

Annual Report of Benthos, Reef Fish and Invertebrate Surveys for Reef Slope and Reef Flat Areas in Rodrigues 2006

E. R. Hardman, F.E. I. Blais, M. S. Desiré, J.S.J Raffin, S. Perrine, R. Raffaut, M. Chinien-Chetty and J. Towill.

Shoals Rodrigues, Pointe Monier, Rodrigues

January 2007



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Abstract

Surveys of reef composition and fish and invertebrate populations were undertaken using the Global Coral Reef Monitoring Network methodology during March/April 2006 and October/November 2006, to continue a monitoring programme that began in 1999. Nine sites around the fringing reef were included: Rivière Banane, Passe Armand, Grand Bassin and Ile aux Fous (reef flat and reef slope stations), Passe Cabris, Trou Blanc and Passe L'Ancre (reef flat stations only) and Passe Demi and North Ile aux Sables (reef slope only). The surveys show that coral cover is high on the reef slopes at Rivière Banane, Grand Bassin and Ile aux Fous (>50%), but is low at Passe Demi, North Ile aux Sables and Passe Armand (<30%). In contrast, coral cover was low on all reef flat sites (<30%) and there was a high percentage cover of rubble at Passe L'Ancre, suggesting that these sites are being subjected to human and natural impacts. Despite these impacts, live coral cover has remained stable at the sites between March 2002 and October 2006. There are however, seasonal changes in macro-algae cover, with increases observed during October 2004 and 2005. The fish community at all sites tended to be dominated by Damselfish. Emperors and Grouper were rare or absent and no Triggerfish, Snapper or Trevally were observed at any site during the surveys. This lack of large piscivorous predators suggests that the fish population may be unbalanced due to overfishing. There have also been declines in the number of Damselfish, Surgeonfish, and Butterflyfish since March 2002 at some sites and fish communities are dominated by small, under-sized individuals, further indications of overfishing. Invertebrates were low on the reef slope sites and most sites were dominated by the bio-eroding urchin, *Echinometra mathaei*; this species also dominated the reef flat sites. At all sites, molluscs and crustaceans were either rare or absent; in particular *Tridacna* clams were in low abundance and large gastropods such as *Pleuroploca trapezium* were not observed. This may be an indication that local consumption is resulting in over-harvesting. It is suggested that the development of marine reserves will protect the healthy reef slopes from future impacts and aim to facilitate recovery of the degraded reef flat areas.

1 Introduction

Rodrigues is surrounded by a fringing reef, which forms an almost continuous band measuring approximately 90km in length. The reef encloses a shallow lagoon, which, at 240km², is twice the area of the island itself. The maximum tidal range is approximately 1.5m, and since the average water depth in the lagoon is less than 2m, many areas are exposed at low spring tides. The water depth immediately beyond the reef slopes is usually within the range of 10m to 30m. The island has three major channels, one dredged channel for the main harbour at Port Mathurin in the north, and natural channels in the south near Port Sud Est and in the East at St Francois. Several small passes are also found at intervals around the reef.

The reefs of the island consist mainly of scleractinian corals, with *Acropora* spp. dominant on both the reef flat and reef slope. 140 species of coral were recorded in Rodrigues during the first Marine Biodiversity Workshop held in September 2001, of which 25 were *Acropora* spp. (*Shoals of Capricorn Programme*, 2002). The coral cover on the reef slopes around Rodrigues is relatively healthy, while reef flat areas are more heavily impacted, both by fishing (particularly trampling by octopus fishers (Clark, 2001)) and by bleaching events (Hardman *et al.*, 2004).

In order to evaluate temporal changes in the health of the coral reef and the populations of fish and invertebrates that it supports, monitoring activities have been carried out since 1999. The data is also made available to the Global Coral Reef Monitoring Network (GCRMN), being submitted via the regional network administered by the Indian Ocean Commission. This report details findings of the GCRMN monitoring activities that took place in 2005, and contains some comparisons with data from 2002 - 2005 (Hardman *et al.*, 2006; Lynch *et al.*, 2004a; Lynch *et al.*, 2004b).

2 Materials and Methods

Surveys were carried out at six reef slope and seven reef flat stations around the island by *Shoals Rodrigues* staff in March/April and October/November 2006. Of these, the stations at Rivière Banane, Grand Bassin, Passe Demi and Passe Cabris were within the 4 proposed marine reserves, whilst the remaining stations were outside of the proposed reserves. The site locations are listed in Table 1 and shown in Figure 1.

Table 1. The location of the monitoring sites at which surveys were carried out

Site Name	Reef flat GPS Position	Reef slope GPS Position
Rivière Banane	19° 40.224' S; 63° 28.224' E	19° 40.154' S; 63° 28.484' E
Passe Armand	19° 40.272' S; 63° 24.982' E	19° 40.084' S; 63° 24.677' E
Grand Bassin	19° 39.408' S; 63° 21.447' E	19° 39.381' S; 63° 21.366' E
Trou Blanc	19° 45.401' S; 63° 28.443' E	
Passe L'Ancre	19 ° 48.825' S; 63° 25.613' E	
Passe Demi		19° 42.515' S; 63° 17.562' E
N Ile aux Sables		19° 40.770' S; 63° 17.984' E
Passe Cabris	19° 39.587' S; 63° 26.406' E	
Ile aux Fous	19° 39.313' S; 63° 23.593' E	19° 39.218'E; 63° 23.977' E

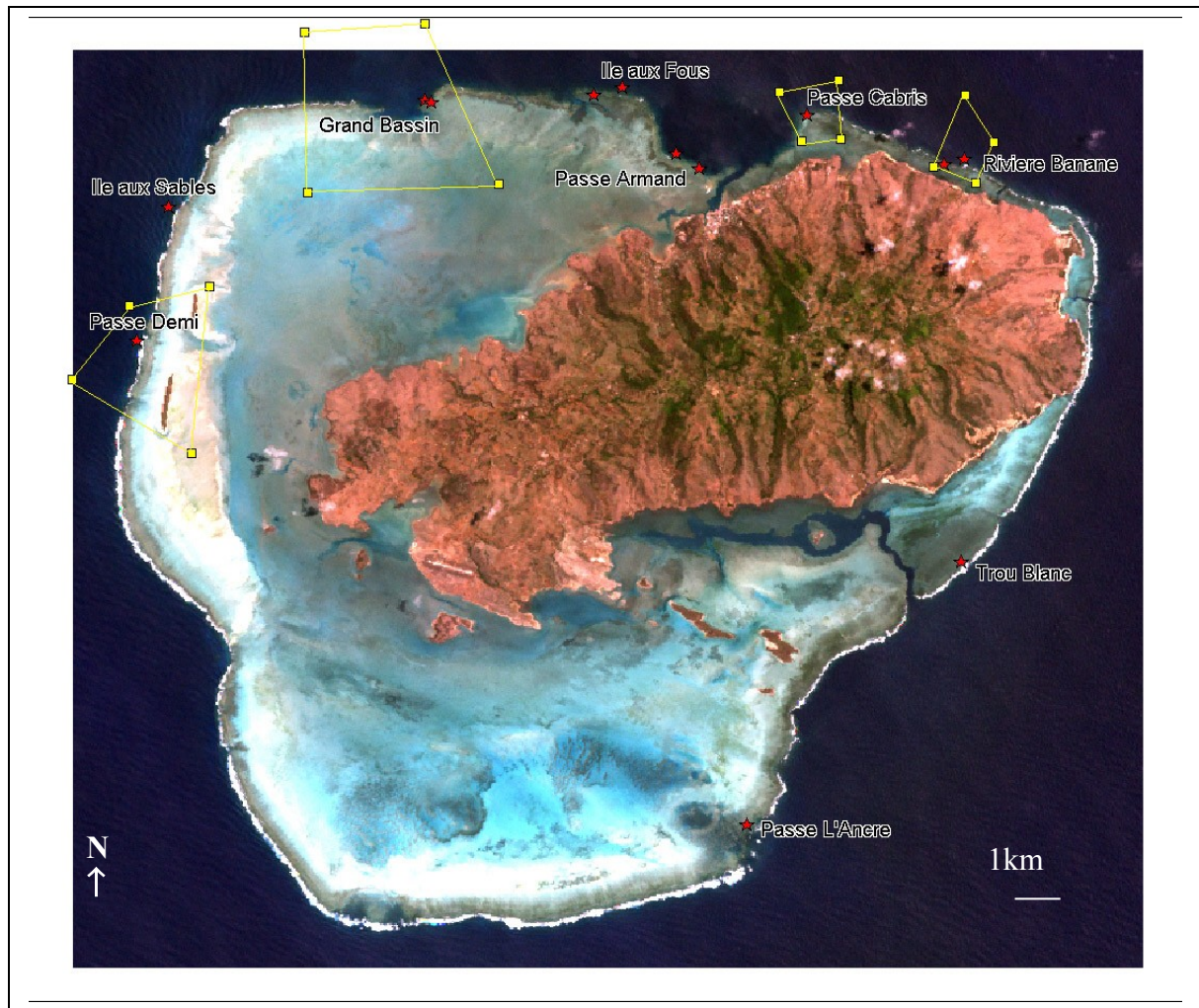


Figure 1. The location of reef monitoring sites around Rodrigues and the position of the 4 proposed marine reserves.

The depth on the reef flat was approximately 1m, while surveys on the reef slope took place at between 6m and 12m depth. Reef flat monitoring was carried out by snorkelling, with SCUBA used for reef slope surveys. The location of the site was recorded on a GPS and transects marked by metal bars and buoys. The methodology used was that of the Indian Ocean Commission regional reef monitoring network as described in their manual (Conand *et al.*, 1997), for which three transects were laid at each station. To facilitate replication of the surveys, the transects were permanently marked at 0m, 5m, 10m, 15m and 20m, using 1m lengths of concrete re-enforcing bar hammered into the reef.

Counts of all fish encountered were carried out for a belt of 50 x 5m along each transect, by 2 observers while coverage of benthic species and abiotic features was determined by line intercept along the first 20m of each transect. Surveys of invertebrates were carried out by determining abundance of species over a belt 20 x 5m wide for each transect. The lengths of 12 key fish species were also estimated at each site (Anderson, 2006).

Water temperature was measured at each site using a CTD (Valeport 600 MKII) and nutrient concentration (nitrates, nitrites and phosphates) were determined using the Palintest system.

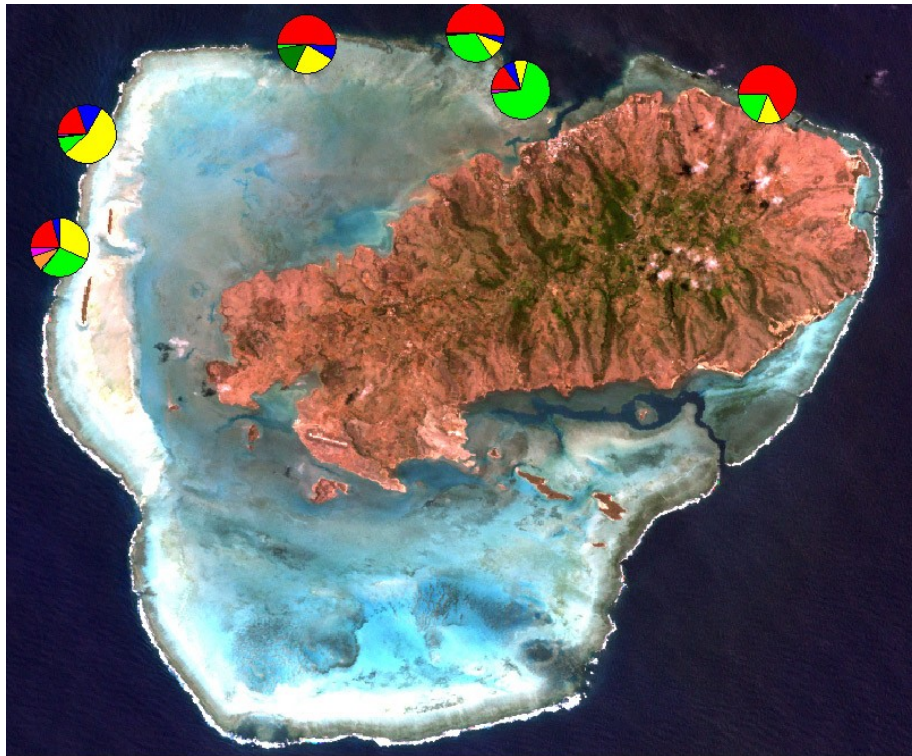
3 Results

3.1 Benthos

During the summer surveys, live hard coral cover on the reef slope was >50% at Grand Bassin, Rivière Banane and Ile aux Fous, but <25% at Passe Demi, North Ile aux Sables and Passe Armand (Figure 2). The sites at Passe Demi and North of Ile aux Sables were dominated by coralline algae (>30%) with a high percentage of the soft coral *Sinularia* sp. at North Ile aux Sables (14%), whilst Passe Armand was dominated by turf algae (69%). All sites had a low percentage of recently dead coral (<2%) and rubble (<10%), however the percentage cover of the red macro-algae *Asparagopsis taxiformis* was high at Grand Bassin (16%).

During the winter surveys, live coral cover on the reef slopes was also >50% at Grand Bassin, Rivière Banane and Ile aux Fous and <30% at Passe Demi, North Ile aux Sables and Passe Armand. The sites at Passe Demi and North of Ile aux Sables were dominated by coralline algae (>35%) with a high percentage of the soft coral *Sinularia* sp. at North Ile aux Sables (14%). Turf algae was high (28%) at Riviere Banane and Passe Demi. Macro-algae was very low (<2%) or absent at all sites and no dead coral was recorded. Rubble was however >10% at Passe Armand and Ile aux Fous.

Cluster analysis highlights 2 separate groups with Rivière Banane, Ile aux Fous and Grand Bassin grouped together at 73% similarity and Passe Demi, Passe Armand and North Ile aux Sables grouped together at 70% similarity. Summer and winter surveys show high similarities at all sites except at Ile aux Fous and Passe Armand, due to large decreases in turf algae between March and October at the 2 sites (Figure 3).



(A) Summer



(B) Winter

Key










 Living Hard Coral	 Coralline Algae	 Zoanthids
 Soft Coral	 Macro-Algae	 Sand
 Dead Coral	 Turf Algae	 Rubble

Figure 2. The percentage cover of the different benthic habitats at the 6 reef slope sites during (A) Summer (March) and (B) Winter (October).

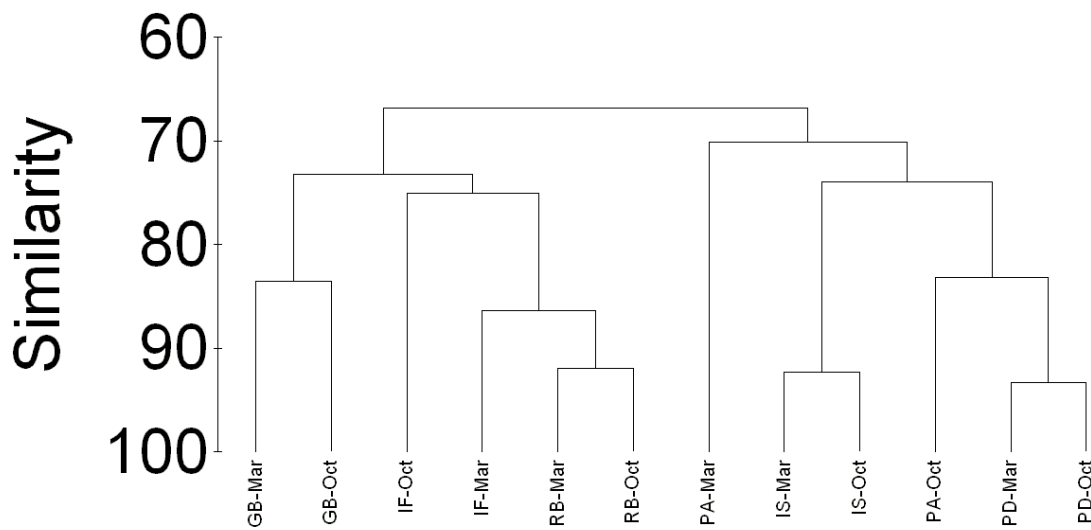
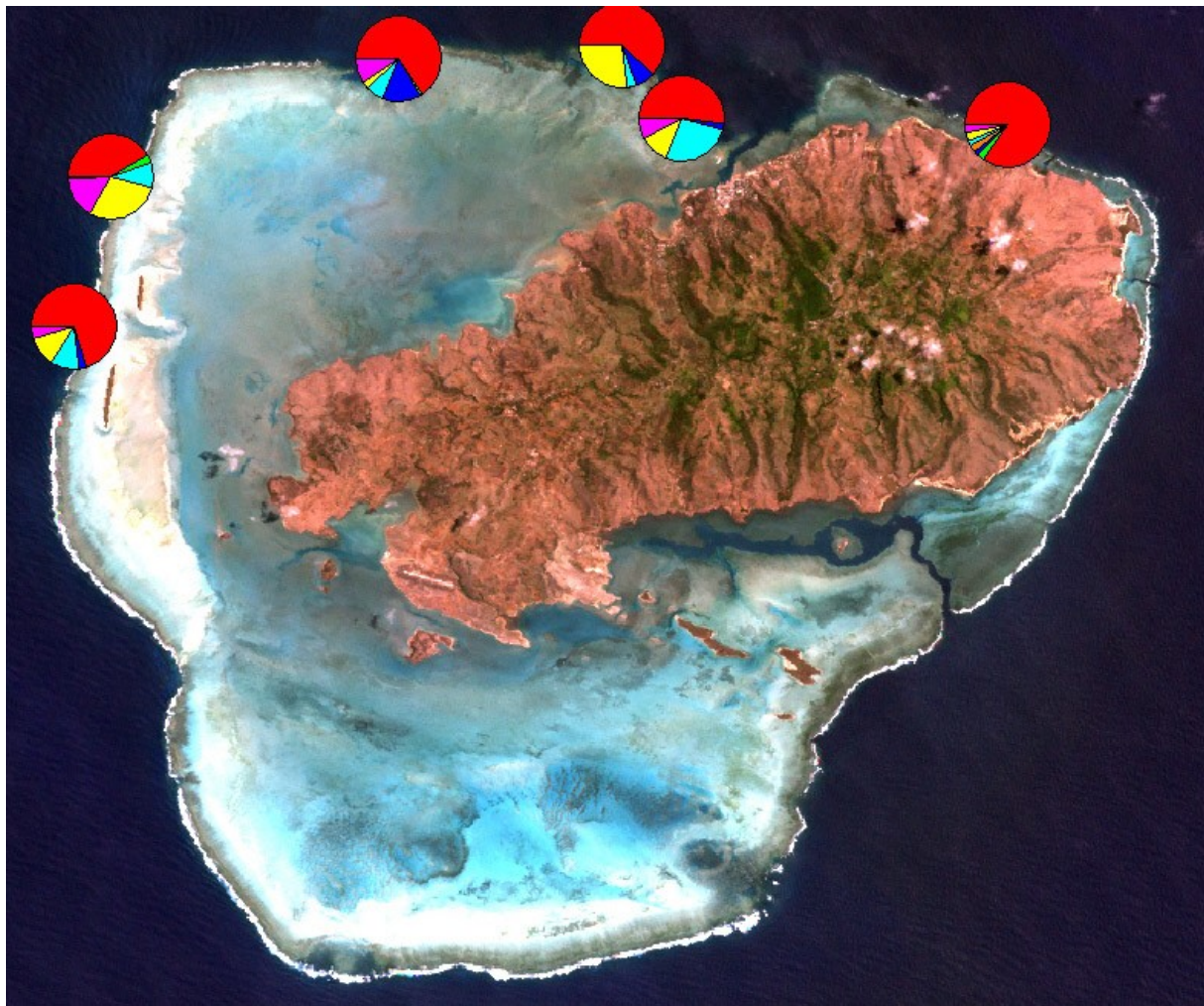


Figure 3. Cluster analysis ($\sqrt{\cdot}$ -transformed) of the benthic cover at the 6 reef slope sites during summer (March) and winter (October) (GB = Grand Bassin, IF = Ile aux Fous, IS = North Ile aux Sables, PA = Passe Armand, PD = Passe Demi, RB = Rivière Banane).

In both summer and winter surveys, the coral cover on all reef slope sites was dominated by branching *Acropora* spp., in particular *A. austera*, *A. abrotanoides* and *A. nobilis* (Figure 4). Branching corals were dominant at Passe Armand with encrusting corals (*Montipora* spp.) also common. At Grand Bassin, Rivière Banane and Passe Demi, the corals were dominated by branching *Acropora* spp. (>60%) with other growth forms forming only a low percentage cover. At Ile aux Fous, branching *Acropora* spp. also constituted over 50% of coral cover and the massive corals *P. daedalea* and *Leptoria phrygia* were also common (35%). Similarly, at North Ile aux Sables branching *Acropora* spp. made-up over 40% of coral cover with the massive coral, *P. daedalea* also common.



Key

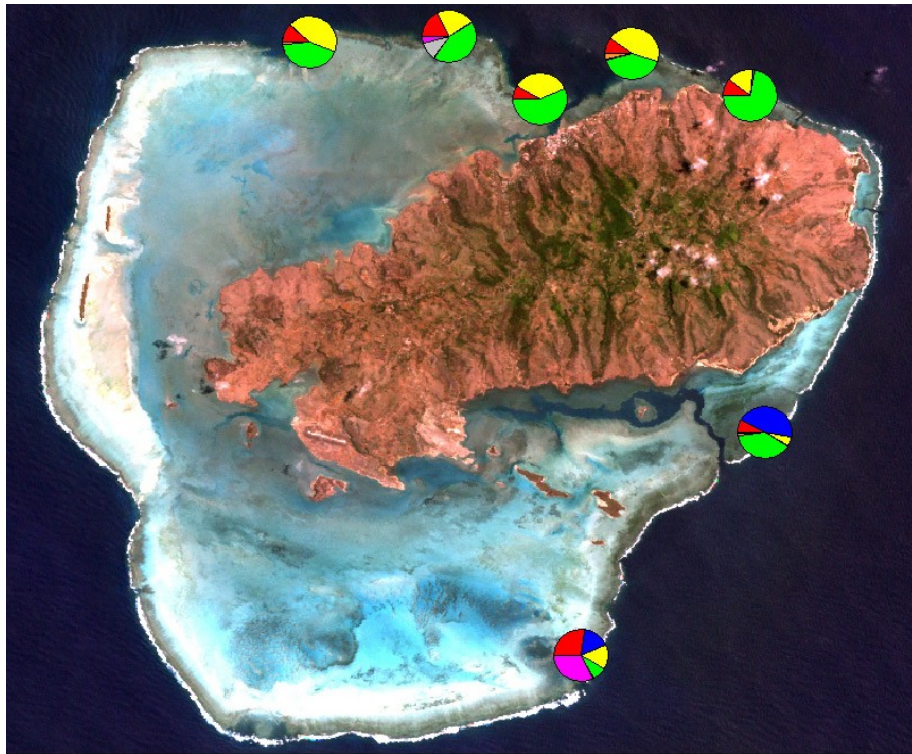
■ Digitate Acropora	■ Encrusting Acropora	■ Massive Coral
■ Branching Acropora	■ Sub-massive Coral	■ Mushroom Coral
■ Tabular Acropora	■ Encrusting Coral	■ Fire Coral

Figure 4. The proportion of coral cover consisting of each of the 9 growth form categories.

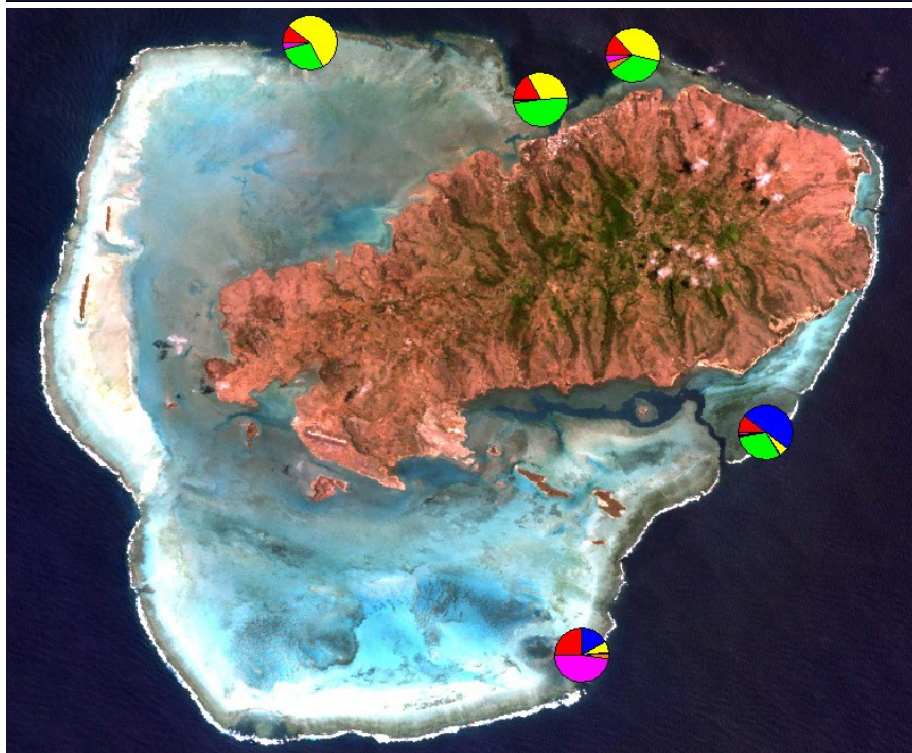
During the summer surveys, coral cover on the reef flat was 8-12% at Rivière Banane, Passe Armand, Grand Bassin, Trou Blanc and Passe Cabris, 18% at Ile aux Fous and 28% at Passe L'Ancre (Figure 5). The sites at Rivière Banane and Ile aux Fous were dominated by turf algae, whereas Passe Armand, Grand Bassin and Passe Cabris were dominated by turf and coralline algae and the site at Trou Blanc was dominated by the soft corals *Xenia* sp. and *Efflatounaria* sp. (46%). Dead coral was 11% at Ile aux Fous, but was not observed at any other site and rubble was high (33%) at Passe L'Ancre.

During the winter surveys, coral cover was 10 – 13% at Grand Bassin, Trou Blanc and Passe Cabri, 17% at Passe Armand and 25% at Passe L'Ancre; the remaining 2 sites could not be surveyed due to weather constraints. The site at Grand Bassin was dominated by coralline algae, whereas Passe Armand and Passe Cabris were dominated by turf and coralline algae and the site at Trou Blanc was dominated by the soft corals *Xenia* sp. and *Efflatounaria* sp. (50%). Dead coral was not observed during the survey, however rubble was very high (48%) at Passe L'Ancre.

Cluster analysis groups Passe Armand, Passe Cabris, Grand Bassin, Rivière Banane and Ile aux Fous together at 75% similarity; the southern sites, Passe L'Ancre and Trou Blanc are more distinct (Figure 6). Summer and winter surveys show high similarities at all sites except at Grand Bassin, due to large decreases in turf algae between March and October at this site.



(A) Summer



(B) Winter

Key

- | | | |
|--|---|---|
| ■ Living Hard Coral | ■ Coralline Algae | ■ Zoanthids |
| ■ Soft Coral | ■ Macro-Algae | ■ Sand |
| ■ Dead Coral | ■ Turf Algae | ■ Rubble |

Figure 5. The percentage cover of the different benthic habitats at the 7 reef flat sites during (A) Summer (March) and (B) Winter (October).

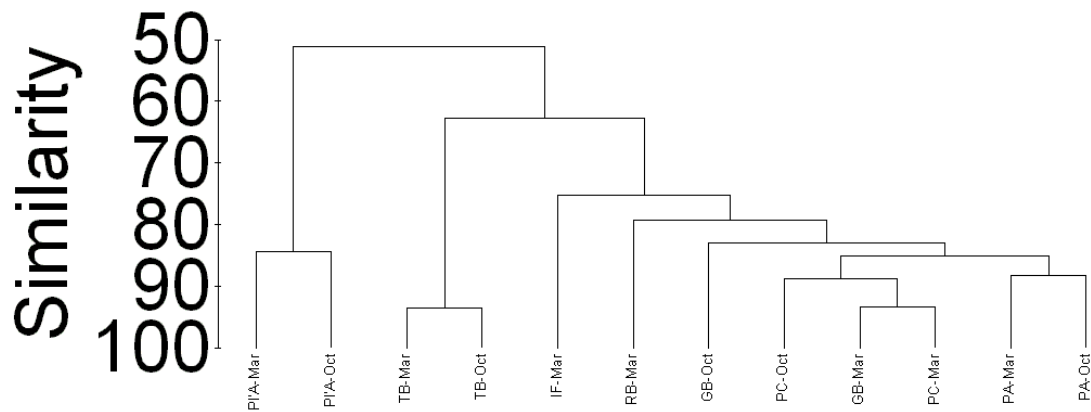
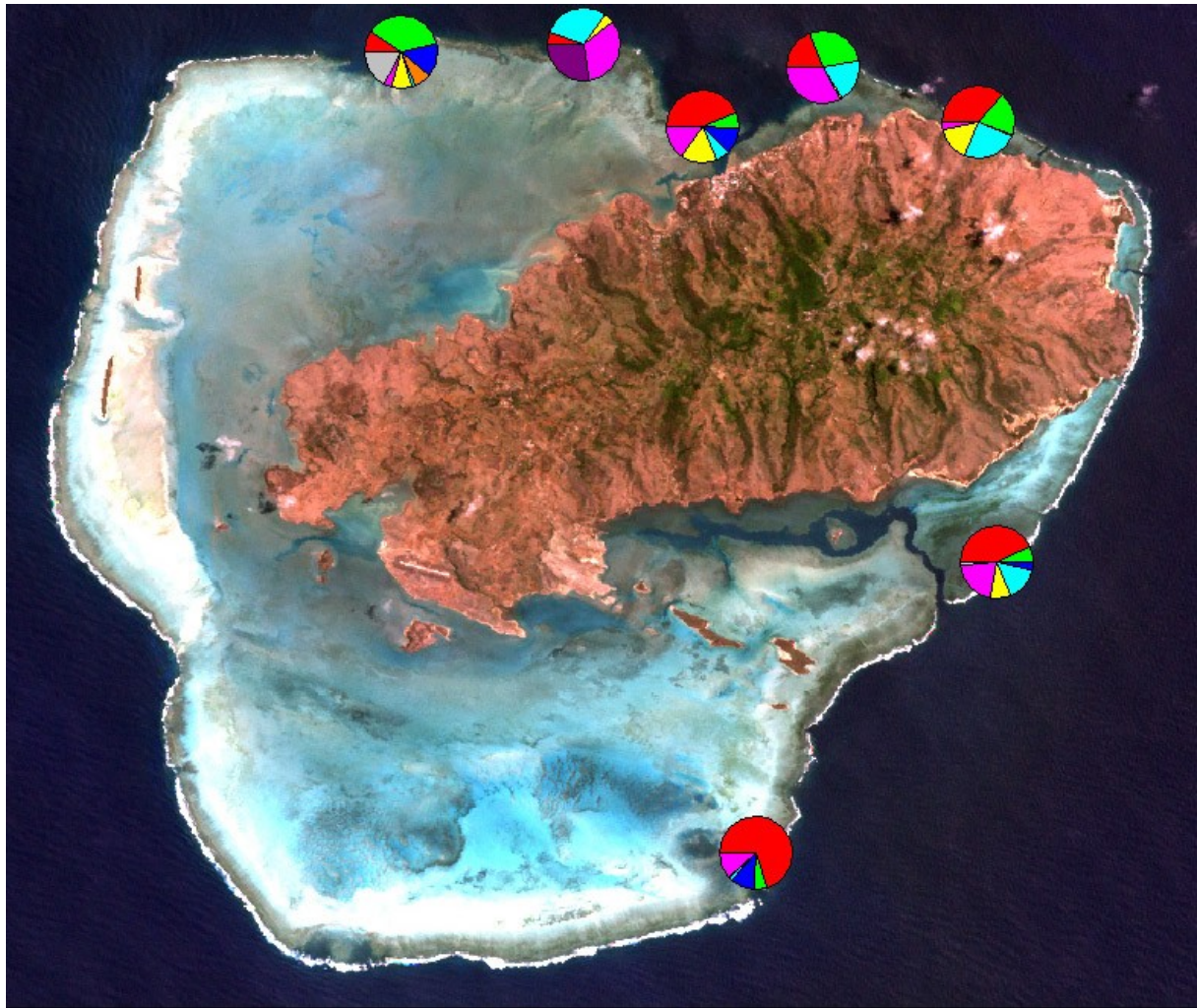


Figure 6. Cluster analysis ($\sqrt{}$ -transformed) of the benthic cover at the 7 reef flat sites (GB = Grand Bassin, IF = Ile aux Fous, PA = Passe Armand, PC = Passe Cabris, PI'A = Passe L'Ancre, RB = Rivière Banane, TB = Trou Blanc).

The dominant coral growth forms were more variable on the reef flats than on the reef slope with sub-massive and encrusting growth forms more common (Figure 7). Live hard coral was however dominated by branching *Acropora* spp. at Passe Armand (*A. nobilis*), Rivière Banane (*A. abrotanoides*), Trou Blanc (*A. formosa*), Passe L'Ancre (*A. formosa*) and Passe Cabris (*A. austera*). Digitate *Acropora* dominated Grand Bassin (*A. digitifera*), whereas at Ile aux Fous, *Fungia* spp, encrusting *Montipora* sp. and the sub-massive species *Porite rus* were dominant.



Key










 Digitate Acropora	 Foliose Coral	 Massive Coral
 Branching Acropora	 Sub-massive Coral	 Mushroom Coral
 Tabular Acropora	 Encrusting Coral	 Fire Coral

Figure 7. The proportion of coral cover consisting of each of the 9 growth form categories.

3.2 Fish

On the reef slopes during the summer surveys, the highest number of individuals was recorded at Rivière Banane (mean of 474 individuals) and the lowest number at Passe Armand (44 individuals) and Ile aux Fous (47 individuals) (Table 2). The highest number of species, genera and families were observed at Grand Bassin (30 species; 22 genera and 10 families). The lowest numbers of species and families were recorded at Passe Armand (19 species, 12 genera and 6 families) and Ile aux Fous (17 species, 13 genera and 7 families). During the winter surveys the highest number of individuals was also recorded at Rivière Banane (mean of 142 individuals) and the lowest number at Passe Demi (98 individuals). The highest number of species were observed at Passe Demi (28 species) and Passe Armand (27 species) and the lowest at Grand Bassin (22 species). The highest number of genera were recorded at Rivière Banane (20 genera), whereas the lowest were observed at Grand Bassin and Passe Demi (16 genera) and the highest number of families were observed at Passe Armand (10 families). Species Diversity calculated using the Shannon-Weiner Diversity

Index was highest at North Ile aux Sables during the summer ($H' = 2.471$) and at Passe Demi during the summer ($H' = 2.670$) and lowest at Rivière Banane ($H' = 1.387$ in summer and $H' = 1.821$ in winter). Pielou's Index of Evenness was highest at Passe Armand ($J = 0.819$ in summer and $J = 0.805$ in winter) and lowest at Rivière Banane ($J = 0.456$ in summer and $J = 0.581$ in winter). Based on fish genera, Cluster Analysis highlights seasonal differences in the fish communities at each site. The summer surveys at Passe Armand and Ile aux Fous group together at 78% similarity; summer surveys at Passe Demi and North Ile aux Sables group together at 74% and winter surveys at Ile aux Fous, Passe Demi, Rivière Banane and North Ile aux Sables group together at 68% similarity. The winter surveys at Grand Bassin and Passe Armand group together with the summer survey at Grand Bassin at 63% similarity, while the summer survey at Rivière Banane is very distinct (Figure 8).

Table 2. The mean number of individuals, species, genera and families and species diversity indices for the fish communities at each of the 6 reef slope sites during summer (March) and winter (October).

(A) Summer

	Rivière Banane	Passe Armand	Grand Bassin	Passe Demi	Ile aux Fous	Ile aux Sables
No. Individuals	474	44	287	144	47	112
No. Species	21	19	30	23	17	24
No. Genera	18	12	22	16	13	15
No. Families	8	6	10	8	7	6
H'	1.387	2.412	2.249	1.998	2.236	2.471
J'	0.456	0.819	0.661	0.637	0.789	0.777

(B) Winter

	Rivière Banane	Passe Armand	Grand Bassin	Passe Demi	Ile aux Fous	Ile aux Sables
No. Individuals	142	107	101	98	111	132
No. Species	23	27	22	28	25	24
No. Genera	20	19	16	16	18	17
No. Families	8	10	9	9	7	7
H'	1.821	2.654	2.060	2.670	2.306	2.218
J'	0.581	0.805	0.666	0.801	0.716	0.698

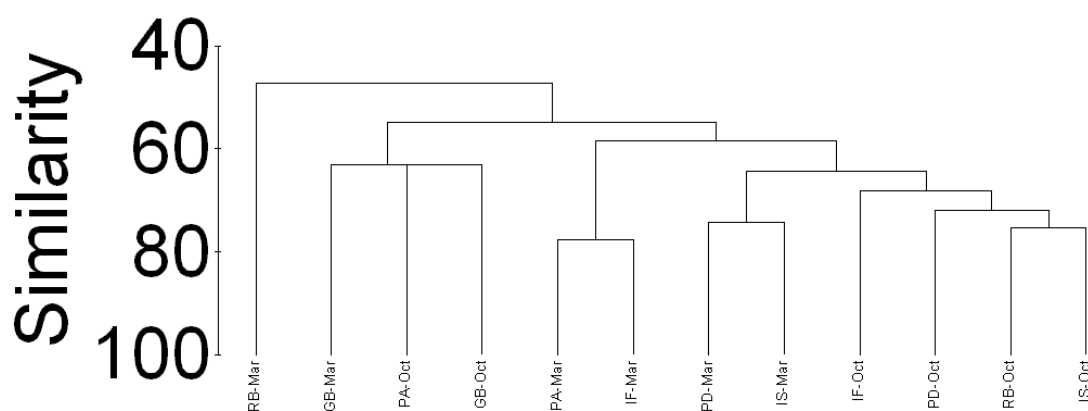
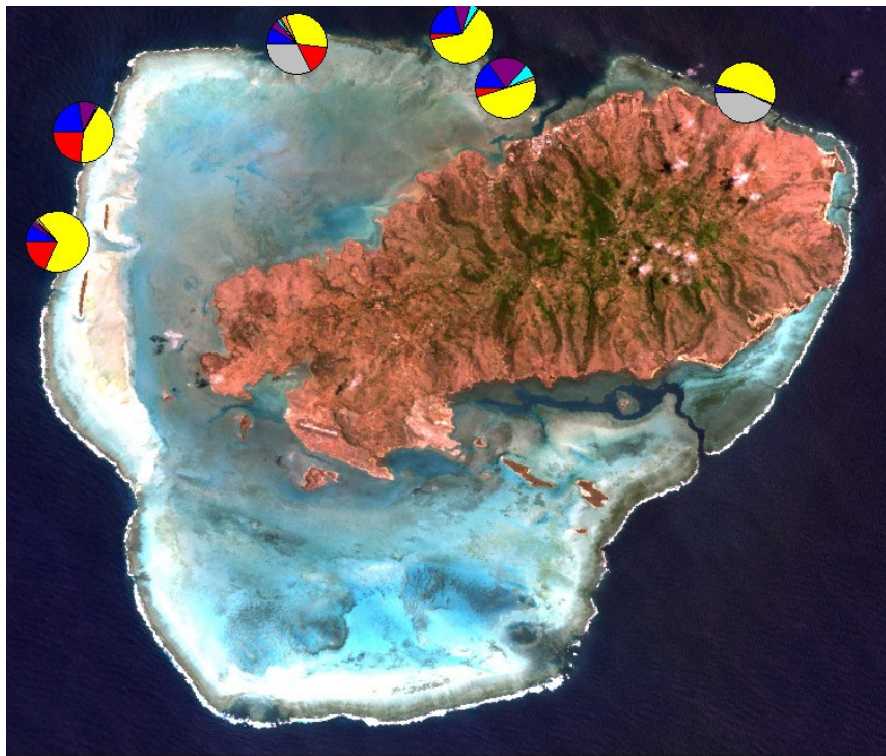


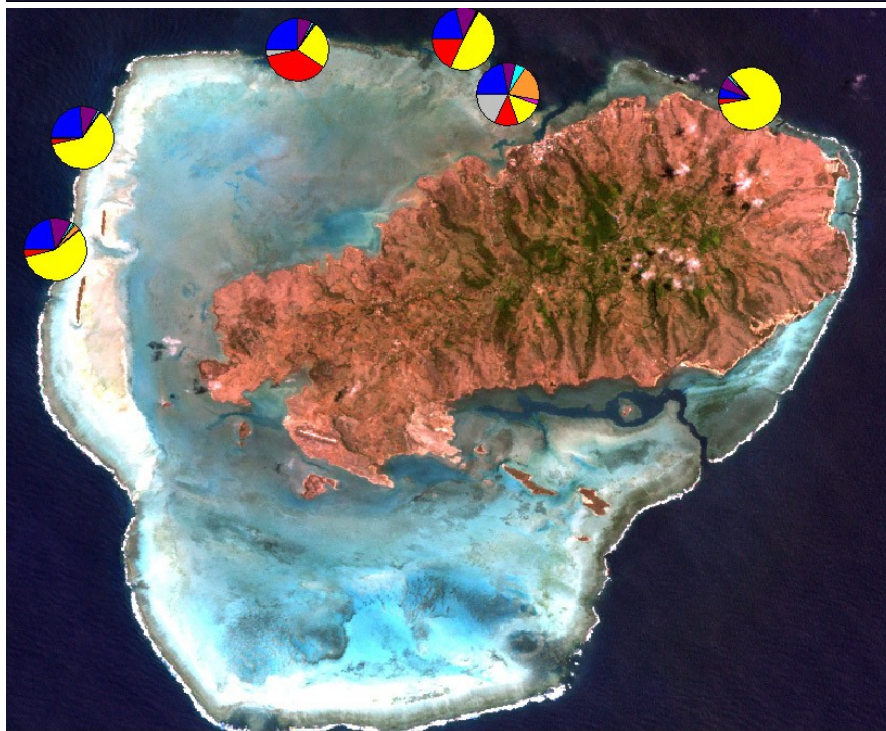
Figure 8. Cluster analysis ($\sqrt{\cdot}$ -transformed) of the fish genera observed at the 6 reef slope sites (GB = Grand Bassin, IF = Ile aux Fous, IS = North Ile aux Sables, PA = Passe Armand, PD = Passe Demi, RB = Rivière Banane) during summer (March) and winter (October).

Damselfish (Pomacentridae) dominated the reef slopes at all sites during summer and were particularly abundant at Rivière Banane (Figure 9); during winter all sites except Passe Armand and Grand Bassin were dominated by Pomacentridae. Pomacentridae were dominated by *Chromis* spp. at Rivière Banane, Passe Demi and North Ile aux Sables, and *Abudefduf* spp. at Passe Armand, Grand Bassin and Ile aux Fous. Surgeonfish (Acanthuridae) dominated the fish community at Passe Armand during the winter and were also common at Grand Bassin (summer and winter), North Ile aux Sables (summer and winter), Passe Demi (winter) and Ile aux Fous (winter). Parrotfish dominated Grand Bassin during the winter and were also common at Passe Demi (summer) and North Ile aux Sables (summer). The Fusilier, *Pterocaesio tile* was common during the summer at Grand Bassin and very common at Rivière Banane (mean of 200 individuals). The number of Butterflyfish (Chaetodontidae) per site ranged from a mean of 0 to 6 individuals, and no individuals were observed at Rivière Banane during the summer survey. Emperors (Lethrinidae) were only represented by 1 species (*Gnathodentex aurolineatus*) and were rare or absent at all sites, except at Passe Armand during the winter survey. Groupers (Serranidae) were also rare or absent. No Triggerfish (Balistidae), Trevally (Carangidae) or Snapper (Lutjanidae) were recorded at any site.

During the summer surveys, the majority of individuals of the 12 key fish species observed were juveniles. At North Ile aux Sables however, all *Chaetodon trifasciatus* were above the published length of maturity (FishBase, 2006) and at Passe Armand 90% of *Abudefduf sparoides* were adults. During winter, all individuals of *Mulloidichthys vanicolensis* observed at Ile aux Fous and at Passe Armand were above the published length of maturity, as were all *Epinephelus spilotoceps* at Passe Demi and all *C. trifasciatus* at Rivière Banane.



(A) Summer



(B) Winter

Key










 Acanthuridae	 Serranidae	 Pomacentridae
 Labridae	 Lethrinidae	 Scaridae
 Chaetodontidae	 Mullidae	 Other

Figure 9. The distribution of fish families at the 6 reef slope survey sites during (A) Summer (March) and (B) Winter (October).

Table 3. The percentage of the 12 key fish species observed, which were below the published length of maturity (FishBase, 2006) at the 6 reef slope sites (RB = Riviere Banane, PA = Passe Armand, GB = Grand Bassin, PD = Passe Demi, IS = North Ile aux Sables, IF = Ile aux Fous) during Summer (March) and Winter (October).

(A) Summer

Species	Length at maturity (cm)	% Juveniles					
		RB	PA	GB	PD	IS	IF
<i>Epinephelus spilotoceps</i>	21.2	-	-	-	-	50	100
<i>Plectropomus laevis</i>	65.2	-	-	-	-	100	100
<i>Lutjanus fulvus</i>	23.8	-	-	-	-	-	-
<i>Lethrinus nebulosus</i>	37.4	-	-	-	-	-	-
<i>Mulloidichthys flavolineatus</i>	24.0	-	-	-	-	-	-
<i>Mulloidichthys vanicolensis</i>	24.0	-	100	-	100	100	-
<i>Caranx melampygus</i>	51.3	100	-	100	-	-	-
<i>Chaetodon trifasciatus</i>	11.8	-	100	100	83	0	75
<i>Abudefduf sparoides</i>	10.6	-	10	-	-	-	-
<i>Scarus ghobban</i>	48.8	-	-	-	-	-	100
<i>Rhinecanthus aculeatus</i>	16.8	-	-	-	-	-	-
<i>Naso unicornis</i>	36.1	-	-	-	-	-	-

(B) Winter

Species	Length at maturity (cm)	% Juveniles					
		RB	PA	GB	PD	IS	IF
<i>Epinephelus spilotoceps</i>	21.2	100	-	100	0	100	-
<i>Plectropomus laevis</i>	65.2	-	-	-	50	-	-
<i>Lutjanus fulvus</i>	23.8	-	-	-	-	-	-
<i>Lethrinus nebulosus</i>	37.4	-	-	-	-	-	-
<i>Mulloidichthys flavolineatus</i>	24.0	-	-	-	-	-	-
<i>Mulloidichthys vanicolensis</i>	24.0	-	0	-	-	-	0
<i>Caranx melampygus</i>	51.3	-	100	-	-	-	-
<i>Chaetodon trifasciatus</i>	11.8	0	-	67	100	-	20
<i>Abudefduf sparoides</i>	10.6	-	0	-	-	-	-
<i>Scarus ghobban</i>	48.8	-	100	100	-	-	-
<i>Rhinecanthus aculeatus</i>	16.8	-	-	-	0	-	-
<i>Naso unicornis</i>	36.1	100	-	-	-	-	-

On the reef flat, the highest number of individuals during the summer surveys was recorded at Passe L'Ancre (mean of 256 individuals) and the lowest number at Grand Bassin (mean of 49 individuals) (Table 3). The highest number of species and families were observed at Passe Cabris (23 species, 17 genera and 7 families) and the lowest number of species and families were recorded at Rivière Banane (9 species, 8 genera and 3 families). During the winter surveys, the highest number of individuals was recorded at Passe Armand (mean of 273 individuals) and the lowest number at Passe Cabris (mean of 147 individuals). The highest number of species and families was observed at Passe Cabris (28 species, 18 genera and 8 families) and the lowest number was observed at Grand Bassin (12 species, 8 genera and 4 families).

Species Diversity calculated using the Shannon-Weiner Diversity Index was highest at Passe Cabris ($H' = 2.581$ in summer and $H' = 2.383$ in winter) and lowest at Rivière Banane in summer ($H' = 1.473$) and at Grand Bassin in winter ($H' = 1.782$). Pielou's Index of Evenness was highest at Passe Cabris in summer ($J = 0.823$) and at Grand Bassin in winter ($J = 0.717$) and was lowest at Rivière Banane in summer ($J = 0.670$) and at Passe L'Ancre in winter ($J =$

0.645). Based on fish genera, Cluster Analysis again highlights seasonal variations in fish communities, particularly at Passe L’Ancre and Grand Bassin (Figure 10). The Trou Blanc surveys are grouped together with Passe L’Ancre (winter) and Ile aux Fous (summer) at 67% similarity and Passe Armand, Passe Cabris, Grand Bassin (winter) and Passe L’Ancre (summer) are grouped together at 57% similarity. Grand Bassin and Rivière Banane fish communities during the summer surveys were distinct.

Table 4. The mean number of individuals, species, genera and families and species diversity indices for the fish communities at each of the 7 reef flat sites during summer (March) and winter (October).

(A) Summer

	Rivière Banane	Passe Armand	Grand Bassin	Trou Blanc	Passe L’Ancre	Passe Cabris	Ile aux Fous
No. Individuals	61	87	49	141	256	101	147
No. Species	9	14	15	12	21	23	21
No. Genera	8	10	13	11	16	17	15
No. Families	3	4	5	6	6	7	7
H’	1.473	1.984	2.080	1.847	1.765	2.581	2.111
J’	0.670	0.752	0.768	0.743	0.580	0.823	0.693

(B) Winter

	Passe Armand	Grand Bassin	Trou Blanc	Passe L’Ancre	Passe Cabris
No. Individuals	273	164	217	177	147
No. Species	25	12	16	26	28
No. Genera	16	8	11	18	18
No. Families	5	4	5	5	8
H’	1.949	1.782	1.985	2.102	2.383
J’	0.606	0.717	0.716	0.645	0.715

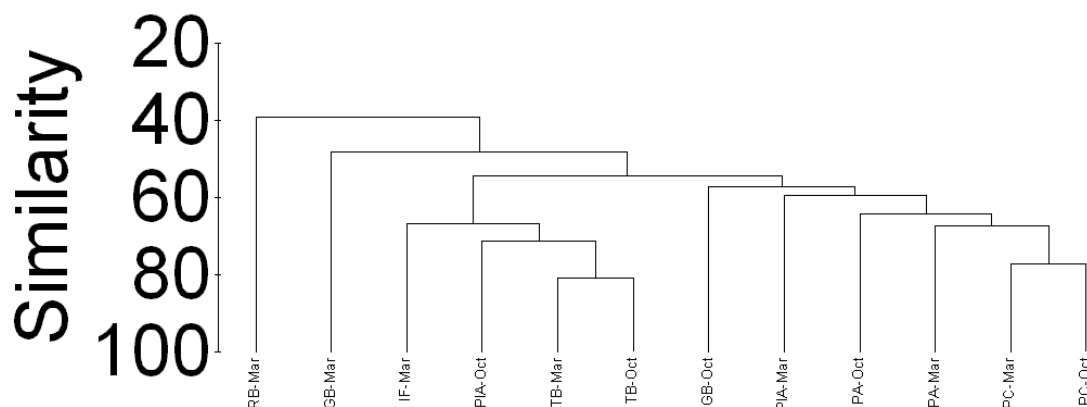
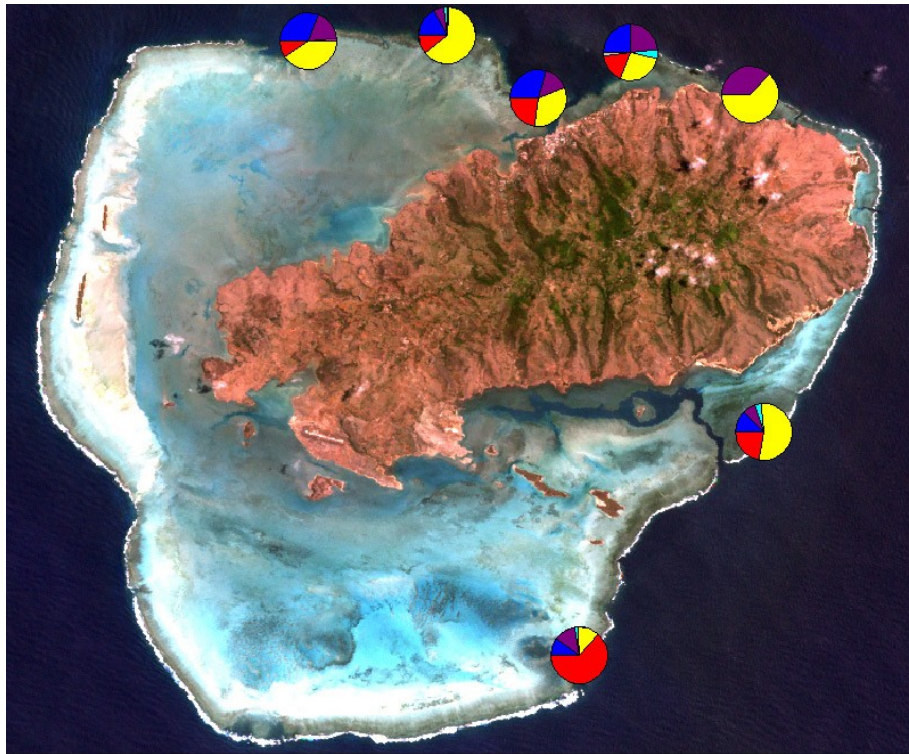


Figure 10. Cluster analysis ($\sqrt{\cdot}$ -transformed) of the fish genera observed at the 7 reef flat sites (GB = Grand Bassin, IF = Ile aux Fous, PA = Passe Armand, PC = Passe Cabris, P’A = Passe L’Ancre, RB = Rivière Banane, TB = Trou Blanc) during summer (March) and winter (October).

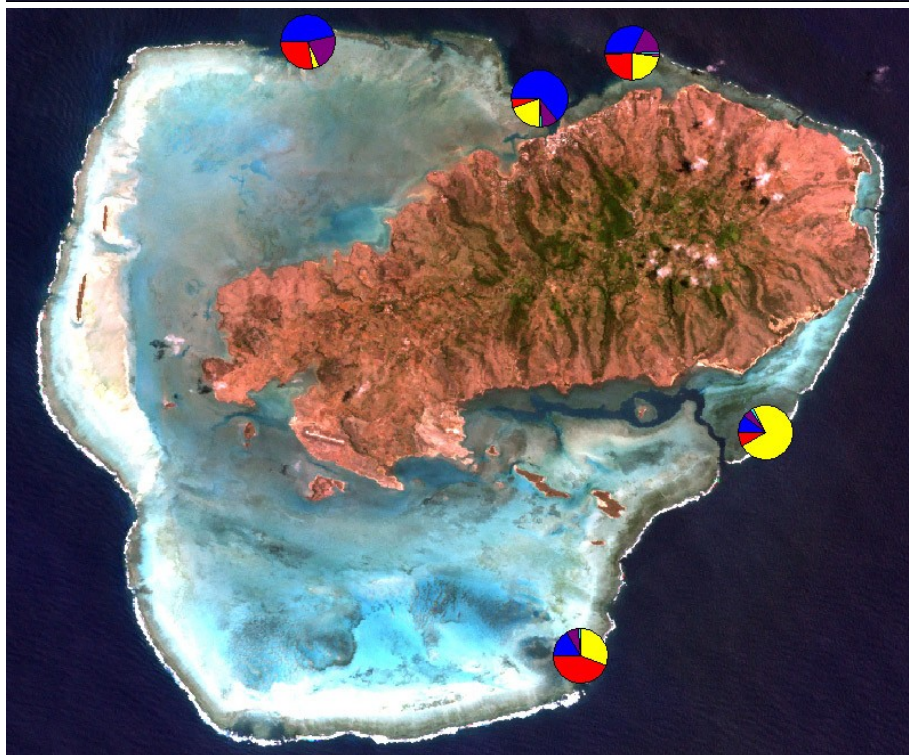
During the summer surveys, Damselfish (Pomacentridae) dominated the reef flat sites at all sites except for Passe L’Ancre (Figure 11); during the winter surveys, only Trou Blanc was

dominated by Pomacentridae, although they were common at all sites. Pomacentridae were dominated by *Chromis viridis* and *Stegastes limbatus* at Rivière Banane, *Stegastes* spp. and *Dascyllus aruanus* at Trou Blanc, *Stegastes limbatus* at Passe Cabris, *Stegastes nigricans* at Ile aux Fous, *S. limbatus* and *S. nigricans* at Passe Armand and *Pomacentrus indicus* and *Abudefduf sexfasciatus* at Grand Bassin. The fish community at Passe L’Ancre was dominated by Parrotfish (small immature parrotfish). Surgeonfish (Acanthuridae) dominated the fish communities at Passe Armand, Grand Bassin and Passe Cabris during the winter surveys and were common at Grand Bassin, Ile aux Fous, Passe Armand Passe L’Ancre and Passe Cabris during the summer. Wrasse were common at Passe Cabris, Riviere Banane and Passe L’Ancre during the summer and at Passe Armand, Grand Bassin and Passe Cabris during the winter. A mean of between 0 and 5 Butterflyfish were observed at the reef flat sites and no individuals were recorded at Grand Bassin, Passe Armand or Rivière Banane during the summer or at Grand Bassin during the winter. Emperors (Lethrinidae) and Groupers (Serranidae) were only present at Ile aux Fous during the summer, and were only represented by 1 species each (*Gnathodentex aurolineatus* and *Epinephelus spilotoceps*, respectively). No Snapper (Lutjanidae), Triggerfish (Balistidae), Trevally (Carangidae) or Fusiliers (Caesionidae) were recorded at any site.

During the summer surveys, the majority of individuals of the 12 key fish species observed were juveniles. At Rivière Banane however, all *Rhinecanthus aculeatus* were above the published length of maturity (FishBase, 2006) as were all *Mulloidichthys flavolineatus* at Ile aux Fous and at Passe Cabris, 67% of *Epinephelus spilotoceps* were adults. During winter, all individuals of *R. aculeatus* observed at Grand Bassin were above the published length of maturity, and 75% of *Chaetodon trifasciatus* were adults at Passe Armand.



(A) Summer



(B) Winter

Key










 Acanthuridae	 Serranidae	 Pomacentridae
 Labridae	 Lethrinidae	 Scaridae
 Chaetodontidae	 Mullidae	 Other

Figure 11. The distribution of fish families at the 7 reef flat survey sites during (A) Summer (March) and (B) Winter (October).

Table 5. The percentage of the 12 key fish species observed, which were below the published length of maturity (FishBase, 2006) at the 7 reef flat sites (RB = Riviere Banane, PA = Passe Armand, GB = Grand Bassin, TB = Trou Blanc, PIA = Passe L’Ancre, IF = Ile aux Fous, PC = Passe Cabris) during Summer (March) and Winter (October).

(A) Summer

Species	Length at maturity (cm)	% Juveniles						
		RB	PA	GB	TB	PIA	IF	PC
<i>Epinephelus spilotoceps</i>	21.2	-	-	-	100	100	-	33
<i>Plectropomus laevis</i>	65.2	-	-	-	-	-	-	-
<i>Lutjanus fulvus</i>	23.8	-	-	-	-	-	-	-
<i>Lethrinus nebulosus</i>	37.4	-	-	-	-	-	-	-
<i>Mulloidichthys flavolineatus</i>	24.0	-	-	-	100	100	0	-
<i>Mulloidichthys vanicolensis</i>	24.0	-	-	-	-	-	-	-
<i>Caranx melampygus</i>	51.3	-	-	-	-	-	-	-
<i>Chaetodon trifasciatus</i>	11.8	-	61	-	100	80	78	-
<i>Abudefduf sparoides</i>	10.6	-	-	-	-	-	-	-
<i>Scarus ghobban</i>	48.8	-	100	-	100	-	-	-
<i>Rhinecanthus aculeatus</i>	16.8	0	-	100	-	-	-	-
<i>Naso unicornis</i>	36.1	-	-	-	100	100	100	-

(B) Winter

Species	Length at maturity (cm)	% Juveniles				
		PA	GB	TB	PIA	PC
<i>Epinephelus spilotoceps</i>	21.2	-	-	100	100	100
<i>Plectropomus laevis</i>	65.2	-	-	-	-	-
<i>Lutjanus fulvus</i>	23.8	-	-	-	-	-
<i>Lethrinus nebulosus</i>	37.4	-	-	-	-	-
<i>Mulloidichthys flavolineatus</i>	24.0	-	-	-	-	-
<i>Mulloidichthys vanicolensis</i>	24.0	-	-	100	100	-
<i>Caranx melampygus</i>	51.3	-	-	-	-	-
<i>Chaetodon trifasciatus</i>	11.8	25	-	57	57	71
<i>Abudefduf sparoides</i>	10.6	-	-	-	-	-
<i>Scarus ghobban</i>	48.8	-	-	-	-	-
<i>Rhinecanthus aculeatus</i>	16.8	-	0	-	-	-
<i>Naso unicornis</i>	36.1	100	-	100	100	100

3.3 Invertebrates

The abundance of invertebrates tended to be low on the reef slopes and a total of only 20 species were recorded during all surveys, with 14 observed during the summer surveys and 20 in the winter surveys. During the winter surveys, only 2 species were recorded at North Ile aux Sables, however the lowest number of individuals were recorded at Grand Bassin and Passe Demi (mean of <7 individuals); during the summer, Rivière Banane and Grand Bassin had the lowest number of species (mean of 4 species), whereas the least number of individuals were observed at Grand Bassin (mean of 5 individuals). In both the summer and winter surveys, the highest number of individuals was recorded at North Ile aux Sables (mean of >350 individuals) and the highest number of species at Passe Armand (mean of 12 species in winter and 8 species in summer). Species Diversity calculated using the Shannon-Weiner Diversity Index was highest during the summer at Grand Bassin ($H' = 1.289$) and at Passe Demi during the winter ($H' = 1.214$) and lowest at North Ile aux Sables ($H' = 0.058$ in summer and $H' = 0.013$ in winter). Pielou’s Index of Evenness was also highest at Grand Bassin in summer ($J = 0.930$) and at Passe Demi in summer ($J = 0.754$) and was lowest at North Ile aux Sables ($J = 0.036$ in summer and $J = 0.019$ in winter). Cluster Analysis suggests

that there is little seasonal variation in the invertebrate communities at each of the 6 sites. Communities at each site are however fairly distinct, with Passe Armand, Ile aux Fous and North Ile aux Sables grouping together at 61% similarity and Rivière Banane and Grand Bassin grouping together at just 41% similarity (Figure 12).

Table 6. The mean number of individuals and species and species diversity indices for the invertebrate communities at each of the 6 reef slope sites during summer (March) and winter (October)

(A) Summer

	Rivière Banane	Passe Armand	Grand Bassin	Passe Demi	Ile aux Fous	Ile aux Sables
No. Individuals	35.3	158.3	5.3	18.8	137.0	367.3
No. Species	4	8	4	6	7	5
H'	0.793	0.324	1.289	1.175	0.251	0.058
J'	0.572	0.156	0.930	0.656	0.129	0.036

(B) Winter

	Rivière Banane	Passe Armand	Grand Bassin	Passe Demi	Ile aux Fous	Ile aux Sables
No. Individuals	21.0	132.6	6.7	5.9	115.3	400.0
No. Species	5	12	5	5	8	2
H'	1.038	0.591	1.190	1.214	0.233	0.013
J'	0.645	0.238	0.739	0.754	0.112	0.019

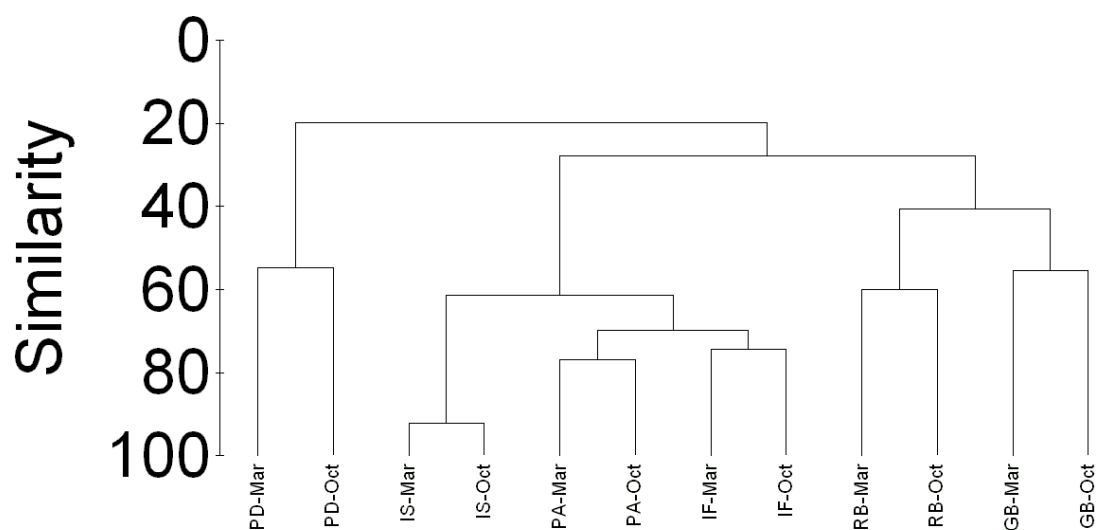
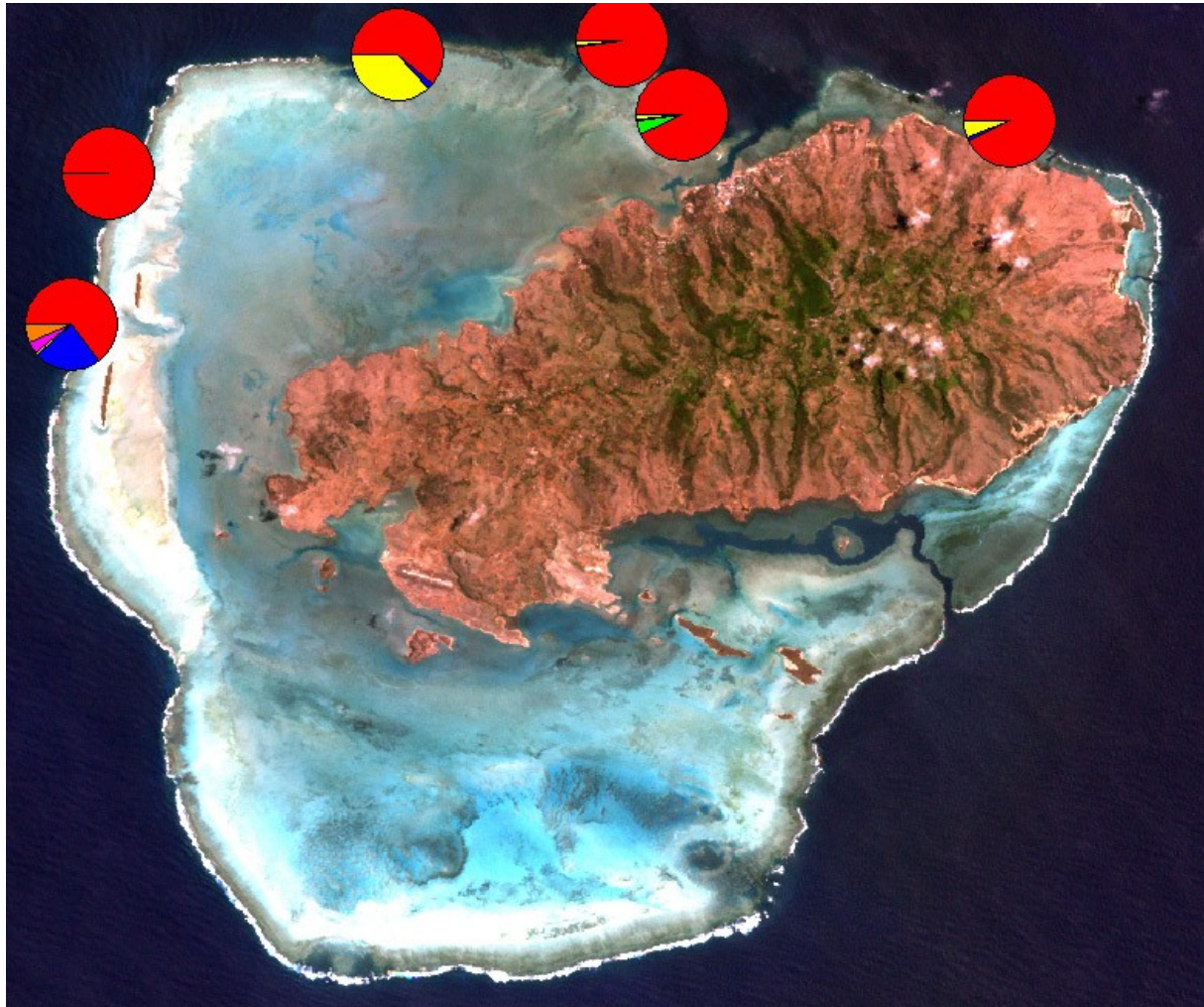


Figure 12. Cluster analysis ($\sqrt{\cdot}$ -transformed) of the invertebrate species observed at the 6 reef slope sites (GB = Grand Bassin, IF = Ile aux Fous, PA = Passe Armand, PC = Passe Cabris, PI'A = Passe L'Ancre, RB = Rivière Banane, TB = Trou Blanc) during summer (March) and winter (October).

All sites were dominated by Sea Urchins (Echinoidea), especially *Echinometra mathaei*, which was particularly abundant at North Ile aux Sables, where a mean of >350 individuals were recorded (Figure 13). The Sea Cucumber (Holothuroidea) *Stichopus chloronatus* was relatively abundant at Passe Armand (mean of 6 individuals), however holothurians were very

rare at the other sites. Gastropods were completely absent from Passe Demi in the summer survey and were only found in low numbers at the other sites and the Bivalve, *Tridacna maxima* was only observed at Passe Demi and Passe Armand (mean of 1 individual at each site). Crustaceans were only represented by hermit crabs (*Dardanus* sp.) which were observed at Passe Demi, Ile aux Fous and North Ile aux Sables during the summer surveys only.



Key

- | | |
|---|---|
| ■ Sea Urchins | ■ Bivalves |
| ■ Sea Cucumbers | ■ Octopus |
| ■ Other Echinoderms | ■ Crustaceans |
| ■ Gastropods | |

Figure 13. The distribution of invertebrates at the 6 reef slope survey sites.

Nineteen invertebrate species were recorded on the 7 reef flat sites, with 14 observed in summer and 17 in the winter surveys. The highest number of individuals was recorded at Passe Armand (mean of >5 individuals and 10 species) and the highest number of species was recorded at Passe Armand in the winter surveys (11 species) and at Passe Armand and Grand Bassin in the summer surveys (10 species) (Table 5). Invertebrates were very low at Passe L’Ancre where only 2 species were observed and only 2 individuals were recorded in the winter surveys, with 8 observed in summer. Species Diversity calculated using the Shannon-

Weiner Diversity Index was highest at Passe Cabris ($H' = 0.689$ in summer and $H' = 0.723$ in winter) and was lowest at Trou Blanc ($H' = 0.046$ in summer and $H' = 0.068$ in winter). Pielou's Index of Evenness was also highest at Passe Cabris ($J = 0.314$ in summer and $J = 1.569$ in winter) and lowest at Trou Blanc ($J = 0.033$ in summer and $J = 0.042$ in winter). Cluster Analysis indicates that there is little seasonal variation in invertebrate community structure, except at Grand Bassin. The analysis groups Passe Armand, Trou Blanc and Grand Bassin (winter) together at 71% similarity and Passe Cabris, Rivière Banane (summer) and Grand Bassin (winter) together at 64% together with the community at Passe L'Ancre being more distinct (Figure 14).

Table 7. The mean number of individuals and species and species diversity indices for the invertebrate communities at each of the 7 reef flat sites during (A) Summer (March) and (B) Winter (October).

(A) Summer							
	Rivière Banane	Passe Armand	Grand Bassin	Trou Blanc	Passe L'Ancre	Ile aux Fous	Passe Cabris
No. Individuals	176.1	536.2	302.5	326.8	8.0	29.3	226.6
No. Species	4	10	10	4	2	4	9
H'	0.369	0.181	0.355	0.046	0.160	0.226	0.689
J'	0.266	0.078	0.154	0.033	0.231	0.163	0.314

(B) Winter					
	Passe Armand	Grand Bassin	Trou Blanc	Passe L'Ancre	Passe Cabris
No. Individuals	571.7	138.2	523.3	2.3	163.6
No. Species	11	8	5	2	9
H'	0.221	0.487	0.068	0.387	0.723
J'	0.092	0.234	0.042	0.559	1.569

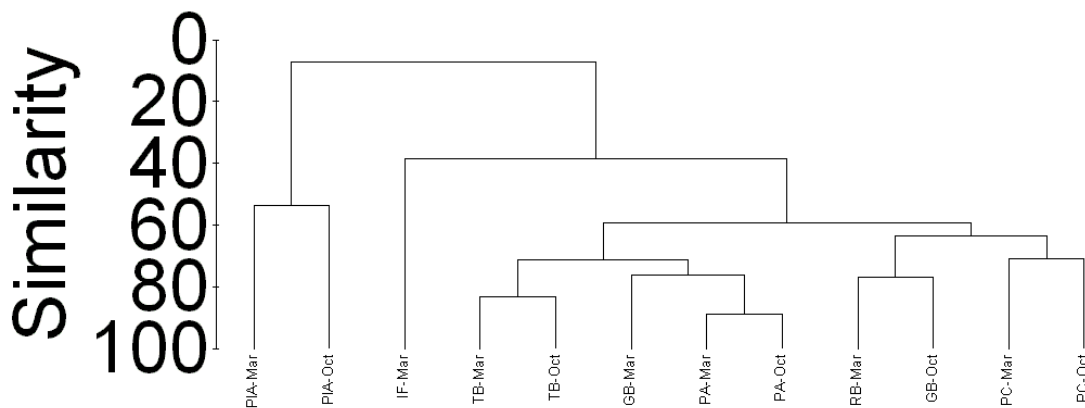
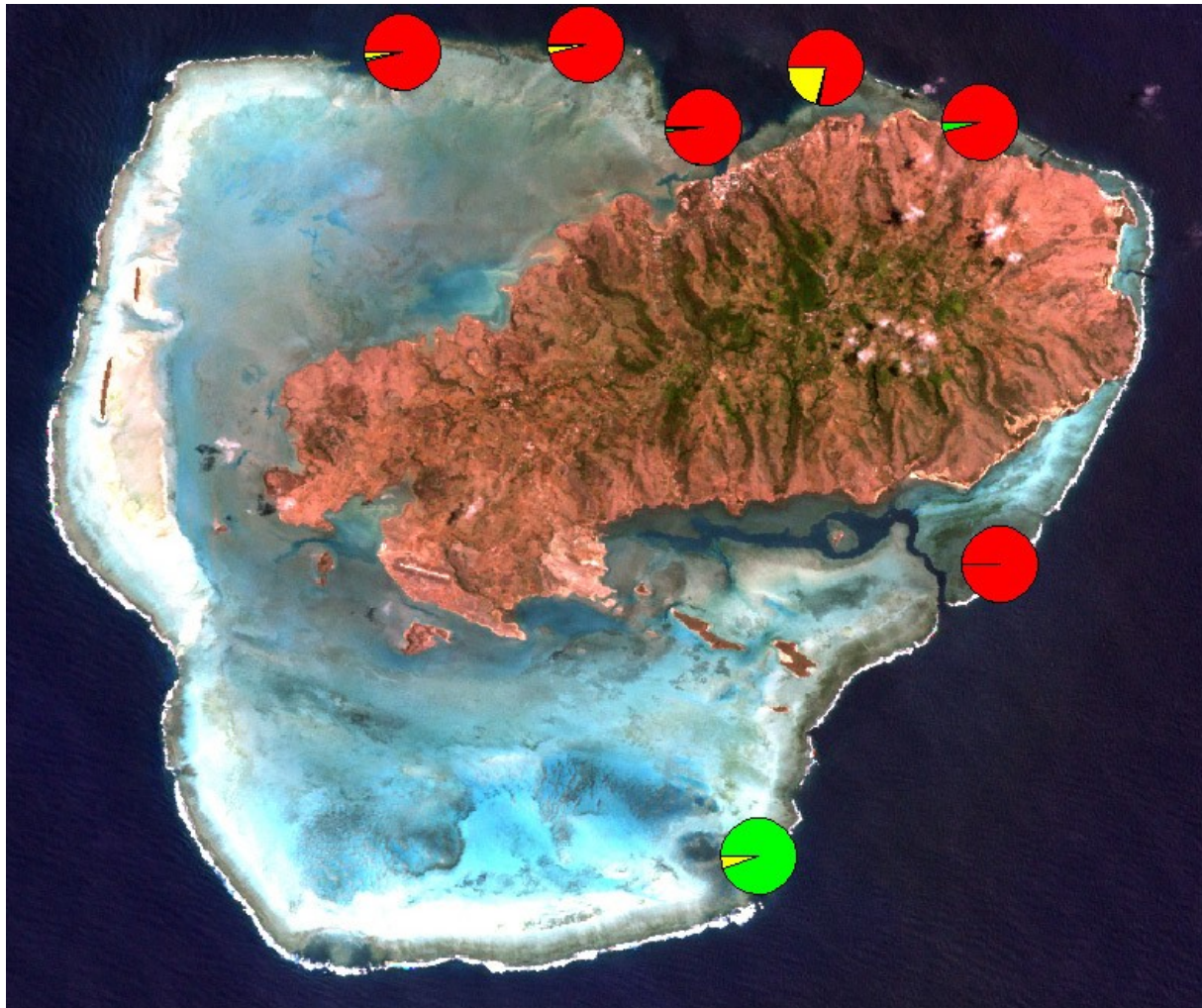


Figure 14. Cluster analysis ($\sqrt{\cdot}$ -transformed) of the fish genera observed at the 7 reef flat sites (GB = Grand Bassin, IF = Ile aux Fous, PA = Passe Armand, PC = Passe Cabris, PIA = Passe L'Ancre, RB = Rivière Banane, TB = Trou Blanc) during summer (March) and winter (October).

All sites except for Passe L'Ancre were dominated by Sea Urchins (Echinoidea), especially *Echinometra mathaei*, which was particularly abundant at Passe Armand, Trou Blanc and Grand Bassin (mean of >150 individuals) (Figure 15). The gastropod, *Trochus maculatus* was

relatively abundant at Passe Cabris (mean of 12 individuals in winter, but 54 in summer), however molluscs were rare at other sites and completely absent from Trou Blanc and Rivière Banane in the summer surveys. The Bivalve, *Tridacna maxima* was only observed at Passe Armand, Trou Blanc and Grand Bassin (≤ 2 individuals). Crustaceans were only represented by hermit crabs (*Dardanus* sp.) which were observed at Passe Armand, Grand Bassin, Trou Blanc and Ile aux Fous during the summer surveys only.



Key

■ Sea Urchins	■ Bivalves
■ Sea Cucumbers	■ Octopus
■ Other Echinoderms	■ Crustaceans
■ Gastropods	

Figure 15. The distribution of invertebrates at the 7 reef flat survey sites.

3.4 Comparison over 5 years

3.4.1 Benthos

Multi-dimensional scaling (MDS) indicates that at the 3 reef slope sites where comparisons can be made, the benthic composition at Passe Armand in 2002 - 2005 is different from that at Grand Bassin and Rivière Banane, however at the latter sites there was little change in benthic composition over time (Figure 16). Benthic composition in October 2004 at Rivière Banane

and Grand Bassin was more distinct due to a high percentage cover of macro-algae at this time (40% and 36% respectively); benthic composition at Rivière Banane during 2006 was also distinct due to an increase in turf algae ($\geq 20\%$). The benthos at Passe Armand during March 2006 was very distinct from all other sites due to a very high percentage cover of turf algae (69%).

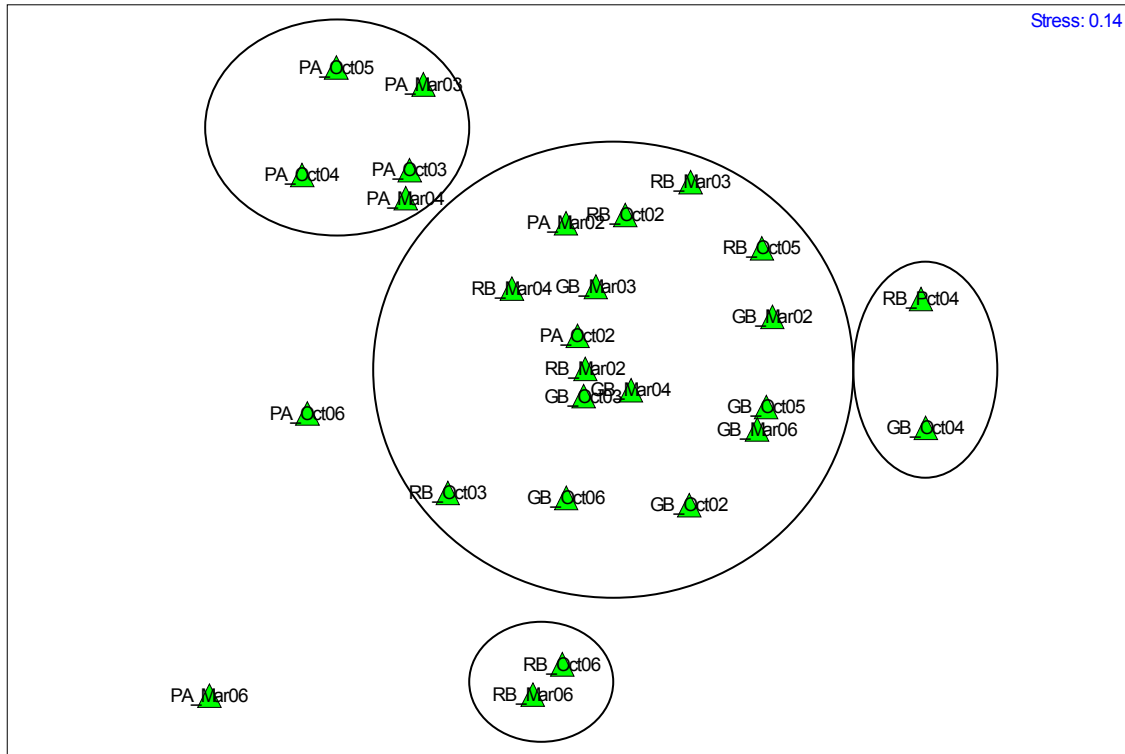


Figure 16. Multi-dimensional scaling plot of benthic composition at the 3 reef slope sites between March 2002 and October 2006 (RB = Rivière Banane, GB = Grand Bassin, PA = Passe Armand).

Considering hard coral only, there has been no change in the percentage cover at Grand Bassin coral cover has remained high with a mean of $53.5 \pm 2.7\%$ (1-way ANOVA, $F = 4.75$, $df = 8$, $p > 0.05$). At Rivière Banane, coral cover was high, with a mean of $49.6 \pm 2.9\%$, but was significantly higher during March 2006 (1-way ANOVA, $F = 3.72$, $df = 8$, $p < 0.05$) (Figure 17). At Passe Armand, there was a significant decline in coral cover between October 2002 and March 2003 from $>40\%$ to $\leq 25\%$ and coral cover remained low in the following years (1-way ANOVA, $F = 4.75$, $df = 8$, $p < 0.05$).

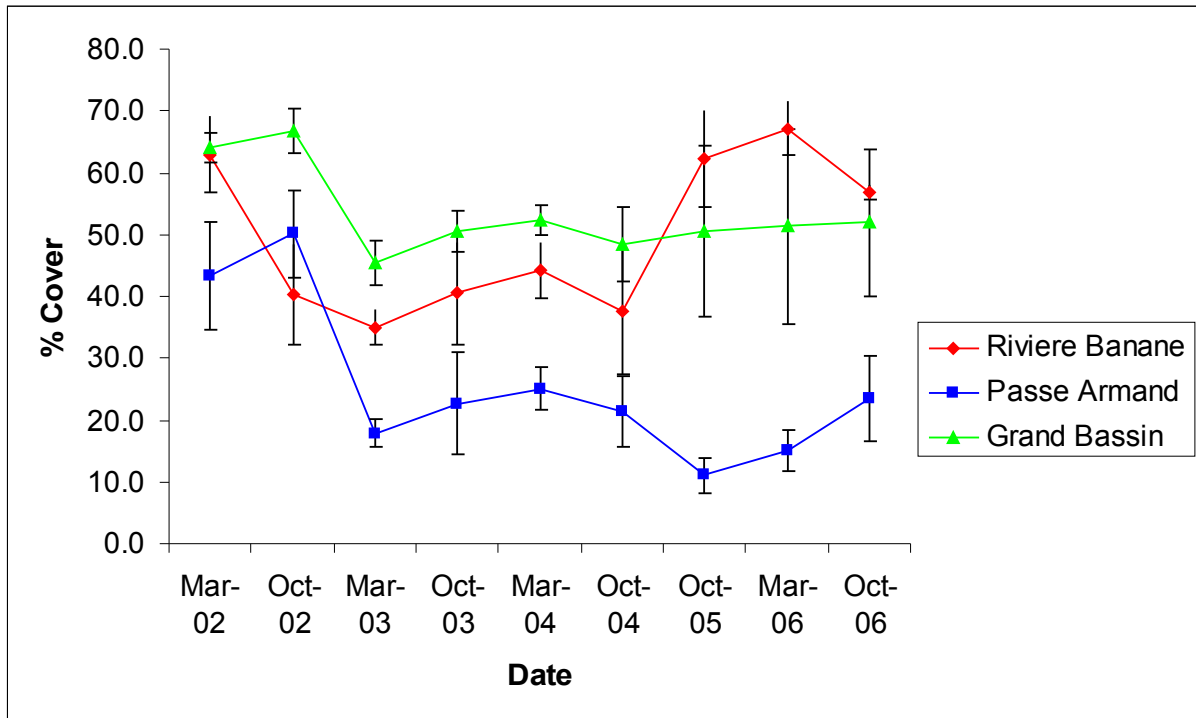


Figure 17. The percentage cover (\pm SE) of hard coral at 3 reef slope sites between March 2002 and October 2006.

Multi-dimensional scaling shows that at the 4 reef flat sites where comparisons over time can be made there is little difference in the benthic composition at Rivière Banane, Passe Armand and Grand Bassin between March 2002 and October 2006 (Figure 18), with sites consisting of low coral cover and high cover with coralline algae. Benthic composition at Trou Blanc is however more distinct, due to the high cover of soft coral. Benthic composition at Rivière Banane in October 2003 and March 2006 is distinct due to a high percentage cover of turf algae (>70%) and at Trou Blanc during October 2002 due to a high percentage cover of macro-algae (37%).

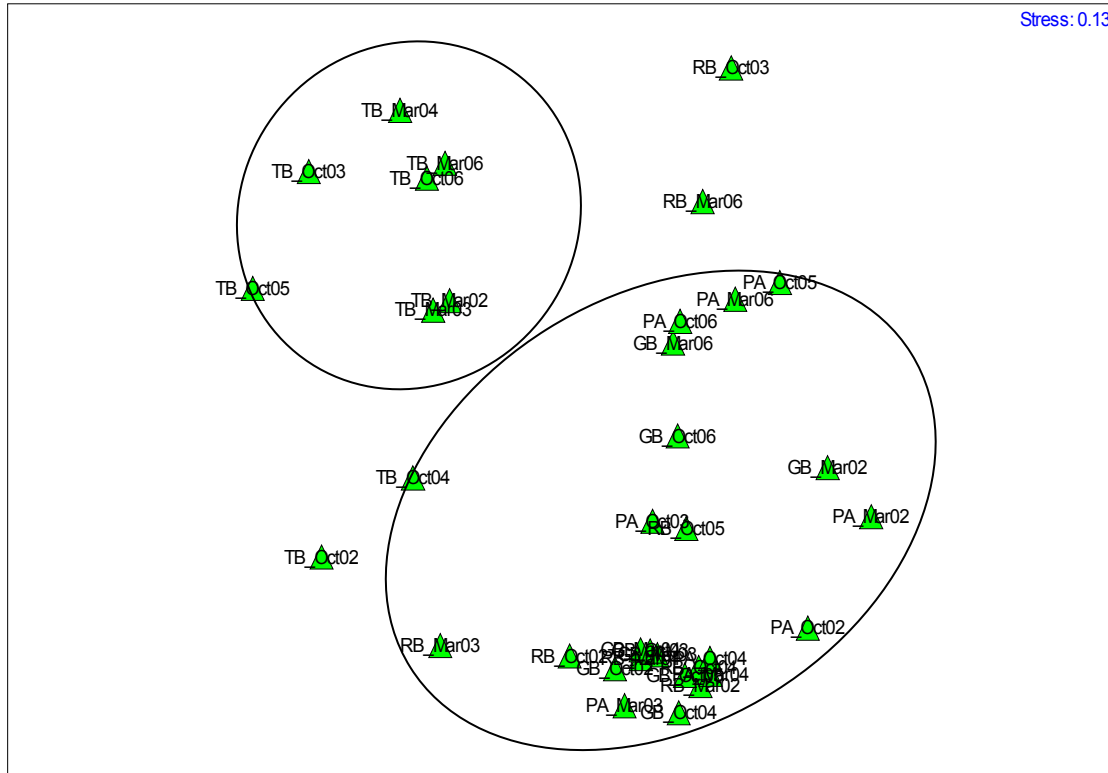


Figure 18. Multi-dimensional scaling plot of benthic composition at the 4 reef flat sites between March 2002 and October 2006 (RB = Rivière Banane, GB = Grand Bassin, PA = Passe Armand, TB = Trou Blanc).

Hard coral cover is low on the reef flat sites, however has remained stable between March 2002 and March 2006 at Rivière Banane (mean: 11% cover, 1-way ANOVA, $F = 0.97$, $df = 7$, $p > 0.05$), Grand Bassin (mean: 15% cover, 1-way ANOVA, $F = 2.41$, $df = 8$, $p > 0.05$) and Trou Blanc (mean: 12% cover, 1-way ANOVA, $F = 2.94$, $df = 8$, $p > 0.05$) (Figure 19). The very high coral cover recorded at Passe Armand in October 2002 is likely to be due to a change in transect position and if this data point is removed there has also been no change in coral cover at this site (mean: 13% cover, 1-way ANOVA, $F = 1.91$, $df = 7$, $p > 0.05$).

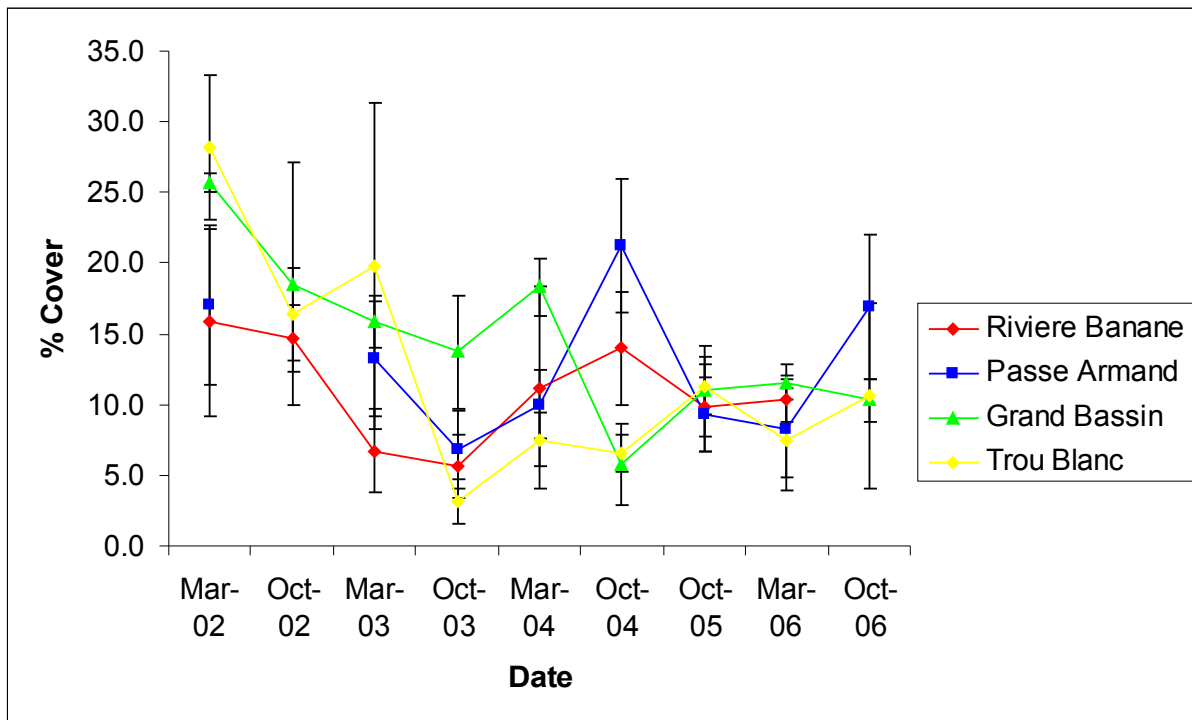


Figure 19. The percentage cover (\pm SE) of hard coral at 4 reef flat sites between March 2002 and October 2006.

3.42 Fish

Multi-dimensional scaling (MDS) shows that on the reef slope sites there has been little change in fish community composition over time, with communities at Rivière Banane grouping together and those from Grand Bassin and Passe Armand grouping together (Figure 20). Communities at all 3 sites during March 2003 and March 2006 were distinct due to high numbers of the Fusilier, *Pterocaesio tile*.

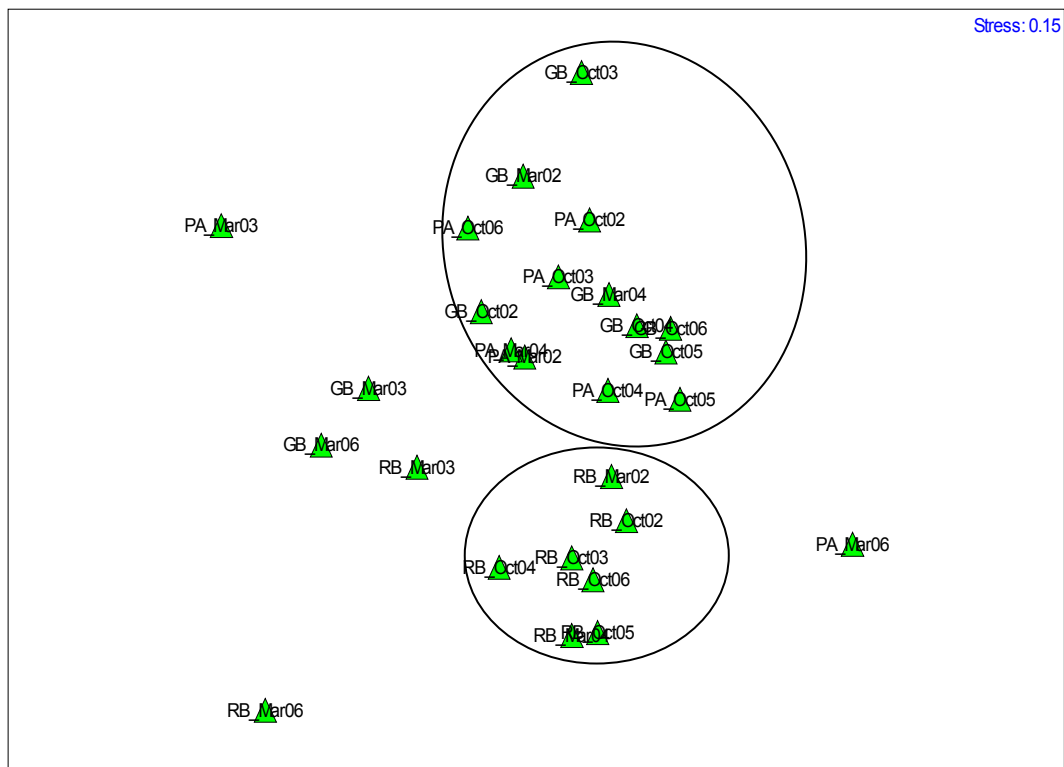


Figure 20. Multi-dimensional scaling plot of fish community composition at the 3 reef slope sites between March 2002 and October 2006 (RB = Rivière Banane, GB = Grand Bassin, PA = Passe Armand).

Considering the 5 most commonly occurring families of fish, there was a significant decline in the abundance of Damsel fish on the reef slope at Passe Armand after October 2004 (1-way ANOVA, $F = 7.87$, $df = 8$, $p < 0.001$). At Grand Bassin there were peaks in abundance during October 2002 and March 2006 whereas at Rivière Banane, Damsel fish numbers have remained high (mean of >70 individuals) throughout the surveys. There was no change in the numbers of Surgeonfish on the reef slopes at Rivière Banane or Passe Armand, with numbers remaining low over time. At Grand Bassin however, there was a general decline in numbers after March 2002 (1-way ANOVA $\sqrt{\cdot}$ -transformation, $F = 8.52$, $df = 6$, $p < 0.001$). The numbers of Butterflyfish remained low on the reef slope at Rivière Banane between March 2002 and October 2005 (mean of ≤ 7 individuals). There was however a significant decline in the number of Butterflyfish on the reef slopes at both Passe Armand and Grand Bassin after October 2002 (1-way ANOVA, Passe Armand: $F = 7.14$, $df = 8$, $p = 0.001$; Grand Bassin, $F = 9.18$, $df = 8$, $p = 0.001$). At all 3 sites, Wrasse showed a decline in numbers after October 2002, however numbers then increased again in March 2006 (1-way ANOVA, Rivière Banane: $F = 5.54$, $df = 8$, $p = 0.001$; Grand Bassin: $F = 2.87$, $df = 6$, $p < 0.05$; Kruskal-Wallis, Passe Armand: $F = 5.35$, $df = 8$, $p < 0.05$). There was no obvious temporal pattern in the abundance of Parrotfish at any of the 3 sites.

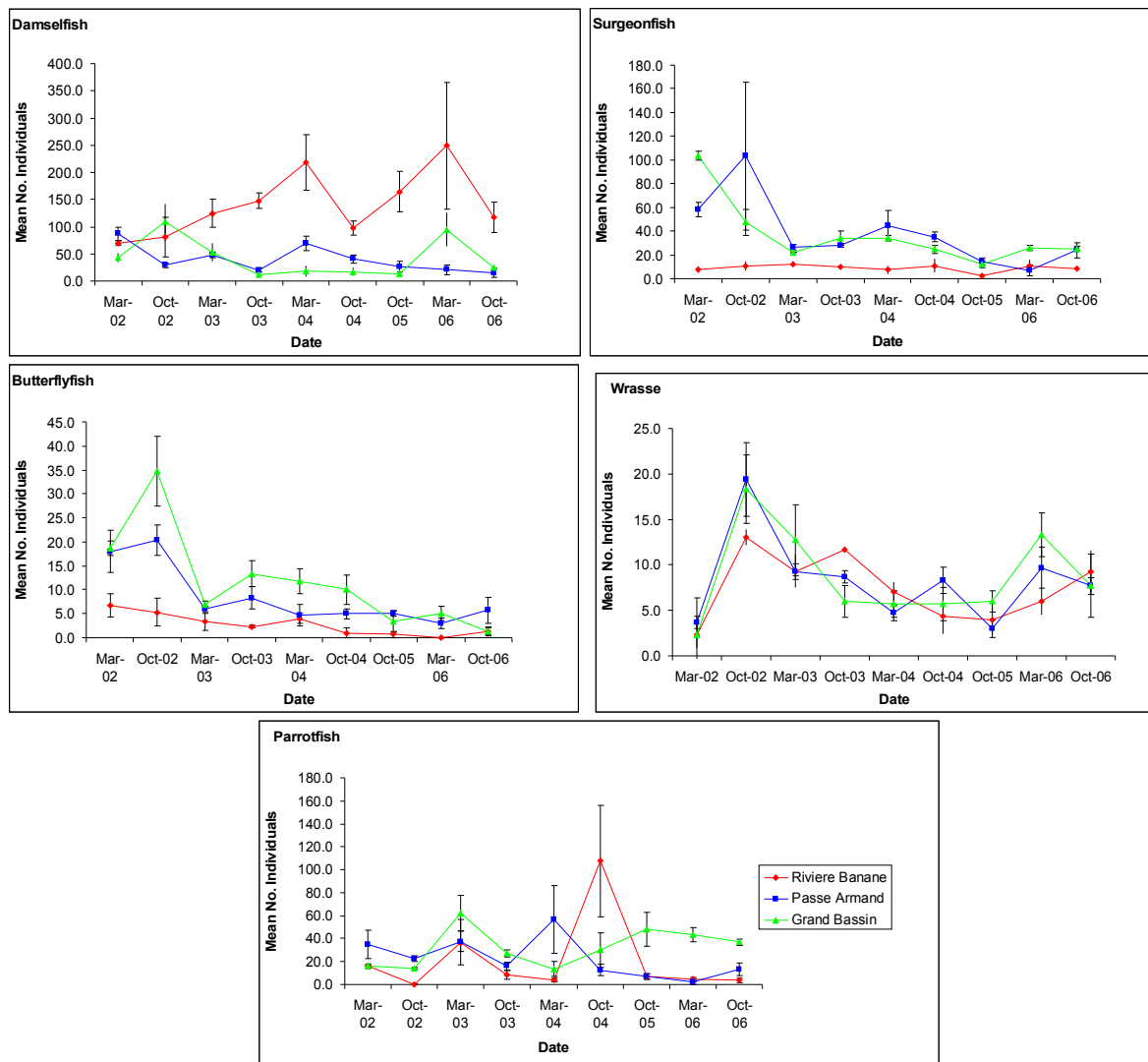


Figure 21. The change in abundance of Damsel, Surge, Butterfly, Wrasse and Parrotfish (\pm SE) at Rivière Banane, Passe Armand and Grand Bassin between March 2002 and October 2006.

Multi-dimensional scaling (MDS) shows that on the reef flat sites there has been little change in fish community composition over time, with communities at Rivière Banane, Passe Armand and Grand Bassin grouping together and those from Trou Blanc being more distinct (Figure 22). Communities at Passe Armand, Rivière Banane and Grand Bassin were separate in March 2002 due to low numbers of Wrasse. Passe Armand in October 2005 groups more closely with Trou Blanc due to very high numbers of Damsel in this year (mean of 242 individuals) and Trou Blanc in March 2006 groups more closely with Passe Armand, Rivière Banane and Grand Bassin due to a low numbers of Damsel and high numbers of Parrotfish during that survey.

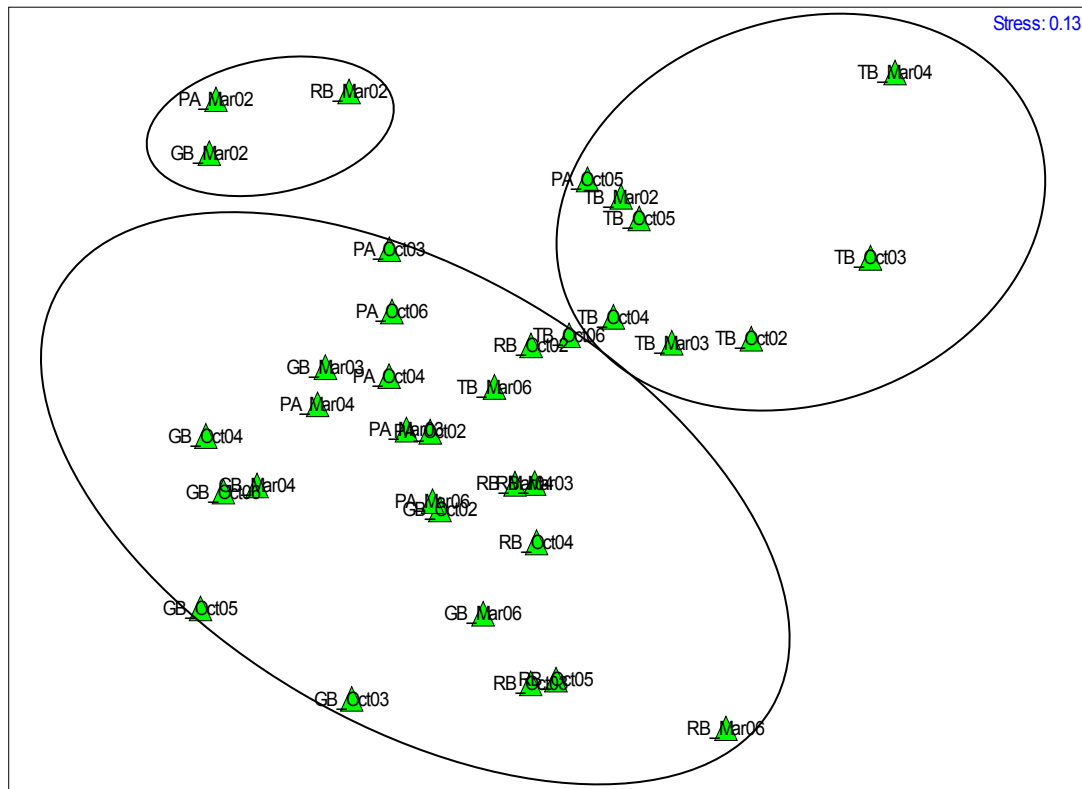


Figure 22. Multi-dimensional scaling plot of fish community composition at the 4 reef flat sites between March 2002 and October 2006 (RB = Rivière Banane, GB = Grand Bassin, PA = Passe Armand, TB = Trou Blanc).

Considering the 5 most commonly occurring fish families, there was no change in the abundance of Damsel fish on the reef flat at Passe Armand over time and Trou Blanc showed no obvious temporal patterns in Damsel fish abundance (Figure 23). At Grand Bassin, there was however, a significant decline in the abundance of Damsel fish after March 2003 (1-way ANOVA, $F = 7.91$, $df = 8$, $p < 0.001$) and at Rivière Banane the abundance has declined since October 2002 (1-way ANOVA, $F = 5.50$, $df = 7$, $p < 0.05$). There was no change in the abundance of Surgeonfish at Rivière Banane or at Passe Armand. At Grand Bassin, there were significant declines in numbers of Surgeonfish during the winter surveys as well as during March 2006 (1-way ANOVA, $F = 8.12$, $df = 8$, $p < 0.001$) and at Trou Blanc numbers were significantly lower in October 2002, October 2003 and March 2004 (1-way ANOVA, $F = 18.19$, $df = 8$, $p < 0.001$). There was no change in the numbers of Butterflyfish over time at Rivière Banane or Passe Armand with numbers remaining low (mean of < 9 individuals). At Grand Bassin, there were significantly lower numbers of Butterflyfish during October 2002 and March and October 2006 (1-way ANOVA, $F = 3.36$, $df = 8$, $p < 0.05$) and at Trou Blanc, there was a significant decline in numbers from March 2002 (1-way ANOVA, $F = 7.44$, $df = 8$, $p < 0.001$). There was no change in the abundance of Wrasse at Rivière Banane. At Passe Armand, there were significantly lower numbers in March 2002, followed by an increase in the subsequent months (1-way ANOVA, $F = 5.17$, $df = 8$, $p < 0.05$). At Grand Bassin, there were significant declines in numbers during March 2002, October 2003 and March 2006 (1-way ANOVA, $F = 28.59$, $df = 8$, $p < 0.001$) and at Trou Blanc, there were significantly lower numbers of Wrasse in March 2003-March 2004 compared to the remaining months (1-way

ANOVA, $F = 9.97$, $df = 8$, $p < 0.001$). There was no change in the abundance of Parrotfish at Rivière Banane, Grand Bassin or Passe Armand over time; at Trou Blanc there was a significantly higher number of Parrotfish during March 2006 than the remaining months (1-way ANOVA, $F = 3.82$, $df = 8$, $p < 0.05$).

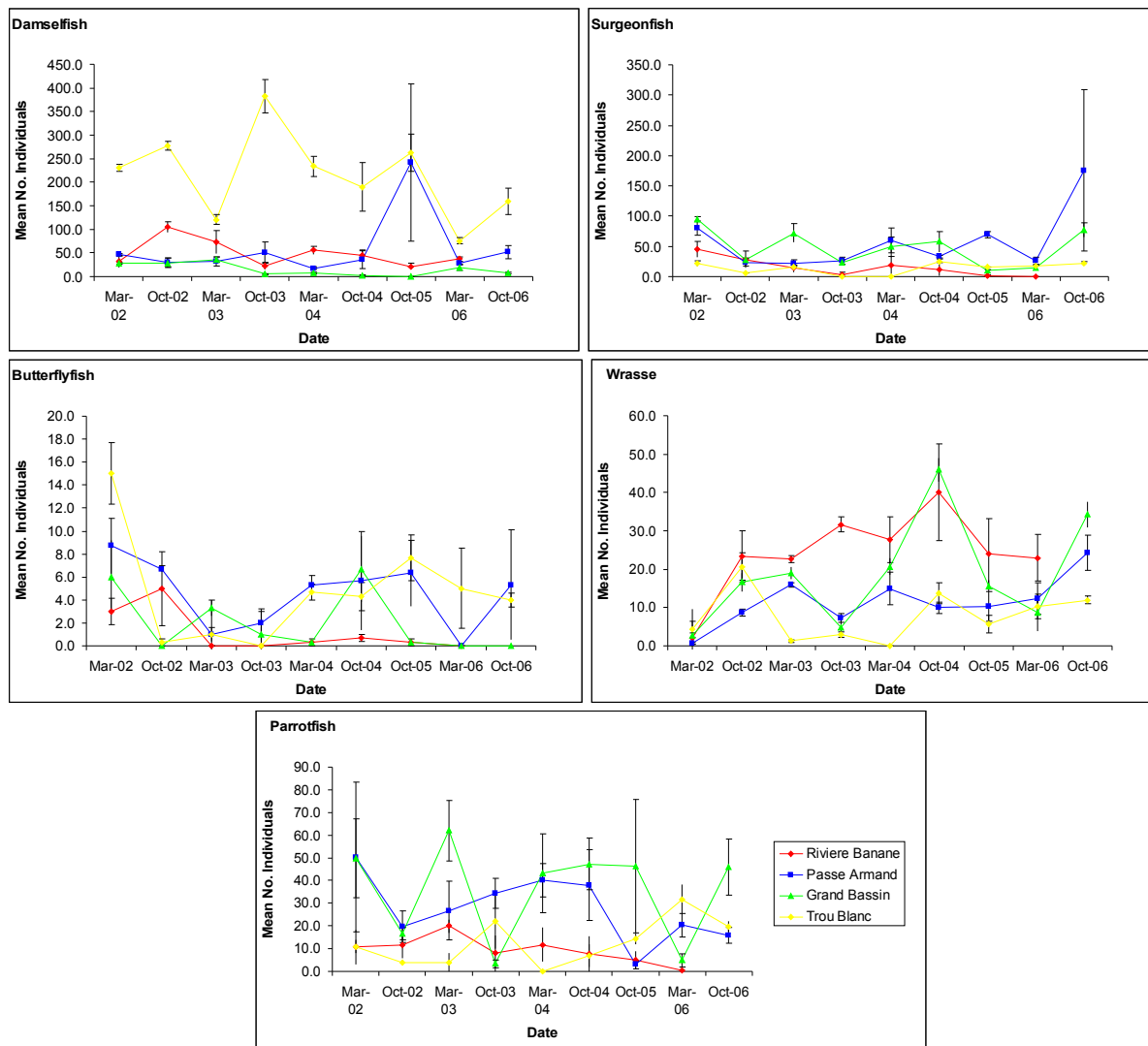


Figure 23. The change in abundance of Damsselfish, Surgeonfish, Butterflyfish, Wrasse and Parrotfish (\pm SE) at Rivière Banane, Passe Armand, Grand Bassin and Trou Blanc between March 2002 and October 2006.

3.43 Invertebrates

Multi-dimensional scaling (MDS) shows that on the reef slope sites there have been little change in invertebrate community composition over time at Passe Armand and Rivière Banane (Figure 24). At Grand Bassin, however, there is a separation between the communities present in March 2002, October 2002 and October 2004 and those present in March 2003, 2004 and October 2005 – October 2006 due to no *Diadema* sp. being present in the latter surveys. The community present during October 2003 groups more closely with the community at Rivière Banane due to high numbers of *Echinometra mathaei* being present at that time (mean of 39 individuals).

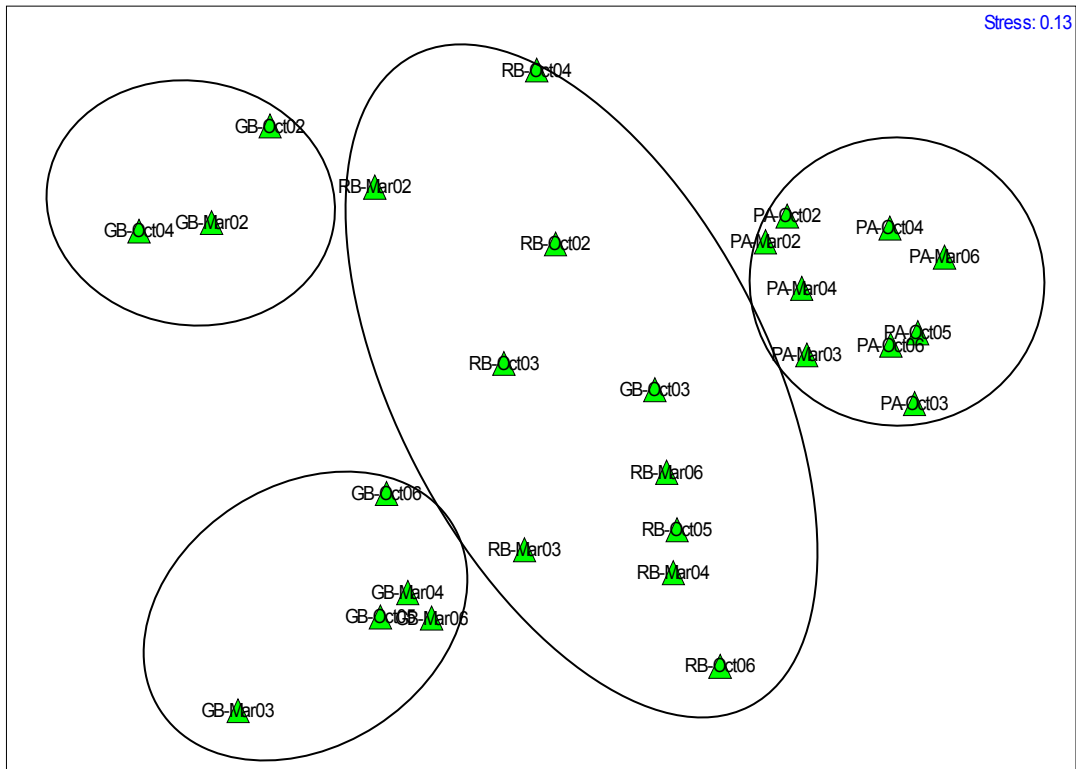


Figure 24. Multi-dimensional scaling plot of invertebrate community composition at the 3 reef slope sites between March 2002 and October 2006 (RB = Rivière Banane, GB = Grand Bassin, PA = Passe Armand).

On the reef slope there has been no change in the numbers of *Echinometra mathaei* at Rivière Banane or Grand Bassin over the 5-year survey period and numbers have remained low (Figure 25). At Passe Armand however, there were significantly more *E. mathaei* in October 2003 than in the remaining months (1-way ANOVA, $F = 7.85$, $df = 8$, $p < 0.001$)

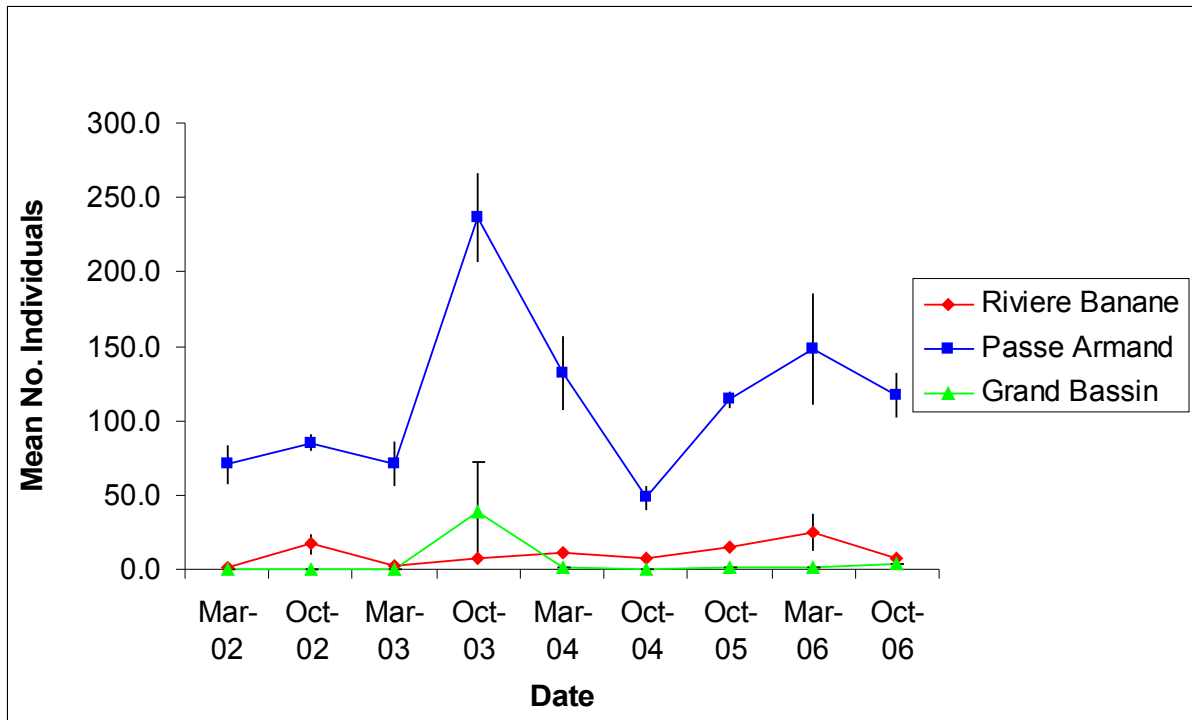


Figure 25. The change in abundance of *Echinometra mathaei* (\pm SE) at Rivière Banane, Passe Armand and Grand Bassin between March 2002 and October 2006.

On the reef flat, Multi-dimensional scaling shows that there have been a number of temporal variations in invertebrate community composition at the different sites (Figure 26). The communities at Passe Armand in March 2004 and October 2005 – 2006 group together with those of Rivière Banane in March 2004 and October 2005 and Grand Bassin in March 2006 due to very high numbers of *Echinometra mathaei* (>250 individuals). In contrast, Rivière Banane during March 2002 and October 2004 group together with Grand Bassin in October 2004 due to very low numbers of *E. mathaei* (\leq 30 individuals). The community composition at Passe Armand during October 2002 is distinct due to a low number of *E. mathaei* and high number of *Diadema* sp., whereas the communities at Passe Armand in March 2003 and October 2003 are distinct due to high numbers of the sea cucumber, *Stichopus chloronatus*. There are also temporal variations at Trou Blanc, with communities in October 2005 – October 2006 distinct due to high numbers of *E. mathaei*.

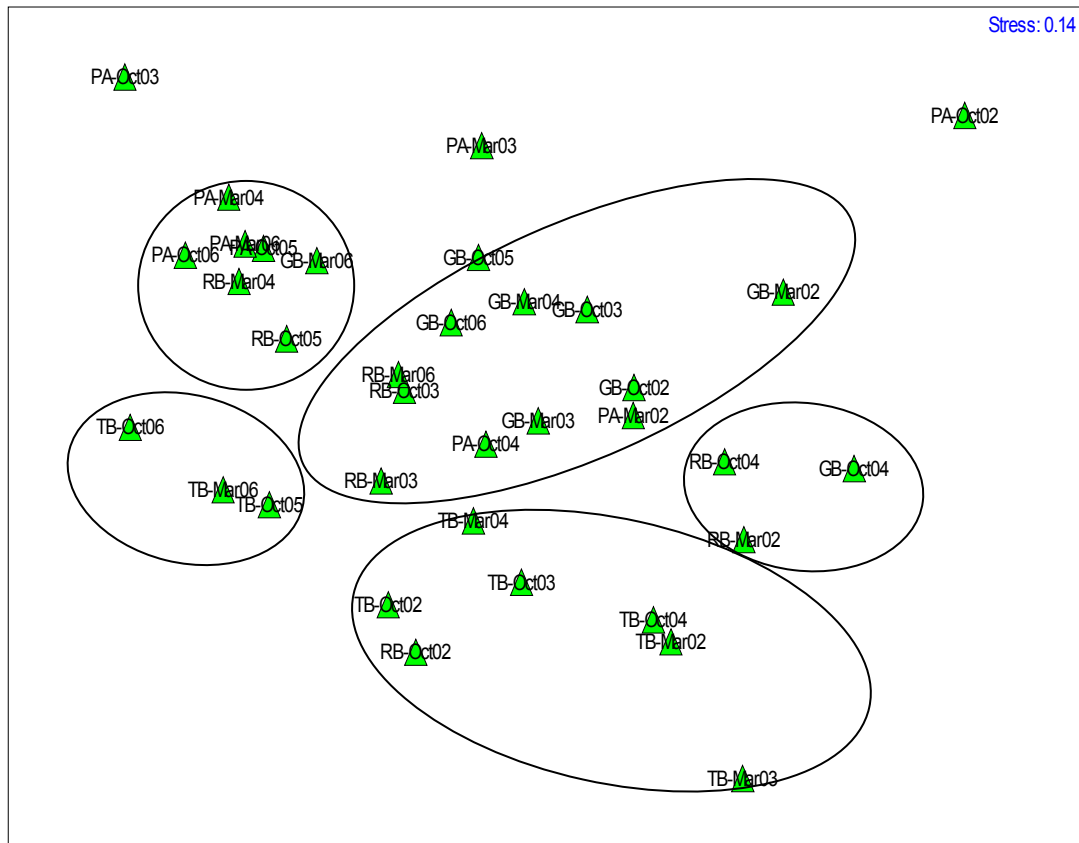


Figure 26. Multi-dimensional scaling plot of invertebrate community composition at the 4 reef flat sites between March 2002 and October 2006 (RB = Rivière Banane, GB = Grand Bassin, PA = Passe Armand, TB = Trou Blanc).

On the reef flat, there was a significant increase in the abundance of *Echinometra mathaei* between March 2002 and March 2006 at Grand Bassin, followed by a decline in October 2006 (1-way ANOVA, $F = 5.71$, $df = 8$, $p = 0.001$). There has also been a significant increase in numbers at Trou Blanc during October 2005 – October 2006 (1-way ANOVA, $F = 4.87$, $df = 8$, $p < 0.05$). At Passe Armand, the abundance of *E. mathaei* was significantly higher during October 2003 and October 2005 – March 2006 than during the remaining months (1-way ANOVA, $F = 5.68$, $df = 8$, $p = 0.001$) and at Rivière Banane, higher numbers were recorded in March 2004 and October 2005 (1-way ANOVA, $F = 5.25$, $df = 7$, $p < 0.05$).

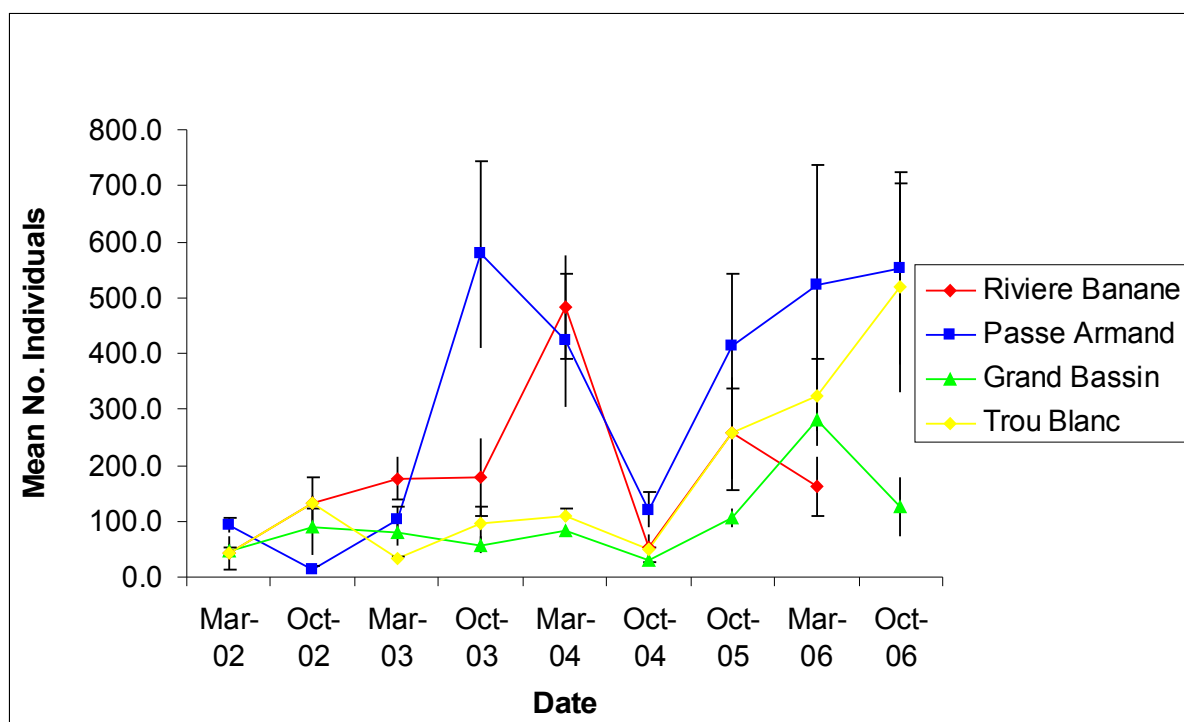


Figure 27. The change in abundance of *Echinometra mathaei* (\pm SE) at Rivière Banane, Passe Armand, Grand Bassin and Trou Blanc between March 2002 and October 2006.

3.5 Water Quality

On the reef flats, water temperature varied between 26.700°C during summer and 23.648°C in winter; on the reef slopes, temperature varied between 26.622°C in summer and 23.646°C in winter (Table 6). Nitrate concentration showed significant differences between sites, varying from 0.240mg l⁻¹ at Rivière Banane reef flat to 0.002mg l⁻¹ at North Ile aux Sables (1-way ANOVA, F = 46.65, df = 11, p<0.001). Nitrite also varied significantly from 0.016 mg l⁻¹ at Ile aux Fous reef slope to 0.000mg l⁻¹ at North Ile aux Sables (Kruskall-Wallis, H = 25.34, df = 11, p<0.001). Phosphate concentration did not vary significantly between sites (1-way ANOVA, F = 1.75, df = 11, P>0.05).

Table 8. Water quality measurements at the 13 survey sites.

Site	Temperature (Summer) °C	Temperature (Winter) °C	Nitrite (mg l ⁻¹)	Nitrate (mg l ⁻¹)	Phosphate (mg l ⁻¹)
Passe Armand Flat	25.587	23.423	0.001	0.138	0.0
Passe Armand Slope	25.824	24.007	0.001	0.104	0.2
Grand Bassin Flat	-	-	0.002	0.172	0.0
Grand Bassin Slope	-	23.239	0.009	0.103	0.2
Rivière Banane Flat	25.618	-	0.006	0.240	0.8
Rivière Banane Slope	27.398	23.465	0.003	0.066	0.0
Trou Blanc	25.968	23.734	0.006	0.086	0.2
Passe L'Ancre	28.489	23.786	0.006	0.135	1.1
Passe Cabris	27.837	-	-	-	-
Ile aux Fous Flat	-	-	0.003	0.190	0.8
Ile aux Fous Slope	-	23.871	0.016	0.002	0.0
Passe Demi	-	-	0.002	0.128	0.2
Ile aux Sables	-	-	0.000	0.224	0.2

4 Discussion

Hard coral cover was high on the reef slope at Rivière Banane, Grand Bassin and Ile aux Fous (>50%), but was low at Passe Demi, North Ile aux Sables and Passe Armand, which were dominated by coralline algae. There was however low dead coral cover at all sites, suggesting that the sites are generally healthy. The coral cover was dominated by branching *Acropora* spp., in particular *A. austere*, *A. abrotanoides* and *A. nobilis*. In contrast, coral cover was low on the reef flat sites (<30%) and dead coral cover was high at Ile aux Fous during the summer survey with a high percentage cover of rubble at Passe L'Ancre, suggesting that these sites are being subjected to human and natural impacts. Coral bleaching affected corals during 2002 (Hardman *et al.*, 2004) and a further bleaching event occurred in March 2005 resulting in bleaching of 90% of *A. austera* colonies at Passe Armand and Ile aux Fous (Hardman *et al.*, 2005). The sites are also likely to be impacted by trampling and boat damage from octopus and seine net fishers. Despite these impacts, live coral cover has remained stable at the reef flat sites between March 2002 and October 2005.

Coral cover on the reef slopes at Rivière Banane and Grand Bassin has also remained stable since March 2002; there was however a decline in coral cover at Passe Armand between October 2002 and March 2003. The 2003 coral bleaching event only affected corals on the shallow reef flat (Hardman *et al.*, 2004) and there was no corresponding increase in dead coral or rubble in 2003, suggesting that this change may be simply due to a change in position of the permanent transects. Similarly, the changes in the percentage cover of coralline and turf algae are likely to be due to variations in the way surveyors recorded the benthic categories. Comparisons between the benthic composition in 2002 – 2006 suggests that there was an increase in macro-algae on the reef slopes at Grand Bassin and Rivière Banane in October 2004 and that macro-algae was also high at Grand Bassin and Ile aux Fous in October 2005. It is however likely that this is a natural seasonal occurrence taking place during the winter months as macro-algae returns to low levels in the following summer surveys.

On the reef slope all sites except Passe Armand and Grand Basin were dominated by Damselfish, with very high numbers being recorded at Rivière Banane. Damselfish were also dominant at the reef flat sites during summer, although sites tended to be dominated by Surgeonfish in winter. At all sites, Emperors and Grouper were rare or absent and no Triggerfish, Snapper or Trevally were observed at any site during the surveys. This lack of large piscivorous predators suggests that the fish population may be unbalanced due to overfishing. There have also been declines in the number of Damselfish, Surgeonfish and Butterflyfish over time on the reef slopes at Passe Armand and Grand Bassin. On the reef flats, there were less obvious temporal trends in fish abundance, however Damselfish and Surgeonfish declined at Grand Bassin and Butterflyfish declined at Trou Blanc. The decline in Surgeonfish may be due to overfishing as these species are targeted by the lagoon fisheries, however Damselfish and Butterflyfish are not targeted by the fisheries and thus the decline in their numbers may be an indication of changes in the benthos, such as a decline in live coral cover or an increase in macro-algae. At both the reef slope and reef flat sites, the majority of key fish species observed were below the published length of maturity. This suggests that either these areas are important grounds for juveniles or that the population is dominated by small under-sized individuals due to intense fishing of the adult individuals.

Invertebrates were low on the reef slope sites, particularly at Grand Bassin and Passe Demi and all sites, were dominated by the urchin, *Echinometra mathaei*. This species also dominated all of the reef flat sites, except for Passe L'Ancre and was very common at North Ile aux Sables (slope), Passe Armand (flat), Trou Blanc (flat) and Grand Bassin (flat). There

were temporal variations in the abundance of *E. mathaei* at the reef flat sites, with large increases observed during some years and there has been a general increase in numbers over time at Passe Armand and Trou Blanc. The high number of this species may be as a result of intense fishing pressure and the removal of predator fish species. *E. mathaei* is a bio-eroder and so their high density is cause for concern, especially with possible increase in the incidences of coral bleaching resulting in higher coral mortality. At all sites molluscs and crustaceans were either rare or absent; in particular *Tridacna* clams were in low abundance and large gastropods such as *Pleuroploca trapezium* were not observed. This may be an indication that local consumption is resulting in over-harvesting.

Nutrient values were low, however nitrate values were significantly higher at Rivière Banane reef flat. Rivière Banane is an important agricultural area in Rodrigues and this might be an indication that fertiliser run-off is occurring. Further surveys carried out at different times of the year are however needed to confirm whether this is indeed the case.

Considering the sites within the proposed marine reserves, it can be seen that the reef slopes are generally healthy with high coral cover (>50%) at Grand Bassin and Rivière Banane and a low percentage cover of dead coral. Fish communities are dominated by Damselfish, with Parrotfish dominant at Grand Bassin during winter and the endemic Damselfish, *Pomacentrus rodriguesensis*, was observed at Grand Bassin and Rivière Banane. At present, the majority of fish species are however undersized; invertebrates also tend to be low at all sites. The reef flat sites within the proposed marine reserves are more degraded with low coral cover (<12%). The abundance of fish was low at Rivière Banane and at Grand Bassin during summer and Damselfish and Surgeonfish had declined over time at Grand Bassin. The invertebrate community at these 2 sites was dominated by very high numbers of the urchin *Echinometra mathaei*, suggesting that erosion of the reef structure may be occurring. The presence of marine reserves in these areas will protect the healthy reef slopes from future impacts and aim to facilitate recovery of the degraded reef flat areas.

5 References

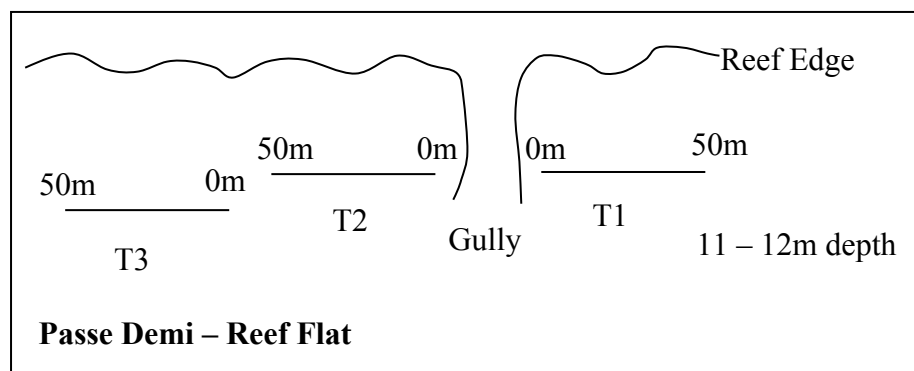
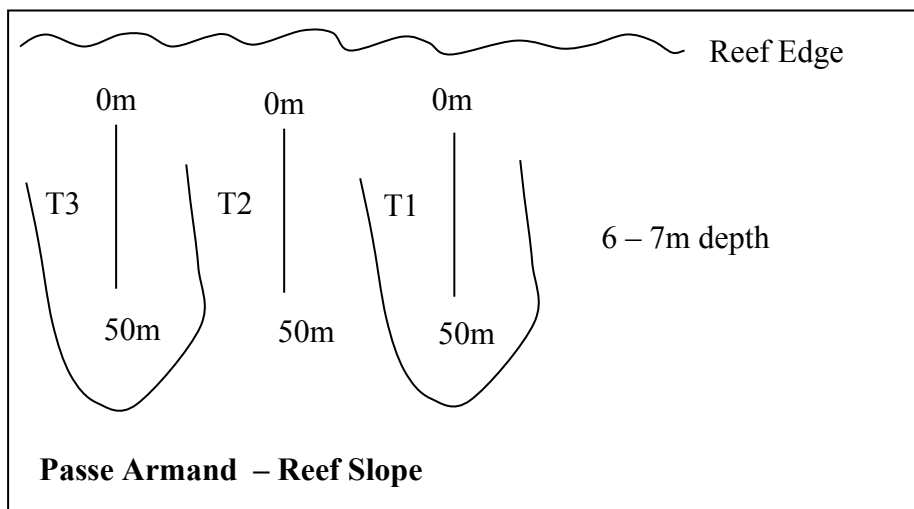
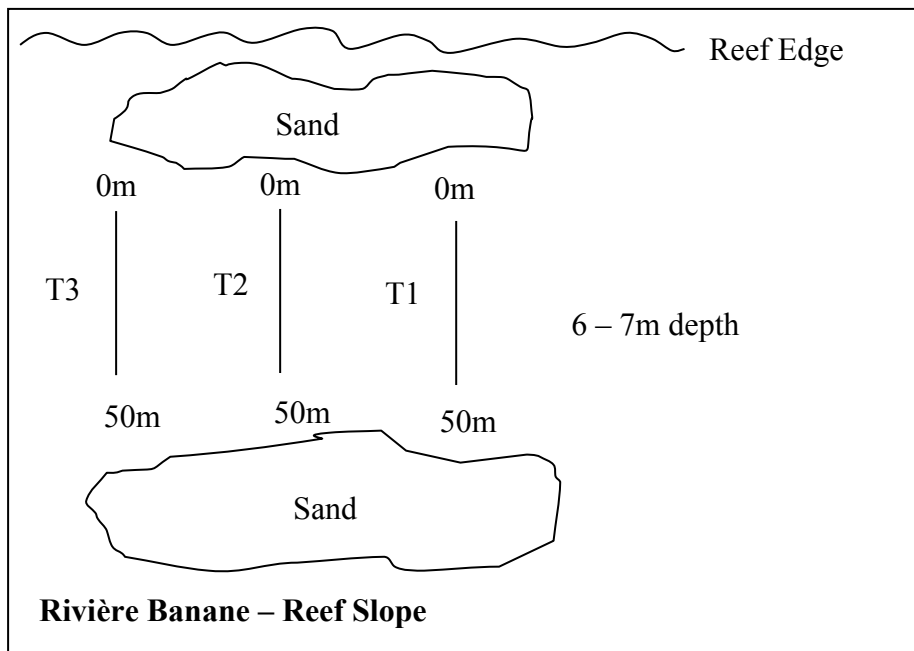
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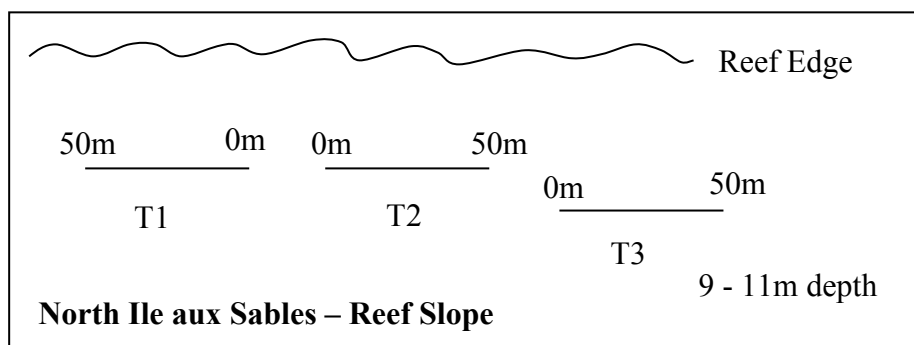
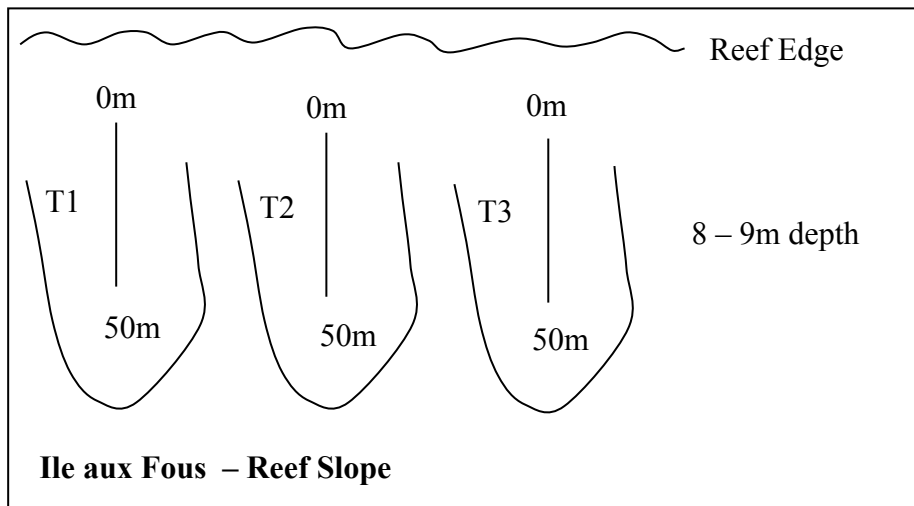
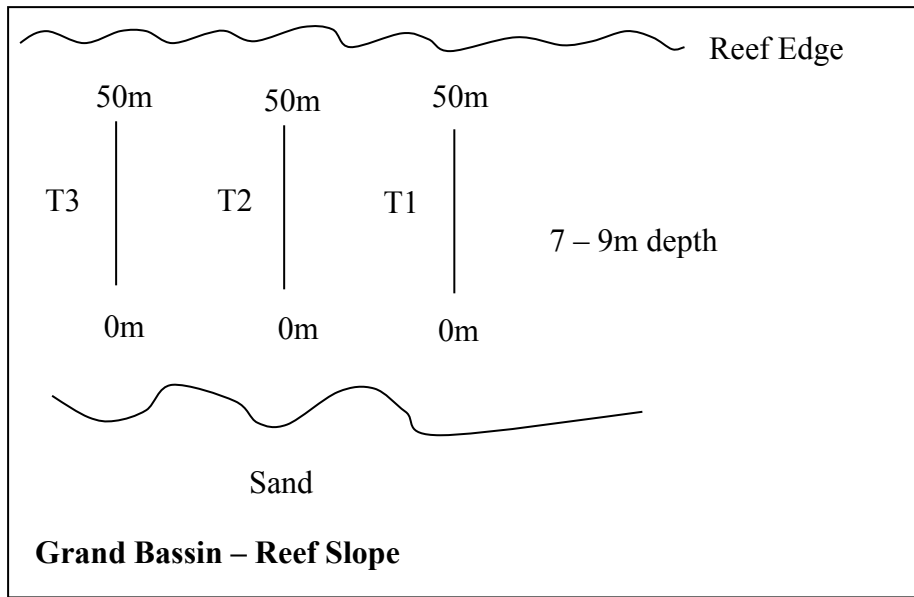
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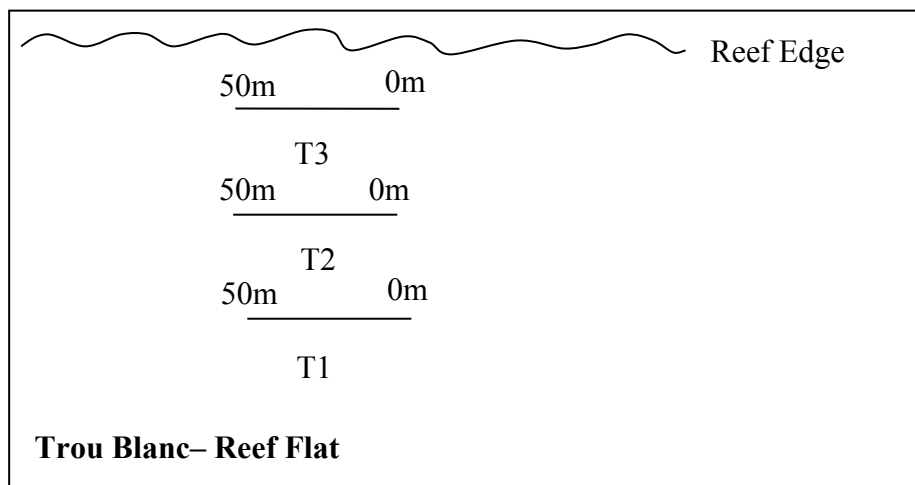
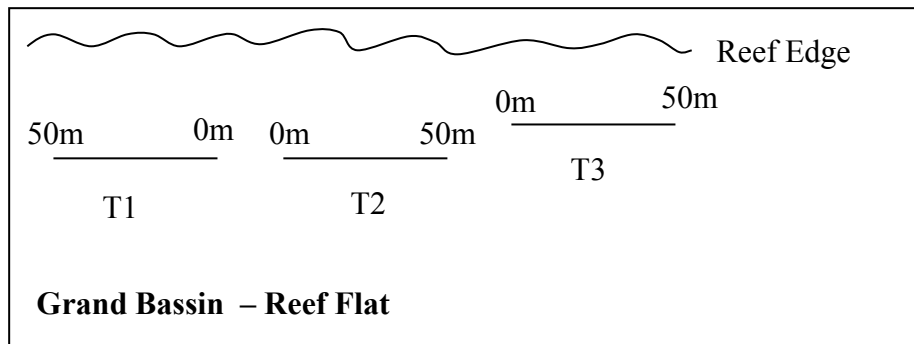
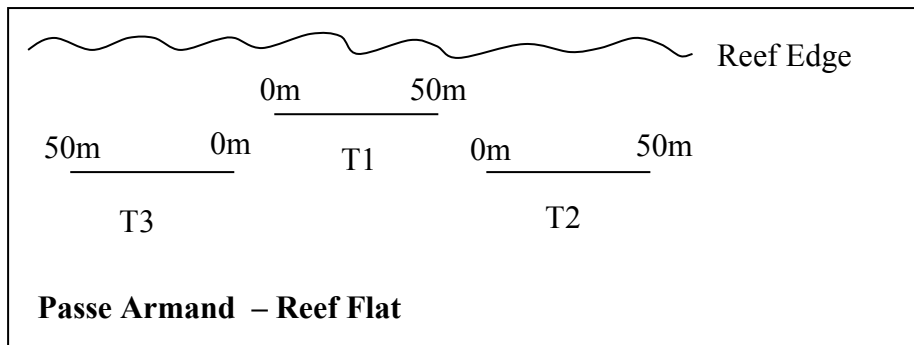
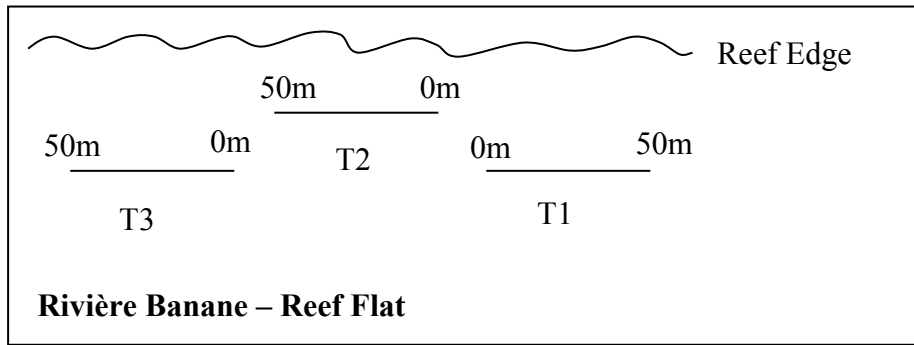
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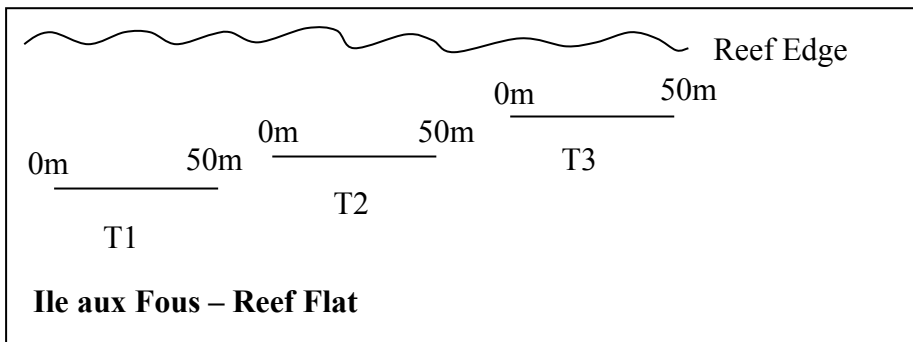
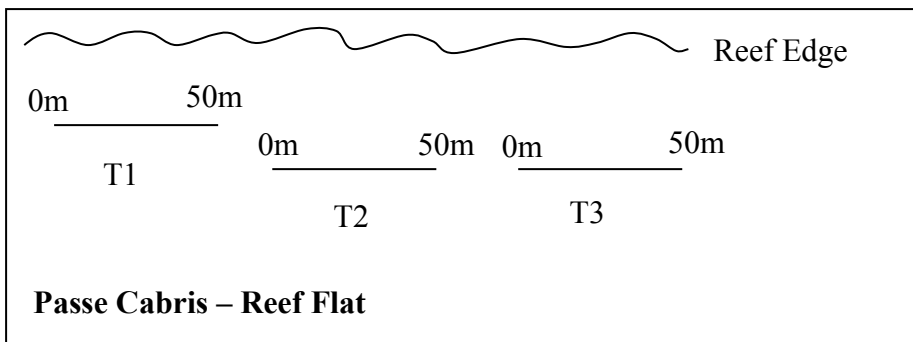
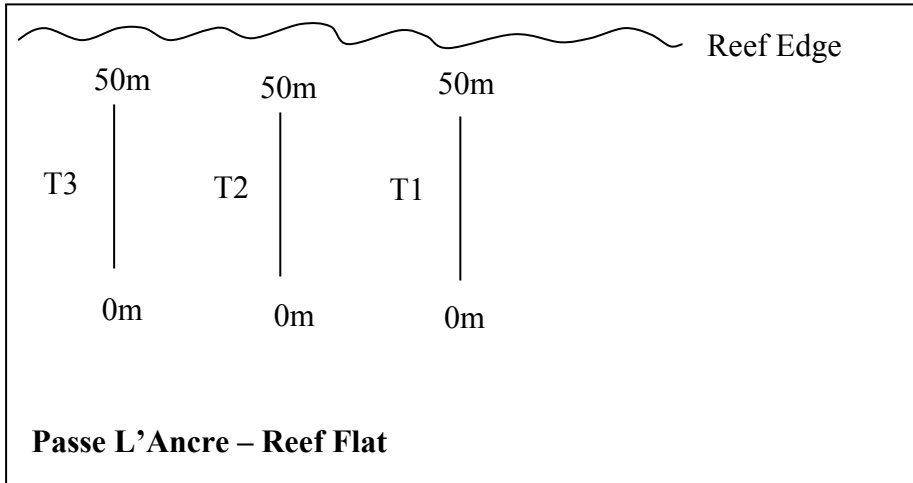
6 Appendices

6.1 Transect Locations









6.2 Data Tables

Table A1. The mean percentage cover of the different benthic habitats at the 6 reef slope sites during (a) summer (March) and (b) winter (October).

(a) Summer

	Rivière Banane	Passe Armand	Grand Bassin	Passe Demi	Ile aux Fous	North Ile aux Sables
Digitate <i>Acropora</i>	54.8	7.1	31.6	16.9	31.4	8.1
Branching <i>Acropora</i>	2.0	0.0	1.5	0.0	0.0	0.7
Tablular <i>Acropora</i>	0.8	0.0	6.3	0.8	2.1	0.0
Encrusting <i>Acropora</i>	1.7	0.0	0.0	0.0	0.0	0.0
Foliose Coral	0.0	0.0	0.0	0.0	0.0	0.0
Sub-massive Coral	1.3	4.1	3.3	1.5	3.0	2.4
Encrusting Coral	3.4	1.9	1.6	0.8	15.9	5.7
Massive Coral	4.3	1.9	10.4	0.8	0.0	3.9
Mushroom Coral	0.0	0.0	0.0	0.0	0.0	0.0
<i>Millepora</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0
Soft Coral	0.0	6.5	7.8	4.3	3.4	13.8
Dead Coral	0.0	0.0	0.0	0.0	1.3	0.3
Zoanthids	0.3	0.0	0.0	0.2	0.3	0.0
Macro-Algae	0.0	0.0	15.6	0.0	0.0	0.0
Turf Algae	19.5	68.6	2.7	28.4	32.8	10.0
Coralline Algae	13.0	7.8	22.8	32.0	9.8	54.3
Rubble	0.0	2.2	0.0	5.5	0.0	1.8
Sand	0.0	0.0	0.0	9.0	0.0	0.0

(b) Winter

	Rivière Banane	Passe Armand	Grand Bassin	Passe Demi	Ile aux Fous	North Ile aux Sables
Digitate <i>Acropora</i>	49.9	16.0	37.4	16.2	48.9	8.0
Branching <i>Acropora</i>	1.0	0.0	0.0	0.0	0.2	0.6
Tablular <i>Acropora</i>	0.8	1.4	6.1	0.4	4.2	0.0
Encrusting <i>Acropora</i>	2.3	0.0	0.0	0.0	0.0	0.0
Foliose Coral	0.0	0.0	0.0	0.0	0.0	0.0
Sub-massive Coral	1.0	3.2	2.5	6.1	0.0	1.2
Encrusting Coral	1.5	1.8	1.2	4.5	8.1	8.2
Massive Coral	0.3	1.0	4.8	1.5	0.4	2.3
Mushroom Coral	0.0	0.0	0.0	0.0	0.0	0.0
<i>Millepora</i> sp.	0.0	0.0	0.0	0.0	0.2	0.5
Soft Coral	0.3	4.9	8.8	4.4	0.3	13.5
Dead Coral	0.0	0.0	0.0	0.0	0.0	0.0
Zoanthids	0.3	0.0	0.0	2.8	0.3	0.0
Macro-Algae	0.3	0.0	0.0	0.0	1.5	0.0
Turf Algae	28.1	19.8	11.8	27.8	8.7	3.3
Coralline Algae	14.3	38.7	27.4	23.0	13.8	61.8
Rubble	0.0	13.2	0.0	5.5	12.0	0.7
Sand	0.0	0.0	0.0	7.8	1.5	0.0

Table A2. The mean number of fish species present at the 6 reef slope sites during (A) summer (March) and (B) winter (October).

(a) Summer

	Rivière Banane	Passe Armand	Grand Bassin	Passe Demi	Ile aux Fous	North Ile aux Sables
Medium dark surgeons 20-40cm	0.0	6.7	1.3	8.3	9.3	10.3
Small dark surgeons <20cm	9.7	0.0	20.7	2.0	0.0	9.3
<i>Acanthurus triostegus</i>	0.0	0.0	0.0	0.0	0.0	4.3
<i>Naso unicornis</i>	0.3	0.0	0.0	0.0	0.0	0.0
<i>Zebrasoma desjardinii</i>	0.7	0.0	0.0	0.0	0.0	1.0
<i>Zebrasoma scopas</i>	0.0	0.0	3.7	3.0	0.7	0.7
<i>Pterocaesio tile</i>	200.0	0.0	90.0	0.0	0.0	0.0
<i>Chaetodon auriga</i>	0.0	1.0	0.0	0.0	0.7	0.3
<i>Chaetodon guttatissimus</i>	0.0	1.3	1.7	0.3	0.0	0.0
<i>Chaetodon lunula</i>	0.0	0.3	0.0	0.0	0.0	0.0
<i>Chaetodon madagaskariensis</i>	0.0	0.0	0.3	0.0	0.0	0.0
<i>Chaetodon melannotus</i>	0.0	0.3	0.3	0.0	1.3	0.0
<i>Chaetodon trifascialis</i>	0.0	0.0	2.7	0.3	0.0	0.0
<i>Chaetodon trifasciatus</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Chaetodon unimaculatus</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Chaetodon vagabundus</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Chaetodon xanthocephalus</i>	0.0	0.0	0.0	0.0	0.0	0.7
<i>Forciper flavissimus</i>	0.0	0.0	0.0	0.3	0.0	0.0
<i>Cheilinus trilobatus</i>	0.0	0.7	0.0	0.0	0.0	0.3
<i>Cheilinus chlororus</i>	0.0	0.0	0.0	0.0	0.0	0.7
<i>Coris aygula</i>	0.0	0.0	0.0	0.0	0.0	1.3
<i>Hemigymnus fasciatus</i>	0.0	0.0	1.7	0.0	0.0	0.0
<i>Anampses caeruleopunctatus</i>	0.0	0.0	0.3	0.7	0.0	1.0
<i>Anampses meleagrides</i>	0.0	0.0	0.0	0.7	0.0	2.0
<i>Gomphosus caeruleus</i>	0.3	1.7	1.7	0.3	0.7	0.3
<i>Halichoeres marginatus</i>	1.0	0.0	0.7	0.0	0.0	0.0
<i>Labroides bicolor</i>	0.7	0.0	0.3	0.0	0.0	0.0
<i>Labroides dimidiatus</i>	0.3	0.0	1.0	0.0	0.0	0.0
<i>Stethojulis albovittata</i>	0.0	0.0	1.0	0.0	0.0	0.0
<i>Thalassoma genivittatum</i>	3.7	7.3	6.7	2.7	3.3	5.0
<i>Thalassoma hardwicke</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Gnathodentex aurolineatus</i>	0.7	1.0	8.7	1.7	0.3	0.0
<i>Oxymonacanthus longirostris</i>	2.3	0.0	2.7	0.0	0.0	0.0
<i>Mulloidichthys flavolineatus</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Mulloidichthys vanicolensis</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Parupeneus barberinus</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Parupeneus bifasciatus</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Parupeneus cyclostomus</i>	0.0	0.0	0.0	0.3	0.0	0.0
<i>Abudefduf sexfasciatus</i>	1.0	10.3	55.0	9.3	12.3	2.3
<i>Abudefduf vaigiensis</i>	0.0	0.0	0.0	0.7	0.0	0.0
<i>Chromis chrysura</i>	0.0	1.3	0.0	0.0	0.0	0.0
<i>Chromis dimidiata</i>	0.0	0.0	0.0	6.0	0.0	0.3
<i>Chromis nigrura</i>	188.0	0.3	17.7	62.3	3.3	22.0
<i>Plectroglyphidodon dickii</i>	26.0	0.7	6.7	3.0	4.3	7.7
<i>Plectroglyphidodon johnstoniatus</i>	6.0	0.7	7.0	4.3	0.7	2.3
<i>Pomacentrus caeruleus</i>	0.0	0.0	0.0	0.0	5.7	0.0
<i>Pomacentrus indicus</i>	27.7	1.3	2.3	8.0	2.3	8.7
<i>Pomacentrus pikei</i>	0.0	0.7	4.3	1.7	0.3	4.0

	Rivière Banane	Passe Armand	Grand Bassin	Passe Demi	Ile aux Fous	North Ile aux Sables
<i>Pomacentrus rodriguesii</i>	0.3	4.3	2.0	0.0	0.0	0.0
<i>Stegastes peliceri</i>	0.0	1.7	0.0	0.7	0.0	0.0
<i>Scarus scaber</i>	1.0	0.0	0.0	0.0	0.3	0.0
<i>Chlorurus sordidus</i>	3.3	2.3	0.7	27.0	1.0	25.0
Small immature parrotfish	0.0	0.0	43.0	0.0	0.0	1.7
<i>Cephalopholis argus</i>	0.0	0.0	0.0	0.0	0.0	0.7
<i>Epinephelus spilotoceps</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Epinephelus merra</i>	0.0	0.0	1.0	0.0	0.0	0.0
<i>Epinephelus spp</i>	0.3	0.0	0.0	0.0	0.0	0.0
<i>Pseudoanthias evansi</i>	0.3	0.0	0.0	0.0	0.0	0.0
<i>Siganus sutor</i>	0.0	0.0	0.7	0.0	0.0	0.0
<i>Zanclus cornutus</i>	0.0	0.0	1.3	0.3	0.3	0.0

(b) Winter

	Rivière Banane	Passe Armand	Grand Bassin	Passe Demi	Ile aux Fous	North Ile aux Sables
Large dark surgeons >40cm	0.0	0.0	0.0	0.0	0.7	0.0
Medium dark surgeons 20-40cm	0.0	6.3	0.0	2.0	2.7	9.0
Small dark surgeons <20cm	7.0	15.7	21.0	19.0	19.7	22.3
<i>Acanthurus triostegus</i>	0.0	0.0	0.0	0.0	0.3	0.0
<i>Naso lituratus</i>	0.0	0.0	0.0	0.0	0.3	0.0
<i>Naso unicornis</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Zebrasoma desjardinii</i>	0.0	0.0	0.0	0.7	0.0	0.0
<i>Zebrasoma scopas</i>	1.0	2.0	4.3	0.3	0.0	0.0
<i>Pterocaesio tile</i>	0.0	16.7	0.0	0.0	0.0	0.0
<i>Chaetodon auriga</i>	0.0	0.0	0.0	0.0	0.3	0.0
<i>Chaetodon guttatissimus</i>	0.0	0.7	0.0	0.0	0.0	0.0
<i>Chaetodon lunula</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Chaetodon madagaskariensis</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Chaetodon melannotus</i>	0.0	0.0	0.3	0.3	0.0	0.0
<i>Chaetodon trifascialis</i>	0.0	5.0	1.0	0.7	0.0	0.0
<i>Chaetodon trifasciatus</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Chaetodon unimaculatus</i>	0.0	0.0	0.0	0.0	0.0	0.7
<i>Chaetodon vagabundus</i>	0.7	0.0	0.0	0.0	0.0	0.0
<i>Chaetodon xanthocephalus</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Chaetodon zanzibarensis</i>	0.0	0.0	0.0	0.7	0.0	0.3
<i>Forcipiper flavissimus</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Heniochus monoceros</i>	0.7	0.0	0.0	0.0	0.0	0.0
<i>Paracirrhites arcatus</i>	0.0	0.0	0.0	0.0	0.0	1.3
<i>Bodianus macrourus</i>	0.0	0.3	0.0	0.0	0.0	0.0
<i>Cheilinus trilobatus</i>	0.0	0.0	0.3	0.0	0.0	0.7
<i>Cheilinus chlororus</i>	0.3	0.0	1.0	0.0	0.0	0.3
<i>Coris aygula</i>	0.0	0.0	0.0	0.0	0.7	0.0
<i>Hemigymnus fasciatus</i>	0.3	0.0	0.3	0.0	0.7	1.7
<i>Anampses caeruleopunctatus</i>	0.7	1.0	0.0	0.0	0.0	0.0
<i>Anampses meleagrides</i>	0.0	0.0	0.0	4.0	0.0	0.0
<i>Anampses twistii</i>	0.0	0.0	0.7	0.3	1.0	1.0
<i>Gomphosus caeruleus</i>	0.3	0.0	0.0	2.3	0.3	0.3
<i>Halichoeres marginatus</i>	0.7	2.3	0.0	0.0	2.3	0.3
<i>Halichoeres nebulosus</i>	0.0	0.0	0.0	0.0	0.7	3.0
<i>Labroides bicolor</i>	0.0	0.0	0.0	0.7	0.0	0.0

	Rivière Banane	Passe Armand	Grand Bassin	Passe Demi	Ile aux Fous	North Ile aux Sables
<i>Labroides dimidiatus</i>	1.0	0.0	0.0	1.3	0.7	0.3
<i>Stethojulis albobittata</i>	2.0	0.7	0.0	0.0	2.7	1.3
<i>Thalassoma genivittatum</i>	4.0	2.7	5.3	2.3	3.0	4.0
<i>Thalassoma hardwicke</i>	0.0	0.7	0.0	0.0	0.0	0.0
<i>Gnathodentex aurolineatus</i>	1.0	20.0	0.7	3.0	0.3	0.0
<i>Oxymonacanthus longirostris</i>	0.7	0.3	3.3	0.7	0.0	0.0
<i>Mulloidichthys flavolineatus</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Mulloidichthys vanicolensis</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Parupeneus barberinus</i>	0.0	0.0	0.3	0.0	0.0	0.0
<i>Parupeneus bifasciatus</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Parupeneus cyclostomus</i>	0.0	0.0	0.0	0.0	0.0	1.0
<i>Parupeneus macronemus</i>	0.0	2.0	0.0	1.0	0.0	0.0
<i>Abudefduf margariteus</i>	0.0	0.0	1.0	4.0	0.0	0.0
<i>Abudefduf sexfasciatus</i>	0.0	6.7	15.3	13.0	13.7	14.7
<i>Abudefduf vaigiensis</i>	6.0	0.0	0.0	0.0	0.0	0.0
<i>Chromis chrysur</i>	0.0	0.0	0.0	10.7	0.0	0.0
<i>Chromis dimidiata</i>	0.0	0.0	0.0	13.3	0.0	0.7
<i>Chromis nigrura</i>	66.0	0.0	0.0	0.0	9.3	44.7
<i>Plectroglyphidodon dickii</i>	20.7	0.0	6.3	2.7	25.3	7.3
<i>Plectroglyphidodon johnstoniatus</i>	0.0	2.0	0.0	1.7	2.3	0.3
<i>Pomacentrus caeruleus</i>	0.0	0.3	0.0	0.0	0.0	0.0
<i>Pomacentrus indicus</i>	24.0	1.7	1.0	6.3	0.0	10.7
<i>Pomacentrus pikei</i>	1.0	0.3	0.7	3.0	2.0	2.7
<i>Pomacentrus rodriguesii</i>	0.3	3.0	0.0	0.0	0.7	0.0
<i>Stegastes peliceri</i>	0.0	1.3	0.0	0.0	0.0	0.0
<i>Scarus scaber</i>	0.7	1.0	0.3	0.3	1.0	0.0
<i>Chlorurus sordidus</i>	0.0	2.7	1.3	0.0	0.0	0.0
<i>Scarus stronglycephalus</i>	0.0	0.7	0.7	0.3	0.0	0.0
Small immature parrotfish	3.0	8.7	34.7	2.7	19.7	3.7
<i>Cephalopholis argus</i>	0.3	0.0	0.0	0.3	0.0	0.0
<i>Epinephelus spilotoceps</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Epinephelus merra</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Epinephelus spp</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Pseudoanthias evansi</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Variola louti</i>	0.0	0.0	0.0	0.0	0.3	0.0
<i>Siganus sutor</i>	0.0	2.7	0.7	0.0	0.0	0.0
<i>Zanclus cornutus</i>	0.0	0.0	0.0	0.0	0.0	0.0

Table A3. The mean number of invertebrate species present at the 6 reef slope sites during (A) summer (March) and (B) winter (October).

(a) Summer

	Rivière Banane	Passe Armand	Grand Bassin	Passe Demi	Ile aux Fous	North Ile aux Sables
<i>Echinothrix diadema</i>	8.3	0.0	2.3	0.0	0.7	0.7
<i>Echinometra mathaei</i>	24.7	148.0	1.0	1.7	130.7	364.3
<i>Echinostrephus molaris</i>	0.0	1.7	0.0	12.3	3.3	0.0
<i>Heterocentrotus mammillatus</i>	0.3	0.0	0.0	0.0	0.3	0.0
<i>Holothuria atra</i>	0.0	0.7	0.0	0.0	0.0	0.0
<i>Stichopus chloronatus</i>	0.0	6.3	0.0	0.0	0.3	0.0
<i>Actinopyga sp.</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Tropiometra carinata</i>	0.0	0.3	0.0	1.7	0.0	0.0

	Rivière Banane	Passe Armand	Grand Bassin	Passe Demi	Ile aux Fous	North Ile aux Sables
<i>Stephanometra indica</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Ophicoma erinaceus</i>	0.0	0.0	0.0	0.7	0.0	0.0
<i>Trochus maculatus</i>	0.0	0.3	0.7	0.0	0.7	1.0
<i>Turbo argyrostomus</i>	2.0	0.0	1.3	0.0	0.0	0.0
<i>Cypraea caputserpentis</i>	0.0	0.3	0.0	0.0	0.0	0.0
<i>Cypraea annulus</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Cypraea tigris</i>	0.0	0.0	0.0	0.0	0.0	1.0
<i>Conus</i> sp	0.0	0.0	0.0	0.0	0.0	0.0
<i>Vasum</i> sp	0.0	0.0	0.0	0.0	0.0	0.0
Nudibranch	0.0	0.0	0.0	0.0	0.0	0.0
<i>Tridacna maxima</i>	0.0	0.7	0.0	0.7	0.0	0.0
<i>Dardanus</i> sp	0.0	0.0	0.0	1.7	1.0	0.3

(b) Winter

	Rivière Banane	Passe Armand	Grand Bassin	Passe Demi	Ile aux Fous	North Ile aux Sables
<i>Echinothrix diadema</i>	11.7	2.0	0.0	0.0	0.0	0.0
<i>Echinometra mathaei</i>	7.0	117.0	3.7	0.7	110.7	399.3
<i>Echinostrephus molaris</i>	0.0	0.0	0.3	1.3	0.7	0.0
<i>Heterocentrotus mammillatus</i>	0.0	0.3	0.0	0.0	0.0	0.0
<i>Holothuria atra</i>	0.0	1.3	0.0	0.0	0.0	0.0
<i>Holothuria edulis</i>	0.0	0.0	0.0	0.0	0.3	0.0
<i>Stichopus chloronatus</i>	0.0	6.0	0.0	0.0	0.0	0.0
<i>Actinopyga</i> sp.	0.0	0.0	0.0	0.0	0.3	0.0
<i>Linckia</i> sp	0.0	0.7	0.0	0.0	0.0	0.0
<i>Fromia</i> sp	0.0	0.0	0.0	0.0	0.3	0.0
<i>Tropiometra carinata</i>	0.7	0.3	0.3	3.3	0.0	0.0
<i>Stephanometra indica</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Ophicoma erinaceus</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Trochus maculatus</i>	0.0	1.7	1.7	0.0	2.0	0.7
<i>Turbo argyrostomus</i>	0.0	0.0	0.7	0.0	0.0	0.0
<i>Lambis chiagra</i>	0.0	0.3	0.0	0.0	0.0	0.0
<i>Pleuroploca filamentosa</i>	0.3	0.0	0.0	0.0	0.0	0.0
<i>Cypraea caputserpentis</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Cypraea annulus</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Cypraea tigris</i>	0.0	0.0	0.0	0.0	0.0	0.0
<i>Conus</i> sp	1.3	1.7	0.0	0.3	0.7	0.0
<i>Morula</i> sp	0.0	0.0	0.0	0.0	0.3	0.0
<i>Vasum</i> sp	0.0	0.0	0.0	0.0	0.0	0.0
Nudibranch	0.0	0.3	0.0	0.0	0.0	0.0
<i>Tridacna maxima</i>	0.0	1.0	0.0	0.3	0.0	0.0
<i>Dardanus</i> sp	0.0	0.0	0.0	0.0	0.0	0.0

Table A4. The mean percentage cover of the different benthic habitats at the 7 reef flat sites during (A) summer (March) and (B) winter (October).

(a) Summer

	Rivière Banane	Passe Armand	Grand Bassin	Trou Blanc	Passe L'Ancre	Passe Cabris	Ile aux Fous
Digitate <i>Acropora</i>	3.9	4.0	1.8	4.8	19.8	0.0	1.0
Branching <i>Acropora</i>	2.2	0.3	3.6	0.7	1.7	3.7	0.0
Tablular <i>Acropora</i>	0.1	1.2	1.3	0.4	2.8	0.0	0.0
Encrusting <i>Acropora</i>	0.0	0.0	1.1	0.0	0.0	0.0	0.0
Foliose Coral	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Rivière Banane	Passe Armand	Grand Bassin	Trou Blanc	Passe L'Ancre	Passe Cabris	Ile aux Fous
Sub-massive Coral	2.1	0.5	0.3	0.4	0.2	1.5	5.3
Encrusting Coral	1.6	1.2	1.5	0.3	0.2	0.3	5.9
Massive Coral	0.5	1.1	0.3	0.8	3.3	4.7	0.8
Mushroom Coral	0.0	0.0	0.0	0.0	0.0	0.0	4.9
<i>Millepora</i> sp.	0.0	0.0	1.8	0.2	0.0	0.0	0.0
Soft Coral	0.0	0.0	0.2	45.7	16.0	0.0	0.0
Dead Coral	0.0	0.0	0.0	0.0	0.0	0.0	10.5
Zoanthids	0.0	0.0	0.0	0.0	0.0	0.7	0.7
Macro-Algae	1.0	0.0	0.4	0.7	0.0	0.2	0.6
Turf Algae	71.6	55.8	41.9	38.3	8.8	39.9	42.4
Coralline Algae	16.6	35.9	44.0	5.5	14.7	45.2	22.8
Rubble	0.0	0.0	0.0	1.1	32.5	0.0	5.0
Sand	0.4	0.0	1.9	1.3	0.2	4.0	0.0

(b) Winter

	Passe Armand	Grand Bassin	Trou Blanc	Passe L'Ancre	Passe Cabris
Digitate <i>Acropora</i>	7.0	0.3	3.3	16.3	5.8
Branching <i>Acropora</i>	1.5	4.6	1.3	1.5	0.2
Tabular <i>Acropora</i>	3.0	1.9	0.0	3.8	0.0
Encrusting <i>Acropora</i>	0.0	0.8	0.0	0.0	0.0
Foliose Coral	0.0	0.0	0.0	0.0	0.0
Sub-massive Coral	0.8	0.1	4.3	0.6	2.4
Encrusting Coral	1.3	0.6	0.2	0.2	0.0
Massive Coral	3.1	0.3	1.5	2.5	4.3
Mushroom Coral	0.0	0.0	0.0	0.0	0.0
<i>Millepora</i> sp.	0.3	1.7	0.1	0.0	0.0
Soft Coral	0.0	0.0	50.0	17.3	0.0
Dead Coral	0.0	0.0	0.0	0.0	0.0
Zoanthids	0.0	0.0	0.5	0.0	0.0
Macro-Algae	0.0	0.0	0.7	0.0	0.3
Turf Algae	48.1	28.7	30.8	0.2	35.7
Coralline Algae	32.8	56.6	5.0	6.8	41.0
Rubble	1.2	4.5	1.7	47.7	5.0
Sand	1.1	0.0	0.8	3.3	5.3

Table A5. The mean number of fish species present at the 7 reef flat sites.

	Rivière Banane	Passe Armand	Grand Bassin	Trou Blanc	Passe L'Ancre	Passe Cabris	Ile aux Fous
Medium dark surgeons 20-40cm	0.0	25.7	12.3	0.0	0.0	0.0	0.0
Small dark surgeons <20cm	0.0	0.0	1.7	16.3	25.0	21.0	24.0
<i>Acanthurus triostegus</i>	0.0	0.7	1.3	0.0	0.0	5.0	0.7
<i>Naso unicornis</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Zebrasoma desjardinii</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Zebrasoma scopas</i>	0.0	0.0	0.0	1.3	0.7	0.0	0.7
<i>Pterocaesio tile</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Chaetodon auriga</i>	0.0	0.0	0.0	0.0	0.0	2.0	0.7
<i>Chaetodon guttatissimus</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Chaetodon lunula</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Chaetodon madagaskariensis</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Chaetodon melannotus</i>	0.0	0.0	0.0	5.0	1.7	1.3	0.7
<i>Chaetodon trifascialis</i>	0.0	0.0	0.0	0.0	1.0	1.0	0.0
<i>Chaetodon trifasciatus</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Rivière Banane	Passe Armand	Grand Bassin	Trou Blanc	Passe L'Ancre	Passe Cabris	Ile aux Fous
<i>Chaetodon unimaculatus</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Chaetodon interuptus</i>	0.0	0.0	0.0	0.0	0.3	0.0	0.0
<i>Chaetodon vagabundus</i>	0.0	0.0	0.0	0.0	0.0	0.3	0.0
<i>Chaetodon xanthocephalus</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.7
<i>Chaetodon zanzibarensis</i>	0.0	0.0	0.0	0.0	0.7	0.0	0.0
<i>Forciper flavissimus</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Cheilinus trilobatus</i>	0.0	0.7	0.0	0.0	0.0	0.0	0.0
<i>Cheilinus chlororus</i>	0.0	0.0	0.7	0.0	0.0	0.0	0.0
<i>Coris aygula</i>	0.0	0.0	0.0	0.0	0.3	0.0	0.0
<i>Hemigymnus fasciatus</i>	0.3	0.7	0.0	0.0	1.7	0.7	0.7
<i>Anampses caeruleopunctatus</i>	1.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Anampses meleagrides</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Gomphosus caeruleus</i>	0.0	0.0	0.3	0.3	0.7	0.7	2.3
<i>Halichoeres hortulanus</i>	0.0	1.0	0.0	0.0	0.0	0.0	0.0
<i>Halichoeres marginatus</i>	4.3	1.0	1.7	0.0	0.7	3.3	0.0
<i>Halichoeres nebulosus</i>	0.0	0.0	0.0	0.0	10.7	0.0	0.0
<i>Labroides bicolor</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Labroides dimidiatus</i>	0.0	0.0	0.0	0.0	0.0	0.7	0.0
<i>Stethojulis albovittata</i>	0.0	0.0	0.0	3.0	3.0	4.7	0.0
<i>Thalassoma genivittatum</i>	17.3	9.0	6.0	4.3	8.7	8.3	1.0
<i>Thalassoma hardwicke</i>	0.0	0.0	0.0	2.7	6.7	5.0	5.0
<i>Gnathodentex aurolineatus</i>	0.0	0.0	0.0	0.0	0.0	0.0	1.3
<i>Oxymonacanthus longirostris</i>	0.0	0.0	0.0	0.0	0.0	2.0	0.0
<i>Mulloidichthys flavolineatus</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Mulloidichthys vanicolensis</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Parupeneus barberinus</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Parupeneus trifasciatus</i>	0.0	0.0	0.7	0.0	0.0	0.0	0.0
<i>Parupeneus cyclostomus</i>	0.0	0.0	0.0	0.3	0.0	0.0	0.0
<i>Abudefduf sexfasciatus</i>	0.0	0.0	11.0	0.0	0.0	0.7	19.0
<i>Abudefduf vaigiensis</i>	0.0	0.0	0.0	0.0	0.0	0.0	1.3
<i>Chromis chrysur</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Chromis dimidiata</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Chromis nigrura</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Chromis viridis</i>	0.0	0.0	0.0	0.0	11.3	0.0	1.0
<i>Chrysiptera glauca</i>	0.0	0.0	0.3	7.0	7.7	2.0	0.0
<i>Dascylus aruanus</i>	0.0	0.0	0.0	46.7	0.0	0.0	23.3
<i>Plectroglyphidodon dickii</i>	0.7	0.0	0.3	0.0	3.7	2.0	0.0
<i>Plectroglyphidodon johnstoniatus</i>	0.0	0.0	0.0	0.0	0.0	1.0	0.0
<i>Pomacentrus caeruleus</i>	0.0	0.0	0.7	0.0	0.0	0.0	0.0
<i>Pomacentrus indicus</i>	7.0	1.0	0.0	0.0	0.0	5.3	0.0
<i>Pomacentrus pikei</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Pomacentrus rodriguesii</i>	0.0	0.3	0.0	0.0	0.0	0.0	0.0
<i>Stegastes limbatus</i>	3.0	13.7	0.0	22.0	11.0	17.0	0.7
<i>Stegastes nigricans</i>	27.3	13.3	7.3	0.0	0.0	0.0	46.7
<i>Stegastes peliceri</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Hipposcarus harid</i>	0.3	0.7	0.3	0.0	0.0	0.0	0.0
<i>Scarus scaber</i>	0.0	0.0	0.0	0.0	0.0	0.0	3.3
<i>Chlorurus sordidus</i>	0.0	11.3	4.7	0.0	17.3	8.3	5.3
Small immature parrotfish	0.0	8.3	0.0	31.7	141.7	8.3	8.0
<i>Cephalopholis argus</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Epinephelus spilotoceps</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.7
<i>Epinephelus merra</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Rivière Banane	Passe Armand	Grand Bassin	Trou Blanc	Passe L'Ancre	Passe Cabris	Ile aux Fous
<i>Epinephelus spp</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Pseudoanthias evansi</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Siganus sutor</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Zanclus cornutus</i>	0.0	0.0	0.0	0.0	1.3	0.3	0.0

(b) Winter

	Passe Armand	Grand Bassin	Trou Blanc	Passe L'Ancre	Passe Cabris
Medium dark surgeons 20-40cm	0.0	0.0	0.0	0.0	0.0
Small dark surgeons <20cm	4.3	9.3	0.0	0.0	10.3
<i>Acanthurus triostegus</i>	34.7	62.0	18.3	29.0	28.3
<i>Naso lituratus</i>	133.3	5.7	0.0	0.0	9.7
<i>Naso unicornis</i>	0.7	0.0	0.0	0.0	0.0
<i>Zebrasoma desjardini</i>	0.0	0.0	0.0	0.0	0.0
<i>Zebrasoma scopas</i>	0.0	0.0	0.0	0.0	0.0
<i>Pterocaesio tile</i>	2.7	0.0	4.0	0.3	0.0
<i>Chaetodon auriga</i>	0.0	0.0	0.0	0.0	0.0
<i>Chaetodon guttatissimus</i>	0.3	0.0	0.0	0.3	0.7
<i>Chaetodon kleinii</i>	0.0	0.0	0.0	0.0	0.0
<i>Chaetodon lunula</i>	0.0	0.0	0.0	0.7	0.0
<i>Chaetodon madagaskariensis</i>	0.0	0.0	0.0	0.0	0.0
<i>Chaetodon melannotus</i>	0.0	0.0	0.0	0.0	0.0
<i>Chaetodon trifascialis</i>	0.7	0.0	3.3	0.0	1.0
<i>Chaetodon trifasciatus</i>	2.0	0.0	0.3	0.3	1.0
<i>Chaetodon unimaculatus</i>	0.0	0.0	0.0	0.0	0.0
<i>Chaetodon vagabundus</i>	0.0	0.0	0.0	0.0	0.0
<i>Chaetodon xanthocephalus</i>	0.3	0.0	0.3	0.3	0.7
<i>Chaetodon zanzibarensis</i>	0.7	0.0	0.0	0.0	0.0
<i>Forciper flavissimus</i>	0.0	0.0	0.0	0.3	0.0
<i>Heniochus monoceros</i>	1.3	0.0	0.0	0.7	0.0
<i>Paracirrhites arcatus</i>	0.0	0.0	0.0	0.0	0.0
<i>Bodianus macrourus</i>	0.0	0.0	0.0	0.0	0.0
<i>Cheilinus trilobatus</i>	0.0	0.0	0.0	0.0	0.0
<i>Cheilinus chlorurus</i>	0.0	0.0	0.0	0.0	0.3
<i>Coris aygula</i>	0.7	0.7	2.3	0.7	0.3
<i>Hemigymnus fasciatus</i>	0.0	0.0	0.0	0.3	1.3
<i>Anampses caeruleopunctatus</i>	1.7	0.0	0.0	0.3	0.0
<i>Anampses meleagrides</i>	0.0	2.7	0.0	0.0	0.3
<i>Anampses twistii</i>	0.0	0.0	0.0	0.0	0.0
<i>Gomphosus caeruleus</i>	0.0	0.0	0.0	0.0	0.0
<i>Halichoeres marginatus</i>	1.7	0.0	0.0	2.0	1.7
<i>Halichoeres nebulosus</i>	4.3	6.0	0.0	0.7	1.3
<i>Halichoeres scapularis</i>	0.0	1.7	0.0	0.0	1.3
<i>Labroides bicolor</i>	0.0	0.0	0.0	0.3	0.0
<i>Labroides dimidiatus</i>	0.0	0.0	0.0	0.0	0.0
<i>Stethojulis albobittata</i>	0.0	0.0	0.0	0.0	1.3
<i>Thalassoma genivittatum</i>	5.3	10.0	2.0	0.3	3.3
<i>Thalassoma hardwicke</i>	10.7	12.7	4.0	4.7	10.3
<i>Thalassoma purpureum</i>	0.0	0.7	3.7	3.3	2.0
<i>Gnathodentex aurolineatus</i>	0.0	0.0	0.0	0.0	0.3
<i>Oxymonacanthus longirostris</i>	0.0	0.0	0.0	0.0	0.0
<i>Mulloidichthys flavolineatus</i>	0.0	0.0	0.0	0.0	1.7
<i>Mulloidichthys vanicolensis</i>	0.0	0.0	0.0	0.0	0.0

	Passe Armand	Grand Bassin	Trou Blanc	Passe L'Ancre	Passe Cabris
<i>Parupeneus barberinus</i>	0.0	0.0	0.0	0.0	0.0
<i>Parupeneus bifasciatus</i>	0.0	0.0	0.0	0.0	1.3
<i>Parupeneus cyclostomus</i>	0.0	0.0	0.0	0.0	0.0
<i>Parupeneus macronemus</i>	0.0	0.0	0.0	0.0	0.0
<i>Abudefduf margariteus</i>	0.0	0.0	0.0	0.0	0.0
<i>Abudefduf sexfasciatus</i>	0.0	0.0	0.0	0.0	0.0
<i>Abudefduf sparoides</i>	7.0	0.0	2.3	0.0	0.0
<i>Abudefduf vaigiensis</i>	6.3	0.0	0.0	0.7	0.0
<i>Chromis chrysur</i>	0.0	0.0	0.0	0.0	0.0
<i>Chromis dimidiata</i>	0.0	0.0	0.0	0.0	0.0
<i>Chromis nigrura</i>	0.0	0.0	0.0	0.0	0.0
<i>Chrysiptera glauca</i>	0.0	0.0	0.0	0.0	0.0
<i>Dascylus aruanus</i>	0.0	0.0	5.7	5.0	2.3
<i>Plectroglyphidodon dickii</i>	0.0	0.0	40.7	27.3	0.0
<i>Plectroglyphidodon johnstoniatus</i>	0.0	0.0	0.0	0.3	0.0
<i>Pomacentrus caeruleus</i>	0.0	0.0	0.0	0.0	0.0
<i>Pomacentrus indicus</i>	0.0	0.0	0.0	0.0	0.0
<i>Pomacentrus pikei</i>	16.0	6.7	0.0	0.0	4.7
<i>Pomacentrus rodriguesii</i>	0.0	0.0	0.0	0.0	0.0
<i>Stegastes limbatus</i>	0.0	0.0	0.0	0.0	0.0
<i>Stegastes nigricans</i>	22.7	0.0	54.7	18.0	26.0
<i>Stegastes peliceri</i>	0.0	0.0	56.0	3.0	0.0
<i>Scarus scaber</i>	0.0	0.0	0.0	0.0	0.0
<i>Chlorurus sordidus</i>	0.7	0.0	0.7	1.3	0.7
<i>Scarus stronglycephalus</i>	2.3	0.0	0.0	24.0	0.7
Small immature parrotfish	0.3	0.0	0.0	0.0	0.0
<i>Cephalopholis argus</i>	12.3	46.0	19.0	52.3	33.7
<i>Epinephelus spilotoceps</i>	0.0	0.0	0.0	0.0	0.0
<i>Epinephelus merra</i>	0.0	0.0	0.0	0.0	0.0
<i>Epinephelus spp</i>	0.0	0.0	0.0	0.0	0.0
<i>Pseudoanthias evansi</i>	0.0	0.0	0.0	0.0	0.0
<i>Variola louti</i>	0.0	0.0	0.0	0.0	0.0
<i>Siganus sutor</i>	0.0	0.0	0.0	0.0	0.0
<i>Zanclus cornutus</i>	0.0	0.0	0.0	0.0	0.0

Table A6. The mean number of invertebrate species present at the 7 reef flat sites in (A) summer (March) and (B) winter (October).

(a) Summer

	Rivière Banane	Passe Armand	Grand Bassin	Trou Blanc	Passe L'Ancre	Passe Cabris	Ile aux Fous
<i>Echinothrix diadema</i>	6.7	4.3	10.0	0.0	0.0	0.3	0.0
<i>Echinometra mathaei</i>	161.7	521.0	282.0	324.7	0.0	167.3	28.0
<i>Echinostrephus molaris</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Heterocentrotus mammillatus</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Holothuria atra</i>	4.7	1.7	2.3	0.0	7.7	0.0	0.0
<i>Stichopus chloronatus</i>	3.0	4.3	0.3	0.0	0.0	0.3	0.0
<i>Actinopyga sp.</i>	0.0	0.0	0.3	0.0	0.0	1.7	0.0
<i>Tropiometra carinata</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Stephanometra indica</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Ophicoma erinaceus</i>	0.0	0.0	0.0	0.7	0.0	1.0	0.0

	Rivière Banane	Passe Armand	Grand Bassin	Trou Blanc	Passe L'Ancre	Passe Cabris	Ile aux Fous
<i>Trochus maculatus</i>	0.0	1.3	2.0	0.0	0.0	54.3	0.7
<i>Turbo argyrostomus</i>	0.0	1.7	2.3	0.0	0.0	0.7	0.0
<i>Cypraea caputserpentis</i>	0.0	0.0	2.7	0.0	0.3	0.7	0.3
<i>Cypraea annulus</i>	0.0	0.0	0.0	0.0	0.0	0.3	0.0
<i>Conus</i> sp	0.0	0.3	0.0	0.0	0.0	0.0	0.0
<i>Vasum</i> sp	0.0	1.0	0.0	0.0	0.0	0.0	0.0
<i>Nudibranch</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Tridacna maxima</i>	0.0	0.3	0.3	0.7	0.0	0.0	0.0
<i>Dardanus</i> sp	0.0	0.3	0.3	0.7	0.0	0.0	0.3

(b) Winter

	Passe Armand	Grand Bassin	Trou Blanc	Passe L'Ancre	Passe Cabris
<i>Echinothrix diadema</i>	6.0	5.7	0.0	0.0	0.0
<i>Echinometra mathaei</i>	551.3	124.0	517.7	0.0	134.3
<i>Echinostrephus molaris</i>	0.0	0.0	0.0	0.0	0.0
<i>Heterocentrotus</i> <i>mammillatus</i>	0.0	0.0	0.0	0.0	0.0
<i>Holothuria atra</i>	1.3	1.0	0.0	2.0	0.0
<i>Holothuria leucospilata</i>	1.0	0.0	0.0	0.0	0.0
<i>Stichopus chloronatus</i>	6.0	0.3	0.0	0.0	1.3
<i>Actinopyga</i> sp.	0.0	0.0	0.0	0.0	0.0
<i>Synapta maculata</i>	0.0	0.0	0.0	0.0	0.3
<i>Bohadschia</i> sp	0.0	0.0	0.0	0.0	0.3
<i>Tropiometra carinata</i>	0.0	0.0	0.0	0.0	0.0
<i>Stephanometra indica</i>	0.0	0.0	0.0	0.0	0.0
<i>Ophicoma erinaceus</i>	0.0	0.0	4.3	0.0	0.0
<i>Trochus maculatus</i>	1.3	0.3	0.0	0.0	11.7
<i>Turbo argyrostomus</i>	0.0	1.3	0.0	0.0	11.3
<i>Cypraea caputserpentis</i>	1.0	4.3	0.0	0.0	1.7
<i>Cypraea annulus</i>	0.0	0.0	0.0	0.0	1.0
<i>Conus</i> sp	1.3	1.3	0.3	0.3	1.7
<i>Vasum</i> sp	0.3	0.0	0.0	0.0	0.0
<i>Morula</i> sp	1.7	0.0	0.0	0.0	0.0
<i>Nudibranch</i>	0.0	0.0	0.3	0.0	0.0
<i>Tridacna maxima</i>	0.3	0.0	0.7	0.0	0.0
<i>Dardanus</i> sp	0.0	0.0	0.0	0.0	0.0