Instruments for Internalising the Environmental Externalities in Commercial Fisheries

Report to Ministry of Fisheries
(SEC 1999/05 - objective 1)

K.F.D. Hughey
R. Cullen
G.N. Kerr
P.A. Memon
C. Robb

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Agribusiness and Economics Research Unit
P O Box 84
Lincoln University
Canterbury

Ph.: (64) (3) 325 2811
Fax: (64) (3) 325 3679
http://www.lincoln.ac.nz/AERU/

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Preface

New Zealand is widely regarded as having innovative fisheries management systems. However commercial marine fishing activities can create many types of environmental externalities. Fisheries legislation requires that the externalities be internalised and fisheries management agencies must choose from a wide range of instruments those which are best suited to the tasks determined in the relevant legislation. Selection of best instruments can be aided by following a hierarchical decision process, which first screens the universe of devices to produce a feasible set. Instruments in the feasible set can be rated against several performance criteria and the ratings combined to give weighted scores for each feasible instrument.

The research reported in this publication explains how Environmental Impact Assessment techniques can assist in identifying the significant externalities which occur in commercial fishing. It subsequently reviews the literature and examines case studies to identify the range of externalities associated with New Zealand commercial marine fisheries. Finally it trawls the literature to establish the broad range of possible instruments for use in internalising fisheries externalities. The instruments and their current New Zealand and world uses are grouped in five categories.

AERU Research Report No 243 outlines the criteria used to rank the instruments listed in this report, and the Decision Support System developed to aid fisheries managers select internalisation instruments.

Ross Cullen
DIRECTOR

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Summary

Commercial fisheries in New Zealand having significant environmental externalities are identified and a framework for comparative Environmental Impact Assessment is proposed. From this analysis and from a survey of international literature covering the spectrum of resource sectors a range of 21 instruments within five broad categories is proposed as having potential for application within commercial fisheries management. These categories are: Regulatory approaches (9 instruments), Financial incentives (5 instruments), Voluntary approaches (4 instruments), Legal Remedies (1 instrument), and Education and Information Supply (2 instruments). Most of the regulatory and financial instruments have had some application in New Zealand, although 'environmental performance bonds' (used extensively in mining) might have potential for application to some fisheries. Voluntary approaches are being developed and there is potential for much further application in New Zealand, subject to auditing-type requirements. Legal remedies (tort law) and 'Informal regulation', including corporate environmental reporting, also offer potential as internalisation instruments. The major challenge facing fisheries managers is how to determine which instrument or combination of instruments is most likely to be effective in internalising the externality(s).

CHAPTER 1

INTRODUCTION

1.1 Brief background

Sustainable fisheries management is an important policy issue worldwide from ecological, social and economic perspectives. A particular area of current concern in New Zealand is the negative environmental externalities (unintended side effects – see section 4.1 for a detailed definition) associated with commercial fishing practices. As part of giving effect to key principles of the Fisheries Act 1996[1] the Ministry of Fisheries (MFish) is in the process of developing its Fisheries 2010 strategy, complementary to the Government's Environment 2010 strategy (Ministry for the Environment 1995). One of the 12 founding principles, upon which the Fisheries 2010 strategy will be based, states:

> *"Internalisation of External Environmental Costs: Fisheries management policy should ensure the unpriced environmental effects (or external costs) associated with fishing are 'internalised', that is, they are assessed and consistently charged, where appropriate, to users and consumers who benefit from them."*
>
> (Ministry of Fisheries 1996).

The term 'environment' is not defined in the Fisheries Act 1996 but is assumed, as per the stated rationale in the MFish brief upon which this work is based, to be aquatic environment and the biophysical features thereof.

The stated **overall objective** of the MFish project, SEC 1999/05, is:

> *"to determine methods or processes to internalise the environmental externalities of commercial fishing that will allow fisheries managers to address the obligations in the Fisheries Act 1996 to avoid, remedy or mitigate the adverse effects on the aquatic environment".*

The purpose of this report is to fulfil the requirements of objective 1 of the contract, i.e., "to review the economic, environmental, and resource management literature, including case

[1] The Fisheries Act 1996 includes the following key sections within PART II: PURPOSE AND PRINCIPLES:
SECT. 8. PURPOSE--
(1) The purpose of this Act is to provide for the utilisation of fisheries resources while ensuring sustainability.
(2) In this Act--
"Ensuring sustainability" means--
(a) Maintaining the potential of fisheries resources to meet the reasonably foreseeable needs of future generations; and
(b) Avoiding, remedying, or mitigating any adverse effects of fishing on the aquatic environment:
"Utilisation" means conserving, using, enhancing, and developing fisheries resources to enable people to provide for their social, economic, and cultural wellbeing.
SECT. 9. ENVIRONMENTAL PRINCIPLES--
All persons exercising or performing functions, duties, or powers under this Act, in relation to the utilisation of fisheries resources or ensuring sustainability, shall take into account the following environmental principles:
(a) Associated or dependent species should be maintained above a level that ensures their long-term viability:
(b) Biological diversity of the aquatic environment should be maintained:
(c) Habitat of particular significance for fisheries management should be protected.

studies relating to internalising environmental externalities, having regard to a full range of regulatory, economic, social, institutional, and behavioural policy instruments".

1.2 The Policy Question/Framework

Decision makers in fisheries management, when faced with environmental problems, have a logical sequence of decisions which they must work through before deciding on the policy instruments which are most likely to resolve the environmental problems. This sequence is as follows:

(i) The environmental impacts/externalities must be defined.
(ii) The type of fishery within which the impact/externalities occur must be defined.
(iii) The significance of the environmental impacts/externalities must be evaluated.
(iv) The range of policy instrument(s) that will best internalise the externalities must be determined.
(v) The effectiveness of these instruments, in meeting the environmental aims of fisheries and other related legislation, needs determining.
(vi) Instruments are selected that best meet a range of evaluation criteria.

Like section 5(2)(b) of the Resource Management Act (1991) (RMA), the Fisheries Act (1996) includes a provision for 'avoiding, remedying, or mitigating any adverse effects of fishing on the aquatic environment' (section 8(2)(b)). However, unlike the RMA, the Fisheries Act does not include any specific provisions for undertaking EIAs against which internalisation instruments could then be recommended (see Williams 1997: 508). Consequently, before identifying internalisation instruments we think it is important to develop an EIA framework appropriate for fisheries management and consistent with the Government's Environmental Protection and Enhancement Procedures (last revised 1987, Williams 1997). This requirement is also observed in Auditor-General (1999: 54) who concluded:

> "*... currently, the Ministry is not able to make informed recommendations to the minister on issues such as the effects of fishing on the environment, and inter-relationships of fish species.*"

1.3 Study Approach

In the tender we stated "our methodological approach to addressing the project requirements can be summarised as follows:

1. review the literature and examine case studies (and where necessary by other means) to identify the externalities associated with New Zealand commercial fisheries and the internalisation instruments potentially applicable to fisheries management;
2. determine criteria, using an iterative process incorporating identification, checking and revising, to evaluate the application of these instruments to internalise environmental externalities in the range of New Zealand commercial fisheries contexts; and
3. develop a decision support system and guidelines, in part by using an iterative process, for the use of these criteria to assist select appropriate internalisation instruments by the Ministry."

For objective 1 we have reviewed the literature and examined case studies to:

1. identify the externalities associated with New Zealand fisheries; and
2. the internalisation instruments potentially applicable to fisheries management.

In undertaking this work we have used an iterative approach which involved:

1. undertaking a preliminary literature review, providing this review to MFish for comment, gaining feedback from the Ministry and revising the content;
2. clarifying the decision-making process (see section 2.2) to further include a framework for assessing the significance of environmental externalities (i.e., an EIA framework). This task is important for policy analysts as it enables them to identify and concentrate on high priority environmental issues.

Upon beginning this review we observed that the categories of: statutory controls and incentives; institutional design and participation processes; and education are broadly encompassing of the range of instruments that could be used to internalise externalities. To explore each of these categories it was necessary to examine the full range of regulatory, economic, social, institutional, and behavioural policy instruments.

1.4 Report Format

The report has three main sections, apart from the introduction and conclusions:

1. In section 2 we develop an Environmental Impact Assessment framework appropriate for fisheries management.
2. We then identify the range and relative significance of biophysical environmental externalities associated with commercial fishing in New Zealand (section 3). This part of the review also helps identify the range of instruments already in use in New Zealand and assists with identifying case studies against which new instruments and criteria for selection can subsequently be tested (part 2 of the SEC 1999/05 research);
3. Section 4 examines the range of instruments that can be used to internalise environmental externalities. The instruments are outlined, the resources/issues they have been applied to are summarised, and their application, or potential if not already applied, to fisheries management is evaluated. This section concludes with an identification and evaluation of instruments we consider have potential within the New Zealand context.

CHAPTER 2

A FRAMEWORK FOR ASSESSING THE ENVIRONMENTAL IMPACTS FROM FISHING

2.1. Background to EIA and Relevance to Fisheries

Fishery managers are often unable to address all environmental issues immediately. Consequently, issue prioritisation becomes necessary. The environmental impact assessment literature provides frameworks within which this prioritisation may take place. One of the most widely utilised frameworks is the *Leopold Matrix*, which was originally developed for the United States Geological Survey (Leopold et al, 1971).

The Leopold Matrix lists all activity (project) actions along one axis and all potential impact parameters along the other. For example, scallop dredging (the activity) would include actions such as: shipping, dredging, wildlife stocking & management, ocean dumping, exhaust emissions, spills & leaks, and operational failure. The impact of each of these actions on each impact parameter is assessed and scored on two different criteria, impact magnitude (on a scale of –10 to +10, with negative signs indicating undesirable impacts) and impact importance (on a 0 to 10 scale, with 0 meaning not important). The completed matrix provides a visual indicator of both the range and severity of impacts.

Key criticisms that have been addressed to the matrix approach include (Glasson, Therivel and Chadwick, 1999; Morgan, 1998):

- Non-inclusion of spatial aspects of impacts,
- Non-inclusion of temporal aspects of impacts,
- Inability to include indirect impacts,
- Inability to model synergistic impacts.

Some of these criticisms can be addressed through the development of guidelines for use of the matrix. Matrix approaches to impact identification and evaluation are simple tools that help to organise information and provide it with an initial structure. Network and system models provide richer descriptions of effects and interactions, but are much more complex than matrices. The Leopold matrix provides an *indication* of overall significance of an activity or proposal – but the limitations of the approach must be recognised, particularly in an environment as complex as marine fisheries.

One avenue for assessing relative impacts of different activities is to derive parameter impact scores for each cell in the Leopold Matrix by multiplying parameter impact magnitude and parameter importance scores.

Impact magnitude **X** Parameter importance **=** Parameter Impact score

All parameter impact scores for the activity are then added to derive an overall activity impact score. This approach has been criticised by Clark et al. (1979) because the importance of the different impact categories is implicitly given equal weighting. If this approach were adopted, the highest relative weights would occur by default in impact categories with the largest number of impact parameters. This criticism has been addressed by weighted matrix approaches, such as the *Battelle Environmental Evaluation System* (Dee et al. 1973) and the United States Army Corps of Engineers' *Water Resource Assessment Methodology* (WRAM) (Solomon et al. 1977). Within their specific contexts, these approaches weight factors for importance within and between categories. For example, the Battelle EES breaks environmental impacts into 4 categories (ecology, environmental pollution, aesthetics, and human interest) before breaking each of those categories into sub-categories and specific parameters to which importance scores are pre-ascribed. The weights for the Battelle matrix were derived by asking a group of experts to allocate 1000 points across the 74 impact parameters included in the matrix. Similarly, the WRAM uses the sub-categories:

environmental quality, regional development, national economic development, and social wellbeing.

2.2. An EIA/AEE Assessment Framework

These impact identification and evaluation systems form the basis of the approach utilised within this study to evaluate the relative merits of alternative environmental externality management policies. Initially, however, the use of matrix approaches to issue prioritisation is described. Table 1 reproduces a reduced form of the original Leopold Matrix that has been revised to incorporate better the elements of the marine fishery environment. In the interests of relevance and parsimony, all activities and impacts that are not relevant to commercial marine fishing have been removed. Some elements have been slightly redefined or added. For example, in the original matrix there is no parameter that would address impacts on non-endangered dolphins. The parameter "mammals" has been added to allow their incorporation.

For any particular activity many cells in the Leopold Matrix will be empty. For example, the activity "Paua fishing" involves only a limited number of actions. It does not involve dredging or ocean dumping and exhaust emissions are so small that they can be ignored. Similarly, many impacts will be non-existent. Paua fishing, for example, has no effect on erosion or deposition. One cell is completed in table 1 to indicate how information is reported. For the activity under consideration (say Scallop fishing) the magnitude of the impact of the act of dredging on erosion is –6 (quite large and negative), while its importance is 5 (moderate). The parameter impact score for this fictitious example would therefore be –30.

The modified Leopold matrix does not incorporate the relative importance of the different impact classes. To address this issue, weighted matrices are often used. These incorporate value judgements about the importance of different impact classes, often derived by voting or Delphi approaches. A weighted matrix that uses the four classes represented in the Leopold matrix is presented in Table 2. Weights have been arbitrarily set in order to illustrate the operation of this simple tool. In this case, biological factors have been judged to be most important (importance score of 40/100), while cultural factors have been judged to be least important (10/100). Impacts range from –10 (extreme negative impact) to +10 (extreme positive impact). The impacts may be derived from inspection of the Leopold matrices for each fishery, or by utilisation of aggregate parameter impact scores for each impact category within the Leopold matrix. The aggregate parameter impact scores will, of course, need to be scaled to derive impacts within the –10,+10 range. Fishery C has the greatest negative aggregate impact under the illustrative weighting scheme in Table 2.

Clearly, the outcome of such an approach is highly dependent on a number of judgements. Changing the weights in the weighted matrix can have a dramatic effect on the ordering of total impacts. No less importantly, the importance and impact scores in the Leopold matrix are judgements that can have a significant impact on final outcomes. While these matrix approaches have a number of deficiencies, their utility should not be under-estimated. They provide a simple, yet coherent, method for screening the aggregate set of fishery management "problems" in order to prioritise those most in need of management attention. It should be noted, however, that such screening approaches do not identify the ability of managers to resolve the problems identified as having the greatest impacts.

Table 1
Fishing Impact Matrix

Impact magnitude/impact importance	**Fish harvest**	**Dredging**	**Wildlife stocking & management**	**Shipping**	**Ocean dumping**	**Exhaust emissions**	**Spills & leaks**	**Operational failure**
Physical and chemical characteristics								
Ocean (water quality)								
Atmospheric quality								
Erosion		-6/5						
Deposition								
Biological conditions								
Non-endangered aquatic plants								
Endangered plant species								
Non-endangered birds								
Endangered birds								
Non-endangered mammals								
Endangered mammals								
Non-endangered fish & shellfish (includes bycatch)								
Endangered fish & shellfish (includes bycatch)								
Non-endangered benthic organisms								
Endangered benthic organisms								
Ecological relationships								
Food chains								
Cultural factors								
Wilderness & open spaces								
Recreational fishing								
Recreational boating								
Recreational swimming								
Parks & reserves								
Unique species or ecosystems								
Cultural patterns, lifestyle (includes tangata whenua)								
Health & safety								
Employment								
Transportation network (movement access)								
Utility networks								

Table 2
Weighted Impact Matrix (hypothetical only)

Environmental component	Weight	Fishery A		Fishery B		Fishery C	
		Impact	Score	Impact	Score	Impact	Score
Physical & chemical characteristics	20	-9	-180	-3	-60	-5	-100
Biological conditions	40	-2	-80	-5	-200	-4	-160
Ecological relationships	30	-5	-150	-4	-120	-6	-180
Cultural factors	10	3	30	3	30	4	40
Total	**100**		**-380**		**-350**		**-400**

Score = Impact x Weight

CHAPTER 3

BIOPHYSICAL ENVIRONMENTAL EXTERNALITIES ASSOCIATED WITH COMMERCIAL FISHING IN NEW ZEALAND

There has been a great deal of research around the world into the externalities associated with commercial fishing. The negative biophysical externalities caused by commercial fishing activities can generally be ascribed to one or a combination of the following:

- Habitat damage, e.g., as a result of dredging or bottom trawling;
- Disruption to the food chain through excessive harvest of a predator or prey species, e.g., the rig-paddle crab relationship;
- Nonfish bycatch, e.g., mainly seals, dolphins and birds in NZ waters;
- Non target fish species bycatch impacting on these fisheries and on other types of fishers, e.g., recreational;
- Discarding, i.e., catching and dumping of undersized or non-commercial fish stock; and
- Marine pollution through deliberate or accidental actions including, for example, gear losses and wastes from fish processing.

This section of the report will describe the situation with respect to the NZ fisheries from this perspective. It is primarily based on recent (post 1990) published and unpublished research. Findings from other countries will be used where there is insufficient NZ information to comment on the likelihood of similar externalities in New Zealand. We are cognisant that there may be potentially significant unpublished information in the Ministry of Fisheries records in Wellington and in the regional offices relating to instances of observed environmental impacts associated with fishing activities but we have not had an opportunity to access this data.

One of the problems we faced in reviewing the literature on environmental externalities was how to determine the relative significance of externalities i.e., how to express the extent of the externality problem in terms of indices such as species survival, sustainability, etc. While many authors have identified the types of externalities associated with particular fisheries, few have been able to report on their significance. Significance is important for several reasons:

- To meet the requirements of sections 8 (Sustainability) and 9 (Environmental principles) of the Fisheries Act 1996 (see footnote 1);
- To determine the relative ecological impacts of the different externalities so that priorities for remedial action can be determined;
- So that only those impacts that are deemed significant problems are managed.

In undertaking this review we have looked for and tabulated the following attributes of biophysical environmental externalities:

- Types of externalities
- Fisheries the externalities occur in
- Why the externality occurs
- Significance of the externality (if stated)

Comments are made on each of these attributes following the tabulation below.

The main types of externalities and their level of significance in key NZ fisheries are summarised in Table 3(a-f). Only the principal (generally those reporting first hand peer reviewed research) and/or 'conflicting' authors are cited in the table.

Table 3
Environmental Externalities Associated with Commercial Fisheries in New Zealand

(a) Habitat damage			
Externality	**Target fishery and cause**	**Significance of externality**	**Key reference**
Habitat damage: 1. Dredging impacts on sea floor	• Scallop dredging disturbs the sea bed	Significant effect on substrate and therefore on associated species – reductions in species richness	Thrush et al. (1998)
	• Oyster dredging	As above	Cranfield & Michael (1998)
2. Demersal trawling can damage the sea floor	• Snapper trawling	As above	Thrush et al. (1998)
	• Orange roughy?	Unknown but likely effect on seamounts, etc.	Probert (1996)
(b) Disruption to the food chain			
Externality	**Target fishery and cause**	**Significance of externality**	**Key reference**
Disruption to the food chain	• Paddle crabs and rig – over harvesting one species without understanding affect on another(s)	• Unknown but thought to be significant if too many rig are caught, i.e., paddle crabs multiply and are very small	1980s Catch
(c) Nonfish bycatch			
Externality	**Target fishery and cause**	**Significance of externality**	**Key reference**
Nonfish bycatch e.g., mainly seals, dolphins and birds in NZ waters	• Tuna longline: affects on albatross and petrels; taking baits and crashing into gear	• On a global basis thought to be highly significant; likely to be significant for some NZ species	• Bergin (1997) and Baird (1998)
	• Jack mackerel mid and deep water trawls catching dolphins and seals in Taranaki	• Highly significant for one company	• Baird (1998)
	• Southern squid fishery and sea lions – caught in trawls	• Varies between years but significant conservation issue	• Baird (1998)
	• Nearshore gillnet fisheries catching for kahawai and small sharks (i.e., rig, elephant fish, school shark and spiny dogfish) catching Hectors dolphins and yellow eyed penguin	• Has been very significant around Banks Peninsula	• DoC and MAF (1994)

(d) Non target fish species bycatch			
Externality	**Target fishery and cause**	**Significance of externality**	**Key reference**
Non target fish species bycatch	• Tuna long lining impacting on striped marlin. Range – lack of awareness of stratification of fish species • Tuna long lining impacting on blue shark, caused by fishing in areas where sharks congregate	• Equivalent to recreational catch, but unknown effect of fishery sustainability • Growing problem around the world. Significance of impact unknown in New Zealand	• Francis et al. (1998)
(e) Discarding (also includes highgrading)			
Externality	**Target fishery and cause**	**Significance of externality**	**Key reference**
Discarding (also includes highgrading in some situations)	• Middle depth and deepwater trawl – southern blue whiting, hoki, orange roughy and oreo – cause hard to identify but can be linked to size of catch, i.e., caused by burst nets owing to the large catch potential when fishing aggregations • Snapper fishery – both discarding and highgrading	• Relatively low levels: impacts on other commercial fisheries and on discard fish stocks • Suggests 20-30% discard (trawling) and states (p23) that a study by Ministry of Fisheries has shown that highgrading is common in the snapper fishery- particularly with longline fishers. (Suggests hook changes to help prevent this)	Clark et al. (1998) Feldman (1996)
(f) Marine pollution			
Externality	**Target fishery**	**Significance of externality**	**Key reference**
Marine pollution	All fisheries – can be liquid wastes and solid wastes, e.g., packaging and pieces of nets which can impact on nonfish species; can also be dumping of processing waste		Slooten and Dawson (1995), Church (1998), Gregory (1998)

3.1 Types of Externalities

The information in Table 3 indicates that most fishing techniques, on occasion, have associated externalities in New Zealand waters including and habitat damage :

- bottom dredging causes invertebrate coral and habitat damage
- bottom trawling causes invertebrate coral and habitat damage
- mid water trawls can capture marine mammals
- gillnets capture marine mammals and sometimes penguins
- longlines can catch sea birds and non-target fish species.

Table 4 provides a summary by fish stock.

Marine pollution from a variety of sources can impact on fisheries (e.g., Church 1998:36) notes that some 50,000 tonnes of hoki offal are dumped into the sea each year by vessels fishing on the continental slope off the South Island West Coast. Decomposing waste could locally deplete oxygen levels. A preliminary assessment confirmed that enough waste reaches the sea floor to alter the species composition impact and on non-fish species (Slooten and Dawson 1995).

There are at least two techniques that typically have minimal direct impact so long as catch limits/quotas are appropriately established. These are:

- diving, e.g., for paua or kina
- trapping, e.g., for blue cod or crayfish.

3.2 Fisheries in which the externalities occur

Tables 3 and 4 identify the target fisheries in which externalities are known to occur. The main fisheries we have identified from the literature and from anecdotal knowledge are:

- Oyster, Scallop: Bottom dredge. The nature of this fishery/method is that externalities will occur wherever these fisheries are located.
- Snapper, Orange Roughy: Trawl – bottom. Externalities will occur anywhere the bottom is anything other than muddy.
- Hoki, Oreo, Jack mackerel, Southern blue whiting, Southern squid: Trawl – mid water. Externalities in these fisheries will only occur where there is the significant presence of non-fish species. Kahawai and small sharks (i.e., rig, elephant fish, school shark and spiny dogfish): Gillnet - bottom set. Externalities in these fisheries will only occur where there is the significant presence of non-fish species.
- Tuna: Long line. Externalities in this fishery will only occur where there is the significant presence of non-target fish species and non-fish species.
- Paddle crab – trap. The food chain (or dependent species) externality will only occur if this species is over-fished or if its predator (rig) is over-fished.

While most fishing methods can have associated environmental externalities, it is clear that there are many fished stocks where externalities (perhaps other than marine pollution which to an extent must apply to all fisheries) are not recorded. This could be for at least 3 reasons:

1. There are no significant externalities;
2. There is insufficient data, for whatever reason, to indicate the presence of an externality - Slooten and Dawson (1995) suggest this is the case in a range of coastal gillnet and others fisheries;
3. Some of the externality targets are not present in many fishing areas in significant numbers, e.g, key seabird species, seals and dolphins.

3.3 Why the Externality Occurs

We know to some extent about the possible causes of the externalities. In many instances, it is a combination of the catching device and its mode of operation in association with the presence of non-target fish species or some other value of concern, e.g., seabirds, marine mammals or important bottom habitat. It is the combination of the mode of operation and presence of non-target fish species or some other value of concern that is particularly important as demonstrated in a number of papers, e.g.,

- Francis et al. (1998) reported that problems occur when the longlining for tuna does not adequately take account of the different depth distributions of tuna and non target species when the latter are present;
- Bergin (1997) noted an initial lack of avoidance mechanisms was contributing to seabird bycatch in tuna longlining;
- DoC and MAF (1994) identified ‘poor’ practice as contributing to the Hector’s dolphin bycatch problem in gillnets. Ssee also Donoghue (1998); Baird (1998) reported a similar problem for one fishing company targeting jack mackerel and hoki off Taranaki with bottom and mid water trawling.

Table 4

Summary of Ecological Significance of the Biophysical Environmental Externalities from Commercial Fishing in New Zealand

Target Fishery	Catch method	Habitat damage	Disruption to the food chain	Nonfish bycatch	Non target fish species bycatch	Discarding (also includes highgrading	Marine pollution	Principal information source
Oyster	Bottom dredge	42		42				Thrush et al. (1998)
Scallop	Bottom dredge	42		42				
Snapper	Trawl - bottom	42				41		Thrush et al. (1998)
Orange Roughy	Trawl - bottom	42				44		Probert (1996)
Paddle crab or Rig	Gillnet		41?					
Tuna	Long line			42	42 (marlin: recreation) 42 (blue shark)			Baird (1998)
Jack mackerel	Trawl – mid water			41				Baird (1998)
Southern squid	Trawl			41↓				Baird (1998)
Kahawai & small sharks (i.e., rig, elephant fish, school shark and spiny dogfish)	Gillnet – bottom set			41↓3				Slooten and Dawson (1995)
Southern blue whiting	Trawl – mid depth					44		Clark et al. (1998)
Hoki	Trawl – mid depth					44	42	Clark et al. (1998), Church (1998)
Oreo	Trawl – mid depth					44		Clark et al. (1998)

Key to significance:
1 = Known to be significant, based on peer reviewed published research findings
2 = Externality demonstrated and potentially significant, but insufficient research to verify
3 = Externality demonstrated but potentially not significant as there is insufficient research to verify
4 = Externality demonstrated not to be significant, based on peer reviewed published research findings
↓ = Problem declining

3.4 Significance of the Externality, Assessed Within the EIA Framework

Where researchers have sometimes commented on the significance of an externality, it is usually only in general terms or with a plea for more research to determine the significance of the impact. However, as can be noted from Table 3, a few researchers have made specific comments, often though related to a specific aspect of interest in the fishery. Table 4 is a compilation of fisheries known to have externalities occurring, based on our evaluation of the significance of these externalities, from an ecological perspective. We could have further subjected, based on our judgements from the literature, this information to analysis within our EIA framework. Each of the key problem fisheries identified in table 4 could be evaluated individually (as per table 1) and then the findings from these compared. We have not done this because we believe such an analysis should be based on use of a Delphi technique and that is beyond the brief and the resources for this project. Such an approach would be somewhat similar to the notion of Comparative Risk Assessment (see Ministry for the Environment 1996).

Fisheries with 'significant' externality problems appear to be:

- Any bottom dredging fishery on a non silt/sand substrate, e.g., oyster and scallop;
- Any bottom trawl fishery on a non silt/sand substrate, e.g., snapper and orange roughy;
- Long line fisheries where there is the presence of non target fish species or seabirds in high numbers at the same fishing water level, e.g., tuna;
- Mid water trawl fisheries where marine mammals are present in 'significant' numbers, e.g., southern squid; and
- Gillnet fisheries where dolphins and yellow eyed penguins are present, e.g., rig and other small sharks and kahawai.

Based on this evaluation, the most easily quantified (and best known) of these externalities in New Zealand waters appears to be 'nonfish bycatch', a problem associated with a number of fisheries. We consider, however, that bottom trawling and dredging are the most serious long-term threats because:

- Their impacts are likely to be long-lasting;
- Their impacts will be multiple, i.e., food chain disruption and habitat loss and disturbance;
- At first glance the problems appear difficult to avoid, remedy or mitigate.
- The impacts are also very difficult to quantify in terms of their magnitude (see for example Jones 1992, Thrush et al. 1998, Cranfield and Michael 1998).

Consequently there is likely to be considerable debate between competing stakeholders about the size of the impact, management measures, etc. A Delphi technique, incorporating multiple stakeholder input, might be a means of improving this form of analysis, were such an improvement considered necessary.

CHAPTER 4

INSTRUMENTS FOR INTERNALISING ENVIRONMENTAL EXTERNALITIES IN FISHING

4.1 Underlying Rationale for Internalising Externalities

Negative externalities are costs imposed upon another person or firm where there is no contractual relationship between the two parties. The term externality is also widely used to describe situations where there is damage caused to part of the natural environment as a consequence of economic activities, including in some instances by fishing. In those cases costs are recognised by individuals who are concerned about the natural environment.

Because of the absence of a contractual relationship between two parties, external costs can be ignored by the person or firm who creates them. The outcome is that inefficient levels of production or consumption occur as illustrated in Fig.1. Externalities are shown by the vertical gap between Total Costs (TC) and Total Social Costs (TSC). Fishing companies who focus solely on the costs they face may supply effort up to level E2 where total profits (Total Revenue (TR) minus Total Costs) are maximised. If external costs are recognised, the efficient level of effort to apply is E1 where Marginal Social Cost equals Marginal Revenue.

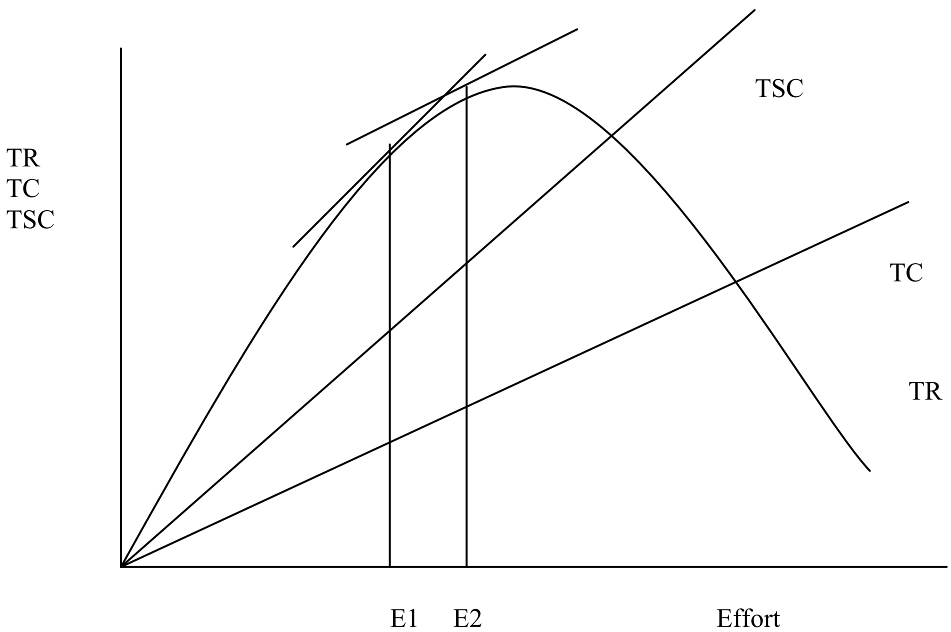

Figure 1
Efficient Level of Fishing Effort

If fishing effort is identified as being at an inefficient level, actions can be proposed to internalise costs and reduce the externalities. Generally, externalities can only be reduced at some cost and there is an economically optimal level of externality reduction. The optimal level occurs where the marginal cost of externality reduction equals the marginal benefit from externality reduction (Pearce and Turner 1990).

Internalisation occurs when the external costs associated with fishing are 'recognised' by the firm creating the externality. A key point is the need to change fishing companies' behaviour or their fishing-related activities, to avoid, remedy, or mitigate externalities. This can occur if the firms creating the external costs take any of the actions listed below, resulting in reduced incidence of the externality creating behaviour:

- Reduce or stop or change the pattern or timetabling of fishing in an area, or during certain times.
- Change the fishing technologies used and their application – net size, hooks, lines, Bycatch Reduction Devices (BRD).
- Apply more caution during fishing to reduce risk of polluting, or causing damage by fishing in multi species areas, or trawling the sea floor.
- Change behaviour once fish have been caught and deal with non-target fish species, to reduce bycatch, and potential discards.
- Change behaviour once non-target species have been caught and deal with them as effectively as possible to minimise the externality.
- Invest in activities such as stock enhancement or habitat creation to offset the environmental effect.

To address the above we have surveyed a wide range of international literature covering a broad spectrum of environmental management issues.

4.2 Instruments for Internalising Environmental Externalities in Fishing

Environmental externalities are associated with many economic activities and there is an extensive literature analysing types of externality, instruments for correcting externalities, and criteria for evaluating those instruments (Verhoef 1999). Our focus is on externalities associated with fishing but we commence this section with a listing of instruments of environmental policy adapted from Russell and Powell (1999, p309).

1. Prohibition (of inputs, processes or products)
2. Technological specification (for production, recycling or waste treatment)
3. Technological basis for discharge standards
4. Performance specification (discharge permits)
5. Tradeable performance specification (tradeable permits)
6. Pollution charges
7. Subsidies
    (i) Lump sum for capital costs
    (ii) Marginal for desired results
8. Liability law provisions
9. Provision of information
    (i) To polluters (technical assistants)
    (ii) To investors, consumers, activists (eg US Toxics Release Inventory)
    (iii) To Consumers (green product or process)
10. Challenge regulation and voluntary agreements.

This listing of instruments which have been developed to deal with pollution from land based firms illustrates there are many ways to respond to externalities. While some literature lumps all instruments into two categories - Market Based Incentives and Command and Control - that approach disguises the range and diversity of approaches possible.

Fishing environmental externalities comprise a range of diverse events: marine pollution from ship's discharges; bycatch of non-target fish species; damage and mortality to non-fish species; destruction of fish habitat. While all of these externalities are undesirable, in only some instances will they cause disastrous outcomes. If that is the case then society will typically tolerate some amount of the externalities. However in some instances society judges that fisheries externalities are unacceptable and strive to avoid them completely. The result is that in most cases society will find acceptable, instruments which reduce the level of externalities so long as the level achieved meets some minimum standards. Only in rare cases will society resort to instruments that target zero level of fisheries externality.

Commercial fishing firms pursue profits, and their behaviour can be modified by many instruments to reduce the level of externalities associated with fishing toward a desired or optimal level. The pollution control instruments listed above hints there may also be an extensive list of instruments which could be used to tackle fishing externalities, and that is indeed the case. Potential means to achieve fisheries externality reductions include the following:

- Information supply and education leading to voluntary actions.
- Codes of practice leading to changes in behaviour of fishing firms.
- Conservation easements. These devices bind companies to a set of conditions such as prohibition of fishing certain areas, or use of certain technologies.
- Requirements to make offsets through habitat enhancement or stock enhancement
- Regulations which specify: season; zone; technology; age and sex selectivity; retention and utilisation requirements; input limits; harvest limits.
- Financial incentives: fines, taxes, subsidies, performance bonds etc, to change fishing company behaviour. Note, these could be reduced fishing subsidies which reduce fishing effort and so less externality is created.
- Rights based approaches: IQ, IVQ, ITQ, CDQ, territorial use rights which lead to change in behaviour and less externality created
- Legal remedies. Fishing company whose actions create environmental damage may face claims for damages.

Many of these instruments have been invoked and used in many countries, often in an attempt to reduce or prevent excessive harvesting of fish species. Some items on the list are used specifically to tackle fishing environmental externalities, others appear to have potential for use with internalising fisheries externalities. A large amount of literature exists exploring the effectiveness of various fisheries management policies and the requirements for their success (Anderson 1986, De Alessi 1998, Hanna 1997, OECD 1997). Our focus in this research is the effectiveness of approaches to internalise environmental externalities, and we briefly explore each of the approaches listed above. We report on instruments which have been used for pollution control or other non-fishing externalities, if the instruments appear to have some potential for use in fisheries management.

CHAPTER 5

REGULATORY APPROACHES

Regulatory approaches can be developed which restrain fishing companies (Table 5). The intent of regulations is either: to stop fishing companies creating environmental effects by restricting how, or when, or how much they can fish; or instructing them how to perform once the environmental effect has occurred to minimise the damage that results.

Some critics suggest that regulatory regimes for environmental protection are less efficient compared to financial incentives and are democratically illegitimate but this is not necessarily the case (Cole and Glossman 1999). Critics of regulatory instruments are insensitive to the historical, technological and institutional contexts that can determine the comparative efficiency of alternative policy instruments.

Table 5
Summary of the Characteristics and Potential Application to Fishing of Regulatory Instruments

Instrument	Main world uses	Current NZ uses	Applicability to fishing
No take zones	Protect juveniles, spawning areas etc		No fishing in specified zones means externalities not created
Marine Reserves	Protect juveniles, spawning areas, habitat etc	Banks Peninsula, Long Bay etc	Area set aside for preservation of marine species
Closed seasons, areas	Protect juveniles, spawning areas etc	Near sub Antarctic islands.	No fishing during designated times and /or in prescribed areas.
Size or sex selectivity	Direct effort away from specified ages, sex individuals	Rock lobster, size requirement	Requirement for fishers to return to sea all prohibited catch
Bycatch Reduction Devices -BRD	Reduce rate of bycatch of fish and other species	Pingers on gill nets	Vary technology used while fishing to reduce bycatch of fish or other species
Technology ban	Prevent externalities associated with specific harvesting technologies	Drift netting ban, Vessel size limits	Reduce bycatch by only allowing techniques which cause few externalities
Input limitations	Reduce externalities associated with number of potlifts, boat days etc		Reduce volume of fishing activity and associated externalities
Catch limitations	Reduce externalities associated with effort	Foveaux Strait oysters	Limit total harvesting and associated externalities
Retention and utilisation requirements	Reduce dumping of target and non -target species	Catching Against Anothers Quota (CAAQ), Fishing Against Anothers Quota (FAAQ)	Allow non target catch to be landed, not dumped

Closed Seasons, Zones, No take Zones, Marine Reserves

One way to reduce environmental effects occurring is to introduce no take zones. A variant of that approach is time and area closures. These are widely used to restrict harvests of fish, but they can also be applied to deal with environmental externalities, including protecting juveniles, vulnerable populations, and non target bycatch (McGinn 1998). Closed areas can prevent fishing in bays where the at risk populations are predominant, and can protect juveniles of fast growing species. Equally importantly closed seasons and closed areas can protect marine mammals and other non target species during fishing operations. Alaskan groundfishing, New Zealand squid fishing and other fisheries have closed times and zones to protect seals, sea lions and other species (OECD 1997, Hansford 1999, Fujita et al. 1998). Marine reserves have been established at twelve coastal locations in New Zealand, to provide no-take zones and protect habitat and inshore species from commercial harvesting. Similarly marine mammal sanctuaries (established under the Marine Mammals Protection Act 1977) have been implemented around the Auckland Islands and around Banks Peninsula to protect marine mammals from fishery impacts.

Closed seasons and areas require gazetting of the dates and regions where the ban on fishing applies. Their effectiveness as a means to reduce biological externalities is highly dependent on the importance of the time or zone protected for the at risk species. Generally, the effectiveness of this measure is determined by the extent to which it is able to separate the species to be protected from the fishing activity. If the fishing exclusion zone is a relatively small part of the habitat for the mammal species, then it will provide relatively little protection unless fish congregate there at specific times or are particularly vulnerable there. Excluding fishers for a time period, or from a region may displace the fishing effort to another time period or region, and the total level of biological effect will only be reduced if the displaced fishing causes less harm than original fishing. In some instances it may be possible to establish a marine reserve, and attain a ‘double dividend’ of increased population numbers within the reserved area and increased harvests in the harvested area. A key requirement for this to occur is for the gain in dispersal from the reserved area to exceed the harvest loss from the old pre-reserve area (Sanchirico and Wilen 1998).

Implementation of closed seasons and zones may appear to be a simple matter of gazettal, but local political pressure can make their introduction a protracted affair. However surveillance can be costly if fishers are unwilling to accept the closures and enforcement actions are needed to make the bans effective.

Closures can be accompanied by size and sex selectivity measures, and by gear and vessel restrictions. In New Zealand waters, Hookers Sea lions calving near Sub Antarctic islands are protected from trawlers by a combination of area closures, and fishing operation restrictions (Baird 1998).

Marine reserves have recently been hailed by North American writers as likely to bring many ecological benefits. Their introduction is touted as necessary to reverse the trends of declining fish stocks which occur in many of the world’s fishing areas (Clark 1999, Lauck et al. 1998). The attractions of closed areas and marine reserves include their apparent simplicity and ability to overcome fishing externalities. As noted in the paragraphs above the biological and economic effects of introducing these areas are dynamic, and can be complex. The downside of this approach are the potentially large losses in output due to the closure.

Size or Sex Selectivity, BRD

Fishing effort is directed at target species, but fishing technology is imperfect and bycatch is a widespread problem particularly in multi-species fisheries (Unwin and James 1998, OECD 1997, Hanna 1999). Bycatch may include fish, mammals, birds, shellfish, corals and plants. Fishing technology can be modified in attempt to reduce bycatch of non-target fish species which often have high mortality rates among fish returned to the sea. Bycatch Reduction Devices (BRD) have been developed to reduce the likelihood of capturing some non target species. Regulations can be introduced which require fishing firms to use more selective fishing technologies, to return to the sea protected individuals (size, sex), or to use BRD (Bergin 1997, Broadhurst et al. 1997, Hall 1997, Rogers et al. 1997).

Fishing technology can also be modified to select larger sizes. Size and sex selectivity can be pursued by introducing minimum or maximum sizes, and penalties for possession of undersized or oversized specimens respectively, or of spawning females. Minimum size regulations provide a financial incentive to target larger specimens. The objective of size and sex selectivity measures is to tackle growth and recruitment overfishing. Allowing young fish to grow to larger size before capture may increase the productivity of a fishery. Allowing fish to grow to a larger size may increase spawning rates, and hence increase recruitment into the fishery.

The effectiveness of BRD has been examined in several studies (Bergin 1997, Hall 1997, Broadhurst et al. 1997, Rogers et al. 1997), covering prawn fisheries, squid fisheries, tuna fisheries, etc. These studies often report a clear tradeoff between bycatch reduction and increased CPUE for the target species.

The ability of size and sex selectivity measures to conserve fish stocks is often quite limited. Captured fish are often damaged by contact with fishing gear, measurement, and release. Limitations to effectiveness include variability of growth rates between individuals, and between regions. The presence of multiple species limits the effectiveness of mesh size to prevent capture of juveniles, if species vary in size and growth rates. Migratory species will be caught at different ages and sizes at different locations on their migration path. These factors are likely to make fishers unwilling to accept size selective gear limitations.

Technology Bans

One strategy which has been widely used during the past decade is the banning of certain technologies. Drift netting and longlining are two well known examples of technologies which have been banned by many countries because of their destructiveness to non target species.

Input Quantity and Catch Limitations

Reductions in total level of fishing days, pot lifts and net sets can be directed at reducing the level of externalities through reduction in the level of effort applied to fishing. Similarly regulations can be introduced which limit total harvest with the intention of controlling the amount of environmental effect which occurs.

Retention and Utilisation Requirements

Several authors report estimates of the level of discarding in fisheries (McGinn 1998, Hanna 1999). Regulations could require fishing companies to land all fish caught, and outlaw discarding of catch. This approach forces fishing companies to partially recognise the externalities associated with their fishing. Where fishing companies also are required to hold quota for all species caught, mechanisms may be needed to facilitate the landing of non target species. Leasing of quota (Fishing Against Another Quota (FAAQ)), and Catching Against Anothers Quota (CAAQ) are ways to accomplish that. These approaches have been used in New Zealand (Boyd and Dewees 1992, Annala 1996).

Regulation of Behaviour Towards Non Target Capture

Sea mammals, turtles, birds and other species are accidentally captured during fishing. Fishing companies can be regulated to minimise the damage which occurs by treating non target species as humanely as possible. Albatross, sea lion and seals, can be released from some fishing operations before they are too severely damaged or killed. Hall (1997) reports that tuna fishers have been required to separate tuna from dolphins, and to search for ways to prevent dolphins herding, through use of sound, chemical and other repellents.

CHAPTER 6

FINANCIAL SYSTEMS

A range of economic or financial approaches can be applied to fisheries management (Table 6).

Table 6
Summary of the Characteristics of Financial Instruments and their Potential Application of Fisheries Management

Instrument	Main world uses	Current NZ uses	Applicability to fishing
Charger	Provide incentive to reduce, eg, pollution	Conservation Services Levy, applied to some non-fish bycatch	Apply tax to variable inputs, boats, outputs, to reduce profits and externalities
Subsidies	Reduce costs of inputs	R&D assistance	Reduce costs of developing BRD
Environmental performance bonds	Provide financial incentive to avoid creating externalities	Mining, biodiversity protection	Provide incentive to not damage habitat or marine ecosystem
Financial inducements	Bribe to behave in desired way		Financial reward if do not create environmental externalities
Rights based			
IQ, ITQ, IVQ CDQ, Share fisheries	Reduce race to fish	NZ QMS	Creation of rights reduces need to race, provides incentive to maintain asset, so less externalities created

Charger

Fishing companies can be provided financial incentives to reduce the externalities they produce. Fines provide punishment for firms which create externalities. Charger for externalities can provide continuing incentives to reduce the level of externality created. Subsidies can be provided to encourage firms to adopt different technologies or practices which reduce the level of externalities. Firms which create externalities might be required to fund offsetting actions such as stock enhancement.

Financial incentives have long been hailed as potential means to achieve internalisation of externalities, particularly when the externality involves air or water pollution. Economists have frequently pointed to the superiority of some financial incentives over regulatory approaches to manage externalities. Pollution charges for example are argued to achieve reduction in emissions at lower cost than will regulations. Pollution charges provide continuing incentives to firms to reduce emissions, and can collect revenue for government. Despite the claimed superiority of pollution charges they are not widely used to control externalities. Reasons for their light use include the difficulty of setting (and modifying) pollution charges to achieve target levels of pollution, the difficulty of monitoring emissions levels from sources, the lack of precise knowledge of marginal abatement costs, and industry opposition to their use. Some of these problems can be overcome for example by monitoring firm's use of inputs such as fossil fuels and levying pollution charges on measured inputs rather than outputs. Opposition by industry to another charger which may reduce profitability, and affect their international competitiveness could be overcome by government reducing other taxes in the economy. But the problem of selecting the appropriate charger level remains, and trial and error is needed to determine how firms respond to charger.

Fishing companies in New Zealand already pay substantial tax on diesel used for fuel, and in principle the tax could be increased to achieve a reduction in externalities. But this seems to provide a very crude way to motivate fishing companies to reduce fishing environmental externalities which are much more closely linked to fishing area, timing and type of equipment used than to quantity of diesel used.

Subsidies

Rather than relying upon blunt charger to change fishing company behaviour, sharper financial devices can be proposed. Subsidies are an alternative to taxes or charges and may have some potential for use in fisheries. Fish attracting devices (FAD) have been developed in tuna fisheries in an attempt to find alternatives to sets on dolphins (Hall 1998), and FAD and R&D for new or improved FAD could be subsidised by government. Examples of the use of these approaches are not easily found.

Environmental performance bonds

Environmental performance bonds are a relatively recent addition to the arsenal of devices for managing environmental externalities. Firms whose activities have potential to create environmental externalities can be required to deposit a sum which will be forfeited if they infringe the agreed environmental standard associated with their activity. Use of environmental performance bonds has become quite common during the past fifteen years, and they are used with mountaineering expeditions, mining companies, tourist vessels and others to ensure that sites do not get degraded by their actions (Shogren et al. 1993). Environmental performance bonds have potential for use with fishing operations, particularly when they involve fishing in environmentally sensitive areas.

Fishing firms which create externalities might be required to fund offsetting actions such as stock enhancement. There is a need to monitor to determine if firms are 'going through the motions' or are genuinely creating new stock. The key requirement for this approach to succeed is monitoring by fishery managers to detect companies who destroy fish habitat or cause some other environmental infringement.

Financial Inducements

Fujita et al. (1998) report the Alaska Marine Conservation Council has proposed that 'clean fishers' who have low bycatch rates, be granted greater initial allocations of harvest quotas, a financial incentive for lower levels of externality. This approach will require monitoring to determine which firms have lower bycatch rates and its effectiveness is dependent upon the elasticity of supply of clean fishing.

Rights Approaches: IQ, IVQ, ITQ, CDQ, Territorial Use Rights

An externality arises in fishing due to the race to fish, which occurs when fishing firms lack secure rights to the stock. Racing can result in disregard for future harvests, other fish species, habitat, and non-fish species. Rights approaches aim to reduce the incentive to race by providing more secure property rights to fishers. There are a wide range of rights approaches which have been used or proposed to manage fishing including: Territorial Use Rights for Fishing (TURFs); Individual Quota (IQ), Individual Vessel Quota (IVQ), Individual Transferable Quota (ITQ), and Community Development Quota (CDQ). The detail of those schemes vary on who is able to own the rights and their tradability, but the key feature common to all is the creation of rights to harvest fish within a defined area.

Rights approaches are used by many countries to manage fishing and are generally judged to be successful at reducing the race to fish (OECD 1993). There is still reason to be concerned about bycatch, discards, non-fish capture, habitat damage and other environmental effects in fisheries with rights based management. There is some ability to reduce discard and bycatch problems in multi species fisheries, if rights holders have or can readily obtain landing rights for many species. In some fisheries territorial use rights have been developed which provide limitations on entry, and encourage husbanding of the resource (McGinn 1998, Young 1999). But there is clear evidence that external environmental effects occur in rights based fisheries (PCE 1999) and these require targeted policies of the types listed above.

CHAPTER 7

VOLUNTARY APPROACHES

Hitherto, many societies have viewed oceans as vast fishery frontiers. These frontiers are suffering depletion and straining the limits of sustainability. The challenge is to develop sustainable governance systems through institutional transformation (Hanna 1997). The institutional capital needed for sustainable fisheries governance is comprised of several pieces:

- A perception of the fishery as an integrated ecosystem
- An identification of stakeholders
- An allocation of decision making power and responsibility which vests all interests and internalises the source of control amongst stakeholders
- Incentive structures which promote long-term management skills among fishery interests
- Management processes that promote adaptability to change.

Many societies have historically relied on state regulation, usually through controls on inputs into the fishing process, such as limited entry licensing, gear restrictions, and fishing ground closures to mitigate detrimental environmental impacts associated with commercial fishing. Such input controls do little to avoid a 'race for fish' situation, resulting in unsustainable fishing practices. Their modest overall level of success has prompted policy makers to look for alternative solutions (see Table 7). One such approach is by encouraging greater stakeholder participation in fisheries management in a collaborative manner (co-management). Other alternative approaches include codes of practice, accredited environmental management systems and conservation easements.

Table 7
Summary of the Characteristics of Voluntary Instruments and their Potential Application of Fisheries Management

Instrument	Main world uses	Current NZ uses	Applicability to fishing
Co management	Right holders draw up operating systems	Challenger Scallop	Peer agreements reduce externalities
Codes of practice	Agreed behaviour which limits externalities	HSNO, Agchem	Industry develop, adopt, codes which limit or preclude externalities
Accredited environmental management systems	Industry develops systems - externally audited prior to accreditation	Marine Stewardship Council, ISO 14001	Industry develop, adopt, systems with environmental policy which aims to limit or preclude externalities
Conservation easements	Negotiated agreements restricting a parties behaviour	QEII Trust, Ducks Unlimited	Negotiated agreement to not take certain actions eg create externalities

Co-Management

The term co-management (or co-operative management) is used here broadly to describe systems that encourage co-operation and mutualism. The significance of such approaches may have been little understood and appreciated until recently (Berkes 1989). Co-management presents a new challenge to our way of thinking about the management of natural resources.

Co-management shares management responsibility between the state and local communities or resource user groups. Such arrangements can range along a continuum from self-management to advisory management. By including a range of stakeholder input and values, co-management has the potential to transform the current extractive and single-species management focus to a more sustainable, ecosystem-based approach. Such an approach would recognise the marine environment as an ecosystem linked to the land and air, not just a 'fish basket' for human consumptive purposes (Wallace 1997).

A basic principle of co-management is self-governance within a legal framework established by government (Jentoft and McCay 1995). For its part, government must be willing to share this responsibility with stakeholders (Pinkerton 1989).

Co-management provides a number of potential benefits for marine management, including the problem of managing environmental externalities (Table 8). Bringing different stakeholder groups together to communicate helps these groups to both redefine their own problems, and to gain understandings of the problems of other groups. Shared solutions become more likely and conflict less likely, as previously fixed preferences can change when different groups articulate their interests together (Healey 1993; Young 1995).

The inclusion of stakeholders within a management process can provide a wider base of information and knowledge, particularly in respect of local and regional fish patterns, and the identification of key issues.

Legitimacy of any regime is essential to encourage fishers and other marine stakeholders to voluntarily advance their collective interests at the partial expense of their private interests. By involving different stakeholders in the management process, and by establishing a pattern of co-operation based on reciprocity, co-management has the potential to enhance legitimacy. Increased legitimacy is also likely to procure increased levels of compliance with rules and regulations (Jentoft and Mikalsen 1994).

Perhaps most importantly, the opportunity for participation in decision-making should encourage stakeholders to see themselves as collective managers or stewards of the resource. This may provide the incentive for adopting sustainable fishing practices, and for action in conservation spheres such as habitat protection and rehabilitation. At its most fully-developed, the co-management process should see stakeholders take an ecological approach to management rather than focusing purely on single species management.

Whether the benefits of co-management will be realised will depend on a number of factors, including the institutional design of any fisheries co-management regime. There is no single right way to design and implement a co-management agreement (Pinkerton 1994). However, certain factors can be identified as predictors of success, which can cumulatively contribute to the realisation of the benefits of co-management benefits. These factors are presented in Table 9.

Other factors may influence successful co-management. Firstly, co-management tends to operate more favourably when stakeholder groups already have a cohesive social system. Valuable social capital may accompany such social cohesion, including the presence of social norms against resource misuse, the likelihood of reciprocal behaviour patterns, and effective means of social sanctioning of rule transgressors (Ostrom 1990; Pinkerton 1989). Secondly, co-management is likely to be more easily implemented if there is already a degree of trust amongst the various stakeholder groups (Jentoft 1989). Thirdly, other exogenous factors may be important, such as having a facilitative political mechanism, and the absence of strong external threats to the legitimacy of the co-management agreement (Ostrom 1992; Pinkerton 1989).

Various forms of co-operative stakeholder groups have been established in the fisheries sector along a continuum of co-management. Hughey et al. (2000) has classified these into three categories: self-management, co-management and advisory management (Table 10). New Zealand has a range of co-operative management approaches, only some of which explicitly recognise the importance of environmental externalities (e.g., Bathgate and Memon 1998; Hughey et al. 2000). For some individual fish species stakeholder companies which represent ITQ owners have formed, e.g. the Challenger Enhancement Scallop Company. For some other species advisory groups including commercial and recreational fishers, iwi and environmental groups have formed, e.g. the PAU 5 working group. In other circumstances, multi species/ecosystem based groups have formed, e.g. Guardians of Fiordland's Fisheries. The latter two types of groups advise the Ministry of Fisheries on appropriate management.

Table 8
Potential Benefits of Co-Management

Consensual, democratic decision making
Reduced stakeholder conflict
Broader resource knowledge
Better, more equitable regulations
Increased legitimacy
Increased compliance
Greater stewardship by resource users

Table 9
Institutional Design Factors for Successful Co-Management
(Source: adapted from Pinkerton 1994).

1. Clear boundaries
2. Clear membership criteria
3. Appropriate scale management units
4. Clear interception agreements
5. Local all-stakeholder co-management boards
6. Coordinating regional management board
7. A degree of local control
8. Clear definition of local powers
9. Protocols and rules that promote multi-party collaboration

There are many examples around the world of fisheries co-management, but the focus of these arrangements is typically on entry, harvest rates, seasons, technologies, to reduce the risks and ensure sustainability of fisheries. The potential for co-operation under co-management between fishers in Japan, Netherlands and Denmark was found to be highest where fisheries are relatively homogenous with non-migratory species (OECD 1997). Multi-species fisheries which have a range of fishing technologies and variable seasons are more prone to disagreements. Fishers can be provided incentives to join co-management groups, e.g., in Netherlands were granted 10 percent more fishing days and the possibility of renting or hiring quota within a year (OECD 1997). Seventy percent of fisher respondents in the Netherlands state 'they are more inclined to follow group rules than rules imposed by the government' (OECD 1997).

There is an argument that democratic cooperation systems may result in higher discount rates being applied, and less willingness to take actions with long term implications such as conservation. If participants are risk averse and have little certainty over their future access to fish stocks they may vote today for continued harvest rather than conservation (OECD 1997).

Codes of practice

Codes of practice may be described as a particular variant of a co-management agreement. A code of practice is a document negotiated and agreed by interested stakeholders on best practice for a particular industry (Stevens 1999). Codes cover the range from educational documents to codes that are enforced through regulation. There is a wealth of topics covered by codes, including codes specifically aimed at preventing or reducing environmental externalities (Caddy 1999). These codes can be developed by industry participants with and without input from government and external parties.

FAO has recently provided international leadership in developing fisheries codes of practice that…' set out principles and international standards of behaviour for responsible practices … with due respect for the ecosystem and biodiversity' (FAO 2000). FAO has published nine technical guidelines in support of the implementation of such codes. Several nations and regions have complemented the action of the FAO by publishing their own codes of conduct for responsible seafood industry.

The Marine Stewardship Council (http://www.msc.org/) is a charitable, not for profit, non-governmental, international organisation set up to promote sustainable fisheries and responsible fishing practices worldwide, through developing long term, market based solutions, which meet the needs and objectives of both the environment and commerce.

Central to the purpose of the MSC are its Principles and Criteria (i.e. Standard) for Sustainable Fishing, against which independent certification companies may certify fisheries, on a voluntary basis. Fish from certified fisheries and fisheries stakeholders are then eligible to use the MSC logo, which conveys to consumers the assurance that the fish or fish product is from a well managed and sustainable fishery and that it has been fished responsibly. The MSC lists many international companies and organisations amongst its members but nothing from New Zealand, as yet.

In New Zealand, both the Agricultural Compounds and Veterinary Medicines Act 1997 and the Hazardous Substance and New Organisms Act (1996) refer to codes of practice. The Chief Executive of the Ministry of Agriculture and Forestry or the Environmental Risk Management Authority can issue a code as a method for implementing requirements of regulations under the relevant Act. Although these codes may have significant industry input and do address environmental externalities, these are not voluntary codes, and are essentially regulatory methods.

Table 10

Characteristics and Examples of Stakeholder Involvement Contributing to Fisheries Management

Types of groups	**Self management**	**Co-management**	**Advisory management**
	←	CONTINUUM OF CLASSIFICATION	→
Definition	Fishers decide on own operating regime but within a framework established by government that applies to all fisheries.	Equal sharing of power and decision making responsibility between government and stakeholders.	Government facilitates most aspects of management and sets rules but liaises/ consults closely with stakeholders.
Criteria	• Self funded • Self managed and facilitated • Largely self compliant • Seeking self control	• Largely government funded • Shared management and facilitation • Largely reliant on government compliance • Seeking shared management	• Government funded • Government managed and facilitated • Reliant on government compliance • Trying to influence change/ lobbying
Voluntary or Facilitated	Voluntary Facilitated	Voluntary Facilitated	Voluntary Facilitated
New Zealand example and position on continuum	Challenger Scallop Enhancement Company (Hughey et al. 1998)	Guardians of Fiordland's Fisheries (Hughey et al. 1998)	Rock Lobster Industry Council PAU 5 management group (Bathgate and Memon 1998)
Australian example and position on continuum	(AFMA (Kaufmann and Geen 1997))	Northern Prawn Fishery Management Advisory Committee Torres Strait Fisheries Management Committee (Council for State of the Environment in Australia 1996)	

Participation in Australia and New Zealand	ITQ owners: commercial fishers and some processors	Ranging from ITQ owners/ fishers/ processors, but also includes scientists, government, and community interests	Likely to be broad but ranging from ITQ owners/ fishers/ processors, to also include scientists, government, and community interests
International example and position on continuum	Lake Titicaca, Peru (Le Vieil and Orlove 1990); Reef management by clan chiefs in the South Pacific (Johannes 1981)	Village multi-sector cooperatives in Japan (Lim et al. 1995)	British Columbia Halibut fishery (Grafton, pers. comm.)

Source: Based on the continuum notion of Pinkerton (1994)

Codes of practices which attempt to address environmental externalities have been developed in the agricultural and aquaculture sectors in New Zealand. Three examples are the Code of Practice for the Management of Agrichemicals (NZS 8409), the Code of Practice for Fertiliser Use (NZFMRA, 1998) and the Mussel Industry Council Environmental Code of Practice (1999). The impetus for these codes has come from the Resource Management Act. All three codes have a stated purpose of satisfying s. 17 of the RMA which states a duty to avoid, remedy or mitigate adverse environmental effects from activities associated with the industry.

The Code of Practice for the Management of Agrichemicals has the objective of providing practical and specific guidance on the safe, responsible and effective use of agrichemicals. It has a formal nationwide training programme associated with it and became a NZ Standard in 1995. It is referred to many resource management plans produced by regional councils in relation to agrichemical use. The Code now has a formal Accreditation Programme associated with it (GROWSAFE®) which audits compliance with code requirements.

The other two codes are voluntary codes and have adopted a different approach to the standard-based approach used in the agrichemical code. Both codes place emphasis on self-monitoring and self-audit whereby companies or individuals operating under the Code are required to measure and assess environmental effects associated with their activities. In the mussel industry, the Mussel Industry Council carries out monitoring requirements of the code. An impetus for both codes was the avoidance of strict regulation by regional councils of day-to-day activities through resource consent conditions. In addition, it is important to the long-term viability of the industries that they are perceived as "environmental responsible" in part because of the public nature of resource consent processes under the RMA. In comparison to the agrichemical code, neither the mussel or fertiliser code has a requirement for external audit or penalties for non-compliance.

A lack of publicly available audits or evaluations is a problem common to many such approaches. Government could signal a requirement for mandatory reporting of all such approaches and provide a standard against which such reports could be prepared. The Triple Bottom Line approach (see for example Buchanan 1998) could be one means of getting companies to report on economic, environmental and social aspects. Hubbards, the cereal company, is one of the first New Zealand companies, to commit itself to this approach ("The Press" 22/3/2000).

There is debate about the extent to which voluntary codes of practice are properly evaluated (Slooten and Dawson 1995). The Mussel Industry Environmental Code of Practice and the Code of Practice for Fertiliser Use have been well received by members of the respective industries and noted as positive actions by regional councils (Marlborough District Council 1997, Environment Waikato 1999). However, their success at addressing environmental externalities cannot yet be quantified, given that they are very recent initiatives. Where the effects of an industry are easily observed and attributable to a single industry, such as mussel rope tie material deposited on beaches, it will be relatively straightforward to measure the success of a code at addressing an externality. However, where the size and cause of an externality are not clear, as is the case with many of the fishing externalities identified in Section 2, assessing whether codes are successful will not be straightforward.

There are limited examples of comparable initiatives in the fisheries sector in New Zealand. Existing Fisheries Management Agreements (FMA) could potentially be modified to include codes of practice directed at avoidance of externalities, e.g., fishing companies could agree to cease fishing for a species while spawning is occurring to ensure satisfactory number of juveniles. The PAU 5 working group developed a harvesting code of practice in 1994.

Environmental Management Systems

Environmental management systems are an alternative voluntary approach that is closely related to codes of practice. There is obvious overlap between the style of the mussel and fertiliser codes with environmental management systems. Environmental management systems, particularly those accredited to the ISO 14000 standards, are viewed as an instrument for ensuring access to international markets, given the possibility that market access requirements can include environmental concerns (TradeNZ, undated). Ensuring market access is a potential benefit environmental management systems and codes of practice, although not yet strong enough, should not be overlooked as a driver for voluntary methods. Unlike its European equivalent (EMAS), the ISO 14000 standard does not include mandatory public reporting of environmental performance.

Conservation Easements

Easements are used in several countries to achieve various land use objectives. An obvious example is for an organisation such as Ducks Unlimited to take an easement over an area of land to achieve a biodiversity protection objective (Anderson 1998). The easement is a charge against the title for the area of land, and prescribes the specific activity or outcome to be achieved. There is no title to areas of sea, but quota holders do own property rights. An organisation could obtain a title against those property rights and restrain the quota holder from taking environmentally damaging actions? The key requirements for this approach to be used in the marine environment must be determined.

New Zealand's Conservation Act 1987 includes provision for agreements between property owners and the Department of Conservation. At their most formal level these Conservation Covenants are registered against the title of the land and require certain actions to be met by the negotiating parties. A lesser measure, A Letter of Agreement, enables conservation to happen but without legal remedy in the case of default.

CHAPTER 8

LEGAL REMEDIES

In many spheres of life two or more parties can negotiate over use of resources and reach agreements which are acceptable to both. If there is dispute between two parties over use of resources they can seek to resolve their dispute by way of court action. A party who believes they have been wronged by another can seek damages to compensate them for the injury suffered. An example to illustrate the operation of this approach is as follows. Two firms are sited on the bank of a river and one firm discharges BOD into the river. The second firm is sited downstream of the firm which discharges the BOD material, and relies upon the river to provide a source of clean water for its business. The downstream firm incurs costs because of the discharges by firm upstream, and may seek damages to compensate for the loss suffered. Obtaining award of damages will require proving that the emitter did discharge BOD and had an obligation not to do so, that the complainant holds property rights to clean water and that loss has indeed been incurred.

Law in some countries has been strengthened by including definitions of liability and strict liability which increase the likelihood of complainants winning damages claims. The incentive underlying tort law and damages claims is that firms and individuals will recognise the possibility of damages claims, and act prudently to avoid or reduce the possibility of such claims succeeding. However, the potential of this instrument to curb fisheries externalities seems to be limited by the need for complainants to show they have well defined rights to undisturbed habitat, or to harvest levels, and that these rights have been damaged by some fishing related activity (Table 11).

Table 11
Summary of the Characteristics of Legal Instruments and their Potential Application of Fisheries Management.

Instrument	Main world uses	Current NZ uses	Applicability to fishing
Tort law	Liability for pollution damages	RMA is a 'strict liability' law	Potential damages claims provide incentive to avoid creating externalities

CHAPTER 9

EDUCATION AND INFORMATION SUPPLY

This approach can aim to provide information to members of the fishing industry in the belief that better informed fishers will cease or reduce the level of externality creating behaviour (see Table 12 for a summary of instruments). The approach requires effort to capture, report and distribute information to fishing companies. Workshops may be required to reinforce the ideas and achieve buy in by industry participants.

The effectiveness of this mechanism will be determined by the willingness of industry participants to accept the information provided, recognise the case for change, and adhere to responsible behaviour. Incentives such as financial penalties can also be provided which reinforce responsible behaviour (OECD 1997). Effectiveness is likely to be higher where there are known stable groups of fishers who are likely to be self monitoring, and less effective where the converse occurs (Acheson et al. 1998).

One variant of the information supply approach is to place observers on fishing vessels who collect information on bycatch rates, inform skippers, who then voluntarily move to a new fishing location when bycatch rates become excessive (Fujita et al. 1998, Caddy 1999). Fujita et al. (1998) note that skippers require access to real time data on bycatch rates to be able to respond, and when observers began to withhold that information the system broke down. It is crucial for the success of this approach that industry personnel have confidence in the validity of the information available on the environmental effect.

Some examples of the types of externalities where this approach has been employed include:

- Agreement not to sail between Poor Knights Island and the North Island, to reduce the chances of marine pollution from oil discharges.
- Production of an Australian fishing conditions handbook, in Japanese – Catch fish not birds (Bergin 1997).

Table 12
Summary of the Characteristics of Education Instruments and their Potential Application of Fisheries Management

Instrument	**Main world uses**	**Current NZ uses**	**Applicability to fishing**
Publications, guides, kits, etc	numerous	Numerous, e.g., biodiversity protection	Informed people change behaviour, not create externalities
Informal regulation e.g., environmental reporting	Toxics Release Inventory and corporate environmental reporting		Information release plus community pressure, modifies firm behaviour

Informal regulation including environmental reporting

Information supply strategies may also be directed at consumers, investors and activists. The notion behind this approach is that communities have an ability to pressure businesses into changing behaviour if there is a gap between actual and community desired behaviour. The community is perceived as providing informal regulation of the industry which creates the externality. This is the most recent approach developed to tackle pollution and has been subjected to some research to discern its effectiveness. In the US there are mandated disclosures of toxic releases via the Toxic Release Inventory (TRI). Pargal et al. (1999) examine whether there is evidence of informal regulation effecting a variety of emissions in USA and Indonesia. They find very strong evidence that informal regulatory forces are pervasive in both countries, and that community incomes have a powerful negative association with pollution intensity (Pargal et al. 1999, p.6).

These reductions in pollution are believed to occur because citizens and investors are well informed about emissions levels and, particularly in higher income areas, exert pressure on firms in their region. Konar and Cohen (1997) have shown that firms which take the largest stock price hit after release of TRI data were more likely to cut down those discharges relative to other firms in their industries, than were the largest emitters in their industry, or a random sample of firms.

Could a similar approach be used to reduce fisheries externalities? Where fishing companies are locally based, identifiable, and credible information is readily available about the externalities each firm creates, it is plausible that informal regulation will be effective. An active policy of collecting and releasing information will be an essential requirement for the instrument to be effective. This new approach to control of externalities seems worthy of further investigation in a fisheries context.

Corporate Environmental Reporting is one means that companies could use to disclose their environmental record. Over the last 10 years, an increasing number of companies internationally (though few in NZ) are choosing to move from a mention of the environment in the regular annual report, to producing a specific stand-alone corporate environmental report (CER).

Currently there is no standard for CER. Some initiatives are aiming to raise the standard and increase the degree of comparability between reports. Best known are the Global Reporting Initiative (GRI) and the International Benchmarking Survey, performed for the second time in 1996 by SustainAbility and the United Nations Environment Programme.

Environmental reporting in NZIJ very slow to take off. KPMG Peat Marwick in association with the Society of Accountants, launched a Best Annual Environmental Report Award in 1995 as part of the Society's annual report awards.

Entries have risen each year and the standard of the reports has increased, but overall the standard still falls well short of international initiatives. The slow take up was a factor in the inclusion in the Coalition agreement between National and New Zealand First in 1996 of an undertaking to make disclosure of environmental impacts by companies mandatory. This agreement was not implemented. Some policy work was undertaken within MfE & in 1998 a scene-setting report "Corporate Environmental Reporting" was published by KPMG. Hughey (2000) addresses some of these issues in relation to Ecologically Sustainable Development for fishing in Australia and New Zealand.

CHAPTER 10

ASSESSMENT OF INSTRUMENTS

Environmental externalities have been recognised and studied for more than a century since the days of Marshall and Pigou (Verhoef 1999). A wide range of instruments has been proposed to overcome externalities as discussed in Section 3.2. Variants of those instruments can potentially be used to modify fishing company behaviour to internalise environmental externalities. Many of these instruments have been used in New Zealand fisheries management, to a greater or lesser extent. Notable exceptions include performance bonds, conservation easements (covenants), legal remedies and information provision to achieve informal regulation. Table 13 summarises these instruments.

Determining which instruments are 'best' requires some criteria to judge performance and data to evaluate performance of the instruments. However, and as noted by (Slooten and Dawson 1995), most evaluation studies of the performance of some of these instruments are at best limited. Consequently, clear and robust criteria are necessary to evaluate this performance as a basis for selecting appropriate management tools.

CHAPTER 11

CONCLUSIONS

Negative externalities are costs imposed upon another person or firm where there is no contractual relationship between the two parties. The term externality is widely used to describe situations where there is damage caused to part of the natural environment. In those cases costs are recognised by individuals who are concerned about the natural environment.

Determining the nature and extent of the environmental externalities associated with many New Zealand fisheries is sometimes not easy because the marine environment is difficult to research. Moreover, there is currently no accepted framework or policy for the assessment of fisheries' environmental impacts. However, it is clear that some commercial fisheries in New Zealand are associated with significant environmental externalities. While non-fish bycatch is often publicised, our initial assessment is that bottom trawling and dredging are likely to cause the most serious environmental externalities associated with New Zealand commercial fishing, both for the short and for the long term.

Commercial fishing firms pursue profits, and their behaviour can potentially be modified by several means to reduce the level of externalities associated with fishing toward a desired or optimum level. A variety of instruments has been tried in fisheries around the world to avoid, remedy or mitigate the environmental externalities associated with fishing. These instruments and others from other areas of environmental management have been identified and evaluated for their potential application in fisheries management. Ultimately, choice of mechanism(s) is strongly dependent on the fish species pursued, fishing technology employed, industry structure, and nature of the environmental externality. In practice, combinations of instruments are frequently used which complement or support each other.

The effectiveness of these various instruments is not easily assessed and in Part 2 of this project we will identify criteria that can be used to guide mechanism selection. A range of criteria can be used to evaluate the performance of internalisation instruments and judgement is required to determine choice and sequencing of performance criteria.

Table 13
A Summary of the Instruments, Examples of their Main World and NZ Uses and Potential Application to Fisheries Management

Instrument	Main world uses	Current NZ uses	Applicability to fishing
Regulatory			
No take zones	Protect juveniles, spawning areas etc		No fishing in specified zones means externalities not created
Marine Reserves	Protect juveniles, spawning areas etc protect habitat	Banks Peninsula, Long Bay etc	Area set aside for preservation of marine species
Closed seasons, areas	Protect juveniles, spawning areas etc	Near sub Antarctic islands.	No fishing during designated times and /or in prescribed areas.
Size or sex selectivity	Direct effort away from specified ages, sex individuals	Rock lobster, size requirement	Requirement for fishers to return to sea all prohibited catch
Bycatch Reduction Devices (BRD)	Reduce rate of bycatch of fish and other species	Pingers on gill nets	Vary technology used while fishing to reduce bycatch of fish or other species
Technology ban	Prevent externalities associated with specific harvesting technologies	Drift netting ban	Reduce bycatch by only allowing techniques which cause few externalities
Input limitations	Reduce externalities associated with number of potlifts, boat days etc		Reduce volume of fishing activity and associated externalities
Catch limitations	Reduce externalities associated with effort	Foveaux Strait oysters	Limit total harvesting and associated externalities
Retention and utilisation requirements	Reduce dumping of target and non - target species	Catching Against Anothers Quota (CAAQ), Fishing Against Anothers Quota (FAAQ)	Allow non target catch to be landed, not dumped
Financial systems			
Charger	Provide incentive to reduce, eg, pollution	Conservation Services Levy, applied to some non-fish bycatch	Apply tax to variable inputs, boats, outputs, to reduce profits and externalities
Subsidies	Reduce costs of inputs	R&D assistance	Reduce costs of developing BRD
Environmental performance bonds	Provide financial incentive to avoid creating externalities	Mining, biodiversity protection	Provide incentive to not damage habitat or marine ecosystem

Financial inducements	Bribe to behave in desired way		Financial reward if do not create environmental externalities
Rights based			
IQ, ITQ, IVQ CDQ, Share fisheries	Reduce race to fish	NZ QMS	Creation of rights reduces need to race, provides incentive to maintain asset, so less externalities created
Voluntary approaches			
Co management	Right holders draw up operating systems	Challenger Scallop	Peer agreements reduce externalities
Codes of practice	Agreed behaviour which limits externalities	HSNO, Agchem	Industry develop, adopt, codes which limit or preclude externalities
Accredited environmental management systems	Industry develops systems - externally audited prior to accreditation	Marine Stewardship Council, ISO 14001	Industry develop, adopt, systems with environmental policy which aims to limit or preclude externalities
Conservation easements	Negotiated agreements restricting a parties behaviour	QEII Trust, Ducks Unlimited	Negotiated agreement to not take certain actions eg create externalities
Legal Remedies			
Tort law	Liability for pollution damages	RMA is a 'strict liability' law	Potential damages claims provide incentive to avoid creating externalities
Education and Information Supply			
Publications, guides, kits, etc	numerous	Numerous, e.g., biodiversity protection	Informed people change behaviour, not create externalities
Informal regulation e.g., environmental reporting	Toxics Release Inventory and corporate environmental reporting		Information release plus community pressure, modifies firm behaviour

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APPENDIX 1: Publications from this work.

Note that the following list includes publications reporting on all the research objectives from SEC 1999/05.

Kerr, G.N., Cullen, R., Hughey, K.F.D., Memon, A. (2000), Criteria for Selecting Policy Instruments to Internalise Environmental Externalities from Commercial Fisheries Management in New Zealand. Paper to IAIA'00 Back to the Future: Where Will Impact Assessment Be in 10 Years and How Do We Get There?" 19-23 June 2000 Hong Kong Convention and Exhibition Centre, Hong Kong.

Memon, A., Hughey, K.F.D., Cullen, R., Kerr, G.N. (2000), Processes and Methods to manage fisheries externalities in New Zealand's Exclusive Economic Zone. ISRM Conference, Washington, June, 2000.

Cullen, R., Kerr, G.N., Hughey, K.F.D., Memon, A. (2000), Selection of mechanisms to achieve internalisation of fishing externalities. Paper to NZ Agricultural and Resource Economics Society conference, 30/6-1/7 2000, Blenheim.

Hughey, K., Cullen, R., Memon, A., Kerr, G., & Wyatt, N. (2000), Developing a Decision Support System to manage fisheries externalities in New Zealand's Exclusive Economic Zone. Paper to International Institute of Fisheries Economics and Trade 10th biennial conference – Microbehaviour and Macroresults, University of Oregon – 10-14 July 2000.