Evaluation of Monitoring and Reporting Needs for Groundfish Sectors in New England

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TABLE OF CONTENTS

FORWARD

The New England Fishery Management Council (NEFMC) is currently considering proposals by several groups of multispecies permit holders to opt out of the current Days-At-Sea effort control system of management to form harvesting cooperatives called "Sectors". There is a widespread recognition by the fishing industry, environmental community, and fishery managers that the current monitoring and reporting system for the groundfish fishery is unlikely to be adequate for Sector management. However, there is a lack of consensus on exactly what changes to the system are needed.

To facilitate the development of an effective and efficient monitoring system, the Gulf of Maine Research Institute (GMRI) commissioned Howard McElderry, principal of Archipelago Marine Research, and Bruce Turris, principal of Pacific Fisheries Management Inc., to assess monitoring and reporting needs for Sector management in New England. McElderry and Turris have extensive experience designing, implement and operating monitoring and reporting systems for fisheries operating under output controls.

The findings, opinions and recommendations of this report are those of McElderry and Turris. GMRI does not endorse any specific approach or standards for monitoring. GMRI commissioned this report solely to provide information to Sector organizers, NEFMC, and the National Marine Fisheries Service.

We would like to thank the many leaders in the groundfish fishery of New England that provided insight and perspective for this report. Members of the fishing industry and staff at the National Marine Fisheries Service were interviewed and NMFS' review of the Phase I and Phase II reports was extremely valuable. Funding for this report was made possible by the generous contributions of the Gordon and Betty Moore Foundation and the Alex C. Walker Foundation.

More information about GMRI's Sector initiative and copies of both the report can be found on the GMRI website at http://gmri.org/community/outreach and by contacting Cindy Smith, Northern Sector Coordinator at 207-228-1653; csmith@gmri.org or Libby Etrie, Southern Sector Coordinator at 207-228-1684 or eetrie@gmri.org.

ABSTRACT

This report provides recommendations from two experts from outside the New England region to industry and managers on potential options for monitoring and reporting of Sectors for the New England multispecies fishery. The report advises that the current monitoring and reporting system for the fishery is inadequate for the timely and accurate catch monitoring that will be necessary under Sector management. Several options (or components) for monitoring and reporting are outlined, and a phased approach to implement these options is recommended. The report recommends implementing an enhanced dockside monitoring program and data collection system (Options 1 and 2) in the initial year of Sector operation followed by a phased introduction of an at-sea monitoring program (Option 3) using a combination of human observers and electronic monitoring.

The report provides cost estimates for the monitoring and reporting system based on a potential scenario of 50% of New England's groundfish fishing vessels operating under a Sector management program and being allocated 80% of the total catch. Within Sectors they assume a fleet size of 325 vessels, spending about 28,000 days at sea and making about 5,000 landings.

The proposed options or components of the monitoring and reporting system and estimated operating costs are as follows:

Option 1: Prior to the start of a trip the vessel hails-out to a third-party, independent contractor and, upon completion of harvesting activities, the vessel hails-in to the contractor when and where they will be landing, if the product is being trucked, and where the fish is going (auction, processing plant). The vessel captain submits their completed VTR to the contractor within 7 days of offloading and the buyer submits the completed Dealer Report (DR) to the contractor within 7 days of receiving the fish. The contractor reviews the VTR and DR data for completeness, enters the data into a data base program, and merges the data to determine species catch weights by area. An assumed discard rate mortality is applied and added to the landed weight mortality. The contractor then calculates total mortality by stock and deducts the mortality from the applicable vessel and Sector allocations. Within 48 hours of receiving all data associated with a vessel trip, status reports are provided to the Sector manager and NMFS. The Sector manager reviews the catches against the vessel's and Sector's allocations. NMFS uses the data to monitor Sector catch mortality against the Sector allocations. The estimated cost for Option 1 ranges from $380,000 to $684,000 to cover the Sector component of the fishery.

Option 2: Builds on Option 1 by adding independent monitoring of offloading, including sorting and weighing the landed catch. For some small ports, where fish is landed and trucked to a processor or auction, roving monitors would be used to witness and inventory catch offloaded from vessels and transferred to trucks, and a dockside monitor would observe sorting and weighing at the destination. Costs for dockside monitoring (which would be in addition to Option 1 costs) are estimated to range from a low of

$456,000 (lower range, 50% monitoring) to about $1 million (higher range with 100% monitoring).

Option 3: Builds on Option 2 by adding independent monitoring of the catch at sea, either through electronic monitoring (EM) and/or at-sea observers (ASOP). EM uses cameras, sensors, and GPS on vessels to record vessel and fishing location, activity, catch, and compliance with regulations. All gillnet and hook & line vessels and trawl vessels fishing in a single area under mandatory retention would be able to request EM in lieu of human observers. Trawl vessels fishing multiple areas and/or not subject to mandatory retention must request an at-sea observer. Observer costs per day are estimated to range from $700 - $1,000 while daily costs of EM are $150 - $200 (including annualized equipment costs). The total cost of at-sea monitoring (which would be in addition to Option 1 and 2 costs) are estimated to range from $5 - $6 million for 50% coverage to $8 to $10 million for 100% coverage. There would also be a surcharge to dockside monitoring costs for EM based monitoring that would add from $148,000 to $414,000 depending on level of coverage.

The next step is to develop monitoring system specifications to enable more detailed cost analysis and eventually serve as a formal statement of work. Development of specifications will require considerable discussion among stakeholders and should include detailed information on critical issues that drive cost (e.g., fleet activity, coverage levels, landing ports, staffing levels, timelines, reporting requirements, etc.), project deliverables and timelines. Once a more detailed statement of work has been defined, a plan for program delivery will need to be developed including a service delivery model, monitoring program oversight, funding arrangements and the responsibilities of the parties involved. The report recommends that some, but not all, monitoring and reporting costs should be borne by industry. The report acknowledges that it may be difficult for the industry to bear the full cost of new monitoring programs while the fishery is rebuilding, however, experience has shown that monitoring programs are likely to be used more responsibly and efficiently by industry if it is sharing in the costs.

EXECUTIVE SUMMARY

The New England Fisheries Management Council is currently considering proposals by several industry groups in the multispecies fishery in New England to opt out of the current effort control system of management to form harvesting cooperatives called "Sectors". These Sectors are self-organizing groups of fishery permit holders that, if approved, will receive an annual allocation of each of the groundfish species they catch in return for devising and implementing a legally binding plan to keep their total catch at or below their allocation. The Sectors will also be responsible for developing and implementing a system of monitoring and reporting measures that is adequate to ensure that all catch is accounted for. All Sector members will be jointly and severally liable if Sector allocations are exceeded.

The Gulf of Maine Research Institute (GMRI) commissioned the authors to examine the existing New England fishery monitoring systems, determine changes needed for Sector based management, and provide advice on how monitoring systems could be implemented in New England. To gather information for this study we spent a week in February meeting with key New England industry and agency stakeholders. The findings from these meetings and other information provided to us have been assembled into two reports. The first report (Phase I), completed in April 2008, described the existing New England multispecies groundfish fishery, the current state of the fishery monitoring systems and changes needed to enable Sector based management. The second report (Phase II) built on the Phase I report findings providing more detailed advice on monitoring systems and associated costs for Sector fisheries. Both reports were presented to the New England Fishery Management Council for feedback and comment. The final report is a compilation of Phase I and II reports, reflecting comments received.

Phase I – Assessment of Monitoring Needs

NOAA Fisheries Service has begun the process of developing new guidance to assist regional fishery management councils in finding measures to end overfishing in all U.S. commercial and recreational fisheries by 2010. To end overfishing and prevent it from occurring in the future, the new law requires all fisheries to be regulated under annual catch limits (ACLs), with accountability measures to ensure that catches do not exceed ACLs.

As part of Amendment 16 to its Multispecies (groundfish) Plan, the New England Fishery Management Council (NEFMC) is working on a more comprehensive Sector management program, a system that would allow groups of fishermen to enter into contractual agreements and operate with a limited number of pounds available for harvest. Each Sector's TACs will be set to ensure conservation goals were accomplished while allowing each Sector to develop its own unique set of rules. Sectors will be required to report their catch regularly consistent with the multispecies FMP Sector reporting requirements. Both landings and discards will be counted against the Sector's TACs. Assumed discard rates will be used and applied against a Sector's share unless a

Sector can provide other accountability for the discards and obtain an exemption. Sectors will be responsible for developing annual Operations Plans that outline how the Sector will monitor their catch.

Since there have generally been only target TACs in groundfish, the days at sea (DAS) restrictions are the primary management tool for controlling effort and total catch. Rolling area closures are also used to reduce fishing mortality. Increasingly restrictive input controls and rising operating costs have made it more difficult for vessel operators to remain economically viable. Management changes need to be implemented that enable operators to improve economic returns and allow for sustainable management of the groundfish resources.

In place since 1994, the current effort control program has recently come under fire because of the low level of fishing allowed per vessel and concerns over the wasteful discarding of fish. Some industry members suggest there is a culture of discarding in the industry and that the problem is increasing and hurting the rebuilding of stocks.

There does not appear to be much confidence in the accuracy of the data collected on discarding and species catch by area. The combination of unreported and misreported harvesting information impairs both the manager's ability to properly manage on a stock specific basis and the scientist's ability to accurately assess the health of the stocks. Adding to the problem is the delay in having data available to managers in a meaningful format that enables them to make timely, informed and responsible decisions that protect the groundfish resources.

Many believe that more than half of the active fleet will participate in Sectors. The number of Sectors is unknown, but may range between 12 and 19. Sector membership will vary and most Sectors will likely be managed internally with individual allocations that allow vessels to move annual catch entitlements (ACE) around to improve economic efficiency and optimize the harvest of the Sectors' allocations. Industry sees Sectors as a means of moving away from the inefficiencies realized from input controls that result in regulatory discarding and under-harvested stocks.

The design of an effective and comprehensive monitoring program is guided by having a clear understanding of the objectives for the program. The primary tool used to sustainably manage groundfish fisheries is the total allowable catch (TAC). TACs are generally set at a level where the annual fishing mortality will not decrease the standing stock. This requires knowledge of the true annual catch and mortality. It is extremely difficult to ensure catch mortalities are kept within TAC limits when all mortalities are not accounted for. Specifically, managers need an accurate accounting of the total catch and release mortality on a stock specific basis.

Sustainably managed groundfish fisheries depend upon high quality research and assessment information (biological data, survey data, fishery data). Monitoring programs can improve on the precision of data collected from the fishery as well as the type and

amount of information (set locations, water temperature, currents, biological samples, habitat type, etc.).

While Sector management will provide the framework for individualizing fishing operations, monitoring is a tool for levelling the playing field by reassuring participants that individual and Sector accountability and compliance is being scrutinized. The monitoring program (combined with the individual allocation) better aligns each fisherman's incentives with those of the Sector and the manager.

There is concern that most vessels will not be able to maintain a viable fishing operation if they were required to have 100% at-sea observer coverage at $1200 a day. If the monitoring program is unaffordable, too many vessels will be forced out of the fishery or into a position of non-compliance. However, in so far as effective monitoring provides for successful Sector management, it allows for improved economic returns to the fishermen.

There are a number of monitoring tools available. The tools used in the options presented in this report include VMS, VTRs, dealer reports, a hail program, a dockside monitoring program with roving monitors, electronic monitoring, and at-sea observers.

The terms used throughout this report are described below:

VMS Vessel Monitoring System: the vessel tracking systems already found on all groundfish vessels participating in the federally regulated multispecies fishery.

VTR Vessel Trip Report: the reports completed by the vessel operator providing information on catch and discards by species and area on a set and trip basis.

DR Dealer Report: the report completed by companies purchasing the fish from the vessel providing detailed information on the catch weight by species.

HP Hail Program: a program that allows vessel operators to communicate their activity (start and completion of a fishing trip and scheduled landings).

DMP Dockside Monitoring Program: a program in which a third party contractor monitors and reports on the sorting and weighing of the catch on shore.

EMP Electronic Monitoring Program: a program using cameras, sensors, and GPS on vessels to record vessel and fishing location, activity, catch, and compliance.

ASOP At-sea Observer Program: a program using observers on vessels to record vessel fishing location, activity, catch, compliance and to collect biological data.

RM Roving Monitor: an individual who meets vessels at the point of offloading to confirm and record information and install/remove EMP equipment.

DM Dockside Monitor: an individual who monitors and records the sorting and weighing of groundfish catch from a vessel.

LR Landing Report: a report completed by the DM providing detailed information regarding the total weight by species offloaded from a vessel subject to DMP.

EMR Electronic Monitoring Report: A report of the area specific retained and released catch by a vessel as recorded by the vessel's EMP equipment.

OR Observer Report: A report of the area specific retained and released catch by a vessel as recorded by the At-sea Observer

Using a combination of the above tools, three basic monitoring approaches are identified for consideration. Options 2 and 3 also have sub-options. A total of six monitoring options are presented, but nine scenarios are identified. As we progress through the options, they become more comprehensive in the tools used and the extent to which the tools are utilized. Not surprisingly the latter options better meet sustainable management objectives but are also more costly. In the body of the report each option describes the roles of the Sector manager, NMFS, and third party contractor. The pros and cons of each option relative to the industry and government objectives are also identified.

Option 1: Modified Status Quo
HP + VMS + VTR + DR

This option is similar to the current monitoring requirements. The primary difference is that a third party contractor collects the information. This option also assumes that NMFS will continue with some low level of at-sea observer coverage similar to existing levels.

Prior to the start of a trip the vessel hails-out to the contractor, reporting their intention to commence fishing, when they will be leaving port and when they plan to land. Upon completion of harvesting activities the vessel hails-in to the contractor when they will be landing, landing location, if the product is being trucked, and where the fish is going (auction, processing plant). The vessel submits their completed VTR to the contractor within 7 days of offloading and the buyer submits the completed Dealer Report (DR) to the contractor within 7 days of receiving the fish.

In addition to providing the hail services, the contractor reviews the VTR and DR data for completeness, enters the data into a data base program, and merges the data to determine species catch weights by area. An assumed discard rate mortality is applied and added to the landed weight mortality. The contractor then calculates total mortality by stock and deducts the mortality from the applicable vessel and Sector allocations. Within 48 hours of receiving all data associated with a vessel trip, status reports are provided to the Sector manager and NMFS. The Sector manager reviews the catches against the vessel's and Sector's allocations. NMFS uses the data to monitor Sector catch mortality against the Sector allocations.

Option 2: Dockside Monitoring
HP + VMS + DMP + VTR
a) < 100% DMP + DR
b) 100% DMP

This option builds on Option 1 by adding independent monitoring of the product either at the point of landing or at the processing plant and assumes that NMFS will continue with some level of at-sea observer coverage similar to existing levels. The hail program is the same as in Option 1. The difference between 2a) and 2b) is the level of dockside monitoring and the use of dealer reports in the absence of dockside monitoring data.

Upon completion of harvesting activities the vessel hails-in to the contractor when they will be landing, landing location, if the product is being trucked, the time it will be offloaded, where the fish is going, and the scheduled time for the plant to receive the fish. The vessel also hails-in the estimated total weight of fish being offloaded, the major species categories and requests a Roving Monitor (RM) in the case where the product is being trucked and a Dockside Monitor (DM) to monitor the catch at the location it is being sorted and weighed. The vessel submits their completed VTR to the RM or DM or within 7 days of offloading.

a) < 100% DMP +DR: If the product is being trucked from the landing port the vessel may be met by a RM who will check and record the number of totes/boxes and species loaded onto the truck as well as the vessel's holds to see that all the fish has been offloaded. The RM may not necessarily attend every truck offload, but often enough so the vessel operator believes the probability is high.

Once the product reaches the location where it will be sorted and weighed a DM may be present to monitor and record the sorting and weighing of the product. The DM may not attend every offload, but frequently enough so that the plant and vessel operator believes the probability of being monitored is high. For monitored offloads, the DM completes a Landing Report (LR). The buyer of the fish submits the completed dealer report (DR) to the contractor within 7 days of receiving the fish.

The contractor receives and reviews the applicable reports (LR, VTR and DR) for completeness, enters the data into a data base program, and merges the data to determine species catch weights by area.

b) *100% DMP:* The role of the RM is the same as in 2a). Once the product reaches the location where it will be sorted and weighed it cannot be offloaded until a DM is present. The DM will arrive 15 minutes prior to the scheduled offloading time and will be present to monitor and record the sorting and weighing of the product and complete a LR. The contractor receives and reviews the applicable reports (LR and VTR) for completeness, enters the data into a data base program, runs edit checks, and merges the data to determine species catch weights by area.

An assumed discard rate mortality, based on the retained catch and the area fished, is applied and added to the landed weight mortality. The contractor then calculates total mortality by stock and deducts the mortality from the applicable vessel and Sector allocations. Within 48 hours of receiving all of the data associated with a vessel trip, status reports are provided to the Sector manager and NMFS.

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Option 3: Dockside Monitoring and At-Sea Monitoring
HP + EM/ASOP + VMS + DMP + VTR

a) < 100% EMP/ASOP
b) 100% EMP + < 100% ASOP
c) 100% EMP/ASOP

This option builds on Option 2 by adding independent monitoring of the catch at sea either through electronic monitoring (EMP) and/or at-sea observers (ASOP). We have assumed 100% DMP (Option 2 b) above) for all three sub-options, but three additional sub-options could have been developed using Option 2 a). The differences in options 3a), 3b) and 3c) are the level of at-sea monitoring.

a) < 100% EMP/ASOP: When the vessel hails that it is going fishing it is required to request at-sea monitoring. All gillnet and hook & line vessels and trawl vessels fishing in a single area under mandatory full retention may request electronic monitoring (EMP) equipment. Trawl vessels fishing multiple areas and/or not subject to mandatory retention must request an at-sea observer (ASOP).

Upon receiving the request, the contractor will advise the vessel operator whether or not they are required to take electronic monitoring, an at-sea observer, or neither for that trip. If the vessel is required to have monitoring on board, they cannot leave port until the EMP equipment has been installed or until an observer has boarded.

b) 100% EMP + < 100% ASOP: When the vessel hails that itisgoing fishing it is required to request at-sea monitoring. All gillnet and hook & line vessels and trawl vessels fishing in a single area under mandatory full retention are required to take electronic monitoring (EMP) equipment. Trawl vessels fishing multiple areas and/or not subject to mandatory retention must request an at-sea observer (ASOP).

For trawl vessels fishing in multiple areas, the contractor will advise the vessel operator whether or not they are required to take an at-sea observer for that trip. If the vessel is required to take an observer, they cannot leave port until an observer has boarded.

c) 100% EMP/ASOP: When the vessel hails that it is going fishing it is required to have at-sea monitoring. All gillnet and hook & line vessels and trawl vessels fishing in a single area under mandatory retention may be required to take either electronic monitoring (EMP) equipment or an at sea observer. Trawl vessels fishing multiple areas and/or not subject to mandatory retention must take an at-sea observer (ASOP).

Upon completion of harvesting activities the vessel follows the same hail-in requirements identified in Options 2. If the vessel had an observer, the observer disembarks and submits a completed Observer Report (OR) from the trip to the Contractor. If it was an EMP trip, the RM or DM boards the vessel to remove and replace the hard drive.

For gillnet and hook & line vessels, the contractor reviews the trip EMP data and compares a percentage of the monitored sets with the VTR information. If the data match within acceptable error limits, the entire VTR data is accepted as accurate. If the error level is too high, an additional percentage of EMP data will be compared with VTR data. If the entire EMP data is reviewed an Electronic Monitoring Report (EMR) will replace the VTR as the accurate record for the trip. For trawl vessels fishing in a single area

under mandatory retention, the contractor will review the EMP data to confirm that the vessel fished in only one area, that the area matches with the VTR, and that there were no discards. If there are no violations, the VTR will be considered an accurate record.

The contractor receives and reviews the applicable reports (LR, VTR, EMR, and OR) for completeness, enters the data into a data base program, runs edit checks, and merges the data to determine species catch weights by area. For all trips where an observer or electronic monitoring is not required, an assumed discard rate mortality, based on the retained catch and the area fished, is added to the landed weight mortality. For EMP and ASOP trips the discard mortality is calculated by applying established species mortality rates to the estimates of discards from the VTR, EMR, or OR. When applicable, the Sector manager will use the at-sea monitoring mortality estimates to request a reduction/exemption from the assumed mortality rate established by NMFS.

The contractor then calculates total mortality (discarded plus retained) by stock and deducts the mortality from the applicable vessel and Sector allocations. Within 48 hours of receiving all of the data associated with a vessel trip, status reports are provided to the Sector manager and NMFS.

Adapting to Sector and quota management (TACs, ACL, and Sector allocations) will, by itself, take time and result in changes to the fleet as Sectors and vessels organize themselves, develop business plans, consolidate ACE, and learn how to maximize fishing and economic opportunities. The general experience in other jurisdictions, where fisheries have moved to quota management, is that there is an adjustment period, but the viability of the fishery improves. A financially healthy fishery is more capable of absorbing increased management and monitoring costs. Alternatively, no monitoring changes concurrent with the movement to Sector management could lead to further discarding and catch misreporting as the opportunity and economic incentives to high-grade and misreport increase. Therefore, it is important to find the right balance between changes to the management framework and monitoring requirements.

The options above should provide the basis for Sectors to develop base level monitoring programs. Government may also want to use the options to set minimum standards. If Sectors want to have exemptions from input controls or assumed mortality rates, they may be required to have minimum monitoring requirements consistent with the options identified.

A phased approach allows for smoother transition and enables government and industry to productively re-profile resources (financial and human) and for new monitoring infrastructure to be put in place and expand with the growing needs of the fishery.

It is apparent that changes are necessary in how the New England multispecies groundfish fisheries are monitored. The following recommendations acknowledge the need to make changes and the difficulties associated with change in an industry facing increasing market competition, growing economic instability, and uncertain future resource availability:

Recommendation 1: **Option 1 should be the minimum monitoring requirements for the common pool fishery.** Even with input controls, the proper management of TACs requires the collection of catch data from the common pool fishery in a timely manner.

Recommendation 2: **Sector monitoring should be phased in over a three year period with Option 2 (dockside monitoring) being required in year 1 and Option 3 (at-sea monitoring) required by year 3.** The industry and government will need time to organize and develop the required infrastructure.

Recommendation 3: **During the first 5 years the monitoring program should be contracted to a single service provider.** Currently, there is no centralized data management system suitable for Sector-based fisheries management and development of one would likely be more efficient and representative after the monitoring program components have been implemented and the bugs worked out. A single service provider can more effectively resolve data issues, realize economic efficiencies, and make responsive adjustments between program components.

Recommendation 4: **The contractor should be selected through a competitive bidding process coordinated by a government agency.** The need for a single service provider during the first 5 years of the program, the lack of a comprehensive industry organization, issues concerning data confidentiality, and the likelihood of multi-source funding arrangements supports having a government agency (NMFS or the Atlantic States Marine Fisheries Commission) act on behalf of the industry as the contracting authority.

Recommendation 5: **Some, but not all, costs should be borne by industry.** Using the monitoring program responsibly and efficiently is more likely if industry is sharing in the costs.

Recommendation 6: **There should be an annual program evaluation.** Evaluation is important to monitor the service provider's performance and to make necessary program operations and efficiency improvements.

Recommendation 7: **There should be a comprehensive communications plan to prepare participants for the new monitoring initiatives, educate them on new and ongoing program requirements, allow for feedback, and identify necessary contacts.**

Phase II – Analysis of Monitoring System Costs and Implementation Issues

This part of the study provides more detailed advice on monitoring systems and associated costs for Sector fisheries. The basic approach for this study was to draw on experiences with British Columbia's monitoring systems and apply this knowledge to a Sector management structure. Archipelago provides stand-alone monitoring programs in a variety of fisheries in British Columbia, Canada, which vary by target species, fleet

characteristics, fishing method, program structure and monitoring objectives. BC groundfish fisheries are described and compared with the New England multispecies groundfish fishery. The report applies the BC monitoring systems in a New England context in order to provide a better understanding of different cost elements and their contribution with respect to the monitoring options identified in the Phase I report. The report assumes all the Phase I report recommendations are followed.

A key recommendation is for a stand-alone integrated service delivery provider supplying dockside and at-sea monitoring, data compilation and reporting. We fully recognize that the proposed system overlaps with monitoring systems that the National Marine Fisheries Service (NMFS) currently runs and, if implemented, Recommendation 3 would create redundancy, as NMFS would need to continue to maintain monitoring systems in a variety of other fisheries. This issue is beyond the scope of our investigation and the approach taken is from the perspective of best serving the needs of a Sector monitoring system.

Monitoring Systems in British Columbia, Canada

Most fisheries in British Columbia have expanded reporting or monitoring requirements that are met through the use of independent third party service providers. Monitoring programs in BC are uniformly structured with a single company providing services for an entire fishery or fleet group, ensuring cost efficiencies and continuity of services across the fishery. In most programs, industry funds the majority of the monitoring service cost and industry associations contract directly with the service provider for monitoring services. Service providers are selected through a competitive bidding process and follow performance specifications defined by industry and Fisheries and Oceans Canada (DFO). The authority for outsourced monitoring services comes through provisions under federal fisheries regulations, a certification process through the Canadian General Standards Board, and through contractual agreements between industry, DFO and service providers.

A summary is provided of several BC fisheries that obtain monitoring services from Archipelago Marine Research Ltd. Included are eight fisheries across multiple species, gears and areas, with different management issues and monitoring systems including the monitoring options identified in the Phase I report. Most relevant to the purpose of this report is the BC groundfish fishery.

BC's groundfish fishery comprises a fleet of about 300 vessels, 3,500 trips, 20,000 days at sea, 230 million pounds landed weight, and a value of about $140 million (CDN). BC groundfish fisheries occur coast wide and year round, and include a variety of gears including trawl, longline, trap, demersal troll and hand line. Trawl fishing involves a fleet of about 70 vessels that further subdivide into a small inshore (Gulf of Georgia) component, an offshore component and a midwater trawl component fishing Hake (*Merluccius productus*). Within the hook and line component, there are about 240 vessels which are separately licensed into six distinct fisheries including halibut,

blackcod, lingcod, dogfish, inshore rockfish, and offshore rockfish. Collectively, the groundfish fishery encompasses about 60 different stocks, delineated by both species and area. License holders are allocated individual quota on an annual basis and there is a significant level of trading in order to establish quota portfolios that meet specific fishing plans and expected bycatch levels. Groundfish fisheries are universally governed by a principle of individual accountability, which mandates high levels of at-sea and shore based monitoring and compels fishers to account for their entire catch, including discards. Monitoring systems include hails, logbooks, a dockside monitoring program (DMP), an at-sea observer program (ASOP) (offshore trawl), and an electronic monitoring program (EMP) (inshore trawl, midwater trawl for hake in northern regions, and hook and line). Most components of the monitoring system are contracted and funded by industry. DFO partially funds the ASOP and EMP and has a major role in contracting the ASOP.

The cost for monitoring services in BC's groundfish fisheries is variable due to factors such as total quantities landed, different fishery efficiencies in using monitoring services, and differences in program monitoring requirements. In terms of total monitoring costs (DMP and at-sea) per vessel per year costs range from about $10,000 to $65,000 (values are in Canadian dollars, which is almost at par with the US dollar at the time of writing). On a per trip basis, costs range from about $600 to nearly $4,000. DMP cost per trip for groundfish fisheries ranges from $65 to nearly $500. At sea monitoring on groundfish vessels is about $600 for observers and $110 to $150 for electronic monitoring. The cost per pound of landed product for all monitoring services is generally less than 4¢/lb - 10¢/lb or 3% - 9% of the landed value of catch. These cost figures are inclusive of both industry and government contributions.

The New England Multispecies Groundfish Fishery

We used 2006 vessel trip reports (VTR) and dealer reports (DR) data provided by NMFS to characterize the multispecies groundfish fishery. The fishery involves nearly 650 vessels, completing about 19,000 trips and 33,000 DAS, landing about 50 million pounds, valued at about $73 million (USD). The historical value of the New England fishery has been higher (over $100 million in 2000/2001). The New England groundfish figures also do not recognize the substantial revenues from non-groundfish catches, most notably monkfish that are landed on groundfish trips. Several fishing gears are used, the most common ones being bottom trawl and gillnet. Nearly 75% of all fishing trips were one day, and 40% of trawl trips were more than two days. The majority of multi day fishing trips were by bottom trawl. Single day trips were estimated to make up about 40% of the total DAS for all gear, and nearly 75% of the trawl DAS were on trips greater than one day.

The spatial distribution of the fishery was examined in terms of number of landings and landed weights by ports. Groundfish landings occur in coastal ports of six states and most activity is in Massachusetts, New Hampshire and Maine. In terms of landing events, the busiest port is Gloucester, with nearly five times the landings as the second busiest port. The top five ports (Gloucester, Portland, Pt. Judith, New Bedford, and

Chatham) account for nearly 65% of the landing events and less than half the ports collectively make up more than 90%. In terms of landed weights, this feature persists but is exaggerated with more high volume landings in the ports of Portland, Gloucester and New Bedford. Less than 25% of the ports make up more than 90% of the landed weight.

Comparison Between BC and New England Groundfish Fisheries

Key statistics of the BC and New England groundfish fisheries were presented for comparison. The BC groundfish fishery lands nearly five times the quantity of fish with a total value nearly double the New England fishery. Removing the high volume/low value hake fishery from the comparison, the BC fishery lands over double the quantities at a value 1.7 times the New England fishery.

The BC fishing fleet is half the size, has one-fifth the number of fishing trips and spends 40% less fishing time at sea. Fishing vessels in the BC fleet range in size from about 15 to over 140 feet although most trawl vessels are 70-90 feet and most hook and line vessels are 35 to 50 feet in length. As compared to BC, the New England fleet appears to consist of a larger proportion of small vessels. It should be pointed out that DAS is defined differently in the two regions and the New England DAS would likely be 10-20% greater if defined using the BC observer seaday definition. The number of landing ports in BC is about half that of New England although landing ports for both fisheries are spread over a large geographic region, with the majority of landing events and pounds landed occurring in very few ports.

While the differences between the two fisheries are striking it is important to point out that the BC fishery has changed considerably over the past decade in response to several forces including: individual quotas, increased at-sea monitoring requirements, increased cost recovery, and the need to improve the economic viability of the fishery. These changes have forced the fishery to consolidate, become more efficient, and bring higher value to the landed product.

Cost Analysis of Monitoring System Options

For the purposes of this analysis we consider the scenario of Sectors attracting 50% of the active fleet and 80% of the total ACE. Within Sectors we consider a fleet size of 325 vessels, spending about 28,000 days at sea and making about 5,000 landings. For the purposes of distinguishing the trips that would be monitored by observers or EM, the Sector fleet further subdivides between single and multi area trawl, and fixed gear. Using historical data from NOAA, 10% probably represents the upper bound of total fishing trips that would take place in multiple areas by trawl. The number of seadays associated with multi area trawl trips is difficult to estimate but as they are likely to be much longer in duration, we chose 30% as a likely upper estimate for seadays, or about 8,400. The number of vessels involved in multi area trawl fishing is estimated at 75 while the balance of the fleet is either single area trawl or fixed gear.

Key points affecting costing for Option 1, Baseline Data Collection (BDC, also termed 'modified status quo' in Phase 1 report) were as follows:

- Option 1 applies to both Sector and Common Pool fishery;
- BDC service consists of hail system and centralized data integration process;
- Hail service contracted to professional call center;
- Sectors have procedures in place to ensure timely delivery of VTR and DR data; and
- Data access and communication method with NMFS has not been specified.

Key points affecting costing for Option 2, Dockside Monitoring Programs (DMP) were as follows:

- Option 2a involving <100% DMP set coverage level at 50%;
- Roving Monitor coverage level set at 50% for both Option 2a and 2b;
- DMP requirements for fishing trips monitored by electronic monitoring will require piece counts (fixed gear vessels) and discard sampling (single area trawl vessels fishing under mandatory retention; and
- Landings that involve direct sales to smaller markets, split offloads between multiple buyers were not considered and would require more study.

Key points affecting costing for Option 3, At - Sea Monitoring were as follows:

- An At-sea Observer Program (ASOP) applies to larger trawl vessels intending to fish multiple areas;
- An Electronic Monitoring Program (EMP) applies to all fixed gear, and trawl vessels fishing single areas under full retention requirements;
- The <100% coverage levels in Option 3 were set at 50%, the value being set for price estimation purposes and was not based on a rigorous analysis of appropriate coverage levels;
- Sector participation will charge vessels with the responsibility to take observers when required and minimal deployment effort will be needed;
- Sector observers should not be of a lower standard than the existing NMFS observers;
- EMP would be based on an audit process (i.e., a random sample of 10% of fishing event imagery to determine if the VTR data meet quality standards and can be accepted for use);
- Option 3a involving 50% EMP coverage would be more practically implemented by installing EM systems on vessels for duration of several fishing trips and conducting EM retrieval and analysis on a longer, perhaps weekly duration.

Cost estimates for the various monitoring options were estimated using a unit cost (low and high value) and scaling to the appropriate factor (landings or seadays) for the Sector fishery. Monitoring system costs in the BC groundfish fishery were used to derive unit costs for each monitoring option in the New England Sector fishery.

The estimated cost for BDC (Option 1) ranges from $475,000 to $855,000 to cover the Sector and Common Pool components of the fishery (of which $380,000 to $684,000 would be attributable to Sectors).

Monitoring Option 2 (DMP) has four components; the former two apply to partial (50%) and full DMP services while the latter two provide an estimated surcharge for additional DMP work required when at-sea monitoring EM is used. The DMP cost range varies from a low of $456,000 (lower range, partial monitoring) to about $1 million (upper range, 100% monitoring). The surcharge could increase DMP costs by 30% - 40%.

At-sea monitoring (Option 3) has three components each with separate pricing for ASOP and EM. The cost ranges from $5 - $6 million for partial monitoring (Option 3a) to $8 to $10 million for full monitoring (Option 3c). Observer costs per day range from $700 - $1,000 while daily costs of EM costs are $150 - $200. The cost per unit declines when moving from partial to fully monitored fishery, reflecting increased efficiencies with fully monitored fisheries.

Since the monitoring options build on one another, component costs were compiled to provide total costs for the six monitoring options. The cost options are also presented in terms of total monitoring cost per pound and cost as a percentage of the landed value of the fishery. The total monitoring cost ranges from 1-2¢/lb for Option 1, 2.5 - 5¢/lb for Option 2, and 17 – 32¢/lb for Option 3. In terms of landed value of the fishery, the ranges are 0.8 - 1.5% for Option 1, 1.5 – 3.3% for Option 2, and 11 – 21% for Option 3.

The NMFS North East Region observer program estimates observer costs at $1,200 per seaday while the BC observer program costs $560 per seaday. The BC observer program is fully contracted as a standalone program and provides essentially the same program services as the combined NMFS – contractor services in the NEFOP. Elements that contribute to the cost difference between regions include:

- Observer deployments in the BC fishery are primarily on large (> 60') trawl vessels that make 6 – 8 day fishing trips as opposed to a high proportion of single day deployments in New England.
- Insurance for observer injuries is much more costly in the US, where it may be more than 15-30% of the observer wage cost as compared to less than 3% in Canada.
- Funding differences also strongly influence cost differences. The BC program is mostly (~75%) funded by industry and there are strong incentives for operational efficiency and prudent use of program resources by industry. The fishing industry also participates in contractor oversight to provide advice on ways to tailor program services to meet their needs in the most cost effective manner. In contrast, within the federally funded program industry is in a position to place costly demands on the NMFS observer program without bearing the financial consequences. The lack of industry participation in the observer program design also makes it likely to contain elements out of balance with the true needs of the program.

The NEFOP is a large, complicated multi-purpose program with several objectives that support a large number of management and research programs. The comparison made here is not intended to suggest that the NEFOP structure is inappropriate, inefficient or unnecessarily complicated for the designed purpose. The point of the comparison is to determine whether an ASOP for the Sector fleet would cost $1,200 or $560 per seaday. In our view, an ASOP dedicated to the Sector fleet would likely cost much less than $1,200 per day seaday for a number of reasons. Firstly, the Sector program would be directed solely toward trawl vessels that make longer fishing trips that create less cost for the observer program. In the current NEFOP the efficiencies gained in monitoring this fleet are lost by the inefficiencies in monitoring the single day deployments. The cost would be lower because the Sector ASOP program would be contracted as a standalone single purpose program with less organizational complexity than the NEFOP. The costs would also be lower with industry paying some of the costs, as the Sector fleet would be motivated to find ways to reduce their monitoring costs. The unit rates presented in Table 6 ranges from $600 to $1,000 per seaday for the Sector ASOP, reflecting the influence of these factors. It is unlikely that the Sector ASOP would cost less than the BC ASOP because of higher insurance costs in the US.

Interpretation of the cost estimates for monitoring options should be made in light of a variety of elements that drive the cost of monitoring programs. The cost estimates are for mature developed monitoring programs. Costs for new programs could be 10 - 30% higher in the first few years after program start up. The estimates represent average costs across the entire fleet, recognizing that costs may vary widely across individual vessels or fleets according to their specific patterns of fishing and other circumstances. The monitoring systems and costs do not take into consideration the fishery response to monitoring, particularly if there is a component of the program cost funded by industry. With a change in management structure and monitoring requirements fishery participants will alter their business strategies to respond to new opportunities and costs.

The cost for various monitoring options is strongly affected by a variety of inputs that determine program size:

- Fishery activity (number of vessels, landings and seadays) - The variable costs of monitoring programs are driven directly by landing events for Options 1 and 2 and seadays for Option 3. For example, within BC programs, a 10% reduction in landing events would result in about a 6% reduction in program costs because of the ratio of fixed to variable costs.
- Fishery landing patterns - The number and spatial distribution of landing ports influences all monitoring options because of larger infrastructure requirements, increased travel time, higher staffing levels.

Program output requirements also directly influence monitoring costs. In addition to the three Options, other outputs include:

- Coverage levels for partially monitored fisheries – The specific coverage level has a direct influence on program effectiveness and costs. Monitoring programs generally have a high ratio of field labor that scales to coverage levels. For

example, in the BC trawl observer program a 10% reduction in observer coverage level would translate to an 8.3% reduction in total program cost.

- Coverage by EMP versus ASOP – With a daily cost of EMP being less than a quarter the cost of ASOP, Option 3 costs will be significantly influenced by the component of the Sector fishery that can be monitored by EMP. The cost for 100% monitoring using EMP would be 4.2 – 4.7 million, or less than the cost of 50% monitoring in Option 3a. There are limits to the capabilities of EMP, but there are also ways the fleet can organize their operations to accommodate the technology.
- Labor Management Practices – The monitoring tools (BDC, DMP, ASOP, and EMP) are similar in respect to their being service programs that primarily consist of high volumes of labor. In BC, DMP and ASOP program labor represents over 80 - 90% of total program cost and well organized operational systems that utilize labor efficiently create significant savings to monitoring program costs.
- Call Up Responsiveness – Staffing strategies for DMP and at-sea monitoring services are significantly affected by call up requirements. The requirement to meet all requests requires strategies to have staff on hand for peak periods of activity (e.g., good weather, strong market conditions). Maintaining staffing levels to respond to requests within short timelines also increases the staffing infrastructure requirements over more steady state conditions.
- Program Reporting Requirements – In addition to responsiveness, the reporting requirements influence the volume of work carried out. Complexity of data, efficiency of data entry process, level of analysis and the number of different reports all contribute to the work volume.
- Audit Levels for EMP - The EMP is designed to use EM data to audit the quality of fisher-supplied data. The level of audit considered was 10%, serving the dual purpose of providing a random sample of the fishery and a 'radar trap' deterrent for VTR misreporting. In the BC groundfish hook and line fishery, the proportion of imagery analyzed increases total EMP costs by about 5% for each 10% increment in proportion of imagery viewed.
- EMP Equipment – EM equipment represents a significant part of the cost of an EMP. Strategies for purchasing or renting EM systems will depend upon patterns of use on vessels. In the BC groundfish hook and line EMP, rental systems are used for about 20% of the 12,000 seadays in the fishery while purchased systems cover the balance. This blend results in a daily equipment cost of about $35, or about 20% of total EMP daily cost. If all vessels rented systems, the daily program cost would rise by about 25% as a result of a doubling of the equipment cost component. If all vessels purchased systems the cost would be higher than the blend because there are a number of vessels that have very low activity levels.
- Cost Recovery Method – Who pays and how cost recovery is structured influences both how program resources are used and overall program costs. The role of industry funding has already been discussed, however there are other elements to this. Receiving program revenue through monthly invoices carries much different administrative cost than separate billings for the 19,000 landing events in the fishery. As well, particularly for industry funding, the fee structures directly influence how program resources are used. For example, levying

monitoring program fees as a cost per landed pound does not encourage efficient use of program labor to the same extent that program fees charged on an hourly basis. The use of rolled up fees (cost per vessel or landing) may create cross subsidies when there are differences in fishing practices within the fleet.

Next Steps

It is hoped that the information and ideas presented in the Phase 1 and 2 reports will be used by the fishing industry, Sectors, Council members, NMFS staff, and other groups and agencies to advance the discussion on Sector monitoring and how it should be organized. The next step would be to develop monitoring system specifications to enable more detailed cost analysis and eventually serve as a formal statement of work. Development of specifications will require considerable discussion among various Sector stakeholders and should include detailed information on critical issues that drive cost (e.g., fleet activity, coverage levels, landing ports, staffing levels, timelines, reporting requirements, etc.), project deliverables and timelines. Once a more detailed statement of work has been defined, a plan for program delivery will need to be developed including a service delivery model, monitoring program oversight, funding arrangements and the responsibilities of the parties involved. Given that NMFS currently provides at-sea observer coverage, discussions will be necessary to assess how best to include existing program delivery with Options 1 and 2 and how to transition from the government program to a third party managed program.

Introduction

The New England Fisheries Management Council is currently considering proposals by several industry groups in the multispecies fishery in New England to opt out of the current effort control system of management to form harvesting cooperatives called "Sectors". These Sectors are self-organizing groups of fishery permit holders that, if approved, will receive an annual quota of each of the groundfish species they catch in return for devising and implementing a legally binding plan to keep their total catch at or below their allocation. The Sectors will also be responsible for developing and implementing a system of monitoring and reporting measures that is adequate to ensure that all catch is accounted for. All Sector members will be jointly and severally liable if Sector quotas are exceeded.

The authors have considerable expertise with commercial groundfish fisheries management and monitoring programs. The Gulf of Maine Research Institute (GMRI) contracted us to examine the existing New England fishery monitoring systems, determine changes needed for Sector based management, and provide advice on how monitoring systems could be implemented in New England. To gather information for this study the authors spent a week in February meeting with key New England industry and agency groups. The findings from these meetings and other information provided to us have been assembled into two reports. The first report (Phase I), completed in April 2008, described the existing New England multispecies groundfish fishery, the current state of the fishery monitoring systems and changes needed to enable Sector based management. The findings were presented in a risk management context, connecting the monitoring level in the fishery with increasing data quality and compliance objectives. In this way the report linked monitoring system cost/practicality issues with levels of management system effectiveness.

The second report (Phase II) was intended to build on the Phase I report by providing more detailed advice on monitoring systems and associated costs for Sector fisheries. The report also examined critical issues with the development of a new monitoring program.

Both reports were prepared for GMRI and presented to the New England Fisheries Management Council. The Phase I report was presented to the New England Fisheries Management Council on 16 April 2008 and Phase II was presented 4 June 2008. Feedback from the Council and other stakeholders was solicited following report presentation and comments have been incorporated into the final report.

Phase I – Monitoring Needs Assessment

Context For This Work

NOAA Fisheries Service has begun the process of developing new guidance to assist regional fishery management councils in finding measures to end over fishing in all U.S. commercial and recreational fisheries by 2010. This deadline is a new requirement under the reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act of 2006. The highest priority in the Magnuson-Stevens Act reauthorization was to strengthen the Act to ensure an end to over fishing. The U.S. Ocean Action Plan also called for expansion of market-based management systems. To end over fishing and prevent it from occurring in the future, the new law requires all fisheries to be regulated under annual catch limits (ACLs), with accountability measures to ensure that catches do not exceed ACLs.

The reauthorization of the Magnuson-Stevens Act includes new language governing all limited access privilege programs (LAPPs) and requires a referendum in which a supermajority of those voting must approve an Individual Fishing Quota (IFQ) program before such a system can be implemented in New England. With these significant new requirements, some members of the groundfish industry decided that Sectors were worthy of close consideration.

Sectors were first authorized in Amendment 13, enabling a group of demersal longline fishermen from Cape Cod to receive a percentage of the available Total Allowable Catch (TAC) for Georges Bank Cod and exemption from certain multispecies regulations.

As part of Amendment 16 to its Groundfish Plan, the New England Fishery Management Council is working on a more comprehensive Sector management program, a system that would allow groups of fishermen to enter into contractual agreements and operate with a limited number of pounds available for harvest. The Council would set each Sector's TACs to ensure conservation goals were accomplished while allowing each Sector to develop its own unique set of rules. Some of the measures for evaluating Sector options include the ability to address wasteful discards, simplify management, accord fishermen greater control over their livelihoods, provide a mechanism for economics to shape the fishing fleet rather than the regulations, and prevent excessive consolidation of fishing businesses so that a day boat fishery can continue.

Sectors will adopt TACs (as shares of the ACL) and Accountability Measures (AMs) for species managed under the Sector's Fisheries Management Plan (FMP). Sectors will be required to report their catch annually consistent with the multispecies FMP Sector reporting requirements. Both landings and discards will be counted against the Sector's ACLs. Assumed discard rates will be used and applied against a Sector's share unless a Sector can provide other accountability for the discards and obtain an exemption. Sectors will be responsible for developing annual Operations Plans that outline how the Sector will monitor its catch.

The need to be accountable and stay within the Sector's catch allocation requires a monitoring program that provides accurate and timely information to fishermen, Sector managers and fishery managers. Such a monitoring program is the focus of this report.

Fishery Background

The New England Fishery Management Council's Northeast Multispecies (Groundfish) Fishery Management Plan regulates catches of cod, haddock, Pollock, redfish, plaice, winter witch, windowpane and yellowtail flounders, and halibut in federal waters. Atlantic cod and yellowtail flounder are two of the weaker stocks. The 10 regulated species are further divided into 19 stocks across 5 management areas. The fishing year runs from May 1 through April 30 and is managed using input controls including limited days-at-sea (DAS), trip limits, mesh size, and seasonal and year round closures

There are approximately 800 vessels currently active in the fishery. Boats range in size from 30 to 100 feet, with the majority measuring between 30 and 70 feet. Otter trawls predominate in the groundfish fishery, while gillnets and hooks, or longlines, are used to a lesser degree.

Table 1. Summary of Gear Designation of Groundfish Vessels in 2004 (permitted and active vessels)

Gear	Number of permitted vsls	% of total	Number of active vsls	% of total
Bottom trawl	794	54%	502	65%
Midwater trawl	6	< 1%	2	< 1%
Other trawl	10	< 1%	6	< 1%
Bottom longlines	163	11%	59	8%
Hand line	133	9%	35	5%
Sink gillnet	282	19%	160	21%
Pots and traps	11	< 1%	2	< 1%
Other	85	6%	7	< 1%
Total	1,484	100%	773	100%

Framework Adjustment 42, 2006; 2004 Data; Permitted vessels is the number of vessels with limited access multispecies permits. Active vessels is the number of vessels that called into the days-at-sea system.

While there were nearly 1500 limited access groundfish fishermen in 2004, only 773 used any of their allocated DAS, and that number has continued to decline. Some preliminary analysis showed that in the 2005/2006 fishery 500 vessels landed 99% of the regulated groundfish catch. The total number of active limited access vessels has declined from roughly 1,000 in 2001 to 773 in 2004 and the associated groundfish catch has fallen from 103 million pounds to 75 million pounds during the same period.

There are still approximately 2000 open access fishing permits for the groundfish fishery but they are severely restricted in what they can catch. Fewer than 300 open access permit holders landed any regulated groundfish in the 2001-2004 fishing years and they landed less than 500,000 pounds (less than 1% of the total groundfish catch) of all regulated groundfish species in those years.

Most of the active vessels are owner-operated with home ports in Massachusetts, Maine, Rhode Island, New Hampshire, and Connecticut though there are some from the Mid Atlantic states. Groundfish is landed at as many as 70 different ports, with fewer than 10 ports handling the majority of fish landed. The primary ports are Portland, New Bedford, Boston and Gloucester. A considerable amount is landed at outports where it is offloaded onto trucks and taken to an auction or plant in a major center.

All vessels participating in the federally regulated groundfish fishery are required to have on board a Vessel Monitoring System (VMS) that pings every 30 to 60 minutes, 24 hours a day, 7 days a week unless the vessel is at the dock for 30 days or more and receives a letter of exemption. The VMS is used to track DAS and monitor vessel location for fishing in unauthorized areas. The enhanced VMS also has e-mail capability.

The Endangered Species Act and Magnuson-Stevens Act require some level of at-sea observer coverage in the groundfish fishery. Observers are provided by the Northeast Fishery Observer Program at an average cost of around $1200 per day. The data from the program is used by the regulatory agencies for stock assessment, economic analysis, and the estimation of bycatch and discards. The observer program attempts to maintain 5% coverage of the A-DAS vessels, and 40% coverage of U.S./Canada, SAP, and B-DAS fisheries. Actual coverage levels are below the identified targets.

Current Management Program

Vessels participating in the federally regulated groundfish fishery receive a permit issued annually by NMFS, including a letter identifying the vessel's DAS allocation. Since there are no TACs in groundfish, the DAS are the primary management tool for controlling effort and total catch (there may also be species specific trip limits for yellowtail, cod and hake).

Prior to leaving port for the grounds, groundfish vessels declare their planned fishing activity to NERO. They also have to give notice of their need for an observer (if they are required to have one that trip) or must have a waiver if an observer is not required. As soon as a vessel passes the demarcation line, the DAS count commences (as recorded by the VMS) and continues until the vessel again crosses the demarcation point on return to port. The VMS records location, speed, direction and date and time information for the vessel. Catch information, including species and area of retained and released catch, is recorded by the vessel operator on a Vessel Trip Report (VTR) and by the observer (whenever an observer is on board). The VTR must be submitted to NERO by the 15th of the following month, creating delays of as much as 45 days.

Many vessels offload their catch directly onto trucks and deliver to a processing plant or the fish auction. Vessels don't weigh their catch on board and only have estimates of the product weight loaded onto the truck. The fish are weighed at the plant or auction and the buyer of the fish is responsible for completing a Dealer Report (DR) that provides an accurate weight of the catch by species. DRs are submitted on a weekly basis to NERO in an electronic format. It takes approximately 2 months or more before NERO has the VTR and DR information on the computerized data base system.

While DAS may be the primary method for controlling fishing effort, rolling area closures are also used by NERO for similar purposes. Closing productive fishing areas throughout the region during strategic times reduces the fleets harvesting efficiency (catch per unit of effort) and results in a lower total catch without reducing the allocated DAS.

Concerns With The Current Management Program

Increasingly restrictive input controls, rising operating costs (fuel prices), and greater market competition (farmed fish) have made it more difficult for vessel operators to remain economically viable. Management changes need to be implemented that enable operators to improve economic returns (reduce operating costs, develop new markets, improve product quality, and better service market needs) and allow for sustainable management of the groundfish resources.

In place since 1994, the current effort control program has recently come under fire because of the low level of fishing allowed per vessel and concerns over the wasteful discarding of fish. Some industry members interviewed suggested there is a culture of discarding in the industry and that the problem is increasing and hurting the stocks. Some discards are caused by regulations (prohibited species, juveniles, catches in excess of permitted trip limits), while other fish may be released for economic reasons (unmarketable, low value, or excessive quantity) or safety reasons (poor weather, too much to bring on board).

The overall quality and timeliness of the data from the groundfish fishery is concerning. There does not appear to be much confidence in the accuracy of the data collected on discarding and species catch by area. VTRs are intended to report discards, but there is a strong belief that this is not happening. Indeed the observer data does not match up well with the VTR data, with the observers recording a higher discard rate than the VTRs. The low level of observer coverage makes it difficult to accurately estimate fleet wide discards, and the VTR data would likely significantly underestimate true discard levels.

There is also concern regarding the lack of accurate information on species catch by area. Many vessels, primarily trawl vessels, fish in more than one management area on a trip. While vessels are required to complete a VTR for each area fished, it is believed that many operators only submit one VTR even if they fished multiple areas.

The combination of unreported and misreported harvesting information impairs the manager's ability to properly manage on a stock specific basis and the scientist's ability to accurately assess the health of the stocks. Adding to the problem is the delay in having data available to managers in a meaningful format that enables them to make timely, informed and responsible decisions that protect the groundfish resources.

Sector Management

The New England Fishery Management Council is working towards providing definition to Sector management, but there is still considerable uncertainty in industry regarding how Sectors will be organized and what rules they will operate under. The Council Operating Policies define a Sector as *"a group of persons holding limited access vessel permits who have voluntarily entered into a contract and agree to certain fishing restrictions for a specified period of time, and which has been granted a TAC(s) in order to achieve objectives consistent with applicable FMP goals and objectives."* The Council has also made it clear that:

- Sectors will have TACs as shares of Annual Catch Limits (ACLs) and Accountability Measures (AMs) for species managed under the Sector's Fisheries Management Plan.
- Sector shares will be allocated as a percentage of the ACL of the applicable FMP.
- Discards will not count towards a Sector's allocation but discards will count against a Sector's share, unless a Sector can provide other accountability for the discards and obtain an exemption.
- A Sector reaching any Sector allocation would result in the Sector's fishery closing.
- A Sector's allocation will not be reduced because another Sector or the common pool fishery exceeded their assigned share.
- A Sector exceeding its annual allocation will have its share reduced in the following year.
- Sectors will be required to report their catch consistent with the Multispecies FMP Sector reporting requirements.
- Transfers of annual catch entitlements (ACE) between Sectors within the fishing year may be allowed.
- Vessels can only fish in one Sector within a fishing year.

Many believe that more than half of the active fleet will participate in Sectors. The number of Sectors is unknown, but may range between 12 and 19. Having a number of different Sectors is one way of minimizing risk – legal risks associated with joint and several liability, and economic risk associated with having the Sector fishery shut down. Sector membership will vary and may be influenced by gear type, species focus, organizational relationship, and regionalism. Most Sectors will be managed internally with individual allocations that allow vessels to move annual catch entitlements (ACE) around to improve economic efficiency and optimize the harvest of the Sectors' allocations.

Industry sees Sectors as a means of moving away from inefficiencies realized from input controls, such as DAS, trip limits, and rolling closures that result in regulatory discarding and under harvested stocks. In addition to providing greater operational flexibility to vessels, Sectors will also have enforcement committees that allow for the internalization of compliance issues associated with Sector rules.

There is still a considerable amount unknown about how Sector management will work:

- What will be the monitoring requirements?
- What will monitoring cost and who pays?
- Will the Council and NERO still use input controls (DAS, trip limits, rolling closures)?
- On what basis will ACE be allocated to Sectors and what shares of ACLs will each Sector have?
- Will the TACs be set low and Sector allocations be less than expected?
- How will the movement of quota between and within Sectors be facilitated?

It is also unclear when Sector management will be in place (no earlier than 2010) and how the common pool fishery will be monitored and managed.

The conservation concerns with Sector management are similar to the concerns for ITQ management. Will there be high-grading? Will there be misreporting of the catch (area of catch and volume of catch)? Will discarding increase as a vessel or Sector approaches their allocation? Will there be enforcement problems associated with different rules in the Sector fishery and common pool fishery? While the Council is working on a motion to require the retention of all legal sized fish, the success of such rules and similar rules to address the concerns above necessitates a comprehensive monitoring program.

Sector Monitoring

The design of an effective and comprehensive monitoring program is guided by having a clear understanding of the objectives for the program. Both the resource managers (government) and the industry (permit holders, fishermen, dealers) have distinct and shared objectives for Sector management monitoring programs.

Resource manager's monitoring objectives:

- ***TAC management:*** The primary tool used to sustainably manage groundfish fisheries is the total allowable catch (TAC). TACs are generally set at a level where the annual fishing mortality will not decrease the standing stock. This requires knowledge of the true annual catch and mortality and the ability to detect changes in stock abundance. It is extremely difficult to ensure catch mortalities are kept within TAC limits when all mortalities are not accounted for. Specifically, managers need an accurate accounting of the total catch and release mortality on a stock specific basis. Therefore, the monitoring programs needs to provide the following:
    - ***Quantify total mortality:*** Accurate total mortality data is difficult to obtain under current conditions in the groundfish fisheries. Generally referred to as

discards, this often unaccounted for catch can represent a serious impediment to sustainability. In most groundfish fisheries, some level of discards is unavoidable. Unwanted catch releases occur when there is no market for the fish; when the value of one fish is greater than another (resulting in the lower valued fish being released); or when retention of a species exceeds the permitted limits. In cases when fish are released at sea, there is almost always some level of associated mortality. When fish are released back to the water, an estimate is taken to determine the quantity released and then a level of mortality is assigned. The mortality rate may be based on the species of fish, condition identifiers, gear used, fishing depth, or length of fishing time. At-sea monitoring can accurately estimate the quantity released and collect information that will aide in mortality estimation.

- ***Species and area (stock) management:*** Not only are there problems accounting for total mortality, but the catch information (both target and non-target) are often not properly recorded by species and area for those fisheries without at-sea monitoring. Fishermen may misreport the species and area of catch in an attempt to bypass the fishing rules or regulations that do not permit the retention of a certain species or quantity in a specific area. Of course, this plays havoc with the data used to manage the fishery and assess the stocks. It is important to manage on a stock basis. Without proper monitoring, smaller stocks could be significantly overfished while larger stocks or less accessible stocks could be underfished.
- ***Timely information:*** In addition to accurate, the information on catch, area and mortality should be timely so that managers know if TACs and ACLs are being exceeded and can take the appropriate action (i.e. closures, new limits, etc).

- ***Improved stock assessment:*** There are many different groundfish stocks commercially harvested in the New England northeast multispecies fishery. An impediment to sustainability in groundfish fisheries is the deficiency in the quantity and accuracy of groundfish research and assessment information (biological data, survey data, fishery data). Monitoring programs can improve on the precision of data collected from the fishery as well as the type and amount of information (set locations, water temperature, currents, biological samples, habitat type, etc.).
- ***Improved compliance:*** Fisheries management is becoming increasingly complex, with more rules being developed and the incentive for non-compliance growing. Compliance with closures, fishing limits, gear restrictions, and reporting requirements can be improved with monitoring.

Industry's monitoring objectives:

- ***Timely and accurate data:*** Similar to the managers, Sector managers and vessel operators will want prompt information about a vessel's catch to properly manage the Sectors allocations, coordinate transfers, and ensure the Sector's fishing opportunities are not curtailed.
- ***Level playing field:*** Fishermen are a competitive bunch, and don't want their peers to have an advantage because they are cheating or not fishing as selectively or

responsibly as they are. While Sector management will provide the framework for individualizing fishing operations. Monitoring is a tool for levelling the playing field by reassuring participants that individual accountability is being checked and complied with. The monitoring program (combined with the individual allocation) better aligns each fisherman's incentives with those of the Sector and the manager.

- ***Affordability:*** It's hard to imagine many vessels being able to maintain a viable fishing operation if they are required to have 100% at-sea observer coverage at $1200 a day. If the monitoring program is unaffordable, too many vessels will be forced out of the fishery or into a position of non-compliance.
- ***Economic benefits:*** In so far as effective monitoring provides for successful Sector management, it allows for improved economic returns to the fishermen by:
    - Removing the need for inefficient management measures such as rolling closures, trip limits, and DAS.
    - Allowing for improved business planning on a seasonal and longer-term basis.
    - Providing for greater operational flexibility to improve product quality, distribution, and servicing of market needs.
    - Allowing for economic efficiencies through consolidation, specialization and regionalization of fishing operations.
    - Improving the asset value (value of Sector allocations) to the fishermen through more clearly defined access and improved economic returns.

Sector Monitoring Options

There are a number of monitoring tools available, depending on how comprehensive the program needs to be to meet stated objectives. The tools used in the options presented in this report include:

VMS Vessel Monitoring System: the vessel tracking systems already found on all groundfish vessels participating in the federally regulated multispecies fishery.

VTR Vessel Trip Report: the reports completed by the vessel operator providing information on catch and discards by species and area on a set and trip basis.

DR Dealer Report: the report completed by companies purchasing the fish from the vessel providing detailed information on the catch weight by species and the vessel the catch was received from.

HP Hail Program: a program that allows a vessel operator to communicate their activity such as commencement and completion of a fishing trip (when they will be leaving, where they will be fishing, when they plan on landing) and scheduled landing and offloading of fish.

DMP Dockside Monitoring Program: a program in which a third party contractor monitors and reports on the sorting and weighing of the catch on shore (often referred to as a weighmaster program).

EMP Electronic Monitoring Program: a program using cameras, sensors, and GPS on board vessels to record vessel and fishing location, fishing activity, catch (retained and released), and compliance with fishing rules (closed areas, mandatory retention, gear restrictions).

ASOP At-sea Observer Program: a program using observers on board vessels to record vessel and fishing location, fishing activity, catch (retained and released) estimates, compliance with fishing rules (closed areas, mandatory retention, gear restrictions) and collect biological samples/information.

RM Roving Monitor: an individual, employed by the third party contractor responsible for the DMP, who meets vessels at the point of offloading to confirm and record information on the hail-in and the number of totes/boxes offloaded for transportation, collect the VTR, and install/remove EMP equipment.

DM Dockside Monitor: an individual, employed by the third party contractor responsible for the DMP, who monitors and records the sorting and weighing of groundfish catch from a vessel.

LR Landing Report: a report completed by the DM providing detailed information regarding the total weight by species offloaded from a vessel subject to DMP.

EMR Electronic Monitoring Report: A report, produced by a third party contractor, of the area specific retained and released catch by a vessel as recorded by the vessel's electronic monitoring equipment.

Using a combination of the above tools, three basic monitoring approaches are identified for consideration. Options 2 and 3 also have sub-options. While there are nine possible monitoring scenarios, a total of six monitoring options are presented. As we progress through the options, they become more comprehensive in the tools used and the extent to which the tools are utilized. Not surprisingly the latter options better meet sustainable management objectives but are also more costly. Each option describes the roles of the Sector manager, NMFS, and third party contractor. The pros and cons of each option relative to the industry and government objectives are also identified.

Option 1: Modified Status Quo
HP + VMS + VTR + DR

Description: This option is similar to the current monitoring requirements. The primary difference is that a third party contractor collects the information. This option also assumes that NMFS will continue with some low level of at-sea observer coverage similar to existing levels.

Prior to the start of a trip the vessel hails-out to the contractor their intentions to commence fishing, including when they will be leaving port and when they plan on landing. The vessel is given a hail-out number and records it in the VTR for that trip. The VMS system must be operating at all times and the VMS data continues to be collected by NMFS for enforcement purposes. Upon completion of harvesting activities the vessel hails-in to the contractor when they will be landing, landing location, if the product is being trucked, and where the fish is going (auction, processing plant). The vessel is given a hail-in number and records it in the VTR for that trip. The vessel submits their completed VTR to the contractor within 7 days of offloading. The buyer of

the fish submits the completed Dealer Report (DR) to the contractor within 7 days of receiving the fish.

In addition to providing the hail services, the contractor reviews the VTR and DR data for completeness, enters the data into a data base program, and merges the data to determine species catch weights by area. This is done by taking the ratio of estimated weights in the VTR and applying those ratios to the landed weights in the DR. An assumed discard rate mortality, based on the retained catch (DR) and the area fished (VTR), is applied and added to the landed weight mortality. The contractor then calculates total mortality by stock and deducts the mortality from the applicable vessel and Sector allocations. Within 48 hours of receiving all data associated with a vessel trip, status reports are provided to the Sector manager and NMFS. Sector managers and NMFS staff will also be able to monitor online vessel hail-out and hail-in activity provided to the contractor.

Upon receiving the status reports, the Sector manager reviews the catches against the vessel's and Sector's allocations. If transfers are required between Sector vessels, the Sector manager will organize it with the appropriate vessels. If transfers are required between Sectors, the Sector manager will work with other Sector managers and NMFS on the appropriate stock and volume of unutilized allocations to be moved.

The status reports from the contractor allow NMFS to monitor Sector catch mortality (both landed and discard mortality) against the Sector allocations. The information is also important for understanding requests from Sector managers for transfers of ACE between Sectors.

Pros:

- Low cost
- Minimal change from current program
- More timely data management and reporting

Cons:

- No independent estimates of at-sea discards
- No independent estimates of species catch by area
- No independent verification of landed weights and species reporting
- No change in incentives for fishermen to:
    - Reduce discards
    - Minimize mortality
    - Fish selectively
- Unable to reduce assumed mortality rate

Option 2: Dockside Monitoring
HP + VMS + DMP + VTR
a) < 100% DMP + DR
b) 100% DMP

Description: This option builds on Option 1 by adding independent monitoring of the product either at the point of landing or at the processing plant (where-ever the fish is sorted and weighed). This option also assumes that NMFS will continue with some level of at-sea observer coverage similar to existing levels. The difference between 2a) and 2b) is the level of dockside monitoring and the use of dealer reports in the absence of dockside monitoring data. The level of DMP is a function of the risks and rewards (costs and benefits) of obtaining accurate and reliable landed weight data.

Prior to the start of a trip the vessel hails-out to the contractor their intentions to commence fishing, including when they will be leaving port and when they plan on landing. The vessel is given a hail-out number and records it in the VTR for that trip. The VMS system must be operating at all times and the VMS data continues to be collected by NMFS for enforcement purposes.

Upon completion of harvesting activities the vessel hails-in to the contractor when they will be landing, landing location, if the product is being trucked, the time it will be offloaded, where the fish is going (auction, processing plant), and the scheduled time for the plant to receive the fish. The vessel also hails-in the estimated total weight of fish being offloaded, the major species categories (this is done for planning purposes for the contractor when scheduling Dockside Monitors) and requests a Roving Monitor (RM) in the case where the product is being trucked and a Dockside Monitor (DM) to monitor the catch at the location it is being sorted and weighed. The vessel is given a hail-in number and records it in the VTR for that trip. The vessel submits their completed VTR to the contractor either at the point of offloading (the VTR is given to the RM or DM) or within 7 days of offloading.

a) *< 100% DMP +DR:* If the product is being trucked from the landing port to the auction or plant the vessel may be met by a RM who will check and record the number of totes/boxes loaded onto the truck as well as the vessel's holds to see that all the fish has been offloaded. The RM does not necessarily attend every truck offload, but often enough so the vessel operator believes the probability is high. The RM collects the VTR from the vessel.

   Once the product reaches the location where it will be sorted and weighed (either by truck or the vessel lands at that location) it cannot be offloaded (from the truck or the vessel) until the scheduled time identified by the hail-in. A DM may be present to monitor and record the sorting and weighing of the product. The DM does not attend every offload, but frequently enough so that the plant and vessel operator believes the probability of being monitored is high. For monitored offloads, the DM completes a Landing Report (LR) for the monitored product and collects the VTR (if not already collected by the RM). The buyer of the fish submits the completed dealer report (DR) to the contractor within 7 days of receiving the fish.

   The contractor receives and reviews the applicable reports (LR, VTR and DR) for completeness, enters the data into a data base program, and merges the data to determine species catch weights by area. This is done by taking the ratio of estimated

weights in the VTR and applying those ratios to the landed weights from either the LR or the DR (in the absence of an LR).

b) 100% DMP: If the product is being trucked from the landing port to the auction or plant the vessel may be met by a RM who will check and record the number of totes/boxes loaded onto the truck as well as the vessel's holds to see that all the fish has been offloaded. The RM does not necessarily attend every truck offload, but often enough so the vessel operator believes the probability is high. The RM collects the VTR from the vessel.

Once the product reaches the location where it will be sorted and weighed (either by truck or the vessel lands at that location) it cannot be offloaded (from the truck or the vessel) until a DM is present. The DM will arrive 15 minutes prior to the scheduled offloading time (in some cases the offloading time will be consistent with the hail-in but often it may be coordinated by the plant and communicated to the dockside monitoring contractor). The DM will be present to monitor and record the sorting and weighing of the product. The DM completes an LR for the monitored product from each vessel and collects the VTR (if not already collected by the RM).

The contractor receives and reviews the applicable reports (LR and VTR) for completeness, enters the data into a data base program, runs edit checks, and merges the data to determine species catch weights by area. This is done by taking the ratio of estimated weights in the VTR and applying those ratios to the landed weights from the LR. The contractor will also track variances between hailed and offloaded weights and DMP and DR weights.

An assumed discard rate mortality, based on the retained catch and the area fished, is applied and added to the landed weight mortality. The contractor then calculates total mortality by stock and deducts the mortality from the applicable vessel and Sector allocations. Within 48 hours of receiving all of the data associated with a vessel trip, status reports are provided to the Sector manager and NMFS. Sector managers and NMFS staff will also be able to monitor online vessel hail-out and hail-in activity provided to the contractor.

Upon receiving the status reports, the Sector manager reviews the catches against the vessel's and Sector's allocations. If transfers are required between Sector vessels, the Sector manager will organize it with the appropriate vessels. If transfers are required between Sectors, the Sector manager will work with other Sector managers and NMFS on the appropriate stock and volume of unutilized allocations to be moved.

The status reports from the contractor allow NMFS to monitor Sector catch mortality (both landed and discard mortality) against the Sector allocations. The information is also important for understanding requests from Sector managers for transfers of ACE amongst Sectors.

Pros:

- Independent verification of landings improves confidence in and accuracy of landed catch data
- More timely data management and reporting than Option 1 (where offloads are monitored)
- Improved compliance
- Improved TAC management

Cons:

- More expensive than Option 1
- Significant change from status quo
- No independent estimates of at-sea discards
- No independent estimates of species catch by area
- No incentive for fishermen to:
  - Reduce discards
  - Minimize mortality
  - Fish selectively
- Unable to reduce assumed mortality rate

Option 3: Dockside Monitoring and At-Sea Monitoring
HP + EM/ASOP + VMS + DMP + VTR

a) < 100% EMP/ASOP
b) 100% EMP + < 100% ASOP
c) 100% EMP/ASOP

Description: This option builds on Option 2 by adding independent monitoring of the catch at sea either through electronic monitoring (EMP) and/or at-sea observers (ASOP). We have assumed 100% DMP (Option 2 b) above) for all three sub-options, but the reader should realize that three additional sub-options could have been developed using Option 2 a) above (< 100% DMP + DR). The differences in options 3a), 3b) and 3c) are the level of at-sea monitoring. The level of at-sea monitoring will be a function of the risks and rewards (costs and benefits) of obtaining accurate and reliable information about catch and discards by area and species.

Prior to the start of a trip the vessel hails-out to the contractor their intentions to commence fishing, including when they will be leaving port and when they plan on landing. The vessel is given a hail-out number and records it in the VTR for that trip. The VMS system must be operating at all times and the VMS data continues to be collected by NMFS for enforcement purposes.

a) < 100% EMP/ASOP: When the vessel hails-out it is required to request at-sea monitoring. All gillnet and hook & line vessels and only trawl vessels fishing in a single area under mandatory retention can request electronic monitoring (EMP) equipment. Trawl vessels fishing multiple areas and/or not subject to mandatory retention must request an at-sea observer (ASOP).

Upon receiving the request, the contractor will advise the vessel operator whether or not they are required to take electronic monitoring or an at-sea observer for that trip. The decision to monitor a trip at-sea will be made by the contractor and based on a statistical model designed in conjunction with NMFS and industry to estimate area, species and vessel discard rates and compare monitored and unmonitored trips. If the vessel is required to have monitoring on board, they cannot leave port until the EMP equipment has been installed or until an observer has boarded. The contractor will install the equipment or have an observer onboard the vessel within 24 hours of the request. During the trip, the EMP equipment is mapping the vessel's location, speed, and direction and recording set and haul locations, fishing activity, and catch (retained and released). Observers are recording set and haul locations, estimating catch, collecting biological information and monitoring compliance with fishing rules (closed areas, gear restrictions, etc.).

b) *100% EMP + < 100% ASOP:* When the vessel hails-out it is required to request at-sea monitoring. All gillnet and hook & line vessels and only trawl vessels fishing in a single area under mandatory retention can request electronic monitoring (EMP) equipment. Trawl vessels fishing multiple areas and/or not subject to mandatory retention must request an at-sea observer (ASOP).

   For gillnet and hook & line vessels, and trawl vessels fishing in a single area under mandatory retention, the contractor will make arrangements for EMP equipment to be installed on the vessel if the equipment is not already on board.

   For trawl vessels fishing in multiple areas, the contractor will advise the vessel operator whether or not they are required to take an at-sea observer for that trip. The decision will be made by the contractor and based on a statistical model designed in conjunction with NMFS and industry to estimate area, species and vessel discard rates and compare observed and unobserved trips. If the vessel is required to take an observer, they cannot leave port until an observer has boarded. The contractor will provide an observer for the designated departure time, provided that 24 hours of advance notice is given. During the trip, observers are recording set and haul locations, estimating catch, collecting biological information and monitoring compliance with fishing rules (closed areas, gear restrictions, etc.).

c) *100% EMP/ASOP:* When the vessel hails-out it is required to request at-sea monitoring. All gillnet and hook & line vessels and only trawl vessels fishing in a single area under mandatory retention can request electronic monitoring (EMP) equipment. Trawl vessels fishing multiple areas and/or not subject to mandatory retention must request an at-sea observer (ASOP).

   For gillnet and hook & line vessels, and trawl vessels fishing in a single area under mandatory retention, the contractor will make arrangements for EMP equipment to be installed on the vessel, within 24 hours, if the equipment is not already on board.

For trawl vessels fishing in multiple areas, the contractor will make arrangements for an observer to meet the vessel within 24 hours of the request. The vessel cannot leave port until an observer has boarded. During the trip, observers are recording set and haul locations, estimating catch, collecting biological information and monitoring compliance with fishing rules (closed areas, gear restrictions, etc.).

Upon completion of harvesting activities the vessel hails-in to the contractor the vessel's landing time and location, if the product is being trucked, offloading time, where the fish is going (auction, processing plant), and the scheduled time for the plant to receive the fish. The vessel also hails-in the estimated total weight of fish being offloaded and the major species categories (this is done to aid the contractor in scheduling dockside monitors), requests a RM (in the case where the product is being trucked) and/or a DM (to monitor the catch at the location it is being sorted and weighed). The vessel is given a hail-in number and records it in the VTR for that trip. The vessel submits their completed VTR to the contractor either at the point of offloading (the VTR is given to the RM or DM).

If the vessel had an observer on the trip, the observer disembarks and submits a completed Observer Report (OR) from the trip. If it was an EMP trip, the RM or DM may board the vessel to remove and replace the hard drive.

For gillnet and hook & line vessels, the contractor reviews the trip EMP data and compares a percentage of the monitored sets with the VTR information (it is possible that the EMP data may cover several trips and would be compared with corresponding VTRs from different trips). If the data match within acceptable error limits, the entire VTR data is accepted as accurate. If the error level is too high, an additional percentage of EMP data will be compared with VTR data (at the vessel owner's expense – the owner has an incentive to accurately complete the VTR). If there continues to be an unacceptable level of discrepancy between the VTR and the EMP data, the entire EMP data will be reviewed and the Electronic Monitoring Report (EMR) will replace the VTR as the accurate record for the trip.

For trawl vessels fishing in a single area under mandatory retention, the contractor will review the EMP data to confirm that the vessel fished in only one area, that the area matches with the VTR, and that there were no discards. If there are no violations, the VTR will be considered an accurate record.

If the product is being trucked from the landing port to the auction or plant the vessel may be met by an RM who will check and record the number of totes/boxes loaded onto the truck as well as the vessel's holds to see that all the fish has been offloaded. The RM does not necessarily attend every truck offload, but often enough so the vessel operator believes the probability is high. The RM collects the VTR from the vessel (and may collect the hard drive).

Once the product reaches the location where it will be sorted and weighed (either by truck or the vessel lands at that location) it cannot be offloaded (from the truck or the

vessel) until a DM is present. The DM will arrive 15 minutes prior to the scheduled time identified by the hail-in. The DM will be present to monitor and record the sorting and weighing of the product. The DM completes a Landing Report (LR) for the monitored product from each vessel and collects the VTR (if not already collected by the RM).

The contractor receives and reviews the applicable reports (LR, VTR, EMR, and OR) for completeness, enters the data into a data base program, runs edit checks, and merges the data to determine species catch weights by area. This is done by taking the ratio of estimated weights in either the VTR or EMR for gillnet, hook & line and single area mandatory retention trawl trips and applying those ratios to the landed weights from the LR. For multi-area trawl trips this is done by taking the ratio of estimates from the OR and applying them to the landed weights from the LR.

For all trips where an observer or electronic monitoring is not required, an assumed discard rate mortality, based on the retained catch and the area fished, is added to the landed weight mortality. For EMP and ASOP trips the discard mortality is calculated by applying established species mortality rates to the estimates of discards from the VTR, EMR, or OR. When applicable, the Sector manager will use the at-sea monitoring mortality estimates to request a reduction/exemption from the assumed mortality rate established by NMFS.

The contractor then calculates total mortality (discarded plus retained) by stock and deducts the mortality from the applicable vessel and Sector allocations. Within 48 hours of receiving all of the data associated with a vessel trip, status reports are provided to the Sector manager and NMFS. Sector managers and NMFS staff will also be able to monitor online vessel hail-out and hail-in activity provided to the contractor.

Upon receiving the status reports, the Sector manager reviews the catches against the vessel's and Sector's allocations. If transfers are required between Sector vessels, the Sector manager will organize it with the appropriate vessels. If transfers are required between Sectors, the Sector manager will work with other Sector managers and NMFS on the appropriate stock and volume of unutilized allocations to be moved. The Sector manager will also resolve disputes involving discrepancies between the VTR and EMP data (proper completion of VTR, keypunching errors, etc.), between the skipper and the observer (species identification, estimates of catch and discards, etc.), or between monitor and unmonitored trips.

The status reports from the contractor allow NMFS to monitor Sector catch mortality (both landed and discard mortality) against the Sector allocations. The information is also important for understanding requests from Sector managers for transfers of ACE amongst Sectors.

Pros:

- Independent verification of landings improves confidence in and accuracy of landed catch data
- Independent verification of estimated catches (retained and discarded) by species and area

- More timely data management and reporting than Options 1 or 2
- Improved compliance
- Improved TAC management
- Improved information for stock assessment
- Provides incentives for vessels to fish selectively, reduce discards and discard mortality, and accurately report catch
- Can increase Sector allocation by seeking reduction/exemption from assumed mortality rate

Cons:

- More expensive
- Significant change from status quo

A Phased Approach

Forcing too much change (and too much added expense) on the industry immediately would likely meet significant resistance and increases the difficulty of implementing constructive and proactive revisions to the management of the commercial groundfish fishery.

Adapting to Sector and quota management (TACs, ACL, and Sector allocations) will, by itself, take time and result in changes to the fleet as Sectors and vessels organize themselves, develop business plans, consolidate ACE, and learn how to maximize fishing and economic opportunities. The general experience in other jurisdictions (Canada), where fisheries have moved to quota management, is that there is an adjustment period, but the viability of the fishery improves. A financially healthy fishery is more capable of absorbing increased management costs.

Alternatively, no monitoring changes concurrent with the movement to Sector management could lead to further discarding and catch misreporting as the opportunity and economic incentives to high-grade and misreport increase. The health of the resource also has a bearing on the economic value. The value of Sector's and its members' allocation is related to the sustainability of the fishery. Therefore, it is important to find the right balance between changes to the management framework and monitoring requirements.

The options above should provide the basis for Sectors to develop base level monitoring programs. Such programs will take into account the size of their vessels, the areas they fish, the species they catch, the ACL, and financial impacts of more monitoring. For example, a Sector may believe that Option 2 a) works best for them initially, but plan on moving towards Option 3 c) over time because they believe they can minimize discard mortality (through selective fishing, shorter sets, and better on deck handling) and increase their ACL by receiving an exemption from the assumed mortality rate.

Government may also want to use the options to set minimum standards. For example, they may require Option 1 as the minimum standard for all vessels fishing in the common pool fishery (in effect the common pool is just like another Sector that is subject to input controls). If Sectors want to have exemptions from the input controls, they may be required to have minimum monitoring requirements consistent with Option 2 a), 2 b) or 3 a). Sectors wanting exemption from the bycatch mortality rate may opt for Options 3 b) or 3 c). The Government and Sectors may also look at monitoring scenarios that combine 2 a) (less than 100% DMP + DR) with less than 100 % EMP/ASOP.

A phased in approach allows for smoother transition and enables government and industry to productively reprofile resources (financial and human) and for new monitoring infrastructure to be put in place and expand with the growing needs of the fishery.

Phase I Recommendations

Based on the information collected and the various meetings with industry, government and other interested parties, it is apparent that changes are necessary in how the New England multispecies groundfish fisheries are monitored. Indeed, new legislation and the advent of Sector management only serve to expedite and focus the discussion on necessary and overdue monitoring improvements.

The following recommendations acknowledge the need to make changes and the difficulties associated with change in an industry facing increasing market competition, growing economic instability, and uncertain future resource availability:

Recommendation 1: **Option 1 should be the minimum monitoring requirements for the common pool fishery.** Even with input controls, the proper management of TACs requires the collection of catch data from the common pool fishery in a timely manner. The current process for collecting catch data takes three months or longer and makes it difficult for fishery managers to monitor the success or failure of management measures and intervene judiciously to avoid excess harvesting.

Recommendation 2: **Sector monitoring should be phased in over a three year period with Option 2 (dockside monitoring) being required in year 1 and Option 3 (at-sea monitoring) required by year 3.** The industry and government will be going through significant change as it moves to Sector management. They will need time to organize and develop the infrastructure (Sector organization, data systems, monitoring capacity, ACE trading network, communications, etc.) to accommodate such change.

Recommendation 3: **During the first 5 years the monitoring program should be contracted to a single service provider.** Currently, there is no centralized data management system suitable for Sector based fishery management and development of one would likely be more efficient and representative after the monitoring program components have been implemented and the bugs worked out. In the interim, the service

provider will need to develop in-house systems to accommodate the various forms of information collected (hails, VTRs, EM, ASOP, DMP, DR). The use of a single service provider will ensure that:

- the data collection methods and requirements are consistent across all Sectors
- there is an integrated monitoring program with all the necessary elements
- there is a common conduit for reporting all information from all user groups

Furthermore, during the first years of the program, there will be data issues that need to be resolved (i.e. DMP data doesn't match up with VTR data, EM data doesn't match up with VTR, ASOP estimates greatly differ from DMP data) by looking directly at the various data collection processes and products. This would be more difficult in a multi-contractor scenario. There are also economic efficiencies to be gained. As the program develops the contractor can make adjustments between program components (i.e. use more EM and less ASOP, have more at-sea observers and less dockside monitors). Additionally, there will not be the costs of redundant infrastructures associated with multi-service providers.

Recommendation 4: **The contractor should be selected through a competitive bidding process coordinated by a government agency.** The need for a single service provider during the first 5 years of the program, the lack of a comprehensive industry organization, issues concerning data confidentiality, and the likelihood of multi-source (government, industry, outside sources) funding arrangements supports having a government agency (NMFS or the Atlantic State Fisheries Commission) act on behalf of the industry as the contractor of monitoring services. This could change over time as industry matures and takes on greater responsibility for the management of the groundfish resource (a natural evolution under quota management). The competitive bidding and selection process should be transparent and involve industry. The process will provide clarity to the work required, obligate potential service providers to identify implementation plans and deliverables, and enable government and industry to evaluate the selected service provider's performance.

Recommendation 5: **Some, but not all, costs should be borne by industry.** While there is clearly rationale for government to absorb some of the costs for monitoring program, there are also important reasons for industry to burden some of the program costs. Using the monitoring programs responsibly and efficiently is more likely if industry is sharing in the costs. Industry will also have a greater incentive to seek out program designs and improvements that minimize costs and better suit operational needs.

Recommendation 6: **There should be an annual program evaluation.** Evaluation is important to monitor the service provider's performance and to make necessary program operations and efficiency improvements. The annual evaluation should assess data quality, compliance, and procedures, and provide a comparative analysis (i.e. DMP vs DR, hails vs VTR, VTR vs DR, VTR vs EM/ASOP, etc.) and comprehensive summary of the fishery data (i.e. vessel activity, landings, distribution, offload amounts, monitoring time, etc.)

Recommendation 7: **There should be a comprehensive communications plan to prepare participants for the new monitoring initiatives, educate them on new and ongoing program requirements, allow for feedback, and identify necessary contacts.** All forms of communication should be used (websites, public meetings, mail-outs, e-mails, newspapers) to correspond with all potential participants. The information provided should not only identify the changes occurring but provide the rationale for the changes and the ongoing evaluation to be conducted.

Phase II – Monitoring System Cost and Implementation Issues

The second part of this study (Phase II) was intended to build on the Phase I report by providing more detailed advice on monitoring systems and associated costs for Sector fisheries. The report also examines critical issues with the development of a new monitoring program.

The basic approach for this study will be to draw on our experience with monitoring systems and apply this knowledge to a Sector management structure. Archipelago provides stand-alone monitoring programs in a variety of fisheries in British Columbia, Canada, which vary by target species, fleet characteristics, fishing method, program structure and monitoring objectives. BC groundfish fisheries are described and compared with the New England multispecies groundfish fishery. The report applies the BC monitoring systems in a New England context in order to provide a better understanding of different cost elements and their contribution with respect to the monitoring options identified in the Phase 1 report. This approach is intended to advance the discussion on cost and practicality for the various monitoring options and to identify key sensitivities that influence monitoring costs. It is recognized that more detailed business planning and further clarification of how Sector management would occur will be needed to more accurately estimate monitoring costs.

Assumptions

This report builds on the Phase I report and, accordingly, we accept all the recommendations in the development of monitoring program structure and cost estimates. Noteworthy in this respect were the following recommendations:

Recommendation 1: **Option 1 should be the minimum monitoring requirements for the common pool fishery.**

Recommendation 2: **Sector monitoring should be phased in over a three year period with Option 2 (dockside monitoring) being required in year 1 and Option 3 (at-sea monitoring) required by year 3.**

Recommendation 3: **During the first 5 years the monitoring program should be contracted to a single service provider.**

Recommendation 5: **Some, but not all, costs should be borne by industry.**

The Phase I report provided further description of the monitoring options. Option 1, which we term Baseline Data Collection (BDC) in this report (termed 'modified status quo' in Phase 1 report), represents the minimum data collection that should be required of all Common Pool and Sector managed fleets. This baseline level of data collection includes the existing tools of Vessel Trip Reports (VTR), Dealer Reports (DR), Vessel Monitoring System (VMS) data, as well as a new tool of mandatory hails in advance of fishing and again upon landing to offload catch. Option 2 applies to the Sector managed

fleet and includes Option 1 and a mandatory Dockside Monitoring Program (DMP). The DMP would involve both Roving Monitors (RM) and Dockside Monitors (DM), the former for product being landed in remote ports to be trucked to the auction or plant, and dockside monitors for landings at primary ports. Option 2 has two sub options for partial and complete monitoring of the fleet. Option 3 applies to the Sector managed fleet and includes Option 2 and an at-sea monitoring program, using either an electronic monitoring program (EMP) or an at-sea observer program (ASOP). The EMP would apply to fixed gear vessels, or trawlers fishing single management areas and subject to full retention, while the observer would be used on multi area trawl fishing trips. Three sub options were identified for Option 3, providing partial coverage of both EM and observer fleets, providing 100% coverage of EM fleet and partial coverage of the observer fleet, and providing 100% coverage of all vessels.

Recommendation 3 sets forth a standalone independent third party service delivery structure for the Sector monitoring systems. We fully recognize that this overlaps with monitoring systems that NMFS currently runs in a variety of New England fisheries, including the current limited access/DAS multispecies groundfish fishery. If implemented, Recommendation 3 would create redundancy, as NMFS would need to continue to maintain monitoring systems in other fisheries. This issue is beyond the scope of our investigation and the recommendation was put forth from the perspective of best serving the needs of a Sector monitoring system. The analysis approach taken in this report continues with the notion that Sector monitoring systems would be independent standalone programs although clearly, the respective roles and interactions between the two programs would need further examination.

British Columbia Fisheries and Monitoring Systems

Service Delivery Structure

Most fisheries in British Columbia have expanded reporting or monitoring requirements that are met through the use of independent third party service providers. There are four companies offering monitoring services in BC, three of which offer specialty services to one or a few similar fisheries. Archipelago is the largest company, providing a broad range of services (*i.e.*, DMP, ASOP and EMP) to several fisheries. Monitoring programs in BC are uniformly structured with a single company providing services for an entire fishery or fleet group, ensuring cost efficiencies and continuity of services across the fishery. In most programs, industry funds the majority of the monitoring service cost and industry associations contract directly with the service provider for monitoring services. Service providers are selected through a competitive bidding process and follow performance specifications defined by industry and Fisheries and Oceans Canada (DFO). Most programs are fully stand alone where the service provider is responsible for developing the methodology and resources to carry out all the steps from program design to final data delivery. The 'products' of monitoring programs are provision of service to meet the operational needs of the fishery and the provision of keypunched, edited data, analyses and reports.

Authorities

DFO has established a regulatory regime for the provision of third party DMP and ASOP monitoring services in the Fishery General Regulations (http://laws.justice.gc.ca/en/F-14/SOR-93-53/index.html). These regulations set out conditions by which DFO may designate and certify individuals (observers) performing observing and dockside monitoring work. All persons performing DMP duties must carry the designation of a certified fishery observer. Sections 39 and 40 of the federal regulations identify the rights, qualifications, duties, restrictions and certification process for fishery observers.

The regulations also set out conditions by which DFO may designate corporations providing DMP services. The regulations require: "*The implementation and adherence to a quality management system for ensuring the integrity of the information collected and compiled that identifies a person responsible for the system and his or her duties, and that describes the operation system, the manner in which records are kept, the control points, the verification procedures and the process for correcting deficiencies in the system.*" In order to address oversight of this requirement, DFO has worked closely with the Canadian General Standards Board (CGSB) to establish a DMP Quality Management System Standard and a listing process for prospective companies wishing to provide DMP services. This standard is a modified and reduced version of ISO9001: 2000 (a generic set of requirements for implementing a quality management systems from the International Organization for Standardization). In order to deliver DMP services in Canada, companies must apply for, receive and maintain listing with the CGSB. The listing process includes the requirement for prospective companies to develop and submit for approval a Quality Systems Manual. An independent CGSB auditor approves prospective companies for CGSB listing on the basis of the quality of the manual and the outcome of initial and ongoing quality management system audits.

Monitoring programs operate under the authority of contractual arrangements between the service provider, industry associations and DFO. The contracts clarify the terms of service, responsibilities of parties, and generally bind service providers with the same privacy of information requirements as would occur if these programs were carried out by government.

Description of Fisheries and Monitoring Systems

Table 1 provides a summary of several different fisheries that receive monitoring services from Archipelago. The top portion of Table 1 outlines the general characteristics of the fishery and the lower portion identifies the monitoring systems in place. The values shown are in Canadian dollars, which is almost at par with the US dollar at the time of writing. The Table identifies eight fisheries across multiple species, gears and areas. The management issues and monitoring systems of these fisheries varies widely.

Table 1. Overview of Selected BC Fisheries and Monitoring Systems (2007).

	Groundfish Fisheries					Other Fisheries			
	Hook and Line	Offshore Trawl	Inshore Trawl	Hake (m/w trawl)	Total Groundfish	Salmon (all)	Shrimp Trawl	Geoduck (diver)	Crab Trap
Fishery Profile									
Vessels	244	48	9	34	**301**	1,485	71	40	52
Trips	1,607	789	364	760	**3,520**	n/a	1,264	2,100	1,973
Seadays	12,000	4,752	839	2,115	**19,706**	n/a	3,720	n/a	4,129
Offload Hrs	4,300	7,100	450	4,750	**16,600**	n/a	n/a	2,300	n/a
Lbs. Landed	28,459,120	81,101,245	299,451	120,600,121	**230,459,937**	43,728,733	1,388,962	3,437,500	8,140,914
$/Lb	$3.00	$0.50	$2.50	$0.10	**$0.60**	$0.69	$1.00	$8.63	$2.00
Total Value	$85,377,360	$40,550,623	$748,628	$12,060,012	**138,736,622**	$30,253,783	$1,388,962	$29,665,625	$16,281,828
Monitoring System Components									
BDC	100%	100%	100%	100%		100%	100%	100%	100%
DMP	100%	100%	100%	100%				100%	
ASOP		100%					~2%	89%*	
EMP	100%		100%	100%**					100%

Source: Fisheries and Oceans Canada

* - Most of the fishery requires monitoring with ongrounds patrol vessels

** - 100% EM in northern region only (72% of total days)

BC Groundfish

BC's groundfish fishery includes four different components, which collectively comprise a fleet of about 300 vessels, 3,500 trips, 20,000 days at sea, 230 million pounds landed weight, and a value of about $140 million (CDN). BC groundfish fisheries occur coast wide and year round. The major gear categories are termed trawl and hook and line, while the latter includes several gears including longline, trap, demersal troll and hand line. Trawl fishing involves a fleet of about 70 vessels that further subdivide into a small inshore (Gulf of Georgia) component, an offshore component and a midwater trawl component fishing Hake (*Merluccius productus*). Within the hook and line component, there are about 240 vessels which are separately licensed into six distinct fisheries including halibut, blackcod, lingcod, dogfish, inshore rockfish, and offshore rockfish. Collectively, the groundfish fishery encompasses about 60 different stocks, delineated by both species and area. License holders are allocated individual quota on an annual basis and there is a significant level of trading in order to establish quota portfolios that meet specific fishing plans and expected bycatch levels. Groundfish fisheries are universally governed by a principle of individual accountability, which mandates high levels of at-sea and shore based monitoring and compels fishers to account for their entire catch, including discards. Monitoring systems include hails, logbooks, DMP, ASOP (offshore trawl) and EMP (inshore trawl, hook and line, and hake in northern regions). Most components of the monitoring system are contracted and funded by industry. DFO partially funds the ASOP and EMP and has a major role in contracting the ASOP.

BC Salmon

Traditionally BC's largest fishery, about 1,500 vessels are active, mostly fishing with gillnets, secondarily by troll gear and then by purse seine. The limited entry fishery utilizes a hail system and logbooks in order to manage the fishery within a series of time and management area harvest openings. An experimental individual quota fishery is in place for two troll fleet groups where DMP is mandatory. The program is contracted by DFO and funded jointly by industry and government.

BC Shrimp Trawl

The shrimp trawl fishery targets northern pink shrimp (*Pandalus borealis eous*) and in recent years has declined to about 70 vessels from historic levels of 300 vessels. Most vessels in the fleet use beam trawls and a small proportion of the fleet has larger vessels and fishes with otter trawl gear. The fishery is managed with shrimp quota allocated by area. The monitoring system includes: hails, to provide real time information on fleet activity; logbooks, to provide catch records by area; and small levels of at-sea and port based sampling to monitor catch and bycatch in the fishery. The program is contracted and funded by industry, except for a small federal contribution for the at sea observing component.

BC Geoduck

Established in 1989, the geoduck (*Panopea abrupta*) fishery is one of Canada's oldest individual quota fisheries. The fleet has remained relatively stable at about 40 vessels that operate as platforms for hookah-rigged divers to harvest this large, highly valued sub tidal bivalve. Geoduck quota is allocated to individual licence holders and harvest areas with specific catch limits are fished on a three-year rotating schedule. Harvest areas are opened following testing for paralytic shellfish poisoning and closed once the area harvest limit has been reached. On-grounds patrol boats are contracted to work with the fleet in coordinating the harvest schedule, to monitor catch by specific harvest areas, and to monitor shipments of geoduck from the grounds by packer. The fishery also has DMP, chartered monitoring vessels (or charter patrol officers), packer landings at some ports and truck deliveries at processing plants in Vancouver. The monitoring program is contracted and funded entirely by industry.

Area A Crab

The Area 'A' crab fishery takes place in the shallow marine waters of Hecate Strait and Dixon Entrance in northern British Columbia. The 50 vessel fleet collectively fishes about 35,000 single buoyed crab traps, fishing for Dungeness crab (*Cancer magister*). The fishery is managed by area soft shell (moulting crabs) closures, vessel trap limits and limits on trap soak duration. The fishery is monitored with hails, harvest logs, and an EMP. The EMP for this fishery began in 2000, primarily out of industry concerns over gear congestion, trap theft and damage, and the lack of restrictions to prevent fishers hauling each other's gear. The EM system includes radio frequency identification (RFID) technology to efficiently record and monitor trap hauls in the fishery. The monitoring program is contracted and funded by industry.

Analysis of Monitoring Costs

Table 2 provides an overview of monitoring service costs for the fisheries identified in Table 1. The values shown reflect total program cost, including industry and DFO funded (where relevant) portions of the program. The left portion of the table shows total program cost by vessel and fishing trip, and ASOP and EMP monitoring costs by monitored day at sea. The EMP costs include the service component and equipment cost, the latter recognizing specific fleet patterns with respect to purchasing or leasing equipment. The monitoring cost per vessel (total monitoring costs per vessel per year) ranges from $200 to $65,000 and on a per trip basis, costs range from about $100 to

nearly $4,000. The DMP cost per trip for groundfish fisheries ranges from $65 to nearly $500. The cost per seaday of ASOP ranges from about $500 to $700 and EMP ranges from $80 to $155.

The center portion of Table 2 shows monitoring system component and total cost as a cost per pound of landed product in the fishery. The relative cost varies widely between fishery and type of monitoring service. The variability is due to factors such as total quantities landed, different fishery efficiencies in using monitoring services, and differences in program monitoring requirements. Except for salmon and shrimp the BDC costs are generally nested within DMP or other monitoring service budgets and are difficult to separately quantify. Among groundfish fisheries, BDC ranges from 0.05¢/lb to 0.8¢/lb, while DMP ranges between 0.2¢/lb and 8¢/lb, ASOP 3.3¢/lb, and EMP 0.1¢/lb to 41¢/lb. The monitoring cost per pound for the inshore trawl component of the fishery is over five times the cost of all other fishery components, owing largely to the high activity and small catch volume of this fishery. Among groundfish, offshore trawl and hook and line total monitoring costs are 3.8¢/lb and 9¢/lb, respectively.

The right portion of Table 2 provides information on the relative cost of monitoring systems scaled to the value of the fishery. Monitoring costs for most fisheries range between 2% and 10% while the inshore trawl fishery is nearly 20%.

Table 2. Summary of Monitoring System Costs for Selected BC Fisheries (2007).

	Average Cost per Unit					Average Cost per Landed Pound					%
Fishery	Cost per Vessel	Cost per Trip	DMP Trip	ASOP per day	EMP per day	BDC	DMP	ASOP	EM	Total	Fishery Value
BC Groundfish											
Hook and Line	$10,655	$1,618	$425		$154	$0.002	$0.024		$0.065	$0.091	3.05%
Offshore Trawl	$64,058	$3,897	$490	$558		$0.0005	$0.005	$0.033		$0.038	7.58%
Inshore Trawl	$16,505	$408	$66		$145	$0.008	$0.081		$0.408	$0.496	19.84%
Hake (Midwater Trawl)	$13,173	$589	$340		$107	$0.000	$0.002		$0.001	$0.004	3.71%
Other Fisheries											
BC Salmon	$200					$0.007				$0.007	0.98%
BC Shrimp Trawl	$1,962	$110		$701		$0.075		$0.025		$0.100	10.03%
BC Geoduck	$18,252	$348	$183			$0.003	$0.112	$0.097		$0.212	2.65%
BC Area A Crab	$6,879	$181			$82	$0.002			$0.041	$0.044	2.20%

Source: Archipelago Marine Research Ltd.

The New England Multispecies Groundfish Fishery

With the current DAS management, the limited access/DAS multispecies groundfish fishery is in a continued state of change and consolidation. Providing a perspective on the fishery for the purpose of examining monitoring system options becomes a multi-step process: determining the activity patterns in the fishery; determining the portion of the fishery that will transition to Sector based management; and finally, determining which portion of the Sector fleet will require ASOP and EMP.

Table 3 provides a summary of fishery data from the 2006 limited access/DAS multispecies groundfish fishery. Several fishing gears are used, the most common ones being bottom trawl and gillnet. The fishery involves nearly 650 vessels, completing

about 19,000 trips and 33,000 DAS, landing about 50 million pounds, valued at about $73 million (USD). The historical value of the New England fishery has been higher (over $100 million in 2000/2001). The New England groundfish figures also do not recognize the substantial revenues from non groundfish that are landed on groundfish trips. These include probably half of the total monkfish catch and substantial landings of lobster as well as some skate, wolfish and cusk. Total monkfish landings were worth over $27 million in 2006 and $41 million in 2005. In fishing year 2005 over $4 million in lobster was landed with trawl and gillnet gear, probably mostly on groundfish trips.

Table 3. Summary of the Limited Access/DAS Multispecies Fishery (2006) by Gear.

	Gear Type							
	Bottom Trawl	Dredges	Gillnet	Hand Line	Long Line	Other	Unknown	Grand Total
Vessels	420	61	200	70	72	52	26	**643***
Trips	10,379	194	6,617	398	883	129	142	**18,742**
DAS	23,418	623	6,885	398	1,177	136	0	**32,636**
Lbs Landed	35,037,931	906,768	9,671,489	245,910	1,154,586	147,745	851,933	**48,016,362**
Catch Value	$56,018,625	$1,471,602	$10,920,962	$454,340	$2,454,527	$240,090	$1,464,901	**$73,025,047**
DAS per Trip	2.26	3.21	1.04	1.00	1.33	1.05	0.00	**1.74**
Lbs per Trip	3,376	4,674	1,462	618	1,308	1,145	6,000	**2,562**
Catch Value per Trip	$5,397	$7,586	$1,650	$1,142	$2,780	$1,861	$10,316	**$3,896**
Catch Value per Lb	$1.60	$1.62	$1.13	$1.85	$2.13	$1.63	$1.72	**$1.52**

* several vessels fished multiple gears Source: 2006 VTR and DR data provided by NMFS.

Table 4 provides a summary of estimated total DAS by fishing trip length and by gear. Nearly 75% of all fishing trips were one day and 40% of trawl trips were more than two days. The majority of multi day fishing trips were by bottom trawl. The number of DAS by gear and trip length was estimated using the midpoint of the trip length (i.e., 2 for trips of 1-3, 4 for trips of 3-5, etc.) and a one DAS average for trips in the 0-1 category. Using this method, single day trips make up about 40% of the total DAS for all gear and nearly 75% of the trawl DAS were on trips greater than one day.

Table 4. Total Number of Trips and DAS Use by Trip Length and Gear for Vessels With Limited Access/DAS Multispecies Permits (2006).

	Trip Length (days)					Total
	0 to 1	1 to 3	3 to 5	5 to 10	>10 (max=16)	Trips
Number of Trips						
Bottom Trawl	6,223	2,002	925	1,124	96	**10,370**
Dredge	73	57	19	40	3	**192**
Gillnet	6,047	352	117	93	2	**6,611**
Hand line	382	11	2			**395**
Longline	680	174	17	10		**881**
Other	110	7	7	1		**125**
All Gear	**13,515**	**2,603**	**1,087**	**1,268**	**101**	**18,574**
Estimated DAS by Gear						
Bottom Trawl	6,223	4,004	3,700	8,430	1,248	**23,605**
Dredge	73	114	76	300	39	**602**
Gillnet	6,047	704	468	698	26	**7,943**
Hand line	382	22	8	0	0	**412**
Longline	680	348	68	75	0	**1,171**
Other	110	14	28	8	0	**160**
All Gear	**13,515**	**5,206**	**4,348**	**9,510**	**1,313**	**33,892**

Source: Based on VTR DR data provided by NMFS.

Figure 1 provides a spatial overview of the fishery in terms of number of landings and landed weights by ports. There are data from 33 ports represented and there are about 30 more that receive landings but in such low numbers that their data are aggregated and not shown in the spatial plots. Groundfish landings occur in coastal ports of six states and most activity is in Massachusetts, New Hampshire and Maine.

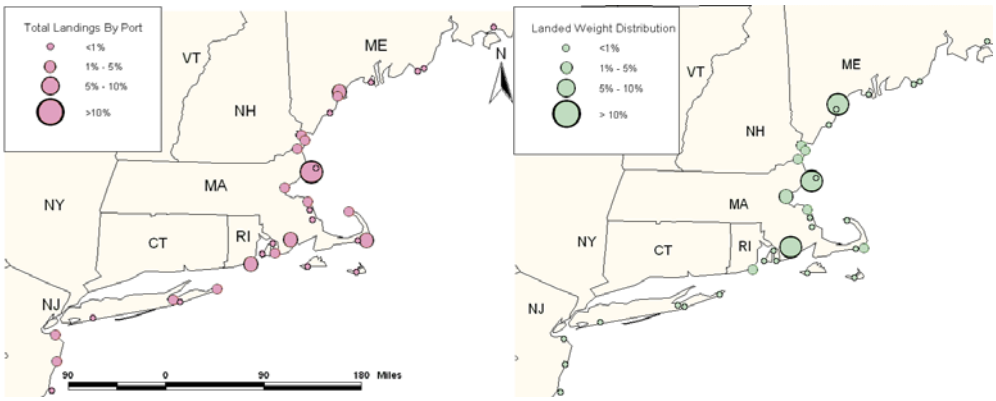

Figure 1. Spatial Plot of Total Landings by Port (left panel) and Landed Weights by Port (right panel) for Vessels With Limited Access/DAS Multispecies Permits (2006). Source: VTR and DR data provided by NOAA.

Figure 2 presents the same landings data as in Figure 1, but shown as the percentage of the total landings and landed weights by port, ordered from most to least. In terms of landing events, the busiest port is Gloucester, with nearly five times the landings as the second busiest port. The top five ports (Gloucester, Portland, Pt. Judith, New Bedford, and Chatham) account for nearly 65% of the landing events and less than half the ports collectively make up less than 90%. In terms of landed weights, this feature persists but exaggerated with more high volume landings in the ports of Portland, Gloucester and New Bedford. Less than 25% of the ports make up more than 90% of the landed weight.

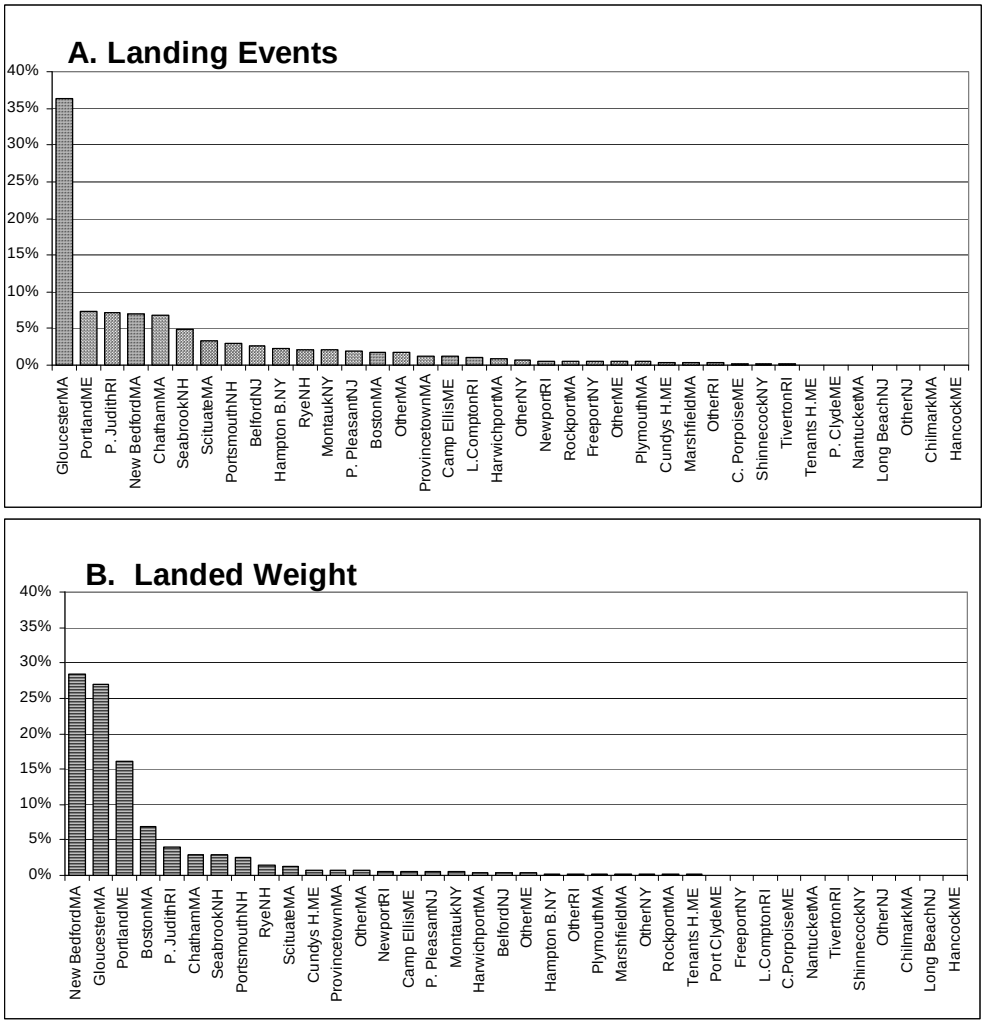

Figure 2. Percentage of Total Landings and Total Landed Weights by Port for Vessels With Limited Access/DAS Multispecies Permits (2006). Source: VTR and DR data provided by NMFS.

Comparison Between BC and New England Groundfish Fisheries

Table 5 provides a summary of some of the key comparative information on the BC and New England groundfish fisheries. The BC groundfish fishery lands nearly five times the quantity of fish at a value nearly double the New England fishery. Removing the high volume/low value hake fishery from the comparison, the BC fishery lands over double the quantities at a value 1.7 times the New England fishery.

The BC fishing fleet is half the size, has one-fifth the number of fishing trips and spends 40% less fishing time at sea. Fishing vessels in the BC fleet range in size from about 15 to over 140 feet although most trawl vessels are 70-90 feet and hook and line vessels are 35 to 50 feet in length. As compared to BC, the New England fleet appears to consist of a larger proportion of small vessels. It should be pointed out that DAS is defined differently in the two regions, with BC using the observer seaday definition (a day is 6 hours or more at sea per day) whereas the New England VMS DAS clocks fractional days while the vessel is over the demarcation line. The New England DAS would likely be 10-20% greater if measured according to observer seaday definition. The number of landing ports in BC is about half that of New England although landing ports for both fisheries are spread over a large geographic region, with the majority of landing events and pounds landed occurring in very few ports.

While the differences between the two fisheries are striking it is important to point out that the BC fishery has changed considerably over the past decade in response to several forces including: individual quotas, increased at-sea monitoring requirements, increased cost recovery, and the need to improve the economic viability of the fishery. These changes have forced the fishery to consolidate, become more efficient, and bring higher value to the landed product.

Table 5. Comparison of Groundfish Fisheries in British Columbia and New England.

	British Columbia				New England		
	Trawl	**Hake**	**Fixed**	**All Gear**	**Trawl**	**Fixed**	**All Gear**
Vessels	57	34	244	**301**	420	200	**643**
Trips	1,153	760	1,607	**3,520**	10,379	8,363	**18,742**
DAS	5,591	2,115	12,000	**19,706**	23,418	9,219	**32,636**
Landing Ports	30	5	30	**30**	70	70	**70**
Lbs Landed	81,400,696	120,600,121	28,459,120	**230,459,937**	35,037,931	12,978,431	**48,016,362**
Catch Value	$41,299,249	$12,060,012	$85,377,360	**$138,736,622**	$56,018,625	$17,006,422	**$73,025,047**
DAS per Trip	4.85	2.78	7.47	**5.60**	2.26	1.10	**1.74**
Lbs per Trip	70,599	158,684	17,709	**65,472**	3,376	1,552	**2,562**
Catch Value per Trip	$35,819	$15,868	$53,128	**$39,414**	$5,397	$2,034	**$3,896**
Catch Value per Lb	$0.51	$0.10	$3.00	**$0.60**	$1.60	$1.31	**$1.52**

Cost Analysis of Monitoring System Options

Profile of Sector Fishery

Sector membership is voluntary and vessels can choose between remaining in the Common Pool and joining a Sector. Knowing the number of vessels and the associated Annual Catch Entitlement (ACE) that these vessels bring to Sectors is important in developing monitoring system options. Current estimates by NMFS are that roughly 650 permits (not all on active vessels) are on the Sector rosters and these permits may represent about 85% of the catch of the active fishing fleet in New England. For the purposes of this analysis we consider the scenario of Sectors attracting 50% of the active fleet and 80% of the total ACE. Once within Sectors the nature of the fleet is likely to differ from the DAS-managed Common Pool fleet. The expectations are that the Sector fleet will consolidate with fewer active boats and have greater access to currently under harvested fish resources. Revenues under Sectors are expected to be higher with substantial levels of cod discards turned into landings and if Sectors are able to catch a larger share of TACs than they have been. We take the conservative approach regarding consolidation and assume that the Sector fleet will be equivalent to the number of vessels in the Common Pool fleet. Table 5 provides a summary of fishery values used for the Sector cost model using the above assumptions about participation. Within the Sector fleet, further subdivision was made between single and multi area trawl, and fixed gear for the purposes of distinguishing the trips and seadays that would be monitored by observers or EM. Using historical data, 10% probably represents the upper bound of total fishing trips that would take place in multiple areas by trawl. The number of seadays associated with multi area trawl trips is difficult to estimate but as they are likely to be much longer in duration, we chose 30% as a likely upper estimate for seadays, or about 8,400. The number of vessels involved in multi area trawl fishing is estimated at 75 while the balance of the fleet is either single area trawl or fixed gear.

Table 5. Summary of Values Used for Sector Monitoring System Cost Model.

	Active Vessels	Trips (Landings)	Seadays
Sector Fishery			
Trawl (single area)	130	6,992	14,000
Trawl (multi area)	75	1,520	8,400
Fixed Gear	240	6,688	5,600
Sector Total	325	15,200	28,000
Common Pool	325	3,800	7,000
Total Fishery	**650**	**19,000**	**35,000**

Assumptions About Monitoring Options

BDC (Option 1)

Baseline Data Collection (BDC, also termed 'modified status quo' in Phase 1 report) represents the minimum data collection that would be required of both common Pool and Sector managed fleets. BDC consists of a fishery management data integration process and a hail system. The most cost effective approach for the hail program would be to contract with a professional call center for receiving calls, provision of hail numbers and real time entry of hail data. The BDC service provider would be responsible for management and training of the call service, and maintaining oversight of program quality, timeline obligations, and overall data quality. More automated forms of data communication (e.g., telephone key entry, VMS, email, web services, etc.) may be used, particularly if hail events do not trigger complicated scheduling where two way communication is needed.

A centralized data management system will be used to integrate hail, VTR, DR and VMS data. The same system will be used for DMP, ASOP and EMP data. NMFS NERO currently has systems in place for VTR and DR data and NMFS enforcement manage VMS data. We envision development of a data management service much like what is being developed by the Cape Cod Commercial Hook Fishermen's Association for management of their Sectors.

- Development of a custom database that imports and links DR, VTR, ASOP and EMP data on a trip-by-trip basis. The database is able to produce the reports necessary for the Sector manager to report landings and discards to NMFS as necessary.
- Use of electronic VTR, where possible. Vessels complete their VTR electronically while at sea and send the encoded information via email in their VMS. The database checks the email account they are sent to and automatically imports the file.
- The DR can either be entered by hand, or with a modified version of SAFIS (the NMFS software for electronic dealer reporting) that includes a module containing the list of Sector vessels and the code to send a copy of the dealer report directly to the service provider. The database would regularly check the FTP site and import new DR data.

DMP (Option 2)

The DMP includes field deployment of DM or RM, data processing, reporting and delivery. Two options were suggested for DMP: <100% monitoring of all landings by Sector vessels and 100% of Sector vessel landings. In order to develop costing estimates for these options the coverage level for the former option was set at 50%. Both options would utilize RM's to monitor landings in the remote ports and the target RM coverage level would be 50% of the total landings.

If EMP is in place the DMP will collect other data during the offload process. Trawl vessels fishing in a single area under mandatory retention would require validation of discard quantities in order to seek an exemption from the assumed discard rate. Fixed

gear vessels carrying EM would require the DMP to provide estimates of piece counts in order to enable translation of pieces to weights (EM does not provide catch estimates by weight).

The number of landing ports will influence overall project infrastructure and travel requirements. The busy ports will likely carry higher numbers of resident DM staff while the more remote areas will have RM staff strategically placed to cover a specific geographic region. As much of the landings in the fishery pass directly or indirectly through a few plants or auction locations there are efficiencies that would easily enable validation of the majority of landing events. Landings that do not follow this pattern (e.g., direct sales to smaller markets, split offloads, etc.) would require more study to ensure their validation without significant addition to program cost.

At-Sea Monitoring (Option 3)

At sea monitoring is intended to provide reliable information on catch by area, including discards. At-sea monitoring includes both an At-sea Observer Program (ASOP) and an Electronic Monitoring Program (EMP). The former applies to larger trawl vessels intending to fish multiple areas while the latter would apply to all fixed gear, and trawl vessels fishing single areas under full retention requirements.

Option 3 has three components: <100% for both EMP and ASOP, 100% EM and <100% for ASOP, and 100% for both EMP and ASOP. For the purposes of making cost estimates we have used a coverage level of 50% for the <100% element. This value is for price estimation purposes and not based on a rigorous analysis of coverage levels.

The significant cost driver in an ASOP is with deployment effort placing observers on vessels where coverage levels are less than 50%. In this ASOP we assume that Sector participation will charge vessels with the responsibility to take observers when required and minimal deployment effort will be needed.

The suggestion has been put forward that the cost of an observer program could be reduced by the provision of a less qualified form of observer to meet the catch monitoring requirements of Sectors. The Sector observer may have reduced responsibilities with respect to biological sampling however, their responsibilities with monitoring catch, and the implications of these data toward ACE for the vessel, create greater need for observers with integrity, a high level of training, and independence from the operations o the vessel. In these respects, Sector observers should not be of a lower standard.

An EMP has four main components: provision of EM equipment (See Appendix 1), provision of field service staff to set up and support EM equipment on vessels, an EM data interpretation process to extract meaningful fishing data from raw sensor and image data, and a data analysis process to integrate these data with information in the centralized data system. The most practical use of EM data for fixed gear would be to use it as an audit tool for fisher supplied data in the VTR. The audit procedure involves 100% examination of sensor (i.e., GPS, hydraulics, etc.) and a random sample of 10% of fishing event imagery. The audit process is designed to determine if the VTR data meet

quality standards and can be accepted for use. Failure to meet quality standards would result in the VTR data being rejected and could lead to a variety of steps depending upon program design. In the simplest instance further imagery could be examined to provide a more accurate assessment of at sea activities. The analysis process for trawl vessels fishing single areas under full retention requirements would involve an assessment of whether all fish caught were kept on board.

The cost of installation and removal of EM systems is significant and it does not make sense to carry out on a single trip basis. Option 3a involving 50% coverage would be more practically implemented by the installation of EM systems on vessels for duration of several fishing trips. Likewise, the retrieval of EM data and analysis/audit process would be more practical if conducted on a longer, perhaps weekly duration.

Cost Estimates of Monitoring Options

Cost estimates for the various monitoring options are provided in Table 6. The costs estimates in Table 6 are for these specific components while Table 7 provides estimates of overall program costs with combinations of the options in Table 6. The method of estimating costs for each option consisted of using a unit cost (low and high value) and scaling to the appropriate factor (landings or seadays) for the Sector fishery. A low and high unit cost was estimated to provide a cost range for each option. Monitoring system costs in the BC groundfish fishery were used to derive unit costs for each monitoring option in the New England Sector fishery.

Table 6. Cost Estimates for Sector Monitoring Options.

	Active Vessels	Trips (Landings)	Seadays	Cost per Unit Low	Cost per Unit High	Total Cost Low	Total Cost High
Option 1 - Baseline Data Collection							
Sector	325	15,200	28,000	25	45	380,000	684,000
Common Pool	325	3,800	7,000	25	45	95,000	171,000
						475,000	855,000
Option 2 - Dockside Monitoring Program							
2a - 50% DMP	325	7,600	14,000	60	80	456,000	608,000
2b 100% DMP	325	15,200	28,000	50	70	760,000	1,064,000
Surcharge for EM Based Monitoring							
2b w/ 50% EM	325	5,928	14,000	25	35	148,200	207,480
2b w/ 100%EM	325	11,856	28,000	25	35	296,400	414,960
Option 3 - At-Sea Monitoring (ASOP and EM)							
3a - 50% ASOP	75	760	4,200	800	1000	3,360,000	4,200,000
3a - 50% EM	250	6,840	9,800	180	200	1,764,000	1,960,000
3a Total						5,124,000	6,160,000
3b - 50% ASOP	75	760	4,200	800	1000	3,360,000	4,200,000
3b - 100% EM	245	13,680	19,600	150	170	2,940,000	3,332,000
3b Total						6,300,000	7,532,000
3c - 100% ASOP	75	1,520	8,400	600	800	5,040,000	6,720,000
3c - 100% EM	245	13,680	19,600	150	170	2,940,000	3,332,000
3c Total						7,980,000	10,052,000

The estimated cost for BDC (Option 1) ranges from $475,000 to $855,000 to cover the Sector and Common Pool components of the fishery. Unit costs of $25 - $45 per landing were used to cover hail and data integration costs.

Monitoring Option 2 (DMP) has four components; the former two apply to partial (50%) and full DMP services while the latter two provide an estimated surcharge for additional DMP work required when at-sea monitoring EM is used. The DMP cost range varies from a low of $456,000 (lower range, partial monitoring) to about $1 million (upper range, 100% monitoring). The surcharge could increase DMP costs by 30% - 40%.

At-sea monitoring (Option 3) has three components each with separate pricing for ASOP and EM. The cost ranges from $5 - $6 million for partial monitoring (Option 3a) to $8 to $10 million for full monitoring (Option 3b). Observer costs per day range from $700 - $1,000 while daily costs of EM costs are $150 - $200. The cost per unit declines when moving from partial to fully monitored fishery, reflecting increased efficiencies with fully monitored fisheries. The cost estimates for EM include annualized equipment costs.

Since the monitoring options build on one another, Table 7 compiles component costs to provide total costs for the six monitoring options. The cost options are also presented in terms of cost per pound and cost as a percentage of the landed value of the fishery. The cost ranges from 1-2¢/lb for Option 1, 2.5 - 5¢/lb for Option 2, and 17 – 32¢/lb for Option 3. In terms of landed value of the fishery, the ranges are 0.8 - 1.5% for Option 1, 1.5 – 3.3% for Option 2, and 11 – 21% for Option 3.

Table 7. Cost Estimates for Sector Monitoring Options.

	Option 1	Option 2a	Option 2b	Option 3a	Option 3b	Option 3c
Low Estimate						
1	$475,000	$475,000	$475,000	$475,000	$475,000	$475,000
2a		$456,000				
2b			$760,000			
2b w/ 50% EM				$908,200		
2b w/ 100% EM					1,056,400	1,056,400
3a				$5,124,000		
3b					$6,300,000	
3c						$7,980,000
Total Low Estimate	**$475,000**	**$931,000**	**$1,235,000**	**$6,507,200**	**$7,831,400**	**$9,511,400**
High Estimate						
1	$855,000	$855,000	$855,000	$855,000	$855,000	$855,000
2a		$608,000				
2b			$1,064,000			
2b w/ 50% EM				$1,271,480		
2b w/ 100% EM					1,360,400	1,360,400
3a				$6,160,000		
3b					$7,532,000	
3c						$10,052,000
Total High Estimate	**$855,000**	**$1,463,000**	**$1,919,000**	**$8,286,480**	**$9,747,400**	**$12,267,400**
Cost/Lb						
Low	$0.012	$0.024	$0.032	$0.169	$0.204	$0.248
High	$0.022	$0.038	$0.050	$0.216	$0.254	$0.319
% Fishery Value						
Low	0.81%	1.59%	2.11%	11.14%	13.41%	16.28%
High	1.46%	2.50%	3.28%	14.18%	16.69%	21.00%

Comparison of BC and the North East Fisheries Observer Program

The NMFS North East Fisheries Observer Program (NEFOP) uses a figure of $1,200 per day when planning budgets for fleet coverage levels. The $1,200 per seaday is in striking contrast to the $560 rate for observers in BC. Understanding the elements that contribute to these differences is necessary to estimate ASOP costs for Sector fisheries.

The NEFOP delivers about 8,200 observer seadays with 35% of the seadays funded by industry (scallop fishery). About 40% of the $1,200 per seaday funds is used by NEFOP to support their functions to deliver the 8,200 seadays while the balance pays for contractor provided observer services. NEFOP provides a broad range of services including observer training, briefing and debriefing staff, an observer bonus pay system, observer travel expenses, vessel reimbursements for observer meals, data entry (scallop program), data handling and quality control, NMFS-issued sampling gear, safety and other equipment, program staff, development of new gear, and Science Center overhead. The contractor portion covers program components including observer wages (including benefits), sampling and safety gear, marine liability insurance, data entry (federally funded seadays), field coordinators, vessel call in coordination (hail service), and program administration activities.

The BC observer program delivers about 5,000 observer seadays with DFO paying for about 25% of the seaday rate and industry paying the balance (i.e., about $420 per seaday) on the basis of individual vessel usage requirements. The observer program is a stand-alone program with all services carried out by a contracted service provider (Archipelago). The $560 seaday rate in the BC program covers essentially the same program functions as the combined NMFS – contractor functions in the NEFOP except that vessels are not reimbursed for observer meals.

There are several reasons for the significantly lower seaday cost in the BC observer program. Observer deployments in the BC fishery are almost entirely on large (> 60') trawl vessels that make 6 – 8 day fishing trips while NEFOP deployments are on a range of vessels sizes with 54% being single day trips. Thus, the mobilization cost per observer day at sea in the NEFOP would be much higher than in BC. Insurance costs are much lower in BC because of legislation differences between Canada and the US. BC observers are covered under the Workers Compensation Act of BC and employers generally pay less than 3% of the gross wage cost. In contrast, observer work in the US is not specifically designated under a single legislative act and observer contractors are therefore required to carry overlapping coverage for a variety of regulations including the Federal Employees Compensation Act (FECA), Longshoreman and Harbor Workers Act (LHWC), and Merchant Marine Act of 1920 (commonly called the Jones Act). Collectively, the insurance cost ranges from 15% to 30% of gross salary, depending upon factors such as employer payroll size, claims history, state or region where operations occur, claim limits, endorsements and other policy specifications. Another contributing factor to NEFOP and BC cost differences may be observer wages. On the surface the NEFOP daily wage rates are higher than in BC, however the rules around what time is paid differ between regions such that wage cost difference between the programs may not be very different. Another significant cost difference between regions is the result of the cost recovery method. The BC program is mostly (~75%) funded by industry and there are strong incentives for operational efficiency and prudent use of program resources by industry. Fishers have developed strategies to utilize the ASOP in a manner to minimize their costs. The fishing industry also participates in contractor oversight to provide advice on ways to tailor program services to meet their needs in the most cost effective manner. In contrast, the NEFOP is mostly federally funded and industry is in a position to place costly demands on the program without bearing the financial consequences. The lack of industry participation in the observer program design also makes it likely to contain elements out of balance with the true needs of the program.

The NEFOP is a large, complicated multi-purpose program with several objectives that support a large number of management and research programs. The comparison made here is not intended to suggest that the NEFOP structure is inappropriate, inefficient or unnecessarily complicated for the designed purpose. The point of the comparison is to determine whether an ASOP for the Sector fleet would cost $1,200 or $560 per seaday. In our view, an ASOP dedicated to the Sector fleet would likely cost much less than $1,200 per day seaday for a number of reasons. Firstly, the Sector program would be directed solely toward trawl vessels that make longer fishing trips that create less cost for the observer program. In the current NEFOP the efficiencies gained in monitoring this

fleet are lost by the inefficiencies in monitoring the single day deployments. The cost would also be lower because the Sector ASOP program would be contracted as a standalone single purpose program with less organizational complexity than the NEFOP. The costs would also be lower with industry paying some of the costs, as the Sector fleet would be motivated to find ways to reduce their monitoring costs. The unit rates presented in Table 6 ranges from $600 to $1,000 per seaday for the Sector ASOP, reflecting the influence of these factors. It is unlikely that the Sector ASOP would cost less than the BC ASOP because of higher insurance costs in the US.

Cost Influences and Sensitivities

Interpretation of the cost estimates should be made in light of a variety of elements that drive the cost of monitoring programs. The cost estimates are for mature developed monitoring programs. Costs for new programs could be 10 - 30% higher in the first few years after program start up. The estimates represent average costs across the entire fleet, recognizing that costs may vary widely across individual vessels or fleets according to their specific patterns of fishing and other circumstances. The monitoring systems and costs do not take into consideration the fishery response to monitoring, particularly if there is a component of the program cost funded by industry. With a change in management structure and monitoring requirements fishery participants will alter their business strategies to respond to new opportunities and costs.

The cost for various monitoring options is strongly affected by a variety of inputs that determine program size:

- Fishery activity (number of vessels, landings and seadays) - The variable costs of monitoring programs are driven directly by landing events for Options 1 and 2 and seadays for Option 3. At this stage, the level of Sector participation is not well understood, nor is the manner in which the Sector will consolidate. A 10% reduction in landing events would result in about a 6% reduction in program costs because of the ratio of fixed to variable costs.
- Fishery landing patterns - The number and spatial distribution of landing ports influences all monitoring options because of larger infrastructure requirements, increased travel time, higher staffing levels.

Program output requirements also directly influence monitoring costs. In addition to the three Options, other outputs include:

- Coverage levels for partially monitored fisheries – In this report, the coverage level for partially monitored fisheries was 50%. The number was put forward for the purpose of providing cost estimate and no rigorous analysis of appropriate coverage levels has been done. The specific coverage level has a direct influence on program effectiveness and costs. On the effectiveness side, a monitoring presence changes vessel fishing practices, perhaps putting monitored vessels at a disadvantage to unmonitored vessels. 100% monitoring levels the playing field by applying a common standard across the fleet. Hence, partial monitoring may only be partially effective for accurate catch and discard accounting by area. In terms of costs, monitoring programs generally have a high ratio of field labor that scales

to coverage levels. For example, in the BC trawl observer program a 10% reduction in observer coverage level would translate to a 8.3% reduction in total program cost. This correlation is not linear as lower coverage fisheries may experience higher deployment costs as more effort is expended to secure monitored events.

- Coverage by EMP versus ASOP – With a daily cost of EMP being less than a quarter the cost of ASOP, Option 3 costs will be significantly influenced by the component of the Sector fishery that can be monitored by EMP. The cost for 100% monitoring using EMP would be 4.2 – 4.7 million (including equipment costs), or less than the cost of 50% monitoring in Option 3a. There are limits to the capabilities of EMP, but there are also ways the fleet can organize their operations to accommodate the technology.
- Labor Management Practices – The monitoring tools (BDC, DMP, ASOP, and EMP) are similar in respect to their being service programs that primarily consist of high volumes of labor. In BC, DMP and ASOP program labor represents over 80 - 90% of total program cost and the ratio of variable to fixed labor units is similarly very high. The labor values for an EMP are lower; however, the point stands that well organized operational systems that utilize labor efficiently create significant savings to monitoring program costs. Using the figures above, efficiencies to gain a 10% reduction in labor cost will result in a program savings of 8 - 9%. Labor laws in most regions generally carry provisions for minimum call up and overtime for various industries or work settings. The labor cost for these can be significant if not managed carefully.
- Call Up Responsiveness – Staffing strategies for DMP and at-sea monitoring services are significantly affected by call up requirements. The requirement to meet all requests requires strategies to have staff on hand for peak periods of activity (e.g., good weather, strong market conditions). Maintaining staffing levels to respond to requests within short timelines also increases the staffing infrastructure requirements over more steady state conditions. Fishing activity is naturally variable and will require monitoring program flexibility to best align with opportunities. Placing practical limits on the monitoring program requirements may cause fishers to wait for service but will result in program cost savings.
- Program Reporting Requirements – In addition to responsiveness, the reporting requirements influence the volume of work carried out. Complexity of data, efficiency of data entry process, level of analysis and the number of different reports all contribute to the work volume.
- Audit Levels for EMP - The EMP is designed to use EM data to audit the quality of fisher-supplied data. The level of audit considered was 10%, serving the dual purpose of providing a random sample of the fishery and a 'radar trap' deterrent for VTR misreporting. In the BC groundfish hook and line fishery, the proportion of imagery analyzed increases total EMP costs by about 5% for each 10% increment in proportion of imagery viewed. Adjustments to the audit level will be a function of the precision requirements of the random sample and the regulation framework built around the 'radar trap'.

- EMP Equipment – EM equipment represents a significant part of the cost of an EMP. Ownership of equipment may make sense for active vessels, enabling the purchase cost (about $9,000) to be amortized over several years and having a one-time technician cost for installation and removal of an EM system. Less active vessels may not have enough activity to justify the expense of purchasing and will pay daily lease costs and technician time for equipment installation and removal. Other strategies are for fishers (or Sectors) to share purchased systems. In the BC groundfish hook and line EMP, rental systems are used for about 20% of the 12,000 seadays in the fishery while purchased systems cover the balance. This blend results in a daily equipment cost of about $35, or about 20% of total EMP daily cost. If all vessels rented systems, the daily program cost would rise by about 25% as a result of a doubling of the equipment cost component. If all vessels purchased systems the cost would be higher than the blend because there are a number of vessels that have very low activity levels.
- Cost Recovery Method – Who pays and how cost recovery is structured influences both how program resources are used and overall program costs. The role of industry funding has already been discussed, however there are other elements to this. Receiving program revenue through monthly invoices carries much different administrative cost than separate billings for the 19,000 landing events in the fishery. As well, particularly for industry funding, the fee structures directly influence how program resources are used. For example, levying monitoring program fees as a cost per landed pound does not encourage efficient use of program labor to the same extent that program fees charged on an hourly basis. The use of rolled up fees (cost per vessel or landing) may create cross subsidies when there are differences in fishing practices within the fleet.

Next Steps

It is hoped that the information and ideas presented in the Phase I and II reports will be used by the fishing industry, Sectors, Council members, NMFS staff, and other groups and agencies to advance the discussion on Sector monitoring and how it should be organized. In order to proceed with the development of monitoring systems further work is needed to develop the specific monitoring program requirements. These specifications would enable more detailed cost analysis and eventually serve as a formal statement of work. Development of specifications will require considerable discussion among various Sector stakeholders and must identify the specific components of the program and how they should operate. It should include detailed information on critical issues that drive cost, (e.g., fleet activity, coverage levels, landing ports, staffing levels, timelines, reporting requirements, etc.), project deliverables and timelines.

Once a more detailed statement of work has been defined, a plan for program delivery will need to be developed. Discussion needs to occur about the feasibility of a contracted independent third party standalone monitoring service and how it would relate to existing NMFS monitoring systems. Finally, discussion is needed to identify monitoring program oversight, funding arrangements and the responsibilities of the parties involved. Given

that NMFS currently provides at-sea observer coverage, discussions will be necessary to assess how best to include existing program delivery with Options 1 and 2 and how to transition from the government program to a third party managed program.

APPENDIX I – ELECTRONIC MONITORING SYSTEM DESCRIPTION

Overview of the Electronic Monitoring (EM) System

The EM systems operate on the ship's power to record imagery and sensor data during each fishing trip. The software was set to automatically activate image recording based on preset sensor indicators (e.g. net retrieval). The EM system automatically restarts and resumes program functions following power interruption. The system components are described in the following sections.

Control Box

The heart of the electronic monitoring system is a metal tamper-resistant control box (approx. 15x10x8" = 0.7 cubic feet) that houses computer circuitry and data storage devices. The control box receives inputs from several sensors and up to four CCTV cameras. The control box is generally mounted in the vessel cabin and powered with 12 volts DC or 120/240 volts AC. In the case of AC power, the control box is generally fitted with a UPS, to ensure continuous power supply. The user interface provides live images of camera views as well as other information such as sensor data and EM system operational status. The interface has been designed to enable vessel personnel to monitor system performance. If the system is not functioning properly, technicians can usually troubleshoot the problem based on information presented in the screen display.

EM systems use high capacity video hard drives for storage of video imagery and sensor data. The locked drive tray is removable for ease in replacement. Depending upon the number of cameras, data recording rates, image compression, etc., data storage can range from a few weeks to several months. For example, using the standard recording rate of 5 frames per second, data storage requirements are 60-100 megabytes per hour, depending upon the image compression method. Using a four-camera set up and 500-gigabyte hard drive, the EM system would provide continuous recording for 52-86 days.

Figure A1. EM control box and user interface installations on two different vessels.

CCTV Cameras

Waterproof armored dome cameras are generally used as they have been proven reliable in extreme environmental conditions on long-term deployments on fishing vessels. The camera is lightweight, compact and quickly attaches to the vessel's standing structure with a universal stainless steel mount and band straps. In general, we generally install three or four cameras to cover general fish and net handling activity and areas around the vessel. In some cases it is necessary to install a brace or davit structure in order to position cameras in the desired locations.

Color cameras with 480 TV lines of resolution and low light capability are generally used. A choice of lenses is available to achieve the desired field of view and image resolution. The cameras have an electronic iris that adjusts automatically to reduce the effects of glare or low light levels on image quality. The output signal is composite video (NTSC) delivered by coaxial cable to the control box and converted to a digital image (480 x 640 pixel resolution). Electrical power (12 volt DC) is carried to the camera on conductors packaged in a single sheath with the coaxial cable.

Figure A2 CCTV camera installations on three different fishing vessels. Each camera has a mounting bracket and stainless steel mounting straps.

GPS Receiver

Each EM system carries an independent GPS, integrated receiver and antenna and wired directly to the control box (there is no attached display interface). The GPS receiver is fixed to mount on top of the wheelhouse away from other vessel electronics.

The GPS receiver is a 12 channel parallel receiver, meaning it can track up to 12 GPS satellites at once while using 4 satellites that have the best spatial geometry to develop the highest quality positional fix. The factory stated error for this GPS is less than 15 metres (Root Mean Square). This means that if the receiver is placed on a point with precisely known coordinates, a geodetic survey monument for example, 95% of its positional fixes will fall inside a circle of 15 metres radius centered on that point.

The GPS time code delivered with the positional data is accurate to within 2 seconds of the Universal Time Code (UTC = GMT). The EM control box software uses the GPS time to

chronologically stamp data records and to update and correct the real time clock on the data-logging computer.

When 12 volts DC is applied the GPS delivers a digital data stream to the data-logging computer that provides an accurate time base as well as vessel position, speed, heading and positional error. Speed is recorded in nautical miles per hour (knots) to one decimal place and heading to the nearest degree.

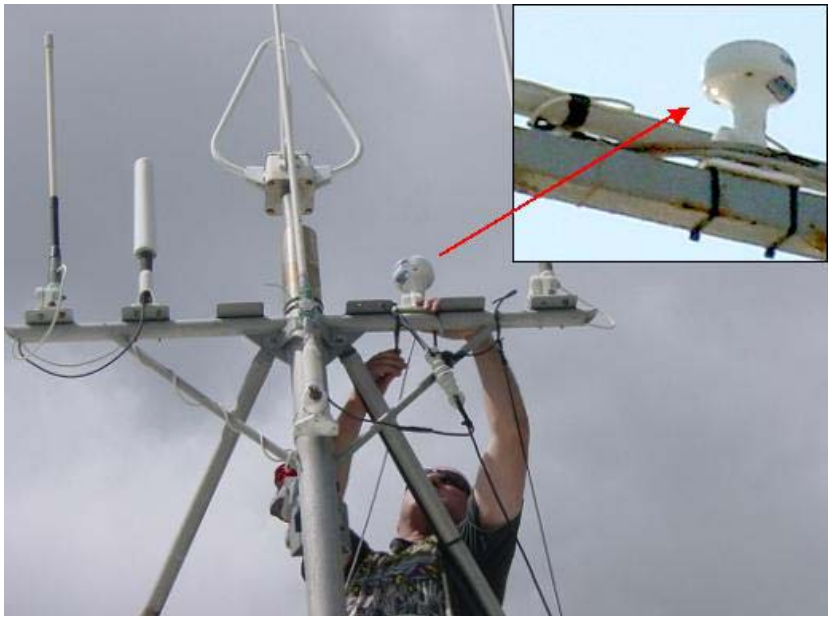

Figure A3. GPS receiver installed in the rigging of a vessel and a close up photograph of the mounted GPS.

Hydraulic Pressure Transducer

An electronic pressure transducer is generally mounted into the vessel hydraulic system (Figure A4) to monitor the use of fishing gear (e.g., winches, line haulers, etc.). The sensor has a 0 to 2500 psi range, high enough for most small vessel systems, and a 15,000 psi burst rating. The sensor is fitted into a ¼ inch pipe thread gauge port or tee fitting on the pressure side of the hauler circuit. An increase in system pressure signals the start of fishing operations such as longline retrieval. When pressure readings exceed a threshold that is established during system tests at dockside, the control box software turns the digital video recorder on to initiate video data collection.

Drum Rotation Sensor

A photoelectric drum rotation sensor is generally mounted on either the warp winch or net drum to detect activity as vessels often deploy gear from these devices without hydraulics. The small waterproof sensor is aimed at a prismatic reflector mounted to the winch drum to record winch activity and act as a secondary video trigger. (Figure A4).

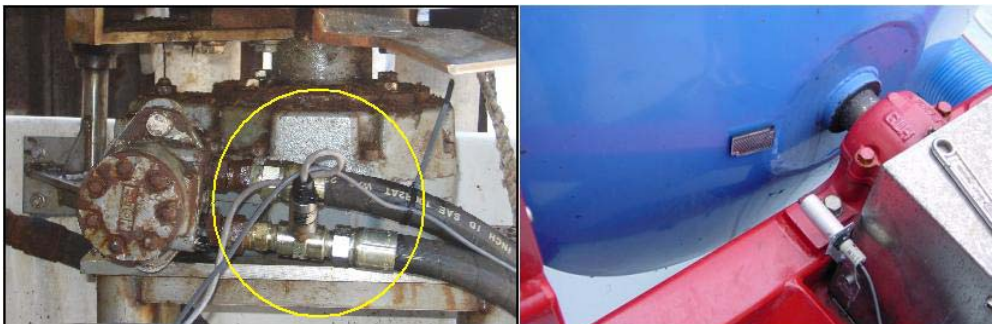

Figure A4 A hydraulic pressure sensor installed on the supply line of a vessel line hauler (left). Drum rotation sensor (right) mounted on pelagic longline vessel, showing optical sensor and reflective surface.

APPENDIX II – LIST OF ACRONYMS

ACE Annual Catch Entitlements
ACL Annual Catch Limits: a new law that required all fisheries to be regulated in order to end overfishing and prevent it from occurring in the future
AM Accountability Measures
ASOP At-sea Observer Program: a program using observers on vessels to record vessel fishing location, activity, catch, compliance and collect biological data.
BC British Columbia, Canada
BDC Baseline Data Collection: also referred to as 'modified status quo' in the Phase I report
DAS Days at Sea**:** fishing days allocated to permit holders in the Northeast Multispecies Fishery.
DFO Department of Fisheries and Oceans: Canadian agency that delivers programs and services that support sustainable use and development of Canada's waterways and aquatic resources.
DM Dockside Monitor: an individual who monitors and records the sorting and weighing of groundfish catch from a vessel.
DR Dealer Report: the report completed by companies purchasing the fish from the vessel providing detailed information on the catch weight by species.
DMP Dockside Monitoring Program: a program in which a third party contractor monitors and reports on the sorting and weighing of the catch on shore.
CGSB Canadian General Standards Board: a Canadian government organization that offers client-centered, comprehensive standards development and conformity assessment services in support of the economic, regulatory, procurement, health, safety and environmental interests of our stakeholders — government, industry and consumers.
EM Electronic Monitoring: cameras, sensors, and GPS on vessels to record vessel and fishing location, activity, catch, and compliance.
EMP Electronic Monitoring Program: a program using cameras, sensors, and GPS on vessels to record vessel and fishing location, activity, catch, and compliance.
EMR Electronic Monitoring Report: a report of the area specific retained and released catch by a vessel as recorded by the vessel's EMP equipment.
FMP Fisheries Monitoring Program
GMRI Gulf of Maine Research Institute: the Gulf of Maine Research Institute is a non-profit marine science center located in Portland, Maine.
HP Hail Program: a program that allows vessel operators to communicate their activity (start and completion of a fishing trip and scheduled landings).
IFQ Individual Fishing Quota
ISO International Organization for Standardization. ISO 9001 contains a generic set of requirements for implementing a quality management system.
LAPP Limited Access Privilege Program
LR Landing Report: a report completed by the DM providing detailed information regarding the total weight by species offloaded from a vessel subject to DMP.
NEFOP North East Fisheries Monitoring Program: collects, processes and manages data and biological samples obtained during commercial fishing trips

NMFS National Marine Fisheries Service: US federal agency with responsibility for overseeing fishery management and research.

RM Roving Monitor: an individual who meets vessels at the point of offloading to confirm and record information and install/remove EMP equipment.

TAC Total Allowable Catch: the annual recommended catch for a species or species group.

VMS Vessel Monitoring System: the vessel tracking systems already found on all groundfish vessels participating in the federally regulated multispecies fishery.

VTR Vessel Trip Report: the reports completed by the vessel operator providing information on catch and discards by species and area on a set and trip basis.