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Perceptions of trends in Seychelles artisanal trap fisheries: Comparing catch monitoring, underwater visual census and fishers' knowledge

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SUMMARY

Fisheries scientists and managers are increasingly engaging with fishers' knowledge (FK) to provide novel information and improve the legitimacy of fisheries governance. Disputes between the perceptions of fishers and scientists can generate conflicts for governance, but can also be a source of new perspectives or understandings. This paper compares artisanal trap fishers' reported current catch rates with landings data and underwater visual census (UVC). Fishers' reports of contemporary 'normal' catch per day tended to be higher than recent median landings records. However, fishers' reports of 'normal' catch per trap were not significantly different from the median CPUE calculated from landings data, and reports of 'good' and 'poor' catch rates were indicative of variability observed in landings data. FK, landings and UVC data all gave different perspectives of trends over a ten-year period. Fishers' perceptions indicated greater declines than statistical models fitted to landings data, while UVC evidence for trends varied between sites and according to the fish assemblage considered. Divergence in trend perceptions may have resulted from differences in the spatial, temporal, or taxonomic focus of each dataset may have been different. Fishers may have experienced and understood behavioural changes and increased fishing power, which may have obscured declines from landings data. Thirdly, Various psychological factors affect memory and recall, and may have affected these memory-based estimates of trends, while different assumptions underlying the analysis of both interview data and conventional scientific data could also have led to qualitatively different trend perceptions. Differing perspectives from these three data sources illustrate both the potential for 'cognitive conflicts' between stakeholders who do not rely on the same data sources, as well as the importance of multiple information sources to understand dynamics of fisheries. We suggest that

collaborative investigation of such divergence can facilitate learning and improve fisheries governance.

INTRODUCTION

Widespread interest in fishers' knowledge (FK) for fisheries science and management (Haggan et al. 2007) derives from two main perspectives. Firstly, FK is thought to contain useful information to improve the performance of fisheries management (Jentoft et al. 1998; Haggan and Neis 2007). FK may encompass a finer spatial resolution and be more up to date than formal scientific knowledge (Rochet et al 2008). FK often also provides a longer historical perspective than other data sources (Dulvy and Polunin 2004; Ames 2007; Lavides et al 2009), especially in tropical reef fisheries (Johannes 1998) and has broader scope. For example FK may include information on ecological, social, technical and economic aspects of fisheries that have historically been neglected by conventional fisheries science (Moller et al. 2004). Secondly, the process of co-management (Jentoft et al. 1998) relies on the development of institutions that facilitate knowledge exchange between stakeholders, scientists and managers to develop greater understanding and more efficient governance (Hoefnagel et al. 2006).

Fishers and scientists commonly have diverging perceptions of resources and may be suspicious of the reliability of one another's perceptions (Gray et al 2008, Hall-Arber 2003), creating barriers for integrating knowledge sources and conflicts in multi-stakeholder arenas. Adams et al. (2003) suggest that such 'cognitive conflicts' may be the main challenge in managing common pool natural resources, while Ostrom et al. (1999) identify shared understandings, one of the factors that can support collective action to sustain resources. However, investigating discrepancies between scientific and fishers' perceptions may also provide opportunities for expansion and revision of scientific knowledge (Johannes and Neis 2007).

Many possible explanations exist for disagreement between scientists' and fishers' perceptions. Disputes often focus on the validity of either perception and the question of which is correct. Scientists may be sceptical when fishers dispute the severity of stock declines (termed the 'you-would-say-that' issue by Daw 2008). Indeed, political conflicts or vested interests can incentivise fishers to bias their stated views either consciously or unconsciously (Harmon-Jones and Harmon-Jones 2007). However, numerous examples exist in which fishers' disputes of scientific findings have been shown to be based on more than strategic self interest (Haggan and Neis 2007).

Disputes can arise simply because they are based on observations of different parts of the fisheries system. FK has been shown to vary according to the social context of fishers (Crona and Bodin 2006) or by the types of gear used (Gerhardinger et al. 2006). Fishers and scientists may perceive the system at different scales (Berkes 2006), or through monitoring different variables (Verweij et al 2010). Inaccuracies or biases can also affect both scientific and fishers' perceptions, due to the context in which perceptions are formed.

Human perceptions are affected by psychological recall processes (Tversky and Kahneman 1973), existing beliefs and behaviours (Balcetis and Dunning 2007) and frameworks of understanding (Miller 2000; Fazey et al. 2006). Perception of trends over time requires the recall, and comparison of current and former conditions, while taking account of variation to distinguish long-term trends from short-term noise (van

Densen 2001). The act of recalling past conditions is accomplished by a variety of cognitive heuristics (Tversky and Kahneman 1974). For example, the 'availability heuristic' is used when estimating the frequency of an event based on the ease with which it is recalled. As such, more available memories, which may be pleasant, unusual or emotive for the individual (Matlin 2004), will appear to be more frequent, and have a greater influence on the perception of past conditions. The 'shifting baseline syndrome' has also been reported to affect fishers perceptions of deteriorating environmental conditions (Saenz-Arroyo et al. 2005; Bunce et al. 2007) and can operate at a societal level, as a result of younger generations being unaware of past abundance (termed generational amnesia); or as a result of individuals forgetting previous abundances (termed personal amnesia) (Papworth et al. 2009).

The process of researching and recording FK has been characterised by Holm (2003) as the construction of a decontextualised knowledge he refers to as FEK*. This useful distinction between *in situ* FK, and FEK* as the product of FK research, highlights inaccuracies or biases which may exist as artefacts of the process of generating FEK*. Recording FK can be affected by political or vested interests of individuals, fisheries management regimes, and methodological aspects of the research (Maurstad 2000; Davis and Wagner 2003)

Scientific data are also subject to potential inaccuracies due to poor resolution, biases, and incorrect assumptions, and fisheries science is well known to be subject to a range of uncertainties (Charles 1998) and even the political and social context in which it is generated (Finlayson 1994). Fisheries-dependent data collection can be biased by misreporting, poor sampling design and effort (over emphases on certain landing sites or gears) and changes in gear use and targeting behaviour by fishers in response to various socioeconomic drivers (de Mutsert et al. 2008). In many fisheries, effort is not monitored, or the resolution is low, while subtle changes in efficiency are difficult to monitor. For example, fishers can introduce or improve fishing technology (e.g. GPS, fish-finders), change the targeting of fish or increase distance travelled, trap soak times or effort exerted during fishing (Jennings et al. 2001). Such changes are almost impossible to record and standardise (Hilborn and Walters 1992). Interviews with fishers have the advantage of being able to investigate such changes (e.g. Neis et al. 1999, Quirijns et al 2008, Eigaard 2009). In multispecies tropical fisheries, data collection is often aggregated at high taxonomic levels and large spatial scales. Underwater visual census (UVC) offers detailed fisheries-independent data, but biases in UVC may arise from spatial extent of sampling, habitat structure and fish behaviour (Edgar et al. 2004) and the method can normally only sample a limited proportion of the available habitat.

Moving beyond the ‘who-is-right’ mode of understanding disputes between FK and science becomes possible with the appreciation that *all* types of knowledge are partial and affected by the context in which they are created (Murray et al 2008). Disputes may provide opportunities to expand the scope of knowledge available for resource management, and to revise scientific understandings, which may be based on too narrow a conception of the system (Hoffmann-Riem and Wynne 2002).

This paper examines how perceptions of resource abundance in the artisanal trap fishery Seychelles differ according to fisher interviews and two common forms of scientific fisheries data: UVC by scientific divers, and landings surveys conducted by fieldworkers. We compare the perceptions of catch, catch-per-unit-effort (CPUE), variance in catches, and abundance trends over a 10-year period.

METHODS

Study sites

Artisanal trap fisheries of the inner Seychelles islands provide a rare opportunity among tropical artisanal fisheries of a long (10+ year) time span of catch and effort data, and UVC data on fish density and biomass.

The fishery is conducted from small boats with outboard engines of 15-40 hp, and uses three types of traditional bamboo traps. *Kasye peze* and *Kasye dormi* are both sturdily constructed and left for a soak time of up to 3 days. *Kasye peze* are unbaited and wedged amongst corals on the shallow reef flats, while *Kasye dormi* are set outside the reef crest in depths of up to 60m and may be baited (Daw 2008). *Kasye lavol* have a lighter construction, are baited, and are placed in a variety of depths for of several hours. Siganids, lethrinids and scarids are the most important families caught in traps but *kasye dormi* also catch substantial quantities of mullids and lutjanids. Octopus, labrids, acanthurids, serranids, haemulids, balistids, muraenids and pomacanthids are also fished while chaetodontids and scorpaenids are frequently caught but discarded. *Kasye lavol* are used to target known spawning aggregations of *Siganus sutor* in which case they catch this species almost exclusively (Robinson et al. 2004).

Trap-caught fish are used for local consumption and are typically sold by fishers themselves, in 'packets', of several fish tied together. The price of packets tends to be constant but their weight and species composition can vary according to catches.

Three areas of Seychelles were chosen for this study to correspond with existing UVC data collection sites (Jennings et al. 1995; Figure 1). The dominant trap type and season were selected in each to maximise the relationship between the data types (Table 1).

[Figure 1]

[Table 1]

Data collection

Perceptions of fishers

Individual, structured interviews were conducted from September to November 2005 focussed on the dominant trap type used in each area (Table 1). In each area a list of trap fishers was compiled from landing site visits and speaking to fishers, local residents, and Seychelles Fishing Authority (SFA) staff. All fishers that could be contacted were approached for interview. Individual trap fishers were asked about their typical catch and effort on a 'good', 'poor' and 'normal' day; their perception of trends over the past ten years (or since the start of their career if less than ten years); their typical catch and effort ten years previously; and several indicators of changes in effective effort (length of vessel, engine power, days fished per week, maximum depth fished, maximum distance travelled from landing site to fishing ground and trap soak time) currently and ten years previously (or since the start of their career if less than ten years). These formed part of an interview which also included understandings of fish stock dynamics and opinions on fisheries management adapted from Walmsley et al (2005)(see Supplementary online material). Catches were generally reported in packets, while effort was described by the number of trap hauls per day. Mean CPUE was calculated by dividing the day's catch by the number of trap hauls. To ensure standardised data within each area, and maximum overlap with the UVC data, fishers were only included in the analysis if they answered questions on the dominant trap type in each region, and spent all of their fishing time within the regions shown in Figure 1.

Catch assessment survey data

Landings data were extracted from the SFA artisanal fisheries catch assessment survey (CAS), a stratified catch and effort monitoring system that has been in place since 1985. Fieldworker effort is randomly distributed between 63 landing sites on Mahé, Praslin and La Digue, within site strata that are defined according to the number and type of boats active at the sites. Fieldworkers record fishing activities (number and types of vessels fishing and number of trips and gears, by type, used) and landings are estimated from counts of the number of fish or packets, sample weights, and estimated percentage taxonomic composition of catches (Mees 1990).

The CAS distinguishes 'active traps' (*kasye lavol*) from 'fixed traps', but not between the two types of fixed traps (*kasye peze* and *kasye dormi*). Interviews with trap fishermen indicated that *kasye dormi* were predominantly used in W Mahé and that there is typically a seasonal pattern in the use of fixed traps in E Mahé, with *kasye* *dormi* being used in the calmer NW monsoon and at least 75% of fishers exclusively using *kasye peze* inside the reef during the rougher SE monsoon. Thus, to maximise the overlap between interview data on *kasye peze*, landings from fixed traps during the SE monsoon (June-September) were selected. Records for fixed traps and active traps from W Mahé and SW Praslin were taken from all months assuming that they represented *kasye dormi* and *kasye lavol* respectively. The few landings records from vessels without outboard engines were excluded, as all interviewees used outboard engines. Mean CPUE was calculated by dividing daily catch by the gear number. A number of data (0.5-10% depending on area) were excluded as the number of gears had apparently been entered erroneously as one, inflating estimates of CPUE.

Underwater visual census

Fisheries-independent indications of trends in fish biomass were obtained from underwater visual census (UVC) conducted in 1994 and 2005. Three sites, representing carbonate reef, granitic reef and patch reef habitats, were surveyed within each of the 3 areas (Figure 1). At each site, 16 replicate 7m-radius point-count surveys of reef fishes were conducted. The abundance and size of 134 species of diurnally-active reef-associated fish were recorded at each count (Jennings et al. 1995; Graham et al. 2006). Length calibration was achieved by estimating the lengths of a random assortment of lengths of PVC pipe before each day's sampling, until the observer was within an error range of 1cm; mean errors for 1994 and 2005 were 3.1% and 2.2%, respectively (Graham et al. 2007). Abundance-length data were converted to biomass using published length-weight relationships (Letourneur et al. 1998; Froese and Pauly 2006).

Data Analysis

Catches as reported by fishers

Most fishermen reported catches in numbers of packets. To allow comparison with landings data, packet numbers were converted to kg based on a sample of 239 original SFA fieldworker datasheets detailing weights of individual packets from July to December 1996 and from July 2004 until June 2005. Packets were significantly larger in 2004 ($p<0.001$). Accordingly, estimates of current and past (ten years previous) catches from fisher interviews were converted by multiplying number of packets by 3.63 kg and 2.94 kg, respectively.

Contemporary catch and CPUE

For an indication of 'current' catches, a subset of landings data was taken for a three-year period prior to the interviews in order to provide enough data (n = 75-150), to indicate the frequency distribution and central tendency of catches in each area. To capture variability in catches, records representing the aggregate catch of more than one boat (~10% of records) were removed. Frequency distributions of catch and CPUE were plotted for each area. Due to the positively skewed nature of the landings data and the existence of outliers, median rather than mean values were chosen to compare with fishers' perception of a 'normal' days catch and CPUE.

For each interviewed fisher, the difference between median landings records, and their reported 'normal' catch and catch per trap (dCatch and dCPUE), was calculated as a proportion of median landings values:

Proportional catch difference ($dCatch_{fa}$) = ($NC_{fa} – M_a$)/M_a

Where: NC_f is a normal day's catch in fishery a according to fisher f, and M_a is the median catch from landings data in fishery a.

For each fishery, the distribution of dCatch and dCPUE was tested for significant differences from zero (Wilcoxon signed ranks non-parametric test) to indicate whether reports of normal catches by fishers, differed from median catches according to CAS data.

Time trends as perceived by catch assessment survey

For analysis of trends in landings data, records from between January 1995 and July 2005 were selected from the CAS database. Average catch per day and average catch per trap (CPUE) were analysed for trends. Visual assessment of data showed different trends between the three main landing sites in the SW Praslin area, so only data from Grande Anse (where the majority of interviews were conducted) were included.

The presence of linear or non-linear trends in each time series was assessed by comparing generalised additive models (GAMs) fitted to each dataset using the gam function from the mgcv package in R. GAMs allow the visualisation of non-linear relationships between dependent and multiple explanatory variables (Zuur et al. 2007). Seasonality in catches was accounted for by the inclusion of a month smoother term in all models except those for the E. Mahé *Kasye peze* fishery, which only included the four months of the NE monsoon. Three alternative models were fit to the data from each area representing: no trend over time (month smoother term only), a linear trend over time (month smoother and year linear terms) and a non-linear trend over time (month and year smoother terms).

The degree to which each model fitted the data was assessed using Aikike's Information Criterion (AIC). Models explaining the greatest proportion of variance with fewest parameters were indicated by the lowest AIC (Burnham and Anderson 2002). ΔAIC was calculated, as the difference between each model and the best of the three models. Residual plots and graphical outputs of the GAM smoother term were examined. Autocorrelation between years was not accounted for, possibly leading to over estimation of the degree of fit, particularly for GAMs.

Where AIC scores indicated a linear trend with year (where the linear trend was favoured over the no-trend model, the modelled change was presented as annual change as a percent of interpolated year 2000 values (change/year/yr2000). Graphical representations of the year smoother from the non-linear trend were plotted and an indication of recent trends was provided by presenting the slope of the GAM between the last 2 years as a % of the ten-year mean.

Time trends as perceived by underwater visual census

Total UVC-measured fish biomass, and biomass of target species (Table S1, Supplementary materials) that were large enough (>6cm body depth) to be caught by the inshore trap fishery (Graham et al. 2007), were analysed for differences between 1995 and 2005. Linear models with year, site (see Figure 1) and site × year interaction were fitted for each area, to square-root-transformed data to reduce the influence of outliers. Models were selected for each area by AIC-based stepwise removal of terms (Zuur et al. 2007) and the difference between years was indicated by the significance of the year term. If site × year interactions were retained in the model selection (suggesting a different trend at each site), trends were reported for each site. Where variances were unequal between years, Welch's t-tests, which do not assume equal variance, were used to test for a difference between years. All detected differences were converted to change/year/yr2000.

Time trends as perceived by fishers

Qualitative indicators of fishers' perceptions of trends were taken as the proportions of fishers who perceived a decline, no change or an increase at each site. Quantitative indicators of trends were also calculated for each fisher as the difference between reported contemporary catches and catches ten years previously (or at the start of their trap fishing activities if they had fished for less than 10 years). Only data from fishers with eight or more years of experience were used for quantitative trends. Six different quantitative trend indices were calculated as a result of using two different reports of current catches ('normal' and 'good' catches); and of using three different units to indicate catch: total daily catch, daily catch per trap in kg, and daily catch per trap in the units used by interviewees (usually packets). Each of these trends were presented as change/year/yr2000.

Indicators of effective effort

Fishers who had been fishing for at least five years were included in the analysis of indicators of effort efficiency. The proportion of interviewees who had increased, decreased or not changed with regards to each indicator was calculated and the percentage change from initial levels for each fisher was calculated. Changes for the sample were calculated in terms of mean percentage change and mean absolute change (e.g. miles).

RESULTS

Perceptions of current catches from interviews and landings

Landings data from all three fisheries showed a typical positively-skewed distribution of catches with extreme values at the higher end of the range (Figure 2). The proportional difference between a fishers' normal catch and the median catch for that fishery (dCatch) was significantly greater than zero for all three fisheries (Table 2) indicating that most fishers' reports of a 'normal' catch (converted to kg) were greater than the median of landings. Fishers reports tended to have greater extremes than landings; five of the 30 interviewees reported 'normal' catches that exceeded the 95% quantiles of landings data. 'Poor' catches were frequently lower than the 5% quantile of landings, and 'good' catches higher than the 95% quantile, particularly in E Mahé. Overall, one third of reported 'poor' catches involved nothing being caught, but only two of the 362 landings records involved no catch, both from Praslin.

[Figure 2]

[Table 2]

When converted to CPUE, fishers' reports showed more agreement with landings data. Reports of 'normal' CPUE in E Mahé and SW Praslin straddled the median landing (Figure 2) and dCPUE was not significantly different from zero (Table 2). dCPUE in W Mahé was lower than dCatch but still generally positive and significantly different from 0 at 10% level. The 95% quantile of CPUE tended to be straddled by reports of 'good' CPUE (Figure 2).

Extreme reported values were apparent in each fishery, especially for catch. Half of the ‘good’ catch reports in E Mahé lay outside the range of the landings data, while one ‘normal’ report in W Mahé was similar to maximum recorded landings. However, expressing reported data as CPUE tended to reduce the occurrence and extent of extreme values. For example, catch reports included three ‘normal’ and 11 ‘good’ values which were larger than the maximum recorded landing, whereas for CPUE, only one ‘normal’ and two ‘good’ reports extended beyond maximum landings. Two SW Praslin reports of ‘good’ catches were two and three times greater than the maximum recorded landings, but were comparable to typical landings when presented as CPUE as they came from three hauls of a large number (ten) of traps.

Time trends according to catch assessment survey

Model selection indicated different trends in the 3 fisheries and in the case of E Mahé, between catch and CPUE (Table 3). Highly significant year terms for W Mahé catch and CPUE and E Mahé CPUE (but not catch) were also reflected in lower AICc values for linear than null models. All linear trends were positive, and equivalent to 2-15% change/year/yr2000. SW Praslin showed no evidence of any long term trend in CPUE, but a trend in catch was indicated by a marginally significant year term in the linear model, which was selected by AIC over the null model.

[Table 3]

The GAMs were selected by AIC in all cases. Graphical representations of the GAM smoother terms gave an indication of the underlying trend in catches by year when seasonal trends are accounted for by the month term in the models (Table 3). All sites show some evidence of declines over the last two years, ranging from 9% of mean values in W Mahé CPUE to 37% in E Mahé CPUE.

Time trends according to fishers' perceptions

Most fishers (82%, n=28) in all areas perceived that catches had declined (Table 4), but quantitative indices of trends gave different conclusions depending on which index was used (Figure 3). Most fishers cited 'normal' catches that were less than previous catches (representing declines of up to 15%/year/yr2000), but roughly half of fishers' 'good' catches were greater than previous catches. In terms of the different indices, daily catch suggested less of a decline than catch per trap, and catch per trap converted to kg indicated less severe declines than catch per trap in the fishers' own units, due to the different packet conversion for current and former times. 'Good' versus previous catch in kg (Figure 3, top right), indicated no decline on average, while 'normal' versus former catch per trap in the fishers own units (Figure 3, lower left) suggested the most pessimistic picture, in which only 1 fisher (from E Mahé) perceived an increase in catches and 13 perceived a decrease of up to 17% /year/yr2000.

[Table 4]

[Figure 3]

Time trends according to UVC data

UVC data from 1994 and 2005 in E Mahé indicated declines in total fish biomass but not in biomass of trap fish (Welch t=2.05, p=0.04) (Table 4). There was a significant site × year interaction at W Mahé so the three sites were tested separately. Total biomass was significantly less in 2005 at the patch reef site (Welch t=4.87, p<0.001), but not at the other sites, while trap fish biomass was significantly lower at all sites (F=4.98, p=0.028), and much lower in 2005 at the patch reef site (Welch t=3.60, p=0.001). No significant trends were detected in SW Praslin.

Comparisons of trend perceptions in the datasets

Qualitatively, 10-year trend indications from the three sources of information were very different. Fisher interviews indicated declines in all areas, UVC from some sites indicated declines and landings data showed increases over the ten years. Landings did, however, indicate a decline in catches over the final one to three years of the time series. When comparing between areas, W Mahé landings data showed the strongest evidence for an increase, the least severe decline according to fisher interviews, but the most evidence for a decline according to UVC. Meanwhile SW Praslin showed no evidence for a decline according to UVC, but had the most pessimistic quantitative indications from fishers.

Trends in fishing behaviour

For most behavioural indicators, the majority of fishers did not report changes, but more fishers reported increases in effort than decreases (Figure 4). The only exception was 'days fished per week' which had decreased for 14% (n=29) fishers and increased for only 3%. Vessel fishing power had commonly increased, with 45% (n=22) of fishers having upgraded to larger engines (nine fishers), or obtained engines for the first time (two fishers), and 41% of fishers fishing in larger vessels. 31% and 44% (n=16) of the fishers had increased the number of traps fished and soak time, respectively, with an average increase of ~25% in each. A minority of fishers had increased the depth or distance at which they fished, with an average extension of 1.4 nm in their range.

DISCUSSION

In this study we compared perceptions of artisanal trap catches and CPUE as obtained from fisher interviews and structured landings surveys; and perceptions of trends over ten years according to interviews, landings surveys and UVC. Landings data indicated lower catch per day, but similar catch per trap to fishers' stated 'poor', 'normal' and 'good' catches both in terms of the central tendency of the data (median CPUE and 'normal' catch per trap), and the range of the data indicated by the frequency distributions and the fishers' reports of 'poor' and 'good' catches. Indications of trends over 10 years however, differed widely, with fisher interviews indicating declines, landings data indicating no trends or increases, and UVC indicating no trends or a decline depending on the site and fraction of the fish community sampled.

Contemporary catch indications from landings and fisher interviews

The observed congruence between contemporary CPUE according to landings and catch per trap according to interviews is encouraging for situations in which time and resources are not available to initiate a structured landings recording programme. For

Seychelles trap fisheries, it seems that if effort is carefully accounted for, a reasonable account of both the magnitude and the variability of *contemporary* catch per trap can be obtained from interviews with fishers (e.g. Lunn and Dearden 2006). However, similar studies over a larger range of fisheries are needed to investigate the generality of this finding.

Our findings emphasise the importance of detailed measurement of fishing effort. Catch per day gave a different and less compatible result than the more detailed catch per trap, because of variations in the quantity of traps used (2-14) and hauls made per day (1-3) by fishers. Extreme reports of high daily catches may have created suspicion of exaggeration by interviewees, but when the data were presented in terms of catch per trap, individuals' answers fell comfortably within the range of the rest of the sample.

Answers to interview questions can be affected by how interviewees interpret the context and wording of questions (Schwarz 1999). For example, a 'normal' catch may have been cited based on a range of catch experiences, which may include or exclude zero catches, or be focussed on particular seasons or areas. Different cognitive heuristics may have been used to construct an answer, such as stating the first trip that is recalled from memory, calculating the desired catch to cover costs and make an acceptable profit, or attempting some form of averaging over the range of a number of recalled trips. To encourage respondents to use a similar anchoring-and-adjustment heuristic (Tversky and Kahneman 1974), and to remove some variability due to fishers placing more or less emphasis on particularly good catches, we asked about 'good', 'poor' and then 'normal' catches. While not eliminating problems of question interpretation, this provided a more standardised measurement of the perception of current catches and also provided some indication of catch variability. Variability is in itself of interest as it affects fishers' power to perceive spatial or temporal trends in catches (Oostenbrugge et al. 2001; Pet-Soede et al. 2001; van Densen 2001), has implications for livelihoods and vulnerability, and it has been shown to rise in response to increasing fishing pressure (McClanahan et al. 2008), potentially indicating loss of fish stock resilience (Hsieh et al. 2006). More generally, variance indicators have been proposed as predictors of ecological regime-shifts (Carpenter and Brock 2006).

Perception of trends from UVC and fisher interviews

Trends perceived from fishers' and UVC data were not in accord, which can be attributed to many factors affecting the two data sources, and the limited overlap between UVC and the fishery in terms of depths, habitats and species. *Kasye peze* fishers tend to fish shallower than the reef slopes targeted by UVC, while *Kasye dormi* fishers can expand beyond the shallow fringing reefs targeted by UVC onto the expansive Mahé plateau. Graham et al (2007) estimated that only 50-60% of trap fishing grounds overlapped with habitats and depths sampled by these UVC data.

Filtering of the UVC data for 'trap fish' changed indications from 'decline' to 'no detectable decline' in E Mahé, and vice versa in W Mahé. Trends in W Mahé were different at the different sites, with severe declines indicated on the patch reef habitat. This illustrates the complexity of comparing independent indicators of fish biomass over a complex heterogeneous seascape and the potentially critical impact of choices of how to select and interpret scientific data for the trends perceived in a resource. If the patch-reef site was representative of areas targeted by trap fishers, this analysis would predict the perceptions of declines reported by fishers.

Perception of trends from landings data and fisher interviews

The importance of effort is again highlighted by different trends indicated by catch and CPUE from landings (Table 3). Figure 4 indicates an increase in some individuals' effective effort through increasing vessel power and soak times. This may account for discrepancy between landings and fishers' perceptions. Fishers may have perceived resource declines, while compensating for them by increasing effective effort. Such declines cannot be perceived from landings without detailed information on changes in fishing behaviour/technology and the spatial distribution of effort. Effective effort can also be reduced by a range of factors, including management regulations, fuel prices, or at a personal level due to ageing, or deterioration of gear or vessels.

Although several fishers reported poor catches of zero, CAS data had few zero catches. This may be due to fishers with zero catches returning directly to mooring/anchorage sites instead of the monitored landing sites, fishers avoiding interviews with fieldworkers on zero-catch days, or fieldworkers preferentially sampling and interviewing fishers with landings over those without. For fisheries in which zero catches are common, the failure to record them may introduce biases in mean or raised estimates from landings data.

The implications of cognitive processes of memory and recall have been scarcely studied in FK literature. This study allows consideration of how they may affect perceptions of resource trends. For example, the time window of ten years may have contributed to the difference in perception of CPUE trends from fisher interviews and CAS data. All six of the GAM smoother terms showed a decline in recent years (although caution should be taken with the interpretation of the ends of GAM smoothers, A. Zurr pers comm.). Fishers answering questions about a ten-year time trend may have answered with regards to recent trends which are more available to memory, even if they were questioned about trends over 10 years.

Similar to most artisanal fisheries in the World (Berkes et al. 2001), catches from the Seychelles trap fishery are sold for profit. Changes in the gross revenue or profits from fishing may therefore be of greater importance to the fisher, and thus better remembered, than changes in quantity of catch (Matlin 2004). Increasing costs and/or decreasing fish prices could result in perceptions of a decline as profitability fell. In Seychelles, fishers' profitability may have been negatively affected by macroeconomic difficulties that worsened over the study period, making imported equipment increasingly expensive; or decreasing unit fish prices (as indicated by the increasing trend in packet size identified over the ten years). More generally, fluctuations in fuel prices, global market prices and government subsidies for fishers may affect perceptions of trends in resource abundance.

The availability heuristic (Tversky and Kahneman 1974) would predict that particularly large or unusual catches would dominate the perception of former catches. In the left-hand panels of Figure 3, 'normal' catches are compared against reported former catches (assuming them also to be normal). If these reported former catches do in fact refer to memorably good catches, then fishers would perceive more severe declines creating a ‘memory illusion’, in which declining trends are exaggerated or incorrectly perceived (Papworth et al. 2009). Memory illusion operates in the opposite direction to the ‘shifting-baseline syndrome’ in which severity of declines is underestimated (Saenz-Arroyo et al. 2005; Bunce et al. 2007). Such potential biases arising from recall remain a challenge for the use of memory-based perceptions of trends, in the absence of records or repeated surveys. Biases are expected to increase with the length of time over which interviewees are asked to remember. Further research is required to investigate the magnitude, and impact of these biases on trend perception. Cognitive science can be used to understand the processes, but to specifically understand them in fisheries, empirical research is needed to compare memory-based verbal reports of catches with independent records of the same individual’s actual catches, in different contexts.

In conducting FK research and creating FEK*, FK is filtered and adjusted through decisions, methods and assumptions of the researchers. The significant impacts of such assumptions are emphasised by comparing the left and right hand panels of Figure 3. Assuming that reports of former catches were representative of memorably ‘good’ catches, and thus comparing them with contemporary ‘good’ catches (right-hand panels of Figure 3) would give less of an indication of declines. Different inferences are also generated depending on the way in which catch estimates from fishers were processed. In this case, trends according to figures converted to kg were more severe than trends calculated from fishers’ own units, and CPUE trends were more severe than catch trends (Figure 3) due to the increasing trap number. This shows the critical impact of how FK is processed and analysed for deriving conclusions. By changing the assumption of how to interpret fishers' reports, the nature of the perceived trend is qualitatively changed.

Conflicts between scientific, or bureaucratic, perspectives on resources and those of resource users are common in fisheries (Gray et al. 2008). In this case, fishers had more pessimistic perceptions of catch trends than scientific data, but in spite of this, fishers were not supportive of introducing effort or catch controls, or limiting entry to the fishery (Daw 2008). Thus, it is important to note that perceptions and knowledge are not the sole factors determining personal environmental behaviour (Kollmuss and Agyeman 2002), and preferences for potential management measures are complicated by a range of political factors, values, personal interests and power relations.

CONCLUSION

All three data sources gave different perceptions of trends in the biomass of fish and catches over the study period. Fishers' experience of the fishery could have resulted in more pessimistic perceptions because of a) increasing numbers of traps and other increases in effective effort, b) an emphasis on recent catch declines, c) psychological biases in the recall of past catches or d) the increasing weight of fish packets effectively reducing the price of fish. Meanwhile, landings data may have perceived positive trends due to a) monitoring of catch by kg rather than packets, b) a long 10-year perspective, without emphasis on recent trends, c) failure to record zero catches and d) an inability to account for increasing efficiency. In addition, the trends implied by each dataset can be qualitatively affected by changing underlying assumptions about the types of fish measured by UVC or the meaning of fishers' reports of previous catches. This illustrates the critical impact of how both FK and scientific data are processed and analysed on the resultant conclusions. This paper has documented changes in effective effort, different trends identified over different timescales, habitats or species, changes in fish price, and the existence of zero catches. Cognitive processes affecting trend perception are potentially very significant, but are not measured or documented in this study and require further research.

An increasingly prevalent perspective suggests the importance of combining multiple information sources for monitoring and learning about social-ecological systems like fisheries (Folke et al. 2003). Fishers may be able to perceive trends more rapidly and locally that are masked from landings data by subtle increases in fishing effort or efficiency or aggregation over large-scales (Neis et al. 1999, Rochet et al. 2008), while landings data may have more statistical power to observe large-scale trends by integrating the catches of many different fishers (van Densen 2001). UVC may be able to monitor actual changes in biomass of fish regardless of variability and change in catchability and fisher behaviour, but may have poor coverage or limited temporal, spatial, depth or taxonomic overlap with exploited fish populations. Neither scientific nor fishers' perceptions can be considered to provide the 'true' picture of the resource, as they are partial in terms of spatial or taxonomic coverage, or the variables considered, and contextually contingent in terms of the methodology, and social-economic environment in which they are created. Consideration of various perceptions increases the awareness of the contingent nature of each, enables conflicts to be identified and addressed, and helps to avoid over-confidence in one signal. Over-confidence in signals from trawler CPUE contributed to the overfishing and collapse of the Northern cod (Finlayson 1994; Neis 1997). Further research should involve fishers and scientists in examining the reasons why perceptions are divergent to improve understandings of trends in the fishery and to investigate issues such as how changes in effective effort influence the different perspectives. Stock assessments supported by various types of fishers' knowledge are needed to provide a reliable and accepted status of the resource. Such processes also help to address 'cognitive conflicts' and facilitate social learning, which is thought to be important for co-management (Armitage et al. 2008).

In the case of the Seychelles artisanal trap fishery, new initiatives have recently been instigated to establish fisher-organisations and co-management, which may provide a medium for such collaborative learning. This research suggests that participatory research and monitoring to address diverging perceptions and understandings will be a key process supporting this initiative. In terms of specific recommendations, the scales of monitoring in co-management should be aligned with those over which fishers perceive the resource and the participatory development of indicator systems may provide a more intuitive and acceptable scientific approach to monitoring and setting management targets.

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Figure Legends

Figure 1. Seychelles study locations. Dark lines indicate the 3 areas of coastline where interviews were conducted. Shapes indicate underwater visual census sites in three different habitats (filled circles = coral, open circles = granite, triangles = patch reefs). Areas for the catch assessment survey are identified by capital letters (AAP = Anse Aux Pins, AB = Anse Boileau, AR = Anse Royale, AK = Anse Kerlan, GA = Grande Anse, PG = Port Glaud, SP = South Praslin), adapted from Jennings et al. (1995)

Figure 2. Frequency distributions of daily catches and catch per unit effort from three different Seychelles trap fisheries from landings data (upper panels) and individual reports of catch and CPUE from fisher interviews (lower panels, circles = 'normal' day, triangles = ‘poor’ day, squares = ‘good’ day) lower panels show a ‘strip chart’ in which each fisher is represented by a different y axis value. Thick vertical lines indicate median and dotted vertical lines indicate 5 and 95% quantiles of landings data.

Figure 3. Quantitative indicators of changes in catch from trap fisher interviews in three trap fisheries, calculated by comparing past catches with either ‘normal’ (left panel) or ‘good’ (right panel) reported catches; and calculated in three different catch units (daily catch converted to kg, CPUE converted to kg/trap and CPUE in original reported units/trap). Asterisks indicate mean values. Vertical lines indicate zero change. Circles = East Mahé *kasye peze*, Triangles = West Mahé *Kasye dormi*, Crosses = Southwest Praslin *Kasye lavol.* Darker shading indicates more severe declines are indicated.

Figure 4. Changes in quantitative indicators of fishing effective effort by trap fishing interviewees during the previous 5-10 years. Mean changes are reported firstly in absolute terms and then as a percentage. Bars indicate the proportion of the interviewees whose indicators had increased, stayed the same or decreased. Days per week refers to days spent fishing. Soak Time refers to time between setting and lifting traps, Max Depth refers to depth of water in which traps were set, Max Range refers to the maximum distance travelled to fishing grounds. * percentage changes in distance and engine power are not displayed due to low or zero initial values.

Figure 1

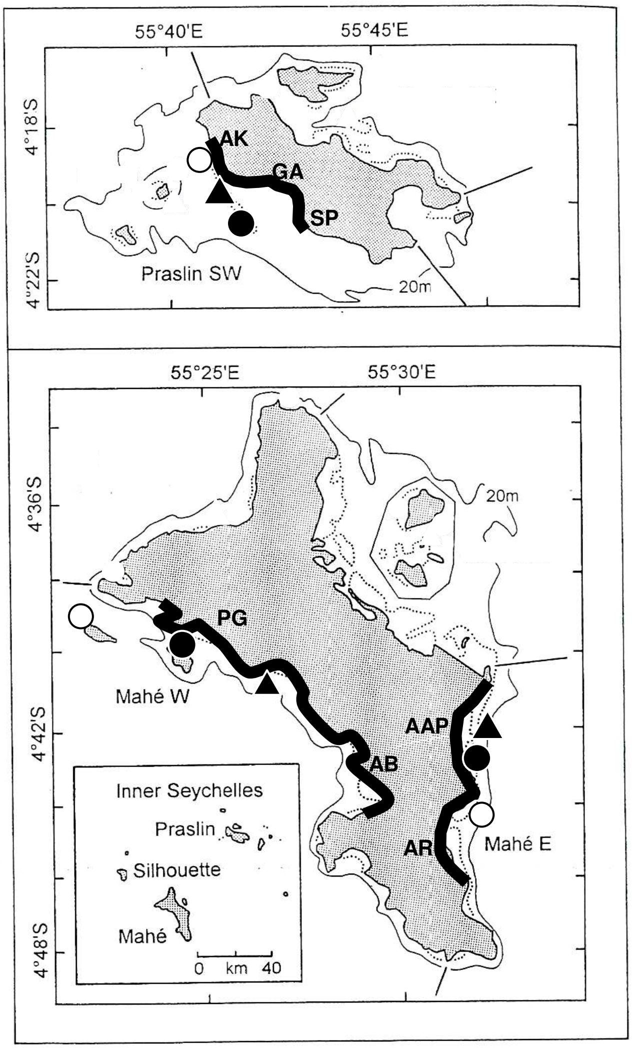

55°40'E
55°45'E
4°18'S
4°22'S
AK
GA
SP
Praslin SW
20m
55°25'E
55°30'E
4°36'S
4°42'S
4°48'S
20m
PG
Mahé W
AAP
AB
AR
Mahé E
Inner Seychelles
Praslin
Silhouette
Mahé
0 km 40

Figure 2

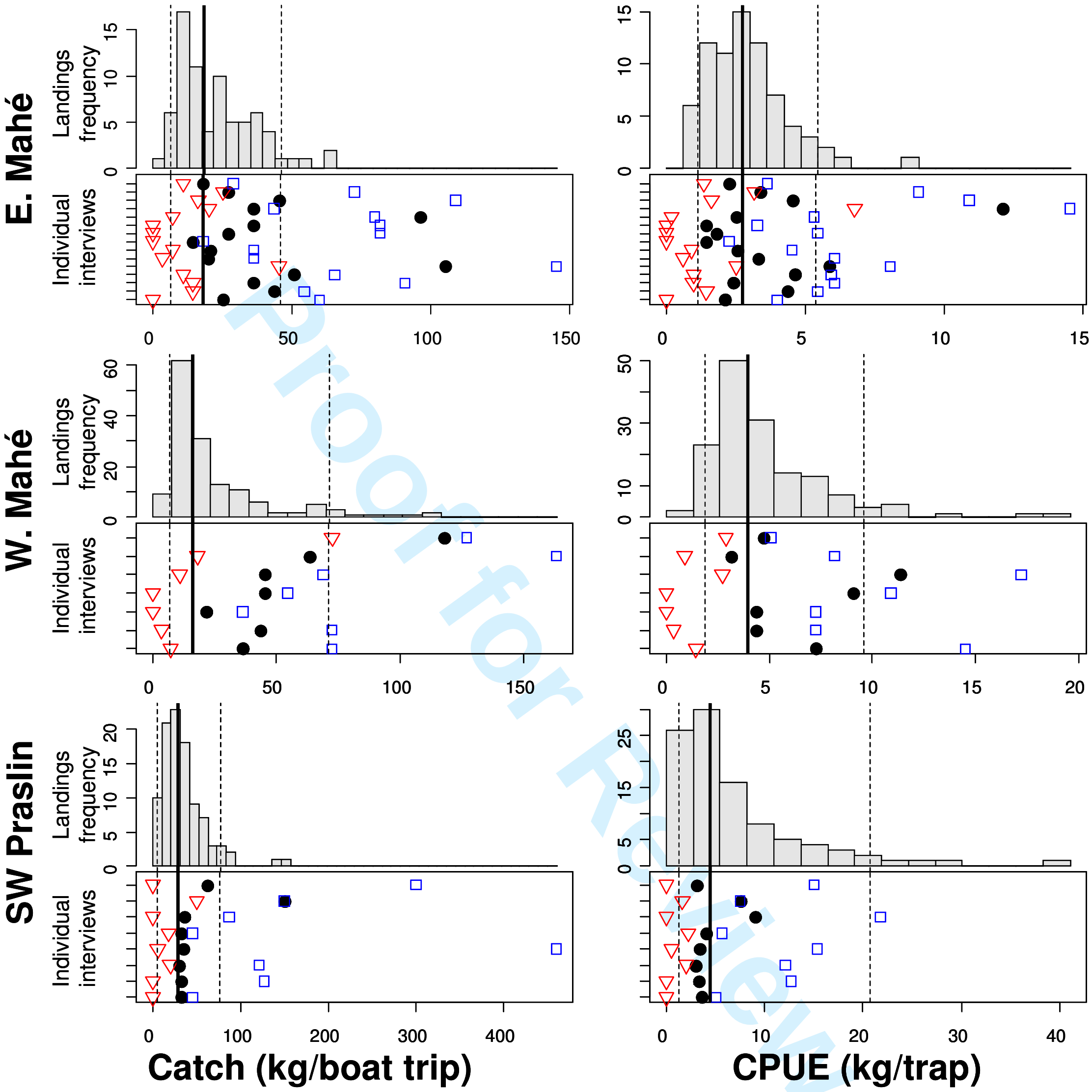

E. Mahé
W. Mahé
SW Praslin
Landings frequency
Individual interviews
Catch (kg/boat trip)
CPUE (kg/trap)

Figure 3

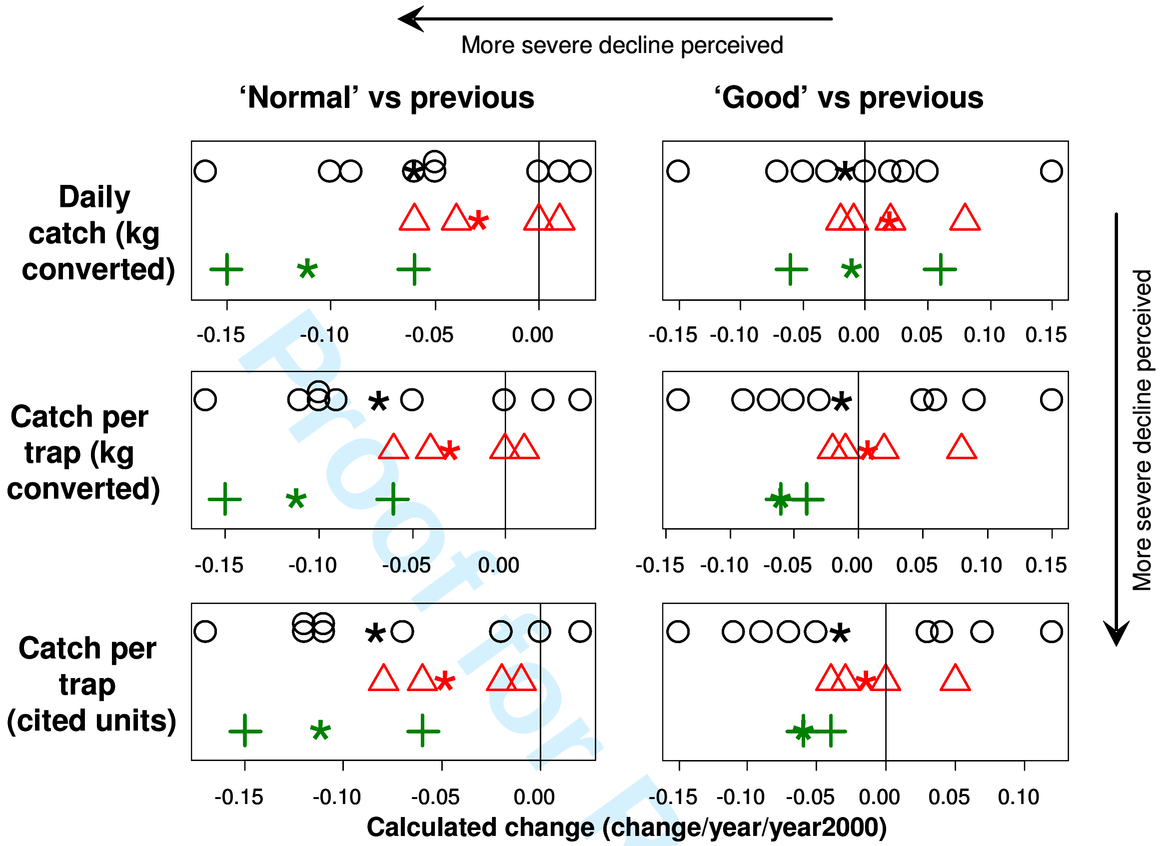

More severe decline perceived
'Normal' vs previous
'Good' vs previous
Daily catch (kg converted)
Catch per trap (kg converted)
Catch per trap (cited units)
More severe decline perceived
-0.15 -0.10 -0.05 0.00
-0.15 -0.10 -0.05 0.00 0.05 0.10 0.15
-0.15 -0.10 -0.05 0.00
-0.15 -0.10 -0.05 0.00 0.05 0.10 0.15
-0.15 -0.10 -0.05 0.00
-0.15 -0.10 -0.05 0.00 0.05 0.10
Calculated change (change/year/year2000)

Figure 4

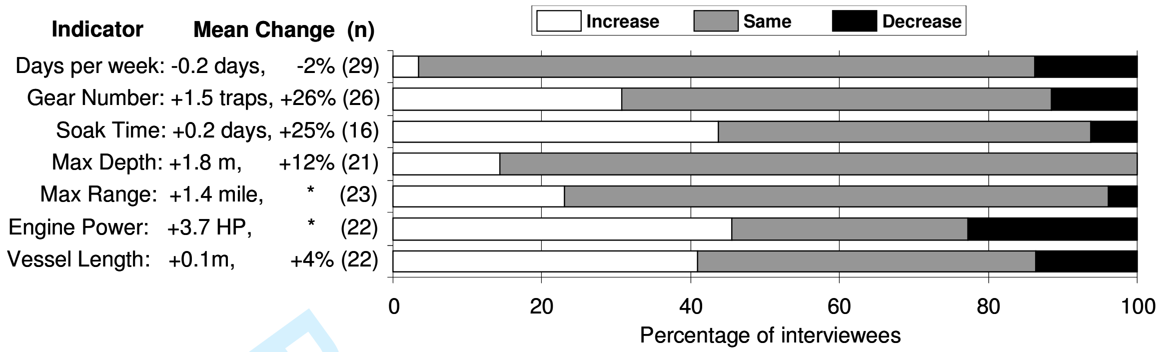

Indicator
Mean Change (n)
Increase
Same
Decrease
Days per week: -0.2 days, -2% (29)
Gear Number: +1.5 traps, +26% (26)
Soak Time: +0.2 days, +25% (16)
Max Depth: +1.8 m, +12% (21)
Max Range: +1.4 mile, * (23)
Engine Power: +3.7 HP, * (22)
Vessel Length: +0.1m, +4% (22)
0
20
40
60
80
100
Percentage of interviewees

Table 1. The area and trap type distinctions used to define the 3 fisheries selected for this study with the total number of fishers identified, interviewed and who refused to be interviewed.

Area	**Gear**	**Number of trap fishers**					**# of landings records**	
		Identified	Interviewed	Refusals	Valid area/gear[2]	Valid trends[3]	Recent catches	10 yr trend
E Mahé	*Kasye peze*	35	23	5	15	11	74[1]	401[1]
W Mahé	*Kasye dormi*	10	8	0	7	5	150	312
SW Praslin	*Kasye lavol*	16	9	4	8	2	100	719[4]

[1] Records from June to September only
[2] Fishers who fished with the specified gears within the area of the UVC surveys and landings data
[3] Fishers with ≥8 years of continuous gear use
[4] Records from Grand Anse only

Table 2. Results of Wilcoxon signed rank tests (with estimated median values) of dCatch and dCPUE (differences between 'normal' catches and CPUE reported by fishers and median landings).

Fishery	N	dCatch			dCPUE		
		Median	**V**	**P**	**Median**	**V**	**P**
E Mahé ***kasye peze***	15	0.998	115	<0.001***	-0.058	77	0.352
W Mahé ***kasye dormi***	7	1.80	28	0.016*	0.195	24	0.094
SW Praslin ***kasye lavol***	8	0.160	36	0.001**	-0.201	15	0.742

Table 3. Selection of candidate models for catch and CPUE of each fishery and indicators of trends where present. Shaded cells indicate the lowest (i.e. best) AIC between the linear models. Smooth terms are plotted with partial residuals (shaded areas correspond to 2 standard errors above and below the estimate of the smooth).

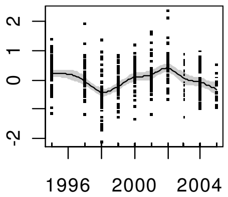
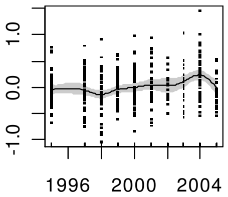
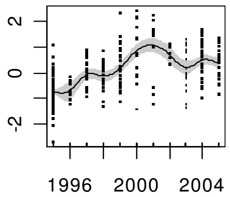
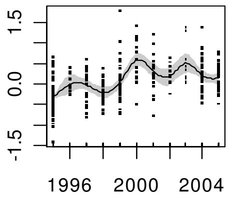
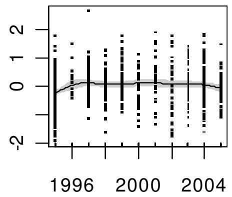
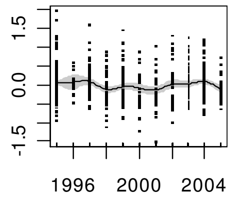
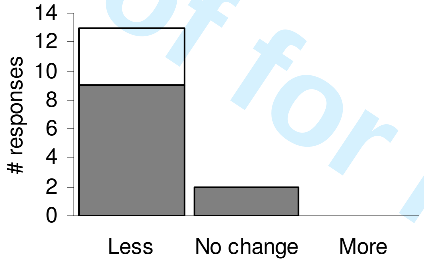
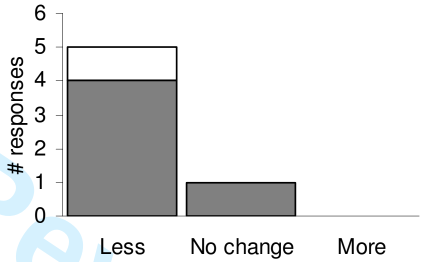
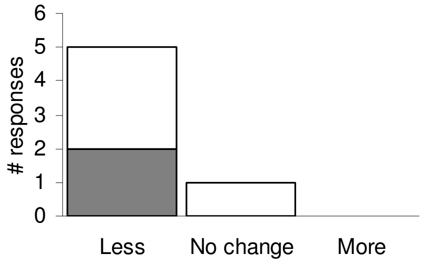
		Area and gear					
		E Mahé Kasye Peze		**W Mahé Kasye Dormi**		***SWP Kasye Lavol***	
		Catch	**CPUE**	**Catch**	**CPUE**	**Catch**	***CPUE***
Model selection (ΔAIC values)	**Null model:** y ~ s(month)	59.2	20.2	162.3	104.1	15.5	13.4
	Linear trend: y ~ year + s(month)	61.2	7.1	62.6	45.0	12.3	14.9
	Non-linear trend: y ~ s(year) + s(month)	**0**	**0**	**0**	**0**	**0**	**0**
10 yr Linear trend	**Linear effect indicated?** (significance of year term)	No	**Yes** (p=0.000)	**Yes** (p=0.000)	**Yes** (p=0.000)	**Yes** (p=0.024)	No
	Modelled change (/10years)		+ 0.91 kg	+ 26.8 kg	+ 2.7 kg	+ 2.4 kg	
	Slope (/year/yr2000)		+ 3.5%	+ 14.7%	+ 7.8%	+ 1.9%	
GAM	**Deviations from mean (% of mean)**	+51% to -37%	+34% to -20%	+111% to -69%	+64% to -49%	+8% to -26%	14% to -16%
	'04-'05 slope (% of mean)	-21.6%	-37%	-17%	-9%	-13%	-27%
	Smooth term (log scale on y axis)						

Table 4. Perceptions of trends from UVC and fisher interviews in each fishery.

		Area and gear					
		E Mahé Kasye Peze		**W Mahé Kasye Dormi**		***SWP Kasye Lavol***	
	Fishes included	**All fish**	**Trap fish**	**All fish**	**Trap fish**	**All fish**	***Trap fish***
UVC	**Trend detected (/year/yr2000)**[1]	- 1.6%	No trend	No trend (coral and granite sites) - 6.3% (patch reef site)	- 1.6% overall (- 7.4% at patch reef site)	No trend	No trend
Fishers' Perceptions	**Perceived trends**[2]						
	No quant. estimates	9		4		2	
	Change from previous to 'normal' CPUE (/year/yr2000)[1]	- 6.1 % (SD=6.7%)		- 2.3 % (SD = 3.3%)		- 10.5 % (SD = 6.3%)	
	Change from previous to 'good' catch (/year/yr2000)[1]	- 0.3 % (SD=9.5%)		+ 1.7 % (SD = 4.5%)		- 0.5 % (SD = 1.4%)	

[1] Proportional changes are calculated as annual change as a percentage of the modelled value for year 2000.
[2]Shaded bars indicate responses based on 8-10 years experience open bars indicate other timespans (9 with 3-7 years and one with 30 years due to leaving and returning to fishing)

Online Supplementary material for "**Perceptions of trends in Seychelles artisanal trap fisheries: Comparing catch monitoring, underwater visual census and fishers' knowledge"**

TIM M. DAW, JAN ROBINSON AND NICHOLAS A. J. GRAHAM

Table S1 - Species selected as trap target species and the cut-off length for inclusion as 'trap fish'

Family	**Species**	**Depth/Fork Length**	**Fork length at 6cm body depth (cm)**
Haemulidae	*Diagramma pictum*	0.33	18.3
Haemulidae	*Plectorhinchus orientalis*	0.29	20.8
Labridae	*Cheilinus fasciatus*	0.32	19
Lethrinidae	*Lethrinus lentjan*	0.36	16.7
Lethrinidae	*Lethrinus mahsena*	0.38	15.9
Lethrinidae	*Lethrinus nebulosus*	0.35	17.2
Lethrinidae	*Lethrinus obsoletus*	0.33	18.3
Lethrinidae	*Lethrinus olivaceus*	0.29	20.8
Lethrinidae	*Lethrinus rubrioperculatus*	0.26	23.3
Lutjanidae	*Aprion virescens*	0.24	25.5
Lutjanidae	*Lutjanus bohar*	0.32	18.9
Lutjanidae	*Lutjanus fulviflamma*	0.3	20.2
Lutjanidae	*Lutjanus gibbus*	0.37	16.2
Lutjanidae	*Lutjanus kasmira*	0.32	18.5
Mullidae	*Parupeneus barberinus*	0.27	21.9
Mullidae	*Parupeneus bifasciatus*	0.29	20.9
Nemipteridae	*Scolopsis frenatus*	0.29	20.7
Pomacanthidae	*Apolemichthys trimaculatus*	0.55	10.9
Pomacanthidae	*Pomacanthus imperator*	0.5	12.1
Scaridae	*Cetoscarus bicolour*	0.35	17.3
Scaridae	*Chlorurus atrilunula*	0.33	18.4
Scaridae	*Chlorurus sordidus*	0.31	19.2
Scaridae	*Scarus falcipinnis*	0.35	17.4
Scaridae	*Scarus ghobban*	0.36	16.7
Scaridae	*Scarus rubroviolaceus*	0.32	18.7
Serranidae	*Aethaloperca rogaa*	0.35	17.3
Serranidae	*Anyperodon leucogramma*	0.25	24.2
Serranidae	*Cephalopholis argus*	0.29	20.9
Serranidae	*Cephalopholis leopardus*	0.3	20.1
Serranidae	*Cephalopholis miniata*	0.28	21.4
Serranidae	*Epinephelus fasciatus*	0.27	22.3
Serranidae	*Epinephelus spilotoceps*	0.25	24.2
Siganidae	*Siganus argenteus*	0.33	18.1
Siganidae	*Siganus puelloides*	0.37	16.4
Siganidae	*Siganus sutor*	0.39	15.4

Example interview guide from E. Mahe (adapted from Walmsley et al)

Rec ☐ Entered ☐

SampleID:

ParFish Trap Interview

Background information:

Fisher Name		Date	
Port		Interviewer	
Community		Location	
Skipper☐ Boat owner☐ Diver☐ Snorkeller☐ FT/PT/Not Fishing			

All questions should be related to the coastal areas of Mahe only and catches in Kasye Dormi or Peze unless the interviewee only uses Kasye la vol

Effort:

Question	Answer	Comments / Notes
For how many years have you been trap fishing here?		
What kind of traps did you use in coastal Mahe in this last year?	Dormi Peser La Vol	
How many days per week did you lift traps here last year?	VN: VS:	
How many traps do you lift per day here?	VN: VS:	
Longest/shortest soak time?		
Vessel Description: Vessel type		
Length:		
Engine type and power:		
Nav equipment:	ES☐ GPS☐	
Fishing Grounds: Normal fishing grounds? *Get as detailed as possible information for coastal sites*	VN VS	
Maximum distance to grounds?		
Minimum distance to grounds?		
Deepest traps		
Shallowest traps		
What habitats do you put your traps on?		
Trap materials		
Bait used		
PAST (aim for 10 years)		
Time delay?		
What kind of traps did you use in coastal Mahe 10 years ago?	Dormi Peser La Vol	
How many days per week did you lift	VN:	

traps here ten years ago?	VS:	
How many traps did you lift per day here? 10 years ago	VN: VS:	
Soak time 10 years ago		
Vessel Description 10 years ago: Vessel type		
Length:		
Engine type and power:		
Nav equipment:	ES☐ GPS☐	
Fishing Grounds: Normal fishing grounds 10 years ago? *Get as detailed as possible information for coastal sites*		
Maximum distance to grounds 10 years ago?		
Minimum distance to grounds 10 years ago?		
Deepest traps 10 years ago		
Shallowest traps 10 years ago		
Trap materials 10 years ago		
Bait used 10 years ago		

Perceptions of resource, and catch rates

Question	Answer	Comments / Notes
Resource condition perception Do you think population of fish you catch are in a good state?		
Trends in catch rate: Over the last 10 years, are you catching more, less or the same amount of fish per trap?		
Why do you think this is the case?		

***Type** and **location** of traps for yield questions:*		
Current Max catch rate: Now, on the best days, how many packets do you catch? How many traps do you use?	No: Traps:	
Current Min catch rate: Now, on the worst days, how many packets do you catch? How many traps do you use?	No: Traps:	
Current Normal catch rate: Normally, how many packets do you catch in a day? How many traps do you use?	No: Traps:	
Current target spp: Which species do you catch mostly now? (If you have 10 packets how many would be each type?)		
Former Normal catch rate: 10 years ago, Normally how many packets did you catch? With how many traps did you used to use?	No: Traps:	

Former target spp: Have the types of fish you catch changed over the last 10 years? (If you had 10 packets how many would be each type?)						

Hypothetical Questions

Question	***Answer***		***Comments / Notes***
Catch rate for unexploited stock: Imagine a place never fished or which has been left for a long time without fishing, what is the most and least number of packets you could catch? How many traps would you use?	Min	No: Traps:	
	Max	No: Traps:	
How did you come up with this answer?			
Recovery time: If no-one fished on your grounds, how long do you think it would take for the stocks to recover so that it was like that? ***How did you come up with this answer?***	Immigr.☐ Growth☐ Reprod.☐		Time unit

Level of Effort

Question	***Answer***		***Comments / Notes***
If more fishers used kasye here do you think you would catch less?			
If some of the other fishermen stopped using kasye would you catch more?			
Do you think the amount of fishing (no traps) for the size of the resource is OK? ***How many traps should there be? Why do you think that?***	Could be greater		
	Just right		
	Too much		

Trends in individual species

Species changes Are there any species which have changed particularly since 10 years ago?		

Species Cards

- I am only interested in populations of fish in the coastal areas around Mahe/Praslin
- This list is not exhaustive, many (e.g. bordomar) are not pictured
- Some pictures show fish which are not found in Seychelles
- I am interested in changes which have occurred over the past 10 years

Card nos.	***Name***	***Often /Rare***	***Many /few***	***Abund.*** ↑→↓	***Size*** ↑→↓	***Notes***
group						

Card nos.	Name	Often /Rare	Many /few	Abund. ↑→↓	Size ↑→↓	Notes
Group						

Group						

Group						

General trends (if groups have not already been covered)

Group	Often /Rare	Many /few	Abund. ↑→↓	Notes
Bourzwa				
All other red snapper				
Vyey makonde				

Structural knowledge and Management opinions

Factors affecting stocks What things control/affect the population of the fish you catch? *(Ask open Q then prompt)* How does this affect fish?	Trap fishing	V Y N	
	Other Fishing	V Y N	
	Predation	V Y N	
	Food	V Y N	
	Habitat quality	V Y N	
	Reclamation	V Y N	
	Recruitment	V Y N	
	Immigration	V Y N	
	Tsunami	V Y N	
	Coral Bleaching	V Y N	
	Other	V Y N	
Of these, which is the most important?			
Management Opinions: What do you think should/needs to be done to manage the kasye fishery ***How much/when/ How?***	Limited licences	V Y N	
	Closed season	V Y N	
	Closed area	V Y N	
	Mesh size	V Y N	
	Others	V Y N	

Information sources and overview

Apart from your own experience, How do you get information about the state of kasye fish stocks?	
Do you see catches from other kasye fishers? How? How many? From where?	
Do you think SFA have a good idea about the state of stocks and the kasye fishery? Do you know what they think/know? Do you agree?	

Personal Information:

Question	Answer	Comments / Notes
How old are you?		
How many years of formal education did you do?		
Ownership of gears Do you own the boat you use?		
Do you own your kasye?		
Do you have any loans to pay on fishing vessel/equipment?		
Fisher importance – Dependents: Including you, how many people rely on your income?		

Other income Other than kasye fishing. What other fisheries or work do you have for income?		
Fisher importance - Dependence on fishing: What proportion of your income comes from kasye fishing?		
Future aspirations Do you want to continue Kasye fishing? Will you still be using Kasye in 10 years time?		

Who else fishes kasye in this area who I could speak to?