SCIENTIFIC OBSERVATIONS IN CCAMLR FISHERIES – PAST, PRESENT AND FUTURE

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Abstract

CCAMLR has the primary competency for managing fishing south of the Antarctic Polar Front. Despite a relatively long history of scientific research and fisheries, CCAMLR's fisheries management strategy has often had to deal with incomplete and uncertain information on affected resources. Fishery-independent studies are difficult and expensive to conduct. In addition, the size of the Convention Area, its remoteness and prevailing inclement weather further complicate matters. Therefore, in addition to the standard catch and effort data supplied by vessels, the collection of data by scientifically qualified observers on board fishing vessels has assumed prominence in the collection of essential data for fisheries management purposes. The Scheme of International Scientific Observation, adopted by CCAMLR in 1992, is designed to gather and validate fishery-related information essential for assessing the status of target species as well as the impact of fishing on dependent and related species, including seabirds and marine mammals. The scheme is limited to scientific observation only and is separate from enforcement issues which are covered by the CCAMLR System of Inspection. Under the scheme, observers are deployed under bilateral agreements between CCAMLR Members and they operate on vessels under flags other than that of their own country. This paper outlines the history of the scheme in terms of its logistics, participation, coverage, changes in research priorities, volume of data collected and data usage. The advantages and shortcomings of the scheme are explored.

Résumé

La gestion de la pêche au sud du Front polaire antarctique relève principalement de la compétence de la CCAMLR. Malgré les recherches et activités de pêche scientifiques menées pendant d'assez nombreuses années, la stratégie de gestion de pêche de la CCAMLR a souvent été confrontée à des informations incomplètes et incertaines sur les ressources affectées. Les études indépendantes des pêcheries sont difficiles à réaliser, donc coûteuses. De plus, la taille de la zone de la Convention, son éloignement et les mauvaises conditions météorologiques ne font que compliquer les choses. En conséquence, outre les données standard de capture et d'effort de pêche fournies par les navires, la collecte de données par des observateurs scientifiques qualifiés, à bord des navires de pêche, a pris de l'importance dans la collecte de données essentielles pour les besoins de la gestion des pêches. Le Système international d'observation scientifique, adopté par la CCAMLR en 1992, a pour vocation de rassembler et de valider les informations sur les pêches, essentielles pour l'évaluation du statut des espèces-cibles, ainsi que de l'impact de la pêche sur les espèces dépendantes et connexes, telles que les oiseaux et les mammifères marins. Ce système se limite à l'observation scientifique et ne concerne aucunement les questions d'application de la réglementation qui sont couvertes par le système de contrôle de la CCAMLR. Le Système fait intervenir les observateurs conformément à un accord bilatéral entre les membres de la CCAMLR, sur des navires battant pavillon d'un Etat autre que le leur. Le présent document rappelle l'historique du Système en matière de logistique, participation, couverture, changement des priorités de recherche, volume de données collectées et utilisation des données. Les avantages et inconvénients du système sont également étudiés.

Резюме

АНТКОМ обладает основной компетенцией в области управления промыслом к югу от Антарктического полярного фронта. Несмотря на относительно долгую историю научных исследований и рыбного промысла, стратегия АНТКОМа по управлению промыслом зачастую сталкивается с неполной и недостоверной информацией по затронутым ресурсам. Независимые от промысла исследования проводить сложно и дорого. Кроме того, размер зоны действия Конвенции, ее

удаленность и преобладающие неблагоприятные погодные условия еще более осложняют ситуацию. В результате, сбор данных квалифицированными научными наблюдателями на борту рыболовных судов стал важным способом сбора данных, необходимых для целей управления промыслом, в дополнение к обычно представляемым судами данным по уловам и усилию. Принятая АНТКОМом в 1992 г. Система международного научного наблюдения предназначена для сбора и проверки относящейся к промыслу информации, необходимой для оценки состояния целевых видов, а также воздействия промысла на зависимые и связанные виды, включая морских птиц и млекопитающих. Эта система относится только к научным наблюдениям и не связана с вопросами исполнения, которыми занимается Инспекционная система АНТКОМа. В соответствии с этой системой наблюдатели работают в рамках двусторонних соглашений между членами АНТКОМа на судах, плавающих под флагом не их собственной страны, а других стран. В данной статье описывается история этой системы на примере материально-технического обеспечения, участия, охвата, изменения приоритетов исследований, объема собранных данных и их использования. Рассматриваются преимущества и недостатки этой системы.

Resumen

La responsabilidad principal de la CCRVMA es la ordenación de la pesca en la región al sur del Frente Polar Antártico. A pesar de que históricamente se han llevado a cabo investigaciones científicas y pesquerías por un tiempo relativamente largo, la estrategia de ordenación de pesquerías de la CCRVMA a menudo se basa en información incierta sobre los recursos pertinentes. La realización de estudios independientes de las pesquerías es difícil y costosa, y es aún más complicada por el gran tamaño del Área de la Convención, su lejanía y las inclemencias del tiempo que en ella imperan. Por lo tanto, además de la notificación normal de los datos de captura y esfuerzo de los barcos de pesca, la recopilación de datos por observadores científicos calificados a bordo de los mismos barcos ha adquirido importancia para la ordenación de las pesquerías. El Sistema de Observación Científica Internacional, adoptado por la CCRVMA en 1992, tiene como objetivo la recopilación y convalidación de datos sobre las pesquerías, esenciales para la evaluación del estado de las especies objetivo y del efecto de la pesca en las especies dependientes y afines, incluidas las aves y los mamíferos marinos. El sistema se limita a la observación científica solamente y no cubre las actividades relacionadas con el cumplimiento que le competen al Sistema de Inspección de la CCRVMA. Los observadores son designados por acuerdos bilaterales entre los miembros de la CCRVMA, y trabajan a bordo de barcos de bandera extranjera. Este documento describe la historia del sistema de observación en términos de su logística, participación, cobertura de las observaciones, cambios en las prioridades de investigación, y volumen y utilización de los datos recopilados. Se examinan las ventajas y desventajas del sistema.

Keywords: scientific observation, CCAMLR Convention Area, international observers, seabirds, marine mammals, marine living resources, CCAMLR

Introduction

CCAMLR was established under the 1982 CAMLR Convention. Currently there are 32 Contracting Parties to this Convention.

CCAMLR is responsible for the conservation of Antarctic marine living resources, including their rational use, in waters located south of the Antarctic Convergence (or Polar Front) at about 50°S (Figure 1). These resources include all species of fish, molluscs, crustaceans and other marine organisms as well as seabirds. Although management of seals and whales falls under the 1973 Convention for the Conservation of Antarctic Seals (CCAS) and the 1946 International Convention for the Regulation of Whaling (IWC) respectively, CCAMLR takes account of the status of these animals as being an integral part of the Antarctic ecosystem for which it is responsible in developing conservation strategies.

The conservation principles outlined in Article II of the CAMLR Convention (CCAMLR, 2004a, Part 1) embody an 'ecosystem' and 'precautionary' approach to the conservation of marine living resources. These principles have set CCAMLR's marine resource management regime apart from other international fisheries organisations. The provisions of Article II require that management of harvesting should aim to conserve not only the targeted species, but also to take into account the indirect effects of exploitation on other species.

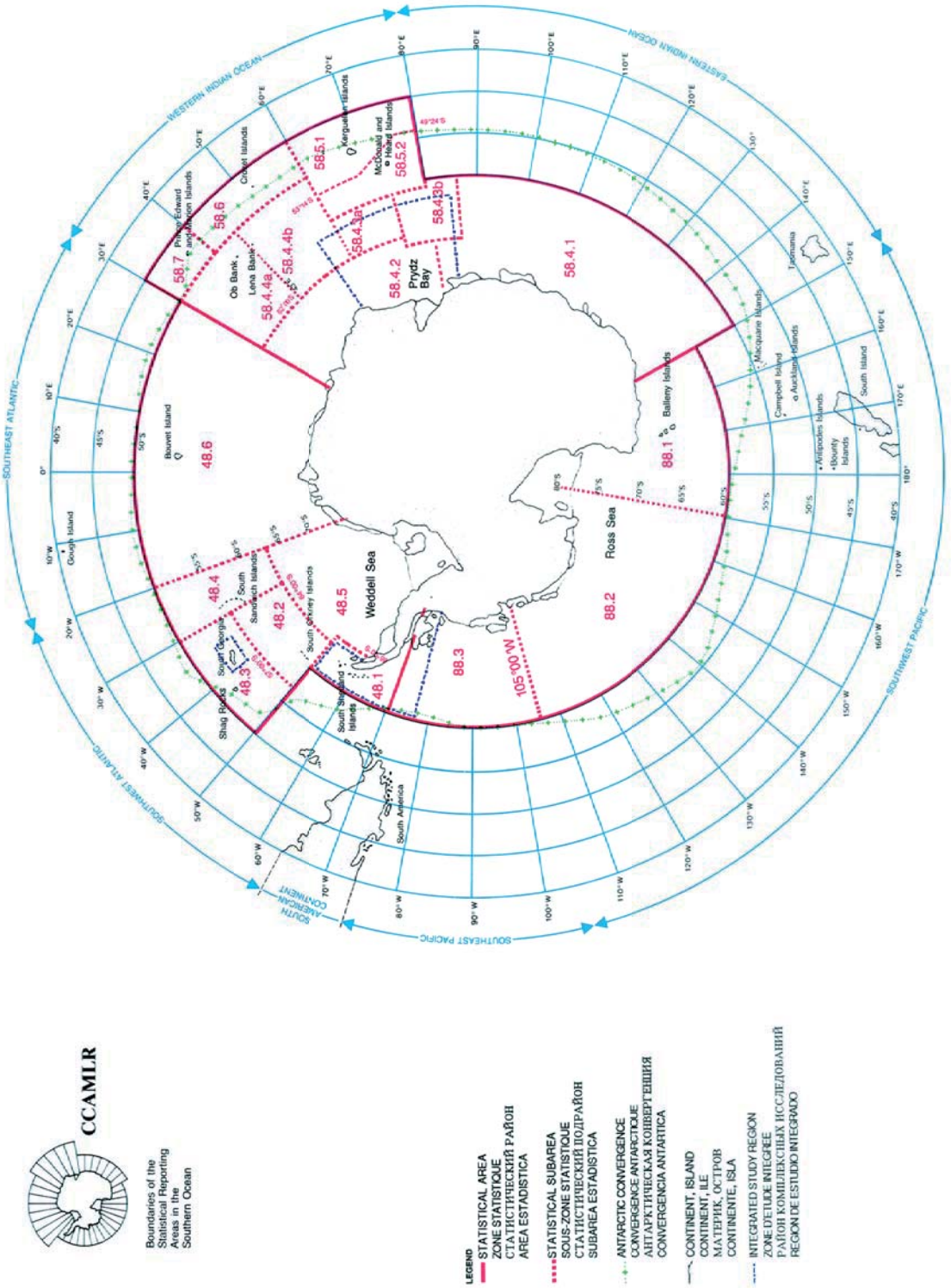

Figure 1: Map of the CCAMLR Convention Area.

The Scheme of International Scientific Observation was adopted by CCAMLR in 1992 and has been in operation for more than a decade. This paper outlines the history of the scheme in terms of logistics, participation, coverage, changes in research priorities, standards of data collection and processing, as well as in relation to the volume and diversity of data collected and subsequent data use. The advantages and shortcomings of the scheme are also explored and future applications are discussed.

Objective and logistics of the scheme

The objective of the scheme is to:

> *Gather and validate fishery-related scientific information needed to assess the status of populations of Antarctic marine living resources and the impact of fishing on such populations, as well as on those of related and dependent species.*

In fulfilling their functions, scientific observers on board a vessel (CCAMLR, 2004a, Part 10, Annex I):

(i) record details of the vessel's operation (e.g. apportioning of time between searching, fishing, transiting and details of set and haul operations etc.);

(ii) take samples of catches to determine biological characteristics;

(iii) record biological data;

(iv) record by-catch (quantities and other biological data);

(v) record cases of entanglement and incidental mortality of birds and mammals;

(vi) record how declared catch weight is measured, including the collection of data on the determination of the conversion factor(s) between green weight and final product in the event that catch is recorded as processed product weight;

(vii) assist the captain of the vessel in the catch recording and reporting procedures, if requested.

It should be emphasised that the scheme is limited to scientific observation and is separated from enforcement issues that are covered by CCAMLR under the System of Inspection[1]. However, CCAMLR, through its Standing Committee on Inspection and Compliance (SCIC), uses certain categories of data collected by scientific observers for compliance assessment purposes. These include data collected on the implementation of CCAMLR conservation measures aiming to minimise the incidental mortality of seabirds associated with fishing (see observer task (v) above)[2]. More recently, scientific observers have also been requested to:

(i) collect and report data on sightings of fishing vessels in the Convention Area, including vessel identification, position and activity (CCAMLR, 1998, paragraph 8.16);

(ii) collect information on fishing gear loss and garbage disposal by fishing vessels at sea (CCAMLR, 1999, paragraph 8.21).

The scheme operates through bilateral agreements between CCAMLR Members to exchange observers (i.e. an observer designated by one Member serves on a vessel flying the flag of another Member). Designating Members appoint scientific observers who are familiar with harvesting and scientific research activities as well as provisions of the Convention and the measures adopted under it, and who are adequately trained to carry out competently the duties of scientific observers as required by the Commission (CCAMLR, 2004a, Part 10, paragraph A(c)).

Receiving Members ensure that their vessel operators cooperate fully with the scientific observers to enable them to carry out the tasks assigned to them by the Commission. This includes giving them access to all data and allowing them to observe all operations of the vessel necessary to fulfil the duties of a scientific observer as required by CCAMLR. Receiving Members also take appropriate action on board their vessels to ensure the security and welfare of scientific observers in the performance of their duties, provide them with medical care and safeguard their freedom and dignity (CCAMLR, 2004a, Part 10, paragraph B(b) and (c)).

[1] CCAMLR has interpreted Article XXIV of the Convention as 'requiring the implementation of a system of international inspection to ensure compliance with conservation measures in force and a scheme of international scientific observation as part of the data gathering machinery necessary to achieve the objectives of the Convention' (CCAMLR, 1991, paragraph 7.5).

[2] The current measures for the minimisation of the incidental mortality of seabird associated with fishing are contained in Conservation Measures 25-02 (2003) and 25-03 (2003) (see CCAMLR, 2004b).

Table 1: Estimated cost of at-sea observer programs (US$) calculated from information provided by CCAMLR Members.

Fishery	Season**	Cruises	Observer days	
Longline	2003 (2002)	39 (27)	3342	(2361)
Trawl	2003 (2002)	17 (16)	761	(809)
Total days			4103	(3170)
Total cost US$*			$1.0m	($0.8m)

* This calculation is based on an average at-sea cost of US$240 a day and excludes travel expenses and daily subsistence payments while not at sea.
** Season is from 1 December to 31 November.

Members are responsible for the training and deployment of scientific observers, their conduct and the submission of data to the CCAMLR Secretariat. The CCAMLR Secretariat coordinates the implementation of the scheme via a network of national technical coordinators designated by Members. Each Member designates a technical coordinator who is responsible for (SC-CAMLR, 1996, paragraph 9.8):

(i) receiving and distributing of scientific observer logbooks and related documents;

(ii) notifying the Secretariat in advance of all designated scientific observers and the duration of their programs;

(iii) ensuring the timely submission of data and reports on observations;

(iv) providing answers to data queries received from the Secretariat.

Under the scheme, the cost of deploying scientific observers and submitting data to CCAMLR is covered by Designating Members or shared between Designating and Receiving Members. These arrangements are formalised in the bilateral agreements between Members. Based on information provided by Members, the total cost of the observation scheme is substantial. For example, CCAMLR Members spent approximately US$1 million on deploying observers during the 2003 fishing season (Table 1). This cost is equivalent to approximately 60% of the US$1.7 million contributed annually by all Members to the CCAMLR budget.

Implementation of the scientific objectives of the scheme

In order to achieve the scheme's objectives, lists of scientific priorities have been developed by CCAMLR's Scientific Committee (SC-CAMLR, 1991, Annex 6, paragraph 4.4). Decisions on the priorities to be assigned to different aspects of the observation program have been made based on several criteria, such as whether:

(i) the stock under consideration is considered to be particularly vulnerable and is one for which only limited information is available;

(ii) the fishery information required is considered vital for the stock assessments undertaken by the Working Group on Fish Stock Assessment (WG-FSA);

(iii) there are critical uncertainties that might be clarified by observations at sea;

(iv) the only reasonable way to collect the data is from observations at sea.

Consideration has also been given to organising individual components of the scheme so as to ensure that observation is sufficiently detailed to achieve the objectives, while some topics can be addressed adequately by making limited observations, others may require a more continuous and comprehensive observational series.

Initially, CCAMLR requested that all fish and fish by-catch data be routinely collected on a haul-by-haul basis. Furthermore, it was considered that, for the time being, research activities under the scheme should be allocated to fisheries in order of priority.

In response to the growing recognition of the problem of incidental mortality of seabirds during longline fishing operations, CCAMLR decided to improve the collection of the information required to address this problem by having recourse to the scheme (SC-CAMLR, 1994, Annex 8, paragraph 4.3). Experience from the 1994 fishing season demonstrated that the use of the scheme was the only practical way of obtaining reliable data on seabird interactions with fishing operations (Miller et al., 2004).

In order to organise the work of scientific observers involving the description of the incidental mortality of seabirds during longline fishing operations, the Scientific Committee prioritised scientific observer tasks so as to be able to obtain appropriate data (SC-CAMLR, 1994, paragraph 9.27(ii)).

This required:

(i) the observation of both the setting and hauling of lines as well as the recording of details of fishing equipment, fishing techniques and the type and nature of deployment of mitigation measures used;

(ii) the retention of all specimens of seabirds brought aboard dead, or, if that is not possible, the retention of, at least, the head, leg and samples suitable for subsequent DNA analysis, together with any bands or other identifying markers;

(iii) that observers undergo training in seabird identification;

(iv) that observers facilitate both the education of, and the dissemination of information to, fishers on the problem of incidental mortality of seabirds and its potential solutions.

In developing the scheme, the Scientific Committee intended that it should be flexible enough to address changes in research priorities identified by the Scientific Committee (SC-CAMLR, 1991, paragraph 10.4). To this end the Scientific Committee keeps the priorities, standard sampling procedures and types of data to be collected by observers under constant review, thus ensuring the collection of all relevant data required by Scientific Committee working groups for stock assessment purposes, or for the assessment of levels of by-catch and incidental mortality of marine mammals and seabirds (Table 2). Some data, such as environmental data recorded during setting and hauling of longlines/trawls, are collected by observers but are not regularly, or routinely, utilised. By constantly reviewing the application of the scheme, CCAMLR is able to identify data which no longer need be collected or whose collection can be made optional (depending on the current research priorities).

Each working group provides input into the allocation of priorities and data collection tasks for scientific observers under the scheme. The Working Group on Ecosystem Monitoring and Management (WG-EMM) provides advice on the collection of krill data, the ad hoc Working Group on Incidental Mortality Arising from Fishing (WG-IMAF) provides advice on data relating to the incidental mortality of marine mammals and seabirds, and the Working Group on Fish Stock Assessment (WG-FSA) provides advice on biological data relating to target and by-catch fish species. Scientific observers also provide feedback on the tasks and priorities set for them through their national technical coordinators. The comments received are used to assess the feasibility of an often demanding workload. This allows observation priorities to be changed, taking into account factors such as the complexity or extent of the required observations and the number of observers deployed per vessel.

A list of the current CCAMLR research priorities for conducting scientific observations on board fishing vessels may be found in the appendix.

Scientific Observers Manual and e-logbooks

CCAMLR initially prepared a number of standard forms and sampling guidelines for use by observers under the scheme. In order for the forms to be used effectively, it was also necessary to provide a detailed handbook to ensure that standard methods were used (SC-CAMLR, 1991, paragraphs 4.11 to 4.19 and Annex 5, paragraph 7.13). In 1993, a pilot edition of the *Scientific Observers Manual* was published in a bound-book format. The manual was subsequently revised in 1996 and published in a loose-leaf ring-binder format. Since that time all observer data have been collected in accordance with agreed standards, submitted to CCAMLR and maintained in the CCAMLR database.

The manual has been published in loose-leaf format to allow technical coordinators to select and make copies of relevant sections for observers. This structure also enables individual sections of the manual to be modified and distributed to all Members without the need to re-issue or reprint the entire manual. The manual is published in the four official CCAMLR languages (English, French, Russian and Spanish). It is also available

Table 2: A summary of the type of data collected by CCAMLR scientific observers in longline and trawl fisheries. SST – sea-surface temperature.

Data collected by observers	Annually used by CCAMLR working groups
Vessel and observation program details	
Vessel details	√
Total number of sets undertaken during the observation program	√
Total number of sets observed	√
Total number of hooks set	√
Total number of hooks observed	√
Fishing gear description	
Longline description	√
Trawl description	√
Offal discharge position	√
Streamer line details	
Streamer line description	√
Daily work schedule	
Daily work schedule (optional)	
Daily setting observations	
Detailed setting information (dates, positions, SST (krill only) etc.)	√
Alterations to line-setting course	
Environmental conditions	
Estimated seabird and marine mammal abundance (optional)	
Seabird activity for day setting only (optional)	
Waste disposal information	
Vessel waste disposal facilities and practices	√
Daily hauling observations	
Hauling information	√
Environmental conditions	
Marine mammal interaction with fishing gear	√
Seabird by-catch	√
Catch composition	√
Hauling mitigation methods	√
Biological data collection	
Scale and otolith collection	√
Length measurements	√
Weight	√
Sex	√
Maturity stage	√
Krill feeding colour	
Tagging information	√
Conversion factors	
Conversion factors	√
Line-weighting data	
Time depth recorder and bottle test data	√
Vessel sighting information	
Vessels sighted in the area	√

Table 3: The format of scientific observer logbooks submitted by CCAMLR Members. Note: electronic logbooks were introduced in 2000. na – not applicable.

Logbook format	1996	1997	1998	1999	2000	2001	2002	2003	2004
Electronic	na	na	na	na	1	40	35	54	54
Paper	4	42	34	40	43	13	12	0	2
Total	4	42	34	40	44	53	47	54	56
% Electronic	na	na	na	na	2	75	74	100	93

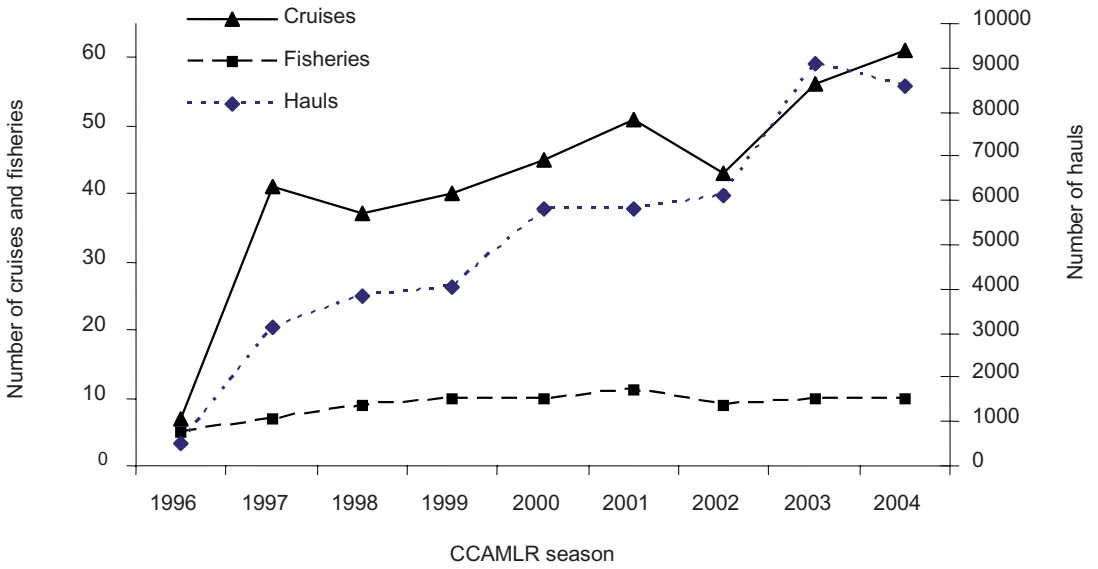

Figure 2: A comparison between observer effort (number of cruises conducted and hauls observed) and the number of active fisheries, by CCAMLR season.

as a PDF version which can be downloaded from the publications section of the CCAMLR website (www.ccamlr.org).

CCAMLR scientific observer sampling procedures are standardised and are set out in the manual. They include detailed instructions on the type of measurements to be taken for each species and the sampling protocols to be followed.

In addition to the text of the scheme and other statutory documentation, the manual is divided into four main sections. These are:

1. Planning of scientific observations
   - background information on the text of the scheme
   - lists of current research priorities
   - data collection and sampling requirements
   - rules for access to and use of CCAMLR data.
2. Observer logbook forms and instructions
   - logbook forms for each fishing method, instructions and examples of how each section should be completed.
3. Guidelines for scientific observers
   - maturity scales for the main commercial species
   - sampling methods, such as otolith collection and storage
   - species identification guides
   - information relating to fish tagging programs.
4. Reference material
   - maps
   - nautical twilight reference tables
   - Beaufort scale definitions
   - a list of CCAMLR data codes.

[3] In particular, these relate to data collection plans to be undertaken by scientific observers on board vessels taking part in all exploratory fisheries for *Dissostichus* spp., e.g. data collected pursuant to the data collection plans for the period up to 31 August 2005 should be submitted to CCAMLR by 30 September 2005 (Conservation Measure 21-02 (2004), paragraph 9(iii) and Conservation Measure 41-01 (2004), paragraph 7) (see CCAMLR, 2004b).

All data collected under the scheme and submitted to CCAMLR must comply with the standard logbook format. This enables such data to be entered into the CCAMLR database in a consistent manner, thus ensuring data integrity and continuity from year to year. Any data submitted using an incorrect format is not accepted into the database and is returned to the data originator for reformatting. The CCAMLR database also contains formatting and logic checks to assist data validation.

In 2000, electronic versions of the logbook (e-logbook) forms were produced in Excel format. The e-logbooks contain logbook forms, instructions and data codes for each fishery and, as the paper version of the manual, are available in the Commission's four official languages from the Scientific Committee section (Scientific Observation page) of CCAMLR's website (www.ccamlr.org).

Since the introduction of e-logbooks, there has been a dramatic increase in their use compared with paper versions. For example, 100% of the logbooks submitted in 2003 and 93% in 2004 were provided in electronic format (Table 3).

The e-logbooks have several major advantages, the main one being cost-effective and fast transmission of data via email as opposed to postal delivery of logbook forms. This allows technical coordinators to receive observer reports from vessels at the end of each fishing trip and email them to the CCAMLR Secretariat[3]. This is important because of the relatively short time between the closure of certain fisheries and the start of the annual CCAMLR meetings, when the current season's data are analysed: every effort is made to ensure that available data are as complete and up-to-date as possible by the time of the meetings.

Other advantages to users of the e-logbooks include codes and instructions in 'pop-up' menus which assist observers to complete forms accurately, built-in logic checks, speedy transmission of all logbook updates to technical coordinators via email, and rapid accurate uploading of logbook data by the Secretariat into the CCAMLR centralised database.

Implementation of the scheme

The scheme was used for the first time in 1993 under a bilateral arrangement between Chile and the UK. As a result, a CCAMLR scientific observer was deployed on board a vessel fishing for toothfish (*Dissostichus eleginoides)* in waters around South Georgia (Subarea 48.3). Since 1995, CCAMLR has mandated participation in the *D. eleginoides* fishery in Subarea 48.3 on the condition that an international scientific observer be deployed on each vessel during all fishing activities.

In 1997, CCAMLR noted the significant contribution scientific observers had made to providing fishery-related information, and decided that such coverage should be implemented for all new and exploratory fisheries[4] for *Dissostichus* spp., as well as fisheries for *Champsocephalus gunnari* and squid (*Martialia hyadesi*) (CCAMLR, 1997, paragraph 8.19).

At present, CCAMLR fisheries targeting a variety of species are subject to the requirement that vessels carry at least one international observer on board each vessel for the duration of fishing activities in the Convention Area. The fisheries include those for *Dissostichus* spp., *C. gunnari*, *Macrourus* spp., *Chaenodraco wilsoni*, *Lepidonotothen kempi*, *Trematomus eulepidotus*, *Pleuragramma antarcticum*, *Paralomis* spp. and *M. hyadesi* (CCAMLR, 2004b).

The deployment of scientific observers on board vessels fishing for Antarctic krill (*Euphausia superba*) is currently voluntary. Despite this, the observer coverage of krill fishing vessels has increased from 8% in 2000 to 67% in 2004 (Table 4). Most of the observers on krill vessels are national observers, although their functions have often been, at least in part, congruous with the scheme.

A summary of all observation programs under the scheme since 1996 is given in Table 4, by fishery and target species. The ongoing implementation and development of the scheme is outlined in Figure 2; particular note should be take of the steady increase in the number of observation programs undertaken as well as the volume of haul-by-haul data collected by observers. This increase

[4] CCAMLR Conservation Measure 21-01 (2002) defines a new fishery as a fishery on a species for which: (i) information on distribution, abundance, demography, potential yield and stock identity from comprehensive research/surveys or exploratory fishing have not been submitted to CCAMLR; or (ii) catch and effort data have never been submitted to CCAMLR; or (iii) catch and effort data from the two most recent seasons in which fishing occurred have not been submitted to CCAMLR (see CCAMLR, 2004b). Conservation Measure 21-02 (2004) defines an exploratory fishery as a fishery that was previously classified as a 'new fishery' and which remains classified as such until sufficient information becomes available for estimation of the fishery's potential yield and the potential impact of the fishery on dependent and related species (see CCAMLR, 2004b).

Table 4: Summary of scientific observation programs, 1996–2004.

Season*	Fishery	Target species	CCAMLR area (area/subarea/division)	Number of cruises conducted	Number of cruises observed	Observer coverage (%)
1996	Longline	*D. eleginoides*	48.3	16	7	43
1997	Longline	*D. eleginoides*	48.3, 58.6, 58.7, 88.1	30	27	90
	Trawl	*D. eleginoides*	58.5.2	4	4	100
	Trawl	*E. superba*	48	5	0	0
	Jig	*M. hyadesi*	48.3	2	2	100
1998	Longline	*Dissostichus* spp.	48.1, 48.2, 48.3, 58.6, 58.7, 88.1, 88.3	30	30	100
	Trawl	*D. eleginoides*, *C. gunnari*	48.3, 58.5.2	7	7	100
	Trawl	*E. superba*	48	10	0	0
1999	Longline	*Dissostichus* spp.	48.3, 58.6, 58.7, 88.1	33	33	100
	Trawl	*C. gunnari*, *D. eleginoides*	48.3, 58.4.1, 58.4.3, 58.5.2	7	7	100
	Trawl	*E. superba*	48	14	0	0
	Pot	*Paralomis* spp.	48.3	1	1	100
2000	Longline	*Dissostichus* spp.	48.3, 58.6, 58.7, 88.1, 58.4.4,	35	35	100
	Trawl	*D. eleginoides*, *C. wilsoni*, *C. gunnari*	48.3, 58.5.2, 58.4.2	9	9	100
	Trawl	*E. superba*	48.1	12	1	8
2001	Longline	*Dissostichus* spp.	48.3, 58.6, 58.7, 88.1	36	36	100
	Trawl	*D. eleginoides*, *C. gunnari*	48.3, 88.1, 58.4.2, 58.5.2	13	13	100
	Trawl	*E. superba*	48	10	2	20
	Pot	*D. eleginoides*	48.3	5	5	100
	Jig	*M. hyadesi*	48.3	1	1	100
2002	Longline	*Dissostichus* spp.	47, 51 (adjacent to CCAMLR), 48.3, 88.1, 88.2, 58.6, 58.7	27	27	100
	Trawl	*D. eleginoides*, *C. gunnari*	48.3, 58.4.4	11	11	100
	Trawl	*E. superba*	48	10	5	50
	Pot	*P. spinosissima*, *P. formosa*	48.3	1	1	100
2003	Longline	*Dissostichus* spp.	51, 48.3, 58.6, 58.7, 88.1, 88.2, 58.4.2, 58.5.2	39	39	100
	Trawl	*D. eleginoides*, *C. gunnari*	48.3, 58.5.2	11	11	100
	Trawl	*E. superba*	48	17	6	35
2004	Longline	*D. eleginoides*, *Dissostichus* spp.	48.3, 48.6, 58.6, 58.7, 58.4.2, 58.4.3b, 58.5.2	44	44	100
	Trawl	*D. eleginoides*, *C. gunnari*	48.3, 58.5.2	11	11	100
	Trawl	*E. superba*	48	9	6	67

* Season is from 1 December to 31 November.

Table 5: Observation priorities for CCAMLR observers on board longline fishing vessels (SC-CAMLR, 1996, Annex 5, paragraph 3.18).

Priority	Description
High	As many length measurements of fish as possible per haul, not exceeding 60.
High	Fish sex and maturity information.
High	Monitoring the incidental mortality of seabirds. Collecting and recording of bird band information.
High	Description of streamer lines used.
High	Information on whether the streamer line was used during every longline set.
Medium	Estimation of commercial and by-catch species in numbers and weight, per number of hooks observed for each set.
Medium	Recording fish discards (both target and by-catch species) per number of hooks observed for each set.
Medium	Evaluation of the efficiency of mitigation measures.
Medium	Collection of fish scales and otoliths for age determination.
Medium	Monitoring the location and time of offal discharge.
Low	Retaining (whole or head and leg) samples of birds for age and species identification.
Low	The estimation of the number of fish per haul damaged during interaction with marine mammals.
Low	Estimation of the number of hooks lost.

has persisted despite the fact that the number of open fisheries has remained steady for the past several years.

CCAMLR soon appreciated that it would be desirable, wherever possible, to have two scientific observers on board longline fishing vessels so as to facilitate collection of all priority data on fish and by-catch species and incidental seabird mortality (CCAMLR, 1995, paragraph 5.29). The need for this was corroborated by reports received from observers that there was insufficient time or capacity for a single observer to complete all the tasks assigned to them in the longline logbooks. CCAMLR recognised that, depending on circumstances, not all tasks may be completed in sufficient detail by a single observer (SC-CAMLR, 1996, Annex 5, paragraph 3.17).

Subsequently, CCAMLR revised the list of observation priorities and agreed the priority order for the major data collection tasks for longline observers (Table 5). This list was designed to be kept under constant review and updated depending on needs identified by the Scientific Committee (SC-CAMLR, 1996, paragraph 3.18; see also footnote 4). Consequently, a single observer is required to complete tasks nominated as being high and medium priority, with low-priority tasks only being completed whenever possible.

From the 2003/04 fishing season, the mandatory deployment of at least two scientific observers per vessel was introduced for exploratory fisheries for *Dissostichus* spp. in Subareas 48.6, 88.1 and 88.2, and Divisions 58.4.2, 58.4.3a and 58.4.3b. These fisheries now require at least two scientific observers, one of whom must be appointed in accordance with the scheme, at all times during fishing activities.

Current achievements and future developments

Despite the relatively long history of scientific research and fisheries in Antarctic waters, CCAMLR's fisheries management strategies have often had to deal with incomplete and uncertain information on harvested resources. The difficulty and expense of conducting fishery-independent studies, as well as the size of the Convention Area (about 11% of the world's oceans), its remoteness and the prevailing inclement weather, have all complicated the situation.

In particular, the introduction of the scheme was designed to address the expansion of the toothfish (*Dissostichus* spp.) fishery into the high-latitude areas of the Indian and Pacific Ocean sectors of the Southern Ocean in the early to mid-1990s (Agnew, 2000; Sabourenkov and Miller, 2004). At the time, the knowledge of toothfish resources was not sufficient to provide a basis on which to implement CCAMLR's ecosystem and precautionary-oriented approaches to fisheries management. This situation was further complicated by the rapid expansion of illegal, unregulated and unreported (IUU) fishing into new fishing areas (Sabourenkov and Miller, 2004). In particular, IUU fishing created additional uncertainty in evaluating the total toothfish

removals essential for stock assessment purposes. The deployment of scientific observers under the scheme on all toothfish vessels in new and exploratory fisheries became a source of urgently required fishery-related data.

Subsequently, the carrying of international scientific observers by fishing vessels has become compulsory for all finfish, crab and squid fisheries. A list of research priorities and observer tasks has been agreed for all these fisheries (see 'Implementation of the scientific objectives of the scheme'). At the same time, and irrespective of the mandatory application of the scheme, the question of what the minimum number of observations to be conducted should be and what volume of data should be collected in each fishery by each observer still needs to be considered by the Scientific Committee and its working groups. This may possibly be done as part of the current initiative by WG-FSA to identify data essential for stock assessment purposes to facilitate prioritisation of the observer workload (SC-CAMLR, 2003, Annex 5, paragraph 10.11) and for the proposed review of the *Scientific Observers Manual* (SC-CAMLR, 2004, paragraph 2.11).

The collection of data by scientifically qualified observers on board fishing vessels has assumed prominence as a means by which CCAMLR is able to collect essential and standardised data for fisheries management purposes and augment standard catch and effort data from the fishery. Thus, the scheme accomplishes its primary objective by providing, on an annual basis, information which is currently required by CCAMLR for fisheries management purposes.

Another, and perhaps the most generally recognised achievement of the scheme, has been its role in reducing seabird mortality associated with CCAMLR-regulated longline fisheries in the Convention Area, especially over the past five years. For four successive years since 2000, levels of incidental seabird mortality in regulated longline fisheries in the Convention Area were negligible in Subarea 48.3, low in the South African EEZ in Subareas 58.6 and 58.7[5] and non-existent in Subareas 88.1 and 88.2. In 2002, the Scientific Committee noted from reported data that incidental seabird mortality levels in the Convention Area were the lowest ever recorded (SC-CAMLR, 2002).

This success can be attributed to a number of factors. First, the fishing industry itself has implemented and effectively complied with mitigating measures including delaying the commencement of fishing until the end of the breeding season for most albatrosses and petrels (Kock, 2001). The CCAMLR fishers' education program has also contributed. In the book *Fish the Sea Not the Sky* (CCAMLR, 1996), CCAMLR clearly outlined not only strong world-wide concern about the survival of seabirds, but also economic reasons for the industry to avoid catching seabirds since '…birds take bait from hooks, and hooks without bait do not catch fish…'.

Secondly, the scheme has enabled the Scientific Committee, especially its ad hoc WG-IMAF, to annually review observer data on the implementation of measures to reduce the incidental mortality of seabirds and to improve these measures. This is clearly seen in the developmental history of CCAMLR's seabird mitigation conservation measures (Miller et al., 2004).

Thirdly, the Commission annually receives and considers advice from the Scientific Committee on compliance with seabird mitigation conservation measures. This advice is based on data collected by scientific observers. CCAMLR keeps compliance with these measures under constant review. Finally, the presence of an international scientific observer on board fishing vessels is assumed to result in some modification of fishers' behaviour. The presence of the scientific observer is thought to act as a deterrent to unacceptable practices and is likely to contribute to minimising potential breaches of conservation measures in force.

It could be argued that the data collected by observers on board commercial fishing vessels have certain limitations as they only document the fishery, and therefore are restricted to fishing strategies of particular vessels and national fleets. Observer programs on fishing vessels do not necessarily provide data for an entire stock or fishery over the stock's entire distribution. Such programs often lack any underlying survey design for their data sampling protocols (e.g. SC-CAMLR, 1998, paragraph 3.66). However, the modern analytical techniques and models used by CCAMLR for stock assessment purposes, such as the Generalised Yield Model (Constable et al., 2000), have been specifically designed to use fishery-dependent data.

In addition, a key element of the CCAMLR unified regulatory framework adopted in 2000 stipulates that data collection, research and fishery

[5] South Africa voluntarily applies the Scheme of International Scientific Observation in toothfish fisheries conducted in its EEZ around Prince Edward and Marion Islands (Subarea 58.7).

operational plans should be established for each new and exploratory fishery (CCAMLR, 2000, paragraphs 10.2 to 10.8; see also Conservation Measure 41-01 (2004) in CCAMLR, 2004b). The Scientific Committee annually reviews these plans and proffers advice on the prosecution of each fishery in question. Such plans introduce survey-design elements into vessel operations and, consequently, into the collection of observer data. As CCAMLR conservation measures set out compulsory procedures to spread fishing effort over fishing grounds, both temporally and spatially, they introduce yet another element of scientific planning to the collection of observer data.

For example, the introduction of small-scale research units in 1999 to assess the relative density of *Dissostichus* spp. using catch-per-unit-effort (CPUE) in new and exploratory fisheries (SC-CAMLR, 1999, paragraph 9.27; CCAMLR, 1999, paragraph 7.18; see also Conservation Measure 41-01 (2004) in CCAMLR, 2004b) required that vessels in exploratory toothfish fisheries collect data in a more rigorous way, and that fishing catch and effort be spread over a number of fine-scale areas. This small-scale research unit approach aims to improve data on toothfish distribution and abundance from areas where information is limited or absent. It also aims to minimise the risk of unacceptable and irreversible damage being inflicted on targeted stocks as well as on dependent and related (e.g. by-catch) species (SC-CAMLR, 2002, paragraphs 3.16 and 3.17 and Figures 1 to 3). Another example of a survey-design element in scientific observation is the recent requirement for observers to tag toothfish, skates and rays in toothfish fisheries in high-latitude waters of the Ross Sea, in the Pacific Ocean sector of the Southern Ocean (see Conservation Measure 41-01 (2004), Annex 41-01/B in CCAMLR, 2004b).

CCAMLR does not view scientific observation on board fishing vessels as a replacement for the collection of fishery-independent (i.e. survey) data, and Members annually undertake a number of designed research surveys (see Conservation Measure 24-01 (2004) in CCAMLR, 2004b; see also Reports of Members' Activities in the Commission section of the CCAMLR website (www.ccamlr.org)). The importance of continuing to conduct fishery-independent scientific surveys is clear: such surveys are often the only source of comprehensive fishery-independent information on the biology, ecology, distribution, population structure and status of harvested species. For example, only a fishery-independent survey can provide data on the spawning, recruitment, migrations etc. of target species. Accordingly, there is a need to ensure that fishery-independent surveys and scientific observation programs deliver data that are complementary and that a proper balance is maintained between these activities. This is what the scheme strives to achieve and its flexibility in terms of responding to changing scientific circumstances is an enduring strength.

The most recent CCAMLR scientific development is a program of work aimed at producing operating models of the Antarctic marine ecosystem (SC-CAMLR, 2004, Annex 4, Appendix D). This initiative includes the development of models to investigate different management approaches aimed at addressing the underlying uncertainties attached to current CCAMLR knowledge on fish biology, fishery monitoring and stock assessment procedures. One aspect of this work will be to develop diagnostic models to investigate the efficacy of observation programs, taking account of such considerations as differences in the kinds of monitoring necessary for improving the understanding of predators, prey and the fishery.

Thus, the scheme continues to be a valuable source of information for CCAMLR's proposed development and future operation of Antarctic krill-centric ecosystem models. Continued provision of reliable fishery-related information on krill stocks is therefore of extreme importance for the development and operation of ecosystem models. In response to recommendations by the Scientific Committee, the level of international scientific observation on krill fishing vessels has increased in the past three years. The observers collect data in strict accordance with the standards outlined in the scheme. Based on the precedents established for other CCAMLR fisheries, it is expected that mandatory deployment of international observers on krill fishing vessels is likely to be considered in the near future. The Commission has already requested the Scientific Committee to prepare advice on the scientific objectives and priorities for the deployment of international scientific observers on krill fishing vessels (CCAMLR, 2004c). Most notably, CCAMLR has already developed and agreed principles for the delineation of small-scale krill harvesting units. The implementation of complementary small-scale krill fisheries management would require feedback of comprehensive fishery-dependent information. This could be done only by means of scientific observation programs. It has also been suggested that the deployment of observers with suitable modelling experience could do much to collect the type of information necessary to document such

imponderables as fishery search time between krill catches and between fishable krill aggregations (Butterworth, 1988; Mangel, 1988).

Therefore, and at least until reliable ecosystem models are developed and tested, the collection of data by scientific observers on board fishing vessels in the Convention Area is very likely to continue to be the key source of a wide range of essential and standardised data for fisheries management purposes. Scientific observation also remains a reliable and important source of data on the interactions of seabirds and marine mammals with fishing operations.

Consequently, implementation of the CCAMLR Scheme of International Scientific Observation is set to be continued on a mandatory basis in all finfish fisheries in the Convention Area and, in future, applied to krill fisheries.

In 2004, CCAMLR decided that annual assessments of compliance with conservation measures should be conducted, and agreed to develop the required procedures (CCAMLR, 2004c, paragraph 6.7 and Annex 5, paragraphs 3.27 to 3.29). Data collected by international scientific observers are considered to be important for assessing compliance, notably with measures focused on by-catch provisions, mitigating seabird incidental mortality and reducing waste disposal. The Scientific Committee will also continue to be involved in the use of scientific observer data for the evaluation of the effectiveness of conservation measures in meeting their objectives.

The scheme's objective is currently limited to scientific observation and separated from the enforcement issues that are covered by CCAMLR under the System of Inspection and a set of other compliance measures such as licensing requirements and port inspections of vessels. If CCAMLR establishes and implements a system for assessing compliance with conservation measures using, *inter alia*, data collected by scientific observers, the application of such data for enforcement purposes might require further consideration by CCAMLR. Until this occurs, it is difficult to speculate as to whether the scheme itself would need to be revised in order to reflect the use of scientific observer data for enforcement assessment purposes.

Conclusions

The CCAMLR Scheme of International Scientific Observation has proven to be an indispensable source of a wide spectrum of fishery-related data, including data describing fishery operations, catch, biological characteristics of target and by-catch species and interactions of seabirds and marine mammals with fishing operations. With the exception of the Scientific Observer Program recently adopted by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT)[6], no other international fisheries management organisation currently has an international program with the scope and coverage of the CCAMLR scheme[7].

The main achievements of the scheme are that it:

(i) annually provides information required by CCAMLR for fisheries management purposes;

(ii) plays an active role in the reduction of the incidental mortality of seabirds associated with longline fishing in the Convention Area.

The scheme also boasts a number of key features which set it apart from, and are in advance of, other national and international fishery observer programs. These include:

(i) its application to the entire Convention Area, i.e. about 11% of the world's oceans;

6 The CCSBT Scientific Observer Program aims at an observer coverage of 10% for catch end effort, and responsibility for the operation of the program will lie with the member whose flag is flown on the vessel. From *The CCSBT Scientific Observer Program Standards* (www.ccsbt.org/docs/pdf/about_the_commission/observer_program_standards.pdf).

7 The work of CCAMLR on the development and implementation of the Scheme of International Scientific Observation was reported to and discussed at the 4th International Fisheries Observer Conference held in Sydney, Australia, from 8 to 11 November 2004. The conference focused mainly on national observer programs, with CCAMLR being the only RFMO present, and participants noted with interest the scheme's comprehensiveness, its international nature and the 100% vessel coverage in most CCAMLR-regulated fisheries. It was especially noted that the scheme provides a steady continuous feedback of information for fisheries management and also allows CCAMLR to evaluate the performance of the conservation measures that have been introduced to manage fisheries. The conference concluded that scientific observation on the high seas in areas of competence of international fisheries organisations should be included on the agenda of its fifth meeting planned to be held in Canada in May 2007 (*Proceedings of the 4th International Fisheries Observer Conference* (Sydney, Australia, 8–11 November 2004 (www.fisheriesobserverconference.com)).

(ii) its international nature, which results in an extra level of credibility being attached to the objectivity of the data collected and their use by the multinational CCAMLR scientific community;

(iii) the 100% mandatory scientific observer coverage on all fishing vessels taking part in all finfish and squid fisheries in the Convention Area;

(iv) the fact that the scheme and its supporting documentation have been developed with the potential to incorporate observations on vessels taking part in fisheries targeting other species, such as Antarctic krill;

(v) the combination of scientific observation with conservation measures defining mandatory data collection, research and fishery operational plans by vessels in each fishery, which greatly enhances the scientific value of observer data;

(vi) the provision of data under the scheme to be used by CCAMLR to evaluate the level of compliance by fishing vessels with conservation measures in force, such as those focused on mitigating seabird incidental mortality, reducing waste disposal by vessels and eliminating IUU fishing.

Acknowledgements

The authors are grateful for Jacque Turner's assistance in preparing historical information on the implementation of the scheme. The authors also thank Neville Smith and Eduardo Balguerías for their constructive comments on the manuscript.

References

Agnew, D.J. 2000. The illegal and unregulated fishery for toothfish in the Southern Ocean, and the CCAMLR Catch Documentation Scheme. *Marine Policy*, 24: 361–274.

Butterworth, D.S. 1988. Some aspects of the relation between Antarctic krill abundance and CPUE measures in the Japanese krill fishery. In: *Selected Scientific Papers, 1988 (SC-CAMLR-SSP/5)*, Part I. CCAMLR, Hobart, Australia: 109–125.

CCAMLR. 1991. *Report of the Tenth Meeting of the Commission (CCAMLR-X).* CCAMLR, Hobart, Australia: 101 pp.

CCAMLR. 1995. *Report of the Fourteenth Meeting of the Commission (CCAMLR-XIV)*. CCAMLR, Hobart, Australia: 153 pp.

CCAMLR. 1996. *Fish the Sea Not the Sky. How to avoid by-catch of seabirds when fishing with bottom longlines.* CCAMLR, Hobart, Australia: 46 pp.

CCAMLR. 1997. *Report of the Sixteenth Meeting of the Commission (CCAMLR-XVI)*. CCAMLR, Hobart, Australia: 152 pp.

CCAMLR. 1998. *Report of the Seventeenth Meeting of the Commission (CCAMLR-XVII)*. CCAMLR, Hobart, Australia: 166 pp.

CCAMLR. 1999. *Report of the Eighteenth Meeting of the Commission (CCAMLR-XVIII)*. CCAMLR, Hobart, Australia: 183 pp.

CCAMLR. 2000. *Report of the Nineteenth Meeting of the Commission (CCAMLR-XIX)*. CCAMLR, Hobart, Australia: 239 pp.

CCAMLR. 2004a. *CCAMLR Basic Documents.* CCAMLR, Hobart, Australia: www.ccamlr.org/pu/e/e_pubs/bd/toc.htm.

CCAMLR. 2004b. *Schedule of Conservation Measures in Force, 2004/05.* CCAMLR, Hobart, Australia: 162 pp.

CCAMLR. 2004c. *Report of the Twenty-third Meeting of the Commission (CCAMLR-XXIII)*. CCAMLR, Hobart, Australia: 169 pp.

Constable, A.J., W.K. de la Mare, D.J. Agnew, I. Everson and D. Miller. 2000. Managing fisheries to conserve the Antarctic marine ecosystem: practical implementation of the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR). *ICES J. Mar. Sci.*, 57 (3): 778–791.

Kock, K.-H. 2001. The direct influence of fishing and fishery-related activities on non-target species in the Southern Ocean with particular emphasis on longline fishing and its impact on albatrosses and petrels – a review. *Reviews in Fish Biology and Fisheries*, 11.

Mangel, M. 1988. Analysis and modelling of the Soviet Southern Ocean krill fleet. In: *Selected Scientific Papers, 1988 (SC-CAMLR-SSP/5)*, Part I. CCAMLR, Hobart, Australia: 127–235.

Miller, D.G.M., E.N. Sabourenkov and D.C. Ramm. 2004. Managing Antarctic marine living

resources: the CCAMLR approach. *International Journal of Marine and Coastal Law*, 19 (3): 319–365.

Sabourenkov, E.N. and D.G.M. Miller. 2004. The management of transboundary stocks of toothfish, *Dissostichus* spp., under the Convention on the Conservation of Marine Living Resources. In: Payne, A.I.L., C.M. O'Brien and S.I. Rogers (Eds). *Management of Shared Fish Stocks*. Blackwell Publishing.

SC-CAMLR. 1991. *Report of the Tenth Meeting of the Scientific Committee (SC-CAMLR-X)*. CCAMLR, Hobart, Australia: 427 pp.

SC-CAMLR. 1994. *Report of the Thirteenth Meeting of the Scientific Committee (SC-CAMLR-XIII)*. CCAMLR, Hobart Australia: 450 pp.

SC-CAMLR. 1996. *Report of the Fifteenth Meeting of the Scientific Committee (SC-CAMLR-XV)*. CCAMLR, Hobart, Australia: 456 pp.

SC-CAMLR. 1998. Report of the Working Group on Fish Stock Assessment. In: *Report of the Seventeenth Meeting of the Scientific Committee (SC-CAMLR-XVII)*, Annex 5. CCAMLR, Hobart, Australia: 301–495.

SC-CAMLR. 1999. *Report of the Eighteenth Meeting of the Scientific Committee (SC-CAMLR-XVIII)*. CCAMLR, Hobart, Australia: 461 pp.

SC-CAMLR. 2002. *Report of the Twenty-first Meeting of the Scientific Committee (SC-CAMLR-XXI)*. CCAMLR, Hobart, Australia: 524 pp.

SC-CAMLR. 2003. *Report of the Twenty-second Meeting of the Scientific Committee (SC-CAMLR-XXII)*. CCAMLR, Hobart, Australia: 577 pp.

SC-CAMLR. 2004. *Report of the Twenty-third Meeting of the Scientific Committee (SC-CAMLR-XXIII)*. CCAMLR, Hobart, Australia: 680 pp.

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APPENDIX

LIST OF CURRENT RESEARCH PRIORITIES IDENTIFIED BY THE SCIENTIFIC COMMITTEE FOR CONDUCTING SCIENTIFIC OBSERVATIONS ON COMMERCIAL FISHING VESSELS*

1. Fishery for *Champsocephalus gunnari*:
   (i) representative length-frequency distributions
   (ii) observations on sex and maturity stage
   (iii) collection of otoliths for age determination
   (iv) observations of the by-catch of other species
   (v) the incidental mortality of predators (birds and seals).

2. Longline fishery for *Dissostichus eleginoides*:
   (i) representative length-frequency distributions;
   (ii) observations on sex and maturity stage;
   (iii) collection of otoliths and scales for age determination;
   (iv) loss rate of fish from hooks during longline hauling; catching performance of different hook sizes and types; observations on the condition of fish on capture (for tagging experiments);
   (iv) monitoring of total incidental mortality of seabirds by species, sex and age;
   (vi) assessment of seabird mortality per unit of fishing effort and relative vulnerability of different species;
   (vii) collection of bird bands and notification of other study markings;
   (viii) evaluation of the efficacy of mitigation measures;
   (ix) investigation of the practicalities of the implementation of different mitigation measures;
   (x) weighing a sample of longline weights while the vessel is alongside the wharf.

3. Fishery for *Electrona carlsbergi*:
   (i) observations of fishing operations
   (ii) observations of the by-catch of other species.

4. Fishery for *Euphausia superba* including by-catch of fish:
   (i) observations of fishing operations
   (ii) collection of haul-by-haul catch and effort data
   (iii) representative length-frequency distributions
   (iv) representative sex and maturity stage distributions
   (v) observations on feeding intensity
   (vi) observations of the by-catch of juvenile fish
   (vii) observations of incidental mortality of predators (birds and seals).

5. Fishery for *Paralomis* spp. (stone crabs):
   (i) observations of fishing operations
   (ii) collection of haul-by-haul catch and effort data
   (iii) representative length-frequency distributions
   (iv) representative sex and maturity stage distributions
   (v) collection of samples of ovaries and eggs
   (vi) representative length-frequency distributions by sex and maturity stages from catches of bottom trawls (bottom trawl surveys).

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* From *CCAMLR Scientific Observers Manual* (www.ccamlr.org/pu/e/e_pubs/obsman.pdf).