Sixteenth Meeting of the Scientific Sub-committee of the British/Seychelles Fisheries Commission

May 2005

Background Paper: SFA 02

Summary of Seychelles Artisanal Fisheries Statistics for 2004 with Notes on Research Activities

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1. Introduction

This paper begins by outlining the Seychelles artisanal fisheries statistics for 2004. Statistics are obtained through the catch assessment survey (CAS), and are reported in full in monthly and yearly technical reports. Major trends in catch and effort for artisanal fisheries are summarised, and problems are identified. Following the CAS report, there are notes on the major research activities carried out by the artisanal fisheries research section in 2004, which were dominated by the spawning aggregation project.

2. Catch Assessment Survey (CAS)

2.1. Total Catch

In 2004, catches generated by the artisanal fisheries showed a slight improvement over the previous year, with 4177 metric tonnes (MT) landed (Figure 1). However, landings remained slightly lower than the average annual catch for the last 20-years (4530 MT), by 7.8 %. Compared to 2003, landings on Mahé increased by 355 MT (11.5 %), whereas landings on Praslin decreased by 30 MT (4 %).

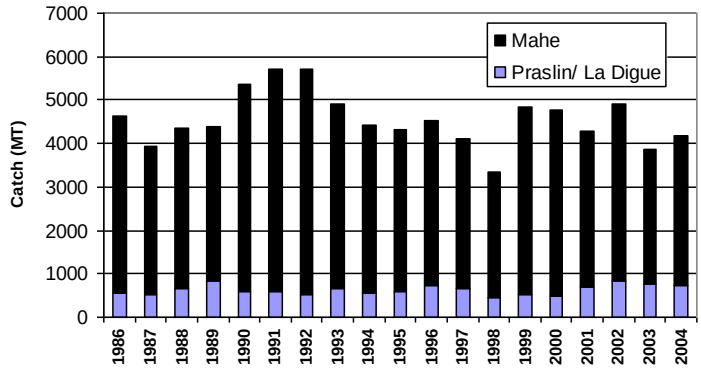

Figure 1. Total artisanal catches (MT) for the years 1986 – 2004, divided into landings for Mahé and Praslin/ La Digue.

2.2. Monthly Catches for the Main Strata in 2004

Monthly catches followed typical seasonal patterns, the highest catches coinciding with the inter-tropical monsoon periods, with 594 MT landed on Mahé in May. As expected, the lowest monthly catch for Mahé, 148 MT recorded in August, coincided with the peak annual wind speeds of the SE Trades. In line with the long-term trend, monthly catches on Mahé were generally an order of magnitude greater than the corresponding catches on Praslin (Figure 2).

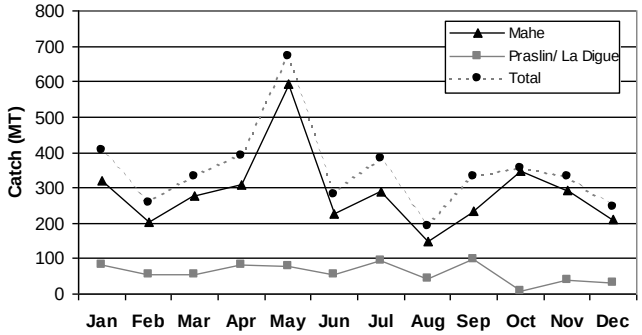

Figure 2. Monthly catches (MT) for Mahé and Praslin/La Digue during 2004.

2.3. Number of Operational Fishing Vessels

Data for 2004 suggest that the maximum numbers of whaler and outboard vessels in monthly operation have declined compared to the previous year. However, mean monthly estimates of vessels in operation indicate that the numbers of schooners and pirogues have increased over 2003. Logbook returns from the sport fishery were poor, precluding estimation of the number of vessels engaged in this fishery (Table 1). A comprehensive boat frame survey was undertaken in October 2004. This approach provides more accurate estimates of fleet size than can be obtained from mean monthly estimates generated by the CAS. A total of 395 artisanal fishing boats were surveyed, comprising 238 mini-Mahé, 103 whalers (lekonomie, lavenir, nouvo lavenir), 36 schooners and 18 pirogues. The actual fleet sizes may be slightly larger, as some vessels may be missed during a boat frame survey. A full report of this boat frame survey is available.

Table 1. Maximum number of fishing vessels in operation for the period 1997 – 2004.

Vessel Type	1997	1998	1999	2000	2001	2002	2003	2004
Pirogue*	40	38	41	37	32	31	30	33
Outboard*	201	214	239	250	236	234	250	239
Whaler	94	90	90	95	95	96	109	93
Schooner	11	11	13	13	14	13	16	20
Sport	28	32	38	35	40	38	21	**
Dropline	3	2	2	2	2	1	0	4

2.4. Catch by Vessel Type

Compared to previous years, the contribution of whaler vessel landings to the overall artisanal fisheries catch in 2004 was low, accounting for around 54 %. Small boats with outboards and schooners performed relatively well in 2004, increasing their contribution to the overall catch. Landings by pirogues and foot fishermen continued to account for a small proportion of the overall artisanal fisheries production (Table 2).

Table 2. Percentage of annual artisanal catch (%) landed by boat type for the period 1997 – 2004.

Vessel Type	1997	1998	1999	2000	2001	2002	2003	2004
Pirogue	3.0	4.0	0.7	1.7	1.2	0.6	1.1	1.3
Outboard	34.0	25.0	33.7	31.6	24.9	25.2	27.2	34.3
Whalers	54.0	62.0	59	59.4	66.7	68.5	63.8	54.2
Schooners	7.0	7.0	5.2	3.9	6.1	4.5	6.8	9.0
Foot Fishermen	1.0	1.0	1.1	0.8	1.1	0.6	0.6	0.9
Research Vessels	1.0	1.0	0.1	0.1	1.7	0.2	0.1	0.1
Dropline Vessels	1.0	1.0	0.1	0.1	0.1	0	0	0

2.5. Species Composition of the Catch

Although still dominant in terms of the overall species composition, for the second consecutive year catches of trevally (karang balo and karang plat) were lower than expected, if compared to long-term trends (Table 3). A total of 1177 MT of this semi-pelagic species group were landed in 2004, representing a drop of 9 % when compared to the previous year. By contrast, catches of the main demersal species groups generally improved in 2004. Landing of the red snapper group, which includes Bourzwa, increased in relative importance (Table 3), the catch increasing from 444 MT in 2003 to 710 MT in 2004. This performance reverses a trend of declining red snapper catches over the previous 3-years. Emperors and groupers both recorded increases in catches compared to 2003, by 10 % and 5 %, respectively. Trap fisheries performed particularly well, with rabbitfish catches increasing by 24 %, from 255 MT in 2003 to 317 MT in 2004. The year 2004 was exceptional in terms of the mackerel fishery, the catch increasing by 108 % compared to the previous year, from 221 to 461 MT. This increase is reflected in the species composition of the overall artisanal catch, with mackerel species showing far greater relative importance to the overall catch in 2004 (Table 3).

Table 3. Species composition of the artisanal catch (%) for the period 1999 – 2004.

Species Group		**Annual Catches**					
English / Scientific	**Kreol**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Trevally (*Carangoides* spp.)	Karang	30	37.0	30.0	41.6	33.6	28.2
Red Snapper (*Lutjanus* spp.)	Bourzwa, etc	1	8.7	14.1	10.0	11.5	17.0
Jobfish (*Aprion virescens*)	Zob	17	11.6	16.4	12.4	15.8	12.5
Emperors (*Lethrinus* spp.)	Kapten	5	8.9	11.3	6.9	6.1	6.2
Bonito (*Euthynnus* spp.)	Bonit	3	1.7	1.2	1.5	3.5	1.9
Groupers (*Epinephelus* spp.)	Vyey	3	3.2	2.5	1.5	2.4	2.3
Rabbitfish (*Siganus* spp.)	Kordonnyen	5	3.4	2.1	4.1	6.6	7.6
Mackerel (*Rastrelliger* spp.)	Makro Dou	6	6.2	6.1	7.0	5.7	11.0
Others		18	19.2	16.3	15.1	14.8	13.3
Total Catches (MT)		**4842**	**4764**	**4290**	**4915**	**3852**	**4177**

3. Research Projects

3.1.Reef Fish Spawning Aggregation Programme

3.1.1. *Introduction*

The MASMA funded component of this research programme has entered its last 6-month period. Several outputs need to be met in this final period, the most important of which is a management plan for spawning aggregations. The management plan will largely focus on species that are known to form transient type aggregations, most belonging to the families Serranidae and Siganidae, and for which there is strong evidence of targeting by fishers. MASMA projects are also expected to deliver strong scientific publications, a process that is underway.

A multi-disciplinary approach has been used to describe and understand dynamics of spawning aggregations and their fisheries, including surveys of traditional ecological knowledge, field studies at aggregation sites, studies of reproductive biology and socio-economic surveys. However, staff constraints, limited funds, and the scale of the task of documenting a huge number of aggregations over such large area, means that there is still much to do in this field in Seychelles. Moreover, given the considerable overlap in aggregation formation for key species, with aggregations forming at roughly the same time at different spawning grounds, the research team had to concentrate on efforts at a few sites in order to demonstrate the applications of this research. Those sites for which aggregation dynamics are well understood can be used as models and case studies to guide the management process. Nevertheless, the programme has attained a level of understanding and momentum to allow a management framework to be developed.

Results from the surveys of traditional ecological knowledge have summarized in earlier reports, so this report summarizes findings for the other major research components that will be utilized for management. It also outlines outputs expected by MASMA

3.1.2. *Field studies*

Extensive field studies were conducted over a two-year period (2003-2005), with expeditions mounted to the atolls of Farquhar, Cosmoledo and Alphonse, and to Praslin/Felicite and Topaze Bank on the Mahé Plateau. A summary of aggregations confirmed visually and through sampling is given in Table 1. At Farquhar, the spatial and temporal dynamics of *Epinephelus polyphekadion* and E. *fuscoguttatus* aggregations at Pass Vingt Cinq Francs were studied using UVC surveys, with samples obtained to refine seasonal, lunar and diel periodicity using histological analyses of gonad tissues. Peak densities of *E. polyphekadion* and *E. fuscoguttatus* were 79.4 and 39.5 fish per m^2, respectively, with aggregations always forming in January and, to a lesser extent, December. Aggregations of *Plectropomus punctatus* at this site were also confirmed, although not subject to UVC surveys. Secondary aggregation sites were found to occur within the lagoon at the western side of the atoll, but understanding the significance of those areas in terms of the reproductive output of the populations needs further work. Given that the most extensive field

studies on serranid aggregations have taken place at Farquhar, this site should be used as a model for development of the management framework.

Field studies at Cosmoledo have tended towards the end of the spawning season for serranids, due to the overlap in seasonality with Farquhar. Nevertheless, aggregations of *E. polyphekadion* and *E. fuscoguttatus* have been located in the Southwest Pass and estimates of density and abundance obtained. Although different census methodologies were employed, densities of both species observed at Cosmoledo in February were always an order of magnitude below those observed at Farquhar. This is probably due to the fact that February represents the last month of the spawning season, with histological evidence supporting this for *E. polyphekadion*. The pass also hosts aggregations of *Plectropomus laevis*, whilst *P. punctatus* was found to form aggregations at various points on the drop-off along the southern outer reef, showing similar dimensions to those observed for *P. leopardus* on the Great Barrier Reef.

At Alphonse, interviews with dive operators indicated an aggregation of *Dermatolepis striolata* formed at a popular dive site on the new moon in April. This was evidenced by video footage taken by tourists at the site. However, SFA divers failed to locate the aggregation in 2005, with depth constraints inhibiting the search. Fishers have reported aggregations of *E. polyphekadion* in the Bijoutier and north St Francois area. SFA divers located an aggregation on the western side of Bijoutier in 2005, which totaled around 50 individuals. Given the low abundances, it is possibly the last aggregation of the season, which may be confirmed through histology. Other explanations for the low abundance may involve fishing effects and/or secondary aggregation sites.

Table 1. Spawning aggregation sites confirmed using a combination of visual, UVC and biological (hydrated oocytes, post ovulatory follicles, GSI) criteria. * Only video footage available.

	Species	Location(s)	Seaonality	Lunar period	Fished
Farquhar	*Epinephelus polyphekadion*	Main pass/Western lagoon	Dec/Jan	New	Yes
	Epinephelus fuscoguttatus	Main pass/Western lagoon	Dec/Jan	New	Yes
	Plectropomus punctatus	Numerous, incl. Main pass	Dec/Jan	New?	Yes
Cosmoledo	*Epinephelus polyphekadion*	SW Pass	Feb?		??
	Epinephelus fuscoguttatus	SW Pass	Feb	New	??
	Plectropomus punctatus	Numerous - incl. Ile du Sud	Feb	New	??
	Plectropomus laevis	SW Pass	Feb	New	??
Alphonse	*Epinephelus polyphekadion*	Western Bijoutier	Apr	New	??
	Dermatolepis striolata	Western Bijoutier*	Apr	New	??
Praslin	*Siganus sutor*	Dividi/ Consolation	Oct - Apr	Full	Yes

Aggregations of *S. sutor* have been confirmed at Pate Consolation and Dividi. Both aggregation sites studied are granitic reefs at depths ranging from 15 to 25 m. Aggregations start to form around 5-days before the full moon, and spawning has usually ceased by 1-day before the full moon, aggregations dispersing soon after. Analyses of GSI and observations of hydrated oocytes indicate that the main spawning season runs from October to April, but spawning may also occur in the SE trades. It is not yet confirmed whether or not aggregations are formed at Dividi and Consolation during all full moon periods of the spawning season, but interviews with fishers suggest that this is the case.

3.1.3. *Reproductive biology*

This MASMA funded project essentially addresses the importance of reproductive biology for management of artisanal resources, of which spawning aggregations are an important component for many exploited species. A major aim of the project was to develop local capacity in reproductive biology and to apply the techniques to species that are suspected or known to form spawning aggregations. Since April 2003, around 2,500 samples have been collected for *E. fuscoguttatus, E. polyphekadion, E. multinotatus, V. louti* and *Siganus sutor*, around 30 % of which have been retained for histological analyses. Seasonality for these species, based on macroscopic staging and GSI, is summarized in Table 2. These data are being utilized to define seasonal, lunar and diel periodicity of spawning, to describe sexual pattern, to investigate mating patterns and to provide accurate estimates of size (age) at maturity. These patterns, notably seasonality, can be used in conjunction with data on spawning aggregation location to shape the management framework. For species for which location of spawning aggregations is not currently known, i.e. *E. multinotatus* and *V. louti*, seasonality will be important if closed seasons are to be considered. SFA technicians are currently analyzing samples prepared histologically, a process which should be complete by the end of 2005.

A training course on reproductive biology was held at SFA in September 2004 and hosted by Dr. Melita Samoilys of IUCN. The course provided technicians with guidelines for histological analyses, with an emphasis on hermaphroditism. A Microsoft Access database was also provided by the consultant, which will be modified for our data requirements.

3.1.4. *Management process and socio-economic surveys*

The management process for spawning aggregations is scheduled to last between March and October 2005. Draft management frameworks are to be presented for discussion at stakeholder meetings, scheduled for July 2005, and a framework presented to the MASMA committee at the 4th WIOMSA scientific symposium in Mauritius at the end of August 2005.

Research findings have shown that fishers exploit spawning aggregations formed by a wide range of reef fish families. However, management will initially focus on the two families which are characterized by the formation of transient spawning aggregations in Seychelles and the wider Indo-Pacific, namely the Siganidae and Serranidae. Transient aggregations of serranids and siganids are targeted regularly in Seychelles. Evidence points to the formation of resident aggregations by members of the families

Lutjanidae, Lethrinidae and Scaridae, particularly on the Mahe Plateau. Problems arising from aggregation fishing are generally considered less urgent for resident aggregations than those arising from the targeting of transient aggregations. Although resident aggregations will not be addressed through specific management frameworks at this stage, specific management interventions will be sought later.

Due to major differences in population biology, fisheries and socio-economics, there will be a dual process for the development of management frameworks for siganids and serranids, although strong linkages will be maintained. A meeting was held in March 2005 with principal stakeholders to discuss issues pertaining to serranid aggregations, including representatives of the Ministry of Environment and Natural Resources (MENR), the Fishing Boat Owners Association, the Islands Development Company (IDC) and the Marine Conservation Society. Outcomes from the meeting comprised agreement on management objectives and a discussion of issues and management regimes. Management of serranid aggregations in the outer islands will be integrated with the Fisheries Reserve Management Areas (FRMAs). A range of management tools are currently being assessed, including closed seasons, seasonally closed areas, total area closures and effort/quota systems. The system is likely to be dynamic and options nested as appropriate. The framework must also be dynamic to integrate new aggregations as more data becomes available and to refine existing regimes.

For input to the management frameworks, socio-economic surveys have been completed for the schooner fishery, in relation to outer island serranid aggregations, and with trap fishers who target siganid spawning aggregations. Staff of MRAG provided useful comments on the methodology for the surveys. Interviews with 25 schooner skippers/owners have been conducted. It appears that most schooner vessels have, in recent years, concentrated on targeting demersal resources on the Mahe plateau, due to high operational costs and better prices for lutjanids such as Lutjanus sebae. Whilst this trend poses problems for the management of those species, management measures aimed at spawning aggregations in the outer islands would have low socio-economic impact for schooner fishers if the current preferences prevail. Management issues were discussed during interviews and more than 50 % of fishers stated that serranid spawning aggregations should not be targeted.

In terms of socio-economics and cultural criteria, siganid aggregations are of far more importance to artisanal fishers that serranid aggregations. Several aggregation sites, now confirmed through field studies, are targeted for at least 4-months of the year by trap fishers. Aggregations tend to be targeted by trap fishers from adjacent areas, and an informal tenure system is emerging. For example, trap fishers from Baie St. Anne on Praslin target the aggregations at Pate Consolation, whilst those from Grande Anse, Praslin, target the aggregations at Pate Dividi. Both communities attempt to discourage targeting of the aggregations by outsiders, for example, trap fishers from Mahe, and there are also resource use rules in place, such as a ban on overnight trap sets. These community based resource use systems are being documented in combination with socio-economic information, both of which will be vital to the management process. A range of options will be investigated, including formalization of the emergent property rights regimes at relevant sites, closed areas/seasons for aggregation sites that are not community associated and effort/gear controls. Socio-economic surveys will also be conducted with trap fishers targeting aggregations at

Anse aux Pins, allowing comparisons to be made with Grande Anse and Baie St Anne. Meetings with stakeholders are planned for May on Praslin and Mahe.

3.1.5. *Expected outputs*

The following technical documents are in preparation for 2005:
1. Management framework for serranid spawning aggregations.
2. Management framework for siganid spawning aggregations.
3. Final technical project report to MASMA and Government of Seychelles

The following scientific publications have been identified as outputs.

1. Investigation of the spatial and temporal dynamics of *Epinephelus polyphekadion* and *E. fuscoguttatus* spawning aggregations at Farquhar Atoll, Seychelles (in prep).
2. The management of serranid spawning aggregations in Seychelles (late 2005).
3. Informal community-based management of spawning aggregations of the shoemaker spinefoot (*Siganus sutor*) in Seychelles: A sustainable aggregation fishery? (Late 2005)
4. Spawning aggregations and reproductive biology of the shoemaker spine foot (*Siganus sutor*) on the Mahé Plateau, Seychelles (early 2006).
5. The reproductive biology of the white-blotched grouper (*Epinephelus multinotatus*) and the lyre tailed grouper (*Variola louti*) on the Mahé Plateau, Seychelles (mid 2006).
6. Applications of GIS for the management and conservations of reef fish spawning aggregations (late 2006).

3.2. CEDA Analyses

Subsequent to training provided in the use of CEDA software by MRAG staff in May 2004, we have performed an analysis of catch and effort data for the inshore trap fishery.

Catch and effort data for the period of 1979 to 2003 were used for the analysis. Annual data comprised aggregated catches for siganids and other trap fish, whilst the number of traps used each year was employed as the measure of effort, combining fixed and active fishing modes for pirogues, outboards and whalers (Table 2). The year 1984 was excluded due to uncertainties with the effort data. Plots of residual catches vs. time and residual catches vs. expected catches also excluded the year 1987 from the analysis.

A Schaefer production model was fitted to the data using least squares, and a bootstrapping technique was employed to estimate the 90 % confidence intervals for the parameters r (intrinsic rate of population increase), K (carrying capacity) and MSY. The initial proportion of the population size prior to 1979 was set at 1.0 (max), due to the fact that the resource base was fished at relatively low levels using wooden pirogues until that time (Wakeford, 2000).

Table 2. Annual catch and effort data for the inshore trap fishery for the period 1979 to 2003

Year	Catch (MT)	Effort (Traps/year)	Year	Catch (MT)	Effort (Traps/year)
*1979	557	_	1992	645.6	160923
1980	580	105000	1993	543.4	134449
1981	500	78000	1994	404.5	85456
1982	440	65000	1995	416	92143
1983	630	121000	1996	438.6	106669
*1984	480	_	1997	306	89855
1985	540	135000	1998	298.8	86126
1986	610	209552	1999	483.1	112627
*1987	286.7	137121	2000	342.1	80584
1988	464.1	132990	2001	337	85022
1989	463.4	97152	2002	488.8	88719
1990	264.9	73418	2003	464.1	92834
1991	506.5	118987			

Table 3. Estimates of the parameters K, r and MSY (metric tonnes, MT) with 90 % confidence interval (CI)

Parameter	Value	90 % CI
K	2,526	1,941 - 3,445
r	0.71	0.53 - 0.96
MSY	452 MT	445 - 471 MT

A relatively poor fit ($r^2 = 0.54$) was obtained from the model, so the results must be viewed with caution (Table 3). However, the fit was slightly better than that obtained by Wakeford (2000), probably due to the additional 6-years data available to our analysis. The estimate of MSY obtained for the inshore trap fishery was lower than that obtained by Wakeford (474 MT; 2000) and Lablache et al. (600 MT; 1988). The catch in 2003 exceeded MSY (452 MT) by around 12 MT. If a conservative approach is taken and the lower confidence interval of MSY used, the catches in 2003 exceeded MSY by around 4 %.

The fishery appears to be operating slightly above optimal levels. However, the next step is to standardise fishing effort for increases in fishing power, which may produce lower estimates of MSY. Management options for the trap fishery, including effort controls, will be considered during the management process for siganid spawning aggregations.