

Issues in monitoring fisheries management performance

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In this paper, issues involved in developing performance indicators to monitor fisheries management are explored. A framework is developed of the groups involved in fisheries management performance and their likely information needs. Possible procedural requirements in implementing a performance-monitoring program is then identified. The legislated performance requirements of the Australian Fisheries Management Authority are reviewed. The authority has taken steps to monitor current management performance, but these steps do not appear to meet the requirements for monitoring and control as set out in this paper.

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Introduction

Market failure in open access fisheries usually results in economic losses, because the most efficient means of harvesting fish resources are not used, and because fish resources are not allocated to the use with the highest social marginal value. In efficient, competitive markets, pricing mechanisms would ensure the optimal allocation of fish resources among alternative uses and between alternative users. However, because property rights over fish are poorly defined in open access fisheries, the market allocation and distribution of fish resources are not optimal.

For this reason, governments have often directly managed fisheries on society's behalf. However, the involvement of government in fisheries management can lead to further misallocation of resources (O'Boyle 1993). This may arise where increased operational and adjustment costs, management costs and/or non-productive rent seeking behaviour by fishers and fishery managers exceeds the benefits from management. Moving fisheries management functions from under direct government control to control by a statutory body partly avoids this situation. However, devolving fisheries management does not guarantee that the interests of both society and the fishery managers will be achieved.

For example, statutory fishery management agencies are often monopoly suppliers (Carter, Klein and Day 1990). Furthermore, because fishery management services are not supplied in the open market, management performance cannot be assessed by the willingness to pay of those receiving the service. Nor is it possible to use the competitive survival of specific services and organizations to indicate satisfactory fishery management outcomes.

In addition to pursuing resource use efficiency, fishery managers are required to meet distributional and equity goals of governments regarding the resource access of various user groups. As a result, fishery managers often have to meet multiple performance objectives. The difficulties of achieving satisfactory fishery management performance, creates a need to monitor and control the performance

of fishery management agencies to ensure that they pursue socially desired outcomes.

Eichner and Brecher (1979) noted that program control is generally seen as being achieved through input regulation, or structural reform, including 'community' (client) control. They proposed that output monitoring should also be used. The control of Commonwealth fisheries management can be seen to be following a similar path of development.

In response to these issues, the Commonwealth Government (1989) has initiated institutional changes to the management of Commonwealth fisheries. These include splitting control of the day-to-day operation of fisheries management off to a statutory body (the Australian Fisheries Management Authority — AFMA), requiring commercial fishers to pay those fishery management costs attributable to commercial fisheries, and developing and applying performance indicators to monitor fisheries management.

Framework for performance monitoring

The information required to monitor the performance of fishery management agencies varies among interest groups and the level of performance control these groups exert over fishery management.

Groups involved in fisheries performance monitoring

Principals

The principals of a fishery management agency are the resource owners who control the agency's performance — that is, the public who asserts this control through government. The principals are concerned with maintaining control of the fishery management agency and can judge the performance of those acting on their behalf, exercising rewards or sanctions on the basis of that performance (Smith 1990).

Fishery management agency

The management agency supplies fishery management services. While the activities of an agency can be monitored, the agency's performance outcomes are particularly important. The agency can monitor its own performance and ensure that it is meeting required performance outcomes.

Client group

Clients, or consumers, of fishery management services can be differentiated as direct or indirect beneficiaries of the management agency's services.

Users of fish resources who do not directly use fishery management services, but who are affected by the outcomes of fishery management, include non-extractive or amenity users — for example, tourists, consumers enjoying the knowledge that these resources exist, option demanders, and possible beneficiaries of probable future medical and fishery benefits (such as aquaculture) through the maintenance of genetic information (Krutilla 1967). These users and their possible uses of fish resources are shown in table 1.

Other users of marine resources may affect fish resource use and availability, but do not come under the fishery management framework¹. This group includes marine-based miners, petroleum companies and shippers.

Table 1: Users and uses of fish resources

Possible *users* of fish resources

- Commercial fishers
- Recreational fishers
- Beneficiaries of environmental benefits
- Non-consumptive users
- Tourists, including whale watchers
- Fish consumers
- Beneficiaries from profits and taxes paid by fishery operators

Possible *uses* of fish resources

Private good uses

- Recreational fishing
- Commercial fishing

Public good uses

- Environmental services
- Bio-diversity benefits, for example, medicinal and genetic resources
- Private non-consumptive uses, including:
 - tourism value (whale watching and diving, for example)
 - existence value (the knowledge that fish resources and the marine environment continue to exist)
 - option value
 - bequest value

Types of performance information

Mayston (1985) emphasized the need to select performance indicators, which focus on data that are useful to the decision making of interest groups. This requires matching performance information to the different levels of management control exerted by the interest groups.

The likely levels of control relevant to the interest groups in fishery management is set out in table 2 with respect to their information needs.

Technical level

At the technical level, interest groups require information to monitor and provide feedback on the operational performance of a fishery. To gather such information, standards are set against those performance outcomes which can be measured. Technical performance measures, such as resource rent returns and sustainable yield, will provide information on industry performance. Other measures monitor

the external effects of commercial fishing, including the level of by-catch and access to the resource by recreational fishers. All interest groups are likely to want performance information at this level — for example, both government and clients with environmental interests will be interested in the maintenance of fish stocks and the level of by-catch.

Administrative level

Gathering administrative information involves questioning the functional performance of a fishery management agency, including the performance of the operational divisions within an agency (such as fishery management, enforcement and licensing).

Institutional level

Institutional issues involve the strategy of the fishery management agency — what is the agency's 'mission' and how does the agency perform its functions? At this level, the appropriate strategy for achieving required outcomes can be identified. For example, institutional information can help to determine whether interest groups (such as recreational fishers), in addition to commercial fisheries, should be included in a particular fishery management advisory committee, and whether the fishery agency's performance objectives are aligned with legislation and policy. Thus, institutional control is the involvement of the agency's senior management in setting goals, deciding on strategies to achieve these goals, and managing the external factors likely to affect the agency's performance.

Social level

This relates to society's endorsement of a fishery management agency's actions through legislation and government policy documents. Social control requires ongoing monitoring to ensure that legislated performance objectives and government policy are consistent with social values, particularly as social preferences and values change over time.

Table 2: Performance information needs

	Technical	Administrative	Institutional	Social
Principals	x			x
Agency	x	x	x	
Clients	x			

Requirements of a monitoring system

A number of fishery performance indicators are used in Australia and overseas. However, O'Boyle (1993) has observed that their application is often uncertain and disjointed, reflecting the lack of clear performance monitoring objectives and an excessive focus on stock assessment. As a result, insufficient recognition is given to the importance of stock levels as they relate to other management requirements, such as economic returns. Nevertheless, objectives for fishery management performance in Australia are clearly defined (table 3).

The process of performance monitoring entails, setting out the objectives and standards for fishery management, against which fishery management performance is then measured and evaluated.

The process of performance monitoring can be further broken into five steps. The

first step is to decide what performance outcomes require monitoring. The selected outcomes should be derived from the established objectives for fishery management.

The second step is to decide which performance indicators to use in monitoring performance, and how, when and where they will be applied. These indicators need to be comprehensive and sufficiently inclusive, or feedback to managers will be uneven and the incentives faced by managers will be distorted. Such distortions can lead to bad resource use decisions. For example, if fishing entitlement prices are taken as a direct measure of the fleet's economic performance, then managers may take an increase in the cost of fishing entitlements as an indicator of improved management performance. However, the price that fishers are willing to pay for entitlements can increase with over-capitalization as well as with improving economic performance (Campbell and Haynes 1990). Therefore, the use of entitlement value as a performance indicator may not allow the management agency to identify fleet over capitalization.

Alternatively, the economic performance of the fleet may be measured, including any external effects of by catch and the possible effects of fishing activities on the marine floor environment. These measures could be done annually or once in five years; in the latter case, interim performance indicators could possibly be used.

These decisions lead to questions of the scale to be used in assessing performance — that is, whether the measures should be restricted to a targeted species of a specific fishery, or extended to include a broader ecological assessment such as that for the Australian south east fishery ecological system.

The third step is to identify appropriate performance standards for the specific indicators. For example, if the stock-size for the maximum sustainable yield is estimated, then it must be recognized that the actual proportional stock required to survive between seasons may vary according to the life history of the fish species. If the mature stocks of fish for a short lived species (such as prawns or squid) are one quarter of stock levels prior to the commercial development of the fishery, then the stock may be assessed as underused. Alternatively, if the mature stocks of fish of a long lived species (such as shark) are one quarter of stock levels prior to commercial development, then the stock may be assessed as being over fished.

The quality of performance outcomes is also an issue, because quality can be oversupplied as well as under supplied. In the open market, the presence of a number of suppliers gives consumers the opportunity to trade off product quality against price. However, fishery management services are supplied by a single agency. Therefore, the performance standards set for particular indicators need to account for the fact that consumers cannot trade off between quality of output and price.

For timely performance monitoring of fishery management, the time lag between the implementation of management actions and performance measurement needs to be as short as possible. However, simple timely indicators are likely to be less accurate and, if used in isolation, can lead to distorted performance incentives for managers (as previously discussed regarding the use of fishing entitlement price as an indicator of economic efficiency). The alternative may be to use more complex but less timely indicators such as a bio-economic analysis of the fishery. However, while a more detailed and accurate measure of performance may result, such indicators demand much data, require a long lead time, and are expensive.

The fourth step is to establish the response options for performance indicators — for example, identifying reasons for poor performance, determining necessary corrective action, and reviewing performance standards and objectives.

Finally, it is necessary to determine who will decide whether there has been a failure to meet performance criteria, and who will respond once that failure has been identified. To minimize a conflict of interests, it is often better if those involved in corrective action are separate from those who monitor performance.

Different Types of Performance Indicators

Reference points

Caddy and Mahon (1995) have reviewed the use of reference points in fishery management, and recommend incorporating limit or threshold reference points in management wherever possible. They define reference points as conventional values derived from a technical analysis of the state of the fishery or fish population, and whose characteristics are believed to be useful for the management of the fish stock.

While their discussion is in terms of fish biology, Caddy and Mahon (1995) have categorized reference points into target reference points and limit reference points.

- Target reference points can be used as indicators of the desired status of particular components of a fishery and of fish resource use. Maximum present values or resource rent maximization values, for instance, are desirable target reference points that can be used to monitor fishery management performance according to the economic efficiency objective.
- Limit reference points can be used to separate or partition undesirable outcomes of a fishery from satisfactory or desirable outcomes. Therefore, they can be used to monitor a fishery and to trigger a previously identified response. This response can constitute a direct action, such as closing an area to certain forms of fishing, or a call for experts to consider the consequences of exceeding or failing below the trigger point.²

Such categories of reference points can be used in a broader context than a biological one. Furthermore, even if biological measures are used, the performance standards for these measures can be established according to economic criteria.

Economic indicators

The characteristics of the goods and services derived from fish resources, such as whether they are private or public goods are likely to affect the ease with which they can be identified and measured. In addition, because a tradeoff exists in the consumption of goods and services between different time-periods, it is important to measure the effect of changes in natural capital as well as current revenue.

There are two reasons to include natural capital in performance accounting. First, an increase or decrease in operational profits may have resulted from over harvesting or a saving of fish stocks. Therefore, unless the effect on resource stocks is included in the performance accounting, changes in current revenue through changes in capital assets will be unaccounted for, and any measure of current performance will be inaccurate. Second, the inclusion of resource capital will be important when considering the future flow of benefits from fish resources.

The economic criterion is to equate the marginal social benefit of foregone consumption with the discounted increase in future marginal social benefit. Discussions in this area *are* well documented in the literature on environmental accounting (see Ahmad, Serafy and Lutz 1989).

The lack of prices consistent with the relative social opportunity cost of fish *in situ* means that fish resources are unlikely to be allocated to their highest marginal value social use. Resource rent is an economic measure in which the above economic characteristics and marginal requirements can be taken into account. Indeed, if an appropriate price for *in situ* fish resources existed, that price would equal the unit resource rent value of the resource ³.

In addition to the issues above, there are conceptual and applied difficulties in using resource rent as an economic measure of management performance. Conceptually, measures of the rent value of a resource will differ according to whether the measures are based on private or social use, or are from the perspective of a fishery. The difference between these measures depends on the extent to which external impacts of resource use are included in the cost accounting.

For a full social accounting, it is necessary to include more than the fishing boat operational costs and the impact of boat operations on the technical efficiency of other boats, as would occur for an industry level assessment (Smith 1969). Full social accounting also requires the inclusion of the effect of target catch and by catch on the subject and other commercial and recreational fisheries, and the effect of fishing activities on the benefits derived from maintaining biological diversity.

Given that the condition of the marine environment can affect the future flow of goods and services derived from fish resources, the effect of fishing activities on the marine environment needs to be included when monitoring fishery management performance (see ANZFAC 1993). For example, Taiwanese bottom trawling off northwest Australia in the 1970s disturbed the marine floor environment and destroyed the sponges where fishing operations occurred. While taking a long time to grow, these sponges have a critical role in the environment of juvenile snapper (*Lutjanus* and *Lethrinus spp.*), a high valued commercial species. As a result of the destruction of sponges, the recruitment of snapper to the north west fishery fell away (Sainsbury 1982).

Use of the marine environment and fish productivity can also be affected by other users of the common resource base. For example, those using the marine environment as a sink for waste could have detrimental or positive effects on the future supply of fish products. While fishery management agencies may not be directly responsible for such activities, the effects may still need to be accounted for in any extensive assessment of management performance, and included in discussions in interdepartmental consultation.

As well as using direct measures of economic performance in fisheries, it may also be useful to ensure that the necessary conditions for economically efficient outcomes are met. The preference by the Commonwealth Government (1989) for the use of individual transferable quotas as a management tool is consistent with this approach.

The distribution of the benefits of fishery management to the different users depends on consultation between the managers and user groups. This requires the

fulfillment of two requirements — namely, identification of the users, and development of a structure in which preferences can be identified and weighted. Such a process can involve high transaction costs.

Performance Requirements for Commonwealth Fisheries

AFMA is responsible for the day-to-day management of Commonwealth fisheries. AFMA's performance requirements under this responsibility are set out in the *Fisheries Administration Act 1991* and the *Fisheries Management Act 1991*. A number of other policy and legislative documents also set out society's performance expectations of AFMA (table 3).

The legislated performance objectives include ecologically sustainable development and economic efficiency, as well as accountability to the fishing industry and society. The administrative requirements set out in the legislation include distributional and accountability requirements. Reference in the acts to the living resources of the Australian fishing zone widens the parameters of fishery management beyond commercial fishing to include non-target species and non-commercial activities. Additional legislative and policy documentation includes the policy document, *National Strategy for Ecologically Sustainable Development* (Commonwealth Government 1992) and the complimentary legislation administered by the Australian Nature Conservation Agency.

Included in AFMA's 1991 legislative requirements are operational procedures that establish formal links with groups who have interests in the management of Commonwealth fisheries. These include groups with fishery agency responsibilities such as government research bodies, state governments and the Commonwealth Government's Fish and Aquaculture Branch, plus client or resource user groups comprised of industry members, recreational fishers, environmental groups and fish consumers. The likely client groups and the possible uses of fish resource uses are set out in table 1.

As part of a strategy to move fishery management closer to its clients, the membership of the AFMA Management Board is required to have an independent chairperson, and industry representation. These procedures are important because they provide a means of identifying clients and client needs, and of helping to meet the equity requirements relating to distribution among users.

The functional requirements identify the groups with whom management needs to deal, ensuring consultation with a wide range of clients. In terms of the framework presented in this paper, such links can supply information and client feedback to AFMA at the technical, administrative and institutional levels of control. For example, an obligation to consult with concerned parties, and to prepare plans, which are open to scrutiny, helps ensure that the government's distributional requirements are met. Moreover, a requirement for AFMA to develop adjustment and restructuring plans confirms the government's desire to eliminate excessive capitalization and overexploitation, and to improve both ecologically sustainable development and efficiency performance outcomes.

The legislation is supplemented by guiding policy documents (such as the *National Strategy for Ecologically Sustainable Development*) and the legislation administered by the Australian Nature Conservation Agency. The latter (table 3) relates to the agency's administration of a number of international environmental conventions to which Australia is a signatory and which impacts on fishery management requirements.

Table 3: Performance requirements for Commonwealth fisheries

Guiding documentation	Objective/operational requirements
<i>Fisheries Administration Act 1991</i>	Efficient and cost-effective management Ecologically sustainable development Maximized economic efficiency Accountability to industry and community Cost-recovery.
<i>Fisheries Management Act 1991</i>	Use of proper conservation and management measures to ensure that the living resources of the Australian fishing zone are not endangered Optimum use of the living resources of the AFZ .
	Functions/procedural outcome and plans
<i>Fisheries Administration Act 1991</i>	Devise management regimes and adjustment programs Consult/cooperate with state governments, industry, general public, foreign governments and businesses, and similar bodies Devise exploratory and feasibility programs Establish and undertake research Prepare corporate and annual plans for public review, and prepare plans of management. Establish and allocate fishing rights Collect a payment from persons exploiting fisheries.

<i>Fisheries Management Act 1991</i>	<p>Plans for fisheries must set out:</p> <ul style="list-style-type: none"> - measures by which objectives are to be attained (catch/ effort controls) - performance criteria against which measures may be assessed - fishing capacity and way it is measured. <p>They must also:</p> <ul style="list-style-type: none"> - define the fishery - allocate fishing rights - specify the kind and units of fishing gear - regulate recreational fishing.
Policy documents	Core objectives
<i>New Directions for Commonwealth Fisheries Management in the 1990s</i>	Sets out the government's major performance expectations for the management of Australian fisheries ,and sets up the new administrative requirements for the formation of AFMA.
<i>National Strategy for Ecologically Sustainable Development 1991</i>	Aims to enhance welfare while maintaining ecological processes and Bio-diversity. Covers inter and intra-generation equity, the "precautionary principle" and cost-effectiveness.
Complimentary legislation (Australian Nature Conservation Agency)	
<i>Wildlife Protection (Regulation of Exports and Imports) Act 1982</i>	Requires an assessment of the ecological sustainability and non-target species impact of fishing operations. Regulates the international trade of species.
<i>Endangered Species</i>	Requires the listing and subsequent prohibition of the harvesting
<i>Protection Act 1992</i>	and trade of endangered species. Requires the development of a recovery plan.
<i>Convention on Biological Diversity 1993</i>	Ensures the conservation of Bio-diversity and the sustainable use of its components.
<i>Whale Protection Act 1980</i>	Prohibits the harming or taking of whales, dolphins or porpoises in Commonwealth waters.

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Sources: Commonwealth Government (1989); Maynes (1995); McLoughlin, Wallner and Staples (1995). The policy documents identify additional areas of responsibility for management, place the performance objectives into an operational framework, and guide AFMA according to any policy changes by the Commonwealth Government as it adjusts to changing social preferences. For example, the *National Strategy for Ecologically Sustainable Development* emphasizes the importance given by government to this objective, and espouses the 'precautionary principle' to ensure that risk and uncertainty are explicitly considered in the decision making process (McLoughlin, Wallner and Staples 1995).

To assist in the monitoring of AFMA's management performance, the authority is required to develop a number of performance indicators and to identify in its annual report how it has functioned according to these indicators. However, the Fisheries and Aquaculture Branch of the Department of Primary Industries and Energy is responsible for monitoring whether AFMA is meeting the legislation and policy requirements. The government is also responsible for ensuring that the legislation and policy requirements meet public expectations.

Current situation

Since AFMA's establishment in 1992, it has taken important initial steps to meet its performance requirements under legislation. Fishery management plans have been developed for three of the seventeen fisheries for which it is responsible — the northern prawn fishery, the southern blue-fin tuna fishery and the Great Australian Bight fishery. These plans restate the need for AFMA to observe its legislated performance objectives in the administration of these fisheries.

AFMA has legislated responsibility for developing fishery management performance indicators as set out in the authority's 1995 annual report. These indicators are used to compare AFMA's 1994-95 performance against the legislated performance objectives in the annual corporate plan (AFMA 1996). Additional work will be required for developing performance indicators for a more comprehensive assessment of AFMA's performance — for example, in the corporate plan (AFMA 1996), the assessment of excess capacity is noted as an indicator that maximum economic returns are being achieved, but the plan does not outline how to measure excess capacity.

To meet the legislated economic efficiency requirement, AFMA will probably need to reassess the current fishery management plans. A reassessment could include an appraisal of the continuing use of input controls, as opposed to individual transferable quotas, in all but the southeast and southern bluffing tuna fisheries. In addition, constraints on boat size in the southeast and East Coast tuna and bill-fish fisheries (which are hindering access to offshore fish resources) may be reviewed.

In further developing its performance indicators, AFMA may need to examine further response options for when performance standards are not being met. For example, there is failure in the south east fishery for the total allowable catches for some individual transferable quota species to be taken: it may be that total allowable catches are set too high and are not consistent with either economic efficiency objectives or ecologically sustainable development objectives, or (if the total allowable catches are correct) there may be institutional barriers preventing

their achievement. In either case, a continuation of the existing situation would most likely result in social losses.

AFMA also needs to identify and set indicators according to the performance objectives. Currently, indicators are focused on operational performance in terms of biological parameters for sustainability, the extent of catch/effort controls as they relate to economic efficiency, administrative costs and client participation (AFMA 1995). These indicators mostly relate to monitoring at the technical level, and there may be discrepancies in the administrative and institutional levels of performance control. These indicators are likely to include whether reference points are appropriately set and what responses are to be initiated when there is a failure to meet a performance requirement.

References

ABARE 1995. Fisheries Survey Report 1995. Canberra. AFMA \W5, Australian Fishery management Authority Annual Report 1994-95, AGPS, Canberra.

— — 1996, Protecting Our Fisheries: Corporate Plan 1995-2000, Canberra.

Ahmad, Y. El Serafy, Salah and Lutz, E. (eds) 1989, Environmental Accounting for Sustainable Development: Selected Papers from Joint UNEP World Bank Workshops, World Bank. Washington DC.

ANZFAC 1993, Resolutions of the 23rd meeting of the Australia and New Zealand Fisheries and Aquaculture Council, 3 December. Sydney, New South Wales.

Campbell, D. and Haynes, J. 1990, *Resource Rent in Fisheries*, ABARE Research Report 90-10, Canberra.

Carter, N., Kjein, R. and Day, P. 1990, How Organisations Measure Success: The Use of Performance indicators in Government, Routledge. London.

Caddy, J-F. and Mahon, R. 1995, *Reference Points for Fishery management*, Fisheries Technical Paper no. 347, Food and Agriculture Organisation, Rome.

Commonwealth Government 1989, New Directions for Commonwealth Fishery management in the 1990s, AGPS. Canberra.

— — 1992, National Strategy for Ecologically Sustainable Development, AGPS, Canberra.

Krutilla, J.V. 1967, 'Conservation reconsidered', *American Economic Review*, vol. 62, no. 4, pp. 128-39.

McLoughlin, K., Wallner, B. and Staples, D. (eds) 1995, *Fishery Status Report, 1994: Resource Assessment of Australian Commonwealth Fisheries*, Bureau of Resource Sciences, Canberra.

Mayston, D.J. 1985, 'Non-profit performance indicators in the public sector', *Financial Accountability and Management*, vol. 1, no. 1, pp. 51-74.

Maynes, G. 1995, 'Application of environmental conventions to commercial fisheries', in Proceeding of ABARE's National Agriculture and Resources Outlook Conference, Canberra, 7-9 February, *Outlook 95*, vol. 1, *Natural Resources*, pp.

281-99.

O'Boyle, R. 1993. 'Fishery management organisations: a study of uncertainty', in Smith, S.J., Hunt, J.J. and Rivard, D. (eds) 1993, *Risk Evaluation and Biological Reference Points for Fishery management*. Canadian Special Publication of Fisheries and Aquatic Sciences no. 120. National Research Council and Department of Fisheries and Oceans, Ottawa, Canada.

Pindyck, R.S. and Rubinfeld, D.L. 1995, *Microeconomics*, 3rd ed., Macmillan, New York.

Sainsbury, K.J. 1982. The Biological Management of Australia's Multispecies Tropical Demersal Fisheries: A Review of Problems and Some Approaches. CSIRO Marine Laboratories report no. 147, Cleveland.

Smith, P. 1990, 'The use of performance indicators in the public sector', *Journal of the Royal Statistical Society*, vol. 153, no. 1, pp 53-72.

Smith, S.J., Hunt, J.J. and Rivard, D. (eds) 1993. *Risk Evaluation and Biological Reference Points for Fisheries Management*, Canadian Special Publication of Fisheries and Aquatic Sciences no. 120, National Research Council and Department of Fisheries and Oceans, Ottawa, Canada.