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Observer Programmes Best Practice, Funding Options and North Sea Case Study

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Observer Programmes

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Observer Programmes

Best Practice Funding Options and North Sea Case Study

A Report to WWF by Marine Resources Assessment Group (MRAG)

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1 Executive Summary

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THE PRIMARY PURPOSE of this report is to demonstrate the utility and value of observer programmes as an integral part of monitoring fisheries and providing information necessary to evaluate the impacts of fishing in an ecosystem context and hence promoting sustainability. In the pursuit of reliable data for management, including catch accounting, stock assessment, ecosystem effects and protected species interactions, fishery managers are increasingly turning to at-sea observers as the most effective and efficient means of collecting information.

At-sea observers offer one of the only independent, cost effective sources of some types of fisheries data, including bycatch composition and mortality, and interactions with sharks, marine mammals, sea birds and turtles. In addition, the presence of observers on vessels will deter or prevent illegal or bad fishing practices such as highgrading[1] or discarding and has been shown to have had a dramatic reduction in the number of cetacean mortalities in some fisheries. This, to a certain extent, is a result of greater emphasis on the compliance component of observer programmes, such as monitoring level of implementation of mitigation measures and encourages or forces vessels to adopt more appropriate operational methods resulting in a positive change in vessel behaviour through the elimination or reduction of these practices.

Although vessel self-reporting is often mandated, realistically, only limited data collection demands can be placed on the captain and crew. An on-board observer programme is necessary to enhance this data collection and will often confirm information gathered from other monitoring and surveillance sources. This includes information on:

- **Vessel and catch position**
- **Commercial bycatch species numbers**
- **Active fishing and searching effort**
- **Amount of quota uptake**
- **Type of gear used**
- **Conversion factors**

With an increasing emphasis on an ecosystem management approach to fisheries, observer programmes have proved to be an effective tool for providing a better understanding of the effect that the fishery has on the ecosystem as a whole.

Best Practice

Not all observer programmes prove to be as effective in meeting their objectives as fishery managers would like. This may be for a number of reasons. Often, the problem is that the objectives themselves are poorly defined, being too vague, or too broad leading to conflicting and changing demands being placed on observers and consequent problems with data quality. Even when objectives are well articulated and understood, subsequent problems with other elements of the programme such as estimation procedures, sampling designs, funding, deployment logistics and compliance can lead to poor programme performance. Careful programme design, including pilot studies where possible, is therefore an essential step in improving the probability of success. Consideration should also be given to the intended use of data outputs. These may be for:

[1] Highgrading refers to a practice whereby fishermen catch more than is necessary to sort the most valuable components of the catch with the resulting discarding of the remainder.

- **Stock assessment purposes**
- **Monitoring TAC/quota utilisation**
- **Implement management regimes such as closures**
- **Environmental impact assessments (bycatch and incidental mortalities)**
- **Satisfying obligations to international agreements and/or organisations**
- **Vessel performance evaluation**
- **Fishery policy development**

Basically to what extent does the data contribute to the actual management of the fishery?

In recognition of this, the first major section of this report (Section 3) is devoted to a detailed discussion of observer programme design, including the importance of well-defined (meaning unambiguous) goals and objectives, estimation methods for metrics of interest to managers, sampling design, setting of coverage levels, service delivery models and special consideration for hard to observe fisheries such as small scale and artisanal fisheries. In addition there is consideration of alternative technology-based approaches to monitoring that may enhance observe programmes, or enable them to focus more on the tasks that they do most efficiently. Finally, Section 3 rounds off with a detailed look at the costs of observer programmes and potential sources of funding.

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The following provides a summary of the main issues raised in Section 3:

i) Goals and Objectives

Most have the objective of science, but this is often mixed with some compliance reporting; few examined have a predominantly compliance role. Observers may contribute to a number of standard monitoring tasks, and are the only method of monitoring some features of a fishery such as discarding, non-commercial species catch, charismatic species interactions (mammals & birds, marine turtles, sharks), uptake of quota and some aspects of biological sampling. Objectives should be considered during planning of the programme.

ii) Coverage Levels

Programmes range in coverage from occasional (<2%) to partial (20 – 30% is usual) to full (100%). Coverage can be characterised in different ways, depending on the critical sampling level. It is usually specified in terms of fishing days, but can also be referred to by vessel or haul coverage. Occasional coverage is cheap but is rarely able to provide estimates of monitored quantities of sufficient precision for assessment purposes. Partial coverage is more expensive and does provide robust estimates at required precision levels, but may run into problems with bias, especially arising from changes in vessel behaviour, or the inability to cover all sectors of a fleet equally, and is not usually used for compliance monitoring. 100% cover is expensive but is useful for compliance monitoring in particular, since it preserves equity of observer placement between vessels.

iii) Service Delivery Model (SDM)

Programmes that we looked at are mostly operated by private observer operations organisations, or directly by government or the Fisheries Management Authority (FMA). The programme objectives and the responsibility for deliveries within the organisational structure exert the greatest influence on the service delivery model (SDM). A feasibility study at the programme inception stage would identify and clarify what these should be at each stage, the organisational component responsible and the linkages between them.

iv) Cost

We detected a relationship between the size of an observer programme and its costs, with larger programmes benefiting from economies of scale, and the reduction of administrative

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costs as a proportion of total costs. The minimum cost of an observer programme with a large number of observer days would seem to be in the region of £100 - £200 per observer day, whereas the cost of smaller programmes was much higher than this. Where observer programmes are in place for purposes of compliance the costs should be placed in the context of the alternative of continued infringements leading to overfishing and continued low returns financially per unit of fishing effort.

v) Funding

Observers can be paid for directly through licensing regimes, recovered by the FMA from the operators or by a central agency (e.g. government or regional organisation). Each approach must ensure that the method is not susceptible to a conflict of interests and that the quality of observation is maintained; that it is perceived to be equitably applied by the fishers; and that funding is sustainable and adequate to ensure that programme objectives are realised. In most programmes that we examined funding is provided by the fisheries management authority (government). Costs can be recovered directly from operators on a fee for service basis, as with the Australian Fisheries Management Authority (AFMA), where there are few vessels operating or from the entire fishery through a levy system. Key features of licensing systems take into account market value of the prosecuted stock and exchange rates, to set a fee rate that provides an acceptable return on the cost of a licence and adequate funding for observer programme sustainability.

Review of Existing Observer Programmes

In section 4, we present the results of a review of several existing observer programmes around the world. The intent here is to provide specific examples of the variety of options for programme design that are discussed in Section 3. The following programmes were considered in the review:

i) Australian Fisheries Management Authority (AFMA) Observer Programmes
ii) The Inter-American Tropical Tuna Commission (IATTC) International Dolphin Conservation Programme (IDCP)
iii) Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) Scientific Observer Programme

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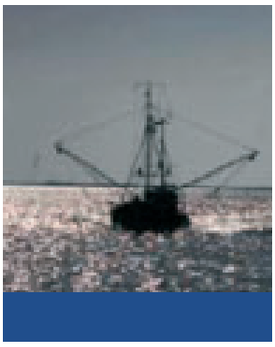
iv) Northwest Atlantic Fisheries Organisation (NAFO) Observer Programme on European Union (EU) vessels
v) British Indian Ocean Territory (BIOT) Offshore Observer Programme
vi) Falkland Island Observer Programme
vii) North Pacific Groundfish Observer Programme (NPGOP)
viii) Irish Sea Cod Recovery Observer Programme
ix) US West Coast Groundfish Observer Programme (WCGOP)
x) Danish Discard Project (project No 94/023: At-sea sampling from the Danish Fishing Fleets in the North Sea and Skagerrak)
xi) Alaskan Marine Mammal Observer Programme (AMMOP)
xii) US Caribbean Bycatch and Discard Observer Programme

An Observer Programme for the North Sea Whitefish Fishery

The last major section of the report provides a preliminary view of using at-sea observers in the North Sea whitefish fishery. This was done with the intention of providing a summary of the likely costs and benefits of running an observer programme to potential participants in the industry as well as to government and fisheries managers. A preliminary analysis of the current observer sampling programme on discards in the North Sea whitefish fleet indicates that about 0.25% of trips or days are currently being sampled, which would classify the programme as "occasional" according to our coverage scheme. From the information available to us it would seem that the programme is unlikely to be able to satisfy the EC's requirement for precision in estimates of bycatch for use in assessments in Council Regulation (EC) No. 1581/2004.

We suggest two alternatives for increased observer sampling in the North Sea. The first would increase sampling simply to meet the precision requirements, which would be a modest three-fold increase. The second would be to broaden the objectives of the observer programme to enable it to validate anecdotal reports of highgrading and black landings, or to monitor the occurrence of charismatic species such as birds and seals. This would require a 20-40 fold increase in coverage. Daily observer costs would be expected to decrease significantly with increased coverage, as the observer system became more efficient.

2 Introduction



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2.1 Purpose of the Study

THIS REPORT aims to demonstrate the utility and value of observer programmesas an integral part of monitoring fisheries to provide information necessary to evaluate the impacts of fishing and hence promote sustainability. In the pursuit of reliable data for management, including catch accounting, stock assessment and protected species interactions, fishery managers are increasingly turning to at-sea observers as the most effective and efficient means of collecting information.

A review of selected observer programmes from around the world was conducted to identify good practice examples which could be incorporated into a set of rules for creating a generic observer programme. They were chosen to give a wide scope across the industry, both in terms of scale (from small scale artisnal to large scale industrial) and management objectives (whether compliance, management or scientific).

An analysis was also undertaken of levels of coverage in the North Sea whitefish fishery necessary to meet the management objectives of the North Sea programme and well as the associated costs and funding options that could be applied.

2.1.1 The Origin and Value of Observer Programmes

Bycatch, the result of unintentional capture of non-targeted species, is composed of a variety of marine life, including fish, mammals, and birds and can jeopardize the sustainability of many species. Scientists estimate that worldwide, during the 1980s and early 1990s, between 17.9 and 39.5 million tons of fish were discarded each year in commercial fisheries[2] and may never be accurately recorded in fishery catch statistics. Recently the FAO updated this figure, estimating annual discards to be as high as seven million tons.

At-sea observers offer one of the only independent, cost-effective sources of some types of fisheries data, such as bycatch composition and mortality, and interactions with marine mammals, sea birds, sharks and turtles. Although vessel self-reporting is often mandated, realistically only limited data collection demands can be placed on the captain and crew.

The impetus for at-sea observer programmes was provided by the need for a better understanding of how fisheries worked, concerns about over-exploitation in some fisheries and a desire to reduce conflicts that arose between industry stakeholders regarding management policies. These conflicts could be attributed to:

- **A lack of trust among the stakeholders**
- **Unsupported policies**
- **No consensus on management priorities**
- **Lack of appreciation of at-sea fishing operations**
- **Gaps in information combined with over-reliance on prevalent data**
- **Issues over compliance**

[2] Alverson, D.L.; Freeberg, M.H.; Pope, J.G.; Murawski, S.A. A global assessment of fisheries bycatch and discards. FAO Fisheries Technical Paper. No. 339. Rome, FAO. 1994. 233p.

[3] Where the terms “programme“ or “observer programme” are used in its non-capitalised form it refers to observer programmes in the generic sense. When the terms “the Programme” and “the Observer Programme/Scheme” are used synonymously within this document, they refer to the specific Observer Programme and all its various components referred to within the respective section.

2.2 Addressing the Terms of Reference

The Terms of Reference of this study are as follows:

i) Review different levels of effective coverage required to meet management objectives and associated costs (administration, employment, training, expenses etc), and funding models underpinning the programme – cover a range of different funding options (levels of contribution from government, industry, other) and the relative merits of the different options.

ii) Outline costs and benefits of observer programmesfor the purposes of sustainable fisheries management (environmental, economical and social).

iii) Identify examples around the world where observer programmes are used and provide a critique of the merits of these as an effective management tool (incorporating the wider environmental objectives/impacts of commercial fisheries). This review should provide examples on a range of different scales (small scale artisanal to large industrial possibly multi species) and with different management objectives (compliance, data collection, trust building and engagement between scientists and fishers in situ, real time enforcement, combating IUU).

iv) Provide recommendations on a potential model which could be advocated for implementation of an observer programme in the North Sea whitefish fishery. This fishery is multi species and a number of the fish species are subject to recovery plans.

v) Explore the potential theoretical economic benefits of having observer data. For example had observer collected data been available for the whitefish fishery since the 1990s, would it have led to improved management advice and what would it have meant for the current fishery? Would this in turn have resulted in increased economic return to the fishery over time, and if so what would have been the cost of the observer system against the projected current revenue?

Chapter 3 addresses Items i and ii of the TOR; coverage level and funding models in observer programmes. Although these issues are covered to some extent within the general review of the example observer programmes, we have added a specific section that looks at these issues in more detail, particularly in relation to the objectives of each programme (either explicit or implied) and the service delivery model, which can have a strong influence on the available options for funding mechanisms.

Chapter 4 examines issues of (TOR (iii)) through a review of selected observer programmes which were chosen to provide a range of different fishery characteristics and data needs from different parts of the world. The purpose of the review is to provide information that can be readily used to make informed choices about the design and development of programmes worldwide. The specific target fishery in this study is the North Sea whitefish fishery. However the review is intended to provide an information base not just for this example, but also for other fisheries that may become candidates for observer coverage in the future.

The review itself is structured as a SWOT analysis of the major features of the various example observer programmes. SWOT stands for Strengths, Weaknesses, Opportunities and Threats. This is an analytical tool most commonly used to assess the strategic position of a commercial company or organisation. Strengths and weaknesses are internal characteristics of the organisation (in this case the observer programme), while opportunities and threats relate to the interaction between the organisation and its environment (in this case the fishery that is being observed). We have therefore used SWOT analysis as a means of structuring the assessment of the advantages and disadvantages of each as a potential model for application elsewhere.

Chapter 5 puts the results of chapters 3 and 4 to use in considering the options for a North Sea observer programme. There is already some observer activity in the North Sea, which we review briefly, before discussing the various options available. We include both TORs (iv) and (v) in this chapter.

A logical approach to resolving these issues was to develop an independent and objective means of collecting detailed data on fishing effort and methods, catch composition including discards, biological characteristics of the catch and the effects of fishing on the ecosystem. Observer programmes, whilst not necessarily providing an ideal solution to all of these problems, certainly go a long way towards improving the understanding of fisheries, and the information base from which to undertake assessments of the effects of fishing.

The evolution of observer programmes can be traced through the establishment and application of several international agreements primarily driven by the United Nations Convention on Law of the Sea (UNCLOS 1982). The key question posed by UNCLOS was, did states have sufficient capability to manage the fishing activity within their respective EEZs? The answer would be reflected in the capacity for the component resources of a Monitoring, Control and Surveillance (MCS) programme, comprising:

- **Patrol platforms**
- **Personnel**
- **Infrastructure**
- **Information systems**
- **Vessel monitoring systems**
- **Institutional support**

Implementation of the approaches recommended by UNCLOS to manage fishing activity within states' waters was crystallised in the UN Fish Stocks Agreement of 1995. Articles 6 and 18 outline the measures for flag states to provide records on fishing activity and catch through the implementation of national, regional and sub-regional observer programmes. Article 25.3 (c) is directed at developing countries to increase their capacity for MCS through development at a local level.

Furthermore, the Food and Agriculture Organisation (FAO) Code of Conduct for Responsible Fisheries of 1995 identified observer programmes as an integral part of MCS. In 2001, the International Plan of Action (IPOA), designed to prevent, deter and eliminate illegal, unregulated and unreported (IUU) fishing, adopted by the Committee on Fisheries (COFI), encouraged the implementation of observer programmes as an MCS tool.

Observer programmes offer a means to monitor fishing fleet activity in remote and often challenging environments for long periods. They provide data for the scientific and management communities that would otherwise be difficult or impossible to verify. They can also provide a means to better understand the fishery from the fishermen's perspective, which is important both for stock assessment and development of successful policy and management measures. Many countries now routinely require vessels to carry independent observers as a condition of fishing their waters.

Observer programmes offer several advantages to developing countries as a means for monitoring local fisheries. The structure of a programme can be tailored according to the resources available and can provide, relatively cheaply, baseline information required for basic compliance and scientific monitoring of a fishery. They also provide an opportunity to show potential donor organisations/countries that local effort and capacity is being developed and applied to better manage fisheries.

Whether motivated by issues of science or compliance, observer programmes should provide outputs that contribute to the development of management measures that encourage good fishing practices and promote both stock and fishery sustainability. This report will explore the extent to which this is the case by conducting a review of a selection of existing observer programmes from around the world. The review will provide insights into the use of observer programmes as a fisheries monitoring tool and the significance of their outputs for management purposes. We will explore the characteristics of each programme and attempt to establish how to evaluate their performance relative to objectives, whether stated specifically or merely implied.

3 Planning the Programme:
Coverage, Costs and Delivery Models

3.1 Introduction

AT-SEA OBSERVER coverage is not uniformly applied throughout fisheries but is conditional on a number of factors:

- **The goals and objectives of monitoring**
- **Optimal estimation methods and sampling strategies**
- **Alternative technology-based monitoring tools**
- **Service delivery models, including deployment logistics**
- **Costs and funding limitations**

In this section we explore these factors in detail in an attempt to provide a road map for the development of new programmes in fisheries currently lacking an observer programme.

Additional information of relevance to the design of observer programmes is provided in Annex 1.

3.2 Legal Authority

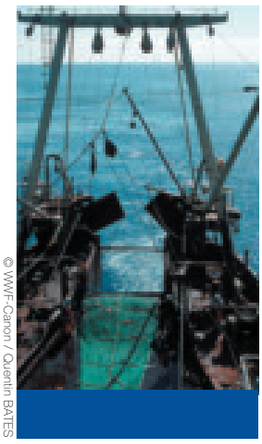
Whatever the formal structure of organisation of a programme, there must be some legal structure in place which allows observers to be placed on vessels, supporting their rights and the rights of the fishermen. This authority can be provided by one or more of the following legal instruments, which provide a mandate and structure for control of the fishery:

- **Ordinance or Act enacting the management regime (e.g. the EEZ or Fisheries Zone)**
- **Regulations**
- **Access agreements for foreign vessels**
- **Licence terms and conditions**

In addition to these forms of primary and secondary legislation, consideration should be given to international, regional, sub regional, national, bilateral and private agreements and/or Memoranda of Understanding (MoU) where appropriate.

For many fisheries, the right to participate is in part predicated on the obligation to accept observers on boats if required. For example, one of the clauses of the licensing terms and conditions for vessels operating within BIOT FCMZ requires permission to be given for an observer to be on board the vessel (see text box overleaf). Unfortunately, for many fisheries which have a long history, especially including coastal community participation, the fishing is considered a community or societal right not a privilege. Such fisheries may not have stringent licensing systems, relying on simple permits with few legal obligations. Fishermen in these fisheries may be particularly resistant to accepting observers as a natural obligation of the right to fish.

The legal authority to place an observer on a vessel and an outline of their role once aboard can be supported by the implementation of an MoU. This defines the selection criteria of observers, tasks to be performed, the general working and living conditions expected to ensure both that the observer is able to perform the required tasks, and their human rights and safety are not compromised. The CCAMLR Scheme of International Scientific Observation and the agreement between the Danish Fishermen's Association (DFA) and the Danish Institute for Fisheries Research (DIFRES) provide models



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BIOT Licensing Conditions
Regarding Fisheries Protection Officers and Observers

• Allow and assist any person identified as a Fisheries Protection Officer or as an Observer to:
i) board the vessel for scientific, compliance, monitoring or other functions
ii) embark and disembark at a place and time agreed
iii) have full access to and use all information, facilities and equipment on board which the Observer may determine is necessary to carry out his or her duties. Without prejudice to the generality of the foregoing this includes access to the fish on board and facilities for their inspection and measurement and the removal of samples; access to vessel records and logs; access to navigation equipment, charts and communications equipment; and access to any other information relating to fishing
• Not assault or obstruct a Fisheries Protection Officer or Observer in the performance of his or her duties.
• Provide the Fisheries Protection Officer and/or Fisheries Observer while on board the vessel with officer level accommodation, food and medical facilities.

Table 1

Considerations for observer-fisher Memoranda of Understanding on the acceptance of observers on board fishing vessels

Subject	Comment
Duties and responsibilities of the observer and the vessel	
Living conditions and status of the observer on board the vessel	Usually the observer is considered an officer
Joining conditions	This may usefully include rules on vessel/trip selection and minimum mobilisation times, for instance in the case where a vessel calls for an observer
Access rights and conditions	The observer needs access to all areas of the vessel required to undertake the specified/ required sampling regime
Provisions to protect the confidentiality of vessel-specific processing and marketing that has commercial implications	The observer may not need access to the processing area, for instance
Considerations of safety	Examples are access to deck areas, provision of survival suits and required IMO safety certificates and inspections
Data to be collected and experiments to be performed, data ownership, access and dissemination rights for data	Fishing activity data (catch, effort, position, time/date, gear specifics) may need to be considered separately from biological and other data (catch and bycatch volume and length/weight, discards, marine mammal and bird observations
Reporting conditions	This should usually include agreements of reports to the vessel and to the authorities
Financial responsibility	For instance it is usual for the vessel to have to bear the on-board costs of accommodation and food of the observer while the observer agency covers training, mobilisation, travel and salary costs

for a best practice system and can be found in Appendix 2. These can be tailored to reflect the concerns and requirements of the respective parties.

The types of details that should be included in MoUs or other agreements between fishers and observer organisations are shown in Table 1.

The application of MoUs within the CCAMLR observer system puts the responsibility on Contracting Parties to ensure that industry and observer providers recognise and adopt the approach and the responsibilities of the programme. This is an important feature as it serves to reassure both vessel operators and observers, and equally provides a framework for conciliation if conflicts arise whilst at sea.

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There may be other advantages that arise from the establishment of such frameworks. One of the outcomes of the implementation of the Danish Discard Project was that the associated increase in co-operation between industry and the scientific community created a platform for future discussions on management issues in a more informal environment, contributing to better understanding and exchange of ideas and greater acceptance of results and measures.

Industry representatives and specifically vessel masters should be made aware of the legal requirements associated with the observer's role and the level of co-operation expected. Likewise, concerns and recommendations from industry should also be addressed and incorporated into agreed standard operating procedures. This can be achieved during initial consultations with industry, agreed by an informal arrangement and will benefit the execution of the programme. Prior to the implementation of the Irish Sea Cod Recovery Observer Programme a master/observer agreement was drawn up to clarify the role of the observer in order to avoid any debate over roles and level of co-operation. This was concluded during consultation with the FPOs prior to mobilisation.

3.3 Goals and Objectives

It is of paramount importance for a rationally constructed monitoring programme to have a clear expression of what it is that the managers and/or scientists need to know and, if possible, how precisely they need to know it. The development of such goals and objectives for a programme ideally would stem from a consideration of the purposes for which data, estimates, and other potential products of the programme are to be used in achieving. Issues that need to be resolved include the required spatial and temporal resolution of data and/or estimates, how quickly data need to be available for use, and the required form of data and/or estimates (e.g., counts of prohibited species caught or weight of total prohibited species catch).

Goals and objectives should be well-defined in the scope, resolution, and form of quantitative information desired. The phrase "well-defined" is used here to mean not subject to ambiguity. Frequently the programme objective is couched in terms of a target coverage level, but without reference to an intended use of observer programme data or estimates. Well-defined objectives should list the types and forms of data, such as catch/effort, bycatch and protected species interactions that the programme will collect, and the priority that should be given to these types. Also included should be a list of quantities that are to be estimated from the data, again with attached priorities. For some estimates it may also be possible to quantify a desired or required (e.g., by statute) level of precision. For others, the quantification of precision may be less readily achieved, particularly in cases for which current procedures do not provide any measure of uncertainty. A common goal for all quantities to be estimated, however, should be that a

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quantification of uncertainty can be computed from the available data (i.e., data should be collected in such a way that uncertainty can be estimated).

Monitoring programme goals and objectives (be they observer or otherwise) generally fall into 3 categories:

- **Science: Collection of information and data on catch, biometrics, bycatch & discards, protected species and environmental parameters. This information may be required for in-season management and/or stock assessment**
- **Compliance: Monitoring of adherence to regulations**
- **Management: Monitoring of fishing activity and fishing effort to develop a better understanding of the operation of the fishery**

Scientific information can include biological, oceanographic, meteorological and operational types. In addition samples can be collected for further investigation for analysis by scientists ashore or under laboratory conditions. The number and type of data sets collected will be determined by the policy of the programme but would typically be comprised of a number of the following:

- **Fishing effort data (gear type, size, number, deployment time)**
- **Fishing location and depths**
- **Catch and discard weight and numbers**
- **Catch and discard composition by species or species group**
- **Incidental mortality by species or species group**
- **Length frequency distributions**
- **Length - weight and other biometric relationships**
- **Age, sex and maturity data**
- **Genetic sampling for stock identification**
- **Stomach contents**
- **Water temperature, salinity etc by depth profile**
- **Meteorological data (e.g. cloud cover, wind speed, wind direction)**

Some of the scientific data collected may also be used as compliance data, for instance the discarding of illegal species or species below minimum landing size may be recorded during a scientific observation but may be reported to the compliance authorities after the event has happened. Although this may not contribute to a prosecution it may be used to help in decision-making processes in subsequent seasons.

Although much of the data for fisheries management purposes can be collected without observers, they are perceived as objective witnesses to fishing activity and as such are ideal as providers of impartial evidence on apparent contraventions of conservation, mitigation or technical measures.

Compliance/management data would include

- **Days at sea**
- **Quota utilisation (of target or bycatch species)**
- **Activity in controlled or restricted areas**
- **Use of prohibited gear types**
- **Flouting of minimum size regulations**
- **Adoption of technical conservation measures**
- **Implementation of mitigation measures for bycatch or incidental mortality**
- **Logbook validation of reported catch and effort**
- **Reporting of illegal unregulated and unreported (IUU) fishing activity**

In organising objectives, it is important to prioritise the factors that will contribute to management of the fishery. Depending on the weighting of scientific or compliance issues, the programme should be tailored accordingly. It is also important to recognize that by their nature, certain types of objectives will conflict with others, and that these conflicts may well grow. In fact, it seems that any well-run reasonably comprehensive scientific observer programme is likely to face increasing pressure for use in compliance as fisheries managers realize the benefits of having observers in

the fishery. For example, since its inception in 1990, in the North Pacific Groundfish Observer Programme has shifted towards a more compliance-oriented system. A review of this programme conducted by MRAG in 1999/2000 described the ways in which this had undermined the science-based data collection process and given rise to concerns over data quality. Similarly, although the CCAMLR programme for toothfish was initially solely oriented towards science, in particular the solution to a bird bycatch problem, it has become used more recently to assess compliance.

This trend is not a comfortable one within observer programmes, because it tends to compromise the science. The solution is to be explicit at the start of the programme planning process in stating that the programme will or will not be used for science and compliance,

Table 2
Monitoring Options

	MCS Tools					Observer		
	Land	Sea	Air	Log book	VMS	Shore Sampling	Obsvs	Research
Absolute Target Species Volume	✓			✓				
Estimated Target Species Volume						✓	✓	
Catch Position		✓	✓	✓	✓		✓	
Commerial Bycatch Species	✓			✓		✓	✓	
Highgrading/Discarding							✓✓	
Non-commercial Bycatch Species							✓✓	
Charismatic Species							✓✓	
Active Fishing Effort				✓	✓		✓	
Searching Effort					✓		✓	
In-season Quota Uptake	✓					✓	✓	
Gear Use		✓					✓	
IUU Activity		✓	✓					
Conversion Factors				✓			✓	✓
Target Species Size and Length						✓	✓	
Commercial Bycatch Species Size and Length						✓	✓	
Non-commercial Bycatch Species Size and Length							✓✓	
General Ecosystem Monitoring							✓	✓
Target and Bycatch Species Other Biological (Maturity etc)							✓	✓

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and to create mutually understood rules under which observer data can be used to monitor and enforce compliance issues.

The simple presence of observers on board vessels often acts as a deterrent to non-compliant behaviour. This may range from not using specific gear when observers are on board to not fishing in certain areas where prohibited bycatch is common. This has the potential to significantly bias scientific data arising from the programme, a problem that is discussed in section 3.2.

Although observers are able to monitor many aspects of a fishery, there are usually alternative monitoring methods available to the management authority. provides an overview of possible aspects of the fishery that can be monitored using observers.

Where there are alternative methods of monitoring these may be better than at-sea observers – for instance position monitoring may be best done using VMS data, although observers can contribute by validating the VMS data when they are on board. Fishing effort (hours fishing) may be better estimated by observers for single tows, but overall unless observer coverage is very high logbooks are the only method of obtaining this information for the whole fleet. The same is true of absolute estimates of catch volume, indicated in table 2 by two ticks. However, there are some issues that are very difficult to obtain information on if observers are not present. These relate to things that are not normally or reliably reported by fishing vessels in other ways, such as

- **Catches of non-reported species**
- **Compliance with occasional or active gear measures (such as actually putting pingers on to nets, cleaning nets, not setting at the same time as discarding offal, moving on when a move-on rule based on critical catch of a bycatch species is triggered)**
- **Research-related issues such as details of search time**

Observer programmes have proved to be effective at providing a better holistic understanding of the position that the fishery occupies within the whole ecosystem. This is an increasingly important issue as fishery management moves more in the direction of ecosystem based management. For instance, the first Canada/United States Observer Programme Workshop, Seattle March 1998 stated:

> **"Observer programmes provide cost-efficient and reliable sources of information about catch, bycatch, and fishing operations and, ultimately, a better understanding of the marine ecosystem and the impact of fisheries on the ecosystem. Alternatives to at-sea observer programmes (such as information collected at shoreside processing plants) provide only limited types of data."**

As shown in the review of observer programmes, some fisheries, such as BIOT, do not have some options for monitoring, such as shore sampling. In these cases the argument is more heavily in favour of using observers than in other programmes where alternatives may be more widely available.

Figure 1 illustrates a rational process for development of an observer programme showing the fundamental importance of setting programme goals and objectives at the outset. The process is divided into three phases: planning, design and implementation, noting (as above) that there is a cycling process between these phases enabling changes at each level as new information becomes available. This process diagram therefore aims to provide a framework not just for the development of new programmes, but for the further development and rationalisation of existing programmes.

When initiating a new observer programme, it should be remembered that whatever purpose and need is identified initially, the programme itself will provide new information that may lead to changes in the stated objectives, or at least the emphasis placed on them. The important point is that such shifts must be a planned part of the process of managing the programme, rather than a gradual creeping of new responsibilities that the programme may not be properly equipped to accommodate. An initial balance among the three types of objectives should be agreed, and subsequently adjusted through a structured, stakeholder supported management process based on new information.

Ideally these decisions should be driven by management and science requirements specified by managers and scientists and adopted at a policy level, rather than from within the observer programme itself.

Developing well-defined goals and objectives is a challenging undertaking, not least due to the number of stakeholders involved, including managers, researchers, industry, and public interest groups. But unless progress is made in this arena, observer programs will continue to be shaped by reaction to events rather than by design.

The following sections of this part of the report provide more detail on the main components and comprise the planning and design phases in Figure 1. These fall into three main categories:

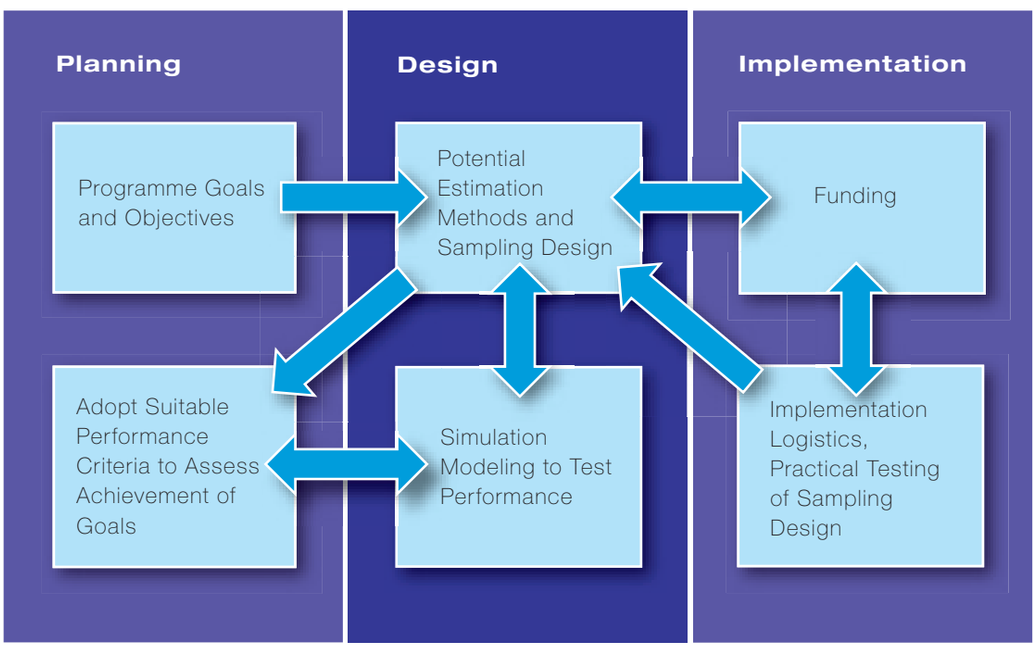
- **Estimation methods and sampling design**
- **Costs and funding**
- **Implementation logistics**

We have further subdivided implementation logistics into the following categories:

- **Organisational structure**
- **Management team**
- **Observers**
- **Training**

Figure 1

Process diagram for rational design and development of an observer programme that incorporates coverage levels to meet specific programme goals and objectives. Testing of the adequacy of coverage is achieved through the adoption of suitable performance criteria.[4]



[4] Developed by MRAG as part of the NMFS Observer Coverage Workshop, July 29-31, 2003 Alaska Fisheries Science Center, Seattle.

Although we discuss sampling design first, we note that the issues of funding, and implementation logistics can have major effects on the implementation of the sampling design. In fact, these issues often have an overriding influence on the sampling that can actually be achieved. While this may tend to undermine achievement of the programme goals and objectives, this is not a reason for not following the procedures outlined for the planning and design phases. Rather, their influence should feed back through the system into the simulation modelling phase to test the performance of the sampling design that is actually implemented, compared to the theoretical optimal approach.

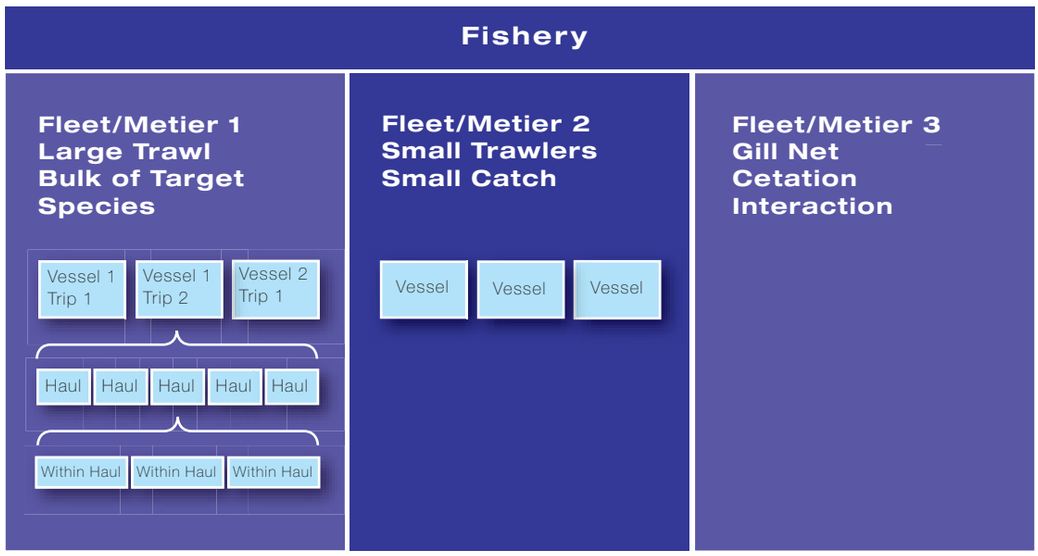
3.4 Estimation Methods and Sampling Design

One important feature of observer programmes is that they almost inevitably produce estimates of the parameters of concern, not absolute values. This is because there is a limit to what an observer can achieve on board a vessel. Even in the case where two observers are on board a vessel, although they may be able to observe every haul they may not be able to sample the whole haul, nor be present simultaneously on the bridge monitoring vessel behaviour and on the deck monitoring the catch.

The range of potential estimation methods and associated sampling designs depends to a large extent on what fishery managers are prepared and/or able to do in order to obtain the data and information that they, or the scientists, need. It may not always be the case that observers are the most efficient means of collecting data. Shore-based rather than at-sea options may prove to be more appropriate in some circumstances. As described in Section 3.8, certain types of vessels are either very hard or practically impossible to observe using conventional observer deployment strategies. These considerations can therefore override statistical aspects of sampling design. In this case, recent technical advances that provide alternative means of collecting observer-type data, such as electronic monitoring using digital cameras[5] should be considered.

Figure 2

Schematic of different levels of sampling that need to be considered in an observer programme. Decisions have to be made about the sampling coverage and strategy for all fleets, and how final coverage will be spread between vessels and trips, between hauls within trips and within hauls.



[5] MRAG (2004). Fisheries Monitoring Technologies. Technical report to the North Pacific Fishery Management Council, Portland, Oregon

Approaches to Statistical Analysis

1 Census Approach. The goal of a census approach is a complete enumeration of the quantity of concern for each fundamental sampling unit (usually a vessel). Although this is not technically a statistical approach at all, it is included here because there may well be some objectives in particular observer programmes for which a census approach is a reasonable alternative. Quantification of bycatch in certain fisheries could possibly be approached through a census approach. The number of mortalities of a rare marine mammal species may also, in some instances, be subject to a census approach. Quite generally, however, a census approach requires observation (without error) of each fundamental sampling unit of concern. Situations under which this is possible are expected to be the exception rather than the norm.

2 Survey Sampling Approach. The sampling approach is based on three fundamental assumptions. First, there exists a finite population of discrete units about which inference is to be made based on incomplete observation (i.e., not a census). Second, the quantity of interest is a characteristic (fixed, immutable value) for each unit in the population and, given that the unit is observed, may be recorded exactly. Finally, the selection of units in the population is completely under the control of the investigator who decides exactly which units are observed and which units are not. The last of these assumptions is well recognized as a major difficulty when faced with observer programmes that must rely on voluntary (or partially voluntary) observer placement, or logistical realities that make some vessels or trips unobservable (e.g., small vessels without adequate safe space for an observer). But violation of the second assumption, that population units possess characteristics that can be observed without error, can be as detrimental to application of a sampling approach as the failure to be able to control observation. This is frequently not recognized in consideration of estimation strategies in observer programs. The sampling approach remains useful for the estimation of many quantities for which observer programs are a useful data gathering tool, however, it should not be taken as the de facto approach of choice for all needs.

3 Model Based Estimators. The statistical approach of modelling formulates a mathematical structure for conceptual quantities called random variables that are connected to both observable phenomena and, possibly, unobservable scientific constructs. Theoretical probability distributions are assigned to random variables, usually in the form of functions that depend on a set of unknown parameters. Properly constructed models connect important aspects of the real problem with values of the unknown parameters, and the goal of analysis then becomes estimation of those parameters, or functions of the parameters. This is a fundamentally different approach to statistical analysis than that of sampling, in which observable quantities are not connected with random variables and probability enters the problem only through the sampling plan used (i.e., the probabilities with which various population units are chosen to be observed). Any number of potential objectives of observer programmes might be well addressed through the use of statistical modelling. The applicability of this approach in any given programme, or for estimation of particular quantities within any programme, will depend on a careful consideration of objectives, logistical realities, what underlying scientific knowledge exists, and whether the quantities being observed may be considered characteristics of discrete population units or are better conceptualized as realized values of random variables.

4 Bayesian Approaches. A Bayesian approach to estimation and inference in a given estimation problem is similar to that of the model based approach (see above), with the additional element that probability can be taken to constitute an epistemic construct. In short, a Bayesian approach equates knowledge with probability. A Bayesian analysis is well-suited to situations that allow a sequential assessment of a given question, such as might occur over successive hauls or trips in a fishery. For example, in estimation of the species composition of catch on a given vessel for a given trip, all hauls observed before the current haul are taken as providing “prior information” relative to the species composition of the current haul.

Once the type of information that is needed and the use to which it is going to be put have been identified, the specific statistical details of the events to be monitored need to be evaluated. For example, a sampling strategy is likely to be different for collecting information on a regular, predictable event e.g. biological characteristics of a target species, such as length frequency, than for detecting a rare unpredictable event such as interactions with marine mammals.

There is no single correct approach to estimation and inference in the statistical analysis of data from observer programs. There is a need, however, for whatever statistical methods are used to constitute a coherent (logically based and internally consistent) set of procedures for estimation and inference. In general the existence of many different levels within the sampling frame needs to be recognised, as shown schematically in Figure 2.

This text box lists the main options for estimating various quantities from a fishery using observers as the primary monitoring tool (extracted from NOAA Fisheries 2003).

Nested sub-sampling such as is produced in observer programmes is well dealt with within standard statistical theory (e.g. see Thompson, S.K. Sampling. Wiley, 1992). Unfortunately, it is almost never the case that there is an obvious "best sampling level". The precision of the estimated values tends to increase, and bias to decrease, smoothly as coverage levels increase. Since costs increase also with coverage levels, one is often left with a simple economic decision. However, because contributions to the overall variance of an estimator may differ with the level of sampling an optimal solution may present itself.

One of the general rules of thumb in designing sampling programmes is that between-vessel variance is often much higher than within-vessel (i.e. between haul) variance (e.g. Pennington and Volstad. 1994; Volstad et al, 1997; MRAG 2002). Therefore it is usually better to sample fewer hauls from more vessels than more hauls from fewer vessels. Equally, within-haul variance is usually smaller than between haul variance, leading to the conclusion that it is usually better to sample little and often than infrequently and a lot.

An interesting feature of partial sampling programmes is the potential for bias arising from changes in behaviour when observers are on board or not on board. MRAG has studied this problem in the North Pacific Groundfish Observer Programme (NPGOP) programme, and found that bias may be significant (MRAG 2003). One potential cause is that while fishermen often know how to avoid large bycatches of protected species, they may choose not to when there is no observer on board because the avoidance strategy may increase costs, or compromise catch rates of target species. When an observer is present they will fish to minimise catches of bycatch species. When an observer is not present they will fish normally, but only report catches of target species. However, Bayesian or Generalised Additive/Linear Modelling techniques can be used to correct for this bias. In this way, using a variety of predictors (such as vessel catch with/without observer, position and time of day/time of year) it is possible to correct data reported by vessels when observers are not present using information from when observers are present.

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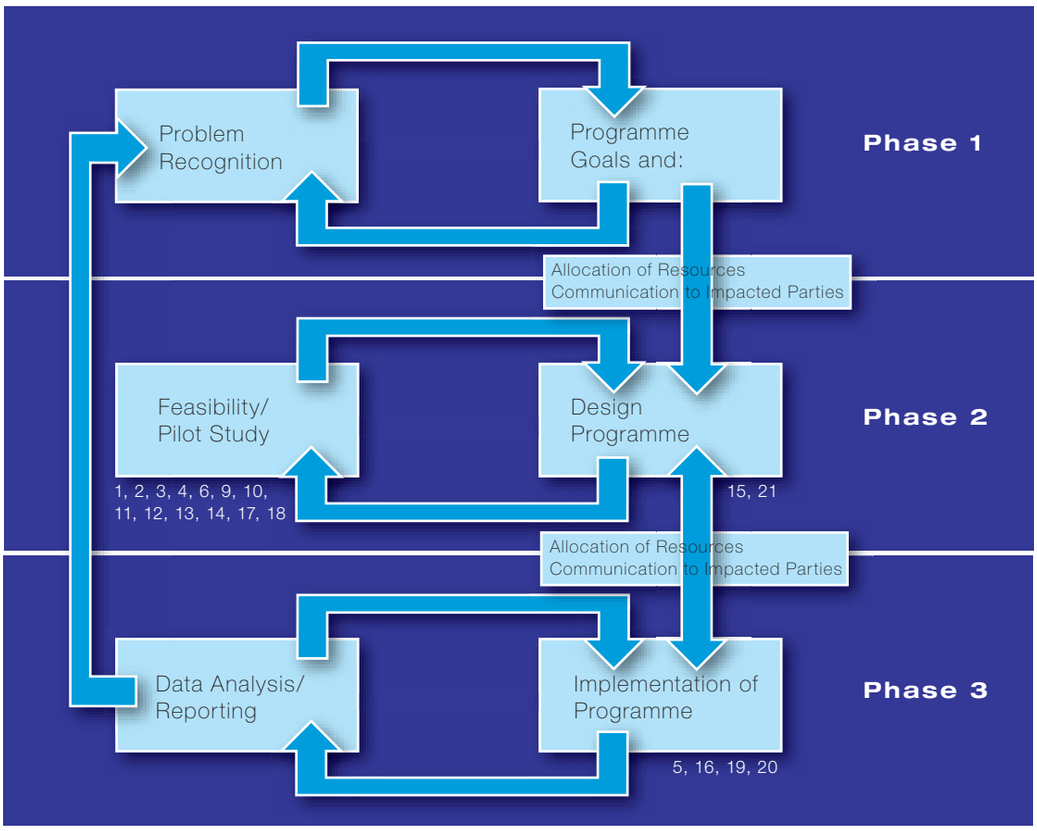
3.5 Determining Coverage Levels

In order to determine required coverage for any programme, it is necessary to obtain information from detailed sampling programmes in order to determine the frequency of events and the variance of estimators. Having done this it is usually possible to determine the most appropriate strategy. However, even with the best data available it may be difficult to assess the level of coverage required in the absence of clear objectives for monitoring. For instance, Northridge and Thomas (2003[6]) showed that if the true catch of common dolphins in the UK Celtic Sea bass fishery was 40 animals, to be 90% sure that the catch was less than the arbitrarily defined limit of 77 animals, one would have to sample 25% of tows. If the true catch was only 10, the larger variance associated with a lower sampling effort of 8% of tows would produce a similarly acceptable 90% certainty that the catch was lower than 77 animals. In order to decide a sampling strategy it would be necessary, in this case, to know

Figure 3

Process of developing an observer coverage strategy to fit a specific problem. The numbers next to each box indicate the various issues listed in the key (below) that need to be taken into consideration at each stage (prepared by MRAG for the NMFS Small Boats Workshop Report, 2003)



1) Distance from shore
2) Type of gear/ fishing method
3) Size of fish
4) Capacity of fish hold
5) Weather
6) Accommodations
7) Economic issues
8) Goals of the observer programme
9) Length of seasons/ time and area closures
10) Seasonality
11) Size of vessel
12) Maintenance of vessel/ age of vessel
13) Work space
14) Power of vessel
15) Fleet characteristics
16) Crew/ captain experience
17) Crew size
18) Length of trip
19) Observer feedback
20) Insurance carried by the vessel
21) Observer personal safety issues

[6] S. Northridge and L. Thomas. Monitoring levels required in European Fisheries to assess cetacean bycatch, with particular reference to UK fisheries. Final report to DEFRA, August 2003.

Table 3

Observer Coverage Levels Advantages and Disadvantages

Coverage	Example	Advantages	Disadvantages
No Coverage		• No cost • Money saved can be applied to other approaches to monitoring	• No observer data • No on-board compliance monitoring • Not equitable compared to other components of the fleet
Occasional coverage (eg <2 % coverage of trips and/or hauls, or specific research programmes)	• Falkland, St Croix	• Cheap to implement • Provides qualitative information on issues of concern • May provide good estimates of particular parameters in directed research efforts • Easily acceptable to fleet	• Cannot provide robust estimates of fleet-wide parameters
Partial coverage (e.g. observers covering 20% or 30% of all trips, and 10-20% of all hauls)	• NPGOP, Irish Sea, Danish	• Cheaper than 100% coverage • More feasible for smaller vessels • May provide sufficient coverage for routine scientific sampling	• Propensity for differences in vessel behavior between observed and non-observed days • Data may be biased for various reasons: including non-random observer deployments and differences in behavior between observed and non-observed vessels • May not provide enough spatial or temporal coverage for special scientific programs (e.g. otoliths, stomach contents sampling for ecosystem studies) • Implementation may be uneven across the fleet and lead to resentment of inequity
Total coverage (i.e. observers on 100% of vessels all the time, monitoring between 30 and 70% of all hauls)	• NPGOP, CCAMLR, NAFO	• Good cover for compliance monitoring • Equitable across the fleet • Possible to collect large amounts of data	• May not provide 100% coverage of fishing effort, if not all fishing activity is observed. • True 100% coverage of fishing effort may require more than one observer on each vessel. • Expensive • May not be feasible to put observers on all vessels (issues of space, cost etc. for small vessels) • May not be necessary for purely scientific programs • Difficult to get fleet acceptance

the true catch and the target catch in order to set the sampling level. The only way to know the true catch is to have a study with very high levels of coverage.

The steps that should be taken in planning coverage levels are summarised in Figure 3. As emphasized in the previous section, the key is to have sufficient understanding of the statistical properties of the parameters of interest, so as to be able to design estimation methods, sampling strategies and hence required coverage in line with both the required precision and bias of the sampling programme and the logistic and financial constraints.

Besides the programme objectives, there are other elements of the programme that may have an impact on the achievable coverage level:

- **Funding available**
- **The profile of the fishery (location, fleet operation, vessel type/size, gear types, species, working environment)**
- **Stakeholder input**
- **The service delivery model and policy on implementation (voluntary, partial or mandatory)**

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Detailed aspects of the effect of these elements are discussed in the following sections. If any of these elements results in a departure from the optimal implementation of the monitoring process, then it is likely to have a detrimental effect on the overall outcome. This may be a marginal difference of little practical importance, or not may be a fundamental change, for example from 100% to partial coverage with potentially much more far reaching consequences. As a rule of thumb, Table 3 provides a summary of the relative advantages and disadvantages of different levels of coverage.

Although specific sampling strategies and levels have to be identified according to the above methodology for each programme separately, in practice the observer programmes that we have reviewed fall into three categories: occasional, partial and low (see Table 3). Our analysis identifies the coverage level in a fishery, but this is a difficult concept to analyse because coverage of all vessels in a fishery may not mean coverage of all days, and similarly coverage of all days does not necessarily mean coverage of all hauls. Where necessary we are specific about this.

3.6 Alternative Technology-based Approaches to Monitoring

The following is a brief review of some of the latest technologies that have been considered as assisting observer programmes.

3.6.1 Cameras

The use of video cameras for electronic monitoring (EM) of the catches was recently trialled in the Canadian longline halibut fishery[7]. Concern over the high cost of a recently implemented observer programme led to the implementation of a voluntary electronic monitoring scheme which would run alongside the at-sea observer programme so direct comparisons between data from the

[7] McElderryMcElderry, H., J. Schrader, and J. Illingworth. 2003. The efficacy of video based electronic monitoring for the halibut longline fishery. Fisheries and Oceans Canada, Research Document 2003/042.

two could be made. In most of the categories studied the results obtained were very similar, the main differences being inaccuracies with the EM system's depth recording and species identification.

Other limitations of the system included the fact that there was no way to record the weight of any of the catch and there were some operational problems which led to a loss of data on about one third of all trips (although these were mainly due to the fact the system was only prototype). There were also financial limitations on the reporting of data. Although technically possible, transmitting the high volume of EM data in real time was deemed to be economically impractical, as a result the data only became available at the end of each trip. This limitation would clearly make the whole system an impractical alternative to observed trips where long periods of time were spent at sea or where data was required in real time for the management of the fishery such as CCAMLR or the West Coast Groundfish Fishery.

Costs of the EM system were estimated at being CND$210 per observer day, less than half that of on board observations. Three quarters of these costs were due to installation, servicing and analysing and producing the data, future costs could be reduced through strategies to improve efficiency and manage labour costs. Steps have been taken in this direction through attempts to develop a computer system that can identify species automatically through digital recognition. So far this has met with limited success in actual fishing conditions due to variable lighting conditions. Once developed it is likely that the software would only really be suitable for longlining fisheries where the fish come on board one at a time, volume and flow of fish on trawl vessels would most likely preclude them from digital recognition in the foreseeable future.

Video monitoring can also be adapted to monitor fishing operations and has been used by the NMFS on vessels to monitor the vessels compliance with fishing regulations. Cameras can be set up to record GPS readings as well as hydraulic and winch activity to check the vessel is not fishing in a restricted zone. It has been estimated that the costs of this system are around 20% the cost of an at-sea observer. Work is also being carried out to develop systems to monitor seabird avoidance devices and identify any birds caught and on

Table 4

Uses of VMS Data

Type of Offence	Value of VMS in Providing Evidence
Unlawful entry into a closed area	For vessels carrying the necessary equipment, VMS is the most efficient MCS tool for monitoring entry and exit into fishing zones, and controlled zones as it is operational over the whole set of zones and for 24 hours a day. However, it provides no information on the location of vessels that are not part of the system.
Failure to properly maintain a logbook	The systematic comparison of VMS data with logbook data may detect inconsistencies in the latter. The process of comparison would be greatly simplified by the introduction of electronic logbooks.
Provision of false information to the relevant fisheries administration	VMS data can be cross-checked with logbook and other data reports on catch and fishing effort (e.g. days at sea).
Tampering or interfering with the transponder	These offences are inextricably linked to the existence of VMS.
Failure to properly maintain a functioning VMS transponder	

wide-angle camera systems to monitor deck activities and ensure all catch is retained aboard if required.

3.6.2 Motion Compensated Scales

Use of motion compensated scales would be most appropriate for single species fisheries, providing accurate information on total catch retained onboard. Actual recorded weights could be compared to observer estimates to establish the level of error. There are several types of scales available depending on precision required and the processing system onboard a vessel. Accurate recording of discard and bycatch species may require addition scales onboard and cost (direct and operational) and space may prove prohibitive.

3.6.3 Industry Participation in Catch and Biological Data Collection

Operational and catch data is routinely recorded by vessels at sea, augmented by biological information on catch and impact on the ecosystem by observers. Expanding the role of the industry may reduce costs of deploying observers or collecting data on those vessels that prohibit observer deployment.

An alternative may be provided by expanding participation of industry. There are a number of working systems combining efforts from both stakeholders such as the scientific community providing direction or assessing efforts by industry to ensure accuracy and objectivity of data collected.

3.6.4 Vessel Monitoring Systems (VMS)

Since they were first introduced at the start of the 1980s, Vessel Monitoring Systems (VMS) have been used as an operational tool to enhance the efficiency of standard monitoring, control and surveillance (MCS) activities.

The types of fisheries offence in which VMS data has been accepted as evidence before a court has been categorised in Table 4.

The VMS position reports of a vessel might well suggest that at a given time it was engaged in fishing activities in a closed area or during a closed period. However, a large number of offences (such as prohibited gear or catching undersized fish) remain that VMS cannot identify.

Catch, effort, and other fishery data required to be reported from vessels that are logged in an electronic form, such as

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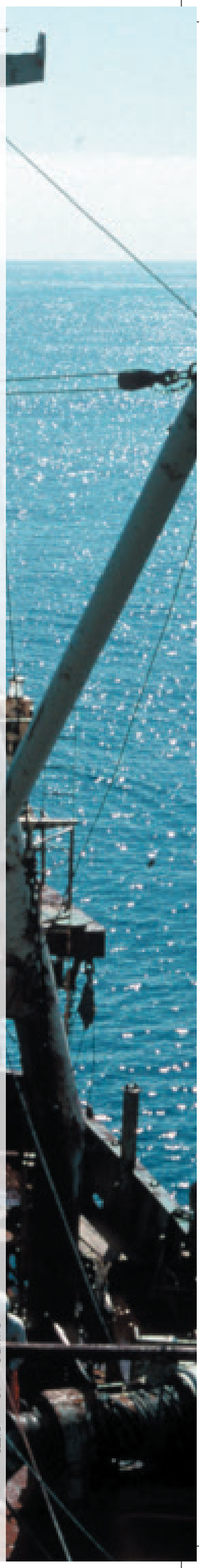
electronic logbooks can be transmitted from vessels to shore stations. Transmitting electronic logbook data via VMS provides for availability of real-time (or near real-time) data, fine scale spatial data, position data reported independent of the operator, and catch and effort data declared prior to boarding/ inspection. Properly formatted electronic logbook data can load onto catch monitoring and management data systems without transcription errors.

VMS with one-way communication usually reports on a set schedule. However, two-way communication permits management agencies to send messages to vessels, which may prove very useful for special notifications of openings, closings, warnings of encroachments near or into restricted areas, etc. Also, vessels can provide notice or declarations when transiting the restricted area, changing from one fishery to another, and transmitting catch data in real or near-real time. This is a valuable tool in fisheries management as it permits the VMS operator to vary the frequency of position information as a function of the behaviour and whereabouts of a vessel.



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3.6.5 Hydraulic or Engine Monitoring

Remote monitoring of fishing vessel activity using directly transmitted data could assist the owners and operators of fishing vessels and companies. Monitoring equipment exists and is readily available for many key vessel activities associated with fishing operations. Hydraulic sensors for monitoring changes in hydraulic pressure can be used to indicate use of fishing gear; winch/drum counters to monitor specific equipment.

3.6.6 Electronic Logbooks

Electronic reporting of scientific, commercial, and recreational fishery data is increasing around the world. In many cases, electronic logbooks have been designed for management use to meet statutory data reporting requirements (vessel, gear, catch, effort, location, etc.). Electronic logbooks provide for easier data entry by fishermen, with fewer transcription errors from paper copies to electronic formats, and seamless downloading directly into management databases. These features make the data much more useable for management and scientific purposes. Electronic logbooks combined with VMS position data would enable managers to attribute landings to specific areas in much more detail than currently available and could be formatted to incorporate data collected by observers. They also have the capacity to collect and log data from various sensors. All sensors and data export systems used for on-board computer data logging should be compatible with required standards (defined electrical signal requirements, data transmission protocol and time, and specific sentence formats).

3.6.7 Gear measurement

Scanmar, Simrad, Wesmar, and Northstar develop and sell systems for mobile fishing gear, primarily trawls, which allow monitoring of various sensors related to fishing activities. These systems use third wire or acoustic links to send signals from specific sensors mounted on the trawl net to a receiver that logs the information into a computer. The price varies for different components and manufacturers.

These systems are not applicable for fixed gears such as pots and longlines where technologies such as radio frequency identification (RFID) would be more appropriate.

3.7 Service delivery models

The FAO describes three different options for an observer programme organisational structure:

- **Fisheries Management Authority (FMA):** Full integration of all components under the control of the FMA (e.g. The Observer Cadre in the North Pacific Groundfish Observer Programme (NPGOP), Australian Fisheries Management Authority (AFMA) Observer programme up to 2001).

- **FMA Plus Contracted Observers/ Supplier:** Partial integration between the 2 parties, where the FMA maintains management control of the programme and influences the selection of the observers, whilst some costs are shared (e.g. Observations conducted under the Industry/Science Partnership between the Scottish fishing industry, Fisheries Research Services (FRS), the North Atlantic Fisheries College (NAFC) and the Seafish Industry Authority (SFIA required observers of different experience and ability depending on the specific project).

- **FMA Plus Contracted Observer Company/Supplier:** Defined fields of responsibility mutually exclusive to the FMA and others to the observer provider. There may be fields of partial integration between the 2 parties, however they are better described as areas of inter-

phase, which become prominent during the product or output elements from the programme (e.g. EU Northwest Atlantic Fisheries Organisation (NAFO) Observer Programme, British Indian Ocean Offshore Tuna Observer Programme).

Those that opt for using an observer company/supplier should reduce the potential for conflicts of interest, by drafting a conflict of interest standard for certified observers and observer companies. Such a draft was used in the NPGOP (see Appendix 2, section 4.5), where it was standard requirement for observers and observer suppliers to declare that they did not have either a financial or personal interest in the vessels or shore-based facilities they were employed to observe. Both financial and personal interests were defined.

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In comparison, the AFMA imposes similar standards in accrediting data collection agencies for providing data collection officers to work alongside AFMA observers in their sub-Antarctic fisheries. AFMA prefers that no directors or employees of the entity seeking accreditation have been employed by a fishing company. If employees have been previously employed by a fishing company, this must be declared. If an observer was previously employed by a fishing company which holds, or has held, an Australian fishing concession in the sub-Antarctic fisheries, they must not be associated with any functions related to that fishing company for a period of 12 months.

The difference in this case is that the "data collection officer" provided directly to the industry by the accredited agency works under the direct scrutiny of an AFMA observer deployed on the vessel at the same time. There is therefore much less likelihood of commercial pressures affecting the work of the data collection officer paid for directly by the industry. In addition, the penalty for non-compliance is severe. If a data collection officer fails in his or her obligations or there are any improper dealings, the contracting agency is "de-accredited" and the fishing company loses its access to the fishery permanently.

Each system has its advantages and disadvantages and the case studies described in Appendix 2 demonstrate these characteristics, some inherent, others cultural. The programme objectives and the responsibility for deliveries within the organisational structure exert the greatest influence on the service delivery model (SDM). A feasibility study at the programme inception stage would identify and clarify what these should be at each stage, the organisational component responsible and the linkages between them. The review of North Pacific Groundfish Observer Programme recommended that the goals and objectives should be re-examined using more structured planning tools such as the Logical Framework developed by Team Technologies Inc. in collaboration with the World Bank.

Four of the case studies are effectively managed by the same FMA, in this case the National Marine Fisheries Service (NMFS), the fisheries branch of the National Oceanic and Atmospheric Administration (NOAA). These are the North Pacific Groundfish Observer Programme (NPGOP), the West Coast Groundfish Observer Programme (WCGOP), the Alaska Marine Mammal Programme (AMMOP) and the US Caribbean Bycatch and Discard Observer Programme. Although each individual programme utilises its own SDM, NMFS provides a SDM for the US as a whole, currently running 14 different observer programmes and employing over 500 observers around the country.

Its origins lie in the 1970s when the NMFS employed observers to carry out work on foreign fishing vessels. However with the advent of the Magnuson-Stevens Act the emphasis changed to designing programmes

for the domestic fleet. The development of these programmes was done largely at a regional level to meet the scientific and management needs of the particular region. As a result there was often little coordination or communication between the areas until 1999 and the establishment of the National Observer Programme Office (NOP). This was based within the existing office of Science and Technology and was created to support the regional programmes and increase their usefulness towards the overall goals of the NMFS.

The NOP has no direct line of authority over the observer programmes which are largely run through the NOAA Fisheries regional offices or science centres.

A 16-member advisory team to the NOP was also established at its inception; the National Observer Programme Advisory Team (NOPAT) has representatives from each Region and each NMFS headquarters office and works with NOP staff to identify issues of national concern, recommend or establish priorities for national research and problem solving, and support information collection and programme implementation. Improvements in data collection, observer training, and the integration of observer data with other research are among the issues NOP works with on a national level.

The NMFS does not directly employ observers but contracts with a number of private sector companies or in some cases educational institutions. Contracts exist between NMFS and private companies/ institutions for all programmes except the NPGOP, where the observer contracts directly with the company. In general the companies are responsible for recruiting the observers and arranging logistics for the trip while the NMFS provides training, certification and normally debriefing. The resulting observer data provides scientific and technical information to NMFS and other agencies of the government, industry, and the public and is used to assist with the conservation, management, and utilisation of resources.

An independent review of the NMFS observer programmes was completed in March 2004 and examined seven of the 14 programmes. The review produced a number of recommendations which can be applied to all observer programmes in general. These were:

- **Develop and implement statistically valid, unbiased vessel selection procedures for observer programmes with contractual relationships with observer providers and continually monitor the implementation to ensure that the vessel selection process is properly implemented**
- **Explore options to improve the retention of qualified, experienced observers**
- **Establish national observer programme priorities and performance measures, develop a mechanism to monitor and report regional programme performance to NMFS headquarters, and ensure that observer programme managers are held accountable for performance related to both national and specific regional programme priorities**
- **Develop model performance work statements for observer provider service contracts**
- **Increase programme outreach efforts to the fishing industry, such as holding regional forums, deploying staff, or utilising the National Sea Grant Programme extension programme or other organisations, to educate the industry and improve industry cooperation with the observer programmes**
- **Explore offering resource neutral (to the extent possible) incentives to increase industry cooperation with the observer programmes.**

For the BIOT, CCAMLR and NAFO Programmes, the FMA contracted an observer provider company. In each case the company was responsible for technical training to complete the monitoring elements of the job,

[8] A definition of artisanal fisheries is provided in Appendix 3

Table 5

Vessel Suitability and Observer deployment Issues

Factor	Detail
Distance from shore	Distance a vessel goes from shore to fish; can change safety rtequirements and time at sea
Type of gear/fishing method	Longline, net, etc.; can increase exposure to observer or decrease space on deck
Size of fish	Large (sharks, swordfish, etc.); can decrease space for observer on deck
Capacity of fish hold	How much fish can a vessel hold; can increase time out fishing
Weather	Weather of a day the observer is to deploy; can prevent deployment
Accommodations	Adequate observer berthing space; can they sleep in a safe, escapable location
Economic Issues	Cost of carrying the observer to the industry; can limit scope of programme industry vs. programme costs
Goals of the observer programme	The objects of a programme; will affect how vessels are covered
Length of seasons/ time and area closures	Derby style, long seasons, closure of inside areas; will dictate when and where the vessels will fish
Seasonality	Does the season take place during the winter or summer months; can have an affect on observer deployment
Size of vessel size of vessel	The length and width of a vessel; can be an indicator if space may be available for an observer
Maintenance of vessel/ age of vessel	The general upkeep, seaworthiness and age of the vessel
Work Space	The amount of deck space available for an observer to sample
Power of vessel	The horsepower of the engine; vessel can be limited in number of crew/ observer by horsepower
Fleet characteristics	Are there a small number of large vessels and the rest small or vice versa?
Crew/ captain experience	Judging the captain's skippering or the crew's deck abilities
Crew size	Maximum capacity of vessel vs. average crew size
Length of Trip	Day trip vs. multiple day trips
Observer feedback	The feedback of observer about vessels
insurance carried by the vessel	Insurance level and rates; does the addition of the observer increase the cost or cancel the vessel's coverage
Observer personal safety issues	Is the personal safety of the observer endangered by a culmination of issues?

whilst health and safety training was delivered by the national certified institutions. The individual observer was responsible for gaining the latter.

Each of these programmes benefited from clear objectives and a well-defined remit of tasks to be performed by observers. A feature of the SDM was the role of observer coordinator, responsible for managing each programme on a daily basis. Crucially, each coordinator had experience of the fishery as an observer and a good understanding of the demands of the role and interaction with the fishers and FMA representatives. They are well qualified to deliver training and orientation to observers and liaise between industry and FMA. As such, the SDM was streamlined, with key elements of the delivery programme performed by or channeled through the coordinator to ensure the programme objectives were met. These included observer recruitment and training, design of sampling and operational protocols, logistical and administrative arrangements and debriefing and quality assurance. The role was supported by access to fisheries scientists and IT specialists from within the observer company and externally by the respective FMA.

3.8 Special Considerations for Small-scale and Artisanal Fisheries

A key consideration for all at-sea observer programmes whether industrial, small-scale or artisanal is the suitability of vessels to accommodate an observer safely and in such a way that he or she can undertake his or her appointed duties. This has particular implications for small-scale and artisanal[8] fisheries which are generally regarded to be harder to monitor than larger scale industrial fisheries, whether it be through an observer programme or other means. This is for many reasons, but some of the main ones are the large number of participants, the small size of vessels, variety of fishing methods and large number of small landing points. In this section we present particular characteristics of fisheries that make them hard to observe and therefore require specific consideration, particularly with regard to deployment and other logistics of observer work.

First of all, the opportunities for deployment on small vessels, compared to the industrial sector tend to be fewer due to the disproportional impact of an extra individual onboard with respect to the working space, responsibilities shared amongst crew, reduction of fishing opportunities and cost (food, fuel). Also rudimentary equipment used will influence health and safety considerations and perhaps adversely affect insurance arrangements; and/or an inadequate transport infrastructure can preclude placement of observers on board boats, which has implications for coverage levels achievable.

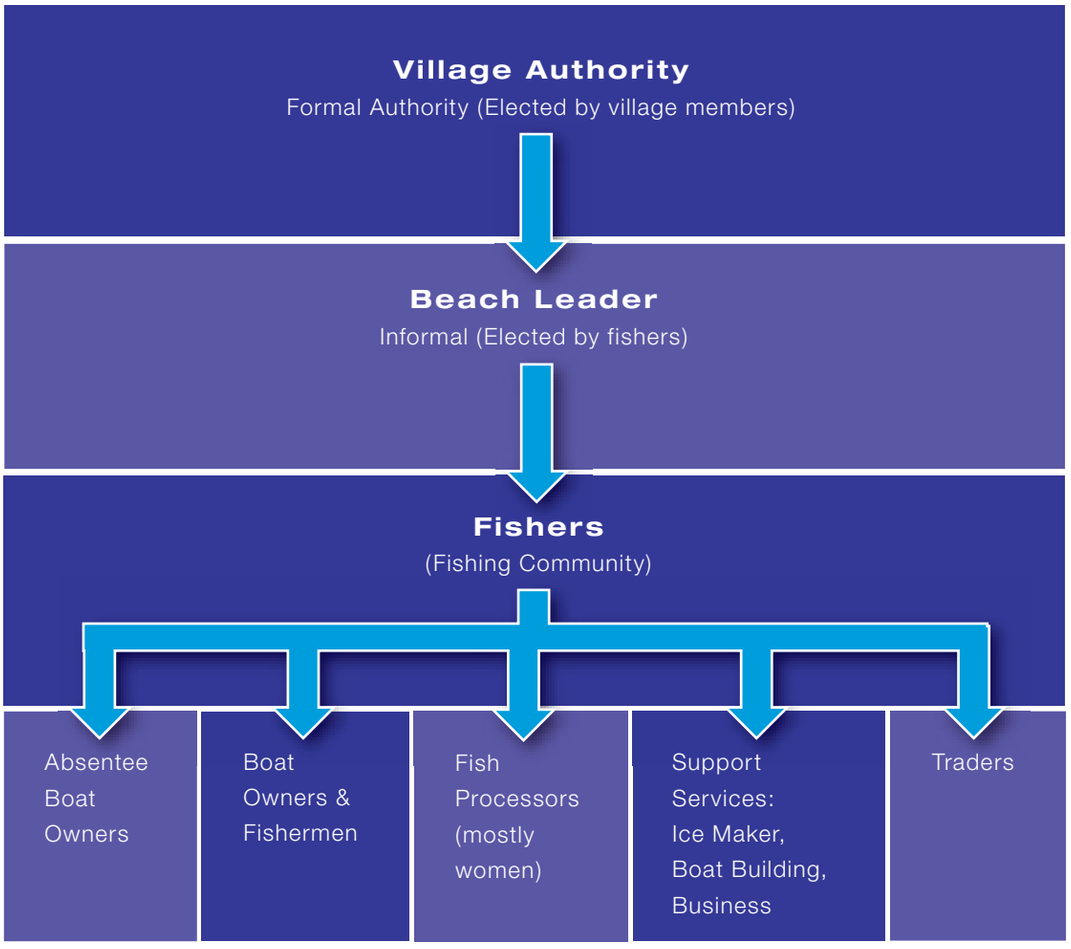
The remote geographical location of some artisanal and small scale fisheries can place the stakeholder communities outside the mainstream of economic, social and political developments and consequently their interests can be overlooked. However the need to understand these small-scale and artisanal fisheries is vital because of their capacity for taking large catches, importance as a major source of food, income and employment. A substantial part of the world fish production is taken by small-scale fisheries and provides employment for millions of fishers either directly engaged in fishing activities or working in fisheries-related activities such as fish processing and marketing, boat building, net making, etc.

The traditional means of production in small-scale fisheries have evolved over a long period of time, and are generally well adapted to the prevailing environmental conditions and the availability of local materials. An observer programme co-ordinator would have to establish if these vessels are suitable for deployment, the prevalent sea and environmental conditions at the intended fishing location and if the vessel is suitably equipped.

Table 5 provides a list of factors identified during the National Marine Fisheries Service (NMFS) Small Boats Workshop in March 2003

Figure 4

A generalised social organisational structure of the typical fishing community



(the Workshop). These factors provided the basis upon which vessels were assessed for suitability for deployments for the US Caribbean Bycatch & Discard Observer Programme. It is still at its inception stage, but one of the objectives of the Programme will be to focus on opportunities for collecting biological data at sea and the use of captain or crew for collecting data if space or safety on vessels does not allow observers.

The Workshop participants noted that the decision to deploy was rarely based on one factor, but rather a combination depending on the duration of deployment, accommodation and work facilities. For example, a consequence of the seasonality of small-scale and artisanal fisheries is that many small-scale fishers exhibit a high geographic mobility. Some fishers are known to migrate hundreds of miles to reach calmer seas and better fishing grounds: Sri Lankan vessels on craft (multi-day class) designed for coastal fisheries can be found on the high seas in the southwest Indian Ocean on Saya de Malha and Nazareth Banks. These vessels would be unsuitable to deploy individuals on for the duration of a trip. Others may be appropriate if observers with suitable experience and appropriate training were provided.

Other factors that should be considered include:

- **When vessel capability, in terms of power and fuel consumption, is mixed, the fleet may not be reliant on any one landing site. This will bring further challenges to logistical arrangements for observers or any shore-based elements of a programme.**

- **Productivity is usually very low in small-scale fisheries compared to those in industrial fisheries. This**

will certainly have consequences for the observer coverage level and the sampling design, particularly if the fishery comprises of a large number of boats. It may be more practical just to collect vital operational and effort details at-sea, and the catch, inclusive of bycatch, brought ashore for sampling. This may lead to further costs because of extra work or fuel involved for fishers, lost fishing opportunities or subsequent delays getting catch to market. It may be productive to offer a financial incentive to ensure that the entire catch will be landed, such as a guarantee to purchase the whole catch. This extra cost can be offset against training and logistical costs if observers are recruited from local fishing communities.

- **The self-employment characteristic of small-scale fisheries and lack of fishers' organisations is very pronounced and suggest that it may be a considerable challenge to obtain a consensus of opinion and general participation in a pending observer programme. Also the dispersed nature of communities, strong cultural identities, loyalty to traditional groups and their associated inter-rivalries plus the different levels of literacy amongst fishers will also compound this. Potential solutions to these problems are offered by local management systems. For example, the creation of the Beach Management Unit (BMU) under the initiative of the Lake Victoria Environmental Management Plan (LVEMP), and the use of ex-fishers to perform observer roles in the Caribbean Bycatch Discard programme.**

The BMUs were first established in Tanzania in 1998 and there are now around 1000 throughout all the East African Community Partner States, which operate with varying degrees of success. They consist of a community elected committee that is empowered to oversee fishery operations and the overall welfare of the fishing community, which would include exercising minimal MCS responsibilities. A typical setup is shown in Figure 4 where the BMU is integrated into the village authority and ideally has the power to enforce any of the countries' fisheries acts. However, these activities are restricted to checking landings, fishing gear and maintaining the vessel registry.

Although not an at-sea observer programme, the nature of small-scale and artisanal fisheries is such that any work performed by shore-based units will provide invaluable information and increase overall coverage and may provide an indication of the affect on data with an observer onboard. Such a system will be used during the Caribbean Bycatch and Discard Programme. Work performed by two at-sea observers will be augmented by efforts ashore. The observers will be ex-fishermen, so they will be aware of local customs and traditions and avoid potential pitfalls; have greater access to individuals during data gathering efforts; and bring the added advantage of minimising training and orientation costs.

3.9 Costs and Funding

One of the most influential factors affecting observer programme design is the availability of funding relative to expected costs. The most common impact is that insufficient funds leads to either a lower than preferred coverage level, or intermittent coverage leading to gaps in data sets with obvious consequences for the stock assessment process. At the same time as considering overall funding, it is important to include cash flow issues, particularly with seasonal fisheries where the funding requirements may vary substantially during the year.

3.9.1 Set-up Costs

In this section we discuss mainly non-recurring costs, such as pilot studies, infrastructure set up, equipment and training. We note, however, that there may by some elements of recurring costs within these items, due to natural wastage, depending on the duration of the programme, the durability of equipment, the turnover of observers etc.

Pilot Studies

Pilot studies can provide an ideal tool to anticipate costs and plan deployment levels in line with available funds. They are particularly important in the case of hard to observe fisheries, such as the drift gillnet fishery for salmon, which is covered by the Alaskan Marine Mammal Observer Programme. This programme presented particular logistical problems for observer deployment onto small vessels in an extremely remote area. A pilot study was undertaken to investigate the fishery how observers could be dispersed along the coastline and at what level of coverage. Once the baseline data had been collected and the annual expected whale mortality estimated, coverage level was set at the minimum to give statistical confidence in estimated quantities. The target level of between 5 and 9% was set for this programme. In this way observer time

and money was not wasted by over-sampling.

Overall it is important to identify the level of coverage required to achieve the goals and objectives of the programme and then design a cost-effective service delivery model.

Infrastructure

A feature of many observer programmes is that they often occur in remote locations. Subsequently the provision of support for at-sea operations will be inflated. It is important to minimise expenses by implementing a cost-effective deployment/recovery procedure by identifying the appropriate resources available that will facilitate the programme and by developing a streamlined service delivery model for its execution.

For the NAFO, CCAMLR and BIOT observer programmes, an agent was appointed by the observer company to provide support locally. This will certainly increase costs but ensures that the observers' interests are catered for overseas, contributing to the smooth running of the programme and fulfilment of contractual obligations.

For the Irish Sea Cod Recovery Observer Programme (implementation of European Council Regulation Proposal 2000/0292), ten observers were mobilised to Northern Ireland, and stationed at ports designated by Department of Agriculture and Rural Development Northern Ireland (DARDNI) and the Fisheries Producer Organisations (FPOs). This minimised disruption to fishing operations and facilitated rapid deployment. The deployment procedure was established at an inception meeting during which FPOs agreed to notify the observer company and FMA simultaneously of vessel availability, port of embarkation; and scheduled time of vessel departure. These details were relayed to the designated observer. Deployment/recovery of observers was carried out by means of local private transport services. Costs were nominal because of the proximity of accommodation to the designated ports. Observers were only required to make contact with the observer company on return to port. At-sea communications were kept to a minimum except in the event of an emergency. After a voyage of three to five days duration, observers were allocated a minimum 36-hour interval before their next fishing voyage.

These features were also shared by the Westcoast Groundfish Observer Programme, during which vessel owners would notify the observer provider of their requirements. The observers were stationed locally at key ports along the coast to allow rapid deployment at minimal cost.

Training Costs

The level of investment required for training depends upon the complexity of the programme, sophistication of the sampling protocols, the potential hazards faced by observer personnel in the field and the rate of turnover of observers.

The complexity of the programme depends in part on the volume and range of types of data (see section 4.3) to be collected, their collation and use. For example, the CCAMLR observer programme provides data for scientific, compliance and fisheries management issues and the training occurs over a week long workshop delivered by individuals who have extensive experience in the field as CCAMLR scientific fisheries observers.

In an attempt to reduce costs, the US Caribbean Observer Programme is using ex-fishermen who have since worked with the US Virgin Islands Department of Fish and Wildlife (DFW) as Environmental Specialists, responsible for marine resource surveys and collection of fishery and bio-statistical data samples. Their experience, knowledge and insights of the fishery avoid the need for extensive training session with orientation and background, identification and sampling themes. The savings will be channelled to provide extra coverage of the fisheries.

Fishing is commonly regarded as one of the most dangerous professions and the hazards can be exacerbated in inclement sea and weather conditions. The type and level of safety training should be to a national and certifiable standard that satisfies practical and legal requirements. UK observers are required to possess valid Marine Safety Agency Sea Survival and Merchant Shipping Medical

[10] Although this is a recurring cost, we include it in this section for ease of reference.

(ENG1) certificates.

Equipment

The level of sophistication of monitoring equipment varies substantially from fishery to fishery. For example electronic fish measuring boards and motion compensated scales would be ideal for recording biological information of catch but they are expensive. These types of equipment are more commonly used for scientific surveys and special projects within an existing observer programme rather than being standard issue for a large number of observers. The cost of sampling equipment per observer is therefore usually relatively modest. Safety equipment, such as survival suits and/or deck working suits, is, however, both expensive and essential.

Information Technology

Information technology requirements for an observer programme are highly dependent on the data types, volume and the use to which they are put. Programmes such as the Irish Sea Cod Recovery are "data-light" being more compliance driven. On the other hand programmes such as the CCAMLR scientific observer programme are "data-heavy" having large amounts of various types of data being collected on a haul by haul or daily basis.

Data input in the field[10]: For a small "data-light" observer programme the capital outlay for supplying observers with laptop computers may initially be too high to be economically viable. However, for all observer programmes, the cost of entering the data collected by the observers into a database on land must be included when IT costs are being considered. The cost of data entry staff to transfer the observer logbooks to electronic format is an expensive outlay and it is often financially more viable to have the data entered at sea by observers when these costs are considered. Costs and benefits of any observer programme should include a projection of future data requirements; though for any "data-heavy" programme data entry and basic analysis can be performed in the field. Individual sets of data can be transferred to a master database upon their return and more complex queries performed.

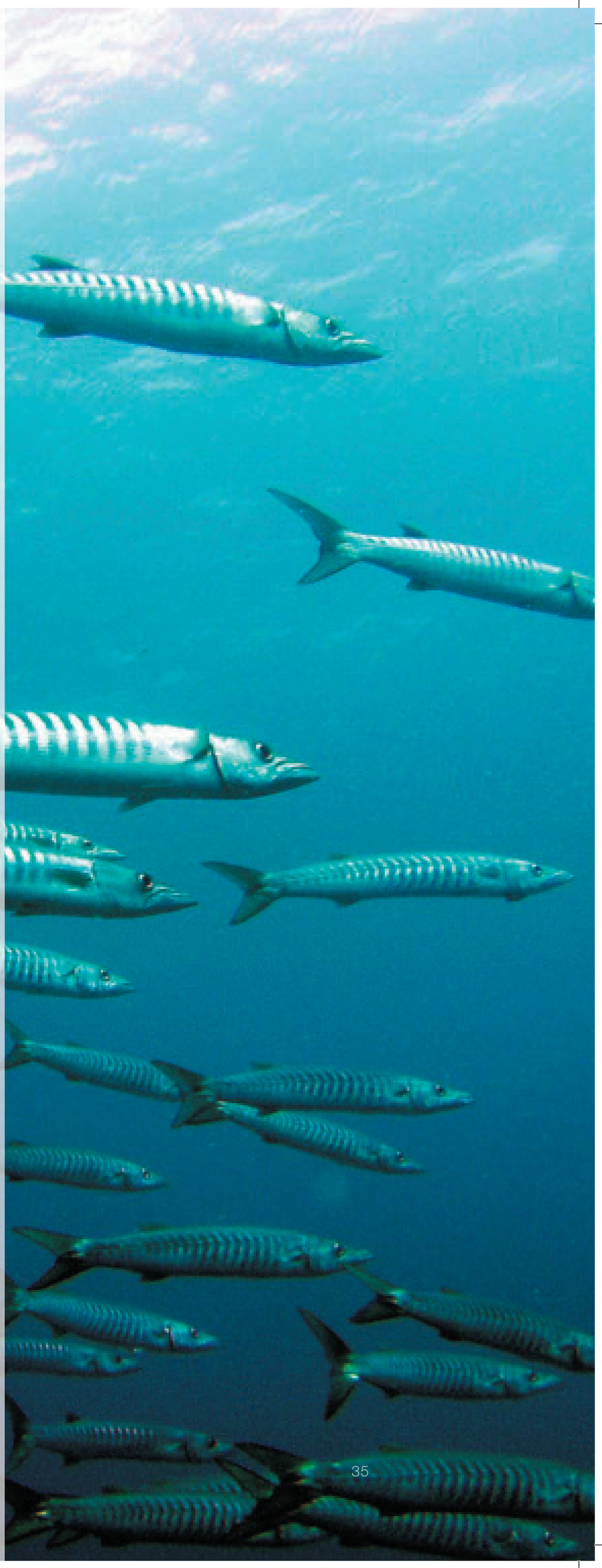


Table 6

Breakdown of Costs Where Available (£)

Type of Offence	CCAMLR	BIOT	NPGOP	St. Croix
Admin				
General Admin	10,500	2,500	129,400	28,900
Training	10,000	4,000	515,400	3,340
Data Management	5,000	3,500		280
Equipment			124,100	550
Deployment		4,000		
Transport	51,000		76,100	1,100
Accommodation				
Observer Costs				
Per Year	130,000	38,000	1,386,800	
Total Cost				
Per Obs. Day	140	374	190	760
Per Year	206,500	52,000	2,231,900	53,400

Capital outlay: The price of a typical laptop computer has decreased greatly over the past few years allowing more observer programmes to incorporate at sea data entry and analysis. A typical laptop capable of data entry and analysis can now be sourced for about £500 and at the lower end of the spectrum hand-held data loggers capable of storing simpler information from £100 upwards.

Recurrent costs: Budgets developed for IT equipment for an observer programme should work on a typical replacement interval of 18 months to two years rather than typical intervals of two to three years on land. Computers and the high moisture and saline conditions of working at sea do not work very well together and critical hardware failures are common. A supply of replacement machines ready to be deployed should always be maintained to minimise any delays in data entry.

Database Development: The level to which IT solutions should be developed within each programme will obviously vary with the amount and diversity of data collected. These can range in complexity from spreadsheets, which have a limited ability to verify and require little training or development, through to more complex relational databases that can be developed to allow data to be collected in a manner that preserves data and database integrity. Data integrity (i.e. the verification of individual data entries such as using correct species code) and database integrity (making sure that all the records in the database are linked together correctly i.e. all catches from a particular fishing event are linked to that event) are critically important in large data collection programmes. As an example, the observer database for the CCAMLR observer programme holds information on about 500,000 individual fish measured over the past

ten years, each of which can be traced back to the individual haul upon which it was taken.

These solutions may seem expensive to develop at first, but in relative terms to the whole programme this cost is often minimal and can save time in the long term. Any IT solutions should require little modification over time unless the data collection programme changes significantly.

In addition to the database development for the management of the data generated within an observer programme, it may, dependent on the size and complexity of the observer programme itself, be sensible to consider the creation of a database system to help in the management of the programme itself. Such systems can help in a number of functions examples of which are listed below;

- **Observer details (contacts, training and experience history)**
- **Vessel owner and agent contact details**
- **Travel (flights, hotels)**
- **Deployment history**
- **Deployment planning**
- **Financial aspects of the programme**

3.9.2 Recurrent Costs

Observer Days

There is an obvious direct relationship between the number of observer days and overall cost. The EU NAFO Observer Programme is a large, all-year-round operation with 100% vessel coverage (at least one observer on every boat). This programme was implemented rapidly with little planning in the wake of the EU/Canada dispute in 1995. The on-going deployment commitment now requires up to 50 individual observers to complete approximately 11,000 observer days per year. On-going costs are so high that since May 2004 the EC has withdrawn funding, putting the responsibility on to the Member States to cover the cost.

The cost per day is, however highly variable from programme to programme. Some of this variation is due to different rates of pay. Observers are most often contracted/ employed by companies in exchange for remuneration (plus benefits) for their services. If the working conditions are particularly tough and the tasks arduous it is important that this is reflected in the rates of pay.

More of the variation derives from the differences in deployment costs. Some programmes, such as NAFO either deploy observers through home ports, or piggy back deployment on facilities that are already present and funded outside the programme (e.g. the EC surveillance vessel in the north west Atlantic). The cost per observer day in this fishery is of the order of only €200 (see below). At the other end of the scale are programmes on small vessels in remote locations, such as the Alaska Marine Mammal Observer Programme. This programme has required the chartering of a specific vessel to deploy observers, and several skiffs from which to observe vessels that cannot accommodate the observer. During the 2002 season, the cost per observer day for this programme was approximately $2,400. This cost includes observer pay, supplies, lodging, insurance, transportation, training, data entry, statistical analysis, and all management staff salaries and overheads.

Although risky from the point of view of data quality, one approach to keeping down the costs is to use market forces. The SDM of the NPGOP has observers being supplied by four or five accredited observer companies that compete on a da-to-day basis for business with industry clients who require observers on board their vessels in order to be able to fish. The cost per day in this fishery, despite its heavy emphasis on scientific sampling is relatively low at about $300 to $350 US per day cost to the industry (there are additional costs associated with NMFS' inputs – see Table 6 for a full breakdown.

Since 1996, the EU participation in the NAFO Observer Programme has been contracted out by the EC to a single observer contracting company. All observers are mediated through the European Commission

[11] Safety and Health in the Fishing Industry. Report for discussion at the Tripartite Meeting on Safety and Health in the Fishing Industry. Geneva, 13-17 December 1999.
[12] S.E. Roberts: "Hazardous occupations in Great Britain", in The Lancet, Vol. 360, No. 9332, 17 Aug. 2002.
[13] European Parliament resolution on fisheries: Safety and causes of accidents (2000/2028(INI)) (Official Journal of the European Communities, 24 Jan. 2002)

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(EC) and costs are paid directly by the EC to the contracting company based upon a daily rate and the receipt of the data record and final report of the observation period. From 1996 to 2004, the observer company has always been UK based, mostly deploying British observers in the interests of transparency considering the flags of participating MS vessels in the NAFO Regulatory Area (NRA). During this time the contract has exchanged hands on four occasions depending on performance of observers provided and the most competitive quote when the tender has become available. Now MS will have to pay

The costs per observer day have gradually reduced from €235 to €164. This represents a fall of 20-24% over a five-year period from 1996 to 2001. The average payment to individual observers has fallen from €126 to €100/day. The individual observer rate has fallen by 20% in real terms since 1996. The differential between company rate and the rate paid to the observer shows that the initial margins fell from the Commission's agreed 40% rate to 30%. Much of the differential was as a result of the depreciation of the Euro against the pound, which effectively required the observer companies to absorb the differential whilst paying the observers a constant rate. A subsequent change in observer contract saw a significant reduction in the rates paid to observers and an increase in margin to the observer company.

A feature of many programmes is the propensity for observers to leave the profession after a short period, citing rates of pay, absence of job security and benefits, limited opportunities for career progression, the stress of being at sea for long periods in some times volatile environments. Although the UK CCAMLR observer programme has been very successful at achieving its respective objectives and an adequate support system is in place, a high turn over rate (40-60% new individuals per year) of observer personnel persists as a result of the seasonal nature of the work and to a larger extent the role is perceived as a transient profession, a stepping stone to other things. Once observers have gained experience in each of the three fisheries (although opportunities realistically exist in two), they tend to seek alternative employment arrangements.

The advantages for continuity of observer personnel are clear in that it can:

- **Promote confidence in the programme amongst stakeholders**
- **Reduce overall training costs**
- **Provide a platform to extend develop an existing one**
- **Reduce conflict with fishers at sea**
- **Maintain quality of data**

A key consideration for programme designers will be to ensure that the rate of remuneration maintains the integrity of the programme. This will be more pertinent in compliance-orientated observer programmes where pressure can be applied on individuals including financial incentives for turning a blind eye.

Insurance

The International Labour Organization's (ILO) report[11] on heath and safety in the fishing industry found that globally as many as 24,000 fishermen and persons engaged in fish farming and processing are killed every year, making fishing and related occupations among the most dangerous professions. According to a study by researchers at Oxford University, fishermen have by far the most dangerous jobs in the United Kingdom[12]. Injury rates are high due to the nature of the marine working environment and the exposure by fishermen to weather and to equipment used

to catch and process fish. In April 2001 the European Parliament adopted a resolution concerning safety and causes of accidents in fisheries which set out not only the high death and injury rate in this sector but also called for a number of specific actions, including regulatory action, to improve this record at both the European and the international level[13].

Observer Programme developers must consider the great diversity within the industry based on the size of the vessel, type of fishing and gear, area of operation, etc and insurances are required for accidents, healthcare and repatriation.

3.9.3 Funding

The influence of funding

Funding has a major effect not only on the level of coverage that can be achieved on a day-to-day basis, but also on the continuity of monitoring. Funding may be the deciding factor in the level of coverage achieved, because there may be insufficient funds to achieve the level required to meet the programme goals. Programs then resort to implementing the highest level of coverage possible with the available funds. If funding is not secure from year to year, then gaps can appear in the observer data time series, potentially causing difficulties for stock assessments (e.g., if biological data on the catch are not available).

There should be consideration of the funding system's ability to generate sufficient fees for other vital components of the fishery e.g. FPV charter and inspection unit(s). This issue should be explored more fully as and when the programme is seen to be more efficient and savings can be identified, perhaps reduced observer coverage, and reductions in other enforcement costs and extra value added generated for those remaining in the fishery.

Donor agencies contributions are supported through Article 25, part 3 of the UN Fish Stocks Agreement (1982). Consideration must be given to the type and extent of the funding and impact of withdrawal upon completion.

Funding mechanisms

Funding can come from a number of sources:

- **Central government**
- **Industry**
- **Regional Organisations**
- **Donor agencies**
- **Shared costs**

As mentioned above, the way the a programme should be funded depends on its objective. The more the fishing industry is the direct beneficiary of the programme, the more it should contribute. If the primary objective is science, we may distinguish between, on the one hand, collecting data for "pure" science that may have no immediate applied benefit and, on the other hand, collecting data for stock assessments to be used in the setting of TACs. In the former case, it is obvious that the government should pay for the programme, while in the latter case, it could well be that the industry should pay, if not all, then at least most of the cost. When the objective is compliance or management, or a combination thereof, one would again expect the industry to pay a fair amount of the cost. Should the government in a case like this pay for the whole programme it would amount to a subsidy of the industry.

As already discussed, most programmes will have several objectives. The implication of this is that the funding model may be case specific, depending on the weights given to the different objectives.

Regional organisations also need to be funded, by member countries and/or the fleets participating in fisheries under their auspices. The general arguments presented above also apply to funding via regional organisations.

We may, however, distinguish between the start-up of a new programme and operating it after it has been established. When it comes to the start-up of a new programme, there may well be a case for a greater degree of government funding until the programme has become well established.

Industry funding may take different forms, from fees on catches or quotas to annual levies on participating vessels.

A Set Up Costs

If the fishery is at the development stage, the impact of leverage on attracting otherwise absent private sector investment should also be assessed i.e. what investment would be required to ensure interest from industry and if potential fishing participants are likely to subscribe.

For example, with the Falkland Island Fisheries development, despite substantial commercial fishing in the south-west Atlantic (SWA) since the early 1970s, the Falkland Islands did not benefit directly until the introduction of the 150nm Falklands Interim Conservation and Management Zone (FICZ) in 1987. This was in response to concerns of uncontrolled fishing close to the Falkland Islands. Substantial investment in local infrastructure, vessel services and organisation was required to attract vessels to operate within the FICZ and an effective management system established to provide adequate MCS of the fishery. The latter was financed by licensing fees and included observer programme as a surveillance measure.

Qualified observer personnel are required to ensure data reliability. To attain an experienced observer team requires sufficient time for individuals to become proficient in their role and duties and develop good judgment when carrying them out. High turnover rates hamper development of an experienced observer cadre and increases training costs because of the continuous need to train new observers.

Observer costs refer to salary, insurance, and deployment costs (logistics, accommodation and subsistence). This can vary broadly depending on coverage levels and deployment opportunities as well as exchange rates in respective countries. Capital equipment will be initially much higher during the first year. However, equipment costs are a recurrent expenditure as the items need to be replaced normally on a three year basis.

The cost of developing protocols is reflected by the nature of the sophistication of the data to be collected and the sampling techniques required. This factor is also apparent in developing the programme database into which all information at sea is collated. The cost of developing the management database will reflect the programme SDM, the responsibilities and linkages between the various components and their outputs. It should be able to provide a snapshot/summarise events for programme managers. Once established it requires routine maintenance reflecting changes or focus within the programme.

Management costs will be proportional to the size of the programme (number of observers) and the number of components and responsibilities within the SDM. If it is a fairly linear SDM with low observer numbers and associated costs, then this will be reflected in the management costs. Other factors to consider are the use of the programme outputs and the associated timescale: Is it required for fishery management purposes i.e. stock management analysis, vessel performance, in which case costs may be higher.

For two of our examples we looked at the costs of operating in the first year, taking into account the set up costs, compared to the subsequent year to year running. The difference was found to range between 11% and 43% and varied depending upon the characteristics of the programme, based on numbers of observers required and turnover, seasonality of the fishery, sophistication of SDM and use of the programme outputs illustrate this.

B Running Costs – Funding Options

Government

Government may provide assistance i) directly or ii) indirectly through the provision of personnel or equipment.

For example Danish Institute for Fisheries Research (DIFRES) receives approximately 90 million Danish Kronor (DKK) from government funding and approximately 73 million DKK from external funding. Funding is distributed between several projects, one of which is the Discard Project (Project Nº 94/023: At Sea-Sampling from the Danish Fishing Fleets In the North Sea and Skagerrak). The programme was staffed by about 10 people, undertaking 1138 trips between 1995 and 2001. The annual cost was £286,500 ($450,000) and allowed coverage of 0.5 – 1% of landings and

less than 1% of trips.

Likewise, in March 2001 the Scottish Executive made available to the Scottish fishing industry a one-off additional grant of £27million. This grant was closely linked to the difficulties that the industry was experiencing at the beginning of 2001, especially in relation to the collapse of cod stocks and the introduction of cod and hake recovery plans. The vast majority of the funding was directed towards de-commissioning but £1,000,000 was ring-fenced with the intention that the money should be spent in an Industry/Science Partnership between the Scottish fishing industry, Fisheries Research Services (FRS), the North Atlantic Fisheries College (NAFC) and the Seafish Industry Authority (SFIA). A Steering Committee was set up comprising of representatives of the Scottish Fishermen's Federation (SFF), FRS, NAFC and the SFIA, as well as Scottish Executive Environmental Rural Affairs Department (SEERAD), with the remit to initiate and oversee all projects associated with the extra funding. The majority of the money was allocated to chartering Scottish fishing vessels and for a range of projects dealing with gear research trials, observer activities and additional charters that investigated various biological aspects of fish stocks.

Industry

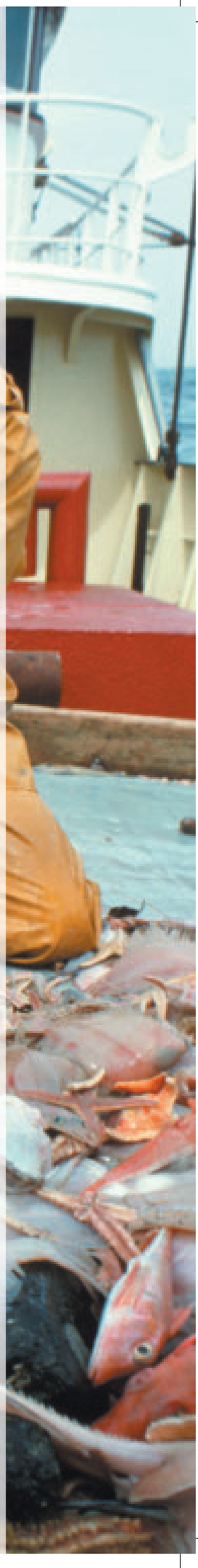
Industry may contribute through the terms and conditions of an agreement or quota/licence fee system. Observer programmes can be expensive and because fisheries are under considerable pressure, stakeholders will be more supportive if the funding is not directly related to the observer programme but rather through access rights, quota or days at sea charges. A legal framework must support the arrangement of payments with appropriate procedures agreed for advance contributions and for redress when defaults occur.

For example, all vessels licensed to fish in BIOT waters are required to accept an observer onboard and generally support the objectives and implementation of the programme. Vessels gain access to the BIOT FCMZ through agreement with representative producer organisations or as individual boats. Agreement and licence fees generate the funds required to implement the Programme. Longline licences are available on a monthly or three monthly basis. Purse seiners are licensed on an annual basis, normally timed just prior to the historical occurrence of tuna shoals in the BIOT FCMZ. Licences are issued according to a merit system. The merit system is based on past performance in relation to indicators such as uptake of licences, meeting reporting requirements, and compliance with technical and conservation measures and co-operation with the Observer Programme.

Another example of industry funding observer programmes through licensing fees is provided by the Government of South Georgia and South Sandwich Islands implementation of the CCAMLR observer Programme for the fisheries around South Georgia. Fees generated, provide funding for management, research, monitoring and control purposes. Industry benefits from a sound fisheries management plan ensuring sustainability of the fishery. Capital investment in the management plan also encourages voluntary compliance with conservation and technical measures, as the vessels may risk access to the fishery if measures are not observed.

The main disadvantage of a system based on a percentage tariff on landings or quota is that actual revenues will not be completely stable, as ex-vessel value is dependent both on market forces and quantity of landings. A collapse in stocks, such as the Alaskan crab, Squid fisheries of the Patagonian shelf and Atlantic cod, or a reduction in quota as experienced in the Patagonian toothfish fishery around South Georgia demonstrates this vulnerability. There would only be cause for concern if the drop in fishing revenues was not accompanied by a drop in the need for observer coverage which would lead to a subsequent shortfall in funds, e.g. if catch rates, or fish prices should fall, but fishing effort should remain the same.

An alternative method of funding programmes directly from industry is provided by the New Zealand example where since 1995, the government has been implementing a scheme to recover from the domestic commercial fishing industry a proportion of funding required to investigate and mitigate the impacts of fishing on protected species of marine wildlife. Conservation Services



Levies (CSL) are approved by the Minister of Conservation, administered by the Department of Conservation, and are collected by the Ministry of Fisheries

Observers provide information on the types of interactions that are occurring between the various fisheries and different protected species. Data on the numbers of different species being caught on observed vessels are used to determine the level of incidental take across fisheries.

If a negative impact of the fishery is established observers are deployed. Funding for observer deployment is provided by the levies and directly retrieved from industry. Once a bycatch problem is successfully addressed, levies will no longer be charged for that interaction. However, fishers have complained that the additional costs of the Conservation Services Levies are making some fisheries uneconomic: although the Conservation Services is only 5% of the total amount of levies charged to the commercial fishing industry, 95% of the overall levy costs were Fisheries Services Levies.

Regional Fisheries Organisations

Previously, funding was provided for observers directly by the European Commission for EU vessels targeting Greenland halibut in the NAFO regulatory Area. However, recent developments in the arrangement for the provision for funding of the EU NAFO Observer Programme have been changed with the entry into force of Council Regulation (EC) No 855/2004. This puts the onus on the EU Member States to provide funding for the placement of observers, through evocation of Article 23 of EC Regulation 2371/2002: Member States are to control the activities carried out by vessels flying their flag outside Community waters, which includes being responsible for placing observers on such vessels. The discontinuation of funding previously provided by the EC was withdrawn citing:

"There is no longer any justification for the administrative and financial burdens involved being borne by the Commission." Article 4 states: "All costs arising from the operation of observers under this Regulation shall be borne by the Member States. Member States may charge these costs, in part or in full, to the operators of their vessels."

Consequently, from 1 May 2004 the EU has withdrawn Community funding for fisheries observers onboard EU vessels fishing in the NAFO region. Some of these costs may be passed directly onto industry.

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Donor Agencies

The Forum Fisheries Agency controls and administers two regional observer programmes; the US Treaty Programme and the Federated States of Micronesia Arrangement Programme. There are approximately 55-60 purse seine vessels in these two programmes, with all vessels required to pay observer placement fees, and carry observers when required by FFA.

The Forum Fisheries Agency (FFA) is responsible for assisting its 17 members to coordinate sustainable tuna fishery management policies in their exclusive economic zone waters, and for promoting the economic development of their tuna fishery resources. The core operations of the Agency are funded largely by contributions from the Member Governments. The Agency also receives funding from a variety of donors and from various cost recovery mechanisms. The total proposed budget for 2005 is US$5,069,037.

The crucial consideration to make when accepting funds from donor organisations is that the contribution is unconditional i.e. does not affect the objectives of the programme.

Shared Funding

Many observer programmes utilise the shared funding option. Of the examples we have

looked at the Inter-American Tropical Tuna Commission (IATTC) tuna dolphin programme, the Australian Fisheries Management Authority (AFMA) observer programmes and the UK North Sea programme are all funded from joint sources.

The funding for the IATTC tuna dolphin programme is divided between the IATTC (30%) and the Agreement on the International Dolphin Conservation Programme (AIDCP) (70%). The member governments of the IATTC share the joint expenses of the all the research programmes including the observer programme. Each member's contribution is based on the proportion of the catch of tunas taken from the Eastern Pacific Ocean (EPO) taken by vessels of member nations that is utilised by that member nation, either eaten fresh or processed for external consumption or export.

All AFMA observer programmes are now jointly funded, 80% of the cost is attributable to industry with the remaining 20% supplied by the government. Depending on the number of boats in the fishery, costs are either recovered directly from operators on a fee for service basis where there are few vessels operating or from the entire fishery through the levy basis. The 80/20 split was decided somewhat arbitrarily about 4 years ago as an intermediate step before full industry recovery. The proportion has not changed due to the significant impact on industry levies. Government has accepted the justification for a 80/20 split and reinforced it in cost recovery policy. All managing of observer data, along with all other data is regarded as a cost attributable to industry.

Finally the UK observer programme, run by CEFAS, is eligible for EU funding as part of the CFP's minimum data collection programme according to Council Decision 2004/555/EC (see Chapter 5). The remainder is funded by Department for Environment, Food and Rural Affairs (DEFRA).

Considerations for Funding Options

Ideally vessels benefiting from the fishery should pay for the cost of observers. However, caution must be exercised to ensure that there are not conflicts of interest between observer companies and industry

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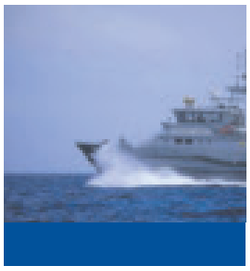
such as those highlighted in the North Pacific Groundfish Observer Programme. When the NPGOP was established in January 1990, the NMFS lacked the authority to collect user fees from participants in the domestic fishery, effectively ending its ability to provide funds. Consequently, the Council devised an interim third party "pay-as-you-go" system under which vessel and processing plant owners contracted directly with private observer companies certified by NMFS, and paid for observer services as needed.

The pay-as-you-go observer procurement system leaves observers and observer companies vulnerable to pressures that could jeopardise the quality and credibility of output data. Currently, the industry is essentially a client to any of several competing observer companies, which imposes certain commercial pressures on and competition between the observer companies. Also individual observers may be subject to similar pressures, leading to collusion with the vessel(s) in order to secure further deployments and/or selection of that company. Observers may also be tempted to collude with a vessel in order to extend deployment by under-reporting catches.

The most pertinent questions regarding funding revolve around the necessity for transparency of the system to ensure reliable data is collected by observers and that there is adequate provision to meet the objectives of the programme. Ideally, the funding option(s) selected should deliver sustainability to the programme with the added benefit of encouraging compliance amongst fishers at an affordable price and provide opportunities for complimentary projects e.g. research, monitoring alternatives, surveillance initiatives, and fishery management development.

4 Observer Programme Review



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4.1 Observer Programmes Selected for the Review

The observer programmes that were used in the review were selected on the basis of a number of factors:

- **The Scope of Observer Programmes** i.e. small-scale to industrial fisheries; and partial/complete to voluntary/mandatory observer coverage
- **The Range of Objectives** i.e. compliance, scientific and/or fisheries management

Compliance

- Adherence to technical and conservation measures
- Mitigation measure implementation

Scientific

- Catch (target and bycatch) composition
- Biological information

Fisheries Management

- Fishing effort
- IUU activity
- Catch volume estimation

- **The Uses of Data:**
  - Primary method of monitoring and control or supporting/integrated with existing control measures;
  - Research/stock management purposes,
  - Ecosystem impact assessment (bycatch, incidental mortality, pollution);
  - Demonstrating support for international agreements or conventions; and
  - Ensuring access for vessels.

Other selection criteria were based on their relevance to illustrate different funding arrangements; organisational structure and service delivery model (SDM) characteristics.

To the extent possible, we looked at the following features of each observer programme:

- **Policy:** Legislation behind the programme
- **Objectives:** Goals of the observer programme
- **Performance Indicators:** Can be used to assess the success of the programme
- **Achievement of Objectives:** Looks at how far the programme has gone towards realising these indicators
- **Fleet & Size Structure:** The Fishery, the type of vessel and the numbers involved
- **Observer Coverage:** Number of fishing trips observed and the associated terms and conditions
- **Type of Data (C/S/M):** Refers to the type of data collected i.e. may be combination and should reflect the objectives of the programme: Compliance (C), Scientific (S) or Fisheries Management (M) related
- **Format:** Data output type i.e. electronic or hard copy e.g. logbook, database and its availability i.e. it should complement its intended use
- **Use of Outputs:** How is the data used i.e. Does it support MCS efforts e.g. vessel logbook entry verification or are the outputs used for management purposes such as closing the fishery if the TAC has been reached
- **Funding Arrangements:** How the costs of the programme are met
- **Implementation Costs:** A summary of all logistical, administrative, management, equipment and insurance costs
- **Consequences:** Essentially, what

would happen if no observer was deployed i.e. could the data be collected using another method; would the vessel be assured of access to a fishery

- **Benefits:** The advantages of implementing the observer programme.

Following the profiles, each programme has been assessed using a SWOT framework. For clarity the following definitions have been applied to be SWOT analysis:

- **Strengths:** Merits of the observer programme
- **Weaknesses:** The flaws of the programme – these may occur at any stage, level or linkage in the delivery model
- **Opportunities:** Identify areas where the programme could be improved or any further benefits derived from its implementation
- **Threats:** Areas which threaten the capability and likelihood of the programme achieving its objectives

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4.2 Summary Programme Review and SWOT Analysis Tables

Australian Fisheries Management Authority (AFMA) Observer Programmes	
Policy	The Australian Fisheries Management Authority (AFMA) was established in 1992 manages all Commonwealth fisheries under the Fisheries Management Act 1991 and the Fisheries Administration Act 1991. Authority to place observers is carried by the Managing Director of the AFMA. The obligation for industry to accept an observer on a vessel is imposed by conditions attached to the fishing concession or the management plan for a fishery. Most observer AFMA observer programmes are mandatory.
Objectives	The AFMA runs a number of different programmes through nine different fisheries, the majority of observer activity is carried out in the Eastern Tuna and Billfish fishery and Antarctic fishery. The scope of the programmes tend to be diverse, however the overall mission of the programme is to: "Collect up to date, reliable, independent and accurate information on the fishing catch, effort and practice of fishing vessels operating in the Australian Fishing Zoneand on the high seas and to provide this information to fisheries managers, research organisations, the fishing industry and the wider community. Data priorities are identified in individual project plans but can be changed at short notice. Generally speaking the observer duties are: • Collect vessel, technical and biological data which is not normally obtainable through logbooks • Verify catch and effort data submitted by the vessel in accordance with its fishing permit conditions • Collect data for research programs supporting fisheries management and other agencies • Monitor vessel compliance with their permit conditions • Educate fishers with respect to observer programme activities and clarify fishing permit conditions • Monitor compliance with respects to marine pollution (MARPOL) • Develop and refine methodologies for the collection of verified data • Prepare a report at the end of each trip. In addition the observer will report on compliance issues where there have been blatant and avoidable breaches. Although they don't hold any compliance powers their reports may trigger compliance actions.
Performance Indicators	Performance is measured as a proportion of fishing activity covered which varies wildly between fisheries, for example 5.1% of fishing shots in the Eastern Tuna and Billfish (ECT&B) or 100% of fishing shots in the sub-Antarctic. Performance targets are usually set in terms of observed sea days.
Achievement of Objectives	Feedback indicates a high level of industry respect for professionalism and quality of work. Data collected is reliable but it is likely that some data is biased by an "observer effect" caused by fishers modifying their behaviour when carrying an observer due to perceived consequences.
Fleet Size/ Structure	For the two main fisheries observed, the ECT&B had 305 licence holders in 2003 – 2004 ranging in size between 13m and 59m. The Antarctic Fishery had four licence holders in the 2003 – 2004 season, ranging in size between 50m and 87m.
Observer Coverage	Ranges between 5.1% of fishing shots in ECT&B to 100% of fishing shots in sub-Antarctic.
Type of Data (C/S/M)	C/S/M
Format	Data is collected at sea as a hard copy and transferred to a standardised database. The database and forms are standardised for all AFMA observer programmes. Data is held and managed centrally by AFMA according to accepted protocols and standards.
Use of Outputs	Basic analysis and reporting is done mainly to AFMA management and external agencies (e.g. Environment Agency for seabird bycatch and CCAMLR for the sub-Antarctic fishing). Although the reports can trigger compliance actions there has been a strong opposition from industry to use these reports for prosecutions.
Funding Arrangements	A policy of cost recovery, or "user pays" is a common feature of Australia's management regime although observer programmes are joint funded by industry and government, currently at a ratio of 80:20. Costs are either recovered directly from operators on a fee for service basis (in cases where there are few vessels operating e.g. sub-Antarctic and blue grenadier factory vessels), or from the entire fishery through the levy base. The cost of managing all observer data, along with all other data, is regarded as an attributable industry cost being charged out to the individual companies in relation to the amount of data they provide.

AFMA Observer Programmes (continued)

Implementation Costs	The cost of the 2003-2004 observer programme was $1.601m AUD.
Consequences	Without observer data there would be no information for stock assessment purposes and probable greater incidence of infringements.
Benefits	Observer data has been successfully used for the implementation of specific programmes, for example the threat abatement plan for the incidental capture of seabirds which successfully reduced mortalities to the target level of 0.5 birds per 1000 hooks. Without observer data the effectiveness of the mitigation method deployed could not have been assessed. Observer work played a critical role in developing stock assessments for the Southern Bluefin Tuna Fishery, as well as supporting research in the yellowfin tuna fisheries and others associated with longline tuna operations.Information collected by observers was primarily responsible for identifying a potential new fishery for pelagic fish off Tasmania, developing seabird and shark bycatch mitigation measures, documenting marine pollution compliance and recording new techniques being introduced by foreign vessels.

Strengths	Weaknesses	Opportunities	Threats
• All feedback indicates high level of industry respect for professionalism and quality of work. • AFMA currently has no scientific capacity to process the data. AFMA observers only collect the data, it is up to others to develop analysis and to use the data. It has been suggested that industry benefits as a result by having scientists from a range of agencies critiquing eachother when it comes to stock assessments.	• Poor perfomance indicators. For all programmes performance is only measured as % of fishing activity covered. • Data liable to be biased due to “observer effect”– fishers changing their behaviour due to presence of observer. • Potential use of observer reports for prosecutions has been opposed by industry, although some reports may trigger copmpliance actions.	• Recent plans to merge the AFMA observer programmes with Integrated Scientific Monitoring Programmes (ISMP) should lead to reduced costs due to ecomomies of scale that will accompany larger at sea gathering programme – although there are some concerns about a merger (see threats).	• By merging the observer programme with the ISMP has caused some concerns in industry – in particular: • The role of the observer on the vessel with regards to compliance issues. ISMP observers have been purely scientific, as a result have been strongly supported by industry. By placing them under AFMA’s control there is a danger that this may place a strain on the relationship between the observer and the crew. • Dilution of scientific advice – by centralising the data analysis there is a danger that the quality of the scientific advice may be diluted.

IATTC International Dolphin Conservation Programme

Policy	Created at the 34th meeting of the Inter American Tropical Tuna Commission (IATTC) in 1992, the International Dolphin Conservation Programme (IDCP) was later formalised under the Agreement on the International Dolphin Conservation Programme (AIDCP) in 1998.
Objectives	• To progressively reduce incidental dolphin mortalities to levels approaching to zero • To seek ecologically sound means of capturing large yellowfin tunas not in association with dolphins • To ensure the long-term sustainability of the tuna stocks in the Agreement Area as well as that of the marine resources related to this fishery.
Performance Indicators	Target number of dolphin mortalities. Reduction in dolphin mortalities to below 5000 by 1999 and from then to levels approaching zero.
Achievement of Objectives	The programme has succeeded in its objectives by reducing mortalities to below target levels. The target level set for 1999 was reached after the first year, in 1994. There are plans to expand the coverage of the fishery to smaller vessels and increase the biological information collected by the observers.
Fleet Size/ Structure	International fleet made up of around 230 purse seiners operating in the eastern Pacific Ocean (EPO) (2002), graded 1-6 depending on size – measured by well volume (m3). All vessels must apply for a dolphin mortality limit (DML) in class size 6 (well volume 508 m3, capacity of 363 metric tons) and have an observer on board. In 2002 90 vessels were issued with a DML.
Observer Coverage	100% on all purse seiners in class size 6. IATTC supply around 68% of coverage, the rest being made up from the national observer programmes from Ecuador, Mexico and Venezuela. Some coverage of smaller vessels (classes 1-5) by countries' own observer programmes. Recent proposal by AIDCP to extend mandatory coverage to class 4 and 5 vessels.
Type of Data (C/S/M)	C/S. Each year a dolphin mortality limit (DML) set. Data collected by observer used to assess if DML has been reached which would lead to the closure of the fishery for the year. Information is gathered to estimate population size, study behaviour and net operation is used in gear studies. While not related to the IDCP, observers also gather information on catches and discards of tuna and related species and take biological samples for study.
Format	Hard data collected and entered into database.
Use of Outputs	Weekly observer reports on estimates of tuna catch by species and dolphin mortalities by stock are submitted to AIDCP Secretariat and used to monitor if the DML is being reached. Once the DML has been set – 5000 in 2004 – it is allocated to the Parties participating in the fishery which distribute it amongst their vessels. The data collected by the observer is used to assess if: • A vessel has met or exceeded its DML • A Party has met or exceeded its national DML • The fleet has met or exceeded a per-stock, per year dolphin mortality cap.
Funding Arrangements	A portion of the licence fee for all vessels eligible for an observer is used by the IATTC and the AIDCP to cover observer costs. The IATTC funds 30% of the programme with the AIDCP funding the remaining 70%.
Implementation costs	In 2003 the IATTC provided £409,338 and AIDCP provided £955,329. Total cost for 2003 - £1,364,667.
Consequences	With no independent observer on board there would be no reliable information on dolphin bycatch. Export barriers to non 'tuna friendly' products.
Benefits	Since the La Jolla agreement in 1992 dolphin mortalities have dropped from around 19,000 to fewer than 1,500 in 2003, which represents about 0.02% of the estimated population. Important scientific information on dolphin behaviour, biology and stock sizes also obtained. The US has in place trade barriers for several of the parties. It is hoped that participation in the IDCP will lead to certification of their products as 'dolphin friendly' and open up the US market.

Strengths	Weaknesses	Opportunities	Threats
• Programme provides 100% coverage for all vessels in IATTC class size 6. • Provides real time data on dolphin mortalities in the form of weekly reports by observer to AIDCP Secretariat, can lead to closure of fishery of mortalities reach unacceptable limits. • Programme objectives were achieved in that the project was successful at reducing mortalities. 1999 target of 5000 mortalities was reached within first year of implementation when mortalities dropped from 15,539 in 1992 to 3,601 in 1993. The current level (2003) is 1501 which represents 0.02% of the population estimate. • Increased detection of infringements regarding dolphin mortalities.	• Some problems with reporting procedure, in 2002 only about 50% of required reports received (2,213 out of 4,382). • Coverage does not extend to smaller vessels in classes 1-5. There is however a resolution which requires these vessels to carry an observer if it has been caught deliberately setting on dolphins. • Coverage does not extent to vessels who are non-Parties to the convention but fishing in the EPO. • Some evidence of potential bribery of observers on some of the vessels to falsify dolphin safe certificates.[14] • Some disagreements over vessel capacity have led to some class 6 vessels not carrying observers.	• Plans to extend coverage to vessels in class size 4 and 5. • Working group has been set up to monitor the activities of vessels belonging to non-parties in the Area. Aims to eliminate the IUU activities. • Labelling products 'Dolphin Friendly' will bring down trade barriers for lucrative US markets for several members.	• May be problem with funding from licence sale. • Bias in observer data. Lack of transparency in data if Parties supply their own observers.

[14] K. O'Connell (2004) Tuna/Dolphin update. Whales alive. Vol. XIII No. 3.

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Northwest Atlantic Fisheries Organisation Observer Programme	
Policy	Article II.1 NAFO convention: To contribute, through consultation and co-operation, to the management and conservation of the fishery resources of the convention area and to promote to this end scientific research and co-operation among the contracting parties.
Objectives	The primary duties of the observer consist of monitoring the vessels to check they comply with the Conservation and Enforcement Measures. This includes: • reporting on fishing activities and discards • verifying entries in logbooks • collecting data on catch and effort (set by set), • collecting samples for scientific work • monitoring the satellite system • reporting infringements to inspection vessels The observers report after each trip to his or her country and to the NAFO Executive Secretary.
Performance Indicators	Increased level of compliance. Number of actions taken against offending vessels. Use of data outputs provided by observers. Availability of observer data for use in real time enforcement.
Achievement of Objectives	Coverage was satisfied. Data was not used for stock management or for enforcement measures. No arrests were made as a result of programme.
Fleet Size/ Structure	22-31 EU factory freezer stern trawlers. Mainly Spanish and Portuguese with occasional German or Danish vessels.
Observer Coverage	While observing: 100% of vessels have observers. It is a mandatory requirement for all vessels to carry an observer onboard. The vessels operate all year round, but highest numbers and observer requirements are during the winter months when catches of Greenland halibut are historically higher. Whole fleet: 100% of vessels are observed.
Type of Data (C/S/M)	C/M. The OP has the potential to deliver C/S/M; however emphasis is on compliance monitoring
Format	Hard data transferred to electronic database upon completion of a trip (can be up to four months worth of data). Observers required to send catch data every five days and report any apparent infringements to the EU FPV in the Regulatory Area within 24hrs.
Use of Outputs	Submitted to the NAFO Secretariat fulfilling EU commitments as a contracting party. The data is not used for real time control and enforcement efforts.
Funding Arrangements	Funded by the EU. However, since European Council Regulation (EC) No. 855/2004 came into force in May 2004, each MS must provide funding for the placement of observers on vessels.
Implementation costs	€4.34m per annum (€2.1m for the provision of observers and associated management costs and €2.24 for the provision of an EU FPV also provides an observer logistical support service)
Consequences	No observer onboard, no entry to the fishery. No objective qualitative data on catch, bycatch or discards to contribute to stock assessment attempts. Continued infringements and misreporting of catches. Potential for further conflict between EU vessels and Canadian Fishing Authorities.
Benefits	Provision of accurate data on catches, giving an indication of the apparent level of misreporting and infringements of technical and conservation measures.

Strengths	Weaknesses	Opportunities	Threats
• Observer programme Provided 100% coverage to large EU fleet all year round. • Data collection objectives precise and achieved.	• Limited opportunity for the provision of training. • Intended data use objectives not fully realised because of the following: - Reporting infringement opportunities & protocols inadequate. - Synergy between observers, EU and MS inspectors incomplete. • Data recording format costly and ineffective i.e. availability and timeliness (hard copy transfer to electronic upon observers return) of data to EU. • Gradual reduction of observer salary by 20%.	• Speeding up of dissemination of observer data could improve the capacity of MS or EC NAFO inspectors of detected infringements. • Joint training programme for observers and inspectors.	• In future all EU MS will be responsible for supplying observers for their vessels fishing in NAFO waters. These new arrangements may encourage less transparency or a conflict of interests if the observer providers are not independent from industry. • Access of repeat offending vessels lowers observer morale and undermines the integrity of the programme.

Implementation of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) Scientific Observer Programme

Policy	The Scheme of International Scientific Observation was adopted in 1992 under Article XXIV of the Convention.
Objectives	Originally initiated from concern over bird mortalities, the scheme has expanded to monitor and report on the operation of fishing activities in the Convention Area with the objectives and principles of CCAMLR in mind.
Performance Indicators	Reduction in bird and marine mammal mortalities. Collection of biological information plus accurate estimations of conversion factors used for stock management purposes. Level of coverage – 100% vessels, 25% fishing activities. Evaluation of effectiveness of conservation and mitigation methods. Assessment of fishery impact on the ecosystem
Achievement of Objectives	Bird mortalities in the longline fishery reduced from 2000 per year in 1995 to just eight in 2004 Observer estimated conversion factors and biological information obtained has been used for stock assessment purposes. Levels of coverage achieved. Recently introduced tagging programme has provided further information for stock assessments as well as biology of the toothfish.
Fleet Size/ Structure	13-18 longlining vessels targeting Patagonian toothfish, 6-9 icefish trawlers, 6-9 krill trawlers
Observer Coverage	Mandatory for all vessels to carry an observer apart from those licensed to fish for krill. The toothfish fishery season commences from 1st May, finishing 31st August or sooner if the TAC is used. The icefish fishery season is from 1st December to 31st November. Observers have been deployed on each vessel to monitor incidental seabird entanglement as well as provide information on catch and fishing effort. The krill fishery occurs from May through to October. As a result the logistical demands to place observers on vessel are very challenging and as such are not mandatory. Alternatively 2/3 observers are deployed at the fishery monitoring centre (FMC) and deployed from there. The observers remain on board for two to four weeks and then are rotated onto other boats in the fleet. Typical observer coverage on krill vessels is 30%, on icefish and toothfish it is 100%. About 70% of hauls and 30% of hooks are observed respectively.
Type of Data (C/S/M)	C/S/M. Information collected by the observers contributes to real-time management of the fishery e.g. marine mammal and seabird mortalities associated with trawling operations for krill and icefish respectively. Observers monitor application of mitigation and conservation measures. Observers also collect biological information on catch and bycatch species which contribute to stock assessments and scientific initiatives e.g. skate survival rates.
Format	Data recorded as hard copy and transferred to database while at sea. Summary reports of fishing operations are submitted on a five day basis. Final report and biological and catch and effort data submitted within one month of end of trip.
Use of Outputs	Estimate interactions with the fishery e.g. depredation rates and impact on stocks; indication of level of bycatch and discards, serves as an objective method of monitoring a vessels application of CCAMLR regulations; provided support/platform for research projects.
Funding Arrangements	Generated from licence fees paid by vessels to Government of South Georgia and South Sandwich Islands.
Implementation costs	Dependent on number of vessels licensed for logistical arrangements and observer salaries, but approximately £140 per observer day.
Consequences	Continued bird mortalities could have led to closure of fishery. Lack of accurate information on catches, bycatches and discards; depredation rates, impact on the local ecosystem; the persistence of bad practices within the fishery and no accurate and objective means of scoring vessel performance, fewer means of encouraging vessels to adopt the CCAMLR approach to the fishery.
Benefits	Observers provide advice to fishers who are often poorly prepared for CCAMLR operational guidelines, particularly with regard to the implementation of conservation and mitigation measures. This has led to significant reduction in seabird mortalities. The programme provides accurate biological and catch data for stock assessments. Real-time compliance intervention in some cases e.g. observers acting in an advisory capacity with regard to minimising marine mammal mortalities through consultation with vessel masters about mitigation measures onboard krill vessels. The programme has also provided support/platform for research projects e.g. skate survivorship project, benthos mapping.

Strengths	Weaknesses	Opportunities	Threats
• Clear objectives and operational protocols devised for the observers and fishery. Initial sampling difficulties and resistance overcome because of effective SDM resulting in the reduction of bird mortalities to negligible amounts. • Provides 100% vessel coverage. • Observers collect data for scientific, management and compliance purposes. • Well supported at a political level. • Well defined SDM and responsibilities of components. • Has achieved objectives of reducing bird mortalities.	• Long deployment (about three to four months) in particularly harsh working conditions. • Work available only on a seasonal basis, which contributes to the high turnover of personnel.	• Re-evaluating the observer programme outputs by prioritising data fields, this is necessary as the requirements have evolved since the inception of the programme.	• Funding dependent on licence revenue generated.

Irish Sea Cod Recovery Programme	
Policy	Implementation of European Council Regulation Proposal 2000/0292: Establishing measures to be applicable in 2001 for the recovery of the stock of cod in the Irish sea (ICES Division VIIa)
Objectives	To monitor bycatches of cod in the haddock fishery with a view to allowing derogations to those vessels that complied with the regulation.
Performance Indicators	Coverage levels 50 trips over one month. Monitor discard rates of cod in the haddock fishery. Check gear configurations are within regulations.
Achievement of Objectives	Despite 100% coverage achieved on vessels participating in the derogation the target coverage of 50 observed trips was not realistic because the programme objectives were too ambitious and did not reflect the real level of interest in the derogation. As a result it was not very cost effective.
Fleet Size/ Structure	Approximately 30 boats were eligible for deployment, all greater than 15m LOA; using semi-pelagic trawls or separator trawls prosecuting haddock or Nephrops.
Observer Coverage	When observing: Over a six week (March to April 2001) period observations of 50 fishing trips were required within a controlled area (approximately 50% of all fishing effort). However, the target number of trips was excessive, plus observer deployment was voluntary. Thus only 19 observed trips, on 13 vessels was achieved. Total: 10% of trips were observed.
Type of Data (C/S/M)	C/S/M. Although the different outputs of monitoring satisfied all three criteria, the main emphasis was on the compliance aspect i.e. correct gear, controlled catches, controlled area.
Format	Hard copies submitted to the FMA, DARDNI
Use of Outputs	Improved estimates of cod bycatch.in the haddock fishery; provide FMA with information on level of adherence to the Regulation.
Funding Arrangements	Funding was provided by the Fisheries Management Authority, Department of Agriculture and Rural Development of Northern Ireland (DARDNI).
Implementation costs	Cost of entire project was £72,000
Consequences	No accurate estimates of bycatch of cod in the haddock fishery, continued decline of Irish Sea cod stocks.
Benefits	Vessels that showed low levels of bycatch allowed certain derogations maintaining the haddock fishery.

Strengths	Weaknesses	Opportunities	Threats
• Relatively low cost of programme. • Constructive consultation with stakeholders led to willingness to implement programme in good faith. • Streamlined SDM with clearly defined goals at each linkage. • Level of co-operation between FMA, industry and observer provider.	• Draft of Council Regulation did not reflect fishery e.g. unrealistic objective of 50 observed trips. • Voluntary observer deployment protocol. • Alternatively, it should have been compulsory for every vessels participating in the fishery to carry an observer.	• The programme has the potential to provide accurate data on cod discards in the haddock fishery in the Irish Sea. • Programme could be expanded to provide data on other bycatch species. • Vessels shown to have low bycatch levels would have benefited from derogations.	• The voluntary framework of observer deployments gave no indication the difference in vessel behaviour with/without an observer onboard and as a result the overall effectiveness of the programme.

British Indian Ocean Territory (BIOT) Offshore Programme	
Policy	To keep under review the conditions and trends of the stocks and to gather, analyse and disseminate scientific information, on catch and effort statistics and other data relevant to the conservation and management of the stocks and fisheries.
Objectives	Collect biological fisheries data for target and bycatch species plus details on fishing techniques and effort which helps play a role in management of tuna fishery.
Performance Indicators	Coverage levels between 5-10% of days. Provision of data for stock assessment purposes. Profile of fishing practices.
Achievement of Objectives	Coverage levels satisfied. Data used for stock assessment purposes.
Fleet Size/ Structure	Tuna fishery made up mainly from French and Spanish (n=40-50 vessels; >1000mt GRT) purse seiners and Japanese longliners (n=15; 300-750mt GRT. The purse seiners target free shoaling yellowfin and skipjack tuna that migrate into BIOT territorial waters. The longliners target mature yellowfin and bigeye tuna.
Observer Coverage	When observing: Two observers mobilised for 3 months maximum during peak of fishing season (December through to end of February) each year. Observer deployed on licensed vessels by the BIOT for 2-3 days where they monitor 100% of fishing activity. Overall coverage: not all vessels are covered, meaning that 5% of all hauls are covered.
Type of Data (C/S/M)	S/C. The programme provides catch, bycatch details and effort data of each fishery. The programme also monitors application of licence terms and conditions, although emphasis is on collecting information on catch and fishing effort.
Format	Data recorded as hard copy later transferred to database at sea. Data and written report submitted at end of observation period.
Use of Outputs	Contribute towards regional scientific assessment of fish stocks in Indian Ocean through the work of the British/Seychelles Fisheries Commission, the British/Mauritian Fisheries Commission, and the Indian Ocean Tuna Commission (IOTC).
Funding Arrangements	Funded by licence revenue.
Implementation costs	Total cost of the programme implementation is £52k.
Consequences	No accurate data on the tuna fishery; thus reduced opportunity for regional cohesion on the management of tuna stocks.
Benefits	Produces data necessary for management and assessment of BIOT tuna fishery.

Strengths	Weaknesses	Opportunities	Threats
• Relatively small size means programme can easily adapt to changes in levels of fishing activity. • Well defined linkages between components. • Clearly identified tasks and outputs. When on vessel 100% of fishing activity monitored.	• Quality of data vulnerable as observers only on vessels for three to four days at a time therefore vessels may behave differently when observer not present. • Due to highly migratory nature of vessels it is not possible to monitor all licensed vessels.	• Only offshore tuna longline observer programme in the region, providing a unique data set. • To expand the programme i.e. greater number of observers resulting in greater coverage	• Funding dependent upon licence revenue which is linked to market value for tuna. • May be discontinued if other MCS tasks are prioritised.

Falkland Islands Fisheries Observer Programme	
Policy	Developed and run by the Falkland Island Fisheries Department.
Objectives	Collect biological fisheries data for target and bycatch species plus details on fishing techniques and effort. This is the only opportunity to obtain biological information from the catch, since none of the product is landed in the Falkland Islands. All vessels also submit logbooks.
Performance Indicators	Data used for stock assessment purposes. Verification of logbook data.
Achievement of Objectives	Data is used in the stock assessments and logbooks are verified.
Fleet Size/ Structure	Fleet of up to 150 vessels in fisheries for squid and finfish.
Observer Coverage	Six observers are employed, covering between 1 and 4% of all days at sea, on finfish and squid vessels. Vessels are randomly chosen, but coverage is not even amongst fisheries. A further two are employed on longline vessels fishing for toothfish with 100% vessel coverage.
Type of Data (C/S/M)	S. The programme provides catch, bycatch details and effort data of each fishery.
Format	Data recorded as hard copy later transferred to database at sea. Data and written report submitted at end of observation period.
Use of Outputs	Contribute towards local and regional scientific assessment of fish stocks.
Funding Arrangements	Centrally funded.
Implementation costs	Total cost of the programme implementation is about £200,000 for about 900 days at sea.
Consequences	Some fisheries (such as Loligo gahi and toothfish) are well sampled. Others are adequately sampled (Illex, southern blue whiting), but the availability of observers and coverage leaves some fisheries only partially sampled between years (such as finfish and rays).
Benefits	Produces the only data available from the fishery.

Strengths	Weaknesses	Opportunities	Threats
• Relatively small size resulting in good flexibility, extremely high quality scientific observation and the opportunity for innovative scientific research alongside observations. • Distinct and continuing separation between science (observers) and compliance (fisheries patrol vessels and inspectors) means that science is not compromised	• Rather low coverage of some fisheries, and lack of any opportunity for acquiring data from other sources such as landings, leads to sampling bias. • Data collection objectives for stock assessment purposes limited to just those vessels with observers on i.e. reduced means of verifying/gathering information.	• Only way of getting biological information from the fleet. • Good working relationship with fishermen means new science easily undertaken	• There is no other mechanism for acquiring data on the catch. Should there be significant bias or underreporting of catch volume in logbooks the observer programme would not, as it is at the moment, be able to provide the information. • There is currently no incentive for vessels to misreport in logbooks because the fishery is controlled by input (effort) rather than output (quota) mechanisms.

North Pacific Groundfish Observer Programme	
Policy	Three major pieces of legislation give NMFS authority to place observers on boats on programmes operated around the US: • Marine Mammal Protection Act • Magnuson-Stevens Fisheries Act • Endangered Species Act. In addition government regulation 679.50 (subpart E) applies to NPGOP in particular and sets out the terms and conditions under which vessels and processing plants must carry an observer as well as guidelines for the sampling rates.
Objectives	Promote sustainable fisheries based on sound scientific processes and environmental practices. Specifically, provide: Catch, bycatch and biological data necessary to support in-season monitoring and stock assessment; information to fishers to increase compliance with specific regulations; improve and maintain the infrastructure necessary to perform observer role; provide information to support marine mammal management and other protected species initiatives and raise awareness of the goals and objectives of the Programme in the fishing industry.
Performance Indicators	Better estimates of bycatch. Programme expanded to include catch and effort recording and monitoring of incidental mortality of marine mammals.
Achievement of Objectives	Better estimates of bycatch were achieved however problems with interpreting objectives by different stakeholders led to conflicts and data was not collected or used as effectively as it could have been. A review recommended that the goals and objectives should be re-examined using more structured planning tools such as the Logical Framework.
Fleet Size/ Structure	Fleet size: 350 vessels and 20 shore plants. The fishery is operable all year round (closures subject to target and bycatch quota limits).
Observer Coverage	Programme responsibilities are shared among NMFS, the Observer Training Centre of the University of Alaska Anchorage (OTC), the fishing industry and five independent observer providers (who are permitted by NMFS). The observer providers hired and deployed 364 observers in 2002. Both vessels and processing plants covered. Based on vessel class (LOA) and processing capability (live weight) of the facility: Fraction of fishing activity observed: Approximately 30,000 - 35,000 days observed annually. Vessels 125 ft. or longer = 100% coverage of fishing days; vessels 60 - 124 ft. = 30% coverage of fishing days; shore plants processing >1,000 mt = 100% coverage of processing days. Shore plants processing >500 mt = 30% coverage of processing days.
Type of Data (C/S/M)	C/S/M. Collect data on catch and bycatch quantity, composition an biological characteristics, document fishery interactions with marine mammals and seabirds, monitor compliance with federal fisheries regulations.
Format	Hard copies by observer provider companies to NMFS within 5 working days and transferred to electronic database, maintained by the NMFS OPO
Use of Outputs	Biological and catch information used to support in-season stock monitoring and stock assessments. The former will contribute to closures of fisheries because of utilisation of target and bycatch quotas. Means of monitoring vessel compliance of quota and closure regulations, application of technical measures and incidence of seabird and marine mammal mortality.
Funding Arrangements	Direct observer costs for industry funded: vessel and processing plants contract directly with private observer companies on 'pay as you go' system – 2% of the value of the fish and shell fish landed. NMFS operational costs are government funded.
Implementation Costs	The annual cost to industry for the NPGOP is estimated to be U$8-10 million for the provision of observers and a further U$2 million in administration and training costs to NMFS.
Consequences	An increase in uncertainty in stock assessment results, because of lack of biological information, which could result in more conservative TACs to ensure sustainable fisheries. This would have a direct negative socio-economic on fishers and related industries.
Benefits	The provision of biological information on catches contributes to management approaches promoting sustainability e.g. provides support for in-season stock management regulations; data supporting ecosystem based management, through the provision of data on bycatch, discards and protected species; and since 1991 there has been increasing emphasis to use the programme as a means of increasing the level of coverage of compliance issues.

Strengths	Weaknesses	Opportunities	Threats
• Performance measured according to stated goals and objectives rather than simply percentage coverage achieved.	• Objectives not achieved because SDM poorly devised i.e. lack of clarity between components, their responsibilities and deliveries. • Quality of data vulnerable to conflicts of interest as vessel and processing plant owners contract directly with observer companies. • Placement of observers on boats is largely opportunistic and not driven by requirements of stock assessments i.e. For smaller boats it is vessel owners, not NMFS, who decide when to take an observer. Therefore coverage and deployment cannot be managed effectively. • Potential bias will also jeopardise statistical reliability of data. • Smaller vessels may face observer costs that are disproportional relative to their earnings. • The current funding mechanism and programme structure do not allow enough flexibility to solve many of these problems or effectively respond to evolving and dynamic fisheries management objectives. • Increasing emphasis on compliance issues, but observers are trained biologists not inspectors. • High observer turnover.	• Restructuring of payment scheme could lead to more effective deployment of observers. • Work with the North Pacific Fishery Management Council to establish requirements for an observer programme that includes a vessel selection process that produces random sampling of the fishery. • Establish a monitoring and reporting process to help ensure that North Pacific Groundfish observer providers are in compliance with the new certification requirements and meet the standards defined in the North Pacific Groundfish Observer Programme regulations. • Goals and objectives should be re-examined using more structured planning tools such as the Logical Framework developed by Team Technologies Inc. in collaboration with the World Bank.	• No formal agreement amongst all components of the NPGOP on what the goals and objectives should be or their priority. • Sampling and data outputs could be threatened by observer harassment or obstruction. • Perception that the integrity of the programme is under threat from relationship between observer provider companies and industry.

West Coast Groundfish Observer Programme	
Policy	Three major pieces of legislation give NMFS authority to place observers on boats on programmes operated around the US: • Marine Mammal Protection Act • Magnuson-Stevens Fisheries Act • Endangered Species Act Observer programme initiated by NMFS in 2001 to implement the Pacific Coast Groundfish Fishery Management Plan as outlined in the Code of Federal Regulations (CFR) part 660. All vessels participating in the groundfish fishery must carry an observer when requested by the NMFS or a designated agent.
Objectives	Gather data needed to better manage the groundfish fishery, in particular improve estimates of total catch including discards and bycatch. Obtain more accurate estimates for stock assessment purposes.
Performance Indicators	None specifically offered, however collection of data from previously unmonitored areas/vessels e.g. previous overestimates of discards for sablefish have also led to an increase in trip limits based on new data to help achieve the OY.
Achievement of Objectives	Data collected by observers was used in an updated bycatch model resulting in increased trip limits for certain deep water slope species. 2004 also saw the highest ever quota for halibut, largely due to a decrease in halibut bycatch. This was noted and reported by observers and is thought mainly due to fleet reduction and depth closures.
Fleet Size/ Structure	1824 vessels (in 2000) split between three sectors; limited entry fleet; open access fleet and recreational fleet. Observers target limited entry trawlers + pilot scheme to cover fixed gear vessels.
Observer Coverage	Observers permanently assigned to one of 13 port groups up the coast. Targeted at 10% of weight of landed catch, although actual coverage is 16% (2003). Vessels to be covered over two month period and selected on random basis on a one year cycle.
Type of Data (C/S/M)	S/M
Format	Hard copy of data taken then entered into central database on vessel via web-based interface to give real-time information to fishery managers.
Use of Outputs	Used to estimate discard rates of key species and give better data for calculating stock status and Optimum Yields (OY) and trip limits for the vessels.
Funding Arrangements	NMFS, using federally appointed funds, contracts with observer providers to cover all costs associated with collection and delivery of observer data to NMFS
Implementation costs	$4.775m to develop structure and run first year. For 2004 congress granted a budget of $5m for programme
Consequences	Collapse of fishery for 9 target species. Using outdated figures for discard rates.
Benefits	Provides accurate data on discard rates of both target and non-target fish. Observers also used for other selected scientific projects.

Strengths	Weaknesses	Opportunities	Threats
• SDM facilitates rapid deployment of observers over a large area of coastline • Encouraged co-operation between fishers and scientists in calling for implementation of programme. • More accurate information on discards used to establish catch limits. • Web-based data entry system gives real-time catch and discard data for management purposes.	• Observers are repeatedly assigned to the same vessel, may lead to reduction in objectivity of reporting and lead to observer bias.	• Provide data which will be used to assist the recovery of 9 of the major target groundfish species.	• Cuts in federal funding.

Danish Discard Project	
Policy	Before the start of this project, biological information about the Danish fishery in the North Sea and Skagerrak was collected through a harbour sampling programme. This provided information on the landed part of the catch but not the discarded part. In order to obtain an estimate of the amount of discarding, a sea-sampling programme was implemented.
Objectives	• Implementation of an at-sea-sampling programme on-board commercial fishing vessels; • Estimates of discards and retention of target and non-target species within all the major fishery types in the North Sea and Skagerrak by sampling the catch at sea on-board commercial fishing vessels; • Developing of a model for estimation of discards of target and non-target species based on the data collected during the project; and • Develop age-length keys of discarded target species, based on otolith readings of otoliths collected on-board commercial vessels and research vessels.
Performance Indicators	Degree of success at forging links between stakeholder groups and scientists. Increased collection data opportunities on discards for stock assessment purposes.
Achievement of Objectives	Greater co-operation between stakeholders and industry. Data on discards collected across range of different fishing gear types, although at a low sampling rate.
Fleet Size/ Structure	North Sea and Skagerrak fleets split into main groups according to gear then further split into individual fishery types according to target species. In total 17 major fisheries recognised.
Observer Coverage	When observing: On average 70% of hauls samples between 1995 and 1998 (2,039 hauls over 24,672 fishing hours). All 17 fishery types were sampled although not in all quarters and all areas. Overall: _ - 1% of all hauls in the fishery are observed.
Type of Data (C/S/M)	S/M. The programme provides information on biological characteristics, distribution and amounts of bycatch and as well as information on fishing effort, gear strategies and circumstances.
Format	Notebook, hardcopy, electronic
Use of Outputs	Developing of a model for estimation of discards of target and non-target species based on the data collected during the project; and develop age-length keys of discarded species, based on otolith collected on-board commercial vessels and research vessels. The outputs are used to support existing data or further work.
Funding Arrangements	DIFRES employs receives approx. 90 million DKK from government funding and approx.73 million DKK from external funding. Funding is distributed between several projects. Actual figures for implementation of the project have been requested but as yet not disclosed.
Implementation costs	The programme was staffed by about 10 people, undertaking 1138 trips between 1995 and 2001. The annual cost was £286,500 ($450,000) and allowed coverage of 0.5 – 1% of landings and less than 1% of trips.
Consequences	Before the start of this project, biological information about the Danish fishery in the North Sea and Skagerrak was collected through a harbour sampling programme. This provided information on the landed part of the catch but not the discarded part. There existed considerable mistrust between the scientific and fishing communities and very little co-operation and it was very difficult to sample landings.
Benefits	The co-operation between industry and scientific communities created a platform for future discussions on management issues in a non-political, more informal forum which will contribute to better understanding and exchange of ideas and greater acceptance of results and findings.

Strengths	Weaknesses	Opportunities	Threats
• First efforts at collecting information from at sea operations. • Discard rates and the rates of retained fish/shellfish were calculated for the majority of fisheries (by weight and as a percentage of the total catch by species, quarter, subdivision and year). • Flexible sampling schedule is re-evaluated several times a year to take into account changes within the fishery. • Demonstrated that co-operation between industry and scientific community could be achieved.	• Not all fisheries were sampled (low levels of coverage approx. 1%) in all quarters and areas because of their seasonal nature (gill-net, purse-seine, pelagic herring trawls fisheries).	• The co-operation between industry and scientific communities created a platform for future discussions on management issues in a more informal environment, contributing to better understanding and exchange of ideas and greater acceptance of results and findings.	• Level of coverage is such that confidence in data for stock assessment levels is low

Alaskan Marine Mammal Programme	
Policy	Required under Marine Mammal Protection Act to monitor all category II fisheries in Alaska for any marine mammal interactions with gill nets.
Objectives	To reduce the incidental take and mortality of marine mammals in gill nets.
Performance Indicators	Obtaining statistically accurate data on marine mammal bycatch. Reducing marine mammal by-catch. Verifying fishers' data.
Achievement of Objectives	Data has been collected on mammal bycatch, including biological data from examining dead mammals, although the cost per observer day is the highest of all observer programmes. As yet no data on whether there has been a definite reduction in mortalities.
Fleet Size/ Structure	Kodiak salmon fishery 180 permits issued. Vessels mostly 7-9m, mainly targeting salmon with gill nets, spread over large area. Fishery operates between June and September.
Observer Coverage	Around Kodiak 103 active licences were sampled at level between 5 and 9%
Type of Data (C/S/M)	S. Under the Marine Mammal Authorisation Programme (MMAP) the NMFS must provide an annual report giving estimates of the stock abundance and any human caused mortalities of all species of mammal in the US. The report must also document the stock's Potential Biological Removal (PBR), which is the level of removal that the stock can withstand while still obtaining their Optimal Sustainable Population (OSP). There is concern that PBR of certain mammals may be exceeded in certain fisheries and the information collected can determine a more accurate value for the OSP and ultimately reduce the incidental take of marine mammals. All data collected is intended for scientific analysis rather than enforcement or compliance issues.
Format	Notebook, hard copy, electronic
Use of Outputs	Determine the level of marine mammal mortalities in the fishery as a whole.
Funding Arrangements	Federally through NMFS
Implementation costs	Different fisheries sampled for 2-3 years. Cost per observer day approximately $2,400
Consequences	No accurate data on marine mammal mortalities may lead to depletion of numbers to dangerous levels.
Benefits	Reduction in marine mammal mortalities when observers on board, more data obtainable on marine mammal interactions.

Strengths	Weaknesses	Opportunities	Threats
• SDM allows for placement observers in remote areas. • Use of 'mothership' extends the opportunities of deployment onto boats that would otherwise be too small for long term deployment.	• Objectives of have not been met i.e. establishing accurate estimation of overall marine mammal mortality and subsequent reduction. • High cost of chartering observer vessels. • Small size of vessels makes observer placement difficult and in some cases dangerous. • Can only offer low level of coverage therefore only suitable for monitoring rare events e.g. cetacean entanglements. • Observer bias – fewer cetaceans caught when observer on board.	• Purchasing own vessels by NMFS would reduce long term costs.	• Safety of observers. • Cuts in federal funding.

US Caribbean St Croix Pilot Study	
Policy	The purpose of this project is to assess the potential for obtaining information on bycatch, discards, and biological data from the commercial fisheries of the US Caribbean. This project specifically addresses Cooperative Research Programme (CRP) Funding Priority A.2 (a, d, and f) for the US Caribbean region.
Objectives	The project will focus on methods for obtaining information on composition and disposition of bycatch and discards at sea, opportunities for collecting biological data at sea, and the use of captain or crew for collecting data if space or safety on vessels does not allow observers through the implementation of a pilot observer programme.
Performance Indicators	Establishing range or scope of data that can be collected. Detecting any bias in data between observed and unobserved vessels. Determining levels of bycatch.
Achievement of Objectives	Programme not yet implemented.
Fleet Size/ Structure	The pilot observer programme will focus on St. Croix fishers. Fishers in this area use the four main gears typical of the US Caribbean that may have problems with bycatch: Gillnets, trammel nets, pots/traps, and hook and line. About 240 St. Croix fishers have commercial fishing permits.
Observer Coverage	The work is scheduled to start late 2004 and will require about 16 months to complete. The at-sea pilot observer project will target observations for four fishing trips per month for 11 months. Observer placement on vessels will be stratified by gear into gill nets, trammel nets, pots/traps, and hook and line, resulting in one trip per gear per month.
Type of Data (C/S/M)	The Programme will collect information on amounts and biological details from retained catch, and discards and compare information collected by observers with that by crew.
Format	Hard copies of records will transferred to database format for analysis
Use of Outputs	The results of the project would form the basis for planning a comprehensive observer programme in the US Caribbean if management agencies should decide such a programme is necessary. The project will primarily address feasibility issues associated with placing observers onboard small scale fishing vessels in the US Caribbean. These are: • Financial, space, and safety considerations for placing observers on board • Limitations on scope of data collection on board • Coordination and cooperation issues with fishers • Alternatives to placing observers on board. The project will also address the data outputs from the pilot study. The project should provide the first opportunity to assess the magnitude of bycatch and discards. Analysis of the data collected ashore and at-sea will provide a preliminary assessment of the likely magnitude of bias that may arise between observed fishing trips and those without and consider ways in which it could be avoided. Progress and final reports will describe the results of the pilot programme, assess options for collecting data at sea, and d evelop recommendations.
Funding Arrangements	Funded by NMFS through the Cooperative Research Programme.
Implementation Costs	Project budgeted at around $96,000 for 70 observer days (40 at sea and 30 on land).
Consequences	Potential pressure on the fishery brought by NGOs e.g. the non-governmental organisation Oceana filed a petition with NOAA Fisheries requesting that the agency initiate rulemaking to establish a programme to count, cap, and control bycatch in the nation's fisheries. This may result in closures or restrictions on the fishery and could have significant socio-economic impact on the fishing community and their dependents.
Benefits	The project will develop recommendations for fishery management agencies in the US Caribbean Region (federal and state waters).

Strengths	Weaknesses	Opportunities	Threats
• Provide set of data on interactions of the fishery on bycatch, discards, marine mammals, seabirds and turtles. • Project specifically addresses Cooperative Research Programme (CRP) Funding Priority A.2 (a, d, and f) for the US Caribbean region. • Observers recruited from local fishers, therefore minimising training and logistical costs.	• Low coverage level of each fishery (1 trip per month). • Dependent on co-operation from fishers.	• The project will provide opportunities for collecting biological data at sea on small-scale artisanal craft and the use of captain or crew for collecting data. • The results of the project would form the basis for planning a comprehensive observer programme in the US. • Analysis of the data collected ashore and at-sea will provide a preliminary assessment of the likely magnitude of bias that may arise between observed fishing trips and those without and consider ways in which it could be avoided. • The project will develop recommendations for fishery management agencies in the US Caribbean Region (federal and state waters).	• If co-operation of fisher was withdrawn then the scope of the Programme would be undermined.

Table 7

Summary of Observer Programmes

Observer Programmes							
Feature	**IATTC IDCP**	**AFMA Observer Pro-grammes**	**Falkland Islands**	**CEFAS**	**NAFO**	**CCAMLR**	
Small-scale							
Artisanal							
Industrial	✓	✓	✓	✓	✓	✓	
Compliance	✓	✓			✓	✓	
Scientific		✓	✓	✓		✓	
Fisheries Management	✓	✓	✓	✓	✓	✓	
Ecosystem Impact	✓	✓		✓		✓	
Funding	FMA/Industry	FMA/Industry	FMA	35% EU 35% UK	FMA/Industry	FMA and FMA/Industry	
Observer Providers	FMA	Private Company	Government	Government Agency	Private Co/FMA	Private Co/ Government	
Size (days observed per year)	13,800 sets (2002)	1,800	900	800	11,200	4,000#	
Cost per Observer Day		£280	£222	£725	£130	£140	
Coverage (% of trips/ vessels/ days)	100% trips	5% (ECT&B) 100% (Sub-antarctic)	1 – 4% days	0.25% trips of about half the fleet	100% trips	100% trips***	

***100% for longliners and icefish. Krill 3 observers between 9 vessels.
#A private company operates the observers at South Georgia, contributing about 1300 observer days across all fisheries. Over the whole of the CCAMLR Area there are about 4000 observer days.

	Irish Sea Cod Recovery	BIOT Tuna	NPGOP	WCGOP	Danish Discard OP	Alaskan Mammal	US Carib Bycatch & Discard OP
						✓	✓
							✓
	✓	✓	✓	✓	✓	✓	
	✓		✓				
		✓	✓	✓	✓	✓	✓
	✓	✓		✓			
				✓	✓	✓	
	FMA	Industry	FMA/Industry	FMA	FMA	FMA	FMA
	Private Company	Private Company	Private Company	Private Company	FMA	Private Company	Private Co/ Industry
	19	42	37,000	4,000	241	395	70**
	£950	£745	£190	£695	£1,190	£1,320	£763
	10% days	3% days	30 – 100% trips##	16% trips	0.5 – 1% trips	5 – 9% trips	Not given: planned 4 trips/month for 11 months

**Split between 40 days at sea and 30 on land.
##Dependent on vessel size.

The cost of observer programmes reflects their objectives, coverage levels, size of the fishery and individual staff costs. Some of the more expensive programmes are those with high coverage levels and specific targets in terms of protected species, such as the Alaskan Mammal programme. Equally, the NAFO programme, with only a compliance remit, appears to be relatively cheap. However, there are other programmes which seem to buck this trend. In fact, there is a relationship between the number of observer days and cost (Figure 5).

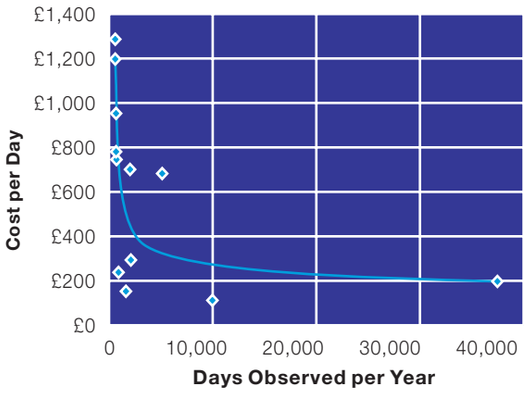
These data include set-up costs, and show that marginal cost quickly approaches the daily cost of an observer as the number of observer days increases. The daily observer cost for mature observer programmes will normally approach £100 - £200.

All observer programmes listed in the table above are controlled by government departments (i.e. the FMA) but individual deployment operation is usually devolved to a private company, though the company is often quite closely connected with the FMA. Standard and target setting may be done by the FMA or the private company, usually in collaboration with international or national scientific bodies.

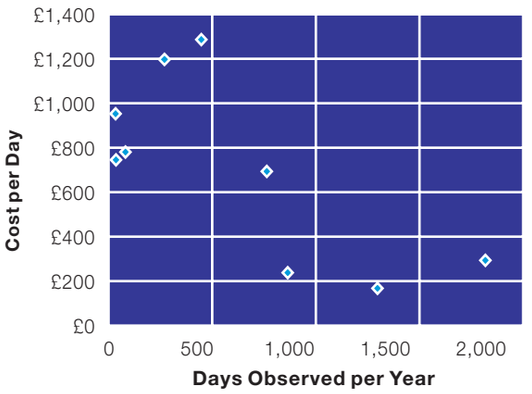
Figure 5

Plots of total observer days and cost per day from the above data

A. Full Dataset with a power function following the trend



B. Dataset for programmes with less than 1000 observer days per year



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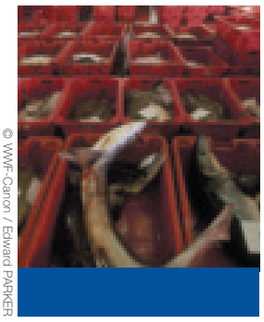
5 North Sea White Fish Observer Programme

IT IS not the role of this project to specify detailed objectives and sampling strategies for a general North Sea whitefish programme, but rather to identify some issues that need to be considered when reviewing the current programmes.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5.1 Features of Current North Sea Programmes

Current EU Regulations Pertinent to Observer Programmes

i) Data Collection Requirements

- **Regulation 1543/2000**

Establishing a Community framework for the collection and management of the data needed to conduct the common fisheries policy. It laid down guidelines for collection of data necessary to improve scientific knowledge as stipulated by the United Nations Food and Agriculture Organisation's Code of Conduct for Responsible Fisheries. It went on to establish both a minimum community programme covering the information strictly necessary for scientific evaluations and an extended programme which includes gathering information which would be likely to improve the scientific evaluations.

- **Regulation 1639/2001**

Establishing the minimum and extended Community programmes for the collection of data in the fisheries sector and laying down detailed rules for the application of Council Regulation (EC) No 1543/2000. This gives more detailed guidelines as to the sampling regimes necessary for the different programmes.

- **Regulation 1581/2004**

Amending Regulation (EC) No 1639/2001 establishing the minimum and extended Community programmes for the collection of data in the fisheries sector and laying down of detailed rules for the application of Council Regulation (EC) NO 1543/2000.

- **Commission Decision 2004/555/EC**

On the eligibility of expenditure to be incurred by certain Member States in 2004 for the collection and management of data needed to conduct the common fisheries policy. It states that states collecting and managing data for the minimum and extended Community programmes will qualify for a financial contribution of 50% and 35% respectively for any expenditure incurred.

ii)Discard Sampling

- **Regulation 1543/2000**

States that discards should be sampled in both the minimum and extended programmes although it does not give any definition of sampling rates or intensities. Annex I, XII and XV of Regulation 1639/2001 defines exactly when discards should be sampled and goes on to give the sampling rates and intensities stratified by species, type of gear and area. It also defines the precision level that the sampling procedure must reach; in the case of discard sampling this should be

level 1: -"sampling to a level making it possible to estimate a parameter with a precision of plus or minus 25% for a 95% confidence level". Annex I, XII and XV have since been updated by Regulation 1581/2004, which goes on to add which species must be sampled for the minimum programmes and which species are optional under the extended programme.

iii) Cetacean Bycatch

- **Regulation 812/2004**

Laying down measures concerning incidental catches of cetaceans in fisheries and amending Regulation (EC) No. 88/98. Gives the guidelines for providing independent observations of fishing activities to provide reliable estimates of the incidental catch of cetaceans through an on-board observers. It calls on member states to design observer programmes for vessels over 15m flying their flag. The percentage of fishing effort covered varies between 5% and 10% according to the fishery, as defined in Annex III. These measures should have been implemented by 1st January 2005.

Currently observer programmes are run by the UK, Denmark, Sweden and Germany in the North Sea and Skagerrak, and they are aimed primarily at discard sampling. Data are available from 1995 in the case of the Danish programme, and from 1997 in the case of the UK (English) programme, and are used by International Council for the Exploration of the Sea (ICES) to calculate discards of key species for input into some assessments (ICES WORKING GROUP 2002, 2001; ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, 2003).

Within England and Wales the programme is run by the Centre for Environment Fisheries and Aquaculture Science (CEFAS). They employ around 8 observers who are permanently based up the east and west coasts. They are trained in fish identification and sampling techniques and are accompanied on the vessels until certified safe and competent to go to sea by themselves. Nationwide they sample discards from a fleet of around 600 vessels in accordance with the protocol set down in EC Data Collection Regulation 1639/2001. This requires different sampling strategies for different gear categories to reflect the relative impact of each fishery in each area. The North Sea is covered by three observers who sample between 150 and 200 days a year to give the 0.25% coverage. For safety and practical reasons only vessels over 10m are sampled, of which there were around 660 registered to fish in the North Sea in 2000. The vessels participate in the programme on a voluntary basis with the observers being responsible for selecting the vessels on a random basis. The normal protocol is to call the selected vessel a few days before departure and, if the captain agrees, to join the vessel at port for a trip of anything between 12 hours and 21 days. As vessel participation is purely voluntary, all data is strictly confidential until sufficiently aggregated and is never used for compliance purposes. There are currently no plans to significantly expand the programme.

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Scottish vessels operating in the North Sea are covered by observers employed by the Fisheries Research Services (FRS) who currently operate programmes for the demersal and nephrops fisheries as well as the pelagic fisheries for herring and mackerel. The largest is the demersal programme which normally covers about 80 trips a year from a fleet of 326 vessels (in 2002) that operate in both the North Sea and off the West of Scotland. In 2002 the coverage was increased by 40 trips due to concern over potentially high discard

rates resulting from a large year class of haddock in 1999 and the temporary closure of the North Sea in 2002. The extra observers were recruited from ex-fishermen and allowed for the collection of a more robust set of data for use by the assessment working groups. Of the remaining programmes, the nephrops observers sample on around 32 trips a year from a fleet of 208 vessels while the pelagic herring and mackerel cover five and ten trips respectively from 33 pelagic vessels. Although there are plans to redesign the programme, this will not expand it but will merely provide better stratification for sampling purposes.

All the UK programmes are small scale, with coverage levels of under 1% of fishing days covered. This is limited largely by the lack of funding but also due to logistical difficulties, poor weather, lack of trained staff, low fishing activity and occasionally a lack of co-operation by fishers. This last factor is due mainly to the fact that all the programmes are currently voluntary, with the fishers registering their willingness to take an observer on board. This often leads to restricted access to certain vessel types or even the vessel leaving early with the observer stranded on the port. A recent amendment to EC 1639/2001 will make it mandatory to take an observer on board if requested, although this will prove difficult to enforce and may lead to bad will between fishers and observers.

The Danish discard project was set up in 1995 to estimate the discard rates and amounts by species in the Danish fisheries. Individual vessels were randomly selected from a larger number of vessels which, in a similar manner to the UK programmes, had registered their readiness to carry an observer. A wide range of the fleet was sampled with vessels selected with different gear types and within different areas. Overall the coverage was low with 1138 observer trips between 1995 and 2001, of which 152 were in the North Sea. The coverage level was estimated at between 0.2 and 1% of all trips although while on the vessel around 70% of the fishing activity was sampled. The project employs 11 biological assistants, two scientific officers and two fisheries consultants and is estimated to cost around £640,000.

5.2 Funding Opportunities Within the EU

Structural funding has been available to the fishing sector within the EU since 1994 when the Financial Instrument for Fisheries Guidance (FIFG) was created and updated in 1999 by regulation (EC) No. 2792/1999. It was created for the purpose of giving structural assistance to the fisheries sector by giving financial aid to projects which encourage the modernisation and diversification of the fishing industry. The emphasis has been to grant aid to initiatives that avoid adverse effects such as a build up of excess production and concentrate on investments which aim to improve the environment, encourage less and better fishing and to lessen the dependence of coastal communities on fishing activities. The current programme is due to finish in 2006 to be replaced by the European Fisheries Fund (EFF), through which approximately €700M per year will be available to projects which help to reduce fishing pressure, allow the recovery of fish stocks and encourage the use of more environmentally-friendly equipment and practices in fishing. As yet no decisions have been made as to whether any EEF funds will be available to support observer programmes. However as one function of them will be to improve the sustainability of European fisheries it should be considered among future options.

However, as observer programmes are considered to be instrumental in collecting data for carrying out the CFP they are eligible for funding according to the Commission Decision 2000/439/EC on a financial contribution from the Community towards the expenditure incurred by Member States in collecting data, and for financing studies and pilot projects for carrying out the CFP. This has been updated in a more recent decision, 2004/555/EC which sets the amount of Community contribution towards the expenditure incurred by each member state in managing its data collection programme. The level of funding will depend upon the type of programme run by each member state as defined in Article 5 of regulation (EC) No 1543/2000.

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Two types of programme are defined; i) a minimum Community programme which covers the information absolutely needed for scientific evaluation and ii) an extended Community programme that includes, in addition to the information contained in the minimum programme, information likely to improve substantially the scientific evaluations. The funding available for these two programmes would be 50% and 35% respectively.

5.3 Considerations for a North Sea Programme

Of the programmes currently running in the North Sea detailed information is only available to us on the English programme, kindly supplied by John Cotter (CEFAS). Data were compiled by the ICES study group on discard and by-catch information (SGBDI) and by assessment working groups to estimate discards.

Currently the English programme samples about 0.25% of hauls in the whitefish and Nephrops fisheries (including Beam, Nephrops, Otter, Pair and Seine gear categories: ICES 2002). From data supplied to us, it would seem that the average number of trips sampled per quarter for cod discarding is nine (over the years 2002 – 2003), with on average seven hauls (75% of those made) being sampled by observers.

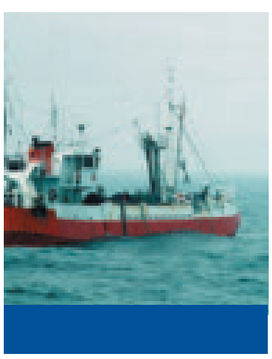
The ICES working group comments that, for the English data at least, the Otter trawl is the most sampled gear (about 500 hours were sampled in 2001; this is roughly equivalent to nine trips sampling seven, two-hour long hauls over each of four quarters) with other gear types being more sporadically sampled. It also comments that for some quarters and gear types the sampling effort is so low, or absent, that no estimates of discard can be made. The ICES w.g. ceased to sit in 2001. Since then, the EC Data Collection Regulation 1639/2001 has enabled higher sampling rates by all North Sea fishing countries. An improved supply of discard data to stock working groups is occurring as a result.

It would seem that the current sampling rate is at Level 1 in our Table 3. That is, it is a rather low level programme at the moment, drawing on the good will of fishermen in the North Sea, and although the programme is clearly stratified towards different fleets, gears, and times of year it is not comprehensive. The ICES Study Group on Discards and Bycatch Information (SGDBI) was not given all available data. The Dutch were prevented from supplying data from their industry at the time.

The question that this discussion inevitably raises, is “Is this level of sampling enough?”. This very much depends on the objective of sampling. One of the stated objectives is clearly to estimate discards of key species (cod, haddock, plaice, saithe, sole, whiting) in the various whitefish fisheries in the North Sea.

If the objective of sampling is simply to understand the difference between different gear types, then it clearly is sufficient. ICES (2002) demonstrates from the UK data that discard rates are highest in beam and pair trawls, although these may not be contributing the highest numbers of discards.

If the objective is for marine mammal monitoring, then the Northridge & Thomas (2003) report indicate that coverage levels of between 8 and 25% might be required, rising to much higher levels for some particularly endangered species. This is because the precision requirements for marine mammal and bird bycatch monitoring are usually high and the events themselves are rare. In the CCAMLR programme, the target is for



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monitoring 25-30% of all hooks set, on 100% of vessels. Although this level of coverage would not seem to be required in the North Sea on this particular fishery at the moment, we would anticipate that with the introduction of Regulation 812/2004 it will be increased to satisfy the EU requirement to monitor 5-10% of fishing activity on all EU vessels over 15m.

If the programme is treated as discard sampling required under the EU's data collection regulation then we find that the precision level relevant to the sampling is that 95% confidence limits need to be within 25% of the mean. This is effectively the same as saying that 1.96 times the CV should be 25%. The appropriate way to calculate current precision levels is to construct a complex multiple-level stratified sampling estimator, analysing accurately the distributional properties of the sampling data themselves, including bias and variance in each stratum and at each level of sampling. We do not have access to this information; a detailed pilot study would be required to acquire them. However, we can undertake some illustrative calculations – see Appendix 4. The method of estimated precision is still not established. Multilevel sampling ideas are hampered by small samples in each gear/vessel type/season category.

The results the calculations in Annex 2 show that the current UK sampling effort delivers 0.25% of the trips and 75% of the hauls which gives a precision level of 32% with a between trip co-variance (CV) of 50%. This precision level will increase as the CV between trips decreases for example a CV of 40% between trips gives a precision level of 26% while an increased CV between trips leads to a lower precision level of 39%. It is important to note that the results are relatively insensitive to the number of hauls monitored between trips and the CV of hauls within a trip, however it is very sensitive to the variance between trips and to the proportion of these trips that are monitored.

Some more detailed and precise work has already been done by Cotter et al (2002) who derived discard estimates based on a sampling method described as "probability proportional to size". For cod, they calculated CVs of their estimates between 20 and 39%, equivalent to precision of between 39% and 76%, somewhat higher than in our illustrative example (see Appendix 4).

5.4 Cost/Benefit Considerations

Options for Future Observer Coverage

The implication of the analysis above is that current levels of coverage may be inadequate for the estimation of discards. We do not know what the optimal level would be, and to estimate it would require considerably more analysis than we have undertaken above. As already pointed out, the optimal level of coverage also depends on what weight is given to the different objectives.


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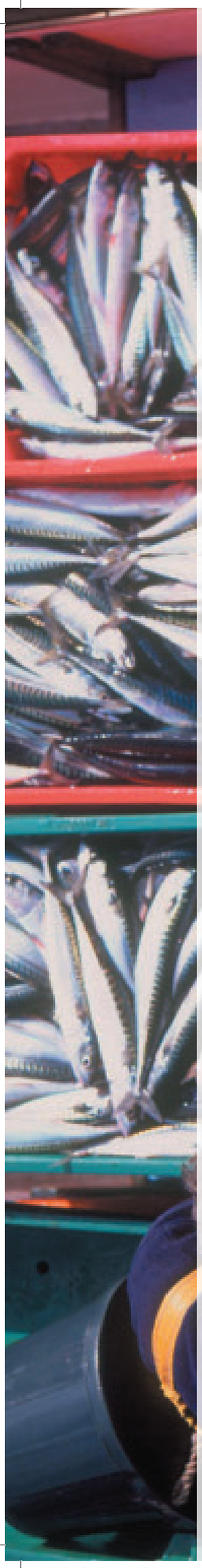
However, we can say that the programme for discard estimation should probably increase so as to cover all gear types/areas/seasons adequately, and should be expanded to include all fishing fleets in the North Sea, i.e., not just the UK, Denmark and Germany. If we take the lower best estimate of precision that Cotter et al. (2002) obtained (95% confidence intervals within 39% of the mean), our table suggests that the level of sampling may need to be increased by a factor of 3. We will regard this as option 2, option 1 being to keep observer coverage at the current level.

The current level of observation is also almost certainly insufficient to enable identification of altered vessel behaviour when observers are present or not present. This is a significant concern when TACs are as restricted as they are for many species, and especially for cod. The question arises whether the current observer programme would be capable of identifying significant highgrading behaviour, if highgrading was discouraged in the management system, and expressing it as discarding.

The current system is also unlikely to be able (and does not have the objective) to provide reasonable estimates of total catch (rather than discard) that could be used



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to make independent estimates of landings. Estimation of total catch on board is not easy for observers, but observation of fishery vessel behaviour should allow an estimate to be made of landed vs discarded/highgraded catch and catch rates, which can be compared with normal declared landings from a particular gear type and area. This might allow validation of anecdotal reports (see, for instance, the UK Fisheries Project report: Cabinet Office, 2003) which put black landings at anywhere between 10% and 50% in North Sea fisheries.

An observer system capable of delivering estimates of total catches in the North Sea, i.e., correcting for fishery behaviour bias, would probably require observer levels in the region 5-10%. Once again, these are ball-park estimates derived from experience in several of our case study fisheries, notably the North Pacific Groundfish Observer Programme. We will call this option 3.

Balancing the Costs

The cost of a much expanded programme could be high. However, the cost to the fishery of overfishing is also high. As part of a recent project analysing the proposal of a Community Fisheries Control Agency we estimated, using data from ICES assessments of North Sea cod, the potential loss to fishermen of continued black landings during a recovery plan.

i) With perfect compliance, and assuming the current very low level of recruitment continues, we estimated that recovery might take five years. This is similar to the advice of ICES (ACFM report 2002) and the lower expectation of the Cod Recovery Regulation (which states as its objective a recovery of between five and 10 years: Council Regulation 423/2004).

ii) However, if 40% black landings continued throughout the recovery, the stock might take 10 years to recover, with a loss of about 190,000 tonnes of cod to the legitimate fishery over the 10 years, which in monetary terms is the equivalent to between £221M and £260M loss to the fishery.

In addition there is an additional loss to the fishery through discards and highgrading of target species which was estimated in 1999 to be around £47M (£11M cod, 31M haddock and £5M whiting)[15].

Costs

In principle, costs and benefits associated with these two alternatives could be assessed. Unfortunately, we do not presently have all the data required to undertake a full-fledged analysis. However, we can make some approximate estimates with the data that we have.

The current UK observer programme operating in England and Wales covers around 800 days at cost of approximately £580,000. This breaks down to about 200 days per year in the North Sea which we can estimate cost about £145,000, or a quarter of the overall cost. This reportedly delivers coverage levels of about 0.25%. However, we note that DEFRA reports 94,000 total days at sea for fishing vessels over 10m in 2003, which would suggest an overall coverage level of slightly lower than 0.25%, i.e. 0.21%.

We can construct a table presenting estimates of overall cost based on these numbers (). Calculations for the cost for the EU as a whole are made assuming that the UK is responsible for about 40% of the total effort in the North Sea.

The total value of catches landed by the UK fleet, both in UK ports and abroad, in 2003 was £520M of which £203M was captured in the North Sea, ICES area IV[16] and from this we can calculate the cost of the observer programme as a proportion of catches landed.

As we have seen from our examples, as observer programmes expand so the cost per observer day tends to drop. In the case of the North Sea this could lead to a drop from £725 per day to £300/day at 5% coverage and £200/day at 10% coverage. These efficiencies are presented in addition to calculations based on

[15] Nautilus Consultants (2001) Economic Aspects of Discarding. Final report prepared for DG FISH, European Commission and MAFF.

[16] Department for Environment Food and Rural Affairs (2004) UK Sea Fisheries Statistics 2003. DEFRA, London.

Table 8

Analysis of potential costs of expanded observer programme in the North Sea for both the UK fleet (for which actual effort and costs is known and calculated) and extrapolation to the whole North Sea fleet (based on an estimated 40% of catches and value being taken by the UK)

		UK Part of North Sea			Whole North Sea			
	% Days Observed	Assumed Daily Price	Number of Days	Total Cost (£)	Assumed Daily Price (£)	Number of Days	Total Cost (£)	% Value of Catch
Option 1: Current Coverage	0.25	£725	200	145,000	1,050.72	500	525,362	0.07
Option 2: 3 x Current Coverage	0.75	£725	713	516,563	1,050.72	1,781	1,871,603	0.26
Option 3: 5% Coverage with Present and Reduced Costs/Day	5	£725	4,750	3,443,750	1,050.72	11,875	12,477,355	1.7
	5	£300	4,750	1,425,000	434.78	11,875	5,163,043	0.71
Option 3 with 10% Coverage with Present and Reduced Costs/Day	10	£725	9,500	6,887,500	1,050.72	23,750	24,954,710	3.41
	10	£200	9,500	1,900,000	289.86	23,750	6,884,058	0.94

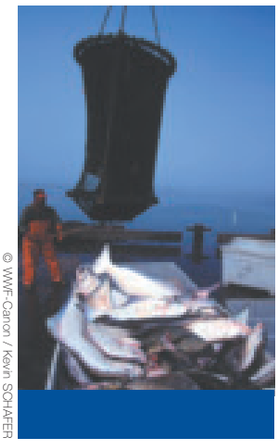
the current cost per day.

There is an argument that moving towards large programmes with lower costs might compromise the quality of observation. However, our experience is that this need not necessarily be so, if the programme is well organised with structured and mandatory training programmes and debriefing. One problem that does arise with such large programmes, however, is that it is much more difficult to engage staff in interesting research and therefore retention of staff may become an increasing problem. One advantage of small costly programmes is that they are able to address the observation system as a research task. The disadvantage of this, of course, is that routine monitoring data may be overlooked. Conversely, an advantage of a large programme is that data collection becomes routine and reliable, and therefore comparable between years, areas and species.

In considering the total cost of a programme, we should also be interested in a comparison with total management costs. A recent report published by the Organisation for Economic Cooperation and Development (OECD)[17] discussed the management costs of running the fishery sector in all the OECD member countries. For each country it gave the management costs as a proportion of the value of catch landed which ranged from 0.1% for Mexico to 38.5% in Turkey, within the European Union the costs averaged out at 10%. These management costs were further split down into three sections:

Research services: used as the basis for managing the system, included data collection and analysis and cost 3.8% of the value of production.

Management Services: include adjusting management settings, such as TAC, within the



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[17] Organisation for Economic Co-operation and Development (2003) The Cost of Managing Fisheries. OECD publications, Paris.

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current system, making changes to the current system and general administration costs. Its costs were 1.9% of the value of production.

Enforcement: ensuring compliance with current fisheries laws, cost 4.8% the value of production.

If we consider an observer programme for the North Sea to be purely for research and data collection purposes then it can be seen that for all the scenarios the relative costs are within the framework guideline of 3.8%. Furthermore, under Commission Decision 2004/555/EC this would qualify for 35% contribution from the Community so even taking the most expensive North Sea situation it would reduce the relative costs from 1.68% to 1.10%.

The costs of such a programme should also be compared against the benefits. There is a potential benefit of the speed of recovery of the cod stock, an increase in the volume of cod to legitimate fishermen as a result of this recovery and also as a result of reduction in or even elimination of black landings. The upper limit of this benefit might be considered to be equivalent to our above estimate of 190,000 t cod that would otherwise be lost to black fish. However, there is also the effect on other species to be considered. Thus the gain would not be restricted to cod, but would extend to plaice, sole and whiting stocks, without needing to have additional observer coverage. There would be an added benefit of knowledge of other fleet interactions (benthos and marine mammals/birds). Long-term, this information is likely to be important, especially if, like fisheries in other parts of the world, there is some interest in certification (eg by the Marine Stewardship Council) of North Sea fisheries.

Our terms of reference mentioned, specifically, the various recovery programmes in place in the North Sea. While the Cod Recovery Regulation (423/2004) does not specifically mention observers, it is clear that any observer programme capable of either estimating discards or total catch with sufficient precision to be of use in assessments would contribute positively to the accurate monitoring of progress within a recovery plan.

Service Delivery

Whether the observer coverage is increased to 0.5 – 1%, or to 5-10%, one needs to consider the service delivery model. At the moment this is based essentially on goodwill between the observer organisers and the fishermen, which in the case of the Danish system is codified as a written arrangement. Our detailed knowledge of the current arrangements in the UK and Germany is limited, but it would seem that moving to a significantly higher level of observer coverage would require negotiation of new agreements, and this may require legislative action to ensure that the ability to accept observers is a legal requirement of obtaining a licence to fish.

There are also serious logistical issues to be considered, because not all vessels will have the space capacity to take a scientific observer on board. It may simply not be possible to put observers on some sectors of the fleet.

Other aspects of the organisation of the current North Sea observer programmes seem to us to be sensible models for continuation, including governmental or government agency control regarding choice of vessels, sampling protocols, deployment etc. A move to contract more of the work to the private sector might result in some reduced costs, although we note that in the case of England, CEFAS is already effectively of that status. Also, as the fishing industry would be the main beneficiary of the programme, a gradual move away from central government funding towards a greater degree of industry funding needs to be considered.

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Finally, there is the issue of coordination between observer programmes run by different Member States in the North Sea. Several of the observer programmes that we have described above take place in large areas with many different national players, and in these circumstances it is usually sensible to have a common approach to agree sampling methods, coverage levels, observer training and tasks etc. This would have the added advantage, especially in an expanded programme such as envisaged above either simply for discards or for other purposes, of ensuring that all fishers experienced similar levels of intrusion during observations.

This would be especially important if there is some implied compliance task for the programme, either directly or indirectly. It would be politically very difficult, for instance, to have an observer programme in one area capable of contributing to estimates of black landings, and being used to do so, unless similar levels of observer coverage with the same objectives were implemented fleet-wide.

We are aware of the continued work of the Study Group on Discard and By-Catch Information. Presumably this will advise on appropriate statistical methods for assigning sample effort across fleets, appropriate coverage, methods for estimating total discards, confidence intervals and bias. It may not advise on coordination with a general programme beyond this level.

Development of a Plan for the North Sea

We have shown above that benefits would result from implementing an observer programme in the North Sea. These benefits would depend upon the level of the programme, but could include:

- **Improved monitoring of discards and biological data on all target species caught**
- **Improved monitoring of other fishery interactions**
- **Improved monitoring of total catch (as opposed to declared catch)**
- **Improved general compliance with recovery plan objectives**

The costs need not be excessive, especially when efficiencies of scale are included.

The question arises, then, of what should be done to move to such a programme. It would be most important in developing observer programmes for the future to recognise that a number of observer programmes already exist, and that their current operations, constraints and opportunities are reviewed in detail. This current paper has not had that focus. After that, our scheme in Figure 1 (reproduced below for convenience) should be followed:

1. Review current programmes in detail, in terms of objectives, coverage, tasks, implementation, interaction with fishers, results and precision of results
2. Agree on programme goals: this should involve input from all stakeholders, government, fishers, NGOs and scientists, and should involve a clear appreciation of the use to which observer data will be put
3. Agree a service delivery model (private or government organised); a funding model (private or government money); a management system (for instance national implementation coordinated by a North Sea observer working group)
4. Deal with any legal requirements arising (for instance a requirement for observers to be accepted on board vessels)
5. Design the programme: programme objectives, sampling methods, sampling design, data to be collected, data storage, data processing, analysis and dissemination of results
6. Undertake simulation testing where necessary to optimise the sampling design and set parameters on the size of the programme required
7. Agree performance targets and sampling targets
8. Agree and initiate a coordinated training programme for North Sea observers;
9. Implement the programme with regular review of practical experience and analytical results

This list is by no means exhaustive, but should form the basis from which current observer systems could be expanded into a coordinated observer programme for the North Sea.

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7 Annex 1
Additional Issues Relevant to the Design of Observer Programmes

7.1 Management team

These are shore-based staff that provide the following services:

- **Recruitment, selection and training of individuals**
- **Day to day management including all personnel and financial matters, and the co-ordination of all logistical components**
- **Development of technical and operational protocols specifically for the observer role and tasks, including all data management issues**
- **Development of supportive documentation for the management system**
- **An advisory capacity on observer issues, agreements or conventions.**
- **Liaison with fisheries authorities and stake holders**
- **Provision of scientific or technical advice**

Ideally, they should have prior senior observer or industry experience in order to realise the potential of the programme and provide FMA administrators and scientific officers with sound advice.

7.2 Observers

The quality of the observers and training provided is reflected in the quality of the outputs. Basic requirements are:

- **Healthy individuals**
- **Elementary education level**
- **Common sense and diplomacy skills**
- **Keen and self-reliant**
- **A sense of humour is mandatory**

An eclectic group of individuals would be preferred, pooling the collective experience from different disciplines. Ideally, these would be broad marine science and/or industry based. Some individuals will be more suitable than others and it is important to identify them and utilise their skills and experience appropriately e.g. the use of a tier system which distinguishes between green and seasoned observers or by the creation of roles which bear more responsibility, such as the appointment of senior observers. Another method would be to allocate specific tasks beyond the baseline remit, which reflect their speciality. Reward can be in the form of academic or sector/peer group recognition.

However, caution must be exercised not to evaluate and remunerate observers on an individual basis. This can produce resentment amongst individuals performing the same role and affect the overall quality of outputs: compliance, scientific and management objectives. A defined and transparent ranking system with considered increments in rate of pay, based on performance and loyalty would be ideal.

Evaluation of observer performance and creating feedback loops on preparation and execution of the role provide essential management tools. The information can be recycled to affect changes in training programmes for the benefit of observers in the field in support of management objectives. This can be achieved through different formats e.g. debriefing sessions, observer report appraisals and questionnaires. An example

is provided in Annex 2. It is important to incorporate these elements in to the observer/company contract so that they are aware of their obligations and ensures that vital information is not lost.

Furthermore, consideration should be given at the initial stages of the programme development to observer salaries in respect of their role onboard. The level of obstruction encountered or standard of working and living conditions an observer may have to endure onboard can be proportional to the limitations imposed on the fishery by technical and conservation measures. Pressure is applied on observers at sea to collaborate with inappropriate fishing activity despite established agreements. If observers are not adequately remunerated for their services, unmotivated individuals may be susceptible to bribes. These circumstances may occur in programmes that require observers to spend protracted periods at sea in excess of three months or more.

The role of the observer and code of conduct, including matters such as confidentiality and use of data or images, should be covered in detail in the contract between the individual and the provider company. This will eliminate any misunderstanding and provide legal recourse for any defaults by either party.

7.3 Training

Training workshops should cover the following topics:

- **Health and safety in transit and onboard vessels**
- **Code of conduct**
- **Background information on fishery characteristics including the prevailing culture and attitudes towards observers**
- **Operational procedures**
- **Level of monitoring**
- **Sampling design/strategies**
- **Data management**
- **Report production**

Familiarisation exercises that introduce observers to the areas above are mandatory. The format of the training should utilise the experience amongst the observer pool. This can be achieved through breakout group sessions covering specific elements of the job or even very simply by creating teams of mixed experience and ability for mutual benefit of those inexperienced observers and the evaluation of individuals suitable for senior ranks. Any field training opportunities should be exploited to the full. These may be rare so any images or actual footage from the fishery should be used to illustrate or clarify points.

Although not mentioned above, vital to the success of a programme is the inclusion or explanation of the observer programme as a management tool and how it is integrated into the management system for that specific fishery: The evolution and advocacy of the observer role for the fishery; the programmes position and links within the SDM; and how the outputs are used or implemented by the FMA in terms of compliance monitoring, environmental impact assessment and stock management.

The case studies indicated that training was afforded more time and at greater cost for those programmes in which full integration of all components was under the control of the FMA (e.g. those administered through the NMFS). A possible threat to the training provided by companies contracted by FMAs is that the company with the most competitive price will often win the contract. As a result some areas of programme delivery may suffer such as training and preparation for the role. This was highlighted in the NAFO Observer Programme Evaluation Review conducted by Banks and Poseidon Ltd. Naturally, it would follow if the observers are poorly prepared, then the reliability of the programme will suffer despite efforts in other areas.

7.3.1 Information Management

Appropriate technology should be developed and provided to observers where technically possible and within budget constraints, to enable the observers to record, store and

analyse the information they have collected as accurately as possible. Technology can here include anything from a simple tape measure, through motion-compensated balances for accurate weight measurement on board fishing vessels to relational databases for on board entry and analysis of data collected.

The timely delivery of high quality of data outputs should be standard for any observer programme. This will generate all round support from industry, scientific and management sectors. Transparent management systems with confidentiality and quality assurance arrangements are the key elements required to achieve this and the information collected by the programme must be available to the FMA in a practical and timely format.

Information flow from within an observer programme can best be described in the timeframe in which it is used.

Real-time

Real-time data are those collected and forwarded to the relevant FMA at the end of each particular fishing operation. These data are compiled at the FMA to provide real-time management decisions within a fishery such as for fishery closure based on catches, size or maturity of target fish or incidental mortality levels. Real-time data require excellent communication means between the observer and the FMA, the transfer of these time-critical data often rely on satellite communications to enable automatic data transfer or at simplest fax communications.

Within Season

Within season data are collected and complied by the observer and forwarded at regular intervals (five-day, weekly or monthly). These often provide summaries with which the FMA can conduct catch verification exercises against the catches reported by the vessels themselves. They can also provide an indication of the levels of data collection obtained so far, e.g. number of fish sampled, so that managers are aware of any problems in the field. This would have been greatly beneficial to the NAFO observer programme. The reported catch data could be rapidly downloaded from the FMA by inspector teams on board inspection vessels or at port. This would effectively reduce the incidence of potentially confrontational events between the observer and vessel personnel, whilst speeding up the availability of information period to the EC and Member States.

Post Season

The main bulk of the data collected by observers are compiled and analysed post season. This includes length frequency data, species composition and detailed fishing effort data. Part of the analytical process may also involve using the data from observers whose role is exclusively or predominantly scientific in a compliance capacity. For example fishing effort data can be analysed for closed area violations even though the observer was not collecting these data for that purpose and was not making any kind of judgement relating to this while deployed at sea.

During the season it may be difficult for an observer to report an infringement on the vessel without compromising their scientific role, but recorded data can be analysed and used to determine the compliance status of the vessel and/or master in the fishery.

Efficient and efficacious data flow from observer programmes can be greatly improved by the use of simple, clear data collection and collation procedures. Simple data forms (both paper and electronic) that can be completed easily and logically make the job of observers much easier.

It is critical that observer data be kept secure at all times. This can be as simple as ensuring that the observer has a lockable cabin or at least a lockable pelican case or similar for their data. Any computer systems should be locked away at all times they are not in use and any data transmissions by radio, fax or email, should be secure and encrypted where possible.

Consideration should be given to establish data exchange or transmission protocols between interested parties and to standardise the recording formats where possible on a regional basis, e.g. the same form can be used for a number of countries, all that needs to change is the language used. Again this onward transmission of data can occur at any of the three levels as discussed above.

The availability of compatible information technology will dictate the level at which data to a certain degree as well as local infrastructure but hard (written) copies provide the basic format and should always be maintained as a contingency for equipment failure.

In addition to the maintenance of a system for the data collected by the observers themselves it is advisable to develop an electronic system for the management of the programme. The number of people involved in the management of an observer programme and the costs associated with developing and maintaining the system relative to the cost of the programme as a whole, will amongst other factors influence the choice of the system from a simple paper-based system, through simple spreadsheets to a fully integrated database system tracking all aspects of the programme. At a basic level the system will be required to track the following information:

- **Observer details, including training and evaluation**
- **Industry sector, particularly vessels details and records of their performance**
- **Observer deployment logistics**
- **All financial aspects associated with the programme**
- **Summary of the collection and use of compliance data**
- **Summary of the collection and use of scientific data**
- **Communication, dissemination and publicity**

8 Annex 2
Sample Size Calculations

We can calculate expected precision levels under different assumptions of the inter-sample variance at two levels: the level of the trip, the primary unit (which we assume to be the level of the vessel under current sampling strategies) and the level of the haul. As we have previously stated, between-vessel (i.e. between –trip in the current model) variance is usually high. For instance, the large differences between discard levels of different gear types given in ICES 2002 suggest that between gear variance might have a CV of 90%. This is unlikely to be the case within gears, but it is still likely that CVs are in the region of 50%. Within-trip haul variance may be lower, 20-40%. These figures are not inconsistent with the results obtained by Cotter et al (2002[18]) sampling the North Sea whitefish fleet.

Adopting these figures, we can use a simple stratified sampling estimator of variance such as that given below (from Wiley 1992):

$$V = \frac{1-f_1}{n} s_1^2 + \frac{f_1(1-f_2)}{nm} s_2^2$$

where V is the variance, f1 is the sampling fraction at the level of the trip (i.e. number of trips sampled, n, divided by total number of trips, N), f2 is the sampling fraction at the level of the haul (i.e. average number of hauls sampled per trip, m, divided by the number of hauls per trip, M), s12 is the variance among primary unit (trip) means, and s22 is the variance among elements within primary units.

Table 5 shows the results of some illustrative calculations using this equation. The current sampling effort delivers 0.25% of trips and 75% of hauls within trips sampled, and this gives a precision of 32% with a between-trip CV of 50%, 26% if CV is 40% and 39% if CV is 60%. Note that the results are relatively insensitive to the number of hauls monitored within trips, and the CV of hauls within a trip. It is, however, very sensitive to the variance between trips, and to the proportion of these trips that are monitored.

[18] A.J.R. Cotter, G. Course, S.T. Buckland, C. Garrod A PPS sample survey of English fishing vessels to estimate discarding and retention of North Sea cod, haddock, and whiting. Fisheries Research 55 (2002) 25–35

Table 5
Illustrative calculations of precision level using the input data and equations described above

CV Between Trips	CV Amongst Hauls Within Trips	Percentage of Trips Observed	Proportion of Hauls Obeserved in a Trip	Precision of Discard Estimate
0.4	0.5	0.25%	0.75	26%
0.5	0.5	0.25%	0.75	32%
0.6	0.5	0.25%	0.75	39%
0.6	0.2	0.25%	0.75	39%
0.6	0.5	0.25%	0.75	39%
0.6	0.5	0.50%	0.75	28%
0.6	0.5	0.75%	0.75	22%
0.6	0.5	1.00%	0.75	19%

9 Annex 3
List of Abbreviations

AFMA	Australian Fisheries Management Authority
AIDCP	Agreement on the International Dolphin Conservation Programme
AMMOP	Alaskan Marine Mammal Observer Programme
BIOT	British Indian Ocean Territory
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CEFAS	Centre for Environmental Fisheries and Aquaculture Science
COFI	Committee on Fisheries
DANIDA	Danish International Development Agency
DARDNI	Department of Agriculture and Rural Development, Northern Ireland
DML	Dolphin Mortality Limit
EFF	European Fisheries Fund
EPO	Eastern Pacific Ocean
FAO	Food and Agriculture Organisation
FICZ	Falkland Island Conservation Zone
FIFG	Financial Instrument for Fisheries Guidance
FPV	Fisheries Patrol Vessel
FRS	Fisheries Research Services
IATTC	Inter-American Tropical Tuna Commission
ICES	International Council for the Exploration of the Sea
IDCP	International Dolphin Conservation Programme
IPOA	International Plan of Action
ISMP	Integrated Scientific Monitoring Programme
IUU	Illegal, Unregulated and Unreported
MCS	Monitoring Control and Surveillance
NAFO	Northwest Atlantic Fisheries Organisation
NAFC	North Atlantic Fisheries College
NMFS	National Marine Fisheries Service
NPGOP	North Pacific Groundfish Observer Programme
NRA	NAFO Regulatory Area
OY	Optimum Yield
SDM	Service Delivery Model
SEERAD	Scottish Executive Environmental Rural Affairs Department
SIFA	Seafish Industry Authority
SFF	Scottish Fishermen's Federation
SGDBI	Study Group on Discard and Bycatch Information
TAC	Total Allowable Catch
UNCLOS	United Nations Convention on the Law Of the Sea
WCGOP	West Coast Groundfish Observer Programme