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An Evaluation of Self-governance in the New Zealand Bluff Oyster Fishery – The Indicator System Approach@

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1. Introduction

Fisheries management is shifting away from both central command-and-control and solely market-led regimes towards devolved management regimes that rely on greater fisher cooperation and participation[1]. This shift comes out of the realisation that relying solely on government planning or market-led private sector actions may not produce optimal outcomes in fisheries management. A participatory management regime that is legitimated by government, by interest groups and by fishers themselves may be better able to address some of the challenges and externalities than non-participatory management regimes.

In New Zealand fisheries, the progression towards a more devolved management regime is to cede some elements of management to self-governing bodies made up of Individual Transferable Quota (ITQ) holders within its fisheries Quota Management System (QMS)[2]. This means that ITQ holders, who have the most to gain from effective management of fish stocks, are now assuming a greater role in the collection and analysis of fish stock data and consultation with other stakeholders than ever before.

Devolved management regimes are often seen to be advantageous because user participation contributes to the overall robustness of the management regime. Similarly, with self-governed fisheries it has been argued that three core benefits can result. These are enhanced economic efficiency (*e.g.*, [8–10]), enhanced institutional effectiveness (*e.g.*, [2, 4, 5, 9]) and enhanced fish stock and fishing environment protection (*e.g.*, [2, 4, 5, 10-12]).

The shift to self-governance has been endorsed by the New Zealand government. Developments, up until 2008, within the then Ministry of Fisheries (MFish), indicated a clear trend of encouragement towards devolved management regimes and self-governance ([13]). Similarly, the New Zealand fishing industry has also showed an increasing interest in and capacity to assume fisheries management responsibilities. Accordingly, since the wide application of ITQs to commercial fisheries in the late 1980s, there have been an increasing number of self-organised quota owner associations (QOAs) in a wide range of fisheries (*e.g.*, the deepwater fishery, crayfish fishery and a number of shellfish fisheries) [14].

Nevertheless, there is a mismatch between the increasing recognition and integration of ITQ-based self-governance in New Zealand's fisheries management and empirical evidence on the benefits of this new regime. Out of the 20 or so QOAs and their respective fisheries [15] only five have to date been researched[3]. However, these researches while indicating promising results have largely been undertaken through unstructured case studies.

Previously, Yang, Fu and Cullen [20] highlighted the absence of empirical evaluations of self-governance and the inadequacy of unstructured case studies to separate the contribution of self-governance from that of ITQs – a potentially efficient fisheries management regime in its own right[4]. To overcome these issues and to assess self-governance in New Zealand fisheries those researchers developed a bio-economic model.

[1] Detailed discussion of the benefits of participatory management regimes can be found in [1-7].
[2] New Zealand's fisheries management framework is generally referred to as the QMS. In fact ITQs are only one element of a wide range of input and output controls, such as fishing gear restriction in certain fisheries and size restrictions in most fisheries.
[3] They are, the Challenger scallop fishery (*e.g.*, [10, 16]), the deep sea crab fishery (*e.g.*, [17]), the rock lobster fishery [18], the orange roughy fishery [19], and the Bluff oyster fishery [7, 20].
[4] Discussion of the merits of ITQs can be found in [21-25].

Their modelling results were promising, as they indicated that self-governance could have a positive impact on stock abundance and profitability in New Zealand's Bluff oyster fishery evaluated.

However, bio-economic modelling has a number of limitations. For one, there are assumptions and, therefore, uncertainties attached to fisheries modelling. Furthermore, although modelling is theoretically sound, the information needed for model adequacy is both time and resource intensive. Finally, modelling usually focuses on the biological and economic performance of fisheries. It typically ignores institutional and resource/environmental dimensions of fisheries management.

In order to address this mismatch and to provide empirical weight to the assertion that self-governance genuinely adds value to fisheries management in New Zealand, more concrete evidence of all aspects of the theorized benefits of self-governance needs to be considered using more thorough methods of analysis. Accordingly, to obtain more concrete evidence, this research isolates and evaluates the full contribution (i.e., economic, institutional and resource/environmental dimensions) of self-governance to fisheries management by applying a novel system of indicators to the Bluff oyster fishery found in southern New Zealand. In comparison with a modelling approach[5], indicators rely far less upon critical assumptions. In addition, the data needed for indicator systems are relatively easy to collect and may often be readily available.

The remainder of the paper is organised as follows. Section 2 reviews the literature on indicators with a particular focus on their use in fisheries management. The literature review also provides the basis for the selection of indicators that are applied in this research. Section 3 explains the method used, and develops an indicator system for evaluating self-governed fisheries. The section includes a discussion about the process by which the indicators are selected. Section 4 presents the results from the indicator system assessment on the self-governing performance of the Bluff oyster fishery – the target fishery of this research. Section 5 discusses these findings. Section 6 provides two policy-related conclusions and also discusses limitations and future research.

2. Literature review

Indicators are often used to evaluate the performance of various phenomena. Because the target systems of evaluation are often complex, indicators are used to "summarise complex information of value" and "…condense … complexity to a manageable amount of meaningful information" [28, p. 8].

Fishing is one sector where indicators have been used to assist management. Although no indicator research has previously been completed to evaluate ITQ-based self-governance, there are a number of indicators that are widely used for fisheries management more generally.

The use of indicator systems for fisheries management has been employed by some major non-government organisations. Since the United Nation's [29] *Report of the World Commission on Environment and Development*: *Our Common Future*, there has been gradual development and use of indicators as a tool for fisheries management [30]. Following their initiation, a series of indicator frameworks were developed by the leading international non-government organisations, namely the United Nations [31, 32], the Food and Agriculture Organisation [33-35] and the Organisation for Economic Co-operation and Development [36-38].

[5] Some examples of modelling papers are [26, 27].

These non-government organisations have published a number of comprehensive guidelines for applying indicators to assist sustainable development. Some works focus on the environment with fisheries being a component of it, while others focus solely on fisheries management.

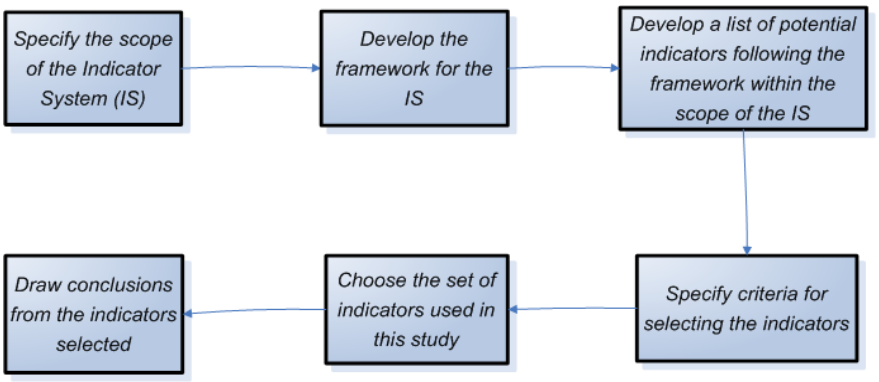
Responding to the United Nations Agenda 21, a special issue of *Marine & Freshwater Research* [39] focused on sustainability indicators in marine-captured fisheries. Several papers in this issue [40-46] illustrate the development and testing of indicators for a specific area of fisheries management. They provide useful insights when selecting a set of candidate indicators for this research.

Since the United Nations Agenda 21, there have been further applications of indicator systems in fisheries management. Not only have there been more indicator studies on ecosystems and the environment[6], indicator applications in economic and social aspects have become more structured and specific. For example, Ithindi [50] in reviewing rent capture in the catch sector applied a framework for using profit and its components (*i.e.*, total revenue and total fishing cost) as indicators for assessing the economic dimensions of fisheries management. Similarly, Allen and Gough [51] researched social dimension of the longline swordfish fishery in California on the fishing community through a set of socially-specific indicators. Another example is that of King, Porter and Price [52] who used indicators to reassess the value of U.S. Coastguard's enforcement role at sea for fisheries.

3. Method

Fisheries management is multi-disciplinary. For this reason, a wide range of indicators can be proposed to assess the performance of a fishery. To assist in the selection of a suitable set of indicators an indicator selection method is required. The indicator selection method developed by the FAO [33] and Rice and Rochet [55] was adopted. The six steps in the method are shown in Figure 1. Each of these steps in the indicator selection method is discussed further.

Figure 1. The six steps in the selection of indicators for the indicator system.



3.1. Scope specification

The scope of an indicator system depends on its purpose and intended users. Furthermore, the purpose of an indicator system should be limited to a specific set of indicators able to evaluate the performance of self-governance in New Zealand fisheries. Hence, the

[6] Some examples of such study include [47-49].

selected indicators should cover areas that are wider than fish stock alone, but narrower than studying all of the impacts of commercial fishing activities. Similarly, the intended users of the indicator system would be fisheries managers and fisheries decision-makers. Accordingly, it is important that the selected indicators and the resulting indicator system should be understandable to members of the fishing industry.

3.2. Framework development

After setting the scope of the indicator system, a framework to organise the selection of indicators was developed. The adopted framework follows the arrangement of the three core dimensions of fisheries management (*i.e.*, economic, institutional and resource/environmental) that are theorized to be enhanced with self-governance[7].

3.3. Development of potential indicators

Candidate indicators from the literature that may serve to reveal the performance of self-governance in New Zealand fisheries were identified. The compiled literature used is shown in Appendix A.

The candidate indicators selected from the literature for the indicator system are subsequently listed in Appendix B. In keeping with the indicator framework applied, the candidate indicators were grouped into the three core dimensions to be analysed: economic, institutional and resource/environmental.

The source literature and candidate indicators compiled are by no means exhaustive. However, the literature and indicators listed in Appendix A and Appendix B, respectively, provide an adequate, relevant and up-to-date representation. Furthermore, the majority of the candidate indicators have previously been used in more than one other indicator study. This suggests their wider acceptance for that role.

3.4. Indicator selection criteria

In order to select appropriate indicator for the indicator system developed from the candidate indicators compiled, various indicator selection criteria were applied. Table 1 shows the indicator selection criteria sourced from the literature. Briefly, each of these indicator selection criteria identified in Table 1 are discussed in further detail below.

[7] The purpose of this research is limited to examining whether the potential benefits of self-governance have been realised. Fisheries self-governance literature focused on three benefits of management devolution: economic, institutional, resource and environmental performance [*e.g.*, 1–7]. Therefore, other fisheries management aspects, however important (*e.g.* social) are not investigated in this paper.

Indicators	Explanatory notes	Sources
Understandable	Indicators are able to communicate information relatively easily to readers and users; and are readily understood by a broad audience (e.g. non-scientists and non-economists).	[32, 33]
Specific/Relevant	Indicators are relatively tightly linked to the relevant activity - high responsive to fishing activity, low responsive to other influences; adequately reflects the management effects of self-governance that they are intended to measure	[33, 38]
Concrete/Scientifically valid/conceptually sound/Adequately documented	Indicators are grounded on theory and are methodologically sound. They are best if based upon existing studies and /or time series data that provide accurate indication of the underlying changes. The influence of self-governance and the impact of differing management regimes should be provided to users.	[32]
Data available/Measureable	Indicators need to be relatively easily obtained. Ideally, they are observable, and/or already exist as commercial or management indicators. Indicators should be able to be measured regularly and consistently over time and across fisheries to indicate improvement or deterioration, and to enable comparison.	[32, 33, 38]
Sensitive/Responsive	Indicators are closely linked to the relevant activity – highly responsive to fishing activity but low response to other influences; adequately reflect the management effects of self-governance that they are intended to measure, and do not provide false signals.	[33, 38]

Table 1. Indicator selection criteria for assessing New Zealand fisheries self-governance.

First, indicators should be understandable and straightforward. Hence, fisheries managers and users should be able to use the indicator system to evaluate the performance of self-governance for their purposes.

Secondly, indicators should be specific and relevant to the area of concern. That is, they should be highly responsive to management regimes, but not to external factors. For example, Compliance Rate is more relevant and specific than the indicator Management Structure.

Thirdly, indicators need to be conceptually sound and grounded in theory. Ideally, they should either have been used in a number of studies or be shown to be able to adequately reflect the effects of a management regime.

Data availability and measurability form the fourth criterion when selecting indicators. The information needed should be able to be gathered or calculated for most New Zealand fisheries. Data for those indicators should either be readily available from existing sources, or could be made available within a reasonable cost and time frame.

Finally, indicators need to be responsive or sensitive to changing conditions. Ideally, the response or change in an indicator should be relatively quick and noticeable, but not show false signals [56].

3.5. Choosing the set of indicators

The general procedure used for selecting indicators was that from the list of candidate indicators, indicators were rated against each indicator selection criterion. An indicator received a ‘tick’ if it met the requirement of the criterion, a ‘question mark’ if it conditionally met the requirement of the criterion, and a ‘cross’ if it would not meet the requirement of the criterion.

The indicator selection rules applied ere that any indicator that got one or more ‘crosses’ or two or more ‘question marks’ were excluded from the final set of indicators used in the

indicator system. These rules make sense because any indicator with one ‘cross’ or two ‘question marks’ would likely compromise the requirement of the criterion and make the interpretation of the indicator ambiguous. Appendices C, D and E show this complete process of selecting indicators for the three dimensions examined.

Following the application of the indicator selection rules, a summary of the specific indicators is provided in Table 2. Some are generalised and combined into one indicator because they measure similar aspects of fisheries management. For example, ‘Involvement of Major Stakeholders in Making and Applying Rules of the Game’, and ‘Capacity to Elicit, Receive and Use Information from All Stakeholders’ were considered to be similar and they were subsequently combined into a single indicator ‘Level of Communication’.

In the second column of Table 2, there are three key indicators showing the economic performance of self-governance: ‘Profitability’, ‘Indirect Fishing Costs’ and ‘Management Costs’. Any single indicator might not be sufficient to fully support or refute the argument whether self-governance adds value to fisheries management with regards to the economic dimension evaluated. However, congruence across a range of indicators would provide results that are likely to be more convincing.

	Indicators
Economic	Profit
	Indirect fishing costs - no. of vessels
	Indirect fishing costs - no. of associated facilities
	Management costs - actual management costs
	Management costs - research costs
	Management cost - compliance costs
Institutional	Existence of users leading group in managing the fishery
	Level of communication
	Catch compliance rate
Resource/environment	Fish biomass
	Total non-fishing areas (*e.g* ., marine reserves and non-take zone)
	By-catch rates

Table 2. Selected indicators for assessing the self-governance of New Zealand fisheries.

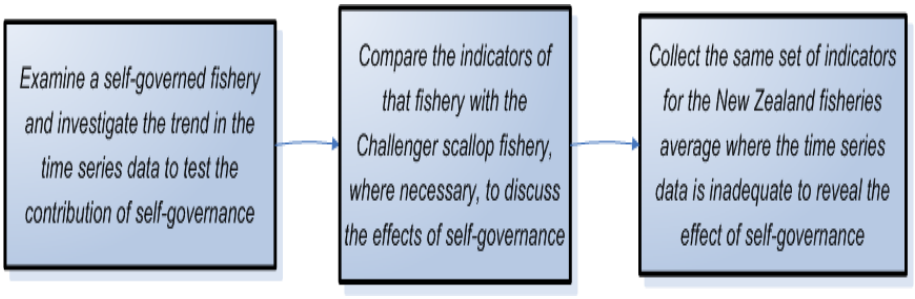
3.6. Drawing conclusions from the indicators selected

For a set of indicators to be meaningful, some reference point must be established [35, 55]. Reference points are needed for indicators to be measured against or compared to. For example, the indicators ‘Non-compliance Rate’ and ‘By-catch Rate’ are preferred to be zero, or as low as possible. On the other hand, not all indicators have an easily definable reference point. For example, ‘Profitability’ does not have an obvious reference point. This makes it difficult to tell if a fishery is performing well economically using just a single profit number.

Conventional reference points used in indicator systems are not appropriate here. Typically, reference points are used to check the performance of a fishery against certain standards (*e.g*., sustainability). In contrast, the purpose of this study is more specific.

Therefore, a double-reference point system was developed for the purpose of ascertaining the performance of self-governance in New Zealand fisheries. The three steps in this double-reference point system are shown in Figure 2. The three steps to this system are briefly discussed below.

Figure 2. The steps involved in the double-reference point system.



The first step involves examining a self-governed fishery and monitoring the time series data of selected indicators. In this examination process, for each indicator, the previous year's figures were used as a reference for the following year. The Bluff oyster fishery was chosen for this study for three reasons. First, the Bluff Oyster Management Plan is the only stakeholder-led plan approved by the Minister of Fisheries in recent years. Its degree and intensity of self-governance, from initial research, made it a good candidate for further investigation. Secondly, the initial analysis by Yang *et al*. [7] called for new methods and more detailed analysis in order to examine the effectiveness of self-governance in the Bluff oyster fishery. Finally, the realisation of self-governance benefits in Bluff might provide more convincing evidence for the generalisation of self-governance benefits. This is because the Bluff oyster fishery is not the most sophisticated self-governance mode in New Zealand. Other fisheries (*e.g.*, the Challenger scallop fishery, the rock lobster fisheries and the deepwater fisheries) have more mature self-governance structures [14]. Therefore, the realisation of self-governance merits in the Bluff case can be more robustly generalised to other more established self-governance fisheries.

In the second step, the same set of indicators for the Challenger scallop fishery was collected in order to add confidence when drawing conclusions from the indicators. Importantly, the Challenger scallop fishery is an excellent bench-mark for comparison because it is viewed as the only successful case of fisheries self-governance in New Zealand [14]. If the indicators for the two fisheries, Bluff and Challenger, agree with each other, that will provide stronger evidence for or against self-governance. Further, it is expected that given Challenger's leading position in fisheries self-governance, indicators for that fishery will provide some evidence of the merits of self-governance even if there is inconclusive evidence from the Bluff fishery.

In the third step the same set of indicators from all QMS fisheries[8] were collected. It is useful to evaluate the two self-governed fisheries by way of comparison to the overall performance of fisheries in New Zealand, which serve as the second benchmark. This benchmark is needed because the improvement in one aspect of fisheries management could be the result of nationwide implementation of the QMS. It would not, therefore, be appropriate to conclude that self-governance in Bluff or Challenger alone contributed to improvement in some measure without examining the national fishing industry performance where QMS are also used. Despite the general trends of the indicators in the fishery, it is expected indicators for self-governed fisheries will outperform the overall fisheries indicators if other factors such as the general economic and management conditions are similar.

[8] It is better to compare the indicators for a self-governed fishery with those for a non-self-governed fishery of a similar nature as reference points. However, not only is there no fishery similar enough to Bluff oysters to base comparison upon, for small fisheries like the Bluff oyster fishery, to protect the confidentiality of the players, economic statistics are not released.

4. Results

The results are mixed in terms of the contribution of self-governance to fisheries management. First, self-governance has different effects on fisheries. It is found that not all the theorised benefits of self-governance are realised in the Bluff oyster fishery, but the results from the Challenger scallop fishery are more encouraging. Furthermore, it is found that different performance effects occur on different dimensions of fisheries management. In particular, it is observed that self-governance improves the economic and institutional performance of a fishery more than it does its resource/environmental performance.

Table 3 summarises our findings from the indicators for the two self-governed fisheries and for all QMS fisheries. The reference for each summary is given in the brackets in the cell. According to the time series data, there is some evidence that self-governance improves the performance of fisheries management in some areas while remaining ineffective in other areas.

	Indicators	Bluff	Challenger	All QMS fisheries
Economic	Profit	NZ $1.43 million more with self-governance than without [20]	Convergence of discount rates [10]	Decreased between 1998 and 2007 [59]
	No. of vessels	Decreased from 15 to 11 between 1996 and 2006 [58]	Decreased from 60 to 31 between 1994 and 2006 [10]	Increased by 17% between 1987 and 1995 [25] then decreased by 46% between 1996 and 2006 [59]
	No. of associated facilities	Decreased from 11 to 5 between 2002 and 2007 [wright, pers. comm., 2009]	Remained at 6 between 2001 and 2007 [60]	Decreased from 260 to 221 between 1996 and 2007 [60]
	Actual management costs	Increased by 50% between 1996 and 2007 [60]	Fluctuated with a decreasing trend between 1996 and 2007 [60]	Remained stable between 1996 and 2007 [60]
	Research costs	Mainly stable between 1996 and 2007 [60]	Decreased by more than a half between 1996 and 2007 [60]	Increased by 31% between 1996 and 2007 [60]
	Compliance costs	Increased by 30% between 1996 and 2007	Decreased by threefold between 1996 and 2007 [60]	Mainly stable between 1996 and 2007 [60]
Institutional	Existence of users leading group in managing the fishery	Yes [7, 20]	Yes [10, 11]	28 QOAs out of 97 QMS fisheries [15]
	Level of communication	Mutual agreement [7]	contracted [10, 11]	NA
	Catch compliance rate	Showed a decreasing trend between 1996 and 2007 [60]	Showed an increasing then a decreasing trend between 1996 and 2007 [60]	Increased by threefold between 1996 and 2007 [60]
Resource/environment	Fish biomass	13 million to 32 million oysters are conserved between 2008 and 2017 by self-governance [20]	Fluctuated between 1996 and 2007 because of the nature of the fishery [10]	For QMS fisheries, the proportion of sustainable fisheries increased from 41% to 54% between 1996 and 2007 [60]
	Total non-fishing areas (*e.g.*, marine reserves and non-take zone)	Unchanged, no non-fishing area (Wright pers. comm., 2009)	Unchanged, no non-fishing area [10]	30 marine reserves, 16 Mātaitai and 8 taiapure [62, 63]
	By-catch rates	Fluctuated with no clear trend [60]	Fluctuated with no clear trend [60]	NA

Table 3. A summary of the trends of all indicators.

From the results in Table 3, it appears the self-governance improves the economic performance of fisheries management the most. This makes intuitive sense because the fishing industry seeks self-governance because of the economic benefits it is expected to provide. However, it is one thing to postulate that self-governance improves a fishery's economic performance, but quite another to provide concrete evidence to support such an argument. This research provides some evidence to support the claim.

Table 3 indicates that improved economic performance with self-governance comes from cost-savings in indirect fishing costs and management costs. In terms of indirect fishing costs, vessel numbers decreased faster in the two self-governed fisheries compared with delayed and slow decline in all QMS fisheries. The other indicator of indirect fishing costs is the Number of Processing Plants. The numbers in Bluff and Challenger self-governed fisheries show a certain level of cooperation in processing. Management costs also indicate improved economic performance in those two fisheries. In the Bluff oyster fishery, there is no evidence of shifting management cost from the public onto users, but there was increased private investment on research. However, in the Challenger scallop fishery, there is evidence for cost-savings in all three aspects (*i.e.*, actual management, compliance and research).

In addition, investigation of institutional effectiveness showed that self-governance in both Bluff and Challenger fisheries helped users' communication and increased compliance rates. Although the degree of self-governance differs between Bluff and Challenger, BOMC (Bluff Oyster Management Company) and CSEC (Challenger Scallop Enhancement Company) carry a number of management functions, which facilitates communication amongst fisheries users. As a result, the number of non-compliance cases decreased following self-governance in both fisheries. In contrast, the number of non-compliance incidents increased for all QMS fisheries.

The last group of indicators show the effectiveness of self-governance on resource/environment management. In Bluff, self-governance contributed to stock rebuilding by organising ACE (Annual Catch Entitlement) shelving. Similarly, Challenger fishers self-governance saw them engaging in scallop enhancement programmes. On the other hand, fishing habitat management is perhaps the area where self-governance contributed the least. No non-fish zone was added to either Bluff or Challenger fisheries though non-fish zone areas have been increasing in total in New Zealand waters. Similarly, the by-catch rates in the two self-governed fisheries show that self-governance did not contribute to greater habitat protection awareness.

5. Discussion

The results generated from the indicator system highlight two policy-related discussion topics. First, it seems that the maturity or sophistication of a QOA plays a critical role determining how the potential benefits of self-governance are realised. This argument is supported by comparing the performance of the Bluff oyster fishery (a relatively young, basic self-governance regime) with the Challenger scallop fishery (a mature, sophisticated self-governance regime). Almost every indicator, but especially those that relate to fisheries management cost-saving, indicate the clear benefits of self-governance in the Challenger scallop fishery.

One aspect that must be noted is the maturity of a QOA is not measured by the establishment period of the self-governance entity, but rather by the legal status of the QOA (*i.e.*, the amount of backing it has from government). The CSEC is younger than the BOMC in terms of years of existence: the CSEC was established in 1994 and the BOMC

in 1992. The difference between the two self-governance regimes is that CSEC's authority is supported by legislation [11], bound by legal agreements and is overseen by government officials. In contrast, the BOMC's self-governance is sustained by mutual agreements amongst its users, and those agreements are not legally binding, backed up by regulation or by legislation. It is the CSEC that has the greatest government support and gains the largest benefits from self-governance.

Therefore, the support of government for a self-governance entity is crucial in order to fully realise the benefits which it may provide. This conclusion aligns well with literature that has emphasised the role of government in co-management regimes. Specifically, Grafton [64] examined three different management regimes (private rights-based, community rights-based and state rights-based) and concluded that the success of any management regime required government facilitation and coordination. Similarly, Townsend [14] also stressed the role of government for self-governance regimes to succeed. However, he argued that the role of government should be more than just facilitation. Accordingly, he reasoned that in order to realise the benefits of self-governance, the government has to be willing and prepared to grant such legal status to the stakeholders.

The second discussion issue is with regard to the specific contributions of self-governance. In both the Bluff oyster fishery and the Challenger scallop fishery, though there was evidence of fish stock conservation and enhancement, no significant measures were taken to manage by-catch or to establish no-fish zones. This result adds empirical weight to the conventional understanding about resource stewardship in rights-based management regimes. There are two different views regarding fish stock and resource conservation in a self-governing fishery. On the one hand, because fisher co-operatives have more exclusivity to the resource, they have more incentive to safeguard their resources and the environment [1, 4, 5, 12]. On the other hand, Townsend [14] noted that when the private costs of protecting fishing resource and habitat outweigh the benefits, fisher co-operatives will fail to address public good problems. This research provides evidence for the claim that both by-catch and environmental management are external to commercial self-governance and that self-governance will not be able to internalise all externalities.

Accordingly, government should pay close attention to environmental management in fisheries. If generalised further, the implication is that government should be in charge of aspects of self-governance where there is a value mismatch between the ITQ-holders and society as a whole. That is why the literature around ITQs and self-governance often recommends that the government should retain a supervisory role to protect the interests of the public (*e.g.*, [5, 65].

However, the above view regarding the government's involvement might need finessing. This is because the need for government supervision varies for different fisheries. McCay [66, p. 11) believed that the ability of the ITQ management regime to address resource conservation issues hinge on "the time horizon for planning, the nature of future rewards for present sacrifices and the extent to which ITQs affect the capacity for collective action." All of these traits vary with fisheries because of the heterogeneity of fisheries and their self-governance structures. For example, the nature of future rewards for present sacrifices will be different between fish stocks. For stocks that decrease catch at present (sacrifice) can yield greater future catch (reward) (*e.g.*, the Bluff oyster fishery), less supervision might be needed. Similarly, for a capable self-governance structure (*e.g.*, the

Challenger scallop fishery), less supervision is required. Therefore, there might be mismatches between the requirements for supervision and the level of supervision.

The consequence of such mismatches can be significant. Excessive amounts of supervision create wastage and tension between managers and users, but inadequate supervision might lead to fishery collapse. In addition, government supervision cannot cover every aspect of fisheries management. In this regard, the issue of supervision in a self-governance regime is similar to the input control regulations a government imposes on fishers. Often, fishers can find ways to get around the controls if they have an incentive to do so. For example, a deemed value system might be able to address part of the by-catch dumping problem, but dumping is always an option if unsupervised.

It might not be enough to recommend government supervision for problems that self-governance cannot address properly. Our finding from the IS study for the Bluff oyster fishery and the Challenger scallop fishery is that self-governance is not a panacea for all problems in fisheries management. There will be areas that this management regime cannot address. Furthermore, not all of these problematic areas can be addressed by government supervision. This is because in terms of resource and environmental stewardship, "[f]ar less is known about what the conditions are, or can be, that lead to individual or collective behaviour to reduce such behaviour, including ways the systems can be designed for that purpose" [66, pp. 17-18). It is important is to realise what are the priorities in fisheries management. Generally, the goal of fisheries management in modern capitalist economies is to utilise the resource efficiently with the proviso that the objective of resource conservation is also met. In this regard, from our findings that ITQ-based self-governance in New Zealand fisheries appears to out-perform the ITQ management regime alone.

6. Conclusions

In this paper, an indicator system is developed and used to evaluate the performance of self-governance in New Zealand fisheries. Indicators have been used extensively in evaluating the sustainability of fisheries, but there has been no indicator system designed previously that was specifically tasked with evaluating self-governance.

Developing an indicator system that evaluates self-governance as opposed to sustainability is necessary because these concepts are different. Specifically, sustainability studies focus on various areas of fisheries management especially the sustainable use of fishery resources. In contrast, self-governance evaluation should be focussed on the theorised benefits of this management regime. Furthermore, one reference point might be sufficient for sustainability studies, where the indicators are compared with a single standard to show the condition of the fishery. In contrast, in order to analyse the effect of the self-governance component in an ITQ fishery, two reference points might be needed. The first internal reference points are used for each indicator to observe whether there is improvement associated with self-governance. The second external reference points are used to study trends in each indicator for the self-governed fishery and a comparable non-self-governed fishery (or the rest of the QMS fisheries if such a comparable fishery is not available).

In applying the indicator system developed herein to evaluate the performance of self-governance in New Zealand fisheries, there were two key findings. First, the indicator system was able to evaluate the performance of self-governance at a disaggregated level. The evaluation was undertaken by selecting suitable indicators from the relevant literature according to the theorised benefits of self-governance in fisheries management. Thus, the

indicator system provided a more complete understanding of the contribution of self-governance for fisheries management. Secondly, the indicator system is effective in separating the contribution of self-governance from the ITQ management regime. This is achieved by the double-reference point system used in this research.

In terms of the contribution of self-governance to an ITQ fishery, the indicator system provides some evidence that self-governance can contribute to economic efficiency, institutional effectiveness and to a lesser extent to resource/environmental preservation. According to the analysis of the Bluff oyster fishery and the Challenger scallop fishery, self-governance contributes to fisheries management beyond that from the ITQ management regime alone. This result agrees with the findings in Yang *et al*., [20]. Based on these findings, self-governance is with some caveats, recommended for wider use in New Zealand fisheries management. It deserves serious consideration for use in other nation's quota management regimes.

6.1. Limitations and future research

There are a few noteworthy limitations of this research. One particular limitation is its scope. Because only two self-governed fisheries were evaluated, there is room for more follow up research to assess the contribution of self-governance. Future research efforts are needed that apply the indicator system developed to other self-governed fisheries to enable generalisable statements to emerge about the contribution of self-governance to fisheries management. Undertaking an extensive large-N research would, however, be difficult as it would require a substantial amount of resources and time to collect and analyse the required information.

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Appendices

Appendix A. Source literature of indicators for New Zealand fisheries self-governance studies.

Source	Purpose	Target	Area 1	Area 2	Area 3	Area 4
NGOs						
UN [31,32]	Sustainable global development	International, national and regional	Environmental	Economic	Social	Institutional
FAO [33]	Sustainable development of fisheries	International, national and regional	Environmental	Economic	Social	Institutional
OECD [36-38]	Sustainable development of environment	International, national and regional	Environmental			
Marin & Freshwater Research [39]						
Bonzon [40]	Sustainable development of fisheries	Mediterranean		Economic	Social	
Chong [41]	Sustainable development of fisheries	India			Social	
Gilbert *et al*. [43]	Fish stock management	New Zealand	Biological			
Hundloe [44]	Fisheries economic sustainability	Generic		Economic		
Seijo & Caddy [45]	Fisheries indicator application	Generic	Biological	Economic		
Ward [46]	Sustainable marine ecosystem development		Ecological			
Recent literature (2000 onwards)						
Ithindi [50]	Fisheries economics	Namibia		Economic		
Allen and Gough [51]	Fisheries environmental impact	U.S.A.			Social	
King *et al*. [52]	Fisheries enforcement	U.S.A.			Social	
Townsend *et al*. [53]						
Mincher [10]		Challenger scallop fishery		Economic		Institutional
Soboil & Craig [17]		Deepsea crab fisheries	Biological	Economic		Institutional
Yandle [18]		Rock lobster fishery				Institutional
Clement et al. [19]		Orange roughy fishery	Biological	Economic		Institutional

Appendix B. Candidate indicators for New Zealand fisheries self-governance studies.

Economic	Source	Institution	Source	Resource/environment	Source
Capital costs/fixed costs	Bonzon [40]; Hundloe [44]	Capacity to elicit, receive and use information from all stakeholders/Management leadership	FAO [33]	Areas of critical habitat (*e.g.*, marine reserves)	FAO [33]
Exporting earnings	Clement *et al*. [19]	Caring and protective attitude and behaviour of users	Chong [41]	biodiversity	FAO [33]; Raakjær *et al*. [48]
Gross value added	Bonzon [40];	Effective communication between stakeholders	Yandle [18]; FAO [33]	Biomass/Targeted biomass	FAO [33]; Seijo & Caddy [45]
Implicit discount rates	Mincher [10]	Enforcement of catch	Mincher [10]; Seijo & Caddy [45]	CPUE	Gilbert *et al*. [43]; Raakjær *et al*. [48]
Indirect fishing costs (no. of vessel, crew and processing facilities *etc*.)	FAO [33]; Bonzon [40]; Hundloe [44]	Existence of outstanding disagreements	FAO [33]	Exploitation rate/Targeted exploitation rate	FAO [33]
Landed price	FAO [33]; Hundloe [44]; Ithindi [50]	Higher level authorities facilitating lower levels of management	Yandle [18]; Clement *et al*. [19]; FAO [33]	Fish population	Mincher [10]; Seijo & Caddy [45]; Ward [46]
Landing value	Soboil & Craig [17]; Clement *et al*. [19]; FAO [33]; Bonzon [40]; Hundloe [44]	Involvement of major stakeholders in making and applying rules of the game	Mincher [10]; Soboil & Craig [17]; Yandle [18]; Clement *et al*. [19]; FAO [33]; Seijo & Caddy [45]	Pre-recruited stock biomass	Mincher [10]
Management cost/Government charges (research, enforcement *etc.*)	Clement *et al*. [19]; Hundloe [44]; Seijo & Caddy [45]	Level of agreement amongst stakeholders	Mincher [10]	Protected species populations/By-catch	Ward [46]
Net return on investment	FAO [33]; Bonzon [40]; Seijo & Caddy [45]	Lowered pollution level	Chong [41]	Recruited stock biomass	Mincher [10]
Net value added	Bonzon [40]	Management leadership	Mincher [10]; Soboil & Craig [18]; Yandle [19]; Clement *et al*. [20]	Size of spawning stocks	Mincher [10]; OECD [36-38]; Seijo & Caddy [45]; Raakjær *et al*. [48]
Operational costs/Variable costs	Bonzon [40]; Hundloe [44]			TACC	Mincher [10]; Soboil & Craig [17]; Clement *et al*. [19]
Productivity of capital	Bonzon [40]			Total catches	UN [31, 32]; FAO [33]
Productivity of labour	Bonzon [40]				
Profits	FAO [33]; Bonzon [40]; Hundloe [44]; Ithindi [50]				
Quality of fish products	Clement *et al*. [19]				
Subsides	FAO [33]				

Appendix C. Analysis of the selection of economic indicators for New Zealand fisheries self-governance studies.

Indicators	Understandable	Specific/Relevant	Concrete/Scientifically valid/conceptually sound/Adequately documented	Data available/Measureable	Sensitive/Responsive
Capital costs/fixed costs	√	√	√	?	√
Exporting earnings	√	?	√	√	?
Gross value added	?	?	√	?	?
Implicit discount rates	√	√	√	?	?
Indirect fishing costs (no. of vessel, crew and processing facilities *etc* .)	√	√	√	√	√
Landed price	√	√	√	√	?
Landing value	√	√	√	√	?
Management cost/Government charges (research, enforcement *etc.*)	√	√	√	√	√
Net return on investment	√	√	√	?	?
Net value added	?	?	√	?	?
Operational costs/Variable costs	√	√	√	√	?
Productivity of capital	√	?	√	?	?
Productivity of labour	√	?	√	?	?
Profits	√	√	√	?	√
Quality of fish products	√	√	√	?	?
Subsides	√	x	√	x	x

Appendix D. Analysis of the selection of institutional indicators for New Zealand fisheries self-governance studies.

Indicators	Understandable	Specific/Relevant	Concrete/Scientifically valid/conceptually sound/Adequately documented	Data available/Measureable	Sensitive/Responsive
Capacity to elicit, receive and use information from all stakeholders/Management leadership	√	√	√	√	√
Caring and protective attitude and behaviour of users	√	?	√	√	?
Effective communication between stakeholders	√	√	√	√	√
Enforcement of catch	√	√	√	√	√
Existence of outstanding disagreements	√	√	√	√	√
Higher level authorities facilitating lower levels of management	√	√	√	√	√
Involvement of major stakeholders in making and applying rules of the game	√	√	√	√	√
Level of agreement amongst stakeholders	√	√	√	√	√
Lowered pollution level	√	√	?	?	x
Management leadership	√	√	√	√	√

Appendix E. Analysis of the selection of resource and environment indicators for New Zealand fisheries self-governance studies.

Indicators	Understandable	Specific/Relevant	Concrete/Scientifically valid/conceptually sound/Adequately documented	Data available/Measureable	Sensitive/Responsive
Areas of critical habitat (*e.g.*, marine reserves)	√	√	√	√	?
biodiversity	?	?	√	?	?
Biomass/Targeted biomass	√	√	√	√	?
CPUE	√	√	?	√	?
Exploitation rate/Targeted exploitation rate	√	√	?	√	?
Fish population	√	√	√	√	?
Pre-recruited stock biomass	√	√	√	√	?
Protected species populations/By-catch	√	√	√	√	√
Recruited stock biomass	√	√	√	√	?
Size of spawning stocks	√	√	√	?	?
TACC	√	√	?	√	?
Total catches	√	√	?	√	?