

Motives for Poaching in Marine Protected Areas in the Seychelles

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Abstract—Motives for non-compliance with no-take regulations in the eight marine protected areas (MPAs) of the Inner Islands of the Republic of Seychelles were investigated using semi-structured interviews with fishers. Discriminant function analysis (DFA) of responses to questions was used to classify known poachers and non-poachers to an accuracy of 94%. This classification procedure can be used to predict the poaching status of fishers of unknown poaching status, based on their responses to a standard set of questions. Although these results are preliminary, they suggest that DFA represents a powerful tool in the investigation of sensitive issues such as illegal fishing, as its use of responses to a combination of relatively innocuous questions allows the prediction of poaching activity to a high level of accuracy without requiring a direct admission to poaching. Qualitative data also presented here support these results and offer further insights into the biological, economic and socio-political motives for poaching.

INTRODUCTION

Marine protected areas (MPAs) are widely thought to have the potential to yield a wide variety of conservation and fishery benefits (Boersma & Parrish, 1999; Lubchenco et al., 2003), but the evidence for this is limited, and, in the case of fishery benefits, tends to come from MPAs which are strictly no-take, and which exhibit total or near-total compliance. Examples of such MPAs include Apo Island, Philippines (Alcala, 1988; Alcala & Russ, 1990; Russ & Alcala, 1996b; Russ & Alcala, 1996a; Russ & Alcala, 1999) and Cousin Island, Seychelles (Jennings et al., 1996; Jennings, 1998; Shah, 1998). Polunin & Jennings (1998) demonstrated a rapid decline in fish biomass at very low fishing pressures, suggesting that high compliance with fishery-related regulations in MPAs is necessary for the realization of fishery benefits. Indeed, enforcement is viewed as the neglected element in fisheries management (Sutinen & Hennessey, 1986).

In the global context of MPAs, 79% possess unknown management or are failing to meet their management objectives (Kelleher et al., 1995). Implicit in this statistic is a low level of compliance, suggesting that MPAs are largely failing to realise their potential as effective fisheries management tools. An understanding of the motives for non-compliance is thus crucial to successful MPA management, both in a fisheries and biodiversity conservation context.

The inshore domestic fisheries of the Inner Islands of the Republic of Seychelles are currently fully exploited and may be locally overexploited (Mees et al., 1998; Wakeford, 2000). In response to this, MPAs have been advocated as buffers against overfishing (Mees et al., 1998). There are currently eight MPAs in the inner islands of Seychelles (Fig. 1). However, lack of fisheries enforcement is a problem common to all fisheries in the Seychelles (Wakeford, 2000), and concomitantly, all but one of the MPAs are poached to some degree (Jennings et al., 1996; Jennings,

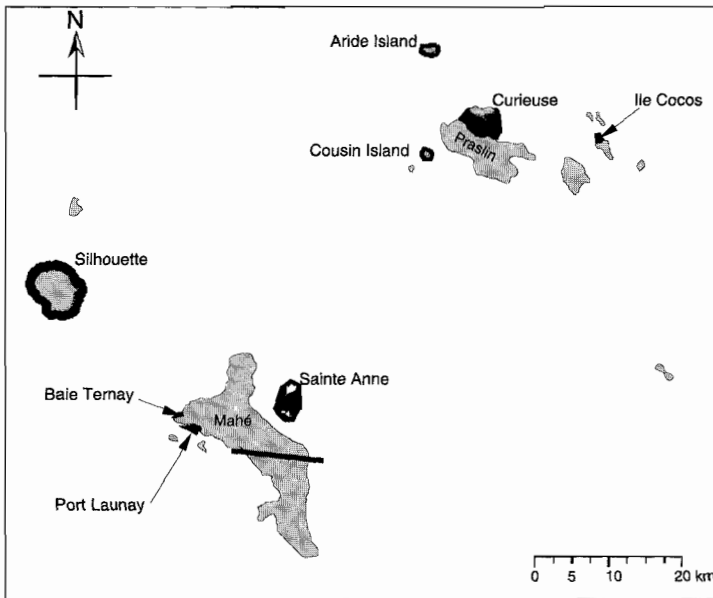


Fig. 1. Map of the Inner Islands of the Republic of Seychelles. MPAs are shown in dark grey shapes: Aride Island, Cousin Island, Curieuse, Ile Cocos, Sainte Anne, Port Launay, Baie Ternay and Silhouette Island. The black line splitting Mahé from east to west indicates the divide from where no poachers occurred further southward.

1998), despite all being subject to no-take regulations. A common challenge to effective MPA management in developing countries is a lack of sufficient financing to implement management (McClanahan, 1999). This problem is particularly relevant to compliance issues, since enforcement is costly yet an increase in expenditure does not necessarily guarantee an increase in compliance (Harrington, 1986; Charles et al., 1999). Management cost-effectiveness is therefore vital in the Seychelles, where only one MPA is fully self-financed (Shah, 1998).

While MPAs are subject to a multiplicity of threats, and it is important to address the impact of several threats acting in concert rather than of individual threats separately (Hendry, 2000), in practice only one threat can be assessed at a time. Fishing “remains the most significant human exploitative activity on the reefs of Seychelles” (Jennings et al., 2000), and as such is considered to represent the greatest threat to MPAs in the Inner Islands of the Seychelles. If MPAs are to fulfil their role in fisheries management, both in the Seychelles and in general, it is imperative to understand the motives for poaching inside them.

This paper seeks to elucidate the sociological characteristics of poachers and non-poachers, and provide insights into the motives for poaching in the MPAs of Seychelles.

MATERIALS AND METHODS

Fieldwork

Anonymous, semi-structured interviews with inshore fishers were considered the most appropriate approach to this research because of the sensitive subject matter and the need to provide interviewees with the opportunity to discuss such issues only to the extent that they felt comfortable.

A ‘key questions’ questionnaire of 45 questions was developed, to complement the open-ended conversation and enable a standard set of data to be collected for all fishers. Verification questions were incorporated into the questionnaire by which the consistency, and thus reliability of responses could be assessed. The questionnaire was reviewed by four members of the Seychelles Fishing Authority (SFA), two English and two Seychellois, and amended accordingly. It was then translated

into Creole, and the Creole version also verified and trialed with a Seychellois before interviews started. Phraseology of the interview questions remained flexible even after trialing verification; if a question appeared to be redundant or ambiguous, it was changed accordingly.

The fisher population of the Inner Seychelles was assumed to consist of two sub-populations, fishers who usually comply, and fishers who chronically poach, in accordance with Sutinen et al. (1990). For the sake of simplicity these two groups are referred to as non-poachers and poachers respectively. Given the time available (six weeks), the aim was to sample 10% of the fishing population, ideally with equal numbers of poachers and non-poachers.

Most recent estimates indicate approximately 900 fishers using boats in the 'Whaler' category (partially decked, one inboard engine) or smaller (Mees et al., 1998; Wakeford, 2000). As all of the MPAs in the Inner Islands of Seychelles are restricted to coastal areas, it was assumed that fishers using these smaller boat types would be the most heavily affected by MPAs. It was also assumed that interviewing one fisher per boat would provide representative information about the activities of that boat, and therefore the entire crew, given the small crew size (Mees et al., 1998; Wakeford, 2000). Sampling was thus stratified by boat type and also across landing sites, the latter in an attempt to obtain equal numbers of interviews with poachers and non-poachers.

Interviews were undertaken at landing sites on the two main islands of the Inner islands of Seychelles, Mahé and Praslin (see Fig. 1). They were generally carried out in Creole, and, where possible, with the assistance of an SFA fieldworker. However, the coverage of the landing sites by fieldworkers is not comprehensive, and for sampling purposes it was often necessary to go to a landing site where a fieldworker was not present. Interviewees were initially classified into one of three groups, namely poacher, non-poacher, and unknown poacher status. Poachers were classified as such based only on an admission of poaching. Classification of fishers into the other two groups was subjective, but supported by a reliability index developed in collaboration with SFA fieldworkers, based on the consistency of responses during the

interview and the SFA fieldworkers' extensive knowledge of the fishers (most of the fieldworkers have worked at SFA for more than 5 years). When interviews had to be carried out in the absence of a fieldworker, the reliability index was based on personal observations and subsequently verified with fieldworkers.

Data analysis

Interview data for all responses and all interviewees were coded. Data for fishers of known status (poacher or non-poacher) were grouped by poacher status, then standardised to proportions of the total number of responses for that question. These response distributions were then tested for homogeneity using the Monte Carlo randomisation procedure on an $r \times c$ contingency table (10,000 replicates). This procedure has been shown to be an appropriate alternative to the Chi-squared test when sample sizes are small (Lewontin & Felsenstein, 1965). Response distributions that were significantly non-random to a value of $p \leq 0.01$ were inserted into a discriminant function analysis (DFA). DFA "generates a linear combination of variables that maximises the probability of correctly assigning observations to their pre-determined groups and can also be used to classify new observations into one of the groups" (Quinn & Keough, 2002). This analysis yields a classification constant and a set classification coefficient (one for each variable), for each pre-defined group. It then reclassifies all individuals of known status according to the formula below, and provides a classification success value for the formula:

$$C_j = c_{j0} + c_{j1}X_1 + c_{j2}X_2 + \dots c_{jn}X_n$$

where C_j is the classification score, c_{j0} is the classification constant, c_{j1-n} are classification coefficients for each of the responses 1,2,...,n, and X_{1-n} are the raw data values for that fisher. The fisher is assigned to the group for which the classification score is higher. This procedure was then used to classify individuals of unknown status.

Qualitative data are presented in the discussion to corroborate findings from Monte Carlo randomisations and the DFA.

RESULTS

In total, 42 interviews were carried out, representing around 12% of small inshore fishing boats in the Seychelles. Prior to analysis, three interviews were excluded for reasons of unreliability. Of the remaining 39 interviews, 22 were of non-poachers, 12 of poachers, and 5 of suspected poachers (who did not admit to poaching but were known to be poachers). Coding of data resulted in 154 response variables, including the 45 key questions. Monte Carlo randomisations were performed on the interview data from the 34 fishers of known status, representing just under 10% of small fishing boats in Seychelles.

Monte Carlo randomisation simulations

Monte Carlo randomisations identified nine questions whose distributions were significantly non-random to a value of $p \leq 0.01$. These are summarised in Table 1, and described below.

Q.1: Are you always certain to catch as many fish as you need?

Of all fishers interviewed, only 21% felt they were certain to catch enough fish. This perception was far more prevalent amongst poachers (42%) than non-poachers (9%); see Fig. 2a. This is most likely due to the larger area of fishing grounds rendered available to poachers by fishing inside MPAs.

Q.2: Do you think that fish should be protected?

Non-poachers most commonly responded affirmatively to this question (50%) compared to

only 20% of poachers (Fig. 2b). Poachers mostly offered conditional responses (70%), suggesting that, for example, fish should only be protected in certain locations (most likely not where they wanted to fish), or that only particular species, or juveniles, should be protected.

Q.3: Do you feel that you receive benefits from MPAs?

Ironically, 57% of non-poachers felt they received benefits from MPAs, while only 27% of poachers felt they received benefits (Fig. 2c). Benefits mentioned included the protection of small fish, and the revenue accrued in Seychelles through tourism.

Q.4: Do you feel that you lose fishing grounds to MPAs?

Sixty-seven percent (67%) of non-poachers felt that they did not lose fishing grounds to MPAs, in contrast to 58% of poachers who felt they lost fishing grounds to MPAs (Fig. 2d). Fourteen percent (14%) of non-poachers, and 33% of poachers, felt that they sometimes lost fishing grounds to MPAs, generally due to seasonal weather constraints or a need to fish for bait in times of scarcity.

Q. 5: Do you think MPAs are a good tool for managing fish stocks?

No poachers (but 23% of non-poachers) thought that MPAs were a good tool to manage fish stocks, and no non-poachers (but 25% of poachers) thought that MPAs were a bad tool for managing fish stocks (Fig. 2e). Poachers and non-poachers

Table 1. Results of Monte Carlo simulations for fishers' response distributions to the nine questions which were inserted into DFA

Response variable	$p \pm SE$	n
Q.1 Perceived certainty of catch	0.0003 \pm 0.0002	34
Q.2 Perceived need to protect fish	0.0067 \pm 0.0008	32
Q.3 Perceived receipt of benefits from MPAs	0.0031 \pm 0.0006	32
Q.4 Perceived loss of fishing grounds to MPAs	0.0000 \pm 0.0000	33
Q.5 Perceived quality of MPAs as a management tool	0.0000 \pm 0.0000	34
Q.6 Perceived suitability of MPA size	0.0001 \pm 0.0001	33
Q.7 Influence of MPAs on choice of fishing ground	0.0004 \pm 0.0002	34
Q.8 Fishing activity in proximity to MPAs	0.0000 \pm 0.0000	34
Q.9 Perceived need to punish poachers	0.0000 \pm 0.0000	33

both most commonly offered conditional responses, although their conditions were markedly different. Sixty-four percent (64%) of non-poachers said that MPAs suffered from enforcement problems, while 83% of poachers said that MPAs were not a good management tool because they created user conflicts.

Q. 6: Do you think the existing MPAs should be bigger / smaller / stay the same size?

Non-poachers' most common response was that

MPAs should stay the same size (57%) while poachers' most common response was that MPAs should be smaller (64%). While some non-poachers thought that MPAs should be bigger (14%), no poachers held this view (Fig. 2f).

Q. 7: Do MPAs influence where you choose to fish?

Most non-poachers were not influenced in their choice of fishing ground by MPAs (73%), while MPAs influenced 67% of poachers' choices of fishing ground (Fig. 2g).

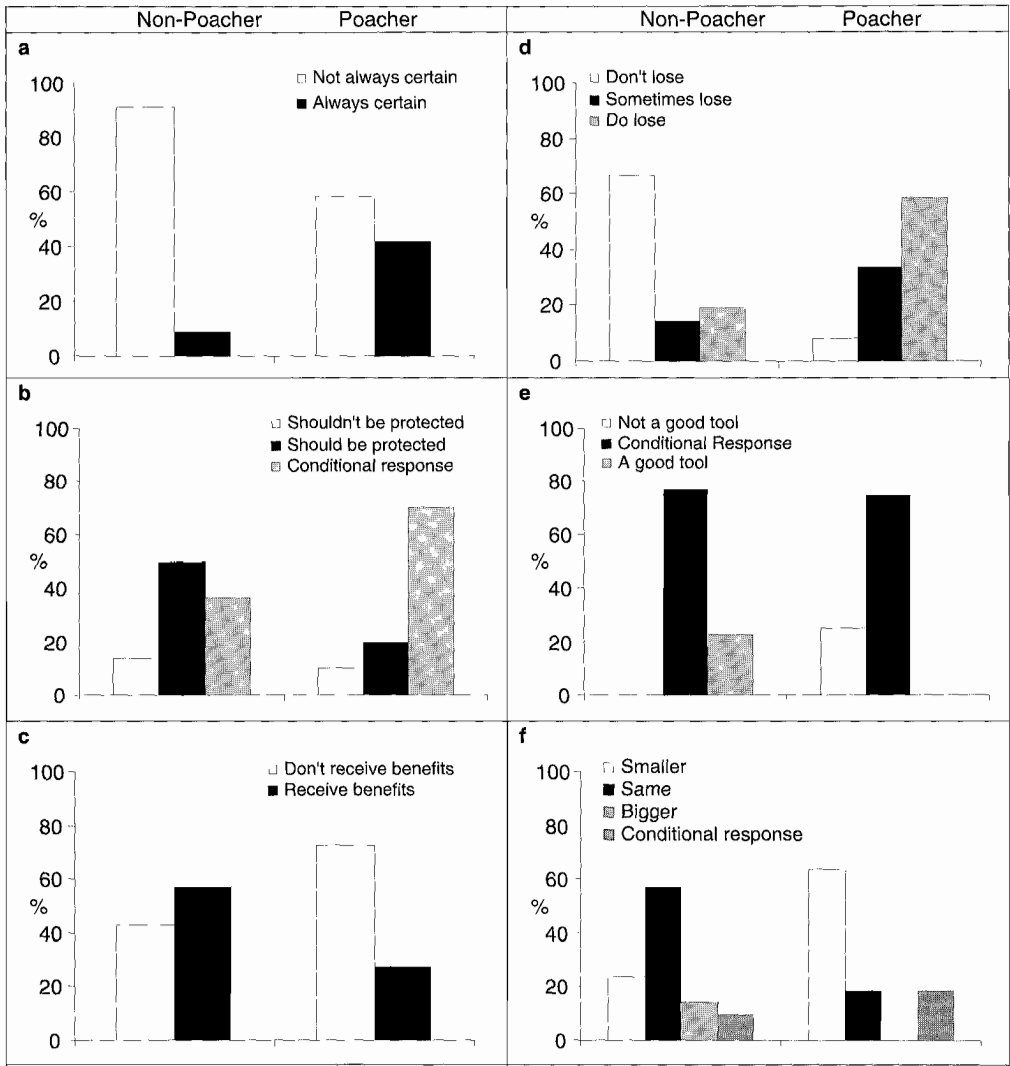


Fig. 2 a–f. Standardised within-group distributions of non-poachers' and poachers' responses to questions regarding a) certainty of catch; b) the need to protect fish, c) receipt of benefits from MPAs, d) loss of fishing ground to MPAs, e) quality of MPAs as a fisheries management tool, f) appropriateness of current MPA size

Q. 8: Do you ever fish near any of the existing MPAs?

Seventy-seven percent (77%) of non-poachers said that they did not fish near MPAs, while 83% of poachers said that they fished near at least one of the existing MPAs (Fig. 2h).

Q. 9: Do you think that poachers should be punished?

The vast majority of non-poachers thought that poachers should be punished (95%), and none thought that poachers shouldn't be punished. In contrast, 50% of poachers thought that poaching should be punished in some way, 17% thought that poaching shouldn't be punished, and 33% thought that punishment should be conditional (Fig. 2i). Conditional responses offered mentioned that punishment should only occur if it is equitably enforced, and that poaching during the south-east monsoon season, when the sea was rougher, shouldn't be punished.

Discriminant Function Analysis

Discriminant function analysis of the above nine variables for known non-poacher and poacher groups was 94.1% successful in classifying fishers of known poacher status. Only one poacher and one non-poacher were misclassified. These variables can thus be considered a very reliable subset of the interview data with which to classify fishers of unknown status. When the classification formula was applied to the five fishers of unknown status, four of them were predicted to be poachers, and correctly so as these five interviewees did not admit to poaching but were known to poach.

The DFA was first applied using all nine variables whose distributions were identified as non-random to $p \leq 0.01$ by the Monte Carlo randomisation iterations. However, these variables may not have all been necessary. To investigate this further, the DFA was subject to a sensitivity analysis, being re-run with different combinations of the variables. Particularly noteworthy is that questions 8 and 9 could both be removed individually, with no reduction in classification success of the fishers of known status. However, this affected the classification success of the suspected poachers, with only 2 or 3 out of 5 being predicted to be poachers upon the removal of question 8 or 9 from the classification formula, respectively.

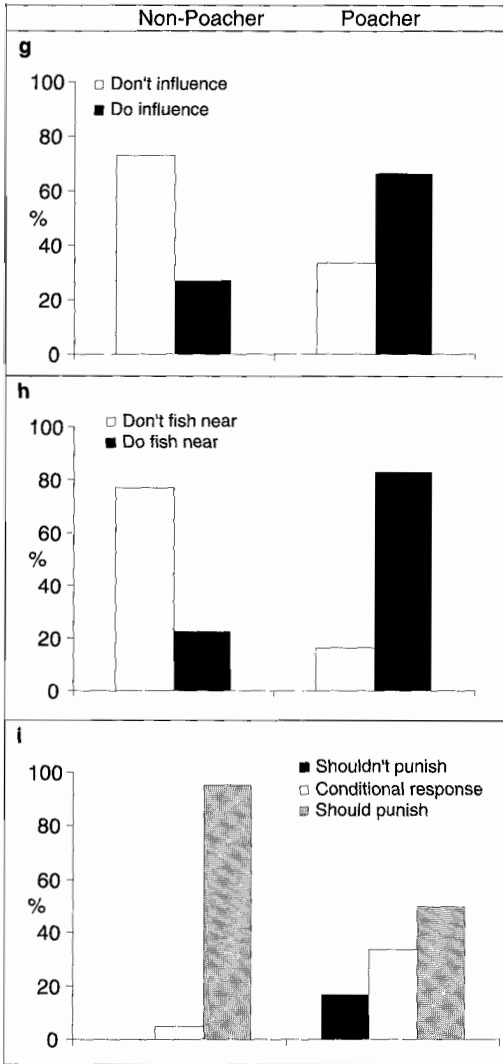


Fig. 2 g–i. Standardised within-group distributions of non-poachers' and poachers' responses to questions regarding g) influence of MPAs on choice of fishing grounds h) fishing near MPAs and i) the need for punishment of poaching.

DISCUSSION AND CONCLUSIONS

The results presented here indicate substantial differences in attitudes of poachers and non-poachers. It is important to understand these differences so that future management and policy decisions can be relevant to the socio-political environment in which they are implemented. One potentially very important aspect of these differences is that of location. Notably, almost all poachers were based in villages in the northern part of Mahé, in close proximity to existing MPAs (see Fig. 1). Given the relatively small scale at which Seychellois fishers currently function, it is logical that fishers who live closer to MPAs might feel that they lose fishing grounds to MPAs more frequently than those who don't, because the latter might either consider existing MPAs to be too distant to be potential fishing grounds, or be located such that alternatives are more readily accessible. It is therefore possible that the observed differences between poachers and non-poachers perceptions and attitudes towards MPAs are largely a product of their proximity to MPAs. This poses a serious challenge to future MPA designation in the Seychelles as fishing pressure and fishers' capacity to travel across larger areas increase, because perceptions might shift towards those of current poachers. The current situation, however, is of great relevance to improving existing management practices. Various motives for poaching were highlighted during the interviews, encompassing economic incentives, education and awareness issues, and the socio-political environment in which MPAs are managed in the Seychelles.

A perceived decline in the abundance of 'legal' fish increases the incentive to fish illegally (Sutinen et al., 1990). The general perception of a decline in fish stocks was almost unanimous—94% of fishers felt that catching enough fish today was more difficult than when they began fishing ($n=33$). However, significantly more poachers were confident of their ability to catch enough fish (Q.1, Fig. 2a), and both non-poachers and poachers stated higher catch per unit effort inside MPAs as a reason to poach. Poachers were also more optimistic about the future status of fish stocks. While 39% of non-poachers thought that it may not be possible to catch enough fish in the future,

only 11% of poachers held this view. When asked what general location current fishers would recommend to new fishers, 25% of poachers recommended fishing exclusively inshore ($n=8$), but no non-poachers advised it ($n=11$). Ninety-one percent (91%) of non-poachers advised exclusively offshore fishing, compared to only 50% of poachers. The greater optimism of poachers concerning the future of inshore fish stocks is presumably due to their use of fishing grounds which experience lower fishing effort, and explains the low proportion (20%) relative to non-poachers (50%) who thought that fish needed to be protected (Q2, Fig. 2b).

While there is some support for MPAs (Q 2, Fig. 2b), an effective way to mobilise and maintain this support is for the purported benefits of MPAs to be perceived by their users; the most tangible benefit for fishers is spillover. However, only 57% of non-poachers and 27% of poachers felt that they were receiving benefits from MPAs (Q3, Fig. 2c). Also, most fishers felt that MPAs should stay the same size or be smaller (Q6, Fig. 2f). In the presence of poaching, the realisation of fishery benefits is unlikely, as indicated by Polunin & Jennings (1998). The duration of continuous protection required for benefits such as spillover to be observed ranges from 10 years (Alcala & Russ, 1990), to as long as 25 years (McClanahan & Arthur, 2001). Furthermore, spillover may not compensate for the absolute loss of fishing grounds (McClanahan & Mangi, 2000). Ultimately, whether people are prepared to accept this uncertainty of return depends heavily on their discount rate of the future. Given the older age of the fishing workforce (Wakeford, 2000), the perceived time required to regain foregone catches if and when spillover happens may well extend beyond their working lifetime, and so discount rates will be high.

While some fishers acknowledge the tourism benefits to be gained from MPAs, this less direct benefit to society is unlikely to sustain long-term support, especially when 54% of fishers feel they lose fishing grounds as a result of MPAs either some or all of the time. Poachers felt very strongly that they lost fishing grounds to MPAs. This was discussed both in terms of an absolute loss, as well as a seasonal loss during the SE monsoon, when

the sea is rougher and so the more sheltered coastal areas, where MPAs are located, are of greater relative importance to assuring catches (Q4, Fig. 2d).

When asked about the extent to which fishers seek other work at various times of the year, 80% of poachers (n=10) never sought other work, and only 10% (compared to 23% of non-poachers (n=18)) sought other work during the south east monsoon. While poaching may help to compensate for lost income from fishing elsewhere and therefore explain this reduced need to seek other work amongst poachers, it is possible that there are less, or no, alternative sources of income available to them other than poaching. In fact, only 8% of poachers (n=12) compared to 27% of non-poachers (n=22) were educated to above secondary level. This may indicate a lower skill level of poachers, which limits their potential sources of income. Furthermore, the largest inshore MPA in Seychelles, Sainte Anne Marine National Park (MNP), faces the poorest part of Mahé (Anon, pers. commun.), and much of the reef and seagrass in the area between Mahé and Sainte Anne MNP has recently been reclaimed (Robinson et al., 2002), reducing the area of legal fishing grounds even further.

In combination, these factors can be expected to severely constrain local fishers' ability to catch enough fish for income generation, and so the incentive to poach inside MPAs, and Sainte Anne in particular, might be very strong, especially during the south east monsoon. The link between education and poaching seems to suggest that poachers are unable (rather than unwilling) to find alternative sources of income, and that poaching is driven heavily by economics. Indeed, 75% of poachers said they would poach more if the price of fuel increased.

Non-poachers also stated that poachers might poach out of a lack of respect for the law. While this was not something that the poachers admitted to, dissatisfaction with the way in which MPAs were managed was expressed. This is reflected in the prevalent perception amongst poachers that MPAs are an unsuitable management tool because they create user conflicts (Q5, Fig. 2e). The most common complaint was that MPAs were there to benefit tourists, not fishers. Indeed, the objectives

of the MPAs of Seychelles do not directly relate to fishery management (Wakeford, 2000). An additional issue raised with respect to Sainte Anne MPA was the recent development of a five star hotel on an island within the MPA, and the past dredging of a navigation channel through the MPA, both of which were considered to impact negatively upon the MPA. Fishers who poached in Sainte Anne considered it highly unfair that they should be punished for poaching when other damaging activities inside the MPA were allowed to continue. This led to the issue of equitable enforcement, which was raised by many fishers (both poachers and non-poachers), with respect to all MPAs. Many fishers said that corruption prevented regulations from being imposed uniformly on everyone. Similarly, while there is a substantial recreational fishery in Seychelles, no attempt is made to reduce recreational poaching.

The current direction in fisheries and MPA management in Seychelles is that of co-management (Wakeford, 2000). However, while Futemma et al. (2002) have shown that positive past experiences of cooperation are likely to improve cooperation in the future, past attempts at collaboration in Seychelles between the government and fishers have stimulated mutual distrust and disrespect. While there is good informal communication between SFA and the fishers, there are no formal channels (Wakeford, 2000), and communication is further hindered by the fact that SFA is a government body, and as such is treated with suspicion by the fishers (Anon, pers. comm.). Fisheries cooperatives have also failed in the past, which has been ascribed by one fisher to a lack of leadership and education: "Seychellois are not prepared to fight for anything because they are not well educated" (Anon, pers. comm.). This situation can lead to despair on the part of fishers, which is quite possibly expressed as poaching.

In conclusion, the results presented here indicate that poaching appears to be driven primarily by economics, exacerbated by lower levels of education amongst poachers, a generally higher (and perhaps false) optimism over the future of fish stocks, as well as the socio-political environment in which natural resource management is currently implemented in the

Seychelles. The example of Sainte Anne MNP, and the nearby land reclamation and its associated impacts, highlights that the spatial distribution of demographics in relation to MPA location and external influencing factors can have dramatic effects on the level of compliance. This should be borne in mind when deciding on new MPA locations, but it should be remembered that any increase in protection may be heavily opposed by fishers. The future success of management of existing MPAs in Seychelles appears to hinge on fostering a trusting relationship between managers and fishers.

Discriminant function analysis demonstrated its potential to quantify poaching activity without requiring an admission of poaching by asking fishers what would generally be perceived as innocent questions about the need for and efficacy of MPAs. The model that has been developed is fairly robust, due to the careful selection of appropriate statistical techniques, and time expended in collecting reliable data upon which to build the analyses. However, the nine variables identified here should be viewed as neither a definitive nor exhaustive list. Re-running the DFA with different combinations of variables showed that while the classification success of known group members remained very high, the predictive capabilities of the classification function were altered. In future work the predictive variables chosen should remain flexible until they can be tested in the field with fishers of known poaching status. Nevertheless, this research shows that interview data can provide far more information than their face value might suggest, if the questions are asked and results analysed correctly.

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