Yes	Yes	Yes	--
Dogfish	Groundfish Trawl - Option B	100%	100 %	100%	--	100%	--	--	--	Yes	Yes	Yes	--
Dogfish	Groundfish*	100%	100 %	100%	--	100%	--	--	--	Yes	Yes	Yes	Hook and Line and Trap: Halibut, Sablefish, Rockfish, Lingcod and Dogfish Hook and Line and Trap fisheries

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online/paper survey	Purchase slips	Hail -in	Hail -out	Comments
Euphausiids	Trawl	100%	--	--	--	100%	--	--	--	Yes	Yes	Yes	--
Hake, Pacific	Groundfish Trawl - Option A *	100%	100 %	100%	100%	100%	--	--	--	Yes	Yes	Yes	Freezer trawlers must have ASOP, others can use EM
Hake, Pacific	Groundfish Trawl - Option B	100%	100 %	100%	--	100%	--	--	--	Yes	Yes	Yes	--
Halibut, Pacific	Groundfish Trawl - Option A *	100%	100 %	--	100%	100%	--	--	--	Yes	Yes	Yes	Prohibited species
Halibut, Pacific	Groundfish Trawl - Option B *	100%	100 %	100%	--	100%	--	--	--	Yes	Yes	Yes	Prohibited species
Halibut, Pacific	Groundfish *	100%	100 %	100%	--	100%	--	--	--	Yes	Yes	Yes	Hook and Line and Trap: Halibut, Sablefish, Rockfish, Lingcod and Dogfish Hook and Line and Trap fisheries
Herring, Pacific	Roe - Seine & Gillnet	--	--	--	--	100%	--	--	--	No	Yes	Yes	--
Herring, Pacific	Food & Bait - Seine	100%	--	--	100%	100%	--	--	--	Yes	Yes	Yes	--
Herring, Pacific	SOK	100%	--	--	--	100%	--	--	--	Yes	Yes	Yes	Ponded & Unponded

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online/paper survey	Purchase slips	Hail -in	Hail -out	Comments
Herring, Pacific	Special Use - ZX	--	--	--	--	--	--	--	--	No	No	No	--
Herring, Pacific	Special Use - ZY	100%	--	--	--	--	--	--	--	No	Yes	Yes	For landings of < 50 t & < 500 pieces
Herring, Pacific	Special Use - ZY over 50 tons	100%	--	--	50%	100%	--	--	--	Yes	Yes	Yes	--
Lingcod, Pacific	Groundfish Trawl - Option A	100%	100 %	--	100%	100%	--	--	--	Yes	Yes	Yes	--
Lingcod, Pacific	Groundfish Trawl - Option B	100%	100 %	100%	--	100%	--	--	--	Yes	Yes	Yes	--
Lingcod, Pacific	Groundfish *	100%	100 %	100%	--	100%	--	--	--	Yes	Yes	Yes	Hook and Line and Trap: Halibut, Sablefish, Rockfish, Lingcod and Dogfish Hook and Line and Trap fisheries
Spot Prawn	Trap	100%	100 %	--	100%	--	--	--	--	Yes	Yes	Yes	--
Rockfish	Groundfish Trawl - Option A	100%	100 %	--	100%	100%	--	--	--	Yes	Yes	Yes	--

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online/paper survey	Purchase slips	Hail -in	Hail -out	Comments
Rockfish	Groundfish Trawl - Option B	100%	100 %	100%	--	100%	--	--	--	Yes	Yes	Yes	--
Rockfish	Groundfish *	100%	100 %	100%	--	100%	--	--	--	Yes	Yes	Yes	Hook and Line and Trap: Halibut, Sablefish, Rockfish, Lingcod and Dogfish Hook and Line and Trap fisheries
Sablefish	Groundfish Trawl - Option A	100%	100 %	--	100%	100%	--	--	--	Yes	Yes	Yes	--
Sablefish	Groundfish Trawl - Option B	100%	100 %	100%	--	100%	--	--	--	Yes	Yes	Yes	--

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online/paper survey	Purchase slips	Hail -in	Hail -out	Comments
Sablefish	Groundfish *	100%	100 %	100%	--	100%	--	--	--	Yes	Yes	Yes	Hook and Line and Trap: Halibut, Sablefish, Rockfish, Lingcod and Dogfish Hook and Line and Trap fisheries
Salmon, Chinook - NC AABM	--	100%	--	--	Some*	Area F Troll - Demo Chinook ITQ: 100%; 0% (others)	--	--	--	Yes	Yes	Yes	ASOP: Area A Seine derby: 8 observer days for 60 observed sets; "No" for the others
Salmon, Chinook - WCVI AABM	--	100%	--	--	--	--	--	--	--	--	--	--	--
Salmon, Chinook - Yukon River	--	100%	--	--	--	--	--	--	--	--	--	--	--
Salmon, Chum - Southern Inside	**--**	100%	--	--	--*	Area H troll - ITE: 100% No for the others	--	--	--	Yes	Yes	Yes	ASOP: Area H troll - ITE: limited ASOP coverage in 2011 by JOT observers; No for "Area D Gillnet - derby" & "Area B Seine - derby"

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online/paper survey	Purchase slips	Hail -in	Hail -out	Comments
Salmon, Coho - North Coast	--	100%	--	--	Some*	Area F Troll - Demo Chinook ITQ: 100%; 0% (others)	--	--	--	Yes	Yes	Yes	ASOP: Area A Seine derby: 8 observer days for 60 observed sets; "No" for the others
Salmon, Coho - Southern Inside	--	100%	--	--	--	--	--	--	--	--	--	--	--
Salmon, Pink - Fraser River	--	100%	--	--	Some*	100%	--	--	--	Yes	Vari able	Vari able	ASOP: No for Lower Fraser gillnet fisheries; Yes for the others
Salmon, Pink - North Coast	--	100%	--	--	Some*	Area F Troll - Demo Chinook ITQ: 100%; 0% (others)	--	--	--	Yes	Yes	Yes	ASOP: Area A Seine derby: 8 observer days for 60 observed sets; "No" for the others
Salmon, Sockeye - Fraser River	--	100%	--	--	Some*	100%	--	--	--	Yes	Vari able	Vari able	ASOP: No for Lower Fraser gillnet fisheries; Yes for the others
Salmon, Sockeye - Skeena and Nass Rivers	--	100%	--	--	--	--	--	--	--	Yes	No	No	--

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online/paper survey	Purchase slips	Hail -in	Hail -out	Comments
Salmon, Sockeye - Somass River	--	100%	--	--	--	--	--	--	--	Yes	Yes	Yes	--
Salmon, Sockeye - Stikine River	--	100%	--	--	--	--	--	--	--	--	--	--	--
Spiny and Pink scallop (areas 12-29)	Trawl	100%	--	--	*	--	--	--	--	Yes	Yes	Yes	*Only if compliance with landing hails is poor
Sea Cucumber	Dive	100%	--	--	--	100%	--	--	--	Yes	Yes	Yes	--
Sea Urchin, Green	Dive	100%	--	--	--	100%	--	--	--	Yes	Yes	Yes	--
Sea Urchin, Red	Dive	100%	Pilot	--	--	100%	--	--	--	Yes	Yes	Yes	--
Shrimp	Trawl	100%	--	--	Var.	100%	--	--	--	Yes	Yes	Yes	--
Shrimp	Trap	100%	100 %	--	100%	--	--	--	--	Yes	Yes	Yes	--
Tuna, Albacore	--	100%	100 %	--	--	--	--	--	--	Yes	Yes	Yes	CND / USA EEZ and offshore

Table A5. Survey of Canadian fishery monitoring in the Quebec Region. Note: this table is a summary of responses received and is neither an official listing of all of Canada's fisheries nor is it meant to be an official source of the listed fishery's monitoring tools or coverage levels. (VMS = vessel monitoring system, ASOP = at-sea observer program)

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online/paper survey	Purchase slips	Hail -in	Hail -out	Comments
Crabe commun Sous-zones 17A-C & 12D-Z	Trap	100%	--	--	--	variable	--	--	--	--	Yes	No	--
Snow Crab - 12F	Trap	100%	100 %	--	4,5 - 20% *	100%	--	--	--	--	Yes	Yes	* selon % crabe blanc
Snow Crab - 13	Pêche index /Trap	100%	100 %	--	2,5% min.	100%	--	--	--	--	Yes	Yes	* selon % crabe blanc
Snow Crab - 17	Trap	100%	100 %	--	15% min.	100%	--	--	--	--	Yes	Yes	[1] : pour le SSN, le délai de transmission du signal a été indiqué dans la colonne Q lorsque disponible
Snow Crab 16	Trap	100%	100 %	--	7 - 15% *	100%	--	--	--	--	Yes	Yes	--
Herring 16A, 16B, 16D	filet maillant, seine bourse, trappe	100%	--	--	--	25%	--	--	--		Yes	No	--
Herring 15 4S	Gillnet	100%	--	--	25%	--	--	--	--	Yes	Yes	No	--
Herring 15 4S	Seine	100%	100 %	--	25%	--	--	--	--	Yes	Yes	No	--

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online/paper survey	Purchase slips	Hail -in	Hail -out	Comments
Lobster Gaspé - Zones 19-21 et I.M. Zone 22	Trap	100%	--	--	--	--	--	--	--	--	No	No	--
Lobster HMCN - 17A-B, 18B-D, 18G-H	Trap	100%	100 %	--	--	--	--	--	--	--	Yes	No	SSN: 17A-B seulement
Northern Shrimp Fishery - SFA 8, 9, 10, 12	Shrimp trawl	100%	100 %	--	5%	100%	--	--	--	Yes	Yes	Yes	--
Phoque du Groënland CN et Phoque gris	Strike*	100%	--	--	On dema nd	--	--	--	--	--	App el jour nali er	No	* Commercial fishery only
Phoque du Groënland IDLM	Strike*	100%	--	--	On dema nd	--	--	--	--	--	App el jour nali er	Yes	* Commercial fishery only
Lumpfish 4S EF CN	A-52 vessel class in 4S (<45'), FG GN	100%	--	--	10% *	--	--	--	--	Yes	No	Yes	ASO put in place in 2010. Very few fishing activities since and no activity has ever been cover by ASO

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online/paper survey	Purchase slips	Hail -in	Hail -out	Comments
Redfish Unit 1	(G+I.M.) - 4RST MG	100%	Optional	--	25% (no-VMS); 10% (w/VMS)	100%	--	--	--	Yes	Yes	Yes	Fishery under moratorium; has a 2,000 t index fishery
Redfish Unit 1	(Madelipêche) - 4RST	100%	100 %	--	25% (10% pour SSN)	100%	--	--	--	Yes	Yes	Yes	Fishery under moratorium; has a 2,000 t index fishery
Thon rouge 4RST	Vessel <65'	100%	--	--	Var.	100%	--	--	--	--	Yes	Yes	--
Greenland Halibut 4RST	Que FG <65', ITQ	100%	100 %	--	5%	100%	--	--	--	Yes	Yes	Yes	--
Greenland Halibut 4RST	Gaspe Lower StL FG ≥45' ITQ LL, grp 1&2	100%	100 %	--	15%	100%	--	--	--	Yes	Yes	Yes	--
Greenland Halibut 4RST	Lower North shore, FG, ITQ	100%	100 %	--	5%	100%	--	--	--	Yes	Yes	Yes	--
Greenland Halibut 4RST	Gaspe-Lower StL, FG, <45'	100%	100 %	--	5%	100%	--	--	--	Yes	Yes	Yes	--

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online/paper survey	Purchase slips	Hail -in	Hail -out	Comments
Cod 3Pn, 4RS	FG, Que North Shore, Competitif vessel <50'	100%	--	--	5%	100%	--	--	--	Yes	Yes	Yes	There is a recreational fishery for 3Pn 4RS cod but not by this fleet.
Cod 3Pn, 4RS	Gaspe - Lower StL FG ≥45' ITQ	100%	100 %	--	20%	100%	--	--	--	Yes	Yes	Yes	There is a recreational fishery for 3Pn 4RS cod but not by this fleet.
Atlantic Halibut 4RST	Que - Gaspe Lower StL FG ≥45' ITQ LL	100%	100 %	--	20%	100%	--	--	--	Yes	Yes	Yes	--
Atlantic Halibut 4RST	Gaspe Lower StL, FG<45', Lobster group A125 & Competitive A127;	100%	--	--	10%	100%	--	--	--	Yes	Yes	Yes	--

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online/paper survey	Purchase slips	Hail -in	Hail -out	Comments
Atlantic Halibut 4RST	Lower North shore East & West competitive & M.I. RPPUM & Upper Middle North Shore <65' competitive	100%	--	--	10%	100%	--	--	--	Yes	Yes	Yes	--
Atlantic Halibut 4RST	Gaspe Lower StL, FG <45', Turbot A124 & IQ AMTG	100%	100 %	--	10%	100%	--	--	--	Yes	Yes	Yes	--
Capelin 4S zone 15	comp. Purse seine	100%	100 %	--	sporadic	--	--	--	--	Yes	No	No	--
Capelin 4S zone 15	Beach seine / comp. Trap	100%	--	--	sporadic	--	--	--	--	Yes	No	No	--
Mackerel	Qc fleet, zone 15 & 16	--	--	--	--	25%	--	--	--	--	Yes	No	--
Scallop IM - Zone 20	drag	100%	100 %	--	--	100%	--	--	--	Yes	Yes	no	--

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online/paper survey	Purchase slips	Hail -in	Hail -out	Comments
Scallop - Zones 16A1, 16C	drag	100%	100 %	--	5%	100 (16C) 0-16A	--	--	--	Yes	Yes	Yes	--
Scallop - Zones 16A2, 16B,16D, 16G, 18D	drag	100%	--	--	--	--	--	--	--	Yes	Yes	No	--
Scallop - Zones 17,18B-C, 19	drag	100%	100 %	--	5% (17A1)	100% (18C)	--	--	--	Yes	Yes	Yes (17 A1)	--
Scallop - Zone 16E, 16F, 18A	drag	100%	100 %	--	--	--	--	--	--	Yes	Yes	No	--
Scallop - Zones 15, 16H-I	--	100%	--	--	--	100%	--	--	--	Yes	Yes	No	--
Stimpson's surfclam IM - Zone 5	Hydrolic dredge	100%	--	--	--	sporadic	--	--	--	Yes	Yes	No	--
Atlantic surfclam IM zone 5	Hand tools	100%	--	--	--	Call	--	--	--	Yes	Yes	Yes	--
Atlantic surfclam IM zone 5	ITQ, Dredge	100%	--	--	5%	100%	--	--	--	Yes	Yes	Yes	--
Whelk - Zone 8	Comp.	100%	--	--	--	--	--	--	--	Yes	No	No	--
Whelk - Gaspésie Zones 11-14	Comp.	100%	--	--	--	--	--	--	--	Yes	Yes	No	--
Whelk - HMCN	Comp.	100%	--	--	--	--	--	--	--	Yes	Yes – Z. 1-2	No	--

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online/paper survey	Purchase slips	Hail -in	Hail -out	Comments
Zones 1-7 & 9													
Sea urchin CN Zone 9-1	--	100%	100 %	--	Yes	100%	--	--	--	--	yes	no	--
Sea cucumber	CN	100%	100 %	--	--	--	--	--	--	--	No	NO	--
Sea cucumber	Gaspési e	100%	100 %	--	30% min with SSN 5 min. or 100%	100%	--	--	--	--	Yes	Yes	DMP 100% but 10% weighted
Toad crab CN Zone CN1 -CN4	Trap	100%	--	--	--	--	--	--	--	--	Yes	no	--
Toad crab IM Zone 12	Trap	100%	--	--	--	25%	--	--	--	--	Yes	no	--
Greenland Halibut – NAFO 0A	--	100%	100 %	--	100%	100% (in Canada)	--	--	--	Yes	--	Yes	--
Greenland Halibut – NAFO 0B	--	100%	100 %	--	100% MG, 20%F G	100% (in Canada)	--	--	--	Yes	--	Yes	--

Table A6. *Survey of Canadian fishery monitoring in the National Capital Region. Note: this table is a summary of responses received and is neither an official listing of all of Canada's fisheries nor is it meant to be an official source of the listed fishery's monitoring tools or coverage levels. (VMS = vessel monitoring system, ASOP = at-sea observer program)*

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online / paper survey	Purchase slips	Hail-in	Hail-out	Comments
N. Shrimp (Borealis & montagui) – EAZ & SFA 1	Trawl	100%	100%	--	100%	--	--	--	--	No	Yes	--	--
N. Shrimp SFA 4	Offshore - Trawls	100%	100%	--	100%	--	--	--	--	No	Yes	--	--
N. Shrimp SFA 4	Inshore	100%	100%	--	10%	100%	--	--	--	Yes	No	No	--
N. Shrimp SFA 4 montagui	Offshore - Trawls	100%	100%	--	100%	--	--	--	--	No	Yes	--	--
N. Shrimp SFA 5	Offshore - Trawls	100%	100%	--	100%	--	--	--	--	No	Yes	--	--
N. Shrimp SFA 5	Inshore	100%	100%	--	10%	100%	--	--	--	Yes	No	No	--
N. Shrimp SFA 6	Offshore - Trawls	100%	100%	--	100%	--	--	--	--	--	Yes	--	--
N. Shrimp SFA 6	Inshore	100%	100%	--	10%	100%	--	--	--	Yes	No	No	--
N. Shrimp WAZ borealis & montagui	Offshore - trawl	100%	100%	--	100%	--	--	--	--	--	Yes	--	--

Table A7. *Survey of Canadian fishery monitoring in the Newfoundland and Labrador Region. Note: this table is a summary of responses received and is neither an official listing of all of Canada's fisheries nor is it meant to be an official source of the listed fishery's monitoring tools or coverage levels. (VMS = vessel monitoring system, ASOP = at-sea observer program)*

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online / paper survey	Purchase slips	Hail -in	Hail -out	Comments
Capelin: 4RST, SA2+3KLPs	(Fixed gear & mobile gear) Gillnet, barr siene, purse seine	100%	MG only	--	Var.	100%	--	--	--	Yes	Yes	No	--
Cod – 2J3KL (Northern)	gillnets, longline, handline and traps	100%	Vessel >35'	--	5%	100%	--	--	--	Yes	Yes	No	--
Cod – 3Ps (Atlantic)	Longline & mobile gear bottom	100%	Vessel >35'	--	10%	100%	--	--	--	Yes	Yes	No	--
Greenland Halibut 2-3KLMNO	Fixed gear - Gillnet, longline, pots; Mobile Gear - Trawl	100%	100%	--	5%	100%	--	--	--	Yes	Yes	Yes	inshore

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online / paper survey	Purchase slips	Hail -in	Hail -out	Comments
Herring 2J3IKLPs	(Fixed gear & mobile gear) Gillnet, barr siene, purse seine	100%	100% MG; ? FG	--	Var.	100%	--	--	--	Yes	Yes	No	--
Herring 4R (Spring Spawner)/ Herring 4R (Fall Spawner)	(Fixed gear & mobile gear) Gillnet, barr siene, purse seine	100%	MG	--	Var.	100%	--	--	--	Yes	Yes	No	--
Lobster – LFA 3 - 14C	--	100%	--	--	--	--	--	--	--	Yes	No	No	--
Queen / Snow Crab - 2GHJ3KLNO Ps, 4R3Pn	Trap	100%	*	--	No target	100%	--	--	--	Yes	No	No	100% mid-offshore; inshore 0%
Redfish: 3LN, 3O, Unit 2	Mobile gear - Bottom	100%	100%	--	5%	100%	--	--	--	Yes	Yes	No	--
Skate 3LNO	Fixed gear Gillnets	100%	Vessel >35'	--	5%	100%	--	--	--	Yes	Yes	No	--
Skate 3LNO	Mobile gear - Bottom	100%	100%	--	5%	100%	--	--	--	Yes	Yes	No	--
Whelk – 2J3K3L4R	Trap	--	--	--	--	--	--	--	--	Yes	No	No	--

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online / paper survey	Purchase slips	Hail -in	Hail -out	Comments
Whelk – 3PS	Trap	100%	100%	--	No target	100%	--	--	--	Yes	No	No	--
White Hake – 3NOPs	Fixed gear - Gillnet, Longline	100%	Vessel >35'	--	5%	100%	--	--	--	Yes	Yes	No	--
Witch Flounder – 3NO	Mobile gear - Bottom	100%	100%	--	5%	100%	--	--	--	Yes	Yes	No	--
Yellowtail Flounder	Mobile gear - Bottom	100%	100%	--	25%	100%	--	--	--	Yes	Yes	No	--
Lumpfish 3Pn 4R	Fixed gear, Vessel > 35'	100%	--	--	5%	0%; DMP bycatch landed	--	--	--	--	Yes	--	--
Lumpfish 3Pn 4R	Fixed gear, Vessel < 35'	0%*	--	--	5%	0%; DMP bycatch landed	--	--	--	--	No	--	*Science specific logbook returned to DFO science
Greenland Halibut 4RST 3Pn 4R	Fixed gear. Vessel class A283 and ≥35'	100%	100%	--	10%	100%	--	--	--	--	Yes	Yes	--
Greenland Halibut 4RST 3Pn 4R	Fixed Gear NL fisher, < 35'	0%*	--	--	10%	100%	--	--	--	--	Yes	Yes	*Science specific logbook returned to DFO science
Cod 3Pn, 4RS	NL Fixed Gear	100%	--	--	5%		--	--	--	--			--

Stock	Fleet or fishing method	Logbook	VMS	Camera	ASOP	Dockside monitoring	Creel	Interviews	Online / paper survey	Purchase slips	Hail -in	Hail -out	Comments
Atlantic Halibut 4RST 3Pn 4R	Fixed Gear, Vessel < 35'	0%*	--	--	10%	100%	--	--	--	--	Yes *	Yes	* Science specific logbook returned to DFO science
Atlantic Halibut 4RST 3Pn 4R	Fixed Gear, Vessel < 45'	100%	--	--	10%	100%	--	--	--	--	Yes *	Yes	*fishing trips in 4RST & 3Pn > 24 hrs and/or landing in ports outside the N&L, fishers required to hail in to DFO on the 2nd and each subsequent day.
Atlantic Halibut 4RST 3Pn 4R	Fixed Gear, Vessel > 45'	100%	--	--	15%	100%	--	--	--	--	Yes *	Yes	*fishing trips in 4RST & 3Pn > 24 hrs and/or landing in ports outside N&L, fishers required to hail in to DFO on the 2nd and each subsequent day.