A perspective on the relationship between individual tradeable quota management and environmental stewardship

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Abstract

Individual tradeable quotas (ITQs) are an example of incentive-based fisheries management in which fishing rights can be privately owned and traded. ITQs are an economic instrument introduced in conjunction with a total allowable catch which is aimed at resolving the problems created by open access in wild fisheries. ITQs were proposed as a means to promote efficiency and there is growing empirical evidence that ITQs meet a number of economic and some social objectives. Even though improved stock status arises mainly from the total allowable catch levels implemented together with ITQs, such improvements have also been attributed to increased environmental stewardship resulting from the allocation of individual fishing rights.

We define environmental stewardship as a set of normative values which private individuals may hold with respect to the marine ecosystem. Environmental stewardship entails perceived duties and obligations to carefully manage and use marine resources. In this paper we do not debate the success or otherwise of ITQs in meeting sustainability objectives, but discuss the premise that this success may in part be a consequence of a change in fishers' environmental stewardship. In particular, we question whether ownership of a use right *per se* creates particular attitudes and behaviours towards resource use that would not be observed from the same individuals if the rights were not owned by them.

In a fisheries context we find little empirical evidence that fishers' environmental stewardship has changed as a consequence of ITQ management. The lack of coherent

attitudinal information, or even simple property owner demographics, scarcely allows quantification of stewardship before or after introduction of ITQ management. Although a co-management approach theoretically enhances stewardship behaviour, changes in quota ownership characteristics in ITQ managed fisheries could lead to effects that either enhance or constrain stewardship and to outcomes that are difficult to predict.

Keywords: Environmental ethics, stewardship, ITQs, fishing rights, co-management.

Introduction

Even though on a global scale exploitation rates for ocean fisheries have declined [1], it is estimated that about 30 percent of fish stocks still require rebuilding [2]. To achieve further reductions in exploitation rates and thus improved sustainability outcomes, some researchers have promoted the use of incentive-based approaches to fisheries management [e.g. 3, 4, 5]. These approaches recognize the importance of relying on economic incentives to influence the decisions of fishers [e.g. 6]. Economists Gordon [7] and Scott [8] were early advocates of using the allocation of use rights[1] as a means to limit access to the commons, and thus to avoid the development of excess capacity in fisheries, and create incentives to conserve fish stocks. Allocating individual fishing rights is one of a number of methods, with common property or communally owned use rights, also successful in achieving positive environmental outcomes for fisheries management [9-16].

As ITQ management has been implemented for over three decades in some fisheries, with an estimated 250 fisheries around the world that now have some form of ITQ management system [17, 18], some empirical evaluation of this type of management approach from an economic, social, cultural, and environmental perspective has been undertaken [19-22].

With regard to the economic impacts of ITQ management, some studies show that ITQs can promote economic efficiency [23, 24] through a reduction in fishing

[1] ITQs are also sometimes referred to as property rights. However, as some authors indicate, ITQs are not 'property' *per se*, but rather a privilege to catch a share of a total allowable catch in a given year [9, 10]. We prefer to use the terms 'fishing right' or 'use right'.

capacity with the more profitable fishers remaining in the fishery, and in some cases through an increase in the value of the output [e.g. 25, 26-29]. In some situations the economic outcomes of ITQs are less well defined. For example, in multi-species fisheries [e.g. 30], in situations of multiple or shared jurisdictions [e.g. 31], in the absence of robust estimates of the resource stock abundance [e.g. 19, 32, 33], in the absence of sufficient monitoring and compliance [e.g. 34, 35] and potentially where a lack of cash flow leads to failure in the market for quota, ITQs may not achieve a high level of efficiency.

Empirical information on the social impacts of ITQs has grown over the past few decades. We label social impacts as those that affect the activity and well-being of a community, the individuals within it, and their families. Social impacts of ITQs have mainly focussed on negative equity outcomes [21, 24, 36] including issues around the initial allocation process [37-40], the extension of corporate control at the expense of small-scale local interests [25, 41-46], and subsequent social stratification, changing social interaction and gender relations [47]. There also appear to be trade-offs between improved economic efficiency and the nature and amount of employment in fisheries, with changing job structures leading, in some cases, to a fall in full-time equivalent jobs [19, 21], mostly affecting crews [48], while other research has shown that ITQs can also lead to an increase in the proportion of full-time jobs and a decrease in the proportion of part-time work [49]. Other effects of ITQs include changes in compliance and misreporting [40, 50] and improved fisher health and safety, resulting from increased flexibility in allocating fishing time [51].

A number of studies have also considered the impacts of ITQ management on the culture of particular indigenous communities. For instance, for the Maori in New Zealand [e.g. 52, 53], the Mi'kmaq in Canada [14], and the Saami in Norway [54] privatisation of fisheries access rights was found to be at odds with cultural norms. In some indigenous communities ITQs were thought to spell the end of a traditional way of life, leading to questions being raised regarding the usefulness of ITQ management in these small-scale fisheries [19].

The effectiveness of ITQs has also been evaluated against resource sustainability and broader ecological outcomes. Costello et al [17] addressed the impacts on target resources in a review of exploitation trends for all ITQ managed fisheries. They found that ITQ managed fisheries were half as likely to collapse as those that were not

managed in this way. Even though Costello et al [17] suggest there is a relationship between target stocks improvement and ITQ management, the process by which these improvements arise is not explicitly discussed. Measuring the success of ITQs in meeting stock sustainability objectives is not simple because the effect of allocating individual tradeable catch shares cannot be easily separated from the effect of setting an appropriate total allowable catch (TAC) level [17, 55]. Essington [20] failed to find systematic evidence of the broader ecological benefits of ITQs, a finding also supported by Melnychuck et al [56].

Garrity [55] points out that the improved ecological outcomes resulting from the introduction of ITQs are theorised to arise largely from changes in individual behaviour linked to greater environmental stewardship. Environmental stewardship has been defined as responsibly managing activities with due respect for the health of that environment by being the environment's caretaker or custodian (the Australian Sustainable Schools Initiative - AuSSI).[2] Authors have stressed that economic drivers may exist in ITQ systems which encourage environmental stewardship, including an increase in the economic value of quota shares [4, 18, 20, 27, 57]. By virtue of their economic interest, fishers would be expected to look after fish stocks, which include the natural ecosystem the fish depend on, in the same way that they look after other assets they own.

Environmental stewardship has also been explained from the perspective of non-economic drivers. In this context environmental stewardship is understood to arise from attitudes and deeper moral norms. Environmental stewardship can be understood as "an ethical responsibility when short-run profit-seeking behaviour dictates practices contrary to long-term maintenance of [environmental] quality [of natural resources]" (p.32). The concept thus relates first and foremost to the ethical dimensions of actions impinging on natural resources, at individual and collective levels. It carries a strong moral dimension, which may work in an opposite direction to personal interests. In this view environmental stewardship is seen as a duty, a moral virtue, or a way to secure future benefits for others [58]. In a detailed investigation of the stewardship concept applied to land use and conservation, Worrell and Appleby [59, p. 268] stress

[2] Definition published on the AuSSI website (accessed 21/09/2011) at: http://www.environment.gov.au/education/aussi/help/glossary.hmtl

that this feeling of responsibility for the benefits of others may encompass the wider community and future generations, as well as the natural world itself. Environmental stewardship has been described as one of the key underpinnings of ecologically sustainable resource use [60].

In this paper we focus on the argument that behaviour in support of long-term environmental stewardship in ITQ managed systems is created by ownership [61]. We define environmental stewardship as a set of normative values which private individuals may hold with respect to marine biodiversity and its uses, and which entails perceived duties and obligations with respect to the careful management of these uses. We discuss the premise that success of ITQs in meeting environmental objectives is a consequence of a change in fishers' environmental stewardship thus defined. In doing so, we consider whether the introduction of ITQs can change existing stewardship in a fishery, and how this may play out in practice given the diversity of individual views of the world and economic situations which may coexist amongst fishers. As a basis for this analysis, we consider theoretical predictions from the psychology of land ownership and examine the lessons derived from empirical studies in fisheries. Based on this, we suggest ways to improve predictions as regards the behavioural changes that may be observed following the introduction of ITQs.

Property ownership and stewardship – the theory

To allow analysis and measurement of change in environmental stewardship in fisheries occurring as a consequence of ITQ management, we need to consider what the connection is between property ownership and environmental stewardship and how environmental stewardship arises. Property and ownership theory in behavioural psychology seeks to explain the connection between property ownership and stewardship (not exclusively environmental stewardship). It explains why we care more about, 'feel' more protective towards, and are more careful with the things we own [61, 62] and why people are likely to take better care of possessions they own [63]. This theory seeks to explain behaviour and decision making when goods are owned from the viewpoint of a self-interested individual and provides insights into the reasons why higher values are placed on goods we own compared to ones we do not own, referred to as 'the endowment effect'[64]. T The objects of ownership can become so deeply rooted within people's self identity that they can be viewed as an

extension of the self [65-68]. Pierce et al [62, p. 85] use the example of the debilitating effects of separating individuals, particularly children and the elderly, from their possessions to illustrate this effect. Ownership feelings and 'self-identity' may be tied up with physical objects but also with facets of employment where a person strongly identifies with a particular profession [61]. Importantly, feelings of ownership are not limited to private goods but can apply to a collective sense of ownership, for instance, to landscapes or entire ecosystems [e.g. 69]. Ownership and property theory can thus help understand our behaviour regarding private and collectively owned goods.

Even though a link between stewardship and property ownership is thought to exist, this link is not fully understood and is the subject of ongoing research. For instance, psychologists who study organizational behaviour strive to improve understanding of the 'sense' of ownership, and the 'motivation' to protect and improve what is owned [63]. Cognitive psychologists continue to investigate whether differences in mental representation, individual differences, expertise, or education, lead to differences in property-related attitudes or behaviour [70, 71].

As mentioned above it is also important to understand the link between property ownership and stewardship but also to understand how environmental stewardship arises, which stewardship theory [72] can help explain. Stewardship theory focuses on the nature of relations between individuals and the object of the relationship. Stewardship theory is built on the hypothesis that a person's core or inherent values form a foundation of consistent ethical values and goals leading to specific moral decision making and behaviour [59, 72]. Stewardship theory considers the possibility that individuals can become stewards, in contrast to agency theory developed by organisational economists, which assumes self-interested individuals. Stewardship theory suggests that, over time, stewardship can develop based on trust, reciprocity, autonomy, discretion, responsibility, job satisfaction, stability and tenure, reputation enhancement, and alignment of objectives.

Stewardship at a collective level

Individuals can be stewards in their own right or at a collective level where a steward places great value on cooperation. They value cooperation over defection and other expressions of self-serving behaviour. This is because of the steward's perception 'that

the utility gained from contractually aligned behaviour is higher than the utility that can be gained through individualistic, self-serving behaviours' [73, p. 25]. When personal core normative values are shared by others, and collective goals overlap, there is an increased likelihood of that person acting in the interests of achieving these collective objectives [72, 74]. In fact, self interest, core values, shared values, and shared objectives need to align for collective goals to be achieved - otherwise the opposite may result (see the concept of "crowding out" in Bowles [75].

Achieving long term sustainability and stewardship outcomes at a collective level in a common property context is mediated by several variables such as access to adequate information, information sharing, and engagement [76, 77]. We learn that environmental stewardship at a collective level also relies on cooperation [78-82]. Trust also has an important influence on the acceptance of collective costs in the interest of resource sustainability [77, 83, 84]. Environmental, agricultural, and forestry research has provided empirical evidence that environmental stewardship is predicated on this common understanding, trust, and cooperation [85-88].

The issue of environmental stewardship at a collective level is of particular interest from a fisheries perspective as co-management and collective resource ownership arrangements are increasingly used to manage fisheries [e.g. 89]. Co-management involves a spectrum of approaches from widened consultation with resource users through to the direct assumption of management functions by fishers [83]. The composition of stakeholder representation on co-management committees and their level of involvement varies [90] but generally includes fishers, quota owners, scientists, and government officials and sometimes conservation and processor representatives [91]. Co-management committees in some fisheries are analogous to company boards in that they determine business paths and futures. From the management literature we know that shared values and stewardship behaviour of management and decision making boards can explain long-term business success [73, 92]. With respect to fisheries, the philosophical alignment of co-management committee members could theoretically result in collective decisions that achieve environmental objectives. Environmental stewardship may also be the result of a common decision making process in which breaking from agreed positions would have social repercussions [93].

Attitudes, norms, beliefs, and behaviour

Stewardship theory helps understand how environmental stewardship, which we defined as arising from a person's set of normative values with respect to the marine environment, is mediated and develops. Understanding these normative values, which include a person's attitudes and beliefs, can help predict their environmental behaviour [94, 95]. The "theory of planned behaviour" provides a general framework for the relationship between attitudes, beliefs, intentions, and behaviour [96, 97]. Resource studies in environment, agriculture, and forestry confirm that attitudes and personal beliefs play a role [98, 99] in achieving environmental outcomes in the context of private land use [60].

Social scientists focus, among other things, on describing and explaining attitudes and personal beliefs towards environmental issues [e.g. 98, 99]. Some 'types' of environmental attitudes are predictive of environmental stewardship behaviour [e.g. 100]. A number of studies have characterised environmental attitudes by describing the extremes, from 'eco-centric' attitudes at one end of the spectrum to 'market based' attitudes at the other [e.g. 101, 102]. Eco-centric attitudes reflect the belief that nature has a value of its own and deserves protection independently of any economic service it may provide and these conservation-centred attitudes are often predictive of pro-environmental behaviour and stewardship in empirical research [103-108]. Moreover, individuals with conservation-centred attitudes are more likely to join incentive schemes that promote conservation outcomes [e.g. 109].

The gradations that occur on the continuum between the two 'extremes' in environmental attitude are complex. Generally individuals are multi-faceted leading to a number of different attitude types including those with multi-objective attitudes. The study of environmental attitudes is widespread in the agriculture and forestry domains [105, 110] where the attitudes of land managers have been characterised using different typologies [e.g. 111, 112]. In general, both pro-environmental and anti-environmental attitudes are found to occur in these communities [e.g. 101, 113].

Above we focused on a person's attitudes and beliefs (their normative values) to understand environmental stewardship as expressed in that person's behaviour. In the agricultural literature, and empirical studies carried out mainly in the USA, Europe, and Australia, increased environmental stewardship behaviour can also be explained

by socio-economic and demographic variables such as lower age, higher educational attainment, female gender [e.g. 100, 114, 115], higher income levels [e.g. 85, 116, 117]. larger acreage, and higher capital ownership [118]. Higher levels of farm debt, higher dependence on farming for an income, being an absentee landlord (or corporate owner), and being a lease holder [108, 119, 120] were predictive of lower stewardship behaviour [e.g. 121, 122, 123]. Even though the reported results apply to many different agricultural 'situations' they may not be generally applicable. In other words, there is no absolute uniformity in either the predictive accuracy of the variables or in the direction of the effect.

The observable (which can be measured (in)directly) and non-observable variables that affect stewardship behaviour in the (mostly agriculture and environmental) literature are summarised in Figure 1.

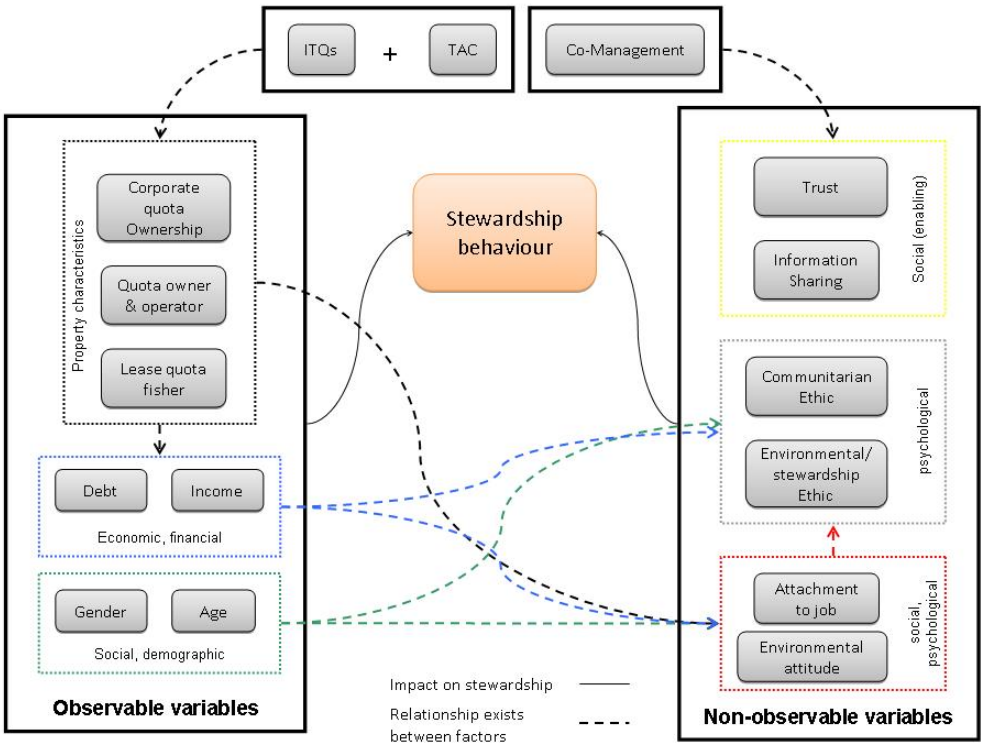

Figure 1: Observable and non-observable social, economic, and psychological variables and property characteristics that affect stewardship, set in the context of ITQ fisheries.

The relationship between the variables illustrated in Figure 1 and stewardship behaviour is complex due to the impacts of the variables on each other (shown by the dashed lines) and to possible non-linear responses. The three variable groups shown at the left-hand side of the diagram are perhaps the most easily determined and therefore

can contribute to better understanding the relationship between ITQs (property characteristics) and stewardship behaviour. The non-observable variables are also critical in determining behaviour and outcomes, and effort need to be made to find at least indirect ways to measure them.

Empirical evidence of stewardship in fisheries

In this section, we examine the types of empirical information that are available to assess potential changes in environmental stewardship that might occur as a consequence of ITQ management. Even though several papers mention the possible influence of environmental stewardship in fisheries [4, 18], there is very little empirical research into variables that predict environmental stewardship and factors that enhance environmental stewardship. For instance, there have been no studies that measure fisher attitudes shown to be predictive of environmental stewardship. In contrast to the agricultural literature, there is also little extant information on the socio-economic and demographic characteristics of fishers that have also been found to be predictive of environmental stewardship. Information is also scarce on personal and community factors that contribute to and enable the development of stewardship, such as information availability and information sharing [e.g. 82]. We first discuss the role of variables that fall into the left-hand side box of Figure 1 followed by those on the right-hand side.

Baseline information

There is also little evidence of empirical research in which actual behavioural changes are simply observed. More specifically, and aside from studies that investigate the environmental consequences of by-catch in ITQ managed fisheries, there are few studies that measure actual changes in environmental behaviour in fisheries[124]. For a statement about potential change in environmental stewardship resulting from ITQ management to be made, the change would need to be measured through, for instance, attitudinal surveys or observing behaviour against a baseline stewardship status prior to the introduction of this management instrument. We consider it unlikely that an environmental stewardship ethic would be completely absent among fishers and in fishing communities prior to such introduction, as most communities are characterised by heterogeneity in this regard[98]. Rather, it is more probable that (regulated) open-access fisheries that existed before ITQs did not translate into effective stewardship

behaviour, evidenced by past levels of over-exploitation, even though similar levels of environmental stewardship ethics were present in the fishing communities then, as they are now.

In light of the absence of baseline information on both the extent and nature of environmental stewardship prior to ITQ introduction, Costello et al [17] acknowledges that there is no conclusive evidence that under ITQ management quota owners *change* their interest in the long term sustainability of fish stocks. Although there are occasional, mostly anecdotal reports that fishers in ITQ managed systems have welcomed cuts in quota, whether such behaviour is due to changes in environmental stewardship ethics, or whether other factors resulted in the observed behaviour remains unclear without further underlying information.

In the absence of direct baseline information on environmental stewardship ethics among fishers, it might be useful to predict the potential presence of environmental stewardship on the basis of other available information such as fishers' attitudes, demographic information, or information on enabling preconditions for a stewardship ethic to arise.

Predictive information - attitudes and beliefs

As mentioned above, fisheries attitudinal information with respect to environmental issues has not been collected even though attitudinal information has been collected with respect to various other issues, such as work conditions, safety, and fisheries management [93, 124-128]. Not surprisingly, attitudinal heterogeneity characterises fishers and fisher communities with respect to these variables [129, 130].

In relation to specific environmental attitudes held by fishers, however, there is surprisingly little information. This is despite the fact that there are many established and well accepted ways in which information on the environmental attitudes of fishers may be collected and analysed. As far as the authors of this paper were able to determine, there has been no study in which post-management changes in environmental attitudes were measured that could shed light on stewardship changes as a result of moving to ITQs. It would seem that collection of attitudinal information, given the continuing move to ITQs as a general approach to fisheries management, particularly for high value species, is a logical step. In particular, it would seem important to collect baseline information against which, at some stage in the future,

the actual effects, perceptions, and environmental attitudes under changed management arrangements can be compared.

Predictive information - socio-economics and demographics

The lack of attitudinal information is mirrored by the notably few fisheries examples of empirically gathered demographic and social information [e.g. 124, 127]. However, research in agriculture shows that, for example, owner characteristics, gender, education, and age can be used as explanatory variables to predict attitudes and thus stewardship, (even though this type of information cannot predict *changes* in attitudes). We hypothesise that a reason for the lack of this simple type of data may be that, unlike logbook information on catch, catch composition, fishing location, gear and other infrastructure details, information about the fishers themselves is not often analysed by fisheries management authorities. Even if this type of demographic information is analysed by an authority, it may not be combined with logbook information to allow, for instance, econometric analyses where fishing behaviour is analysed as a function of these variables. Therefore, even if researchers were to assume that the same predictors for stewardship apply to fishers and landowners (ignoring the fact no universal empirical model applies to the latter), there is inadequate available information in many fisheries to carry out an analysis to 'predict' environmental attitudes and consequently stewardship ethics. A low cost solution in the short term may be to analyse various information sources and databases currently held by different fisheries management authorities, such as owner characteristics, gender, and education, to establish a proxy stewardship baseline, with a focus on collecting of attitudinal data in the future and undertake studies to establish the true predictive variables for fishers.

Enabling information - co-management

The way in which ITQs are implemented is thought to have a major bearing on their success. Unlike property ownership in land-based systems such as agriculture and forestry, ITQs involve an access right to a shared resource and in almost all instances involve the need for some form of collective management. While acknowledging that co-management arrangements have the potential to enhance environmental stewardship, evidence thus far does not confirm this [93]. In fisheries it is useful to look at the pre-condition for environmental stewardship through co-management at

two levels: the fishers and fishery, and the representatives on decision making committees and boards.

At the fishery level, there is a lack of empirical evidence to support the notion that co-managed ITQ fisheries demonstrate improved stewardship behaviour. For instance, Gilmour et al [82] found no strong relationship between trust, the capacity for cooperation, and attitudes to resource management in fisheries, but instead found that perceptions of 'resource conditions' were a key determinant of collective resource stewardship behaviour. Garrity [131] found that another precondition for stewardship, information sharing, is currently not met by co-managed ITQ systems.[3] Co-management systems may in fact provide an incentive to give inaccurate information due to perceived competition between participants [35]. If competition persists under co-managed ITQs, information sharing may not arise naturally (i.e. there are complex and interacting factors at play).

The empirical evidence of the contribution of co-management to potential changes in fishers' stewardship behaviour is complicated by observed changes in patterns of ownership in some co-managed fisheries. Vertical integration that has in some cases accompanied ITQ management has led to quota shares increasingly owned by processors and investors [21, 132]. Quota ownership change and concentration has thus also led to a growth in the number of fishers who depend on lease quota to go fishing.

Arising from such changes, the property rights system which is supposed to encourage behavioural change is no longer the same as when ITQs were first implemented. From an economic perspective these lease fishers face high upfront capital investment costs and are under higher financial stress [e.g. 51, 133]. For the same reason that lease farmers may be forced to place greater weight on short term financial returns and may not be in a position to be oriented towards long term conservation [e.g. 122, 123], lease fishers may feel less sympathetic to sustainability due to lack of ownership. Theoretically at least, lease quota fishers' lack of ownership (or rather access right) combined with economic pressure may result in less information sharing, trust,

[3] It could be argued that, rather than information sharing being a precondition for stewardship, in fact, stewardship has to be present prior to information sharing occurring. People may more readily share information if they perceive this as being in the interest of resource preservation [78], and if they hold resource preservation as an important goal to pursue. Once stewardship is present it may therefore, in the longer term, be self reinforcing through increased information sharing.

cooperation, and ultimately stewardship. However this may be counter-balanced by the fact that lease fishers are always active fishers, and may have a strong interest in the long-term continuation of their activity and their jobs, which is part of their self identity. Studies suggest that the strong attachment of fishers to their jobs is particularly pertinent in mediating stewardship [134-136]. How these opposing forces balance out is currently unknown and would be difficult to determine, and the stewardship consequences of lease fishing thus remain unresolved. We suggest that this is an important area of future research not only for psychologists and sociologists, but for economists as well.

Another aspect that blurs the direct link between the enabling factors of co-management and enhanced stewardship behaviour is the potentially different views and levels of influence of representatives on co-management committees [93]. Empirical evidence suggests that sustainable resource outcomes and stewardship development have been adversely affected by the significantly divergent views and varying political influence of different representatives [93]. For instance, where stakeholder representatives comprise large industrial fishing operations, or fish processing firms who may also control much of the supply of lease quota, unbalanced negotiation outcomes disadvantaging small scale or lease fishers may result [137]. The implications for stewardship are again complex and depend on whether large corporate owners evidence a relatively greater or lower propensity for stewardship. For instance, having a small number of large industrial fishing operations involved in co-management committees could facilitate development of shared understanding, information, and trust. Such players may also be in a better position to take the longer view. Nonetheless, the stewardship ethics of the large industrial fishing operations is largely unknown but may have potentially significant implications on the sustainability outcomes of ITQ managed fisheries [137].

Increasing membership of investors, who do not actively fish, on decision making committees further complicates consequent stewardship outcomes [e.g. 138]. Fishers have been found to have strong attachments to their jobs [134-136, 139, 140] which is pertinent in mediating stewardship. The stewardship ethics of quota owners who are not active fishers is less likely to be driven by their attachment to profession. From other resource studies we learn, for instance, that absentee landowners, who are

similar in some respects to investors in fishery quotas, have a preference for current income and have in some cases reduced stewardship incentives [108, 119, 120].

In summary, a move to fewer and generally larger-scale fishing operations, the concentration of ownership with processors and investors, increasing numbers of lease fishers, and corporate membership on co-management committees may all affect stewardship [141, 142]. However, as with many of the issues discussed in this paper, information is generally lacking and the effects can play in both directions. The authors are also aware of many instances where, for instance, large corporate players exhibit strong stewardship ethics, and where a trend of increasing concentration of ownership has run in parallel to improved resource management outcomes.

Conclusion

From a social science perspective, there is a severe lack of baseline information on the presence or distribution of individual environmental and corporate values and attitudes in fisheries. This makes it difficult if not impossible to associate changes in resource outcomes under ITQ management with changes in stewardship ethics and behaviour. Despite claims, based mainly on the psychology of ownership and property, that stewardship ethics could be enhanced by ITQs, there is little empirical information to support this. Information on variables that may be predictive of stewardship ethics, such as rights owner attitudes, is rarely collected either before or after management changes. The ready availability of data to evaluate the economic and biological outcomes of shifts to ITQ management may even have reduced the imperatives to collect information on the attitudinal and social aspects of the problem.

While psychological theory suggests that there may be a relationship, we conclude there is not enough empirical evidence that improved environmental outcomes are due to *changes* in stewardship ethics arising from changes in access rights associated with ITQ management in fisheries.

Similarly, even though theory suggests that features of the co-management approach [5, 143] in ITQ fisheries could enhance the development of stewardship ethics, there is only a smattering of empirical evidence that supports such an effect. We recognise the potentially important role of management decision processes in fostering a stewardship ethic and preliminary review of the changes in these decision processes

associated with the introduction of ITQs shows that some of these changes may be favourable, and others unfavourable.

Research now needs to focus on how attitudes to stewardship can be defined and measured and how they change with new management approaches [e.g. 82, 102, 144]. Collection of suitable data is a pre-requisite to developing knowledge on how stewardship behaviour can be enabled. Consideration also needs to be given to how co-management arrangements either enhance or impede attitudes to stewardship. After all, the interplay between ITQs, stewardship and environmental outcomes goes beyond just fishers out at sea, and extends to representatives on co-management committees that help to determine resource management outcomes [e.g. 53].

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