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Workshop on the Groundfish Sentinel Program

November 07 - 09, 2001

Moncton, New Brunswick

David J. Gillis / Chairperson

Fisheries Research Branch
Department of Fisheries and Oceans
200 Kent Street, Ottawa K1A 0E6

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Abstract

In association with an internal DFO review of the Groundfish Sentinel Program (GSP), a workshop was held in Moncton New Brunswick on November 07-09, 2001. About 85 industry and government participants were asked to reflect on what benefits are being derived from the GSP, as well as what improvements might be made to position the Program as an effective and cost-efficient component of the Atlantic groundfish assessment process.

The workshop was opened with an overview of the Groundfish Sentinel Program at the Atlantic level, including how it is situated within the Canadian and Atlantic stock assessment process. The origins and evolution of the Program were reviewed, followed by, in turn, an overview of each of the Regional sentinel programs. A summary was presented of various approaches now being used in conducting cooperative research, including the Groundfish Sentinel Program.

The four Regional sentinel programs were analysed more closely in four sessions focussed on the areas of project design, data quality and quantity, data treatment and assessment, and other species and research. A number of potential refinements to existing designs were identified and will be followed up in Regional sentinel meetings. Several analyses of the costs of conducting sentinel activities, including the value of sentinel landings, were presented on a project and a Regional basis. Comparisons were made between projects and between the sentinel and non-sentinel components of these stocks and the degree to which each component contributed to assessment inputs. Approaches to determining costs and benefits of the Groundfish Sentinel Program were explored, and those based on relating costs to impacts on assessments (as opposed to inputs) were favoured. Several methods of isolating impacts of data from sentinel sources were demonstrated.

Industry support for the Groundfish Sentinel Program was found to be generally high. Important reasons included improved industry confidence in assessments using sentinel data, improved communications between DFO Science and industry and a better understanding of the assessment process generally by industry involved in sentinel projects. A number of suggestions for improvement were made and these will also be followed up in Regional sentinel meetings.

The workshop concluded with a look at the future of sentinel, focussing on financing approaches and guidelines for change. While the continuance of government funding was seen as crucial, it was suggested that future financing might be tied to increasing allocations once rebuilding starts.

Résumé

Un atelier de travail portant sur le Programme des Pêches Sentinelles du poisson de fond a eu lieu du 7 au 9 novembre 2001 à Moncton, au Nouveau-Brunswick, dans le cadre d'un examen interne du programme effectué par le MPO. Les quelque 85 représentants de l'industrie et du gouvernement ont eu l'occasion de réfléchir aux avantages issus du programme et aux améliorations qui pourraient y être apportées afin qu'il devienne un élément efficace et rentable du processus d'évaluation du poisson de fond de l'Atlantique.

L'atelier a commencé par un survol du Programme des Pêches Sentinelles du poisson de fond au niveau de l'Atlantique, y compris où il s'inscrit dans le processus d'évaluation des stocks du Canada et de l'Atlantique. A suivi un tour des origines et de l'évolution du programme, puis un survol de chacun des programmes régionaux des Pêches Sentinelles. Un résumé des diverses approches utilisées aujourd'hui pour mener des recherches concertées, y compris le Programme des Pêches Sentinelles du poisson de fond, a ensuite été présenté.

Les quatre programmes régionaux des Pêches Sentinelles ont fait l'objet d'une analyse en profondeur lors de quatre séances mettant l'accent sur la conception des projets, la qualité et la quantité des données, le traitement et l'évaluation des données, les espèces autres et la recherche. Un certain nombre d'améliorations éventuelles à la conception des projets ont été identifiées; elles seront l'objet d'un suivi lors de réunions régionales sur les Pêches Sentinelles. Plusieurs analyses des coûts des activités de contrôle, y compris la valeur des prises issues de ces pêches, ont été présentées en fonction de chaque projet et de la région. Ont suivi des comparaisons des projets, des composantes de ces stocks visés ou non par des Pêches Sentinelles et du degré auquel chaque composante a contribué à la production des évaluations. Les approches qui ont servi à établir les coûts et les avantages du Programme des Pêches Sentinelles du poisson de fond ont été examinées, celles établissant un rapport entre les coûts et les incidences sur les évaluations (par opposition aux intrants) étant retenues. Plusieurs méthodes pour isoler les incidences des données issues des Pêches Sentinelles ont aussi été décrites.

L'appui de l'industrie à l'égard du Programme des Pêches Sentinelles du poisson de fond s'est révélé généralement élevé. Les principales raisons à l'origine de ce niveau d'appui incluent la confiance accrue de la part de l'industrie dans les évaluations reposant sur les données issues des Pêches Sentinelles, la meilleure communication entre le secteur des Sciences du MPO et l'industrie, et une meilleure compréhension du processus d'évaluation en général de la part des participants aux projets des Pêches Sentinelles. Les améliorations suggérées seront examinées lors des réunions régionales portant sur les Pêches Sentinelles.

L'atelier s'est terminé par un coup d'œil sur l'avenir des Pêches Sentinelles, mettant l'accent sur des mécanismes de financement et des lignes directrices concernant le changement. Bien que le maintien du financement public ait été considéré comme essentiel, on a proposé que le financement futur soit lié à une hausse des allocations lorsque les stocks commenceront à se rétablir.

Executive Summary

A Workshop on the Groundfish Sentinel Program was conducted at Moncton New Brunswick on November 07-09, 2001. This workshop was a major element in an internal review of the Groundfish Sentinel Program (GSP) that was conducted by the Department of Fisheries and Oceans during the 2001-02 year.

In opening the workshop, Serge Labonté, Director-General, Fisheries and Biodiversity Science, welcomed the 85 participants, who including government scientists and managers, sentinel and non-sentinel industry representatives and several external guests. He reminded participants that the purpose of the review and the workshop was to reflect on what benefits are being derived from the Groundfish Sentinel Program, as well as what improvements might be made to position the Program as an effective and cost-efficient component of the Atlantic groundfish assessment process over the longer term.

Overview of the Groundfish Sentinel Program

The Groundfish Sentinel Program is a series of research activities where government funds and proceeds from sentinel catches are used to engage commercial groundfish fishers over sections of the Atlantic Coast in structured fishing for scientific purposes. The Program was initiated in 1994 after the flow of data and information about declining groundfish stocks was lost as a result of the closure of numerous commercial groundfish fisheries in the early 1990s. The original objectives of the Groundfish Sentinel Program were 1) to enhance scientific information and monitor trends in the biomass of depressed stocks and those under moratorium, and 2) to involve fishers directly in the scientific assessment process, and thus foster cooperation and understanding between the Department and the fishing industry.

The main resources of interest are six Atlantic cod stocks from Labrador to the Scotian Shelf, and haddock off the eastern Scotian Shelf. Other species are also caught in sentinel activities, and in total sentinel information is used in assessing the condition of 15 groundfish stocks across the Atlantic Coast. Individual sentinel projects are managed by DFO Scientists in each of the Atlantic Coast Regions (Gulf, Laurentian, Maritimes and Newfoundland). In each case, the Science group interacts closely with the local fishing industry to design, implement and monitor the ongoing operation of these projects.

Until 1996, projects were funded by Human Resources Development Canada. DFO provided scientific expertise to oversee the projects and provided funds for scientific equipment and the observer coverage. Since 1996, the sentinel survey program has been funded by DFO, as well as by the revenues generated from the sale of the fish caught. Currently, DFO contributions to the Program are about $5 million, and the value of catches is just over $1.5 million. Sentinel projects have been running for up to eight years in some cases. In total, there are currently 19 groundfish industry associations and groups which are contractually involved in the Program, and 27 separate sets of sentinel activities are being conducted.

Design Issues

All Atlantic groundfish sentinel projects fall into one of three basic design types. The sentinel index approach, which involves controlled fishing to monitor trends in relative stock abundance, is being used in all Regions (but not all sentinel stocks). Other design approaches such as stratified random sentinel surveys and commercial index fishing, where fishers are allowed more freedom to monitor fish concentrations, are also used in selected situations.

Within these basic design types, there is considerable variability between Regions in most major design features; including stock area coverage, gear type and diversity, level of effort control (time and place), and in the use and role of DFO staff, industry staff, and third-party functions (observers and dockside monitors). In contrast, data collection and collation is relatively standardized. Many of these Regional specificities are the result of factors such as local stock condition and distribution, priority needs for additional stock information, and industry preferences. It was acknowledged at the workshop that these design differences were, per se, not necessarily a problem provided that Groundfish Sentinel Program objectives were being met.

The need for time and place controls to facilitate quantitative analysis, on one hand, and, on the other, the flexibility fishers seek to have in order to get some direct feeling for the condition of a stock sometimes creates tension between DFO Science and the industry. It was agreed that further discussions at the Regional

level might lead to a more widely accepted balance, recognizing the need for both continuity and coverage. Several Regions may consider adding a small mesh gillnet element to the index programs to improve recruitment monitoring. Instances where data was collected but not heavily used were noted and continuing with these programs was questioned, but it was also argued that such data may serve a future purpose and should be continued.

Quality and quantity of data
While roles and responsibilities in sentinel data collection and handling vary markedly between Regions, standard types of data verification and control checks are in place in all cases. Industry involvement in data handling varies widely. Sampling levels seem high in many projects, extremely so in several cases. It was demonstrated that sampling levels can be assessed quantitatively, and agreed that these techniques can and should be used to re-focus sampling in a considered fashion to optimize the benefit of sentinel activities. The potential benefits of optimizing numbers of sampling sites and the deployment of sentinel effort were also recognized.

Data treatment and assessment
Sentinel data is designed to serve seven primary groundfish stocks. At least eight other stocks are secondary beneficiaries of sentinel data. A number of techniques are in common use to control or mitigate against biases in sentinel data which might result from factors such as gear saturation, gear configuration, aggregation of data from different sites and times, and extreme observations. For the most part, data from sentinel sources augment existing analyses in assessments of stocks rather than introduce new types of analysis.

There is a generalized belief among industry participants that incorporating sentinel data into an assessment leads to improved assessment of stock status, but it was also noted that it has not been possible to objectively examine the influence and impact of sentinel data on assessments. Several advances in this regard were made at the workshop. It was demonstrated for two stocks (4Vn cod & 4TVW haddock) that the addition of sentinel indices reduced variability and clarified risk assessment, even when the sentinel and non-sentinel signals were contradictory. It was also demonstrated on two stocks (4TVn cod and 3Pn4RS cod) that the influence within an ADAPT formulation of a number of separate indices from sentinel and non-sentinel sources could be differentiated and ranked. Refinement and use of this approach might assist making future choices between indices but also raises the need to better understand the relationship between influence and accuracy.

An observed strength of the Groundfish Sentinel Program is that it is capable of sampling the stock at otherwise inaccessible locations and at times not normally covered by other fishery-independent assessment tools, particularly research vessel surveys. However, it was recognised that the full utility of abundance monitoring based on sentinel activities cannot be known until its responsiveness is tested as stocks undergo periods of change more pronounced than has generally been the case to date.

A number of specific suggestions for improvements were made, but of note is the need to develop techniques to incorporate major sentinel series that are not yet used in the assessment into the determination of stock status in a more structured fashion. This need is particularly true for the commercial index fishing records that are collected in most areas.

Other species and research
Assessments for at least eight other stocks currently benefit substantively from data from sentinel sources. A diversity of other research questions and issues not directly related to the determination of the status of primary and secondary sentinel stocks benefit from the Groundfish Sentinel Program, primarily through having a platform for the collection of samples and measurements.

Efficiency & Cost-effectiveness
For evaluative purposes, the cost of sentinel activities was taken to include government funding, in-kind contributions by all parties and the value of fish sold. Nominal program costs vary substantially across stock areas, in reflection of original funding envelops, stock areas, numbers of fishers, and resource condition. Including sentinel costs, total assessment costs for four of the seven primary stocks are the highest among all Atlantic zone commercial marine resources, and costs for the other three primary sentinel stocks are also in the high range.

Assessment inputs (numbers of measurements, indices, etc.) were reviewed, but it was established that assessment inputs alone are not a satisfactory proxy for impact on the outcome of the assessment and by extension not a suitable basis for cost:benefit analysis. The different management approach between Regions leads to different roles and responsibilities profiles and deployment of human resources is not standardized. As a result, comparative analysis of relative efficiency in these issues is difficult. However, per activity costs, as a measure of overall cost efficiency between individual projects, varies substantially. Some differences can be attributed to vessel size effects, and activity constraints imposed by the sampling protocol, however, remaining cost differences for similar work should be investigated further.

Many industry participants felt the best approach to cost: benefit analysis is to consider how to do more with what resources and information are available, rather than to look for what can be cut from the Program. There was substantial support for making more use of data, especially those not currently used, and for refocusing excessive sampling and measurement to make better use of existing resources.

Participants involved in the Program stressed that there were benefits from sentinel activities and results that were important but intangible from a cost perspective. Examples include improved communication and acceptance by industry, awareness of the scientific approach, and opportunities to undertake ancillary and opportunistic research.

Industry Perspectives on Sentinel

There is broad support for the Groundfish Sentinel Program among the Atlantic groundfish industry, who feel that the program lends credibility to and builds support for the assessment process, and that it is an important vehicle for dialogue between DFO Science and the industry on resource status and conservation issues. Notwithstanding, the industry is prepared to discuss refinements and improvements to the Program and identified a number of issues for further consideration.

The merits of focussing on an objective-based approach were highlighted, coupled with a rigorous monitoring of results to evaluate the actual impact of sentinel efforts on the determination of stock status. There is a need to better identify and to present the impact of sentinel activities on the outcomes of assessments, for the purposes of being able to monitor and demonstrate sentinel benefits on an on-going basis.

The sentinel industry believes that the Department's focus should be on improving the benefits derived from the current level of fiscal resources available to Groundfish Sentinel Program rather than looking for ways to reduce funding for the Program.

The Future of Sentinel

There was a strong view among workshop sentinel participants that current government funding of sentinel activities must be maintained and preserved for the foreseeable future. Among other future financing alternatives, discussions centered on the merits of linking the maintenance of sentinel datasets to commercial fishery operations, where and when this is possible. It was observed that funding future sentinel activities using catch revenues reduces the dependence on government funding sources, but introduces the prospect that changing stock conditions could affect sentinel funding at a critical time.

In considering the future, the need to maintain and improve the scientific integrity of the Groundfish Sentinel Program was an overriding concern. It was recommended that any significant changes to funding levels be discussed in advance with the affected industry groups.

Opening Remarks
Serge Labonté, Director-General, Fisheries and Biodiversity Sciences

In opening the workshop, the Director-General of Fisheries and Biodiversity Science, Serge Labonté welcomed all participants and noted the broad and powerful mix of Groundfish Sentinel Program interests in the room, including DFO Science and industry partners (Annex 2). He noted also the presence of the Atlantic Regional Directors of Science, DFO Fisheries Management staff, representatives of the FRCC, and the Provinces. He acknowledged two external participants involved in the workshop; Dr. Dan Lane of University of Ottawa and Bruce Chapman of the Groundfish Enterprise Allocation Council. Mr. Labonté also noted the attendance of Laura Taylor Singer from the Gulf of Maine Aquarium, who was observing the workshop.

Mr. Labonté observed that ecosystem changes such as altered weather patterns, longer-term climate changes, and modified oceanic conditions were increasingly complicating the management of natural stocks. As evidenced by earlier declines, these groundfish stocks are fragile and need to be managed most carefully. With change, previous approaches may lose their effectiveness, creating the need to expand our competence by taking a multidisciplinary approach and developing strong partnerships. He recalled that DFO's current Strategic Plan calls for the development of a wider partnership base by 2005, and indicated that DFO will develop these partnerships to (i) increase leverage and (ii) build confidence and respect with partners. Mr. Labonté pointed out that in a true partnership each partner must contribute and each must benefit, and that we must always strive to make our contributions go further and enhance the benefits derived. He saw this workshop as an opportunity to ensure the Groundfish Sentinel Program is an effective and cost-efficient partnership.

Serge Labonté recalled the origins of the Groundfish Sentinel Program and revisited the original goals and objectives. He pointed out that most of the financing came originally from government sources, and that this continues to be the case, although catch value is also substantial in some instances. He observed that while different approaches have been taken by the various DFO Regions in the implementation and subsequent growth of the program, sentinel information is now used in groundfish assessments in all Regions and provides an opportunity to conduct other research and sampling.

Mr. Labonté reflected on the recently completed Stock Assessment Review that considered the relationship between investment in assessments and the knowledge so gained. The Groundfish Sentinel Program was noted in that exercise to be a relatively large investment, but also one that provided benefits in addition to direct input to assessments. A closer look at the Groundfish Sentinel Program was recommended, and this has led directly to this current review. He stated the purpose of this review is to position the Groundfish Sentinel Program as an effective and cost-efficient component of the groundfish assessment process on a longer-term basis.

In closing, Mr. Labonté challenged the workshop to identify and preserve the strengths of the Groundfish Sentinel Program and consider what changes need to be made in the spirit of adaptation and growth in the partnership.

Session 1: Introduction to the Groundfish Sentinel Program

The introductory session was designed to provide and present to participants for information an overview of the origins and implementation of the Groundfish Sentinel Program, both from a National perspective and in each of the Atlantic DFO Regions. For context, an overview of other forms of science:industry joint initiatives was included. The session was chaired by Dave Gillis, Fisheries Research Branch, Ottawa.

1.1. Presentation: Groundfish Sentinel Program, Design and Implementation
D Gillis

After supporting substantial and economically significant fisheries for generations in some cases, many groundfish stocks north of the mid-Scotian Shelf came into distress in the early 1990s. Following TAC reductions in the previous several seasons, fishing on the northern (2J3KL) cod stock was stopped in mid-season 1992. By the fall of 1993, six Atlantic cod stocks were closed to fishing and TACs were reduced sharply on other groundfish stocks. Further closures were seen over the next several years (Figure 1).

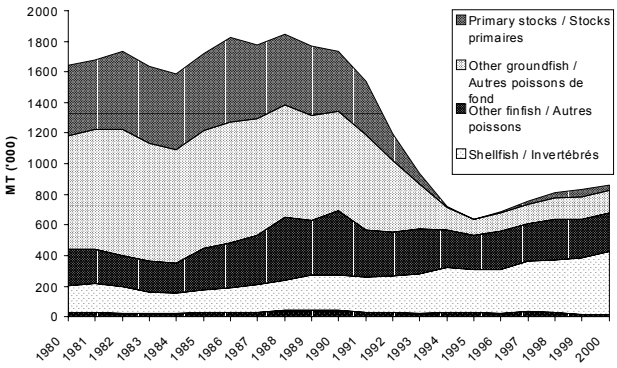


Figure 1. Atlantic commercial fishery landings by species group, 1980 – 2000. Primary stocks are those which are the focus of sentinel projects.

Beyond the obvious and immediate impact of these events on the economic livelihood of many Atlantic Coast communities, the closure and reduction of so many groundfish fisheries had a negative impact on the stock status assessment process for these resources. While commercial fisheries catch rate series were no longer being widely used as indices of abundance in the analytical assessments prevalent among these stocks, the commercial fishery had remained an important source of general knowledge of fish abundance, distribution and movement. Sampling of the commercial catches in port and at sea remained a primary source of biological samples and measurements upon which to build population models.

Additionally, the activities of commercial fishermen were the primary means by which the fishing industry maintained its own perspective on the status of these stocks, by comparing and interpolating recent catch results against the accumulated knowledge of the distribution and abundance of those resources over many years of commercial exploitation. Paradoxically, the reduction and closure of fisheries amplified the need for information about stock status at the same time as removing and restricting an important source of information used to monitor stock status in the established fashion.

Concerns for the impact of closures for the stock assessment process and the need to maintain contact with these resources became focussed within the then recently created Fisheries Resources Conservation Council (FRCC). In its November 1993 report, the FRCC recommended;

> *"To provide continuity in stock assessments, attention must be paid to the possibility of using commercial vessels to maintain or implement some form of fishing activity, on a wider temporal basis or geographic scale than scientific surveys alone, but with strong controls to minimize possible adverse impacts on conservation actions. Such fishing could take the form of 'experimental' or 'sentinel' (test) fisheries."*

At this time, government monies were being made available to support initiatives to deal with a range of outcomes triggered by fishery closures. These included programs to reduce capacity in and dependence on the fishery, income support for those who would remain, and monies to engage those to remain in activities relevant to the future of the fishery and resource economy of the Atlantic Coast. What evolved was the concept to direct some of these latter funds to conduct a program of organized and controlled harvest by commercial fishers to collect information about the stocks under moratoria for the purpose of monitoring their condition. First efforts became operational in mid-1994, with primary funding from Human Resources Development Canada (HRDC), specifically the 'Green Projects' component of The Atlantic Groundfish Strategy (TAGS), and technical and scientific support from DFO.

A clear statement of goals and objectives for this program are not available from this formative period, but can be readily inferred from the design of early projects and from the earliest reports of results. The goal of the Groundfish Sentinel Program is presented as: to improve groundfish stock assessments and conservation decision-making. The two objectives are presented to be (1) to enhance scientific information and monitor

trends in the biomass of stocks currently under moratoria; and (2) to involve fishers directly in the scientific assessment process, and thus foster cooperation and information flow with the fishing industry.

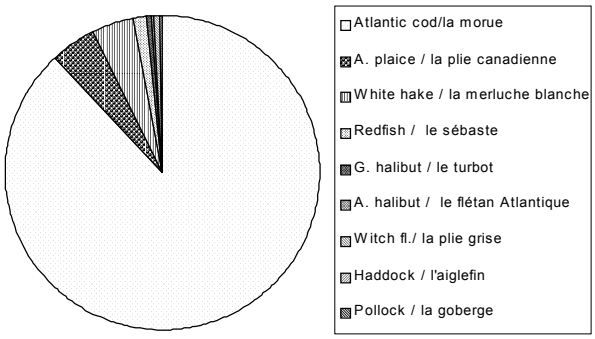


Figure 2. Landings (%) in sentinel activities, by species, 2000

The list of sentinel projects grew over 1994 and 1995 to include all Atlantic Regions. The application of project funding from HRDC to address the needs of the evolving and growing Sentinel Program was neither smooth nor easy. The administrative strictures of programming tied to income support had its influence on the design and implementation of many early sentinel programs and some of these influences remain evident today.

For the 1996 season and thereafter, primary funding responsibility for the Groundfish Sentinel Program has been vested with DFO. Initial allocations were $6,000,000.

Today, the Groundfish Sentinel Program is well developed across all four Atlantic DFO Regions. There are 27 distinct sentinel activities conducted under contracts with 19 industry organizations based in five Eastern Provinces. Types of projects vary inter- and intra-regionally, but include stratified random surveys, controlled fishing for index purposes, and commercial index fisheries as well as a number of more specialized project designs. Conducting the sentinel program has also created numerous instances where other research and sampling is conducted on an opportunistic basis. In 2000, 210 fishing enterprises were engaged in sentinel activities, which corresponded to approximately 550 fishermen. Sentinel activities are targeted at and were originally designed to monitor the 6 major cod stocks from southern Labrador to the eastern Scotian Shelf, plus haddock on the eastern Scotian Shelf. In addition, however, sentinel information collects information on a considerable number of other species and is a factor in assessing 15 other groundfish and pelagic stocks in the Regions.

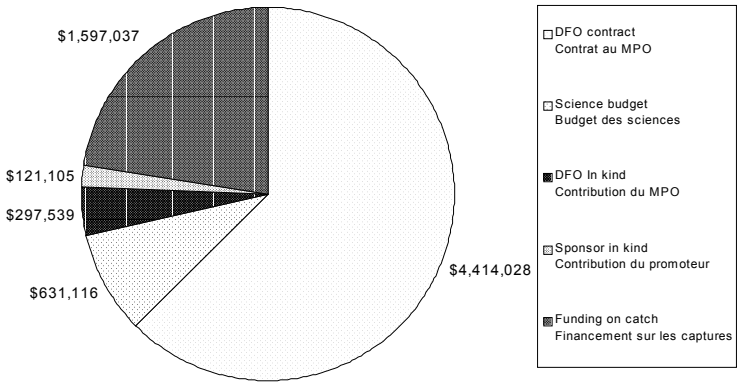


Figure 3. Sentinel funding for 2000, by source

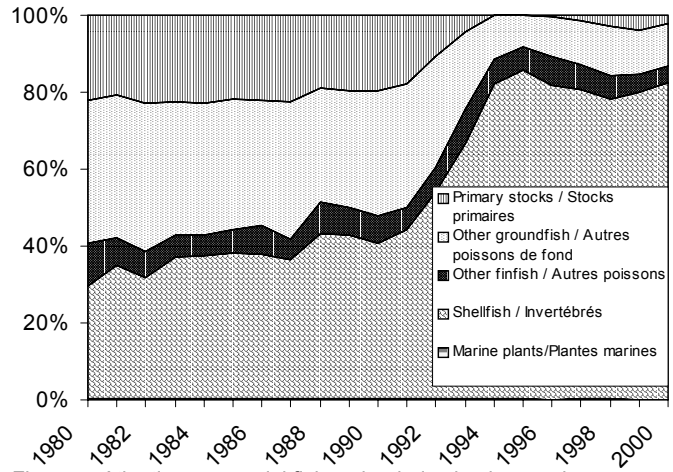


Figure 4. Atlantic commercial fishery landed value by species group, 1980 - 2000

Sentinel activities engage a wide range of gear types, both fixed and mobile are allotted a modest allocation in each relevant stocks area. In sum, landings from sentinel activities in 2000 totalled close to 1,900 mt of groundfish, of which some 90% was Atlantic cod. American plaice and white hake comprised the bulk of the remainder (Figure 2).

In 2000, just over $7,000,000 of financial support was directed toward the Groundfish Sentinel Program (Figure 3). Of this amount, $5,000,000 originated with DFO, in the form of contracts with industry organizations and DFO staff time and services. In addition, DFO and the industry collectively contributed services

in-kind worth about $420,000. The value of fish caught, which is to be directed to fund sentinel activities, was worth an additional $1,560,000 in 2000.

By 1999, after up to five years of operations, differences in approach to the design and data treatment among sentinel projects were becoming evident. At the 1999 zonal assessment for Atlantic cod at Rimouski, Quebec, the meeting recommended that the Groundfish Sentinel Program be reviewed from a technical perspective. In 2000, a wider review of the entire DFO stock assessment process documented the investments being made in each and every stock assessment and reflected on the knowledge gained in the process. In that exercise, stocks where the Groundfish Sentinel Program was in place were noted to have relatively high assessment costs. The Report of the National Stock Assessment Review recommended that the Groundfish Sentinel Program be examined further to ensure that it was both efficient and cost-effective.

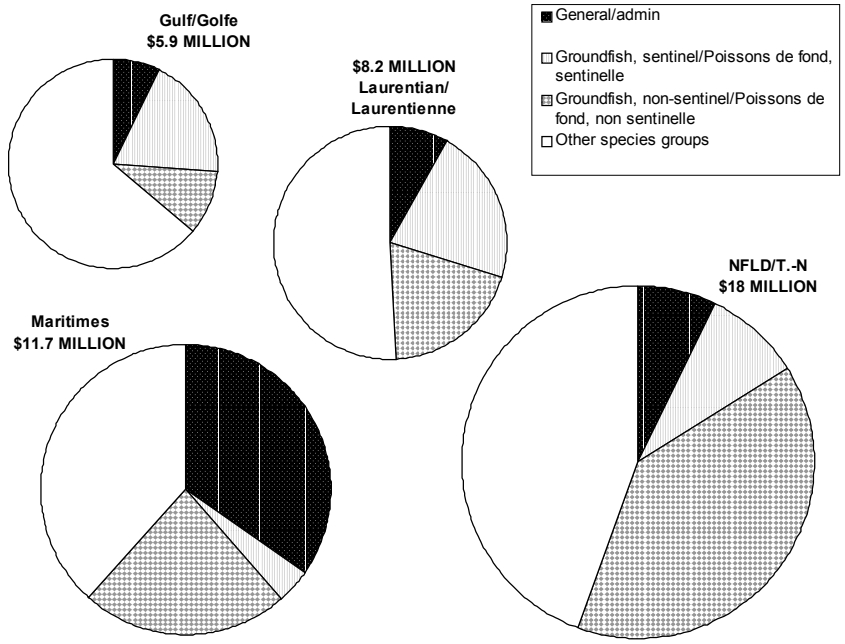


Figure 5. Stock assessment expenditures for 2000 by species group, Atlantic Coast

In this context, DFO Science Sector commissioned the Sentinel Program Review to be completed in the 2001-2002 year. The Terms of Reference (Annex 3) establish the purpose of the review as;

… *to provide recommendations designed to position the sentinel fishery program as an effective and cost-efficient component of the groundfish assessment process on a longer-term basis.*

<<Sentinel Review Terms of Reference, June 2001>>

Three broad objectives for the review have been set out; (1) describe the groundfish sentinel survey program and associated projects; (2) consider and advise on what changes may be necessary; and, (3) identify challenges to be addressed in implementing change.

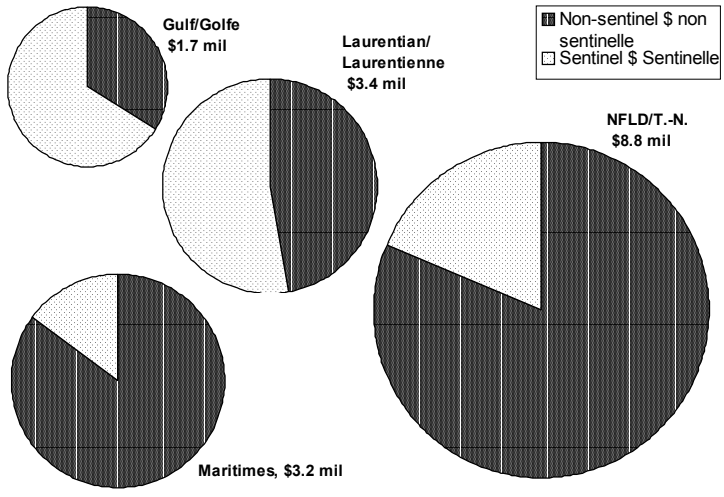


Figure 6. Regional stock assessment expenditures for groundfish in 2000, Atlantic Coast

In considering the current and future role of the Groundfish Sentinel Program, it is important to also be aware of the wider context within which the sentinel program must exist.

Those stocks that were the original target of sentinel efforts have not rebuilt at the rate that had been hoped and expected at the onset of the program. Commercial landings from sentinel target stocks and other groundfish stocks have remained at close to 1993 levels (Figure 1) to 2000,

and immediate prospects for significant and widespread stock growth are not evident for groundfish. At the same time, landings of other species groups have remained stable or increased. This situation is now reflected in a significant change in the relative contribution of species groups to the total value of the Atlantic fishery.

At the same time, the assessment cost for groundfish stocks remains a robust proportion of the total available stock assessment budget for the Atlantic Coast, where $17.4 million of the total of $44.0 million is directed at groundfish species.

Globally, the Groundfish Sentinel Program constitutes about 29% of the groundfish assessment budget on the Atlantic Coast. The relative contribution to sentinel activities varies considerably between Regions in reflection of, among other considerations, the number and diversity of species involved in the commercial fisheries in each Region.

1.2. Presentation: Industry-Science Initiatives; An Overview
P Fanning

Paul Fanning provided an overview of the range of industry:science cooperative arrangements that can exist, based on experiences and examples derived from the Maritimes Region.

The cooperative relationship between the Department and the industry may be a formal one, such as described in a Joint Project Agreement (JPA) or a First Nations Agreement. Alternately, there may be a less formal arrangement in place where the industry agree to complete certain samplings and cover any costs out of their own quota or from a special allocation. In some other cases, the work is done strictly on a volunteer basis.

Sentinel fisheries are an instance where the bulk of the financial support comes from government sources. In Maritimes Region, the sentinel program is covered by a JPA but in other Regions arrangements are typically covered by a standard contract approach.

Fanning provided a number of examples of different cooperative arrangements. Emerging fisheries in Maritimes Region are also covered by an Agreement, but as a matter of policy (Emerging Fisheries Policy), participants in these exploratory and experimental efforts are required to conduct scientific sampling and measurements designed to clarify resource status and promote a sustainable level of harvest. Skate in Division 4VW and monkfish in Divisions 4X & 5Zc were shown as examples.

In several examples, commercial fishing fleets are directly involved in undertaking resource surveys, for the purpose of augmenting the data available for stock assessment. In the case of cod in Division 4X, the mobile fleet conduct a survey using their vessels in accordance with a design approved by DFO Science, which is conducted within the commercial allocation provided for that fleet. The fixed gear fleet also conducts a survey for Atlantic halibut across the Scotian Shelf and the southern Grand Banks, which incorporates a commercial index component. In this case, a special allocation has been made for this purpose.

Other examples of cooperative research arrangements shown included white hake, offshore and inshore scallops, northern shrimp, Arctic surfclam, rockweed, lobster and jonah/rock crabs. Fanning provided several examples of how the results of these cooperative and industry initiatives are being incorporated into the stock assessment process and adding to knowledge of stocks and stock status.

Fanning drew special attention to the Fishermen and Scientists Research Society (FSRS), which is a body created specifically to promote interactions and understanding between the industry and science in the Maritimes Region. The FSRS is the sentinel contractor for the 4VsW program, but is also involved in a range of other science-related projects and activities. The FSRS is an effective tool in advancing science and the understanding and communication of science in the Maritimes Region.

In summarizing, Fanning feels that sound science can and is being done on a cooperative basis. In fact, many activities benefit from or require assets such as technology and ship time, which the industry is sometimes in

a good position to provide. He noted that strong science oversight was a key element, and was required in both design and implementation. He stressed that cooperative work couldn't replace the basic long-term monitoring programs conducted by government, and that we must recognize that there are instances where industry involvement shouldn't be expected since they may feel the results would not be in their interest.

1.3. Sentinel Project Inventory

A comprehensive and detailed information set concerning the current structure of each of the Regional sentinel programs was compiled for the review. Types of information available in the summary included DFO and industry contacts, detailed financial information, an account of human resources involved in each component of the program, protocols for management and implementation, and a full list of deliverables.

The project inventory was designed to permit data and information on separate and discrete sentinel activities or projects to be available for study and comparison. In cases where more than one contract is let to provide similar input to a common project (ie: Gulf sentinel index projects), these contracts were listed separately and combined as and when necessary. In other instances, more than one sentinel activity was covered by a single contract. In these cases, financial and human resource commitments were apportioned among these different activities as appropriate.

In this manner, twenty-seven (27) separate components of the Program were recognized.

1.4. Regional Sentinel Program Summaries:

To provide participants with a general appreciation for the design and implementation of the Groundfish Sentinel Program across the coast, each DFO Regional team presented a general overview of the Groundfish Sentinel Program in their Region.

1.4.1. Maritimes Region

There are two independent Sentinel projects in the Maritimes Region, 4VsW and 4Vn. Both Sentinel projects have the primary objective of obtaining new indices of fish stock abundance. Additional objectives include monitoring distribution and migration; age, growth and survival; maturity and diet and stock structure. Another important objective is to continue and foster the co-education of scientists and fishermen to support sustainable fisheries.

Although there are many operational differences between the 4VsW and 4Vn sentinel programs, the major elements are the same. Each includes a stratified random survey component and commercial index component. In addition, in 4Vn, there have been a number of individual projects that have run for one or more years over the 8 years of sentinel programs. These include migration monitoring, hook and gear experiments and elements of studies within the Bras d'Or Lakes.

These sentinel projects have offered additional benefits to DFO. They provide information from areas not included in the regular DFO surveys (inshore areas and untrawlable areas) and from a season (Fall) when DFO has no current survey. The development of an ecosystem approach to fisheries management has been enhanced by the program's collection of environmental and, most importantly, predator-prey data.

Sentinel program results in Maritimes Region have been incorporated into the assessments of 4 different groundfish stocks in a variety of ways (to be elaborated further). In addition to the assessments, biological data from sentinel observations have been used in several other stocks and the diet information collected by sentinel fishermen has been a major contribution to the current ecosystem modelling efforts.

There are also some key issues surrounding the utility and long-term success of the sentinel programs. The first and most fundamental is the long-term funding through government support and revenues generated by the sentinel catches. Mechanisms to sustain the project funding have been developed and should be effective when fish stocks have been rebuilt to some degree. In the shorter-term, cuts in the DFO funding have undermined the program and data collection cuts have already occurred. Further reductions in the program

are required even at the present funding level. The other key issue for the sentinel programs is the credibility and acceptance of the program results by both the scientific and fishing communities. Unless the results generated by the programs are accepted and used in the important task of assessing and managing the fisheries there is little or no benefit in continuing the exercise.

1.4.2. Gulf Region

Since 1994, sentinel surveys projects have been conducted in the Southern Gulf of St. Lawrence (NAFO 4T-Vn cod stock). As for other cod stocks in the Canadian Atlantic, these projects were designed to collect information on the abundance of groundfish and the general biological characteristics of the stock. Commercial fishing vessels are used in the project and adhere to a pre-determined scientific sampling protocol. In both 1994 (1 project) and 1995 (7 projects), project proposals came from industry but followed a DFO Science project design. At that time, projects were largely funded by the Canadian Dept. of Human Resource Development Canada (HRDC). DFO provided scientific expertise to oversee the projects and provided funds for scientific equipment and observer coverage.

Since 1996, the sentinel surveys have been funded almost entirely by DFO. The work is conducted under contracts awarded to recognized fishermen's organizations through a tender process. In 1996 and 1997, ten sentinel survey projects (5 fixed gear and 5 mobile gear) were conducted in the southern Gulf of St. Lawrence (including the Gaspé Coast, Gulf N.B., Gulf N.S., P.E.I. and the Magdalen Islands). The projects involved a total of over 30 groundfish vessels. In 1998, 11 sentinel survey projects were conducted, 5 fixed gear and 6 mobile gear for a total of 27 and 9 vessels respectively. Twelve sentinel surveys projects were conducted in 1999 and 2000. In these two years, the addition of the north Gaspé project brought the number of fixed gear projects to six (6) while the mobile gear sites remained the same at six (6). A total of 39 vessels (30 fixed gear, 9 mobile gear) were used.

Fishing gears were selected in conjunction with harvesters on the basis that they were commonly used in the groundfish commercial fishery within each region. In doing so, comparisons of the data collected through the sentinel program could be compared to commercial data in the event of a re-opening of the directed fishery on cod. This would also allow for maintenance of some of the abundance indices in case the sentinel program was discontinued. Four types of gear are used in the southern Gulf sentinel program: gillnets, longlines, otter trawls and Danish seines. Gear types have not changed since the beginning of the program in each region. Similarly, fishing locations or zones were chosen in consultation with harvesters so that they would be representative of the traditional cod fishing areas while providing extensive (but not complete) geographical coverage of the southern Gulf. Fishing locations have remained the same since the inception of the program.

Sentinel activities commence at the end of June and usually carry on until mid-November in some regions. On pre-determined occasions, other samples are collected (stomachs, gonads, etc). Many others projects have been conducted using the sentinel program vessels as platforms. These include: tagging of various species of fish for migration studies or stock identification, monitoring cod fecundity, collection of samples for observer training and the collection of groundfish stomachs for a study on lobster predation.

Data accumulated from sentinel projects are used in stock assessments of cod, hake, American plaice, winter flounder and yellowtail flounder. For cod, the data from the sentinel program have been used since 1999 to derive abundance indices which are in turn used in the population re-constructions (ADAPT) of stock trends. These indices have also been used in statistical analyses of natural mortality and year-class estimates. Sentinel data and results are disseminated through stock assessments research documents, stock status reports, sentinel survey reports, primary publications, reports to fishermen associations and, radio and TV interviews.

Sentinel activities conducted by harvesters in the southern Gulf of St. Lawrence are closely monitored to ensure data quality and program integrity. Fishing activities and other duties related to the sentinel program are described in detail in protocols in the contracts linking DFO and the fishermen organizations involved. Fishing activities are done under a scientific fishing license with detailed conditions. On all sentinel trips, fisheries observers are used to collect the information and to ensure that the activities are conducted in accordance with the protocols. In addition, dockside monitoring is mandatory to exclude the potential sale of

fish caught illegally. Payments made to the associations for the activities are based on performance on a per-completed-activity basis. Departures from the protocol can lead to non-payment for activities and, as a last resort, to the invalidation of the license and the termination of the contract.

Comments and clarifications on presentation:

An industry representative questioned whether the spatial coverage in the southern Gulf program is adequate, noting that there are large parts of the NAFO 4T cod stock area without fishing sites. He suggested that recent changes in the climate might have resulted in changes in the distribution of cod to areas that are not being covered. The same individual questioned the adequacy of the coverage of the annual (September) groundfish survey in terms of cod. Mr. Chouinard responded that the main change that has occurred recently in the distribution of cod has been a shift from the west to the east, and as a result, he considered that the spatial coverage is probably adequate.

Another industry representative asked for clarification of the criteria for awarding the sentinel program contracts in the Gulf. Mr. Chouinard explained that the contracts are awarded through a tendering process, with selection on the basis of the best-assessed value, which includes consideration of the price.

A question was raised concerning the scientific fishing licenses issued to participating fish harvesters in the southern Gulf sentinel program. The individual asked how these licenses differ from regular commercial fishing licenses, and whether scientific fishing licenses are employed in the Sentinel programs conducted in the other regions. Mr. Chouinard explained that the scientific fishing licenses are a control mechanism that require compliance with the scientific protocols of the southern Gulf sentinel program, through specification of the types and quantities of fishing gear used, areas and dates of fishing activities, requirements for observer coverage and dockside monitoring, and other controls. Mr. Chouinard indicated that the use of scientific fishing licenses is unique to the southern Gulf program

A participant asked for a description of the Sentinel reports. Mr. Chouinard explained that a variety of reports and documents are produced each year, including compilations of the raw data collected by each fish harvester, end of season reports from the participating associations, and others.

1.4.3. Laurentian Region

Sentinel programs were first established in the Northern Gulf in the fall of 1994. As with other Groundfish Sentinel Programs, funding was initially provided by Human Resources Development of Canada (HRDC). There was a strong emphasis placed by DFO Science in the initial meetings with industry that sentinel programs were not ‘make work’ projects and that, as new indices of abundance were the main objective, a strong long-term commitment needed.

An integrated approach to conducting sentinel activities in a uniform fashion between Quebec Lower North-Shore and the West Coast of Newfoundland was taken for both fixed gear and mobile gear vessels. These gear/area combinations are the basic four components of the Northern Gulf sentinel programs. The funding was thus initially split in four parts.

At the initial stages, discussions were held with industry on the protocol and usefulness of each available gear to conduct some scientific work, whether constrained or unconstrained. It was felt that a stratified random survey conducted with many trawlers at a time would provide a “snapshot” of the resource. Such an approach would sample other groundfish stocks present in the area, provide indices on incoming recruiting yearclasses (through the use of a liner), and provide uniform and wide spatial coverage. Given that the annual research vessel survey conducted by the Alfred Needler is currently done in August, the two mobile sentinel surveys were scheduled for July and October, in order to monitor annual fish migrations and individual growth of fish.

For the fixed gear sector, more emphasis was placed on the usage of traditional knowledge. The protocol involved using traditional fishing gear, in traditional fishing grounds at traditional fishing dates. Sentinel sites

were distributed along the coast in a uniform fashion. Since 1995, all sites were kept active and the sampling protocols are uniform in all programs.

There were several particular situations in the Northern Gulf that had to be considered. It is a very large territory with isolated communities, especially on the Lower North Shore of Quebec. There is rough and deep bottom which hampers the spatial coverage of the mobile gear surveys (just as is the case with the Needler survey). However, the deployment of the sentinel programs in the Region was helped by the fact that three important fishermen associations represented the majority of fixed gear and mobile gear fishermen from both areas.

A number of strategic approaches have been taken in implementing the Laurentian Region sentinel programs:

- There is a high level of investment in the people involved. There is minimal turnover of sentinel enterprises and fishermen and they undergo continuous training. Industry is responsible for a wide range of tasks, including field management, data validation and keypunching, some laboratory work on condition and otolith splitting, and other innovative research such as tagging and selectivity studies.
- The establishment of a Steering Committee which represents all four components of the sentinel program and that meets every year in order to review the current year activities and plan for the next contract. This meeting is held during the stock assessment review timeframe.
- Compatibility between fixed gear sentinel activities and commercial activities; not in terms of fishing effort but rather for the type of fishing gear used. On the West Coast of Newfoundland sentinel samplings are conducted while a commercial fishing is underway. In such a situation, fishermen receive an allocation of $200 for the biological sampling and recording of the logbooks for three days of sentinel work done in the week. There are no boat rental costs, fishermen use commercial effort but retain the proceeds from fish sales.
- Mobile gears used in surveys have been standardized, through through the use of a restrictor cable installed between the main warps, which reduced inter-vessel variability from 25% to 6%. Any new boat participating in the sentinel mobile gear survey must undergo this calibration.
- Specific software has been developed at MLI to collate and validate all data that has been collected in sentinel activities. While this software was originally developed for cod data, it is now being used for a range of species taken in sentinel fishing.

These approaches to the Northern Gulf programs require a significant level of personal investment by DFO staff into the ongoing delivery of the program.

Communication is also an important component of the programs and is accomplished in the following ways:

- Through annual meetings with all sentinel fishermen. Their current year's activities are reviewed in order to consider their interpretation of the data they collected.
- With annual circulars for each of the four components of the program. The sponsor writes the fixed gear report in 4S and in 3Pn4R while reports written by DFO provide preliminary estimates of minimum trawlable biomass shortly after each of the mobile gear surveys.
- Distribution of results to all participants. All fishermen receive detailed figures, which illustrate for each fixed gear site, the location of sets, catch rates, bottom temperature and an overall length frequency.
- Publications on specific research conducted in these projects (such as; restrictor cable, effect of soak time and gear saturation on catch rates). Many of these have been presented in national and international forums.
- An Internet site. This site (www.osl.gc.ca) was developed to present the Northern Gulf sentinel programs (links, teams, results, pictures) and includes the above reports.
- Mass media. Currently, three television reports have been devoted to the Northern Gulf sentinel program (CBC – La semaine verte, Swiss television – Télescope and the New York Times - National Geographic Channel).

The Northern Gulf sentinel programs have an important commitment to high standards of scientific quality work. For example:

- All hired personnel are involved in continuous training. Exchanges of personnel between the four different sentinel components and DFO Science are encouraged.
- Fishermen have clear protocols and adequate sampling tools available to them.
- - There is close monitoring of the performance of the sentinel fishermen by field workers, sentinel co-ordinators, data entry clerks and DFO Science. Any fishermen whose work is not up to standard is replaced.
- DFO Science analyses the data to look into any potential bias on catch rates such as effects of soak time, gear saturation and effects of the commercial fishery.

Finally, the four indices of abundance that are derived by sentinel programs in the Northern Gulf have been included in the sequential population analysis for the last three years. These are the longline and gillnet catch rates-at-age, the July and October population numbers-at-age estimated by the mobile gear surveys. This is the earliest time frame that can be met given that at least three yearly estimates are needed to detect a trend. All indices are quite consistent among themselves.

Comments and clarifications on presentation:
A participant requested clarification of the indices of abundance shown in the presentation (were they abundance or biomass?). It was clarified that the mobile gear indices were of relative abundance while the fixed gear indices were expressed in terms of weight.

Another requested the web address for the Northern Gulf sentinel program. It was provided: (http://www.osl.gc.ca/en/peches-sentinelles).

1.4.4. Newfoundland Region:
The closure of northern cod fishery in 1992 and that of 3Ps cod in 1993 created a need for an alternate source of the type of data normally collected from commercial fisheries. There were calls from the FRCC and industry for a cooperative research program to address these needs. A sentinel fishery was proposed that would have a limited number of fisher harvesters collecting biological and catch rate data using scientifically sound techniques. It would be a fixed-gear project covering only those areas inaccessible to RV survey, from the nearshore out to the 100 m contour. Each participant would use strictly-regulated amounts of gear and fish in a traditional manner on their traditional fishing grounds.

The Marine Institute of Memorial University of Newfoundland and DFO Science developed a 6-week program of classroom and hands-on training for fish harvesters in scientific data collection methods. The topics covered were survey and sampling methods, ocean environment, computer training, fisheries resource management and presentation skills.

A Fish Food and Allied Workers Union proposal for a pilot project in 3Ps was approved by the Minister in October 1994, and funded as Green Project under TAGS. Because of HRDC requirements, the project had to be completed before the end of that fiscal year.

The FFAWU and DFO Science decided on criteria for participation and selected twelve sites in Placentia Bay and along the South Coast. Information meetings were held in each area and applications distributed. The successful applicants were selected by a draw.

The twelve successful fishers started training in January 1995. Fishing started in late February, which was outside the traditional season in most areas but necessary because of HRDC regulations. DFO staff provided extensive on-site support to reinforce the new skills gained from training. This twenty-week pilot proved successful in ensuring good data quantity and quality.

In the spring of 1995, sites were added to the 3Ps program and a northern cod (2J3KL) project sponsored by the FFAW started with 51 sites. Smaller projects in 2J3KL, sponsored by the Fogo Island Co-operative Society and the Petty Harbour Fishermen's Co-operative, also began in 1995.

Newfoundland Region projects are based only on fixed-gear in inshore areas. Up to half the gear is set at a fixed (control) site and the remainder at discretionary (experimental) sites. Participants complete a detailed

fishing log and collect biological and oceanographic data. They also constitute an integral part of the Region's tagging program and perform other requested tasks.

The Fisheries Interactions Section of DFO Science is responsible for sentinel projects in Newfoundland Region. It provides extensive field support and training, data handling and quality control, and administration of the various sentinel contracts. It analyses the sentinel data and participates in the assessments of 2J3KL and 3Ps cod. It also provides data to other members of the assessment group.

Session 2: Scientific/Technical Issues

The second session of the workshop was designed to discuss issues of a scientific and/or technical nature. Due to the diverse nature of such issues, and the number of possible points of discussion on these topics, the session was divided into four parts. These parts were focussed on, in turn; (1) Project Design, (2) Data Quality and Quantity, (3) Data Treatment and Role in the Assessment, and (4) Other Species and Research Opportunities.

The first two parts of Session 2 were chaired by Geoff Perry, DFO Science, Newfoundland Region. The second two parts were chaired by Denis Rivard, Fisheries Research Branch, Ottawa.

Session 2, part 1: Project Design **Chair: Geoff Perry**

The initial part of Session 2 was designed to review the various design approaches which have been taken in implementing the Groundfish Sentinel Program across the Atlantic Regions and to reflect on what, if any, design-related changes might be considered that would add value to the assessment of sentinel stocks.

2.1.1. Overview:
All sentinel projects conducted under the GSP can be categorised as being one of three major types of designs. Four (of 27, or 15%) different sentinel components are considered as **sentinel surveys.** Of these, two are conducted simultaneously using mobile gear vessels in the Northern Gulf of St. Lawrence and two others use longline gears in 4Vn and 4VsW respectively. Sentinel surveys are characterised by the fact that the stations are pre-determined in a stratified random fashion, and that they cover most of the stock area over predetermined survey dates. A swept-area estimate of fish density can be calculated and standardised, and an index of biomass can be extrapolated by aerial expansion of the average densities of fish among all strata. The use of small mesh liners allows for estimation of recruitment in the Northern Gulf. These surveys are also useful for monitoring and sampling other species. Due to the random design and wide spatial coverage, catches from this type of survey are comparatively low.

The majority (78%) of sentinel projects in Atlantic Canada are of the **sentinel indice** type, a design which is used in all Regions. All sentinel index projects are intended to monitor trends in abundance over time and estimate local density (Catch Per Unit Effort, CPUE) by deploying fishing activities in a standardized fashion, However, there is considerable variation between the designs. As examples, depending on the project, either DFO and/or the fishermen may select the fishing sites. Sampling periods may be short to monitor precise events, or quite long in order to sample migrating fish. The majority of sentinel index projects are conducted using fixed gear, however, in the southern Gulf, mobile gear vessels are also used, which through the use of liners allows recruitment to be monitored. The dependence on fish catches to support these activities is also quite variable from one Region to the next. Generally, these projects allow fishermen's traditional knowledge to have some influence on the design, but some constraints are required to control biases in year-over-year results.

The last type of sentinel design are **commercial indices**. They represent the primary design for two of the 27 sentinel projects (7%), both in Maritimes region (4Vn and 4VsW), although several other sentinel projects also have a commercial index aspect as part of their design. Commercial index activities allow fishers to sample the population in a less constrained fashion and so, to a greater level, reflect fishermen's traditional knowledge. These projects can allow monitoring of fish concentrations, and might be used in future to extend

pre-moratoria catch rate series. Due to unresolved biases related to targetting of concentrations and differences in gears, these indices have yet to be included as indices of abundance for either cod stock.

Another important factor in the design of the sentinel projects concerns the spatial coverage. These were examined in two perspectives, a first one according to the vessel type (Figure 7) and a second one according to contract type (Figure 8). Here again, the spatial coverage of the stock unit area varies considerably.

Over and above the basic design type, the sampling scheme used also varies between Regions (number of trips per week, fishing effort, soak time, number of sites per trip, tow duration). Also, the type of permits issued for sentinel activities varies from one region to another (commercial with condition, experimental permit, scientific permit).

Each program has a management team, which can include the crews, skippers, observers, data entry clerks, field technicians and industry co-ordinators. Their roles and responsibilities vary considerably among Regions (Annex 4) as a reflection of the commitment to involve different groups in the management of the projects (DFO personnel, fishermen's associations or unions, private companies).

Variations were noted between programs regarding the amount of training (initial, follow-up), through DFO, Universities, Colleges, Observers, and field technicians. The type of training also shows Regional differences. In the Newfoundland region, training addresses the largest range of issues (biological sampling, hydrographic sampling, data forms, use of computers, non-traditional gears, and public relations). Sentinel fishermen from other regions do not use computers in the field operations.

2.1.2. Regional approaches:

2.1.2.1. Maritimes Region

Although there are many operational differences between the 4VsW and 4Vn sentinel programs, the major design elements are the same. All projects are done exclusively with longline gear. Each includes a stratified random survey component and commercial index component. In addition, in 4Vn, there have been a number of individual projects that have run for one or more years over the 8 years of the sentinel program. These include migration monitoring, hook and gear experiments and elements of studies within the Bras d'Or Lakes.

The Sentinel Surveys (SS) in both areas are based on fishing a standardised gear using a fixed number of hooks and specified bait at computer-selected random locations spread throughout the entire stock area. Both surveys are conducted in the fall (September-October). Vessels are paid a charter rate per set and the value of the catch sold is used to fund the programs. In 4VsW the captains and crew conduct all data collection, recording the fishing set information, the catch by species and also collecting length frequency data and biological samples such as otoliths and stomachs. Observers are used on the first trip of each vessel to assist with the sampling and paperwork. Oceanographic observations include water temperatures at the gear for all sets and a subset of Conductivity-Temperature-Depth profiles taken from surface to bottom with an electronic probe. Since 1996, the 4VsW SS component has sampled 252 stations each year except 2001 when the funding shortfall required that the samples be reduced to 200. The 4Vn program samples 50 stations each year but differs from 4VsW in that the bulk of the sampling is conducted by sentinel technicians on the dock (catch weights, length frequencies and biological samples).

The Commercial Index (CI) phases in the two areas are similar but differ is small ways. In both cases, the intent is to obtain an index of stock abundance based on standardised commercial catch rates. The catch per unit effort or catch rate was the primary index of abundance for many years in fisheries science however today has been given little weight for a variety of reasons. The most important reason has been the technical evolution of the fishing gear and practices so that a given unit of effort (day or number of hooks) fished is not comparable over time. For hook and line gear, the most important technical change has been the advent and improvement of fish-finding instruments but improved navigation and communication have also had important

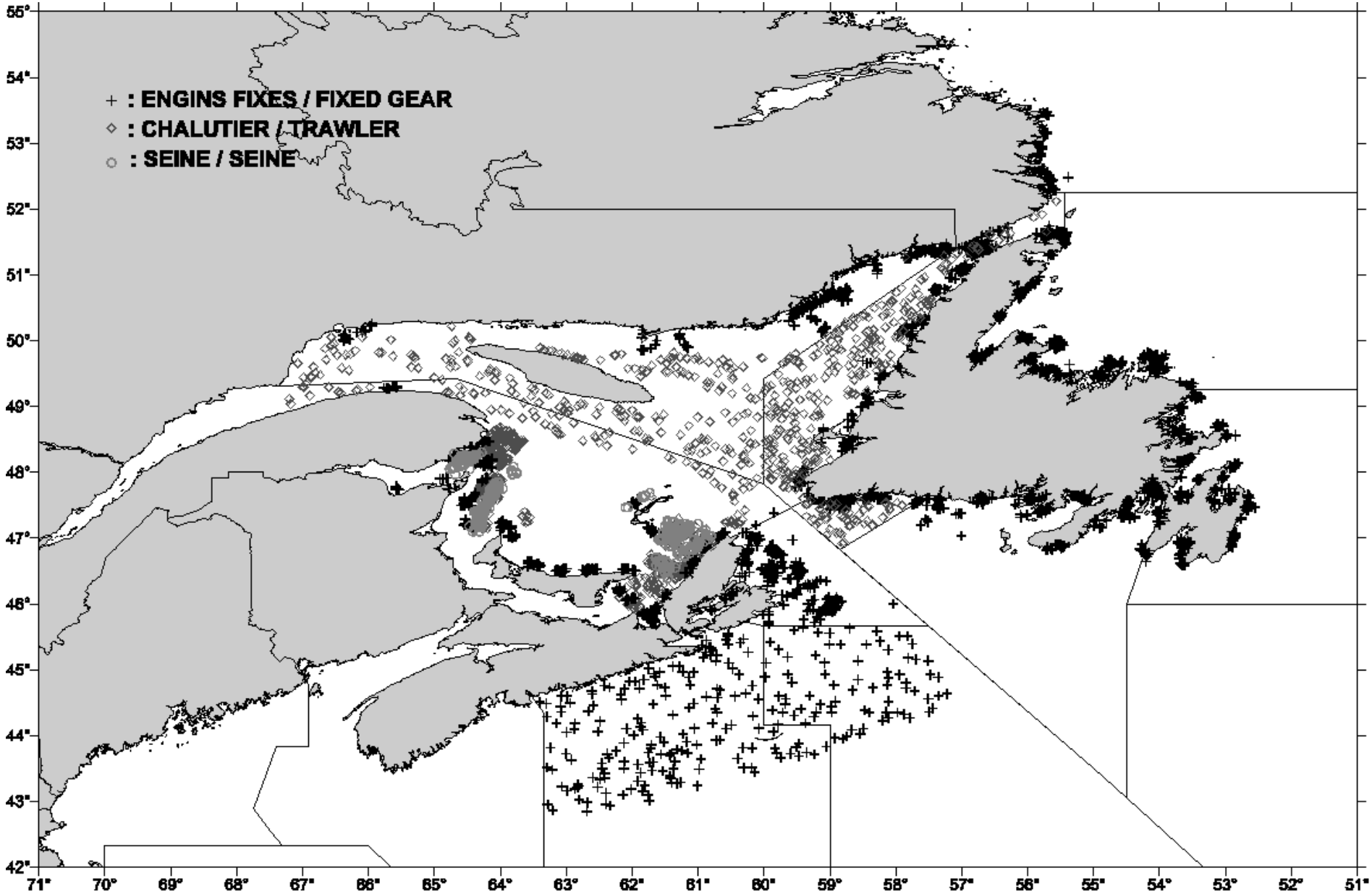


Figure 7: Distribution of sentinel activities by fishing gear type, 2000.

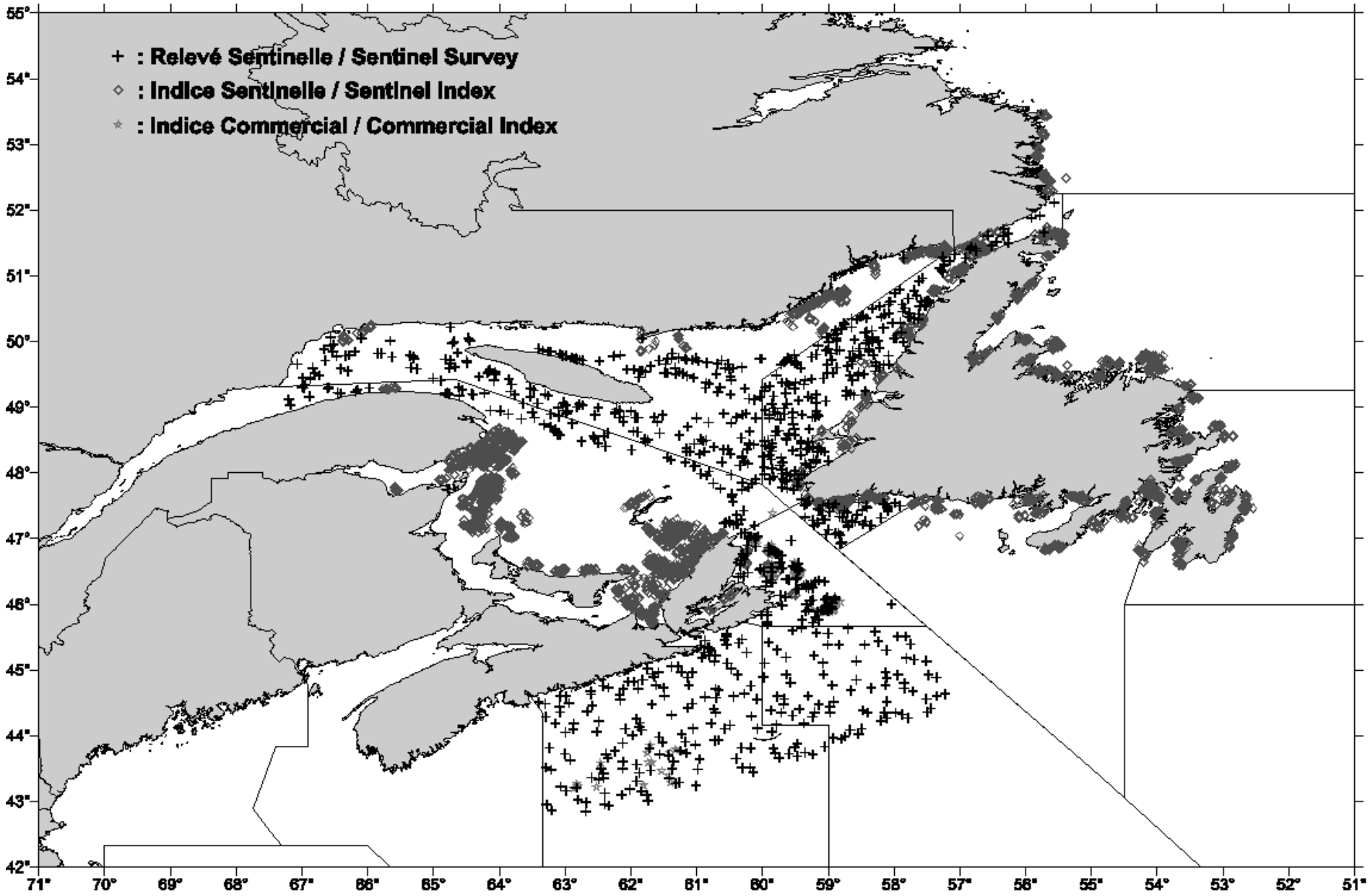


Figure 8: Distribution of sentinel activities by design type, 2000.

effects. Even the relatively simple longline has changed a lot with circle hooks giving better retention of fish and floating line allowing previously inaccesible grounds to be fished. In many cases the technical improvements are not captured in the data available for catch rate analysis and so no accounting for it can be made. The other major reason catch rates have been dropped as indices of abundance is the effect on fishing practices, particularly species targetting, caused by the increasing specificity of fisheries management measures, especially quotas.

The sentinel CI are intended to estimate what catch rates commercial fishermen might experience were they to direct fishing effort without management controls. The details of the gear in use is recorded to try to capture the effects of changes in the fishing technology. The results have been difficult to analyse and no accepted catch rate index has been completed however work on this is continuing. The spatial distribution of catch rate for any given species only covers a small portion of the stock area, presumably the areas of best commercial catch rates for the species.

2.1.2.2. Gulf Region

All components of the Southern Gulf sentinel program are of the sentinel index type. A total of twelve contracts ranging from a single boat to as many as eight are awarded through a tender process to monitor abundance in designated boxes and at sites, which are distributed to collectively cover the historical fishing areas (Figure 9). Both fixed gear (gillnets and longlines) and mobile gear (trawlers and seiners, both lined and unlined) are used, for a total of 6 gear configurations.

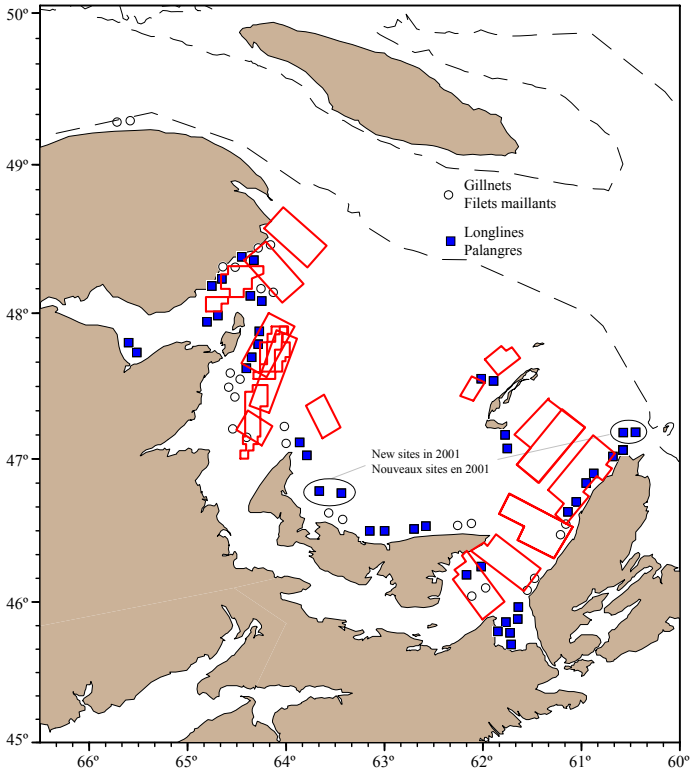


Figure 9: Sentinel sites, southern Gulf of St. Lawrence.

For mobile gear, randomly generated set locations within designated boxes are provided by DFO to the contracted fisher, who completes no more than one trip per week for the duration of the contract. For fixed gear efforts, each fisher must deploy the gear for two days each week within 2.5nMi of two established fixed locations.

These sentinel activities are conducted from the end of June and fishing activities usually carry on until mid-November in some regions. In 2000, 1049 fishing activities (a haulback from an individual fishing site) were conducted by fixed gear vessels and 1034 (tows) by mobile gear vessels. For each activity, a great deal of information is collected. The fishing activity is described (gear information, date, time, position, depth, etc) and catch of all species (number and weight of each species caught) are noted. For cod, hake and flatfish, the basic information gathered is length frequency, sex and otoliths.

Efforts are made to minimize turnover of mobile gear vessels under contract, while the retention of specific fixed gear vessels is more flexible. Full (100%) observer coverage is required for all sentinel activities in the Gulf Region.

2.1.2.3. Laurentian Region

The Laurentian region has only four components contracted out annually on a sole-source basis; two co-ordinated sentinel surveys using mobile gear and two fixed gear sentinel index components. Fixed and mobile

contracts are aligned according to industry groups in the two provinces involved (Quebec 4S and Newfoundland 4R and 3Pn).

The mobile gear surveys are conducted in the same fashion as the DFO Needler survey (stratified random trawl survey with liner). These surveys thus provide biomass estimates for all groundfish species and distribution information on several pelagic species (herring and capelin) All nine boats conduct pre-determined surveys in July and October, not to interfere with the Needler survey conducted in August. These cover most of the stock area, the inshore limit being 20 fathoms (60 meters). Three hundred tows are done for each survey compared to about 240 for the Needler. The use of a restrictor cable reduces greatly inter-vessel variation in wingspread and also avoids shifts in gear geometry (trawl opening) with depth. Observers are present in all surveys because of the use of lined gear.

The fixed gear projects utilize both longlines and gillnet. Additionally, cod traps and feathered hooks are used for tagging purposes. Fishing sites are determined by the skipper and are visited three times per week. There is overlap between the fixed gear and mobile gear surveys in July and October, this allows for some comparison of survey coverage.

All four sentinel components strive for a minimum turnover rate. In the Newfoundland fixed gear sentinel project only, sentinel sampling is also performed during the commercial fishery. This requires that the sentinel protocol is compatible with the commercial fishery in terms of gear configuration. In 2000, a total of 174 fishing activities were done in a commercial context (19% of all activities). In this approach, fishermen do not receive any boat charter, use commercial effort and keep the value of fish sales. The sentinel samplings are maintained and a stipend of $100 per activity is provided to the fishermen for their efforts.

2.1.2.4. Newfoundland Region

There are four components to the Newfoundland sentinel program; a contract with FFAW which covers most of 2J3KL and all 3Ps, and two smaller contracts for smaller parts of the 2J3KL stock with the Fogo Island Co-operative Society and the Petty Harbour Fishermen's Co-operative. Other than the areal extent, the design of activities is identical across all projects, and are of the sentinel index type.

Newfoundland Region projects are based on the deployment of fixed-gear (gillnets, longline, cod trap and baited hand lines) in inshore areas. At each location, up to half the gear is set three times per week at a fixed (control) site and the remainder at discretionary (experimental) sites. The season for sentinel activities is determined independently by fishers at each site, based on local knowledge but typically spans 10 weeks.

Participants complete a detailed fishing log and collect biological and oceanographic data. They also constitute an integral part of the Region's tagging program and perform other requested tasks. Turnover in the Newfoundland sentinel program is kept to a minimum and there is no observer coverage or dockside monitoring. DFO technicians periodically go aboard the boats to reinforce sampling and recording requirements.

2.1.3. General Discussion, Session 2, part 1

Two questions posed to stimulate discussion regarding sentinel project design issues:

- Consider and discuss what (if any) design-related changes should be adopted now or in the future, recognizing the effect that any such changes would have on established data series and on these assessments generally.
- Are there any spatial or temporal gaps, where adjustments would lead to increased value to the assessments?

Much of the discussion was dominated by a series of comments related to the role and usefulness of the Needler survey, particularly in the southern Gulf of St. Lawrence area. As this issue is not directly related to the discussion around sentinel project design, these comments are not reported here.
It was noted several times that there were a lot of differences in the way that sentinel programs and similar projects are designed and being implemented. It was acknowledged that while it was important to study these

differences, the purpose of the workshop was not to impose uniformity, since it is possible the goals of the sentinel could be met by taking a varied approach in different areas in response to local needs.

There were a number of comments made about the problem between the program designs and the inability to follow cod, given that there is perceived changes in migration patterns since the onset of the moratoria and observed changes in bottom temperatures. Industry participants felt a dilemma can arise when DFO Science has discussed site locations with industry at the onset of sentinel programs but find after a few years that some projects do not monitor fish movements adequately. It was noted that this issue is an example of what could be discussed during the review of the sentinel programs, but that if there is to be a change in sampling protocol, then it may affect the meaningfulness of the time series.

The recruitment index derived from the use of 3 1/4" gillnets in the Newfoundland Region sentinel program was of interest to participants from some other Regions. It was noted that for other stocks a number of indices of recruitment were already available. Concerns were raised about bycatches, but this was not reported to be a problem in Newfoundland given that the nets are set on the bottom and that in fact cod is the main species in those areas. Any other commercial species would be recorded and landed. Such an experiment has tried in 4T around Prince Edward Island.

There was a question about the pertinence of maintaining two mobile gear sentinel surveys additional to the Needler in the Northern Gulf. The coordinator indicated there are many factors to take into account. Does the fact that similar trends in biomass are seen in all three surveys indicate that there is over-sampling or that they are all tracking well the cod distribution and abundance? These three indices are quite consistent in following year-classes, in fact it is possible to measure changes in migration patterns, catchability, and even individual growth. The advantage of involving nine trawlers is that the sampling is more intensive than the Needler and that the stock area can be sampled within 7 to 10 days. The Needler survey spans one month and therefore it is more likely to sample the same fish twice. However, the Needler survey is multi-specific, and supports the assessment of a wide range of groundfish and pelagic species as well as other research activities.

Project designs were observed to vary in the degree that they allowed for fishermen's input. Some are considered to be very rigid, others less so. The sentinel designs with the most control (sentinel surveys) have found their way into the stock assessment process as an index much faster than those with have the most fishermen's input (commercial index) which still after many years have not been used as an abundance index. This is frustrating for fishermen involved in the commercial index, particularly in 4Vn and 4VsW.

Some discussion was raised about the pertinence of maintaining sentinel indices on gears if they are not being used as an index of abundance. Some fishermen felt it would be useful to maintain these efforts as they may become suitable in future or prove useful for other purposes at a later date. Other participants suggested that efforts to make such data useful should be a focus, or these efforts should be modified or discontinued.

2.1.4. Summary Points: Project design

1) All Atlantic sentinel projects fall into one of three basic design types, with only the sentinel index approach being used in all Regions (but not all sentinel stocks). Sentinel survey and commercial index designs are also used in selected situations.
2) Within these design types, there is considerable variability between Regions in most major design features; including stock area coverage, gear diversity, level of effort control (time and place), and in the use and role of DFO staff, industry staff, and third-party functions (observers and dockside monitors). In contrast, data collection and collation is relatively standardized.
3) Many of these Regional specificities are the result of local factors such as stock condition and distribution, priority needs for additional stock information, and industry preferences.
4) It was acknowledged that design differences per se were not necessarily a problem provided that Groundfish Sentinel Program objectives were being met.
5) The conflict between the need for time and place controls to facilitate quantitative analysis and the flexibility fishers seek as they 'size-up' a stock became apparent in the discussion, and is the source of some tension between DFO Science and the industry. This was particularly so among Gulf Region participants, where some adjustments have already been made in this program since

1994. Further discussion at the Regional level might lead to a more widely accepted balance between the need for continuity and coverage.

6) Several Regions may further discuss adding a small mesh gillnet element to the index programs to improve recruitment monitoring, but it was also recommended that adding this element where it is not presently used may be unwarranted if reliable recruitment monitoring is already available.
7) The merits of continuing to maintain datasets not currently not used by the assessment was not resolved by the discussion.

Session 2, part 2: Quality and quantity of data **Chair: Geoff Perry**

The second part of Session 2 was designed to outline issues related to the quantity and quality of data collected through sentinel efforts and to consider what improvements are available to ensure best benefit is derived.

2.2.1. Overview:

The overview outlined the different approaches taken to quality control (validations), addressing a number of issues that can affect the quantity of data. The amount of information collected about each cod stock as a result of sentinel activities was also reviewed.

Where fishers are involved in data collection, the quality of the data are often linked with initial and ongoing training, presence of field technicians (whether from DFO or hired by the sponsor) and low turnover of fishermen. The alternate approach is to rely on observer coverage as these companies have adequate training courses and extensive data handling capacities.

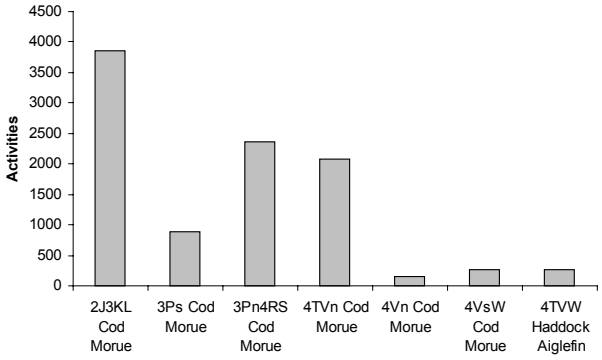


Figure 10: Number of sentinel activities for each target species in 2000.

Quality control is done at many levels; from the moment the fishermen collect the sampling data, reporting accurate positions, measuring the fish in a proper manner, calibrating fish scales and proper species identification. The second level of quality control occurs at the keypunching. This is performed by a variety of means according to the Regions. Higher levels of validation can occur at this point (ex: cross products of fish size against sample weight, reasonable fishing positions). Finally, a third level of validation can occur within DFO science, for example checking if a position is coherent with the strata depth range, comparison of sentinel data against commercial sources.

Regarding data quantity, the basic sampling requirements associated with sentinel (catch and effort, positions, length frequencies, otoliths, related measurements) were summarized. Data volume is not synonymous with quality and is a function of many other factors than the project design and efficiency, including:

- Stock status and local abundance
- Inshore migration (cod traps)
- Fishing effort
- Vessel size and type of index aimed for
- Overhead costs
- Number of activities planned for the year
- Improvements of data collection with time (turnover)
- Weather conditions
- Unsuccessful tows
- Stratified sampling protocols (lengths, otolith, stomachs, and condition...)
- New and specific sampling requests (selectivity experiment)

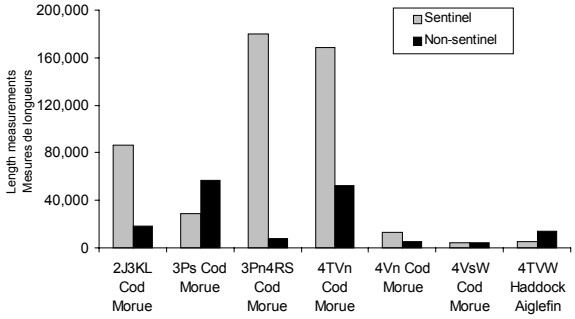


Figure 11: Number of fish measurements for the target species in 2000.

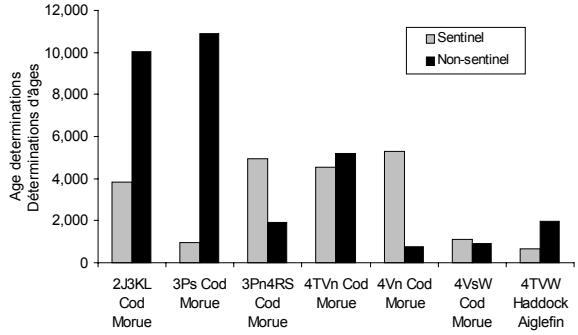


Figure 12: Number of age determinations for the target species in 2000.

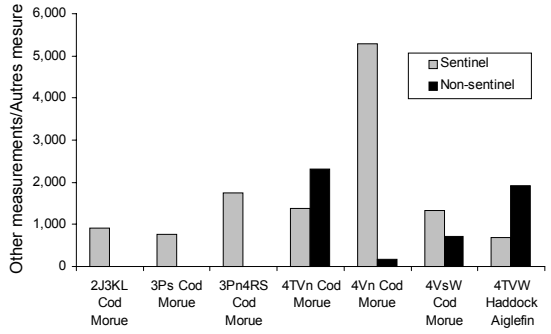


Figure 13: Number of other samples for the target species in 2000.

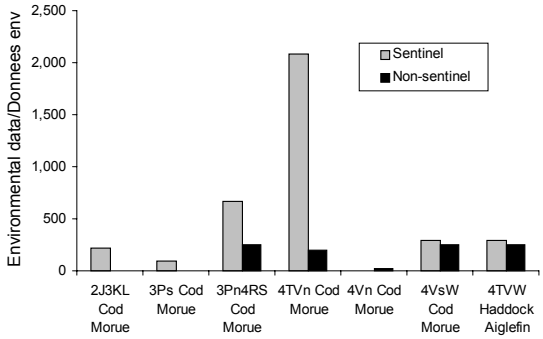


Figure 14: Number of environmental measurements (CTD and Vemco's) for the target species in 2000.

Given these caveats, a few key deliverables for each target stock were examined. When available, the sentinel sources of data were compared to other sources (commercial sampling and DFO research vessel surveys). A sentinel activity is defined by one haul, whether fixed or mobile and is associated with a separate entry of catch and effort, and other measurements and samples. These are shown in Figure10.

Other deliverables on field measurements pertain to the number of fish measured, number of age determinations, other measurements and environmental data (CTD and Vemco's) (Figures 11 to 14).

2.2.2. Regional approaches:

2.2.2.1. Maritimes Region

In respect to data quantity, cod in both stocks (4VsW and 4Vn) is well sampled by sentinel activities, with haddock being more prevalent in 4VsW than in 4Vn. The sampling of other species is limited in 4VsW and non-existent in 4Vn. As for data quality, the use of standard data forms from the observer program along with the associated data entry and edit allow for optimum data control at the source. Keypunching is done through the sponsors, which hire keypunching companies. Following this, the available databases provide standard data products. Recently, the Regional Advisory Process has resulted in greater and critical review of the data.

The existing infrastructure around the sentinel components which include staff and organisation do allow for additional science projects to be addressed (ex: Bras d'Or lakes study)

2.2.2.2. Gulf Region

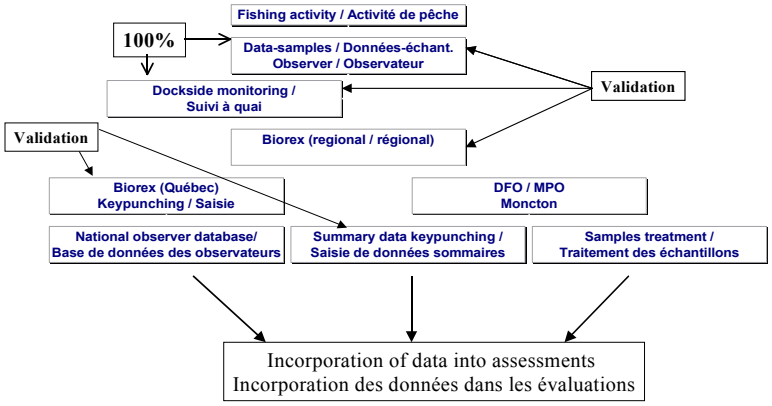


Figure 15. Data collection and handling system for the Southern Gulf cod stock.

For the Southern Gulf, the data quantity and quality is closely related to an understanding of the roles and responsibilities of all involved (fishermen's organisations, captain and crew and the observer). As was mentioned above, the month-long training of the observers along with meetings with fishermen's associations, involved fishermen and occasional presence of DFO personnel on board insures the best data quality.

The data collection and handling is well explained in Figure 15. The keypunching is included in the observer coverage costs.

Here is a summary of the quality controls:

•In-season:

– summary sheets of fishing activity from observer company reviewed daily

–consistency with protocol verified (locations, trip, amount of gear, etc)

–data edits at observer company and DFO

–matching of observer catches with Dockside Monitoring Program

•End of season edits

2.2.2.3. Laurentian Region

Monitoring data quality is performed by a number of different persons and adapted software. All fishermen have undergone training with both DFO personnel, sponsor co-ordinators and specialised colleges and universities. Given that the fishermen are normally present year after year, there is a form of continuous follow-up and training. Fishermen are backed up by a series of field technicians, sponsor co-ordinators, data entry clerks and observers (for the mobile) which continuously monitor data quality. Any work that was not up to standards has resulted in exclusion of participants.

The keypunching is part of the cost of the observer program for Quebec, but not in Newfoundland. Keypunching in the latter case is done by FFAW in Corner Brook. For the fixed gear, all the keypunching is done by hired data entry clerks using specific software developed for fixed gear sentinel.

For the mobile gear, there is monitoring of actual fishing positions against those provided by DFO Science, which follow a stratified random selection pattern. The development of the Internet site where all detailed activities for each fisherman are posted has helped address the occasional criticism about the quality of sentinel fishermen's work.

2.2.2.4. Newfoundland Region

The general approach in Newfoundland Region is similar to the Laurentian Region (above) given that a single contract is awarded to the same organization (FFAW) for three stock areas (2J3KL - 3Ps - 3Pn4R). The program has a low turnover of fishermen between years, which means a long-term commitment, and there is an extensive initial training course that addresses:

- Survey and sampling
- Computer skills
- Fisheries resource management
- Ocean environment
- Presentation skills

DFO technicians are also involved in conducting tagging and doing audits of the quality of sampling techniques and data recording.

The Fisheries Interactions Section handles the management of the sentinel data, which are validated and exported to the groundfish database to be used by the appropriate assessment research scientists. This section is responsible for checking each log and frequency against hard-copy edits. As opposed to the 3Pn4R contract with FFAW, the field technicians and science co-ordinator are DFO employees and DFO personnel do the keypunching.

For the fixed gear sentinel programs for the Newfoundland Region there is an extensive use of CTD along with training and available computers. This is the only Region that has computers available to sentinel fishermen. These data are transferred to the Oceanography Section after validation.

2.2.3. Presentation: How often should we collect length frequencies of cod in sentinel surveys of the southern Gulf ?
G.A. Chouinard

Introduction

In the southern Gulf of St. Lawrence, observers are present on all fishing trips of the sentinel survey program. The role of the observers is to collect the fishing activity information, biological data on the various species and preserve tissue samples (e.g. otolith, entire fish, etc). Vessel crews often provide assistance in collecting the information.

During each fishing trip, length frequencies for cod are collected from every fishing activity. A fishing activity is a fishing set in the case of mobile gear and one day from one fishing site for fixed gears. Otoliths are collected at a pre-determined sampling rate (for example: 1 per 1cm grouping on one set during a fishing trip). The otoliths are returned to the laboratory where they are embedded in fiberglass resin and sectioned using a special saw. Technicians then examine these sections and determine the age of the fish by counting the annual bands present on the otoliths. The age of these fish combined with their length make up an age-length key. The key is applied to the length frequencies to estimate the age of all fish caught during the sentinel surveys. The numbers that are calculated are called the catch-at-age. These estimates are used in two ways in the assessment: 1) the sentinel catch-at–age is part of the removals-at-age from the entire fishery and 2) the sentinel catch-at-age divided by the standardized effort forms an abundance index. In the sentinel surveys, indices are calculated separately for each gear.

Currently the sampling rate of otoliths is designed so that a minimum of 400-600 otoliths will be collected for each key. Previous analyses found that this was the optimal number to provide adequate precision (J. Allard, Université de Moncton, pers. comm.). While the number of otoliths required to provide precise estimates has been studied, this has not been done for length frequencies.

The purpose of the work was to examine whether a reduction in sampling intensity of length frequency would lead to a difference in catch-at-age estimates from the sentinel survey. Reduction in the collection of cod length frequencies could allow for other type of sampling to address specific research questions. This would increase the value of the sentinel survey program as a research tool.

In order to examine this issue, two notions are of interest: precision and accuracy. These two terms are often thought as synonyms in daily conversation but they have different meanings in statistical terms. Precision is defined as the closeness of repeated measurements of the same quantity while accuracy is the closeness of a measure to its true value. For example, from a sample of 200 adults from a city, one could find that the estimated average height of citizens is 1.8 m. This estimate of average height could be more precise if people measured in the sample ranged from 1.5 to 2.0 m. than from a sample that ranged from 1 and 2.3 m. The first estimate may be precise but if you were to measure the height of all citizens and found that the average height was 2.0 m., then you could conclude that the estimate was not accurate because it is far from the true value. Usually, unless there is some consistent bias in the measurements, a precise estimate will lead to an accurate one.

Methods

Data collected during the 2000 sentinel survey program were examined. Two gear types were studied: longlines and seines with liner. These two gear types were examined because they have different age compositions; the longlines tend to catch larger (and older) fish than seines with liners, and because they represent the two different sampling schemes in use in the sentinel survey program of the southern Gulf. The seines with liner and longlines datasets contained 137 and 498 length frequencies respectively.

The analysis was conducted by randomly selecting length frequencies from the database. Selections were made within trip without replacement and using various sampling rates. The number of sets to be selected was calculated by applying the sampling rate to the number of sets where fish were present for each individual vessel. Six sampling rates were examined: they were 10, 20,30,40, 50 and 75 % of the length frequencies. This process was repeated 10 times. Ideally, the selection should have been done several hundred times for each sampling rate to get the full range of potential values. To approximate the work that an observer would be doing in normal operations, an additional condition was that at least one length frequency would be collected from each fishing trip. The catch–at-age from these selections were then compared with the baseline where all fishing activities (100%) were considered. Comparisons for ages 2, 4, 6, 8 were done for the seines whiles ages 3, 5 ,7 and 9 were used for the longlines.

Because we wanted to know how different the values would be from the ones using all available length frequencies, the accuracy of the values was examined. 'Pseudo-accuracy' values were calculated using the formal definition of accuracy (see Stamatopoulos, 1999) as follows:

$$A = 1 - \frac{|m - \mu|}{R}$$

Where A = Accuracy
m = sample mean
μ = population mean
R = range (ymax- ymin)

In this analysis, m was the catch –at-age for a given age from the sub-sampling and the population mean (μ) was the catch-at-age when 100% of the samples are used. The range is a fixed value. In this case, since the range was unknown, it was fixed at a value equal to μ.

Results and Discussion

For the seines with liner (Fig. 1), there was a significant decline in accuracy at age 2 at sampling rates of 50% and less. However, for the other age groups, particularly for ages 6 and 8, there was little loss in accuracy even for sampling rates of 10%.

For longlines (Fig. 2), accuracy was about 90% and higher when 30% or more of the length frequencies were selected. The decline in accuracy for the youngest age (age 3) was less pronounced than that observed for the seines with liner (age 2).

Since the seine with liner is used as an index for young fish, it would be prudent not to reduce much the sampling rate for that gear. When 75 % of the length frequencies were selected, the accuracy at age 2 dropped to 80%. The estimates for these younger age-groups are already quite variable and reduction in sampling could have an important effect on catch projections. However, for longlines the situation was different. It appears that sampling for length frequencies could be reduced markedly to about 30% without any significant loss in accuracy.

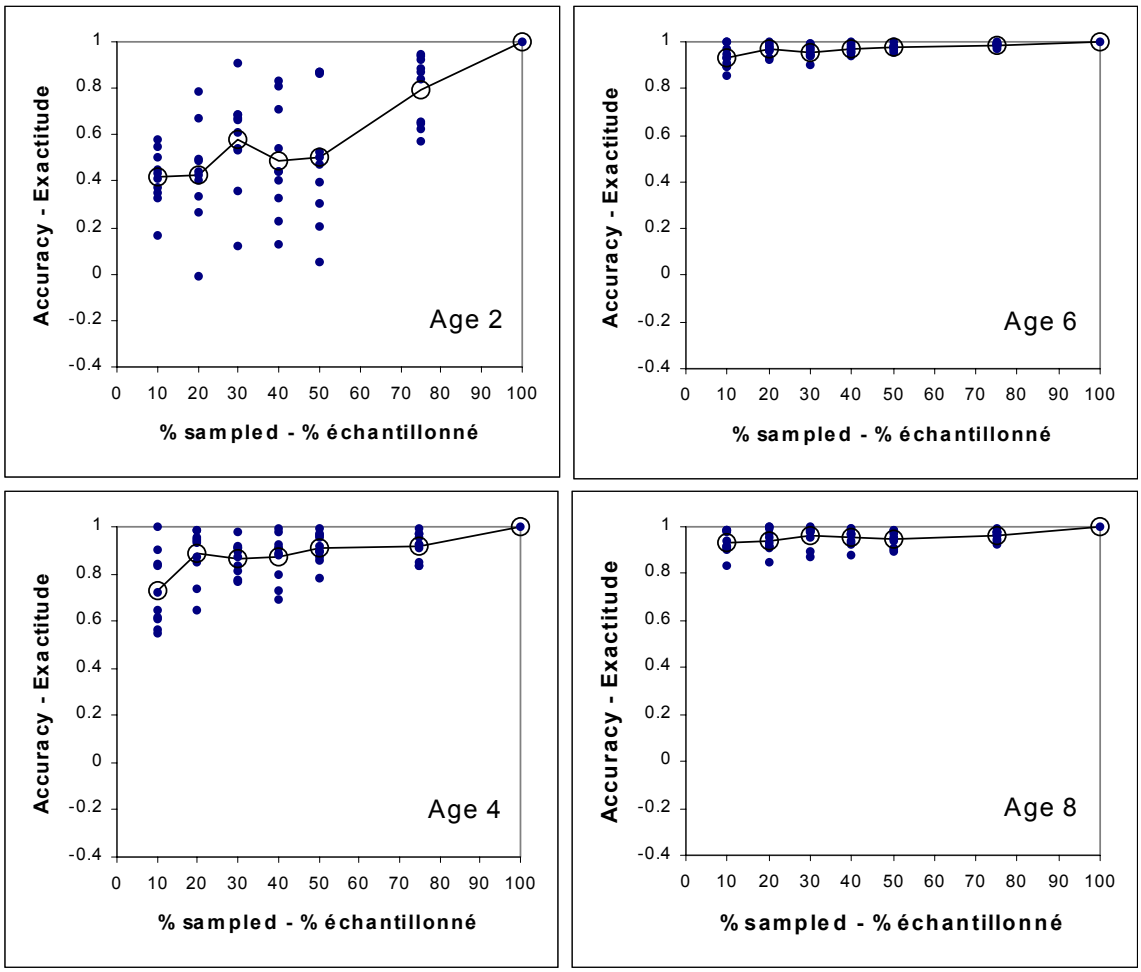


Figure 16: Accuracy of seine (with liner) catch-at-age estimates for ages 2, 4, 6 and 8 for various sampling rates.

The difference in the conclusions can be linked to the difference in the sampling designs. The longlines use a fixed station design while the stations for the seines are randomly selected. Because fish caught together can be more similar than fish in the entire population (Pennington 2001), the variance within a station can be lower than among stations. In the longline (fixed station design), the same stations are sampled repeatedly and hence require fewer samples to estimate catch-at-age.

Some sampling considerations that could be applicable to other sentinel surveys are:

- tow duration can often be reduced considerably for mobile gears (Pennington et al. 2000)
- Age-length keys for cod in the southern Gulf composed of 400-600 otoliths are usually sufficient (J. Allard, Université de Moncton, Moncton, N.B.; unpublished)

References:

Pennington, M. 2001. An evaluation of the IMR summer bottom trawl survey in the Barents Sea. ICES C.M.2001:P16

Pennington, M, L-M. Burmeister and V Hjellvik 2000. Assessing trawl survey estimates of frequency distribution. ICES C.M. 2000:K23

Stamatopoulos, C. 1999. Observations on the geometrical properties of accuracy growth in sampling with finite populations. FAO fisheries technical paper;388; vii, 39 p.

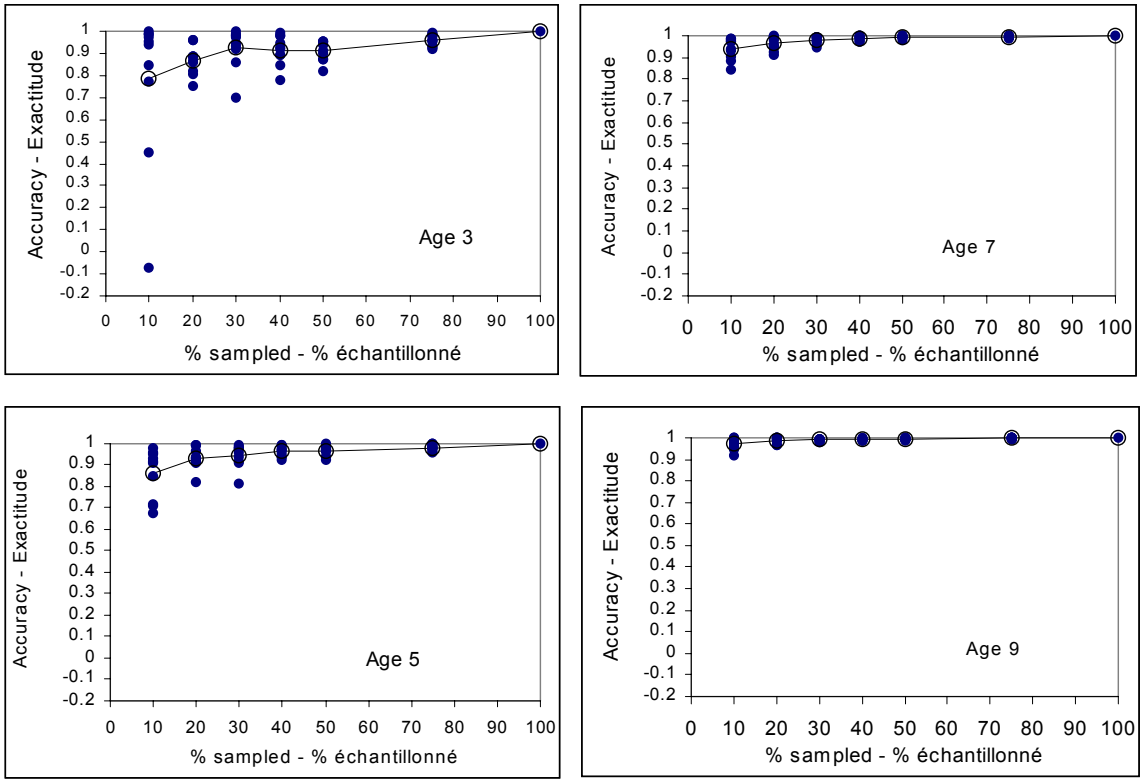


Figure 17: Accuracy of longline catch-at-age estimates for ages 3, 5, 7 and 9 for various sampling rates.

Questions and clarifications on presentation:

Q: Why is there more to be gained by a reduction in sampling intensity for the mobile (seines) than for longline?
A: Mobile gear survey more areas than the fixed gear which essentially stays on the same fishing grounds.

Q: During the presentation, it was mentioned that a 25 to 50% reduction of sampling could be achieved, but in fact, according to the graph, this could reach 75%.
A: The estimates were voluntarily conservative (25 to 50%) because only 10 replicates were included in the analysis.

Q: What is the effect of sample sizes on precision, in addition to accuracy.

A: Precision estimates (as CVs) are obtained from the same analysis, and the results showed that precision improved with sample size up to a point but then stabilized. For example, CVs for age 3 in longline catches dropped from 26% to about 20%, but then didn't go lower.

Q: Could this be due to another variable such as the age length key.
A: This could be looked at, but by drawing 600 otoliths based on length from a large pool, we are already optimizing the age length key.

2.2.4. General Discussion, Session 2, part 2

The following questions were posed to stimulate the discussion:

- Consider the pros and cons of different approaches to data collection and verification, and discuss what (if any) changes should be adopted.

- Identify opportunities where additional information may be collected from sentinel efforts in a cost-effective manner.

An issue was raised about the usefulness of having both observer coverage and dockside monitoring for the Gulf sentinel programs. It was explained that the observers' role is to verify operations at sea and estimate catches, while the dockside monitors validate the actual weight estimate at shore as well to precisely weigh the by-catches. It was commented that while the observer approach may be very efficient from a data gathering standpoint and in the amount of DFO involvement required, it may be less conducive to wider communications between DFO Science and the industry.

A general question on the issue of over-sampling, and whether the recaptured time could be used to do other things, was directed to each Regional DFO sentinel co-ordinator for response. For the Gulf, a reduction in the number of length frequencies would allow more time to the observers to do other things. The situation is different for Newfoundland, as the project is basically aiming for cod and the port sampling program already has adequate sampling of ages and lengths of other species. In the Laurentian Region, there is not adequate port sampling along the West Coast of Newfoundland to replace sampling in sentinel activities. Within sentinel, the problem depends on the gear type: there is room for a reduction measurements of fish for gillnets because there is hardly any variation in size selectivity from year to year for a given mesh size. For the longline, there is much more inter-annual variability, sometimes targeting good incoming year classes. The over-sampling is not an issue for a stratified random survey, catches are generally low because of the nature of the sampling scheme that does not target fish concentrations. Finally for the Maritimes Region, the DFO coordinator stated that emphasis should be given to maximise to amount of data collected from wide range of species already in hand, since those fish are already dead, rather than seeking more fish to sample.

It was noted that while the efficiencies resulting from optimizing sample sizes for measurements of fish at hand may be modest, taking similar approaches to the number of sites could result in significant gains.

2.2.5. Summary Points: Quality and quantity of data

1) Roles and responsibilities in sentinel data collection and handling vary markedly between Regions. Industry involvement ranges from being primarily responsible to marginally involved.
2) These differences relate to industry concerns about veracity and compliance, and to the nature of contracting practices (long-term sole-source arrangements vs. annual bid process).
3) In all cases, standard types of data verification and control checks are in place.
4) Sampling levels seem high in many projects, extremely so in several cases.
5) It was demonstrated that sampling levels can be assessed quantitatively, and agreed that these techniques can and should be used to re-focus sampling in a considered fashion to optimize the benefit of sentinel activities.
6) Although no such results were presented, the potential for benefits of similarly optimizing numbers of sampling sites and the deployment of sentinel effort were recognized.

Session 2, part 3: Data Treatment and Role in the Assessment — Chair: Denis Rivard

The third part of Session 2 was devoted to presentations and discussion of issues related to the treatment of data and the incorporation of sentinel data into the assessment. The segment was chaired by Denis Rivard.

Note: A presentation was made at this point by G. Chouinard on aspects of data quantity and precision. The summary of this talk as well as comments and questions are incorporated into the preceding section of Session 2 on Data Quality And Quantity.

Two additional presentations, by Dr. R. Mohn and A. Frechet, that were originally scheduled for a later session were moved forward and presented in this session.

2.3.1. Overview:
This part of Session 2 commenced with a summary of information related to the topic from around the Regions.

With regard to standardization and treatment of data, a number of factors were identified that must be considered either on a regular or 'as necessary' basis. These include consistency in the manner that data are treated from one year to the next, and the aggregation of data temporally and spatially for analytical purposes. From time to time, extreme observations occur (ie: a single large set) and these must be considered and handled in the proper statistical manner.

Several issues of this type are particular to fixed gear. These include normalizing the effect of soak time on results, and the proper manner to combine data from different places and times for further analysis. Mobile gears may also need to be standardized, as is done with spread restrictors for multi-vessel surveys in the northern Gulf.

In addition to the seven stocks that are the target of sentinel activities (Table 1), there are eight other stocks where the sentinel information also plays a significant role in the assessment. The degree to which sentinel information augments data and information from non-sentinel sources was shown for each stock over five key assessment input types, general indices of abundance, calibration index, biomass index, recruitment index, and estimates from tagging.

Region	Primary Stocks	Secondary Stocks
E. Nfld	2J3KL Cod	
S. Nfld	3Ps Cod	
N. Gulf	3Pn4RS Cod	4RST Greenland halibut 4RST Capelin Unit 1 redfish
S. Gulf	4TVn Cod	4T American plaice 4T White hake
Scotian Shelf	4Vn Cod 4VsW Cod 4TVW Haddock	4VWX+5 White hake 4VsW Skate 4TVW Witch flounder

Table 1. Primary (target) stocks and secondary (sentinel data influential in assessment) stocks by Region, 2000.

2.3.2. Regional Approaches:

2.3.2.1. Maritimes Region
Paul Fanning explained that Maritimes Region uses the sentinel data in a similar fashion (Table 2) in the three primary stocks (4Vn cod, 4VsW cod, 4TVW haddock), and that many of his remarks apply to all cases.

Because the sentinel surveys are conducted over a relatively short time and cover the entire stock area they provide an annual snapshot of stock relative abundance. Results from both 4Vn and 4VsW surveys are analyzed with the standard stratified calculations used for the DFO research vessel surveys. The results are given as stratified mean numbers per set for the entire stock area (Figure 18). At the moment, the

	4VsW SS	4VsW CI	4Vn SS	4Vn CI
4Vn cod			SPA tuning, distribution	distribution
4VsW cod	SPA tuning*, distribution	distribution, abundance		
4VW haddock	SPA tuning, distribution			
4VWX5 white hake	distribution, abundance		distribution, abundance	

* when assessment is next done

SPA tuning requires an age-by-age index of abundance

Table 2. Assessment Uses of Sentinel Program Results in Maritimes Region

sentinel survey provides the primary data products from sentinel sources that are used in the assessment.

The commercial index (CI) fishery information is also considered in all three assessments but to lesser and varying degrees. In 4VsW, catch rates have been so low that there is actually very little catch rate data to use from the commercial index fishery. In 4Vn, there is more data collected by the index fishery, but the series is still short. As of this year, there are four years of results, and this is now enough to begin to indicate any changes in the stock that may be occurring.

The differences in area covered and the concentration in areas of high abundance by the CI can produce conflicting results with the sentinel survey (SS) indices (Figure 19). In 4Vn, the SS index, which includes the whole area, has shown a steady decline in cod abundance since 1994 with the lowest value in 2000. At the same time the CI index has generally risen since its inception in 1996 and is at the highest point in 2000. Analyses which account for the spatial, temporal and gear changes in the CI are required before appropriate comparisons of CI and SS indices can be made.

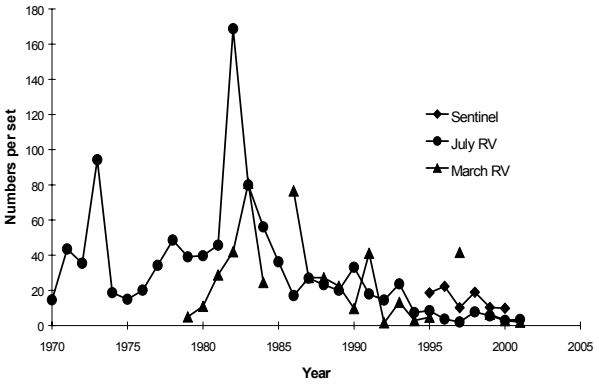


Figure 18. Survey indices in 4VsW cod (ages 3+).

Abundance indices from each of the surveys are used as a tuning index in the model for the three primary stocks. As of yet, these indices have not yet had a significant impact on the conclusions of these assessments due primarily to the shortness of the series, and that they should be expected to have more influence over time. In addition, the conflicting signals from the different indices results in them balancing one another out in the model. Nevertheless, the condition of these two cod stocks in particular is so low that the conclusion of the assessment is essentially a foregone conclusion for the time being.

Abundance of white hake and Atlantic halibut as indicated by the sentinel survey results is also considered in those assessments respectively, though not to tune the model.

For the reasons above, it is not yet known how accurately these sentinel catch rates are reflecting stock abundance. With increased time and as stocks rebuild, it should be possible to see how these indices respond to change in relation to other signals of stock condition. However, there is a clear impact of sentinel on the precision of the estimates, due to having sample sizes more than double those previous.

In terms of new aspects on the assessment, the sentinel has not yet provided the opportunity for any fundamental new approaches in Maritimes Region. It might be possible that the commercial index catch rates provide an opportunity to have commercial-like activity more fully incorporated into the assessment. The use of traditional commercial fishery catch rates series had been suspended for some time prior to closure due to biases related to management and gear changes.

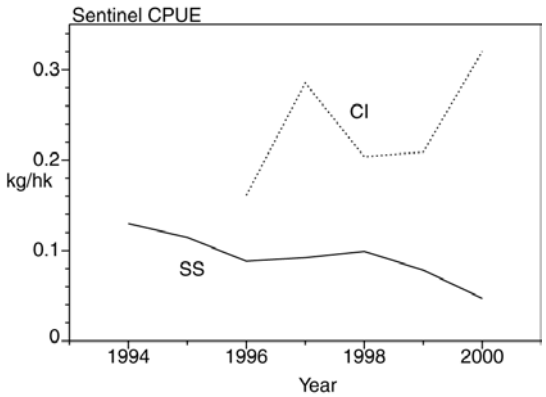


Figure 19. Conflicting trends in the 4Vn sentinel indices.

It is also possible that sentinel information and data will be useful in developing new approaches to modeling these populations that are spatially-oriented and/or based on a multi-species perspective. While these initiatives have been discussed and may have proceeded in any event, sentinel data are now available to be incorporated.

2.3.2.2. Gulf Region

Ghislain Chouinard reviewed in detail the manner in which sentinel data collected from the Gulf Region program is integrated into the assessment.

Detailed sentinel catch records are tabulated by month and gear type, and added to other catches from the fishery on various stocks to estimate total removals for each stock. Age:length keys are constructed for each gear sector (fixed & mobile). Otoliths are knowingly oversampled to provide an abundance of ages, especially from older fish, then a length-stratified subsample of 600 is drawn to build the key. Catch at age (with coefficients of variance), and mean weight and length-at-age are calculated using the AGELEN software.

Catch rates from sentinel fishing are standardized using a general linear model (GLM) to account for differences between areas, time of year, and other factors. This is done separately for six gear configurations (ie: trawls and seines, each lined vs unlined; plus longlines and gillnets). For the two fixed gear configurations, catch and effort are aggregated by month and site. Cells with either a zero catch or less than one day of effort are removed, which is not considered a problem, as there are relatively few such cases. Where new sites have been added to the program since the onset (through re-distribution of existing effort), data from these new sites are only incorporated when four years of data become available.

For the four mobile gear configurations available, catch and effort are aggregated by month/province category. Month alone and vessel/gear combinations showed no significant difference, however, migration of fish seems to create a significant month:province interaction.

Mr. Chouinard reviewed summary graphs of the six aggregated catch rate indices produced by this method, which he noted was very similar to the approach used in the 3Ps cod assessment. What remains unaccounted are differences in size selectivity between gears and between configurations (lined vs unlined) which would affect catch rates. Data in the standardized catch rate series are age-disaggregated and divided against effort from the GLM to permit a more valid comparison of gear/configuration catch rates across ages, and Mr. Chouinard again showed several examples which indicated general correspondence in trends (toward recent decline) among all indices.

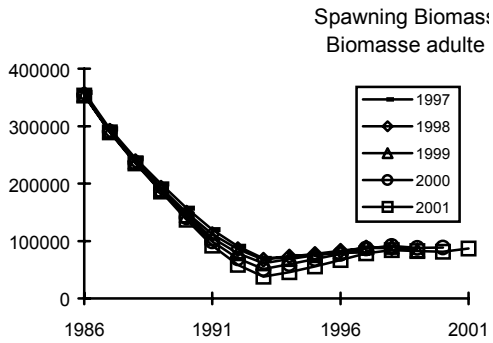


Figure 20. Progressive 4TVn cod model runs from the 1997 to the 2001 assessment.

These sentinel survey indices are used in the assessment two ways. On their own, they are used to obtain estimates of relative yearclass strength, total (and hence natural) mortality estimates, and to study trends in the stock-recruitment relationship. In addition, five of the six (except gillnets) are used within the SPA model as tuning indices. Mr. Chouinard indicated that they continued to work on the gillnet index to resolve problems in incorporating it, and suggested that the use of small mesh panels to widen the selectivity profile of gillnets as is done in Newfoundland Region may be useful.

Mr. Chouinard concluded by illustrating (in Figure 20) the influence of sentinel data by superimposing progressive 4TVn cod model runs from the 1997 assessment to the current year (2001). He observed that there was a slight tendency for recent model runs to depress the size of populations earlier in the 1990's, but that the recent trends in the stock were not significantly up or down. In his opinion, the ability of sentinel activities to respond appropriately to significant stock events, by tracking yearclasses, is not yet clear.

2.3.2.3. Laurentian Region

For fixed gear data, Alain Frechet explained that standardized effort was derived from a mathematical model which deals with variances in timing and sites. Conflicting effects such as gear saturation, effect of soak time, proper use of the restrictor cable (for the mobile gears), and potential local depletion of localised concentrations of cod while the directed fishery occurs are routinely examined. In Laurentian Region, they have looked in detail at soak time and saturation issues for fixed gears. For longlines, he has observed that there is a definite saturation point (1 fish per hook), and that the saturation point drops with time as fish drop off and leave an unbaited hook. It is important to consider all species of fish when doing saturation estimates on hooks and not only the cod. In some instances, a high proportion of hooks may be taken by other species. For gillnets, there is a saturation point as well but it is less well defined since the geometry and hence efficiency of the net degrades as catches increase. A research document is available on that study.

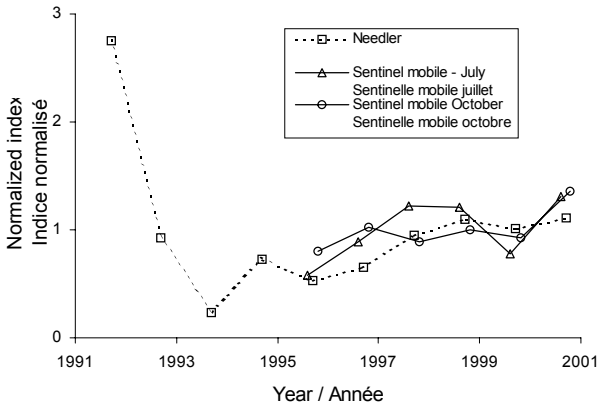


Figure 21: Normalised indices of abundance from mobile gear surveys

The basic data from the fixed gear side of the Laurentian Region sentinel program is a catch rate-at-age for each gear for each year. For mobile gear, (Figure 21) Frechet uses STRAP software to generate population numbers from survey results. The model considers the presence/absence of restrictor cables.

Time is spent to construct an adequate age:length key for each year, or for mobile gears, each survey.

2.3.2.4. Newfoundland Region

Ms Maddock Parsons outlined the use of sentinel data in the assessment of the two Newfoundland Region cod stocks, 2J3KL and 3Ps. She pointed out that in addition to collecting data, sentinel fishers in Newfoundland were active participants in the assessment process.

Sentinel activities in Newfoundland provide data on the biological characteristics such as ages and weights that are used to construct age: length keys and monitor condition and growth. The raw catches from sentinel activities and the length frequencies observed on the catch are used in a standardized format to monitor changes in the stock and the fishery from year to year (Figure 22). She demonstrated a number of examples of such information from both stocks.

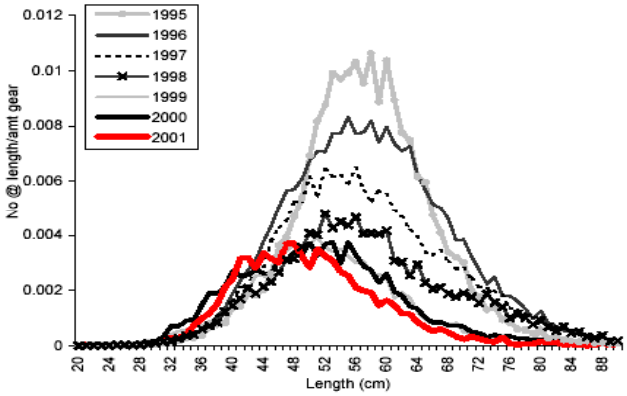


Figure 22. Relative length frequency (number at length/amount of gear) for control and experimental gears. 3Ps linetrawl.

Since 1999, sentinel data has provided, or contributed to, a number of catch rates series for these two stocks. Data are first standardized to deal with the effect of seasonality and other influences, using a protocol established by a working group at the Rimouski Assessment meetings in 1999 and since modified with input from the industry in 3Ps. The criteria for including sets into the model were reviewed. Indices produced using sentinel data include age-aggregated indices and age dis-aggregated indices for both stocks. In age-disaggregated form, these various indices have been found effective at tracking yearclasses as they move through the selectivity range for each gear. Sentinel data from several sources (3 ¼" and 5 ½" gillnets, and longlines) also contributes to a multi-source index of recruitment (ages 0-3) for each cod stock (Figure 23).

Sentinel fishermen have been involved in tagging cod from 1996, and in 2000, tag returns were available to estimate abundance in both 2J3KL and 3Ps, as well as to provide information on fish movements. An animation of catch rates over all years of sentinel activities was shown outside the session as an example of how the sentinel data can be used to infer fish movements on a wide scale.

In closing, Ms. Maddock Parsons re-iterated that in addition to providing traditional knowledge of fish, the environment and the fishing process, sentinel participants collect valuable scientific data and have become an important part of determining status of the stock. This has led to improved client participation, transparency, and credibility of the whole stock assessment process. The website for the Newfoundland sentinel program is:
http://sealane.nwafc.nf.ca/sealane/Divisions/Aquatic_Resources/Sections/Fisheries_Interactions/index.html

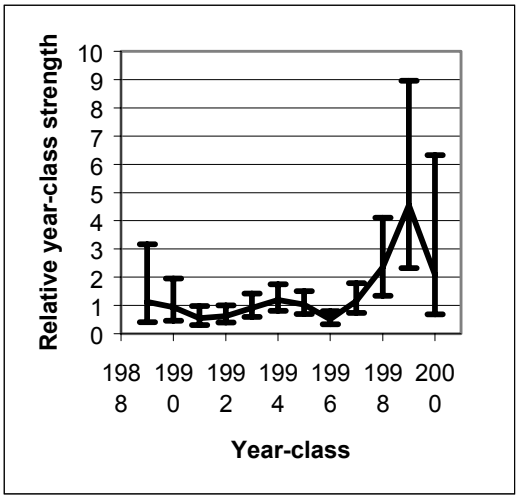


Figure 23. Multi-source (including sentinel catches) index of recruitment, 2J3KL cod

2.3.3. Presentation: Multiple indices vs. risk or impact of sentinel surveys on risk assessment. R. Mohn

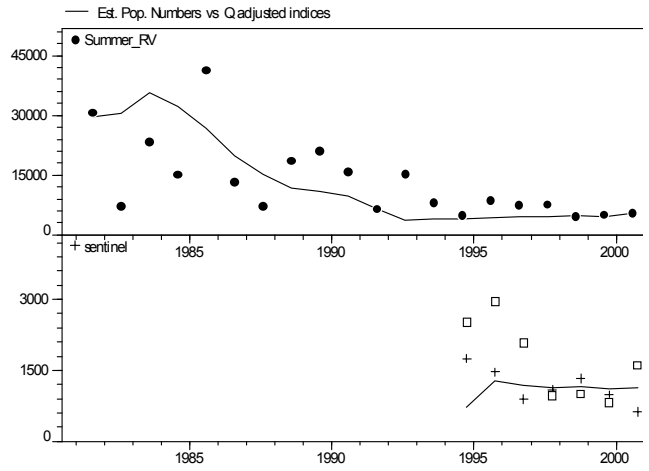


Figure 24. Model fit and data, 4Vn cod

Risk analysis in the context of the generation of fisheries advice is displayed as the probability that a certain action, usually a rate of removal, will result in an unfavorable result. In this context, the better the estimates, the tighter the probabilities and the results of any action are more accurately predicted. This increased certainty improves risk assessment. In general, more indices of abundance result in better estimates of stock status and improve risk analysis. Sentinel surveys are distinct from the research vessel surveys in that they are currently of shorter time duration. In the first example analysis, the assessment of 4Vn cod (Figure 24), the sentinel covers 7 years, while the research vessel survey covers 31. In the second example, 4VW haddock (Figure 25), the sentinel had 6 years of observations. The other difference in these examples is that the Sentinel Surveys were longline instead of otter trawl and did not select as small a fish.

In the case of 4Vn cod, the sentinel survey showed roughly the same falling trend as seen recently in the RV survey. Adding it to the RV data resulted in a slightly lower biomass estimate in the terminal year, 2000. Although there was a slight disagreement in the signal seen in the surveys, the uncertainty in the estimation of stock size was reduced. In the 4VW haddock example, the sentinel survey indices were more strongly at variance with the RV survey and lowered the estimate of stock size in the final year. Again, the inclusion of a contradictory signal improved the precision of the estimates, and hence reduced risk.

In summary, this study suggests that even short series can improve the accuracy of assessments and improve risk assessment. Even when the indices did not agree some improvement was found. A second benefit of the inclusion of sentinel data was that more diagnostics become available which aid in understanding how the multiple sources of information sample the resource.

Questions and clarifications on presentation:

For clarification, a participant asked what influence sentinel data would have if it was not as contradictory. Bob Mohn explained that it would reduce variance around the estimates even more, and result in less controversy about the assessment outcome.

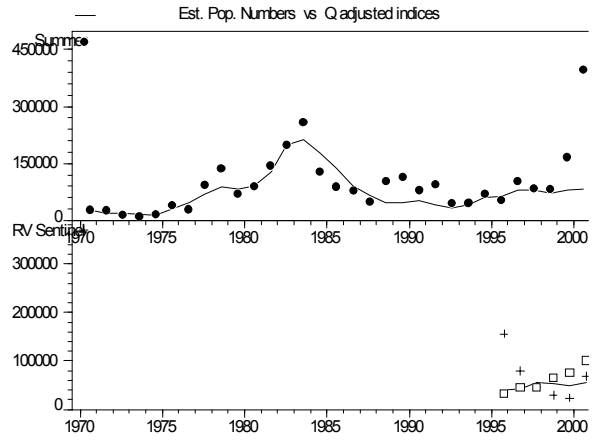


Figure 25. Model fit and data, 4VW haddock

A sentinel industry participant objected to the apparent concern among scientists about the distribution of commercial index fishing effort relative to sentinel and RV survey efforts. He indicated that the CI effort was focussed between 100fms and 200fms because this is where the resource traditionally was most abundant and where the commercial fishery concentrated its efforts previously. He re-iterated the calls of others to find a way to incorporate CI data into the assessment.

An industry sentinel participant from 4Vn had earlier noted that in his area and elsewhere the commercial index fishery information was not being used heavily in the assessment. He voiced concern that while the commercial vessels were getting good fishing in some grounds, both stratified surveys (the sentinel longline survey and the research vessel (Needler) survey) had low catches at those same sites. He asked that a way be found to incorporate commercial index fishing into the assessment rather than have it serve simply as a source of revenue for the program.

Bob Mohn explained that commercial index fishing results were not incorporated into the assessment because science had no method available to do so. He suggested that this area needed more work.

2.3.4. Presentation: Identifying influential indices
A Frechet

One important deliverable of the Groundfish Sentinel Program is to derive abundance indices that can be used in the sequential population analysis in order to estimate stock size. The venue of sentinel programs has produced many new time series of abundance indices that are currently being used in many assessments. An analysis was presented with the objective of putting into perspective the role of all indices used in the estimation of stock size. Two aspects were examined, the role of each index of abundance in the last assessment and the role the indices would have played in the past, given the short duration of the sentinel indices (at the most 6 years in the most recent assessments).

In order to understand better the mechanics of the assessment, some basic notions on the sequential population were presented. The model currently used in most assessments (ADAPT) is a quite flexible and powerful tool that considers many indices all at once. These indices have relevant information on an age by age basis for a number of years. ADAPT will treat all indices, along with information on the catch numbers at age and estimates of natural mortality to calculate the “best” estimate of stock size considering all indices submitted. The role of the various time series of abundance indices considered to estimate stock size are a function of their quality to track particular year classes and estimates of recruitment with the least amount of noise. ADAPT calculates residuals for each age and year considered for each index of abundance. The residual is essentially a goodness of fit indicator, which is the difference between the input index of abundance and the estimated stock size. The lowest average value of these residuals for each index of abundance indicates the best fit.

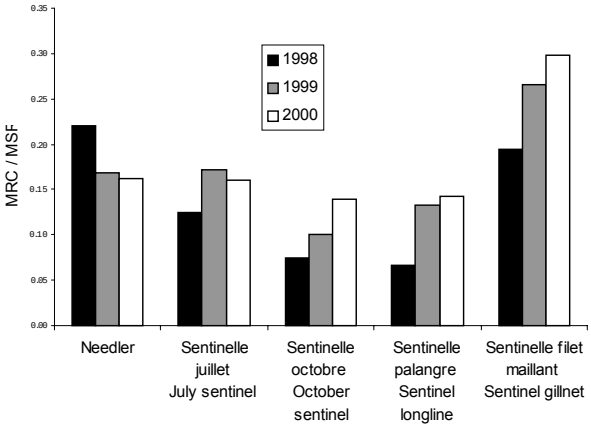


Figure 26: Mean square residuals from the five indices of abundance used in the Northern Gulf cod asssessment (3Pn, 4RS).

The calculations were done on the two cod stocks found in the Gulf of St.Lawrence, 3Pn, 4RS and 4T,Vn [Nov. – April], based on the results of the assessment of the fishing season of 2000. In order to avoid comparing indices covering different time periods, the analysis was limited to the period from 1995 to 2000. This period also corresponds to the most recent period where the indices can influence the perception of stock size (also known as the unconverged part of the analysis). The retrospective analysis was also limited to three years (1995 to 1997) because of the short time series.

Currently, five indices of abundance are used for the estimation of the size of the Northern Gulf of St. Lawrence cod stock (3Pn, 4RS). From the analysis based on the 2001 assessment, the ranking of the most influential indices would be as follows (Figure 26):

1- October mobile gear sentinel survey
2- Longline sentinel index
3- July mobile gear sentinel survey
4- Needler survey
5- Gillnet sentinel index

The influences on the model results from sentinel indices seem to worsen as the time series get longer. The Needler's influence in the assessment however is improving with time. The reasons for these trends are not well understood for moment.

Another approach was presented in order to put into perspective the influence of the indices. A series of ADAPT runs were conducted using one single index at a time (Figure 27). It was found that the most optimistic index available would be the sentinel longline and the least would be the sentinel gillnets. All mobile gear surveys would lie midway. As expected, the final advice on stock size, which includes all five indices, is found in the middle of the various scenarios.

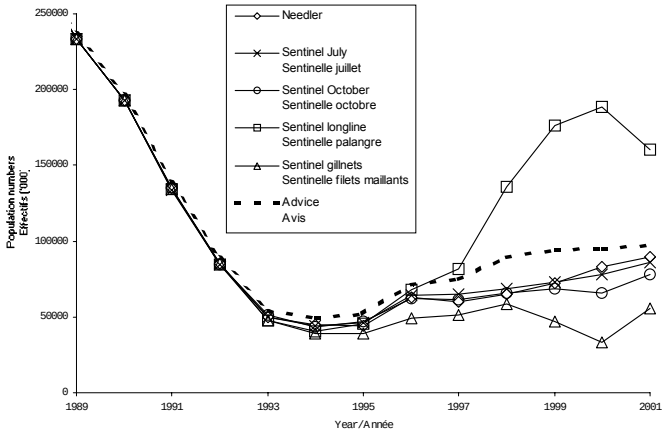


Figure 27: Potential stock trend in population numbers for the Northern Gulf cod stock (3Pn, 4RS), one index at a time.

For the southern Gulf cod stock (4T,Vn [Nov. – April]), the latest assessment used seven indices, one of which was not used in the current analysis as it terminated with the onset of the moratorium in 1994. It is not part of the window of the last 6 years used for this analysis as described above. From the analysis based on the 2001 assessment, the ranking of the most influential indices would be as follows (Figure 28):

1- Sentinel seine index
2- Sentinel seines index with liner
3- Needler survey
4- Sentinel trawl index
5- Sentinel longline index
6- Sentinel trawl index with liner

This analysis is quite useful to place into perspective the role of all indices used in an assessment and could be used ultimately to prioritise funding of any index, whether sentinel or not.

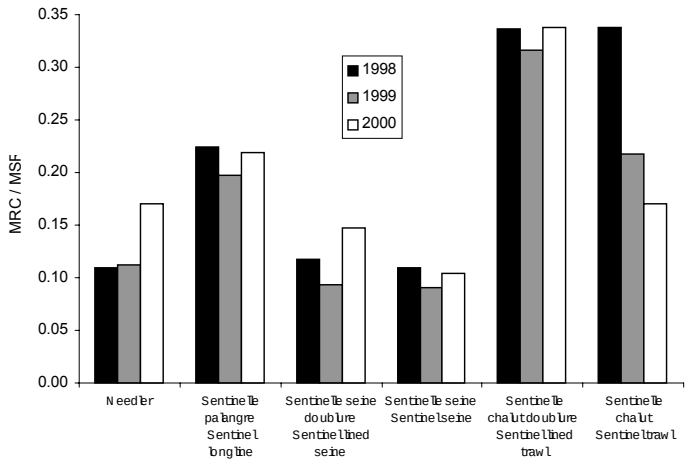


Figure 28: Mean square residuals from the five indices of abundance used in the Southern Gulf cod asssessment (4T,Vn [Nov. – April]).

Questions and clarifications on presentation:
Some DFO scientists asked questions of clarification on the mechanics of the analysis. One concerned the dilemma between the annual trend in any particular index at face value and the effects of the convergence within ADAPT. This would essentially downplay with the trend in the index with time. This explains the fanning out of the various scenarios in Figure 27. An examination of the residual patterns could clarify this. Having multiple indices may result in contradictory trends or indices with little information may prove to be useful in the estimation of stock size.

Finally, some participants encouraged an expanded use of the various methods presented at the workshop to be brought forward and used on a regular basis within the stock assessments. Those who have developed such techniques should detail their approach and distribute the material to DFO scientists in charge of stock assessments.

2.3.5 General Discussion, Session 2, part 3

In order to orient the discussion around the issue of data treatment and incorporation into assessment, a set of four questions were formulated and tables were asked to discuss these questions and provide their views.

1) What are the effects and influences of sentinel data and information on the accuracy of the assessments ?

Most responses to this question were of a positive nature. Sentinel participants were clear in their view that the contribution of the sentinel data to the assessment increased their confidence in the results, improved dialogue between DFO and the groundfish industry, and bettered their understanding of and regard for the scientific process. In the opinion of many, sentinel data improved accuracy of the assessment, and generally broadened and diversified the available knowledge of the stock.

Several comments noted that while the sentinel is obviously adding information to the assessment, it was difficult to see to the extent of influence because there was no analysis provided in the stock status documentation to identify the relative influence of the various inputs considered. As well, as sentinel time series are still relatively short and most of the primary sentinel stocks have been relatively flat over the period, the manner in which sentinel indices will respond to more dramatic stock condition changes of the scale needed to effect rebuilding remain unclear or unknown.

One group offered an opinion that there is still a primacy of RV-based inputs, in that sentinel data tend to be used where it aligns with the RV-based input but not if and where it doesn't.

2) Are there aspects of the assessment which result primarily or solely from sentinel activities?

The common response to this question was that sentinel projects were well suited to provide better information regarding stock distribution than other RV-based sources. This came from being able to sample grounds unavailable to the research vessel due to bottom type or proximity to shore, and by sampling over a much wider proportion of the season. A number of commentators noted that in the absence of any sizeable

commercial fishery in most areas, the Groundfish Sentinel Program was the only other sampling alternative to the research vessel program.

3) Identify what opportunities exist to make further and/or better use of data from sentinel projects, and add values to the assessments?

Several responses to this question recommended that the best way to make better use of sentinel data was to involve the industry more in the data analysis and interpretation processes.

The question of needing to use all sentinel components in the assessment, particularly the commercial index fishing data, was discussed by a number of respondents. Commercial index type data are collected in three of the four programs (ex: Gulf) and industry representatives felt that catch rates are often more indicative of stock condition than other more structured fishing plans. They were frustrated that these data seem to have little influence in the formal analytical assessments. Participants urged that methods be developed to incorporate this data more fully. They also recommended that the prospects of correlating these more recent results with the traditional commercial catch records from the past should be evaluated.

A number of other more specific suggestions to make further use of data from sentinel activities were heard in this discussion:

- clarify stock structures in key cases (ex: 2J3KL cod), and so better interpret what sentinel results actually mean;
- analyse sentinel data more quickly so as to be available;
- develop and expand links between sentinel and commercial fishing, to prepare for re-building;
- revise survey stratification, to be based on established patterns of variance rather than existing areal method;
- favour improving sentinel coverage rather than increasing sampling intensity;
- inter-calibrate index fishing results from fixed and mobile gear configurations;
- make more use of sentinel to support tagging, for assessment and improving stock knowledge. It was then noted that tagging may be impractical where there is no fishery to provide returns;
- use sentinel to clarify stock mixing issues in key cases, (ex: 3P);
- make more use of bottom temperature data.

4) Identify sentinel activities that are not contributing to the assessment(s) and what adjustments must be made to make such activities more effective?

The fact that the Southern Gulf gillnet sentinel index, which represents a substantial amount of the fixed gear sentinel effort, is not currently used to tune the model in the 4TVn cod assessment was discussed. Some participants took the view that if it couldn't be used in this manner it should be dropped. Others felt that even if it wasn't suitable as a tuning index, it served other needs and should be retained. The point was also advanced that data didn't have to be incorporated into an analytical model to be of use in determining stock status.

There was support for augmenting the contribution from gillnets in several Regions by added a small mesh panel component to the gillnet fishing protocol so that this gear might better monitor incoming recruitment. On this point, recollecting earlier questions about the need for multiple indices, it was suggested that the need for an additional index of recruitment should be openly considered before proceeding.

There were multiple comments from some industry participants in the Gulf and Maritimes about the need for more flexibility in locating fishing sites in constrained sentinel components; and a corresponding concern from Science that the basic design parameters for these constrained elements of sentinel might be compromised were that done. In the Gulf, there were calls for a commercial index component to address these needs for flexibility, but only if it could be shown in advance that a method was available to incorporate the data into the assessment. In Maritimes, fishers wanted sentinel vessels under the commercial index component to have access to the 'haddock box' in 4W, arguing that this was historically part of the commercial fishery.

There were several examples given where industry participants felt the spatial and temporal coverage of sentinel should be adjusted.
A number of other more specific suggestions for adjustments to make sentinel activities more effective were heard in this discussion:

- the Groundfish Sentinel Program is not well designed for secondary species, such as white hake and American plaice;
- need to incorporate mid-shore grounds off Eastern Newfoundland into the 2J3KL sentinel program;
- need to consider the merits of stratified vs fixed survey designs on a case x case basis, and consider changes on the basis of need.

In general discussion, G. Chouinard observed that there was a CI component to sentinel in 4Vn where there is no other commercial activity. He asked, since there was an open fishery on the 4TVn cod stock in 4T, isn't there already an opportunity to collect commercial fishery information? Gulf advocates of a CI suggested that it should be added to the sentinel program there. They also urged that the quota to support it should added to the current TAC by the FRCC, and that commercial index fishing be implemented by allowing existing sentinel index vessels to add two or three extra unconstrained trips to those they do already. Another participant repeated the need to determine how to use this data before adding it to the Gulf program.

2.3.6. Summary Points: Data treatment and assessment

1) A number of techniques are in common use to control or mitigate against biases in sentinel data which might result from factors such as gear saturation, gear configuration, aggregration of data from different sites and times, and extreme observations.
2) Sentinel data are designed to serve seven primary groundfish stocks. At least eight other stocks are secondary beneficiaries of sentinel data.
3) Except for several cases where the application of tags by sentinel fishers permits mark:recapture estimates to be attempted, data from sentinel sources augments existing analyses in assessments of stocks rather than introduce new types of analysis.
4) It was demonstrated for two stocks (4Vn cod & 4TVW haddock), that the addition of sentinel indices reduced variability and clarified risk assessment, even when, as in one case, the sentinel and non-sentinel signals were contradictory.
5) It was demonstrated on two stocks (4TVn cod and 3Pn4RS cod) that the influence within an ADAPT formulation of a number of separate indices from sentinel and non-sentinel sources could be differentiated and ranked. This might assist making future choices between indices but also raises the need to better understand the relationship between influence and accuracy.
6) There is a generalized belief among industry participants that incorporating sentinel data into an assessment leads to improved assessment of status, but it was also noted that it has not been possible to objectively examine the influence and impact of sentinel data on assessments.
7) There was a call for analyses to be refined that would illuminate the impact of data from various sources including sentinel on the outcome of assessments, and for such information to be made available in stock status documents.
8) It was recognised that the full utility of data from sentinel sources cannot be known until its responsiveness is observed as stocks undergo periods of change more pronounced than has generally been the case to date.
9) A major strength of the Groundfish Sentinel Program is that it is capable of sampling the stock at otherwise inaccessible locations and at times not normally covered by other fishery-independent assessment tools, particularly research vessel surveys.
10) A number of specific suggestions for improvements were made, but of note is the need to develop techniques to incorporate major sentinel series that are not yet used in the assessment into the determination of stock status in a more structured fashion. This need is particularly true for the commercial index fishing records that are collected in most areas.

Session 2, part 4: Other species and research **Chair: Denis Rivard**

The fourth and last part of Session 2 was devoted to presentations and discussion of (i) the role that sentinel activities play in the assessment of stock status for other than primary species, and (ii) the opportunity (both realized and available) for sentinel to facilitate other research activities not directly related to the primary and secondary stock assessment process.

2.4.1. Overview:
Alain Frechet provided a synopsis of the role of sentinel information in non-primary stocks, and outlined the types of research that are being done across the Coast in association with the Groundfish Sentinel Program.

Except in Newfoundland Region where catches in sentinel activities are almost exclusively cod, sentinel catches of other species are sufficient to provide input to the assessment of a number of other species, which we term secondary sentinel stocks. These secondary stocks are summarized by Region in Table 1. In some cases, slight adjustments such as expansion of sampling areas covered by sentinel and re-distribution of sentinel efforts have been made to facilitate this benefit.

Measurements and samples from primary and secondary sentinel stocks, other than those data needed directly for the determination of stock status are now routinely collected. Such activities includes sampling to determine growth, feeding, condition, maturity, fecundity and other biological characteristics of the species. Tagging is also done (traditional and DST) in association with several sentinel programs and in more lately telemetric studies have been conducted in the Sydney Bight area. These practices represent good use of opportunity to extract additional information from available sentinel catches and a very cost-effective approach to advancing understanding of the biology of the species.

In addition, the Groundfish Sentinel Program provides a platform for a range of other marine research activities, which are summarized on a regional basis below.

2.4.2. Regional Approaches:

2.4.2.1. Maritime Region
Paul Fanning noted that in Maritimes, haddock was also considered (with the two cod stocks) as a primary sentinel species. He re-iterated that the Maritimes sentinel program derived as much information as possible from all catches and that this information added to the understanding of the biology of the many species encountered.

Fanning specifically mentioned the contribution where the sentinel program was used as a platform for fish diet studies, and that for a small incremental cost, this major piece of information is now available to refine ecosystem modeling on the Scotian Shelf.

2.4.2.2. Gulf Region
Ms Rondeau outlined the sampling protocol followed for secondary sentinel species in the Gulf sentinel program. Data and samples from sentinel sources are an important contribution to the assessments for white hake, American plaice, winter flounder and yellowtail flounder.

Ms. Rondeau outlined a long list of additional or special studies that were completed with the involvement of the sentinel program in the southern Gulf. These studies included:
- Cod migration patterns;
- Cod tagging (temperature recording);
- Winter flounder tagging;
- Atlantic halibut tagging;
- Evaluation of cod fecundity;
- Morphological study on hake;
- Collection of different species for observers training;
- Bottom temperature recording;
- Lobster predation.

Ms. Rondeau concluded with a summary of recent publications that were based in part by data and information from sentinel in the Gulf Region.

2.4.2.3. Laurentian Region

Mr. Frechet outlined the other research opportunities specific to the Laurentian Region sentinel program. These included:

- sampling for redfish and turbot as secondary sentinel species;- sampling of small marine mammals (porpoises and seals) and marine birds taken as bycatch;
- tagging mortalityestimates ;
- trace element concentrations, meristics and maturity measurements for stock discrimination purposes;
- application of high-value tags to cod;
- Atlantic halibut tagging;
- lumpfish sampling;
- stock mixing in 3P;
- gear selectivity studies;
- other graduate program research studies are under discussion and may be pursued in future.

2.4.2.4. Newfoundland Region

Rick Stead outlined the following research activities ongoing in the Newfoundland Region:

- cod tagging. The sentinel program is a major component of the ongoing tag program for cod in the Newfoundland Region.
- Lumpfish research. Similar to Laurentian Region;
- Cod physiology studies. Investigations of cod muscle moisture, jointly with MUN;
- sampling of small marine mammals (porpoises and seals) and marine birds taken as bycatch;
- sampling of Atlantic salmon taken as bycatch in cod traps;

2.4.3. General Discussion, Session 2, part 4

Two questions were posed to orient a general discussion on this aspect of the Groundfish Sentinel Program.

1. Identify what opportunities exist to make further and/or better use of sentinel activities in assessing the status of other species and in addressing other research questions.

A theme that ran through this discussion was that the Groundfish Sentinel Program offered the opportunity, which must be taken, to collect information on a widely varied range of species and ecosystem elements, and that this increases our general knowledge on many fronts. Examples of this included marine mammal data from bycatches, information that might be useful in assessing the status of species under the pending Species At-Risk Act, and information on species that were once of secondary importance (to the speaker) but now are the target of directed efforts. It was pointed out that while it was important and prudent to make full benefit of the opportunity to collect additional data, the main goal of the Groundfish Sentinel Program was to provide indices of abundance on those species for which there is considerable concern.

2. Management issues; should these be addressed through sentinel?

Following some elaboration of what intended by the question, one participant voiced a view that the sentinel should not concern itself with management issues, since the primary goal of the program is to determine the appropriate stock status level. The speaker said that this was the focus in his area, and hoped that this is what was being done in other programs.

Summary Points: Other species and research

1) Assessments for at least eight other stocks currently benefit substantively from data from sentinel sources.
2) A diversity of other research questions and issues not directly related to the determination of the status of primary and secondary sentinel stocks benefit from the Groundfish Sentinel Program, primarily through having a platform for the collection samples and measurements.
3) There was no obvious support for using the Groundfish Sentinel Program as a platform to address management questions.

Session 3: Efficiency & Cost-effectiveness Chair: Serge Gosselin

The third session of the workshop was designed to explore and discuss different ways to consider costs and benefits in relation to the sentinel progrfam overall and to individual sentinel projects. This session was chaired by Serge Gosselin, DFO Science, Laurentian Region.

3.1. Presentation: Costs & benefits of sentinel, an introduction.
D Gillis

Introduction:

The analysis of costs and benefits for a program such as the Groundfish Sentinel Program is complicated by the need to consider both benefits that are quantifiable and thus lend themselves to an analytical approach and others which cannot be readily assessed on a quantitative basis. Of the two major objectives of the Groundfish Sentinel Program, the benefit of the program to the assessment is largely a matter of analysis and documentation, and will be the primary subject of this presentation. The impact that the Groundfish Sentinel Program is having on the views of fishers of the assessment and their connection to the resource cannot be analyzed quantitatively within the scope of this review. This important aspect of benefit will be addressed in a more qualitative fashion throughout the workshop, but particularly in the subsequent session devoted to Industry Perspectives on Sentinel.

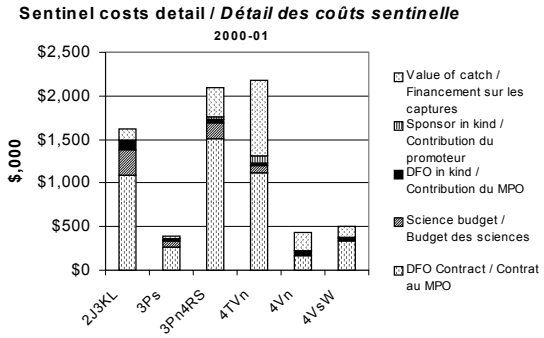


Figure 29. Total costs of sentinel projects targeted at primary stocks.

Costs:

The costs of the Groundfish Sentinel Program were considered on the basis of 1) primary (target) stocks and of 2) regional stock groupings that included both primary and secondary (sentinel data influential in assessment) stocks (Table 1). Information on sentinel costs was derived from the sentinel project summary assembled for the review. Information on non-sentinel costs for these same stocks was derived from the database established for the Stock Assessment Review.

Total costs of sentinel projects targeted at primary stocks (Figure 29) was assembled by including the value of the DFO/Partner contract, services provided by DFO Science that are covered by the Regional sentinel budget allocation, in-kind (from non-sentinel sources) contributions by both DFO and partners, and the full value of catches of sentinel allocations. Sentinel catches are to be used to finance sentinel activities; however, the mechanism used to achieve this outcome varies substantially among Regions and

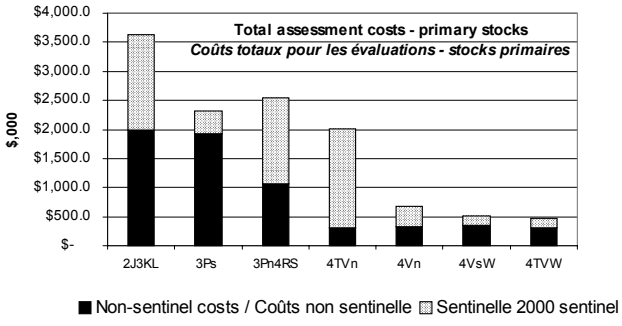


Figure 30. Total assessment costs for primary stocks.

projects. In a number of instances, the value of some part or all of the catch is left in the hands of the partner and/or the individual fisher. Nevertheless, as it is assumed in these cases that this is reflected in or otherwise influences the contracted amounts, the values of all catches were considered to be a source of financing of sentinel activities.

Total Groundfish Sentinel Program costs are highest for the two Gulf of St. Lawrence stocks and relatively high for Eastern Newfoundland. The southern Newfoundland and Scotian Shelf stocks are inexpensive by comparison. Program costs would be influenced by stock area covered. Relatively more of the total cost of the southern Gulf program is related to the value of catches, which are not retained directly within that program.

Because, in some Regions, the sentinel program also supports assessments of other (secondary) stocks, the fraction of total sentinel costs attributed to primary stocks was diminished by 10% for each secondary stock . These fractions varied from 100% in Newfoundland where no other commercial resources are available to sentinel fishers, to 70% in the northern Gulf and the Eastern Scotian Shelf. As ESS cod and haddock are equally sampled by sentinel, these two stocks were assigned 35% each of the total sentinel costs.

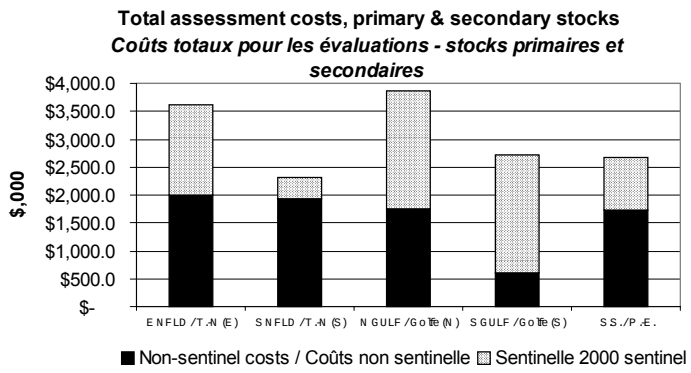


Figure 31. Total assessment costs for stock groups.

Total non-sentinel assessment costs were taken from the Stock Assessment Database. Stock area, and the diversity and number of groundfish and other finfish stocks in each Region which share assessment costs, influences differences in non-sentinel assessment costs. These other stocks are less numerous in Newfoundland and the northern Gulf than elsewhere. Non-sentinel costs were added to sentinel costs to determine total assessment costs for these stocks (Figure 30). Total assessment costs for primary stocks are highest for northern cod, intermediate in the Gulf stocks and 3Ps cod and relatively low for all Scotian Shelf primary stocks.

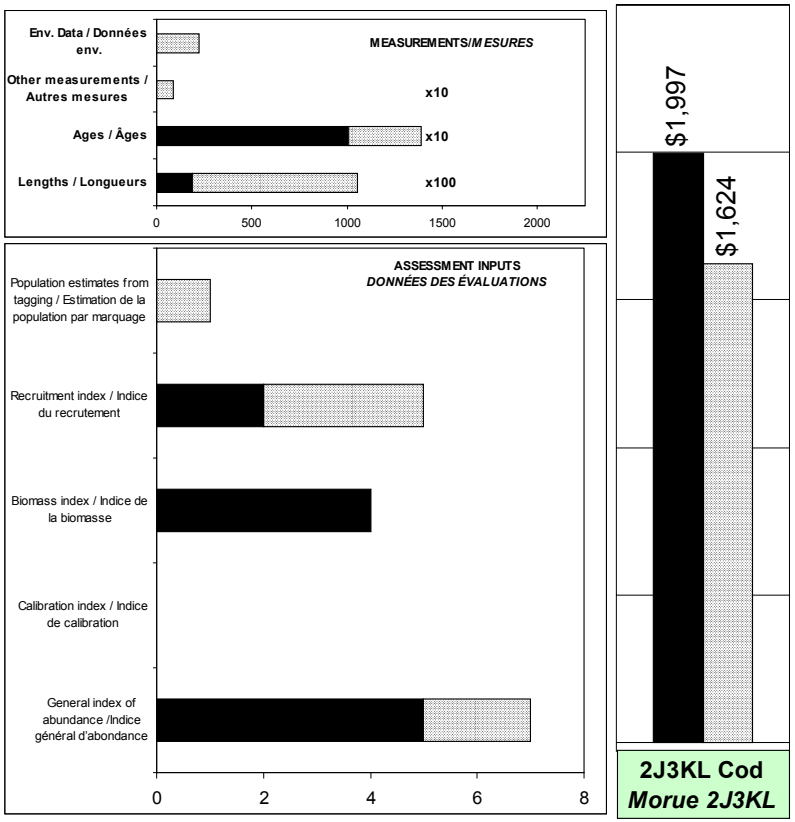
The foregoing analysis is focussed on primary stocks only. To include the total cost of sentinel in the analysis and to sidestep any distortion resulting from the attribution of costs between primary and secondary stocks, the same calculations were repeated including both primary and secondary stocks as a stock group (Table 1). Species group assessment costs were highest in Newfoundland and the northern Gulf and 25% - 35% lower in the other areas (Figure 31).

Benefits:

The Stock Assessment Review database identified seven types of assessment analyses used in Canadian assessments. With the exception of where tagging and tag recovery by sentinel fishers is now being used to infer population sizes, the sentinel program does not add previously unused analyses to these assessments. Aside from tagging information, sentinel data are used to augment existing assessment approaches.

For each of the primary sentinel stocks, numbers of samples and measurements and key assessment inputs were enumerated from the latest assessment, and separated as being from sentinel or non-sentinel sources. Figure 32 summarizes and relates these assessment inputs with their attendant costs. Comparing across stocks indicates general correspondence between sentinel expenditures and resultant additional inputs to the assessment.

This analysis relates sentinel costs to data generated for and inputs to the assessment. It cannot consider the influence these inputs may be having on the outcome of the assessment.



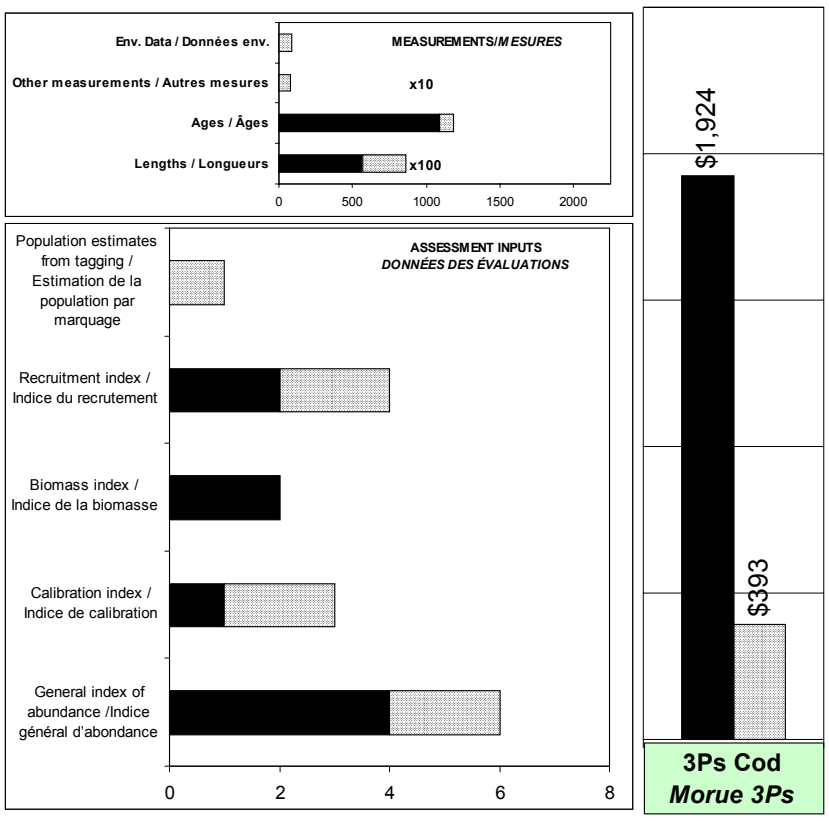


Figure 32. Assessment inputs from sentinel or non-sentinel sources with attendant costs, primary sentinel stocks.

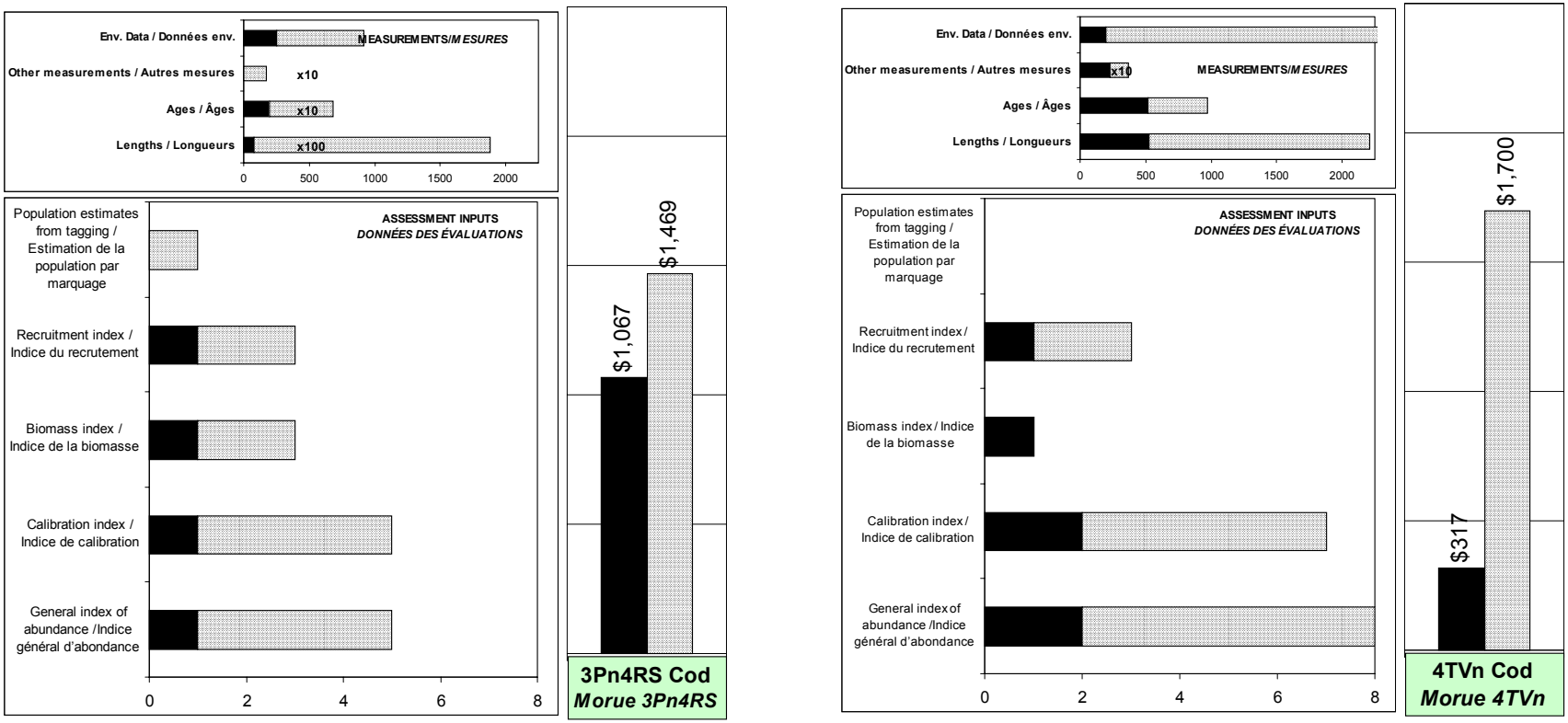
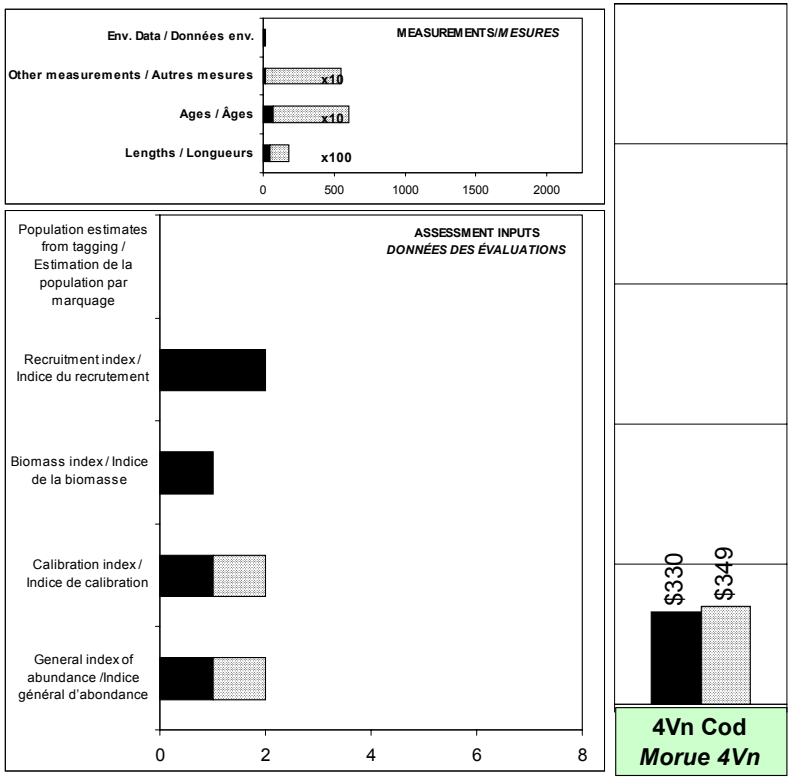


Figure 32 (con't). Assessment inputs from sentinel or non-sentinel sources with attendant costs, primary sentinel stocks.



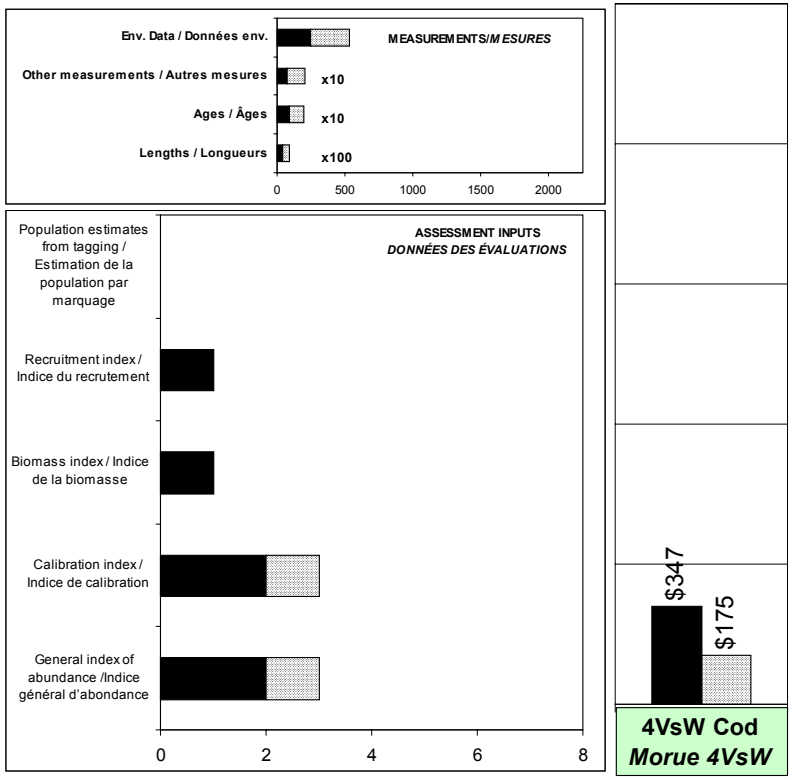


Figure 32 (con't). Assessment inputs from sentinel or non-sentinel sources with attendant costs, primary sentinel stocks.

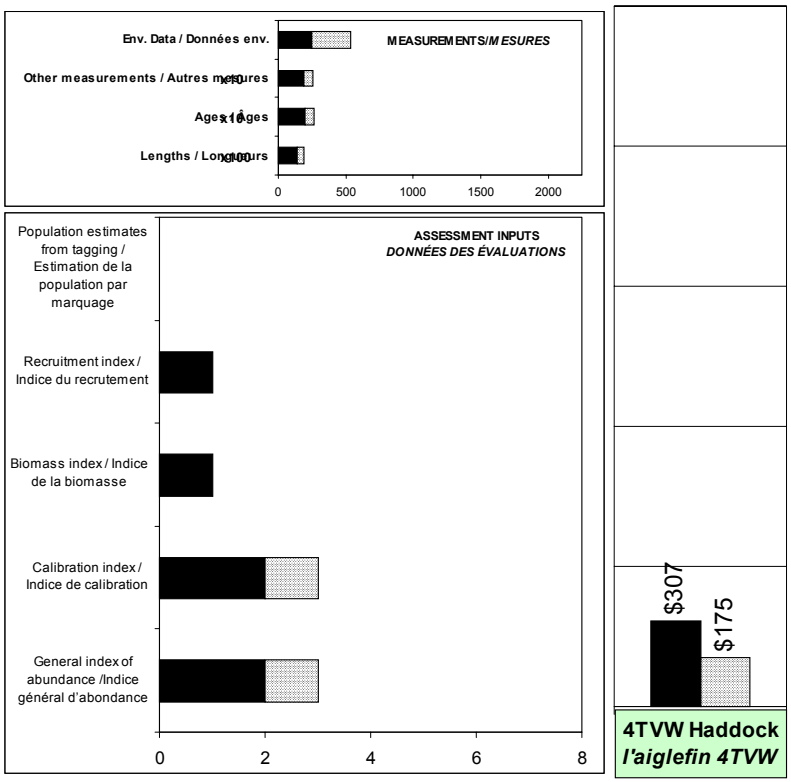


Figure 32 (con't). Assessment inputs from sentinel or non-sentinel sources with attendant costs, primary sentinel stocks.

	No. of vessels involved / # de bateaux	Boat size (ft) / Long. Bateaux (p)	No.fishers (total) / # des pêcheurs (totale)	Gears involved / Engins de pêche utilisés	Seasons pre-determined / Dates de pêche pré-déterminés	Fishing sites not constrained / Sites de pêche sans contraint	Fishing sites constrained / Sites de pêche contraint	Fishing sites assigned / Sites de pêche pré-déterminées
2J3KL Cod	63	18' - 52	168	4	X	X		X
3Ps Cod	16	20' - 40	37	4	X	X		X
3Pn4RS Cod	57	23' - 59	132	5	X	X	X	X
4TVn Cod	39	23' - 65	110	4	X		X	X
4Vn Cod	24	28' - 40	72	1	X	X	X	X
4VsW Cod	8	32' - 42	21	1	X	X	X	X

Table 3. Sentinel projects descriptors relevant to industry benefit.

Separate analyses are needed to pursue the questions arising: ie how many measurements are enough in a given situation? What is the incremental value of adding abundance series? How is precision affected? Some of these approaches have been tried and presented earlier in the workshop (refer to Session 2).

As discussed earlier, industry's views of sentinel do not lend themselves to quantifiable analysis. However, there are a number of descriptors about sentinel projects and programs in the summary database that might be expected to influence the derivation of benefit from sentinel by the industry. These are summarized in Table 3. In addition to standard information related to participation in numbers and by vessels and gear types, Table 3 indicates that there are differences in the degree to which programs constrain the activities of fishers. All programs impose seasons on sentinel efforts, and all programs feature components that prescribe tightly controlled fishing. However, partially constrained or (relatively) unconstrained fishing is not available in all Regions as part of sentinel.

As part of the Stock Assessment Review, cost-related comparisons were conducted over the full range of stocks assessed by DFO across Canada. Several of these have been updated to highlight how primary and secondary sentinel stocks compared to other stocks, which in this instance were restricted to be other Atlantic commercial marine stocks.

In relation to overall knowledge (an aggregate index of fishery, biological and assessment-related knowledge, as determined by the Stock Assessment Review), the assessment costs (sentinel and non-sentinel combined) for all primary sentinel stocks is relatively high (Figure 32) ; but are extremely high for four cod stocks (2J3KL, 3Ps, 3Pn4RS, 4TVn).

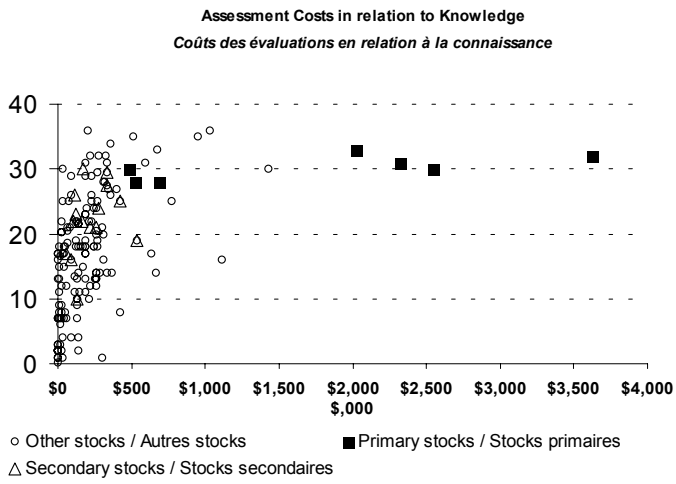


Figure 32. Assessment costs for primary sentinel stocks vs. overall knowledge

Figure 33 relates potential value (as estimated for the purposes of the Stock Assessment Review) to current value (1999). Sentinel stocks remain well below their potential value, with the exception of 3Ps cod. In the reference year (1999), the TAC for 3Ps cod had increased to close to its long term potential value but has since (for 2001) been reduced to half this level. Several of the primary sentinel stocks are among the highest potential value group on the Atlantic Coast, and all are in the top half.

While assessment costs for several of these stocks are the highest on the Atlantic Coast and all are in the high range, potential values are correspondingly high (Figure 34).

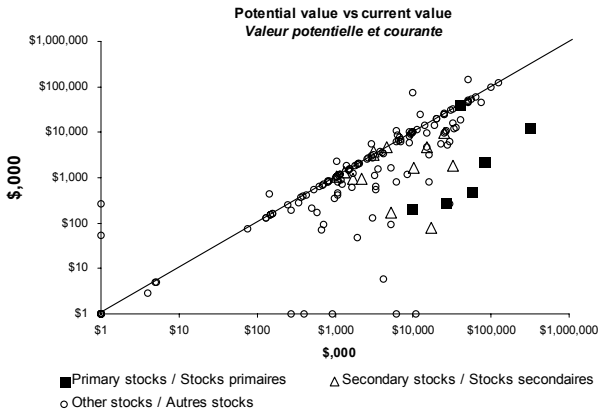


Figure 33. Potential value vs. current value of sentinel stocks.

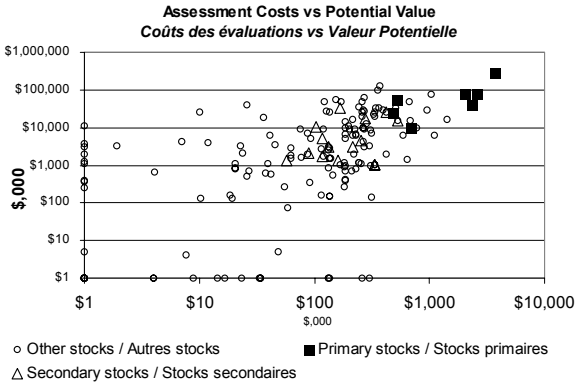


Figure 34. Assessment costs for primary sentinel stocks vs. potential value

3.2. Presentation: Relative efficiency within the Groundfish Sentinel Program.
A Frechet

The four Atlantic Regions (Newfoundland, Maritimes, Gulf and Laurentian) conduct annually some 27 individual components as part of the Groundfish Sentinel Program (Table 4). Some are quite extensive in cost and number of participants while others are quite small, involving sometimes only one vessel and limited funding. The information pertinent to this analysis was extracted from the sentinel project inventory. Three main areas of efficiencies are examined, funding sources, human resources and biological sampling.

Project title		
Laurentian:		Gulf, con't:
1 - Québec fixed 4S		14 - NB fixed 4T
2 - New foundland fixed 4R,3Pn		15 - NB mobile 4T (seine)
3 - New foundland mobile 4R, 3Pn		16 - Gaspé-north fixed 4T
4 - Québec mobile 4S		17 - Gaspé-south fixed 4T
Newfoundland:		18 - Gaspésie mobile 4T
5 - FFAW Sentinel 2J3KL		19 - Magdalen fixed 4T
6 - FFAW Sentinel 3Ps		20 - Magdalen mobile 4T(seine)
7 - Fogo Island Sentinel		Maritimes:
8 - Petty Harbour Sentinel		21 - 4Vn Sentinel Survey
Gulf:		22 - 4Vn Monthly Monitoring
9 - PEI fixed 4T		23 - 4Vn Migration study
10 - PEI mobile 4T		24 - Bras d'or Lakes Study
11 - NS fixed 4T		25 - 4Vn Commercial Index
12 - NS mobile 4T (trawl)		26 - 4VsW Random Survey
13 - NS mobile 4T (seine)		27 - 4VsW Commercial Index

Table 4: Inventory of all sentinel components given in 2000 by the various DFO regions.

There are four main sources of funding of sentinel projects:

-The DFO sentinel funding allocation which is managed by the DFO regional co-ordinators. These allocations may span more than a year.
- Value of fish sales, which are managed by the sponsor to offset the cost of sentinel activities.
- DFO personnel in kind contribution which includes time spent on sentinel activities, travel costs and other related costs.
- The sponsor in kind contributions.

Because of the wide spread in the cost of every project, the dependence for each project on each source of funding is given in proportion (Figure 35). Generally, the in-kind contributions represent a small portion of the programs. There are no in-kind contributions for all Newfoundland-based components (# 2,3,5,6,7,8), which is stipulated in those contracts. The remaining funding is either based on a strong DFO contribution or a strong dependence on catch. Fish value is a proportionally strong component in the case of the N.-B. seines (component #15), PEI fixed in 4T (component #9) and a commercial index (component #25).

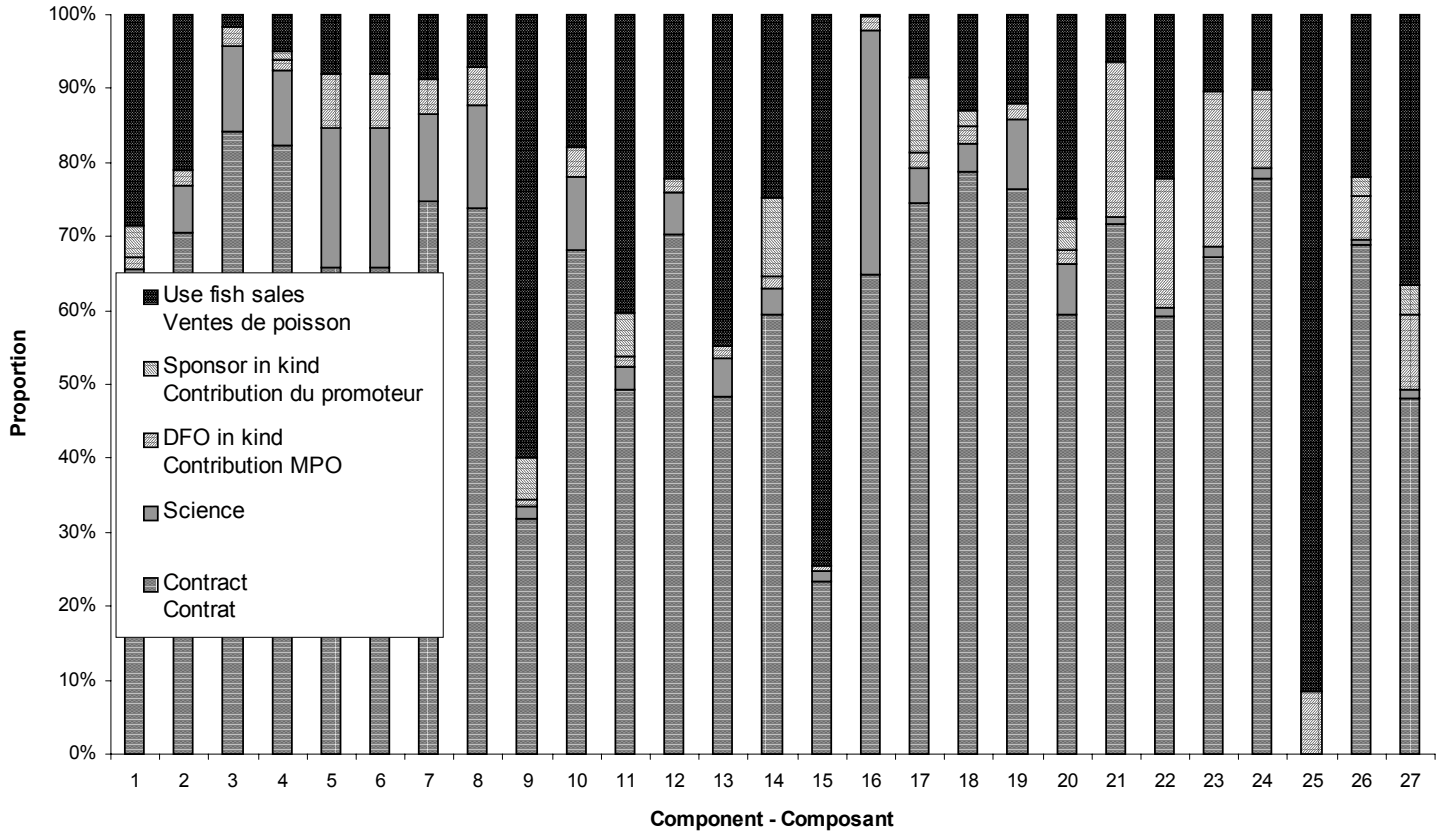


Figure 35: Proportion of the funding sources for each sentinel component in 2000.

The summary of human resources is shown on two figures. The first one concerns the personnel hired to conduct the management of the programs, which are expressed in number of work weeks in the year 2000 (Figure 36). The second graphic summarizes the number of fishermen and crewmembers involved in the various elements of the program (Figure 37).

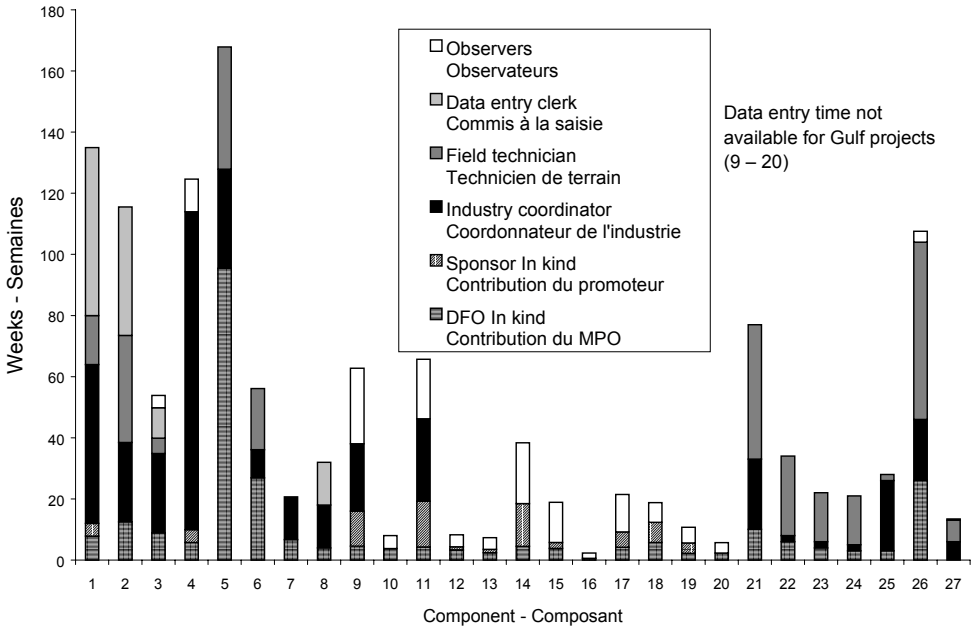


Figure 36: Number of weeks of hired personnel to manage sentinel components.

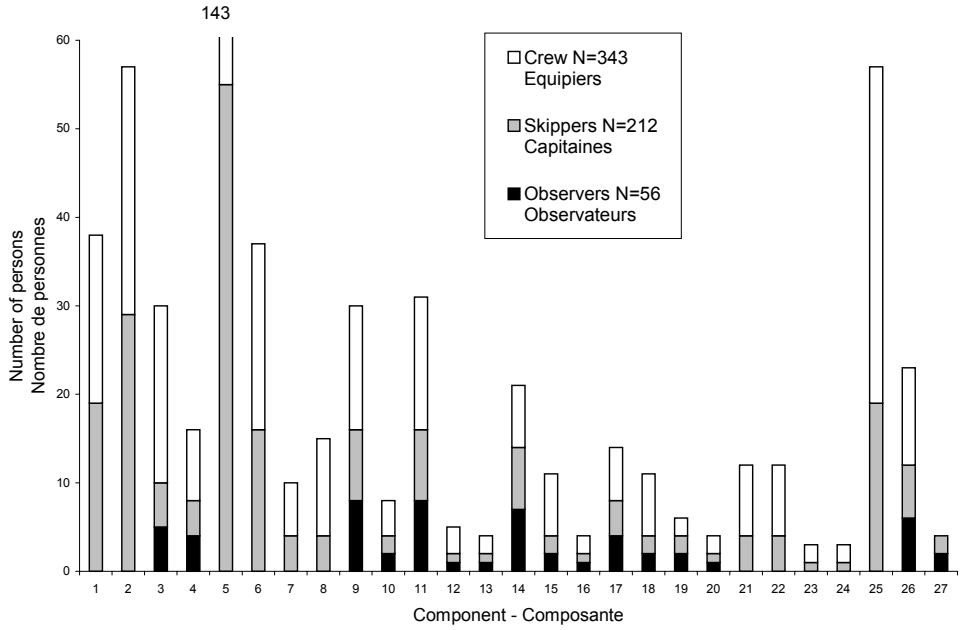


Figure 37: Number of number of fishermen and crew members involved in the programs

Figure 36 reflects different approaches to project administration. In Newfoundland Region (see component #5) of the program management function is the responsibility of DFO personnel. All Laurentian components (components #1 to 4) have a strong dependence on industry personnel for project management. The Gulf components (components #9 to 20) require less administrative support from DFO, due to the size of the contracts, and the strong presence of observer coverage that takes care of the flow of the data. The keypunching is a substantial requirement in all projects. When a sponsor hires a particular person to keypunch data, it is shown here as “data entry clerk”. However, keypunching is also accomplished in other ways; as part of the observer contract, by DFO personnel or by contracting it out by either DFO or by the sponsor. Time devoted to data entry was not available in the Gulf (Figure 36).

Field operations are the primary role of skippers, crewmembers and observers. These are the core of the programs and involve a total of 611 persons in Atlantic Canada in 2000. When observers are present in any component, coverage is always at 100% (Figure 37).

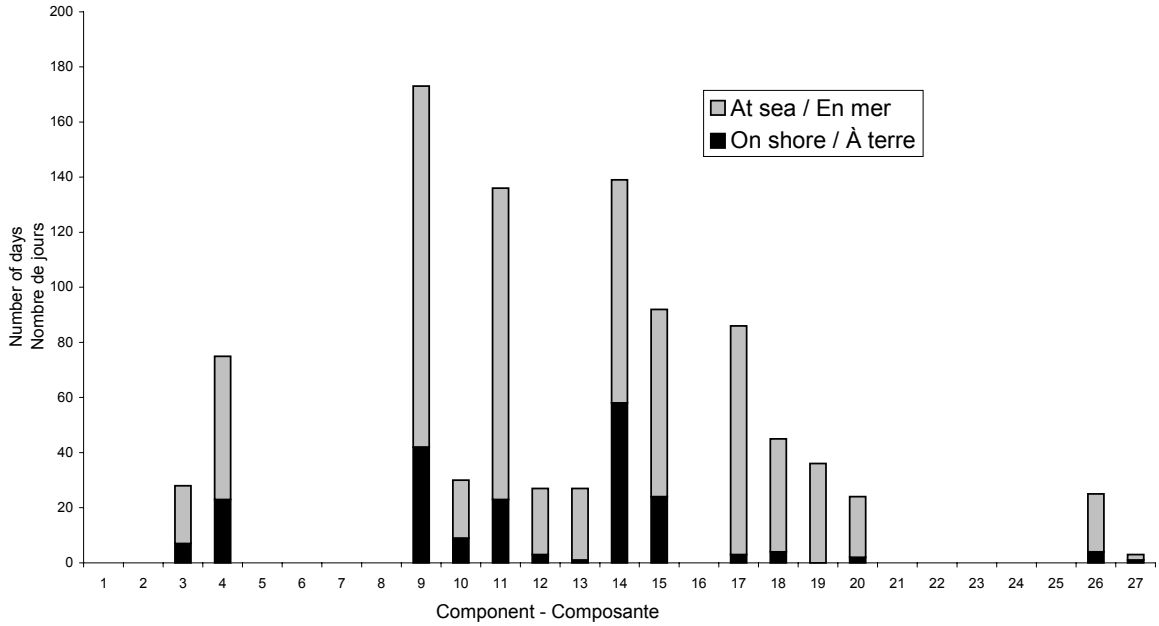


Figure 38: Number of sea days and shore days of observer coverage in the various components in 2000.

The primary purpose of the observer is to verify compliance to the sentinel fishing protocol, which is especially important when non-commercial gear is being used (liners). They are also involved in at-sea sampling and measurements and, where they are used, they are also responsible for data keypunching and validation. This last element is not well captured in Figure 38, however, the observer time at-sea and on shore is included in the management profile (Figure 36). It is apparent from Figure 38 that there is a strong presence of observer coverage for the projects from the Gulf Region, where in addition to ensuring compliance they are used for data collection, validation and transfer to the DFO scientists. Observer presence is also at 100% for both surveys from the Laurentian Region, but, in this instance, their presence is required because the trawls used have a small mesh liner.

Another aspect, which varies considerably among projects, concerns the turnover of fishermen. Given that some contracts are open for annual bids, there may be considerable annual turnover in participants. On the other hand, some components of the sentinel program maintain the same fishermen from year to year, unless there is a major event to allow for a change in participants (Figure 39).

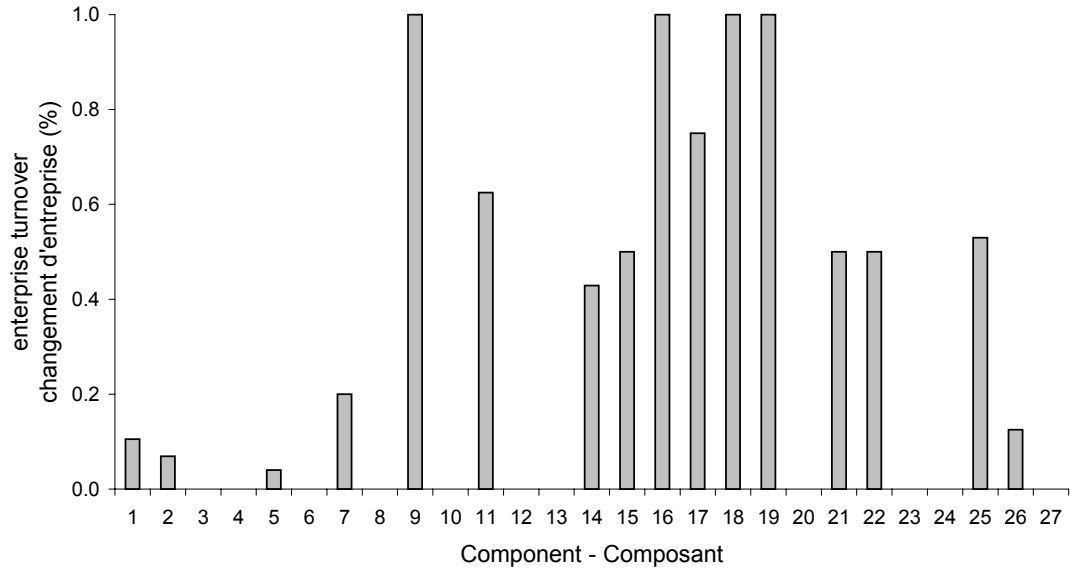


Figure39: Annual turnover of fishing enterprise by component in 2000.

The last series of performance measures pertain to field activities and biological samplings per unit of funding. It must be noted that these are heavily influenced by many factors, such as:

- Stock status
- Sampling effort (number and type of gear, sampling intensity)
- Sampling protocol (stratified random, commercial index, species to be measured)
- Boat size
- Program related costs (observers, dockside monitoring, field technicians, meetings, travel etc.)
- Administration costs for the component

These factors were negotiated for each contract and should be considered when comparing the various components. Project costs used in this analysis include all four primary sources of funding (contract money, fish sales, DFO and sponsor in-kind contribution).

Figure 40 shows the relative efficiency of each component for different types of activities. For the fixed gear components, these are the numbers of gear hauls done in 2000. In some cases, one trip at sea may have two activities, a fixed station and an experimental one, more exploratory in nature, and based on the fisherman's decision. For the mobile gear, an activity is a single haul. The vessel size is generally quite influential on boat charter costs and this is shown in Figure 40 (solid line). In many cases, the mobile gear components involve larger vessels.

Component number 25 stands out as being highly efficient but it must be noted that this is a commercial index with no DFO contract funding. All fixed gear components from Newfoundland Region are also highly efficient (components # 5 to 8), component #5 being the largest sentinel project on the Atlantic Coast. Laurentian Region projects, which have the smallest average boat sizes of the fixed gear components, exhibit relatively low efficiencies .Lowest efficiencies in this analysis appeared in a number of sentinel index projects (# 22-24) in Maritimes Region, however, these are small projects involving several vessels fishing on a quite constrained protocol. Nevertheless, real activity cost differences for similar work may be occurring between projects and programs, and should be investigated further.

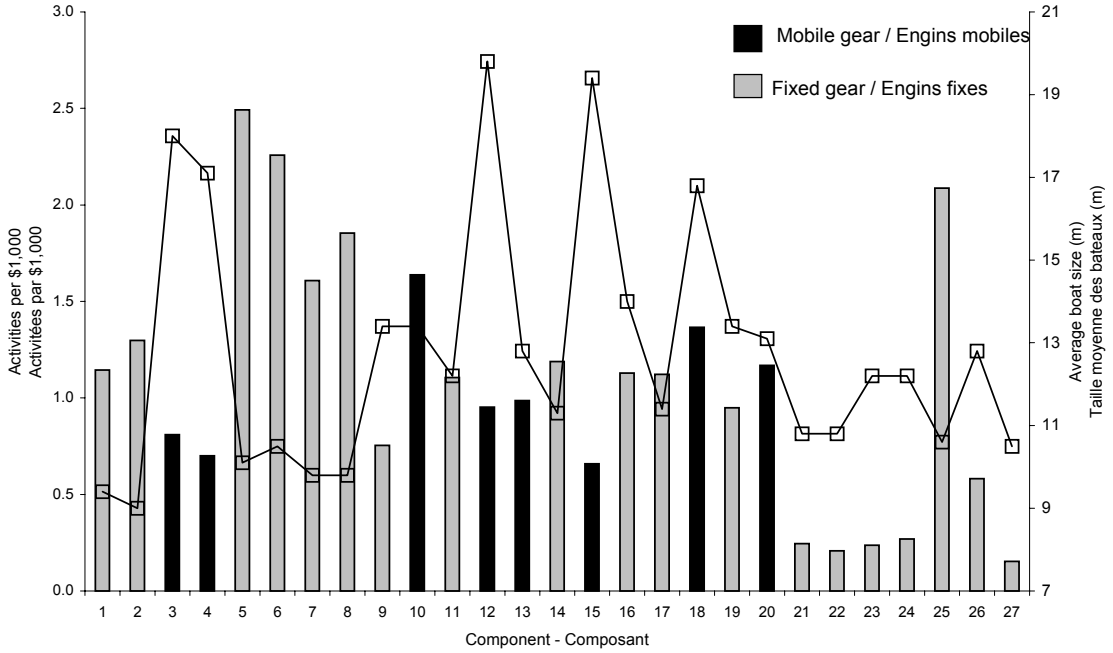


Figure 40. Number of sentinel activities conducted in 2000 per $1,000 invested for each component.

Another efficiency aspect concerns the number of skippers involved in the various components of the sentinel program. This is shown in Figure 41. These will vary according to the type of sentinel activity and are thus presented along those lines. In this case, the component #25 was not presented as it does not have any DFO funding, involves many boats operating in a limited budget. It score would thus be very high.

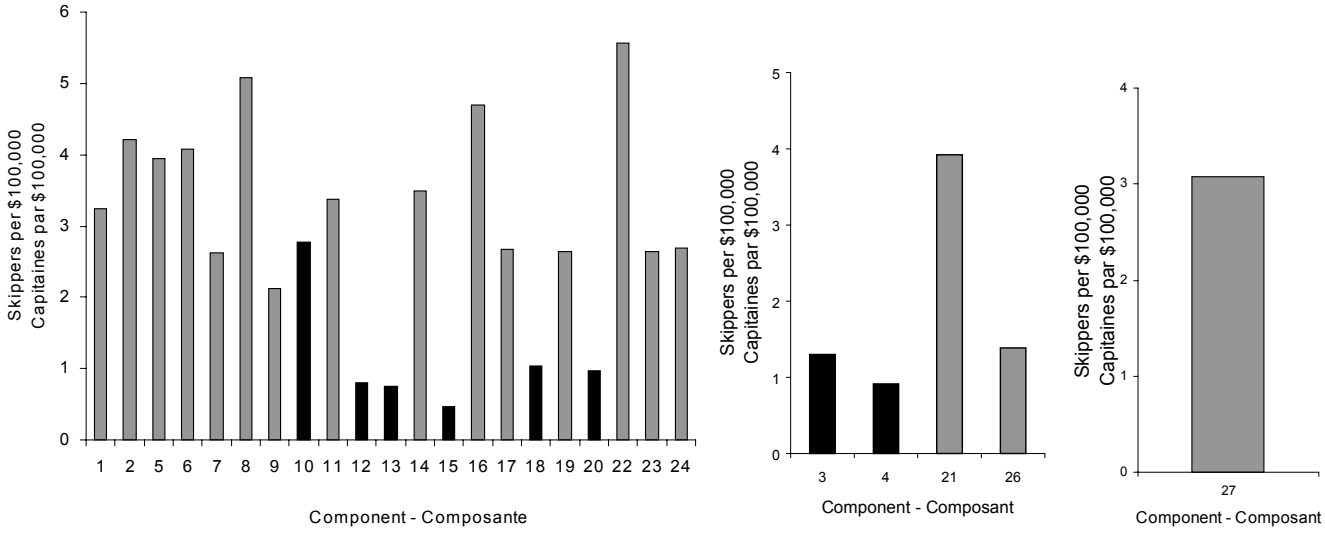


Figure 41: Cost per enterprise involvement in sentinel components (left) sentinel index type (center) sentinel survey type (right) sentinel commercial type.

Finally, the biological sampling was examined (Figure 42). From this it was obvious that cod was the main species measured. Others are reflective of local abundance in the region. Haddock was measured in the Maritimes region, white hake and American plaice in the Gulf region, turbot and redfish in the Laurentian region. Sampling was limited to cod in the Newfoundland region. This approach to studying efficiency is of limited value since it would be heavily influenced by important factors such as the availability of fish in the respective fishing areas and the use of sampling protocols that constrain sample sizes. Also, sample size cannot be directly correlated with the quality of data or the outcome of the project. Moreover, while efficient use of sample collection and measurement effort is desirable, reductions may not have a corresponding effect on overall program costs.

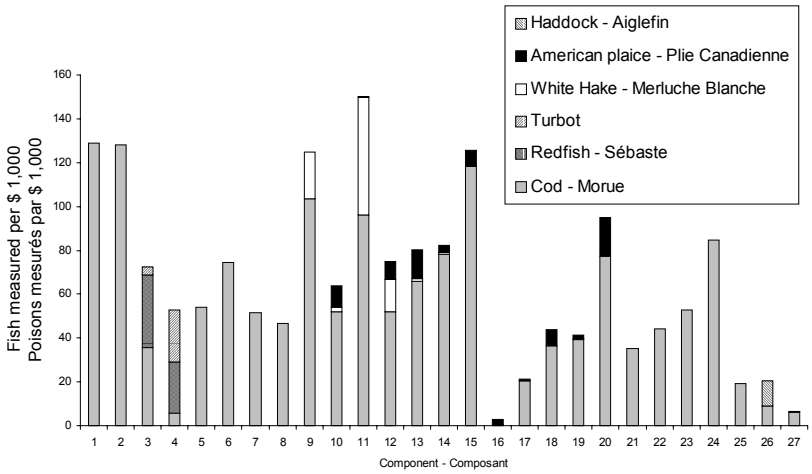


Figure 42: Number of fish measured per $1,000 funding These are given by major specie type.

3.3. General Discussion, Session 3:

The presentations related to costs:benefits and efficiency within sentinel generated considerable discussion among participants. There were a number of questions and points of clarification; in particular, participants wanted to be sure that all costs had been accounted for in a fair and realistic manner. It was acknowledged that the values attributed to fish sales need to be reviewed and the need for corrections was noted in several instances. Nevertheless, these discrepancies were not considered sufficient to change the basic picture to be drawn from the cost:benefit and efficiency presentations.

Regarding measurement of costs:

A number of factors which could influence unit and total cost calculations had been noted in the presentations, however, participants wished to emphasize the importance of several of these in the discussion, particularly stock size and condition.

It was noted that the cost of conducting sentinel activities for a large-area stock in poor condition will be quite different than a small stock in better condition. Also, if comparisons are based on catches or sampling intensity, components may appear to be inefficient where fish are scarcer. Annual or gradual changes in landings have been sufficient in some areas to distort any similar analysis.

There was concern that focussing on any one reference year (2000 in this case) may not reflect the general picture regarding costs or benefits over the longer term. It was explained that it was for this very reason that information on key parameters, especially where values were known to have varied, has been collected on a longer-term basis, and that the final analyses will consider these long-term values where and when necessary to provide a fair perspective.

The approach taken in analysis that all catch value was assumed to contribute one way or another to the implementation of the Groundfish Sentinel Program was not disputed. Several industry representatives confirmed that, in their experience, even where the full value of sales was not directly retained and managed by the program, these amounts were being used to support sentinel in other ways. The different Regional approaches to managing the fish sales issue was noted in the discussion.

Some participants appeared to have been previously unaware that there were ‘revolving funds’ in operation for some components of the Program. There was some concern that this was occurring and a request that

these monies be more fully accounted for to ensure that they were being devoted fully and directly to sentinel activities.

Regarding measurement of benefits:

A number of participants identified the need to consider benefits on basis of quality not quantity. It was re-iterated that some important benefits of sentinel activities were inherently hard to value, and therefore posed a particular challenge to any analytical approach. These items included;

- improved communication, collaboration and trust between DFO Science and the industry, and in some cases between fishers' groups;
- more confidence in and understanding of assessments;
- more understanding of fishers' views (by science);
- opportunity to 'piggyback' other projects and sampling on sentinel activities;
- opportunity for training both fishermen and students in science;
- flexibility - the activity framework is available to be used on short notice at little or no cost;
- more conservationist thinking among fishers, leading to better compliance;
- continuity and stability. It took time to build confidence in the structure, quality and the overall usefulness of the program, and that should be protected.

Toward studying efficiency/cost effectiveness:

A number of participants expressed the general view that the Groundfish Sentinel Program represented good value for the money.

The need to base costs-related evaluations on real benefits was expressed, meaning to judge quality rather than quantity. There was also support for the approach of comparing sentinel costs to other approaches, including non-sentinel assessment costs, and the costs of determining stock status in the period prior to sentinel when the fishery operated.

It was suggested to use the original goals as another reference point, and make sure that the program was providing "reliable indicators of abundance". In this same vein, the group was reminded that it is not necessary for a sentinel index to be used in a model to have value; that over time it can and does have its own inherent value.

In assessing sentinel results against goals, a discussion group recalled that when the sentinel was begun, it was meant to gather data on closed fisheries, but now felt it is important to maintain that data flow even when commercial fisheries open. Another group reminded the assembly that the FRCC has also advanced the idea that the sentinel information flow should continue after reopening of the commercial fishery.

There was a view that stock condition should be a factor in considering value; intending that those stocks in the most distress should receive more time and consideration, as these stocks require more attention to improve things.

The issue of unused data was raised in this discussion. There was general agreement that efforts should and must be made to make use of all data collected during sentinel activities. A number of instances were given, mostly related to commercial index results. There was concern that sources of unused data may not be properly valued, resulting in pressure to discontinue. It was pointed out that while the data may not be used currently, it may be used in the future for some unforeseen but beneficial analysis.

There was general support for addressing the issue of oversampling, where it truly existed. There was an attendant concern that if we lose some of the quantity, the quality may also be affected.

Industry participants in particular advocated that in considering costs:benefit, it is a better approach to consider how to do more with what resources are available, not to look for what the Program can do without.

3.4. Summary Points: Efficiency & Cost-effectiveness

1) The full cost of sentinel activities must include government funding, in-kind contributions by all parties and the value of fish sold.

2) Sentinel program costs vary across stock areas; as a reflection of original funding envelops, stock areas, numbers of fishers, and value of fish sales.
3) When added to non-sentinel assessment costs, the cost of sentinel raises total assessment costs substantially in Eastern Newfoundland and in the Gulf stocks. The proportionate increase is less in Southern Newfoundland and for Scotian Shelf stocks.
4) Including sentinel costs, total assessment costs for four of the seven primary stocks are the highest among all Atlantic zone commercial marine resources. Costs for the other three primary sentinel stocks are in the top quartile.
5) Knowledge of primary sentinel stocks (as an index of 32 information types relevant to stock status) is relatively high for all primary sentinel stocks but not higher than a number of other Atlantic zone commercial stocks.
6) Based on assessment inputs (added data and abundance indices), the Gulf stocks derive relatively high benefit from sentinel activities, while the Scotian Shelf projects provide the fewest additional inputs.
7) For the purposes of analyzing costs:benefits, assessment inputs alone are not a satisfactory proxy for impact on the outcome of the assessment.
8) The management approach taken in different Regions results in substantially different profiles related to roles and responsibilities, and deployment of human resources. As a result, comparative analysis of relative efficiency in these issues is difficult.
9) Per activity costs, as a measure of overall cost efficiency between individual projects, varies substantially. Some differences can be attributed to vessel size effects, and activity constraints imposed by the sampling protocol, however, remaining cost differences for similar work should be investigated further.
10) Many participants, in particular those from industry, felt the best approach to costs:benefit is to consider how to do more with what resources and information are available, rather than to look for what can be cut from the Program.
11) In this regard, there was substantial support for making more use of data, especially those not currently used, and for refocusing excessive sampling and measurement to make better use of existing resources.
12) Participants stress that there were a number of values to sentinel activities and results that were important but intangible from a costs perspective. Examples include improved communication and acceptance by industry, awareness of the scientific approach, and opportunities to undertake ancillary and opportunistic research.

Session 4: Industry Perspectives on Sentinel Chair: D. Gillis

This session of the workshop was set aside to focus on the perspective of the groundfish fishing industry regarding the Groundfish Sentinel Program. One industry representative from each of the DFO Regions was invited to open the session with a brief overview of the views of fishers in their Region. Additionally, an industry representative not directly involved in the Groundfish Sentinel Program was asked to comment. Thereafter, other industry representatives were encouraged to add their own perspective in an open forum.

To gain the perspective of other Gulf industry groups, Osbourne Burke circulated a set of questions to each organization prior to the workshop. Subsequently, other Regional representatives also used these same questions, and they came to provide some structure to the discussion in Session 4. These questions were;

1) What impact has the Groundfish Sentinel Program had on your members' views of groundfish stock assessments in [this Region]?

2) What is the level of support of the members of your association for the current sentinel program?

3) What changes, if any, do your association's members feel should be considered for the Groundfish Sentinel Program in future (i.e. operational, protocol, etc.)?

4.1. Industry presentations:

4.1.1. Maritimes Region Patricia King, Fishermen and Scientists Research Society (FSRS)

Ms. King's overview of the Maritimes industry perspective was organized around the questions above, which she had presented and discussed with both current and past sentinel participants, other fishers, and industry organizations.

1) What impact has the Groundfish Sentinel Program had on industry's views of groundfish stock assessments on the Scotian Shelf?

Ms. King indicated that opinions about the impact of the sentinel program varied from those who felt it was useful and made the assessment more accurate to those who did not feel it was useful and added no accuracy to the assessment. Those who felt it was useful felt the sentinel provided a good understanding and better picture of the stocks, as well as a better understanding of how science is done. This has led to more trust in science. Fishermen can believe the data more because it originated from fishermen. Some fishers are pleased with the program because they feel it has proven that the seals are eating the fish stocks.

Those who do not feel the program useful complain that not enough information is given to fishermen. There are fishers who feel that the random survey design doesn't provide enough focus on traditional grounds. They also feel there should be more survey effort towards the 4Vn line in the 4Vn survey. Regarding the commercial index components, fishers feel the 25% contribution to program costs is a deterrent to participation, and that without having access to the Western/Emerald Bank Closed Area, there is not a true commercial index in 4VsW .

2) What is the level of support of the industry of Maritimes Region for the current sentinel program?

Correspondingly, the level of support for the current program varies among fishers as well. Ms. King observes that **'*many support*** [the Program] ***but few understand'*.** Support is eroded among those who feel that the random survey is not set up right. Due to extremely low catches, the current commercial index is not viable, and because the stock is not re-building and fishers are getting into other things such as snow crab, the Sentinel Program is not their top priority for long periods of the season.

3) What changes, if any, does the industry in Maritimes Region feel should be considered for the Groundfish Sentinel Program in future (i.e. operational, protocol, etc.)?

Fishers in the Maritimes Region were suggesting a number of changes for consideration:
- More information about the Program needed to be circulated.
- More discussions with science were needed.
- Do the 4VsW commercial index on a year round basis.
- Reduce/eliminate the retention of catch revenues (15%-25%) from the commercial index.
- Revise the random survey to reflect traditional fishing areas.
- Add a gillnet survey (Guysborough County) or other gear types.
- Allow a true commercial index, by giving access to the Closed Area.
- Increase sentinel funding from DFO.
- Standardize the sentinel programs in 4VsW and 4Vn.
- Allow the random survey and the commercial index to be done at same time.
- Get rid of the large seal population.

Ms. King stressed that, for the 4VsW sentinel program, the critical change needed immediately is an increase in funding. With low fish catches the past two years and decreased funding, the revolving fund (ie: money carried forward from previous years) is almost completely depleted. Without increased funding, the 4VsW sentinel program cannot continue in 2002.

4.1.2. Gulf Region Osbourne Burke, Federation of Gulf Nova Scotia Groundfishermen (FGNSG)

Mr. Burke's overview of Gulf industry perspectives on sentinel were assembled from questionaire responses from 6 of the 11 industry groups involved in the GSP in the southern Gulf.

1) What impact has the Groundfish Sentinel Program had on industry's views of groundfish stock assessments in the Southern Gulf?

Mr. Burke reported that there were some that felt it was having little or no impact, however, the majority of respondents felt the GSP was having a positive impact on their view of the assessment. He mentioned that some fishers felt that scientific data was not being updated soon enough to stay abreast of changes in the stock. The fact that fishers rotated in some projects meant more could be involved in sentinel but increased the necessary training. He later mentioned that many fishers felt that the stock was in better condition than the assessment indicated; the stock is not rebuilt but it is improved.

2) What is the level of support of the industry of the Gulf Region for the current sentinel program?
The level of support for the program was judged to be good, but some changes were seen as necessary (see below). Fishers generally believed in the sentinel program, stating that they had more faith in the data because fishermen like themselves collected it.

3) What changes, if any, does the industry in the Gulf Region feel should be should be considered for the Groundfish Sentinel Program in future (i.e. operational, protocol, etc.)?
Mr. Burke outlined a number of changes that the fishers groups in the Gulf had identified. These included:

- Allow more participants into the program.
- Allow more flexibility in regard to timing and location. In some cases, fishers are frustrated that they must continue to fish at sites where and when they know they will not get fish and that were not historically productive.
- Increase spatial coverage so as to better cover the migratory pathways and cover all the biomass.
- Secure program financing. There have been cuts since the onset of DFO funding, but the program has grown on the fishers' account.
- Make participants adhere to the protocol or be dis-qualified, alluding to reports of non-compliance.
- Standardize the soak time across Regions at an appropriate interval. Commercial fishers are doing better at 2 hours vs. 4 hours for the sentinel in the same area.
- Introduce a commercial index component to the sentinel program; but only if the results can be used in the assessment.

Mr. Burke related the frustration that many Gulf fishers are experiencing with the assessment due to their distrust and disregard for the results of the annual Needler survey. This issue cannot be separated from the sentinel. Fishers feel that when they have 'hard' information, it is questioned and scrutinized; but that when they try to question the Needler results, they get nowhere.

Mr. Burke finished by stating that the fishers were not afraid to change the sentinel program where necessary if it would improve the program, even if those changes interfered with data sets. He offered that DFO should take the same attitude with the research vessel survey.

4.1.3. Newfoundland Region Harvey Jarvis, Fishermen, Food and Allied Workers, (FFAW)

Harvey Jarvis from the Union of Fishermen, Food and Allied Workers, (FFAW) outlined the views of industry in the Newfoundland Region. His overview incorporated as well the views of the two other industry groups with projects in Eastern Newfoundland, the Fogo Island Cooperative and the Petty Harbour Cooperative.

1) What impact has the Groundfish Sentinel Program had on industry's views of groundfish stock assessments in eastern Newfoundland?

Prior to the establishment of the sentinel program, the industry felt that assessments were conducted behind closed doors, and that there was little opportunity for involvement by fishers. As a result, fish harvester observations were not accounted for in determining stock status, and there was no means of incorporating CPUE information from inshore locations into the assessment.

At present, with the sentinel program in place, Industry is now invited to attend the assessment and to participate in it. In preparation for the assessment, questionnaires are circulated which provide the opportunity for fishers to express their views with regards stock status. Fixed gear catch rates from sentinel and commercial fishing are now available to the assessment and are used as indices of abundance of fish in the inshore areas.

Prior to sentinel, few industry people could understand what was being said about the stock in the assessment documents. The terminology was very technical. Since then, there is better use of terms that fishers understand and can relate to.

As a result of these changes, fishermen feel the information going into the assessment now includes some from areas that they know, and that this 'real' knowledge is based on some 500 years of use. The level of acceptance of the assessments in recent years has varied in relation to catch rates; where catches remain poor, the assessment is generally accepted, but fishermen in areas where catches are high find it difficult to believe the pessimistic view of this stock (2J3KL cod).

2) What is the level of support of the industry of Newfoundland Region for the current sentinel program?
Early in the implementation of the Program, there were problems with issues such as the need for control sites, and with choosing relatively few sentinel fishers on a long-term basis with no opportunity for turnover. Mr. Jarvis felt that these issues have largely been accepted and resolved, but that the issue of 'anti-contractor sentiments', unrelated to sentinel issues themselves, may be an on-going one.

Mr. Jarvis explained that support for the sentinel is gauged in several ways. Each season, both sentinel and non-sentinel fishers review the results of sentinel data collected at all sites (55 sites in 2J3KL) prior to the assessment. An annual questionnaire completed by sentinel and non-sentinel fishers indicates a high correspondence (at 92% of sites where sentinel is conducted) between sentinel and commercial catch rates. Support for and understanding of the sentinel is high where it is conducted. None of the questionnaires returned from those sites suggested that the sentinel should be stopped. At other sites, he mentioned that mis-information can and does cause problems.

3) What changes, if any, does the industry in Newfoundland Region feel should be considered for the Groundfish Sentinel Program in future (i.e. operational, protocol, etc.)?

Mr. Jarvis felt that a greater emphasis on communications would help ensure all fishers understand the benefits of sentinel activities. Reductions to date have left less resources to do this work.

There is also a call from some fishers to extend the sentinel program to the deeper channels of the outer bays.

4.1.4. Laurentian Region — David Decker, Fishermen, Food and Allied Workers, (FFAW)

Dave Decker of the Union of Fishermen, Food and Allied Workers, (FFAW) was chosen to provide an overview from the sentinel industry in the Laurentian Region, which also includes the Capitaines Propriétaires de la Gaspésie Inc. (ACPG), and the Regroupement des Associations des Pêcheurs.de la Basse Côte-Nord (RAPBCN)

Mr. Decker opened by recalling that prior to 1990, it was fishers that were telling the government scientists that the northern cod stock was in trouble. Because the scientists did not try to listen to the industry, and the industry didn't understand what the science was saying and couldn't critique it, the two parties couldn't have an effective discussion. Industry and science stuck to their separate positions and both sides lost because the fishery continued to decline and then closed.

In Mr. Decker's view, the sentinel program has now gotten the two groups (fishers and scientists) to start to work together, and starting to harness the strengths of both groups. There is now a recognition that both sides need the other. He feels that wide discussions such as this workshop are indicative of how industry can now have a good dialogue with science about stock status. He feels strongly that as this new way of working evolves and grows, it will be the sentinel fishers scattered through the communities who will convince the rest of the industry to follow.

Mr. Decker stressed that fishers don't want to be limited to collecting data, but that they want to be involved in the interpretation as well. He supported the continuance of meetings that are now regularly held to review and discuss stock information with fishers in advance of the assessment process. Mr. Decker criticized scientists that studied the fishery at a distance, preferring what he termed the "Jane Goodall ' approach of coming to the field and experience directly what was happening. Exclusion leads to distrust. Inclusion helps to rebuild respect.

Mr. Decker reviewed his presentation with the FRCC last year, where the FFAW recommended a 9,000mt TAC, which he feels was a reasonable proposal. While the decision was in favour of a 7,000mt TAC, he feels that there was a reasonable discussion between industry and science about the state of the stock. He believes that without the sentinel fishery, this dialogue would have been not possible and the recommendation from western Newfoundland for last year would have been far higher than 9,000mt.

Mr. Decker noted that the Laurentian Region sentinel program has been flexible and the Steering Committee has been willing to introduce changes over the years. In his view, funding for sentinel has to be made stable over time, to protect the investment in time and knowledge that has been made in and by the staff running the sentinel program.

Rather than cutting funding, Mr. Decker believes that the best approach to maximizing the value of the Groundfish Sentinel Program is to piggyback other activities onto the sentinel program. In the Laurentian Region, there have been many examples of this over the years, including tagging of cod and halibut, installation of special cod sensors, lumpfish research, snow crab surveys in two areas, greysole surveys, and a major telephone survey of fishers. These activities could be done quickly and cost-effectively because the sentinel program was in place and he feels many of these activities would otherwise not have been done at all. In his view, this is the true value of the Groundfish Sentinel Program.

4.1.5. Non-sentinel industry: B Chapman, Groundfish Enterprise Allocation Council (GEAC)

Bruce Chapman was an invited speaker, representing some perspective from an industry group not directly attached to any sentinel project, but involved in a number of stocks where sentinel is active.

Mr. Chapman opened his remarks by stating he was and has been a supporter of the concept of sentinel fisheries.

To establish the original purpose of the Groundfish Sentinel Program, Mr. Chapman recalled the direction provided by the FRCC in 1993 and 1994, both of which contemplated sentinel 'fisheries'. He further found the FRCC had identified four features to be incorporated into these fishing activities, as being:

- being conducted with scientific aims in mind, under careful scientific control, towards providing supplementary information on stock abundance and distribution, on fish condition and food intake;
- to be comprehensive in nature with respect to gear types, geographic areas of coverage and season;
- important that the scientific community and the industry have confidence in the quality of information coming from this source; and,
- need[ing] to develop a close rapport between sentinel fishermen, DFO scientists and managers, and the industry generally.

He stressed that the intention was to develop a program that would provide supplementary scientific information that instills confidence in both the scientific community and the industry.

He pointed out that the program, as implemented in the Regions, has varied in the approach taken, and now includes 'fisheries', 'surveys', as well as, (less descriptively), 'activities', 'projects', and 'efforts'. He feels that these differences are not incidental and reflect funding constraints and other particularities of each Regions' fishery, but also real differences in views about what is intended under the Groundfish Sentinel Program. He felt that it was not necessary that all projects be the same, but that as a National program, it should be clear how each of the individual projects meet the 'Expectations and Benefits" established for the program.

Mr. Chapman provided a series of recommendations for consideration:

- Use standard terminology across the Program to describe similar activities.
- Follow a standardized, results-oriented approach, as opposed to a 'more is better' philosophy. Since this is now A-base funding, other activities are affected by spending on sentinel.
- Establish quantifiable targets for impacts on assessments, and document the actual impacts.
- Document what biological, environmental and distribution information is collected uniquely by sentinel.
- Commercial index data should be incorporated into assessments or be terminated.
- Terminate specific projects that do not provide target information.

Mr Chapman outlined several perceived benefits of having the Groundfish Sentinel Program:

- Credible information is being generated and used by the Department; and,
- There is improved communications between some fishermen and some scientists in some areas.

Mr. Chapman also noted several areas, of a generalized nature, where there appeared to be problems;

- Some projects are not comprehensive in covering the full normal range of the stock.
- Stratified-random survey approach vs fixed station test-fishing approach. In his view, stratified designs often lead to a lack of confidence among fishermen that the results reflect the actual condition of the stock.

In elaborating on the survey design point, Mr. Chapman reviewed the use of the fixed station approach, or a hybrid (fixed:random) approach in other countries, including the North Sea, Iceland and Norway. He pointed out that fixed station designs were in use in a number of Canadian projects, using the Unit 1 redfish industry survey as an example. In his view, fixed station designs provide scientifically useful and credible results, while permitting fishermen a role in positioning set locations. Since this approach seems to serve the combined interests of science and industry better than the random design does, he feels the fixed station approach should be given more consideration, even if this means interrupting randomly designed series which have been in place for up to 6 years in some cases.

In closing, Mr. Chapman stated his belief that the annual SSR should provide a quantitative description of the impact of the sentinel fisheries data on the assessment. In addition, all fishermen (sentinel & non-sentinel) should be provided annually with an information sheet outlining the results and impact of the sentinel fisheries in their area.

4.2. General Discussion, Session 4

At this point the floor was opened for additional comments and perspectives from other workshop participants.

Among speakers from the floor, there was considerable expression of support for the Groundfish Sentinel Program, and while there were also calls for specific changes to specific projects, there was no voice for discontinuing the program. Speakers generally re-emphasized points made earlier in Regional overviews in support of the program.

A number of speakers emphasized the fact that the Groundfish Sentinel Program has helped to re-establish a degree of trust and a level of dialogue between the industry and the Department. In some areas, it was noted that this change did not come easily, and that there was some initial resistance to the introduction of the sentinel program in their area. The role that communications at all levels plays in building support for the

program and trust in the process was recognized. There were calls for more interactive meetings with fishers about the sentinel as a means of retaining and increasing understanding and support for the benefits of the program.

There were comments in favour of and against the retention of fish sales to offset sentinel costs. In Newfoundland, there are concerns that, with the northern cod stock so low in historical terms, there would be a need to re-direct the funds from sentinel to support these activities. There were also fears of the perception by non-sentinel fishers that sentinel fishers were under some pressure to show good results. A Gulf-based speaker defended the sale of fish, stating that this was required to have the program function smoothly. A Newfoundland participant was unaware that their project could carry-over fish sale revenue from year-to-year and wanted clarification that it could be used only to support sentinel activities in subsequent seasons..

A Maritimes-based speaker called attention to the current funding difficulty in that area, due to extremely low sentinel catches over the last several seasons and the attendant loss of revenue to the program. He explained that the program ran a deficit in 2001, but there is not sufficient funding available at this time to continue the existing program in 2002.

There were calls from several Gulf participants for more flexibility in distributing sentinel efforts, and adjustments to the timing to efforts. While one participant stated a preference for continuing the sentinel program over other RV-based assessment activities, other Gulf speakers supported the sentinel program as an important adjunct to the assessment process.

4.3. Summary Points: Industry Perspectives on Sentinel

1) There is broad support from the Atlantic groundfish industry for the Groundfish Sentinel Program.
2) Industry feels the program lends credibility to and builds support for the assessment process for target stocks, and that it is an important vehicle for dialogue between DFO Science and the industry on resource status and conservation issues.
3) Notwithstanding, the sentinel industry is prepared to discuss refinements and improvements to the program and have identified a number of issues for further consideration.
4) The merits of focussing on an objective-based approach were highlighted, coupled with a rigorous monitoring of results to evaluate the actual impact of sentinel efforts on the determination of stock status.
5) There is a need to better identify and to present the impact of sentinel activities on the outcomes of assessments, for the purposes of being able to monitor sentinel benefits on an on-going basis.
6) The sentinel industry believes that the Department's focus should be on improving the benefits derived from the current level of fiscal resources available to Groundfish Sentinel Program rather than looking for ways to reduce funding for the Program.

Session 5: The Future of Sentinel — Chair: R. Morin

In the concluding session of the workshop, issues related to the future of the Groundfish Sentinel Program were explored; including the need to properly prioritize sentinel activities in the future and approaches to funding sentinel activities. The Session was chaired by Rod Morin, DFO Science, Gulf Region.

5.1. Presentation: Future financing for sentinel activities – What are the alternatives? A. Frechet

Alain Frechet provided a general overview of different financing issues, in order to promote discussion about the funding of the Groundfish Sentinel Program in the future.

The range of available options for future funding of the Groundfish Sentinel Program was tabled and discussed, including;

- DFO funding
- Industry funding

- Integration into the commercial fishery as stocks rebuilds.
- Using current sentinel allocations to offset costs
- Increase sentinel allocation to fund sentinel activities

Several of these alternatives raise issues which would have to be resolved in order to be fully effective.

The first issue has to do with sentinel allocations in relation to stock rebuilding. The sentinel allocation seems relatively large given the current low TAC's, but it should represent a smaller proportion of the TAC as stocks rebuild. There is no need foreseen to increase sentinel allocations as these stocks rebuild. The size of the sentinel allocation should be set to cover the fish caught in the sampling procedures.

In the future, fishermen could choose to quit some sentinel programs, depending on how they are set up, if they are losing money compared to other traditional fishermen involved in the directed fishery. The Northern Gulf experience is in that direction, and was described earlier, (see session 2, part 1, Laurentian approach). The sentinel program there allows for a gradual movement from a full vessel-charter program with no access to fish catches towards a quasi-commercial situation where a lesser amount is paid for sampling but fishermen keep the value of fish sales. In other programs, the design may not create the need to choose between sentinel and directed activities. For example, in 3Ps, it was reported that no participant has left the program even though the TAC rose to as high as 30,000mt in a recent season.

The second issue related to evolving funding has to do with the approach taken by commercial fishermen relative to the structured scientific requirements of sentinel projects. A dilemma arises between the need to collect sentinel data under a strict scientific protocol to derive the best time series versus the commercial fishery, which has economic objectives. Also, fishing techniques are continuously changing, generally in the direction of improving technology and relative efficiency (higher catch per unit effort). This may also affect time series in which technology has not evolved but felt to represent changes in fish density over time. Should the sentinel program follow these technological changes? What are the impacts on the time series?

Another question was raised concerned the fate of excess sentinel allocations. The annual sentinel landings may vary greatly because of the sampling protocol. Should any excess allocation be returned to the directed fishery? Could it be caught in a commercial mode in order to gain more information and build a special fund for bad years?

5.2. Presentation: Adjustment and priorization; an evaluation of approaches.
D. Gillis

In addition to the specific mechanisms for funding of sentinel activities discussed in the previous section, the Groundfish Sentinel Program of the future will have to face decisions on how to adjust and adapt to changes in sentinel resources. To now, there has been no explicit discussion about what factors are most relevant to consider in guiding decisions about how to adjust the Groundfish Sentinel Program in the future. Dave Gillis identified the following possible approaches to prioritization to promote discussion:

- Toward sentinel goals. This approach would preserve those elements of the sentinel program that were most closely related to meeting the original goals and objectives of the Groundfish Sentinel Program;
- Toward selected indices. Under this approach, those indices of abundance which best described the stock condition would be favoured, at the expense of other fishing activities;
- Identify key or proxy sites. This approach would propose to use existing sentinel data and stock information to pare down sentinel activities in a manner that preserved the maximum of information about the stock for the fewest reasonable number of sampling sites or points;
- Consider stock prospects. Under this approach, sentinel activities would be re-distributed in reflection of stock condition and the likelihood that the stock would re-build within a prescribed time;

- Consider assessment needs. Under this approach, the current quality of the assessment with and without sentinel data would guide decisions and priority given to those situations where sentinel information was seen to play more of a role in resolving stock status.

In opening the ensuing discussion, Mr. Gillis allowed that this list was not exhaustive and that other possible approaches to prioritizing sentinel activities likely existed.

5.3. General Discussion, Session 5

The presentations and workshop questions related to the issues of future funding for sentinel and approaches to prioritization generated a lot of discussion among participants. There were a number of questions and points of clarification; and the Chair directed the groups to their tables for roundtable discussion and reports. Principle points emerging from these discussions were the following:

A number of intervenors made the point that the Department must not cut funding to this Program, at least at this time. They noted that the GSP has made great strides in addressing knowledge requirements for these stocks and has restored confidence of the industry in the assessment process where it had become seriously eroded before. Several speakers advocated a better approach than cutting spending on sentinel was to work at increasing the value derived from sentinel efforts and thus the return on the current level of investment in sentinel activities. They argued this could be done by making more out of existing sentinel results, and by adding or 'piggy-backing' new elements onto the sentinel platform.

Other speakers took the attitude that changes in how the GSP is funded are inevitable or even appropriate under certain circumstances. One participant made the point that having a mix of government and industry resources in the sentinel pot makes the arrangement more of a true partnership, where both parties contribute in real terms. Many, however, remained concerned that any substantial move away from government funding toward having the industry pay or the depending on proceeds of commercial fishing would and lead to distrust among fishers about sentinel activities and thus weaken the integrity of the program.

The concept of increasing the use of fish sales in the future to fund sentinel activities, either by increasing the commercial index allocations or by placing a levy on commercial landings, generated considerable discussion. Arbitrarily raising the TAC to provide more fish to sentinel was not considered practical or conservationist thinking. Participants recognized the dilemma of, on one hand, not wanting to cut commercial allocations back in order to provide more fish for sentinel, while on the other hand, not being able to depend on the commercial fishery to provide useful data for stock assessment. Other participants were concerned that allocation decisions to sentinel be driven by the quality of data generated rather than the quantity of fish that could be caught. The potential hazards of depending on fish sales before re-building has taken place was illustrated by the case of the 4VsW, where very poor catch rates have put the existing sentinel program into a deficit position. One participant predicted that cross-subsidization of sentinel activities, using the example of using fixed gear revenue to fund mobile gear surveys, would not be acceptable to some industry sectors.

There was some support among participants for the concept of integrating the maintenance of sentinel datasets into the commercial fishery in the future, especially in those situations when and where stocks were re-building. The arrangement currently in place in the Laurentian Region was interesting to some. The benefits of having some flexibility to adjust to increasing commercial allocations and maintain sentinel databases that way were recognized. Some worried that fishers in these dual-purpose fisheries might 'cut corners' during their sentinel activities in order to maximize their commercial outcomes, but others felt more certain that not all sentinel fishers would abandon the program. Also the need to deal with differences in gears and to follow the evolution of gears was noted as an issue to be addressed in any combined commercial:sentinel program.

There was a strong voice throughout this session for the need to maintain and wherever possible enhance the quality of the Groundfish Sentinel Program, Quality variously included characteristics such as scientific rigor, credibility, flexibility, pertinence, and sustainability. Speakers reminded the gathering that without that integrity, the Groundfish Sentinel Program will not continue re-respective of the source or level of funding. There were also a number of suggestions forwarded for making the program more efficient and reducing any waste that may be occurring now, including reduction of over-sampling, identifying and focussing on key sites and times, lowering administrative costs wherever possible (ie: multiple Gulf contracts).

Several other issues related to funding were notable. There was a call for guidelines to aid in re-distributing sentinel funding between Regions, when and where this might be necessary. There was also a call to ensure adequate guidelines were in place to govern the accumulation and use of surplus funds from one season or activity to cover expenses at another place or time.

In conclusion, several speakers wished to remind the Department that should any significant change in funding levels for the Groundfish Sentinel Program be contemplated in future that the Department should consult directly and in advance with the affected industry.

5.4. Summary Points: The Future of Sentinel

1) A range of options for future funding of sentinel activities was tabled. There was a strong view from sentinel participants that current government funding of sentinel activities must be maintained and preserved for the foreseeable future.
2) Among other alternatives, discussions centered on the merits of blending the maintenance of sentinel datasets into commercial fishery operations, wherever possible. A number of issues that would require further discussion and planning were identified.
3) Funding sentinel activities using catch revenues reduces the dependence on government funding sources, but introduces the prospect that changing stock conditions could affect sentinel funding at a critical time.
4) The need to maintain and improve the scientific integrity of the Groundfish Sentinel Program was an overriding concern.
5) Significant changes to funding levels should be discussed in advance with the affected industry groups.
6) A review of possible approaches to prioritizing sentinel activities during a period of change generated little discussion among participants.

Summary and Closing Remarks **Session Chairs, D Gillis**

Following completion of discussion in the last session, Dave Gillis invited each of the Session Chairs to provide a brief overview of the presentation points and discussion from their respective sessions. Perspectives offered in these summaries have been incorporated into the session reports comprising the bulk of this Workshop Report.

In his closing remarks, Dave Gillis thanked the Session Chairs and rapporteurs for their assistance during the Workshop and outlined the next steps in the production of the workshop report. He expected that the draft report would be available for comment (means to be determined) early in 2002.

Mr. Gillis thanked all the participants for their contribution to the presentations and discussion over the course of the Workshop. He reminded them that the report should be seen as a resource for Regions to use as they implement the sentinel program in their respective areas in upcoming months and years. The report will also serve to reflect and encapsulate the views of the industry and DFO sentinel staff as the Department completes the review of the Program and thereafter manages the delivery of the Groundfish Sentinel Program into the future.

ANNEX 1 - Workshop agenda

AGENDA
Workshop on the Groundfish Sentinel Program

Hotel Delta Beausejour, Moncton, New Brunswick
November 07 – 09, 2001

Wednesday, November 07, 2001		
8:00am – 9:00am	**Registration & Orientation**	
8:00am – 8:30am	Registration	
8:30am – 8:45am	Welcome -	Serge Labonté A/ADM Science
8:45am – 12:00pm	**Session 1: Introduction to the Groundfish Sentinel Program**	
8:45am – 9:30am	Sentinel Program, Design and Implementation	D. Gillis
9:30am – 10:00am	Industry:Science Initiatives; An Overview	P Fanning
10:00am – 10:20am	**BREAK**	
10:20am – 12:00pm	Regional summaries	
10:20am – 10:45am	Maritimes	P Fanning
10:45am - 11:10am	Gulf	G Chouinard
11:10am – 11:35am	Laurentian	A Frechet
11:35am – 12:00pm	Newfoundland	R Stead
12:00pm – 12:15pm	Q&A	All
12:15pm – 13:15pm	**LUNCH**	
13:15pm – 5:00pm	**Session 2: Scientific/Technical Issues**	
1:30pm – 3:00pm	Project design	DFO Coordinators
3:00pm – 3:20pm	**BREAK**	
3:20pm – 5:00pm	Quality and quantity of data	DFO Coordinators
5:00pm – 7:00pm	**Static Presentations/ Cash Bar Mixer (Foyer)**	

Thursday, November 08, 2001		
8:30am – 12:00pm	**Session 2: Scientific/Technical Issues (con't)**	
8:30am – 10:00pm	Data treatment and assessment	DFO Coordinators
10:00am – 10:20am	**BREAK**	
10:20am – 12:00pm	Other species & research	DFO Coordinators
12:00pm – 13:00pm	**LUNCH**	
1:00pm – 5:00pm	**Session 3: Efficiency & Cost-effectiveness**	

1:00pm – 1:40pm	Costs & benefits of sentinel activities to the assessments, an introduction	D Gillis
1:40pm – 2:20pm	Relative efficiency within the sentinel program	A Frechet
2:30pm – 3:00pm	Sampling intensity for sentinel activities – Measurements & observations	Ghislain Chouinard
3:00pm – 3:20pm	**BREAK**	
3:20pm – 4:00pm	Multiple indices vs risk	R Mohn
4:00pm – 4:40pm	Identifying influential indices	A Frechet
4:40pm – 5:00pm	Discussion – Measuring and achieving efficiency and cost effectiveness in sentinel	Plenary
5:00pm – 6:30pm	**SUPPER**	
6:30pm – 9:00pm	**Session 4: Industry Perspectives on Sentinel**	
6:30pm – 7:10pm	Industry presentations, 10 minutes/Region	
7:10pm – 7:30pm	Observations on sentinel – independent industry guests (2)	
7:30pm – 9:00pm	Panel Discussion: Industry Perspectives on Sentinel	

Friday, November 09, 2001

8:30am – 10:00am	**Sessions 3 & 4, continued** Continuation of technical issues discussions from Sessions 3 & 4, as necessary	
10:00am – 10:20am	**BREAK**	
10:20am – 3:00pm	**Session 5: The Future of Sentinel**	
10:20am – 11:15am	Future financing for sentinel activities – What are the alternatives?	Plenary
11:15am – 12:00pm	Adjustment and prioritization; an evaluation of approaches	Plenary
12:00pm – 1:00pm	**LUNCH**	
1:00pm – 2:30pm	Review and synthesis of discussions - Role of sentinel in longer term - Consensus for change - Issues requiring more work	Plenary
2:30pm – 3:00pm	**Closing Remarks**	**D. Gillis**

ORDRE DU JOUR

Atelier sur le Programme Sentinelle pour les Poissons de Fond
Hôtel Delta Beauséjour, Moncton (Nouveau-Brunswick)
7 au 9 novembre 2001

Le mercredi 7 novembre 2001

8 h – 9 h	**Inscription et orientation**	
8 h – 8 h 30	Inscription	
8 h 30 – 8 h 45	Bienvenue	Serge Labonté, A/ADM Science
8 h 45 – 12 h	**Séance 1 : Introduction au programme sentinelle**	
8 h 45 – 9 h 30	Conception et mise en œuvre du programme	D. Gillis
9 h 30 – 10 h	Initiatives scientifiques de l'industrie –Un aperçu	P Fanning
10 h – 10 h 20	**PAUSE**	
10 h 20 – 12 h	Sommaires régionaux	
10 h 20 – 10 h 45	Maritimes	P Fanning
10 h 45 - 11 h 10	Golfe	G Chouinard
11 h 10 – 11 h 35	Laurentienne	A Frechet
11 h 35 – 12 h	Terre-Neuve	R Stead
12 h – 12 h 15	Q&R	Tous
12 h 15 – 13 h 15	**DÉJEUNER**	
13 h 15 – 17 h	**Séance 2 : Questions scientifiques et techniques**	
13 h 30 – 15 h	Conception du programme	Coord. du MPO
15 h – 15 h 20	**PAUSE**	
15 h 20 – 17 h	Qualité et quantité de données	Coord. du MPO
17 h – 19 h	**Présentoirs / Rencontre - Bar payant (Foyer)**	

Le jeudi 8 novembre 2001

8 h 30 – 12 h	**Séance 2 : Questions scientifiques et techniques (suite)**	
8 h 30 – 10 h	Traitement des données et évaluation	Coord. du MPO
10 h – 10 h 20	PAUSE	
10 h 20 – 12 h	Autres espèces et recherches	Coord. du MPO
12 h – 13 h	**DÉJEUNER**	

13 h – 17 h	**Séance 3 : Efficacité et rentabilité**	
13 h – 13 h 45	Coûts et bénéfices des activités sentinelles sur les évaluations de stocks (introduction)	D. Gillis
13 h 45 – 14 h 30	Efficacité relative à l'intérieur du programme Sentinelle	A Frechet
14 h 30 – 15 h	Intensité de l'échantillonnage pour les pêches sentinelles – Mesures et observations	Ghislain Chouinard
15 h – 15 h 20	**PAUSE**	
15 h 20 – 15 h 50	Indices multiples et risques	R Mohn
15 h 50 – 16 h 20	Détermination des indices d'influence	A Frechet
16 h 20 – 17 h	Discussion – Quantifier et atteindre l'efficacité et la rentabilité du programme	Séance plénière
17 h – 18 h 30	**DÎNER**	
18 h 30 – 21 h	**Séance 4 : Perspectives de l'industrie concernant les pêches sentinelles**	
18 h 30 – 19 h 10	Exposés de l'industrie 10 minutes/Région	
19 h 10 – 19 h 30	Observations sur les pêches sentinelles – invités indépendants de l'industrie (2)	
19 h 30 – 21 h	Discussion en groupe Perspectives de l'industrie au sujet des pêches sentinelles	

Le vendredi 9 novembre 2001

8 h 30 – 10 h	**Séances 3 et 4 (suite)** Poursuite, s'il y a lieu, des discussions sur les questions techniques des sessions 3 et 4.	
10 h – 10 h 20	**PAUSE**	
10 h 20 – 15 h	**Séance 5 : L'avenir du programme des pêches sentinelles**	
10 h 20 – 11 h 15	Financement futur du programme – Quelles sont les solutions de rechange?	Séance plénière
11 h 15 – 12 h	Rajustements et établissement des priorités - évaluation des approches	Séance plénière
12 h – 13 h	**DÉJEUNER**	

13 h – 14 h 30	Examen et synthèse des discussions - Rôle à plus long terme des pêches sentinelles - Consensus en vue d'un changement - Questions à approfondir	Séance plénière
14 h 30 – 15 h	**Mot de la fin**	**D. Gillis**

ANNEX 2 - List of participants

Registered Participants
Participants Inscrits

Group/groupe	
DFO Science Sector - Sentinel Secteur des Sciences du MPO - Sentinelle	
Alain Frechet	Laurentian/*Laurentienne*
Marthe Bérubé,	Laurentian/*Laurentienne*
Philippe Schwab	Laurentian/*Laurentienne*
Joanne Gauthier	Laurentian/*Laurentienne*
Paul Fanning	Maritime/*Maritime*
Bill MacEachern	Maritime/*Maritime*
Bob Mohn	Maritime/*Maritime*
Diane Beanlands	Maritime/*Maritime*
Ghislain Chouinard	Gulf/*Golfe*
Amelie Rondeau	Gulf/*Golfe*
Rick Stead	Newfoundland/Terre-Neuve
Dawn Maddock-Parsons	Newfoundland/Terre-Neuve
Todd Paddle	Newfoundland/Terre-Neuve
DFO Science Sector Secteur des Sciences du MPO	
Serge Labonté	Ottawa/*Ottawa*
Denis Rivard	Ottawa/*Ottawa*
Dave Gillis	Ottawa/*Ottawa*
Jean Boulva	Laurentian/*Laurentienne*
Mike Sinclair	Maritime/*Maritime*
Mike Chadwick	Gulf/*Golfe*
Bruce Atkinson	Newfoundland/Terre-Neuve
Geoff Perry	Newfoundland/Terre-Neuve
Serge Gosslein	Laurentian/*Laurentienne*
Hugeuf Benoit	Gulf/*Golfe*
Tom Hurlbut	Gulf/*Golfe*
Rod Morin	Gulf/*Golfe*
Doug Swain	Gulf/*Golfe*
DFO Fisheries Management Gestion des pêches MPO	
Michel Albert	Gulf/*Golfe*
Réjean Hebert	Gulf/*Golfe*
Georges Moores	Gulf/*Golfe*
Gary Brocklehurst	Newfoundland/Terre-Neuve
Jon Hansen	Maritime/*Maritime*
DFO Others Autres MPO	
Catherine Vardy	Gulf/*Golfe*
Patricia Gibbons	Gulf/*Golfe*
Provinces Les Provinces	
Dario Lemelin	Quebec
Mario Gaudet	New Brunswick
Clary Reardon	Nova Scotia
Dave MacEwen	PEI
FRCC CCRH	
Michel Vermette	Ottawa/*Ottawa*
Others Autres	
Dan Lane	Ottawa/*Ottawa*
Bruce Chapman	Ottawa/*Ottawa*
Laura Taylor Singer	Gulf of Maine Aquarium, Portland, Maine, USA
Ola Benoit	BIOREX
France Henry	BIOREX

Industry/Industrie

Group/groupe		Representatives/ représentants		
G	Regroupement des pêcheurs du sud de la Gaspésie (RPSG)	Harold Grenier		
G	Groupe Forillon			
G	Northern Cape Breton Fishing Vessel Association (NCBFVA)	Clifford Aucoin		
G	PEI Groundfish Association (PEIGA)	Wayne Anderson	Frank Hennessey	
G	Regroupement des pêcheurs professionelle des Îles de la Madeleine (RPPIM)	Pierre Arseneau	Rachèle Cyr	Réjean Vigneau
G	Ass'n des pêcheurs de poisson de fond acadiens (APPFA)	Alyre Gauvin	Paul-Hédard Haché	
G	Association des pêcheurs de la MRC Pabok	Gilles Meunier	Gilles Albert	
G	Federation of Gulf Nova Scotia Groundfishermen (FGNSG)	Osborne Burke	Sandy Benoit	Allan Adams, Kay Wallace
G	Maritime Fishermen Union (MFU)	Mike Bellevue	Amédée Savoie	Paul-Aimé Mallet
G	PEI Fisherman Association (PEIFA)	Fred Beairsto		
G	Regroupement des pétoncliers et palangriers uniques madelinot (RPPUM)	Pierre Chevrier	Ghislain Cyr	
L	Fish Food and Allied Workers Union (FFAW) – Western NF	Dave Decker	Jason Spingle	Jacqui House
L	Capitaines Propriétaires de la Gaspésie Inc. (ACPG)	Louis Pageau	Guy Moreault	
L	Regroupement des Associations des Pêcheurs.de la Basse Côte-Nord (RAPBCN)	Paul Nadeau	Frank Collier	
M	Fishermen's Science Research Society (FSRS)	Patricia King	Carl MacDonald	Randy Boutilier, John Levy
M	4Vn Sentinel Association	Kevin Nash	Tim Lambert	David Ferguson, Robert Courtney
N	Fish Food and Allied Workers Union (FFAW) – Eastern NF	Harvey Jarvis	George Feltham	Reg Anstey, Bill Broderick
N	Fogo Island Co-operative Society	Bernadette Dwyer	Kristine House-Best	
N	Petty Harbour Fishermen's Co-operative	Tom Best		

G = Gulf/Golfe L = Laurentian/Laurentienne M = Maritimes/Maritimes N = Newfoundland/Terre-Neuve

ANNEX 3 - Terms of Reference

TERMS OF REFERENCE

REVIEW OF THE SENTINEL SURVEY PROGRAM 2001-02

Background:

Information derived from commercial fisheries activities is a common input into the groundfish stock assessment process. For a number of major groundfish stocks, particularly Atlantic cod, resource declines lead to sharp reductions in catches and fishery closures in 1992 to 1994 and disrupted the flow of commercial fishery information to the assessment process. With support and encouragement from the FRCC, the sentinel survey program was implemented in 1994 to re-establish a source of such information and re-involve fishers in the assessment process, by allowing a limited amount of fishing by commercial fishers under controlled circumstances. The Department provided funding to cover the costs of the projects, and allocations of resource were established for their operation. Sentinel surveys were not intended to have a strong commercial aspect, and the amount of catch in sentinel efforts has been generally low compared to commercial standards.

The need for information of this type is now seen to be considerably longer-term than originally thought. An increasing number of groundfish assessments now incorporate sentinel information as an indicator of stock status. Other types of data and samples for groundfish and other marine species are also increasingly collected through sentinel activities.

As sentinel survey projects have developed and evolved over the period, different approaches to the application of key policies have emerged. For example, fish sales are to be used by the contractor to offset costs of the program. In some cases, the value of catch is permitted to accrue to the contractor and/or the fisher, while in others, any value generated by sale of catch is mandated by contract to be used to offset costs within the sentinel project. Government funding for sentinel surveys remains substantial, totaling about $5 million. This Departmental funding still represents the majority of revenue to the project in most cases, however, exceptions exist where catches can have significant value, and these instances may increase as or when stocks rebuild.

The 1999 Zonal Assessment of Atlantic cod stocks in Rimouski, Quebec recommended a review of how sentinel projects were addressing the goals of the program and an evaluation of the statistical treatment of sentinel data. The recently completed Stock Assessment Review (SAR) demonstrated a log-linear relationship between knowledge costs and knowledge gains; and noted that sentinel surveys represented a relatively large investment in assessment knowledge. At the same time, it was noted that sentinel surveys provide many other benefits in addition to the assessment information derived, and that these projects are only now beginning to provide the solid time series needed for many

assessments. Involvement in sentinel projects has increased industry involvement in the assessment process, which has promoted increased interest in and input to the issue of stock status by resource user groups. The SAR calls for these and other attributes of the sentinel survey to be examined in more detail, in order to identify potential efficiencies and to ensure that the program is cost-effective and properly designed for the longer term.

Purpose:
The purpose of the review is to provide recommendations designed to position the sentinel fishery program as an effective and cost-efficient component of the groundfish assessment process on a longer-term basis. The review will characterize the various elements and data products within the sentinel programs to provide clear, consistent and critical information on the full costs and benefits of each. The recommendations and information provided are intended to assist the management of the program in response to changing natural and fiscal resources.

Scope:
This review will focus on all aspects of the Sentinel Survey Program across the Atlantic Coast groundfish fishery, including goals and criteria for the establishment of sentinel surveys, administrative and policy questions, quality and quantity of data and analysis, effectiveness of the program in contributing to assessments, benefits from involving industry in the assessment process, cost-efficiency in relation to information derived and other assessment tools, re-alignments necessary to optimize resources available, funding mechanisms, and managing change.

Objectives:
1. Describe the groundfish sentinel survey program and associated projects, for the purposes of documenting and understanding their contribution to the Canadian Atlantic groundfish stock assessment process and the impact that they have on the quality of advice on groundfish stock status. To this end, this review will;

    1.1. Document the circumstances leading to the establishment of the program, including prior assessment practices, impact of fishery closures and quota reductions on those assessment practices, and the intended role and goals and objectives of the sentinel survey program in addressing those impacts.
    1.2. Concisely review the development and evolution of sentinel survey projects as an assessment tool for Canadian Atlantic groundfish stocks.
    1.3. Construct an inventory of current projects sufficiently detailed to support comparison with regards to all relevant aspects under review.
    1.4. Identify the range and quality of data and information products being generated from sentinel survey sources, and consider the effect and influence those data and information are having on the quality of the assessments, and on general knowledge of marine resources.
    1.5. Consider the effect and influence that information derived from sentinel survey projects is having on industry's view of stock status and of the results of the assessment.

1.6. Review the range of approaches available to provide assessment data using industry involvement, including sentinel surveys, index fisheries, industry surveys and other forms of sampling, keying on appropriate circumstances for their consideration, and relative costs/benefits.

2. Consider and advise on what changes may be necessary to the groundfish sentinel survey program and associated projects to be an effective and efficient element of the groundfish stock assessment process on a longer-term basis. In so doing, the review will consider information requirements of DFO Science, the FRCC, and the industry and the financial resources necessary and available to meet those requirements. To this end, this review will;

   2.1. Outline what contextual changes have occurred in the time since the establishment of this program which might be relevant in considering the future role for and operation of sentinel surveys.
   2.2. Consider and identify what if any refinement of the original goals and objectives for the program may be necessary; in consideration of contextual changes outlined above and the prospect that some need for information of this type may continue on an extended basis.
   2.3. Determine what changes to key Departmental policies and regulatory requirements should be considered, with a view to ensuring sentinel projects are being conducted prudently and consistently.
   2.4. Identify opportunities where additional information may be collected from sentinel efforts in a cost-effective manner, and where further types of analyses or uses of data may add value to the assessment.
   2.5. Identify issues and solutions related to the quality of data and information being collected in sentinel efforts.
   2.6. Identify any design issues, including spatial or temporal gaps, that may exist in the sentinel program, where adjustments would lead to increased value to the assessment.
   2.7. Evaluate opportunities to improve cost-effectiveness within sentinel survey projects, with due regard for the potential impact on assessments.
   2.8. Evaluate benefits derived from the collection of other information, not related to groundfish, that is being collected through sentinel activities and used by DFO scientists.
   2.9. Consider explicitly the intrinsic value of sentinel information to the fishing industry sector with regards to their view on stock status and their acceptance of the results of the stock assessment process, and what changes are needed to optimize this value

3. Identify challenges to be addressed in implementing changes to the groundfish sentinel survey program and associated projects, and recommend how these changes could be accomplished while respecting needs for continuance and continuity of data and information. To this end, this review will;

3.1. Evaluate prospects for alternative approaches to financing sentinel survey projects, including opportunities to leverage funds from other sources, and the use of resource allocations to defray sentinel project costs.
3.2. Recommend approaches to prioritize components of the sentinel survey program for the future, in respect of evolving stock conditions, evolving approaches to gathering and analyzing information related to stock status, and the availability of research funds.
3.3. Develop guidelines to adjust sentinel efforts in relation to stock rebuilding and recovery.
3.4. Identify residual issues and/or issues arising which cannot be resolved by the review, but which could be addressed by other processes such as the Regional Assessment Process (RAP) and Advisory Committees.
3.5. Propose methods to inform and engage sentinel program participants and users of sentinel information of any planned changes in an effective manner in order to foster continued cooperation.
3.6. Establish a framework of key design and outcome-based elements that can be used in future by project managers to evaluate individual projects and proposals against the established goals, objectives and policies for the sentinel survey program.

Coordination & Responsibilities:

The Senior Advisor, Partnering & Technology (SA, P&T) will be responsible for coordination of the review process and the workshop, reporting directly to the A/Director, Fisheries Research Branch, in Ottawa. The Regional DFO sentinel managers & staff , industry sentinel coordinators, and a Department scientist not directly associated with the Sentinel Program (to be recruited) will form a Sentinel Review Team, chaired by the SA, P&T. The SRT will discuss, design and oversee the implementation of the workshop and the development of relevant documents and review tools. In the implementation of these steps, other Regional and National staff may be asked as necessary to assist the SRT with elements of the review. Process issues related to the review will be addressed by a Steering Committee to include the SA, P&T, the Regional DFO sentinel managers and up to two industry sentinel coordinators to be designated.

Other parties with an interest in this issue (incl; National and Regional DFO managerial staff) will be kept abreast and informed on an on-going basis by all appropriate means.

Approach:
The review will include the collection of available information related to the sentinel survey program from all sources, preparation of descriptive documents, development and application of evaluation tools for analyzing this information, and the development of recommendations. Broad discussion of issues relevant to this review will be achieved through a Workshop on Sentinel Surveys, to be conducted in November 2001. In addition to the Steering Committee, participants in the workshop will include DFO groundfish assessment scientists, independent scientists (from university, US or other), key representatives of the industry groups currently involved in sentinel survey projects,

representatives of the Fisheries Resource Conservation Council, and staff of other DFO Branches including Fisheries Management, Conservation & Protection and Policy & Planning.

Inputs:
Main sources of information for the review will include:

- Documentation relating to the terms of the original program and any subsequent changes;
- Compilation, synthesis and analysis of information related to the past and current implementation of the program, including;
  - Operational and administrative procedures
  - Types, quantity and quality of data and other information collected
  - Relationship of projects to the assessment process
  - Project/program costs
  - Removals and resource implications
- Views of industry, scientists, FRCC, and other DFO personnel on key issues and questions to be collected during the Workshop.

Steps/Timetable:

Advance planning for workshop	June
Detailed ToR for Review	by June 30
Development of evaluation tools	by September
Information compilation and preliminary analysis	July – October
Detailed planning for workshop	September
Workshop	Nov 07-09, 2001
Completion of evaluation and recommendations	Nov – February 2002
Workshop report	March 2002

Deliverables:
A Workshop Report
Recommendations relevant to the objectives, to be developed by a Review Committee to include the Director, Fisheries Research, Regional Science Directors and the Steering Committee.

ANNEX 4 - Roles and Responsibilities in Sentinel Projects

INDUSTRYCOORDINATOR COORDONNATEUR DE L'INDUSTRIE	Deployment of activities *Déploiement des activitées*	Provision of bait *Provision des apâts*	Supervision of field worker *Supervision du technicien*	Navigation *Navigation*	Measurements of the fish *Mesure de poissons*	Tabulation on forms *Tabulations sur formulaires*	Validation of forms *Validations des formulaires*	Keypunching of forms *Saisie des formulaires*	Quality control of the work *Contrôle de la qualité du travail*	Financial management *Gestion financière*	Writing circulars, communications *Rédaction de circulaires, comm.*	Participation in assessment(s) *Participation au(x) évaluation(s)*	Participation to the steering committee *Participation au comité directeur*	Secretariat *Secrétariat*
1 - Québec fixed 4S	■	■	■		■		■		■	■	■	■	■	
2 - Newfoundland fixed 4R,3Pn	■	■	■				■		■	■	■	■	■	
3 - Newfoundland mobile 4R, 3Pn	■		■				■		■	■		■	■	
4 - Québec mobile 4S	■				■	■	■	■	■		■	■	■	
5 - FFAW Sentinel 2J3KL	■		■					■		■	■	■		
6 - FFAW Sentinel 3Ps	■		■					■		■	■	■		
7 - Fogo Island Sentinel	■						■	■	■	■	■	■		
8 - Petty Harbour Sentinel	■									■	■	■		
9 - PEI fixed 4T	■								■	■				■
10 - PEI mobile 4T														
11 - NS fixed 4T	■								■	■				■
12 - NS mobile 4T (trawl)														
13 - NS mobile 4T (seine)														
14 - NB fixed 4T														
15 - NB mobile 4T (seine)														
16 - Gaspé-north fixed 4T														
17 - Gaspé-south fixed 4T														
18 - Gaspésie mobile 4T														
19 - Magdalen fixed 4T														
20 - Magdalen mobile 4T(seine)														
21 - 4Vn Sentinel Survey	■	■	■							■	■			■
22 - 4Vn Monthly Monitoring	■	■	■							■	■			■
23 - 4Vn Migration study	■	■	■							■	■			■
24 - Bras d'or Lakes Study	■	■	■							■	■			■
25 - 4Vn Commercial Index	■	■	■							■	■			■
26 - 4VsW Random Survey	■									■				■
27 - 4VsW Commercial Index	■									■				■

FIELD TECHNICIAN TECHNICIEN DE TERRAIN	Deployment of activities *Déploiement des activitées*	Provision of bait *Provision des apâts*	Supervision of field worker *Supervision du technicien*	Navigation *Navigation*	Measurements of the fish *Mesure de poissons*	Tabulation on forms *Tabulations sur formulaires*	Validation of forms *Validations des formulaires*	Keypunching of forms *Saisie des formulaires*	Quality control of the work *Contrôle de la qualité du travail*	Financial management *Gestion financière*	Writing circulars, communications *Rédaction de circulaires, comm.*	Participation in assessment(s) *Participation au(x) évaluation(s)*	Participation to the steering committee *Participation au comité directeur*	Secretariat *Secrétariat*
1 - Québec fixed 4S														
2 - Newfoundland fixed 4R,3Pn														
3 - Newfoundland mobile 4R, 3Pn														
4 - Québec mobile 4S														
5 - FFAW Sentinel 2J3KL														
6 - FFAW Sentinel 3Ps														
7 - Fogo Island Sentinel														
8 - Petty Harbour Sentinel														
9 - PEI fixed 4T														
10 - PEI mobile 4T														
11 - NS fixed 4T														
12 - NS mobile 4T (trawl)														
13 - NS mobile 4T (seine)														
14 - NB fixed 4T														
15 - NB mobile 4T (seine)														
16 - Gaspé-north fixed 4T														
17 - Gaspé-south fixed 4T														
18 - Gaspésie mobile 4T														
19 - Magdalen fixed 4T														
20 - Magdalen mobile 4T(seine)														
21 - 4Vn Sentinel Survey														
22 - 4Vn Monthly Monitoring														
23 - 4Vn Migration study														
24 - Bras d'or Lakes Study														
25 - 4Vn Commercial Index														
26 - 4VsW Random Survey														
27 - 4VsW Commercial Index														

DATA ENTRY CLERK COMMIS À LA SAISIE	Deployment of activities *Déploiement des activitées*	Provision of bait *Provision des apâts*	Supervision of field worker *Supervision du technicien*	Navigation *Navigation*	Measurements of the fish *Mesure de poissons*	Tabulation on forms *Tabulations sur formulaires*	Validation of forms *Validations des formulaires*	Keypunching of forms *Saisie des formulaires*	Quality control of the work *Contrôle de la qualité du travail*	Financial management *Gestion financière*	Writing circulars, communications *Rédaction de circulaires, comm.*	Participation in assessment(s) *Participation au(x) évaluation(s)*	Participation to the steering committee *Participation au comité directeur*	Secretariat *Secrétariat*
1 - Québec fixed 4S														
2 - Newfoundland fixed 4R,3Pn														
3 - Newfoundland mobile 4R, 3Pn														
4 - Québec mobile 4S														
5 - FFAW Sentinel 2J3KL														
6 - FFAW Sentinel 3Ps														
7 - Fogo Island Sentinel														
8 - Petty Harbour Sentinel														
9 - PEI fixed 4T														
10 - PEI mobile 4T														
11 - NS fixed 4T														
12 - NS mobile 4T (trawl)														
13 - NS mobile 4T (seine)														
14 - NB fixed 4T														
15 - NB mobile 4T (seine)														
16 - Gaspé-north fixed 4T														
17 - Gaspé-south fixed 4T														
18 - Gaspésie mobile 4T														
19 - Magdalen fixed 4T														
20 - Magdalen mobile 4T(seine)														
21 - 4Vn Sentinel Survey														
22 - 4Vn Monthly Monitoring														
23 - 4Vn Migration study														
24 - Bras d'or Lakes Study														
25 - 4Vn Commercial Index														
26 - 4VsW Random Survey														
27 - 4VsW Commercial Index														

OBSERVER OBSERVATEUR	Deployment of activities *Déploiement des activitées*	Provision of bait *Provision des apâts*	Supervision of field worker *Supervision du technicien*	Navigation *Navigation*	Measurements of the fish *Mesure de poissons*	Tabulation on forms *Tabulations sur formulaires*	Validation of forms *Validations des formulaires*	Keypunching of forms *Saisie des formulaires*	Quality control of the work *Contrôle de la qualité du travail*	Financial management *Gestion financière*	Writing circulars, communications *Rédaction de circulaires, comm.*	Participation in assessment(s) *Participation au(x) évaluation(s)*	Participation to the steering committee *Participation au comité directeur*	Secretariat *Secrétariat*
1 - Québec fixed 4S														
2 - Newfoundland fixed 4R,3Pn														
3 - Newfoundland mobile 4R, 3Pn														
4 - Québec mobile 4S														
5 - FFAW Sentinel 2J3KL														
6 - FFAW Sentinel 3Ps														
7 - Fogo Island Sentinel														
8 - Petty Harbour Sentinel														
9 - PEI fixed 4T														
10 - PEI mobile 4T														
11 - NS fixed 4T														
12 - NS mobile 4T (trawl)														
13 - NS mobile 4T (seine)														
14 - NB fixed 4T														
15 - NB mobile 4T (seine)														
16 - Gaspé-north fixed 4T														
17 - Gaspé-south fixed 4T														
18 - Gaspésie mobile 4T														
19 - Magdalen fixed 4T														
20 - Magdalen mobile 4T(seine)														
21 - 4Vn Sentinel Survey														
22 - 4Vn Monthly Monitoring														
23 - 4Vn Migration study														
24 - Bras d'or Lakes Study														
25 - 4Vn Commercial Index														
26 - 4VsW Random Survey														
27 - 4VsW Commercial Index														

SKIPPERS CAPITAINES	Deployment of activities *Déploiement des activitées*	Provision of bait *Provision des apâts*	Supervision of field worker *Supervision du technicien*	Navigation *Navigation*	Measurements of the fish *Mesure de poissons*	Tabulation on forms *Tabulations sur formulaires*	Validation of forms *Validations des formulaires*	Keypunching of forms *Saisie des formulaires*	Quality control of the work *Contrôle de la qualité du travail*	Financial management *Gestion financière*	Writing circulars, communications *Rédaction de circulaires, comm.*	Participation in assessment(s) *Participation au(x) évaluation(s)*	Participation to the steering committee *Participation au comité directeur*	Secretariat *Secrétariat*
1 - Québec fixed 4S	■			■	■	■								
2 - Newfoundland fixed 4R,3Pn	■			■	■	■								
3 - Newfoundland mobile 4R, 3Pn	■			■	■	■								
4 - Québec mobile 4S	■			■		■								
5 - FFAW Sentinel 2J3KL	■			■		■								
6 - FFAW Sentinel 3Ps	■			■		■								
7 - Fogo Island Sentinel	■			■		■								
8 - Petty Harbour Sentinel	■			■		■								
9 - PEI fixed 4T	■	■		■						■				
10 - PEI mobile 4T	■			■						■				
11 - NS fixed 4T	■	■		■						■				
12 - NS mobile 4T (trawl)	■			■						■				
13 - NS mobile 4T (seine)	■			■						■				
14 - NB fixed 4T	■	■		■						■				
15 - NB mobile 4T (seine)	■			■						■				
16 - Gaspé-north fixed 4T	■	■		■						■				
17 - Gaspé-south fixed 4T	■	■		■						■				
18 - Gaspésie mobile 4T	■			■						■				
19 - Magdalen fixed 4T	■	■		■						■				
20 - Magdalen mobile 4T(seine)	■			■						■				
21 - 4Vn Sentinel Survey	■			■	■	■			■					
22 - 4Vn Monthly Monitoring	■			■	■	■			■					
23 - 4Vn Migration study	■			■	■	■			■					
24 - Bras d'or Lakes Study	■			■	■	■			■					
25 - 4Vn Commercial Index	■			■	■	■			■					
26 - 4VsW Random Survey	■			■		■			■					
27 - 4VsW Commercial Index	■			■		■			■					

CREW ÉQUIPAGE	Deployment of activities *Déploiement des activitées*	Provision of bait *Provision des apâts*	Supervision of field worker *Supervision du technicien*	Navigation *Navigation*	Measurements of the fish *Mesure de poissons*	Tabulation on forms *Tabulations sur formulaires*	Validation of forms *Validations des formulaires*	Keypunching of forms *Saisie des formulaires*	Quality control of the work *Contrôle de la qualité du travail*	Financial management *Gestion financière*	Writing circulars, communications *Rédaction de circulaires, comm.*	Participation in assessment(s) *Participation au(x) évaluation(s)*	Participation to the steering committee *Participation au comité directeur*	Secretariat *Secrétariat*
1 - Québec fixed 4S														
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16 - Gaspé-north fixed 4T														
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18 - Gaspésie mobile 4T														
19 - Magdalen fixed 4T														
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