Lagon Bleu Eco Sud marine survey 2012

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FdSc BSc (Hons)

Table of Contents

Section 1.1 - Project outline and objectives

Eco Sud is a non-government organisation (NGO) and was officially registered with the Registry of Associations on the 11th February 2000. The NGO organisation is located within Blue-Bay and currently has 65 members. Eco Sud has been affiliated to MACOSS (Mauritius Council of Social Service) since 2001. In 2008, Eco Sud joined other organisations in dealing directly and indirectly with the sea environment under the aegis of the MSDA (Mauritius Scuba Diving Association).

The global objective of the Lagon Bleu project is to promote the sustainable management of the marine and coastal zones of Blue Bay and Pointe d'Esny by carrying out sensitisation campaigns for the conservation of marine and costal biodiversity and traditional fishing practices by carrying out the following activities:

- To conduct a range of surveys with the aim to gain a better understanding of the state of the site's marine environment, and to identify threatened species.
- To work out an appropriate protection and monitoring strategy, supported by strict and certified scientific data.
- To set up a marine observatory for the monitoring of the environment and sensitisation of its stakeholders.
- To sensitise, inform and train fishermen, tourism operators and the population at large on the importance of the protection of the marine and coastal ecosystem.
- To sensitise and train teachers and students from primary schools of Mahébourg and its' neighboring region.
- To encourage and help fishermen to preserve traditional fishing methods and local know-how so as to guarantee sustainable fishing.

Consequently a series of sensitisation tools and sensitization/training workshops will have to be developed in order to emphasise:

- The importance of the challenges and of the objectives of marine and coastal environment conservation.
- The ecological and socioeconomic threats, on medium as well as long term, represented by practices which are disrespectful of the rules for the sustainable management of a specific and fragile marine ecosystem.

The Eco Sud science report 2012 was conducted and compiled by William Tyler (staff member) and the oversea work volunteers in line with the above objectives.

Section 2.1 – Study area

The Eco-Sud survey report was specifically focused on the coral reef habitats within Lagon Bleu, Mauritius. All data was collected during the diurnal period of 0800 and 1500 hours between January and February 2012. This time window enabled the periods of poor visibility caused by low sun angle to be excluded. The six reef sites (Appendix A – F) within Lagon Bleu were selected for their level of fish abundance and percentage of fish taxa (Fig 1). The fish taxa and relative abundance for each site was determined from previous research undertaken by Kauppaymuthoo, (2010). However, site two was only selected for the preliminary assessment of fish taxa and did not encompass the employed methodology within this report. Site two was selected to determine whether the seabed habitats might play a functional role in providing a refuge for juvenile reef fish during their life stages (Fig 1).

Figure 1. Location of the six reef sites within Lagon Bleu.

The lagoon water temperature averaged 28.7^{o}c ($\pm$1.0) during the study and visibility was high at all sites, averaging 14.8m ($\pm$ 3.3). The fringing reef surrounding Lagon Bleu sheltered the inner reef sites from the tidal amplitude. However, the outer reefs of site one and five displayed a strong current during the onset of high tide, limiting the surveying ability of observers during this period.

Section 3.1 - Benthic composition survey

3.2 Sampling design

The Line Intercept Technique (LIT) has been identified as the most ideal way in which to perform a benthic survey to identify the types of substrate and the coral genera/formations present across each site (Sale, 1990). The topographic layout of the coral sites meant that a division of the different depth zones (flat, slope and crest) was not needed. The LIT transect consisted of a 70 metre transect with 5 metre intervals. Each LIT transect was randomly placed at each site within the GPS parameters, provided by the previous Kauppaymuthoo, (2010) report. Any substrate or coral intercepting the transect belt was estimated directly under the transect line for every 5 metres by using the Line Intercept Technique. All substrate type changes intercepting the transect belt were recorded and coral formations as well as genus level were also recorded. The observer used codes (Table 1) for estimating substrate coverage during the benthic survey. However, due to the type of transect used a direct measurement (to a 1cm pression) of substrate cover was not possible. Although, a percentage estimation was given, which enabled the application of preliminary reconnaissance surveys of the relative substatrate and coral cover for each site to be performed.

Table 1. The substrate codes used for estimating the percentage of coral coverage during the benthic survey.

S	Sand
A	Acropora
ACB	Acropora - Branching
ACT	Acropora - Tabular
CB	Coral - Branching
CM	Coral Massive
CME	Coral- Millepora
CE	Coral Encrusting
CMR	Coral Mushroom
CR	Coral rubble
DC	Dead coral
SH	Staghorn coral
SC	Soft coral

3.3 LIT – Benthic survey results

The mean percentage of benthic coverage was estimated across each of the four sites. All benthic surveys were undertaken by staff member Will Tyler in order to keep researcher bias to a minimum when estimating substrate percentage.

A preliminary assessment of the benthic composition has shown to vary significantly across the four sites (fig 2) with site one (76% $\pm$ 6.8%) and site four (86% $\pm$ 6.7%) exhibiting a higher percentage of sand, whilst site three (28% $\pm$ 6.9%) and site five (44% $\pm$ 9.8%) exhibited a high percentage of branching acropora. However, across site one (19% $\pm$ 6.7%), site three (27% $\pm$ 9.0%) and site five (28% $\pm$ 8.9%) the percentage of dead coral was shown to be similar.

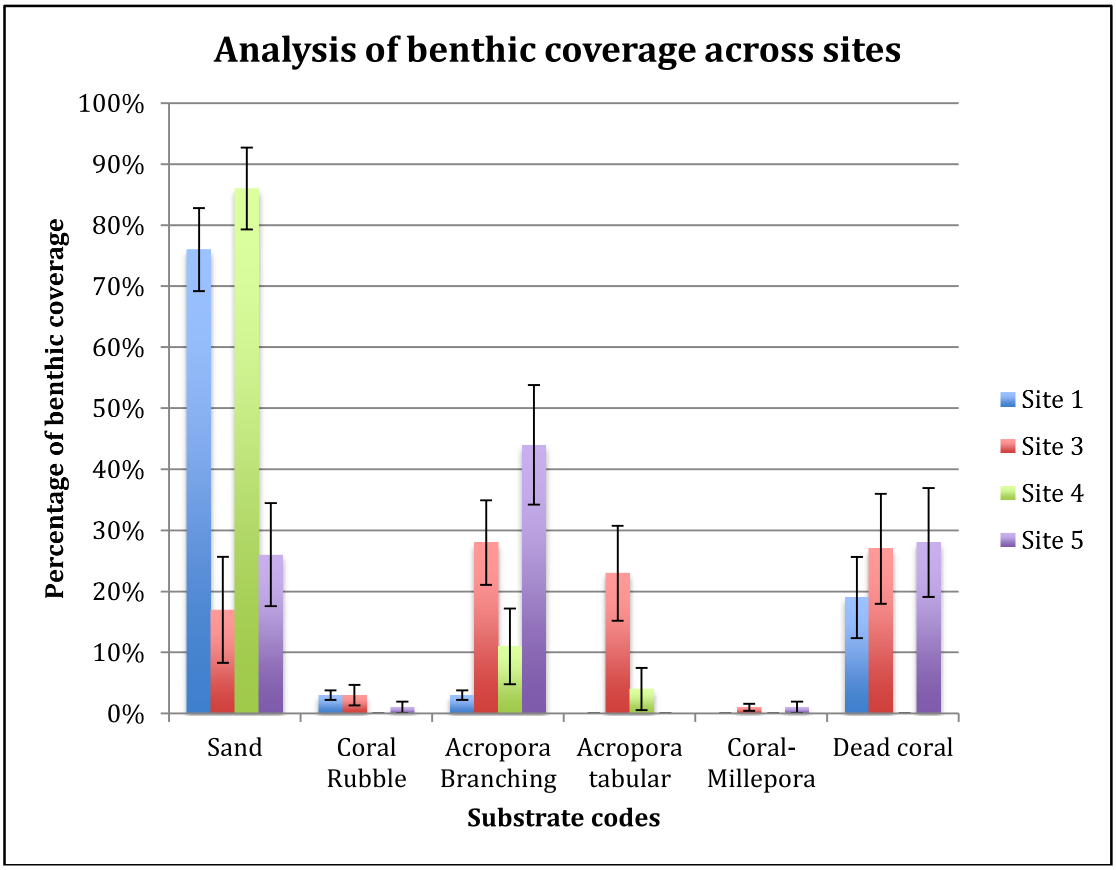


Figure 2. Mean percentage of benthic coverage across each of the four sites.

It should be noted that a change in the LIT transect methodology, which encompasses a transect tape would enable a more direct assessment of the benthic composition across each site to a 1cm precision. This would also enable the percentage cover of the coral composition across the sites to be determined more accurately and establish if certain biotic and abiotic factors may influence their distribution.

Section 4.1 - fish assemblage survey

4.2 Sampling design

The fish assemblages were studied by two independent observers by means of an underwater visual census survey. The first observer carried the slate and the second observer aided in the estimation of species abundance. Observers used snorkelling techniques for implementing the visual census. For each site, a 70 metre belt transect with a width of 2.5 metre either side of the central transect line and up to 5 metres above the transect line was implemented (fig 2) randomly within the GPS parameters, provided by the previous Kauppaymuthoo, (2010) report. The observers maintained a 5 metre distance from the target species when possible in order to minimise errors from fish-observer interactions (fig 2). Furthermore, a ten minute period was given to allow the fish to become accustomed to the transect line and snorkelers. When entering the water the observers descended away from the transect in order to minimise the snorkelers presence. The two observers employed a point count method within the designated parameters and conferred after each 5 metre of the 70 metre transect to give a mean total of abundance (number of individuals) for each species. The Species abundance was then categorised into the following: 1-5, 5-10, 10-20, 20-50, 50-100 and 100+. A number reference system (Table 1) was then employed which enabled numerical assessment of the fish abundance levels. This catergorisation system was applied to limit the number of errors that may be present during the estimation of fish abundance when presented with student observers.

Table 1. Application of the numerical reference system in relation to the fish abundance categories.

Fish abundance categories	Applied numerical reference
1-5	= 3
5-10	= 7
10-20	= 15
20-50	= 35
50-100	= 75
100+	= 125

The two observers recorded fish abundance to species level and were given a target of four species for each transect, two species on the swim out and another two species on the return swim. This type of survey method was implemented in order to limit the possibility of errors occurring during the identification of fish species. Any fish related to that species entering the transect, after that area of transect was sampled were not included as they were not present during the initial count. Fish species were selected from each site using Kauppaymuthoo, (2010) report and were further identified using numerous literature sources; Shelbourne and Ray, (2001), Allen, *et al*, (2010), Sale, (1991) and the search engine http://www.fishbase.org. During each transect, any additional fish species were identified and then noted. These species were then incorporated into the point count survey in order to build on a database of identified species from around each site.

A total of two transects per site were performed for each of the identified fish species in order to determine their overall abundance across the site. This type of method was adopted due to the limited time constraints present within the study.

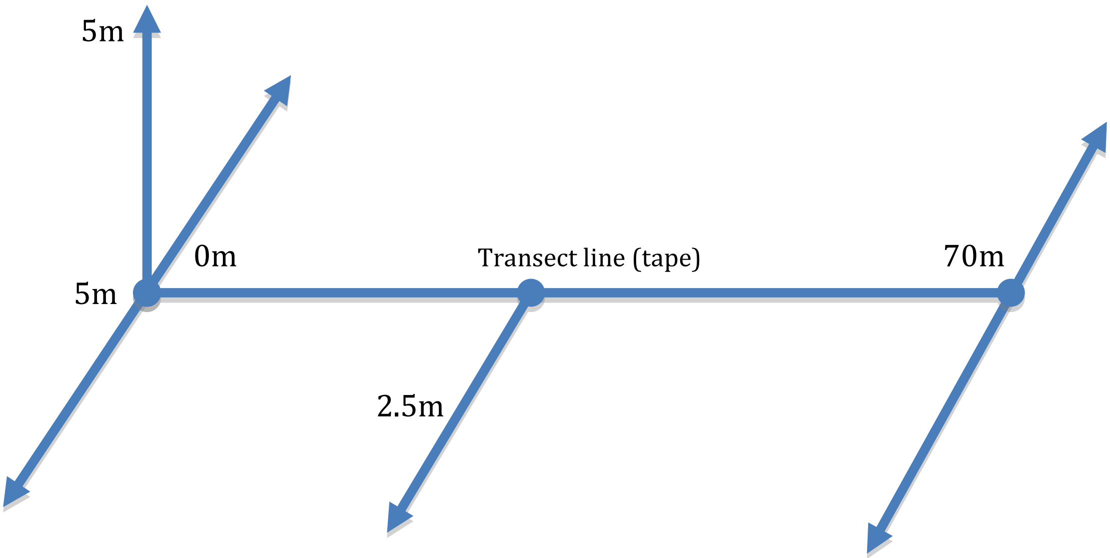


Figure 2. Dimensions of fish belt transect: 5m x 5m x 70m.

Figure 3. Oversea students performing the transect methodology.

4.3 Fish survey results

The main aim of these results were to compare the relative abundance of fish species across the four sites. The employed methodology allowed individuals to be determined to species level and enabled their relative abundance to be ascertained. However, data was unable to be attained for site six due to time limiting factors. Additionally, some of the species total abundance was shown not to be present during the data collection. However, this does not mean that the species may not present within the area. The results discussed below highlight a brief overview of the relative distribution of fish species across each of the sites with a full assessment being implemented at the end of 4 years through the continuation of replicated surveys.

4.3.1 Site one – Transect 1

A total of 32 species were identified within site one (fig 4 & table 2). The *Pomacentridae* species *C. viridis (*139*)* and *D. aruanus (*238*)* were shown to have the highest quantity of individuals across site one. Additionally*,* high quantities of *C. sordidus,* which were in both juvenile and initial phases of their lifecycle and juvenile *P.dickii* were identified across site one.

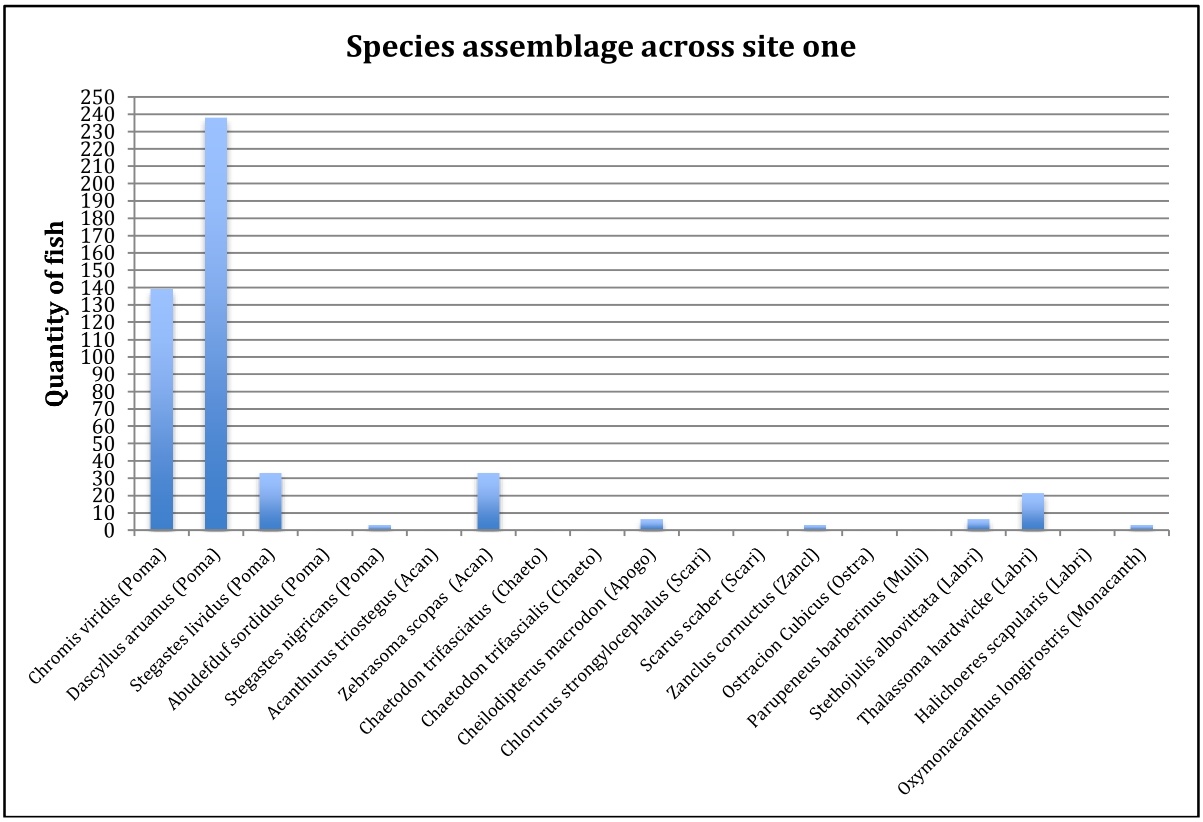


Figure 4. Fish assemblage across site one determined to species level and further categorised into the families; *Pomacentridae* (Poma), *Acanthuridae* (Acan), *Chaetodontidae* (Chaeto), *Scaridae* (Scari), *Apogogonidae* (Apogo), *Zanclidae* (Zancl), *Ostraclidae* (Ostra), *Mullidae* (Mulli), *Labridae* (Labri) and *Moncanthidae* (Monacanth).

Table 2. Additional fish species identified during data collection within site one.

Common name	Scientific name	Family name
Honey comb grouper	*Epinephelus merra*	*Serranidae*
Lined bristletooth	*Ctenochaetus striatus*	*Acanthuridae*
Trumpetfish	*Aulosomas maculatus*	*Aulostomidae*
Bluespotted Cornetfish	*Fistularia commersonii*	*Fistulariidae*
White spotted pufferfish	*Arothron hispidus*	*Tetraodontidae*
Doubletooth soldierfish **Bloodspot squirrelfish**	*Myripristis hexagona* *Neoniphon sammara*	*Holocentridae* *Holocentridae*
Wedgetail triggerfish	*Rhinecanthus rectangulus*	*Balistidae*
Bullethead parrot fish	*Chlorurus sordidus*	*Scaridae*
Grey moray eel	*Gymnothorax nubilus*	*Muraenidae*
Blackbar devil	*Plectroglyphidodon dickii*	*Pomacentridae*
Floral wrasse	*Cheilinus chlorourus*	*Labridae*

4.3.2 Site three – Transect 3

Across site three a total of 38 species were identified (Fig 5 & table 3). The *Pomacentridae* species *D. aruanus* (502) and *S. nigricans* (438) were shown to be the most abundant throughout site three. Additionally, high quantities of juvenile and initial phase *C. soridius* were identified across the site.

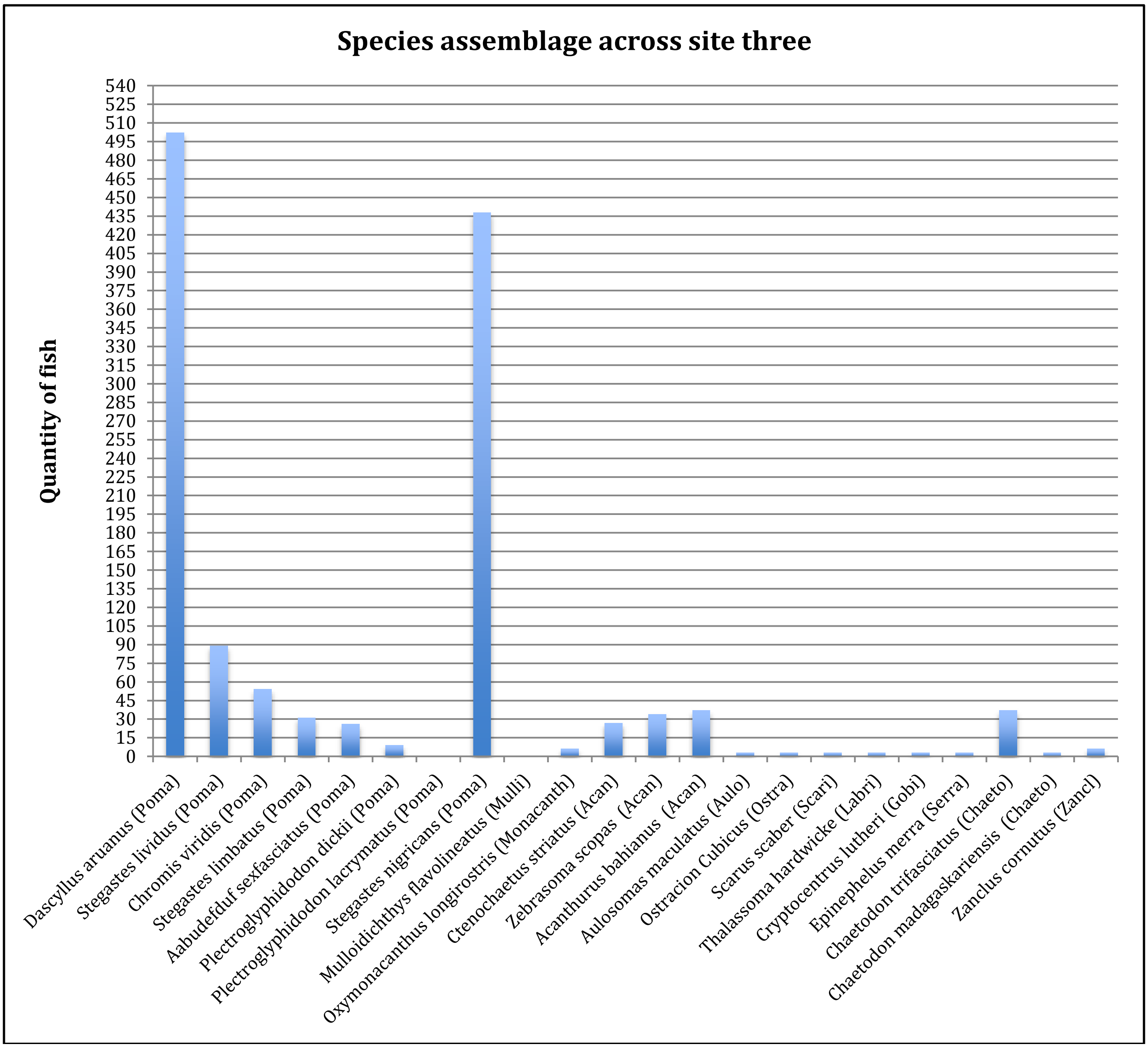


Figure 5. Fish assemblage across site three determined to species level and further categorised into families; *Pomacentridae* (Poma), *Mullidae* (Mulli), *Moncanthidae* (Monacanth), *Acanthuridae* (Acan), *Aulostomidae* (Aulo), *Ostraclidae* (Ostra) and *Scaridae* (Scar), *Labridae* (Labri), *Gobiidae* (Gobi), *Serranidae* (Serra), *Chaetodontidae* (Chaeto), *Zanclidae* (Zancl).

Table 3. Additional fish species identified during data collection within site three.

Common name	Scientific name	Family name
Barred thicklip **Green bird mouth wrasse** **Floral wrasse**	*Hemigymnus fasciatus* *Gomphosus caeruleus* *Cheilinus chlorourus*	*Labridae* *Labridae* *Labridae*
Chevroned butterflyfish **Mirror butterflyfish** **Vagabond butterflyfish** **Zanzibar butterflyfish** **Black-backed butterflyfish**	*Chaetodon trifascialis* *Chaetodon speculum* *Chaetodon vagabundas* *Chaetodon zanzibariensis* *Chaetodon melannotus*	*Chaetodontidae* *Chaetodontidae* *Chaetodontidae* *Chaetodontidae* *Chaetodontidae*
False eye sergeant	*Abudefduf sparoides*	*Pomacentridae*
Bluespotted Cornetfish	*Fistularia commersonii*	*Fistulariidae*
Sailfin tang	*Zebrasoma veliferum*	*Acanthuridae*
Forktail rabbitfish	*Siganus argenteus*	*Siganidae*
Tiger cardinalfish	*Cheilodipterus macrodon*	*Apogonidae*
Doubletooth soldierfish	*Myripristis hexagona*	*Holocentridae*
Bullethead parrotfish	*Chlorurus sordidus*	*Scaridae*

4.3.3 Site four – Transect 4

A total of 31 species were identified within site four (fig 6 & table 4). Across site four *Pomacentridae* species *D. aruanus* (160) and *C. viridis* (90) were shown to be the most abundant individuals. Furthermore, high quantities of juvenile / initial phase *C. soridius* and juvenile *D. trimaculatus* were identified across the site.

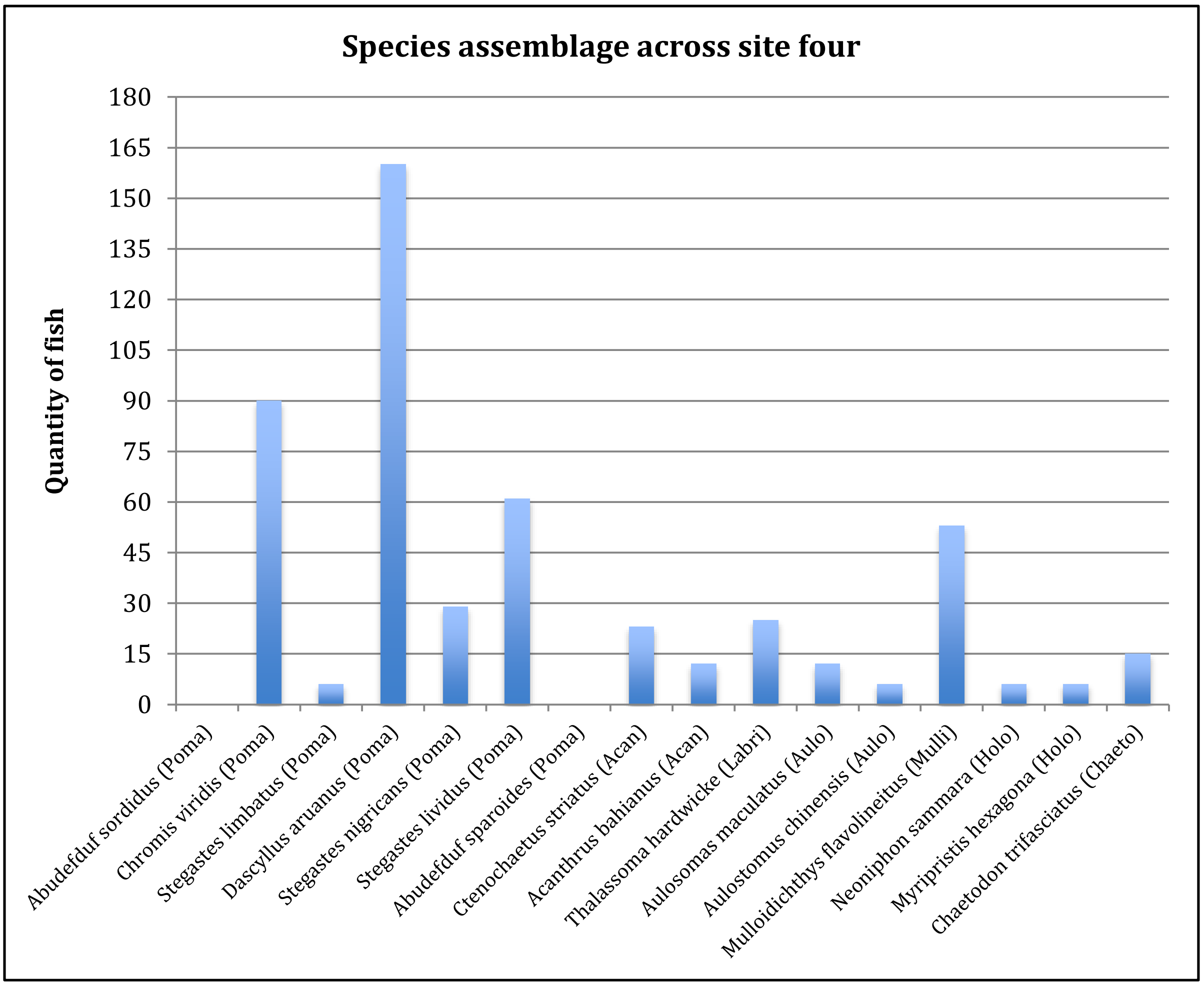


Figure 6. Fish assemblage across site four determined to species level and further categorised into families; *Pomacentridae* (Poma), *Acanthuridae* (Acan), *Labridae* (Labri), *Aulostomidae* (Aulo), *Mullidae* (Mulli), *Holocentridae* (Holo) and *Chaetodontidae* (Chaeto).

Table 4. Additional fish species identified during data collection within site four.

Common name	Scientific name	Family name
Ocean surgeonfish **Desjardin's sailfin tang** **Sailfin tang**	*Acanthurus bahianus* *Zebrasoma desjardini* *Zebrasoma beliferun*	*Acanthuridae* *Acanthuridae* *Acanthuridae*
Scissor-tail sergeant **Three-spot dascyllus** **Blackbar devil**	*Abudefduf sexfasciatus* *Dascyllus trimaculatus* *Plectroglyphidodon dickii*	*Pomacentridae* *Pomacentridae* *Pomacentridae*
Barred thicklip **Crescent wrasse**	*Hemigymnus fasciatus* *Thalassoma lunare*	*Labridae* *Labridae*
Racoon butterflyfish **Black-backed butterflyfish**	*Chaetondon lunula* *Chaetodon melannotus*	*Chaetodontidae* *Chaetodontidae*
Doubletooth soldierfish	*Myripristis hexagona*	*Holocentridae*
Long-billed Halfbeak	*Rhynchorhamphus georgii*	*Hemiramphidae*
Wedgetail triggerfish	*Rhinecanthus rectangulus*	*Balistidae*
Bullethead parrot fish	*Chlorurus sordidus*	*Scaridae*
Longnose filefish	*Oxymonacanthus longirostris*	*Monacanthidae*

4.3.4 Site five – Transect 5

A total of 26 species were identified within site five (Fig 7 & Table 5). The *Pomacentridae* species *D. aruanus* (252), *S. nigricans* (325) and *C. viridis* (313) were identified as the most abundant across the site. Furthermore, high quantities of juvenile / initial phase *C. soridius* and juvenile species *D. trimaculatus* / *O. cubicus* were identified across the site.

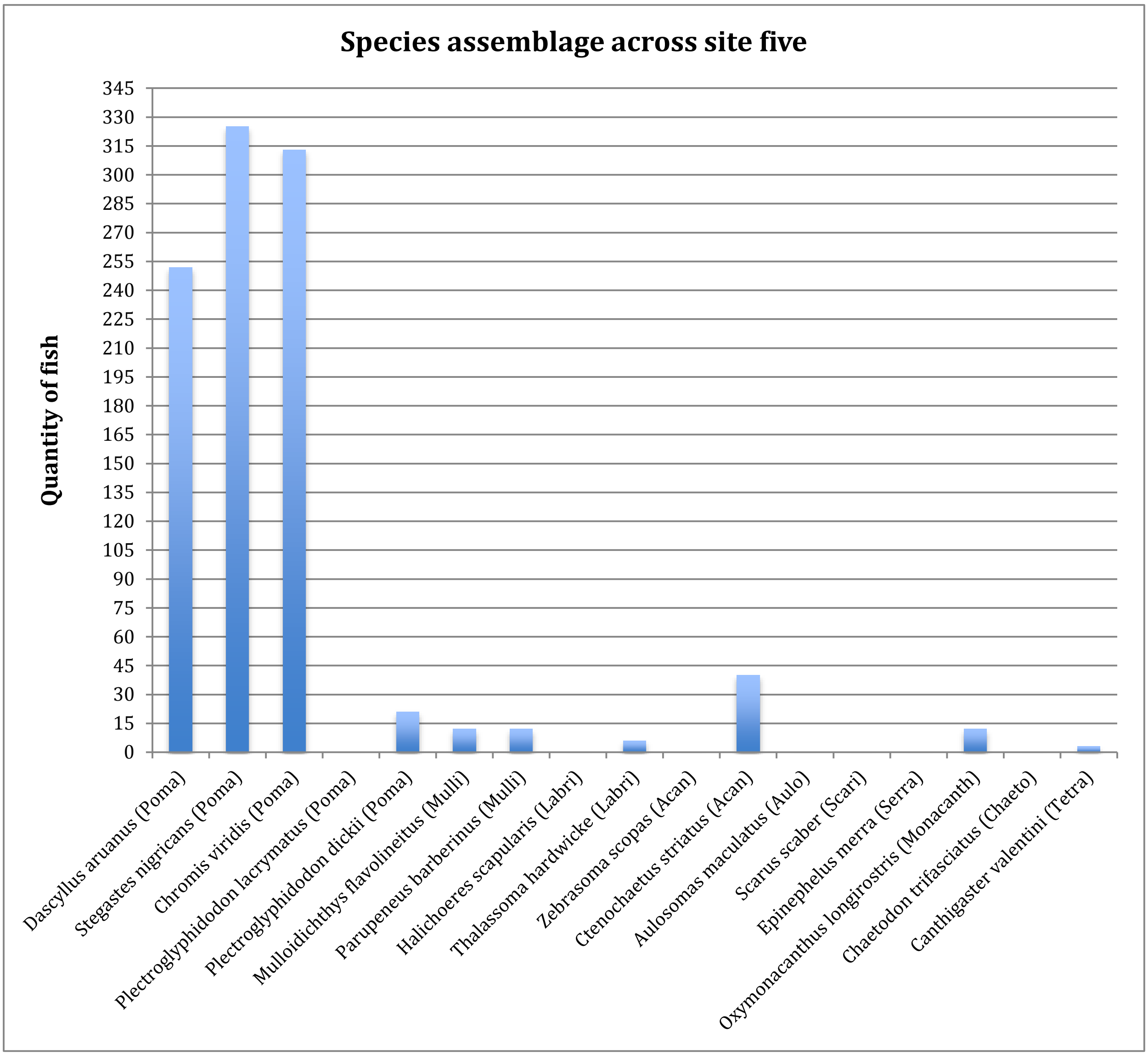


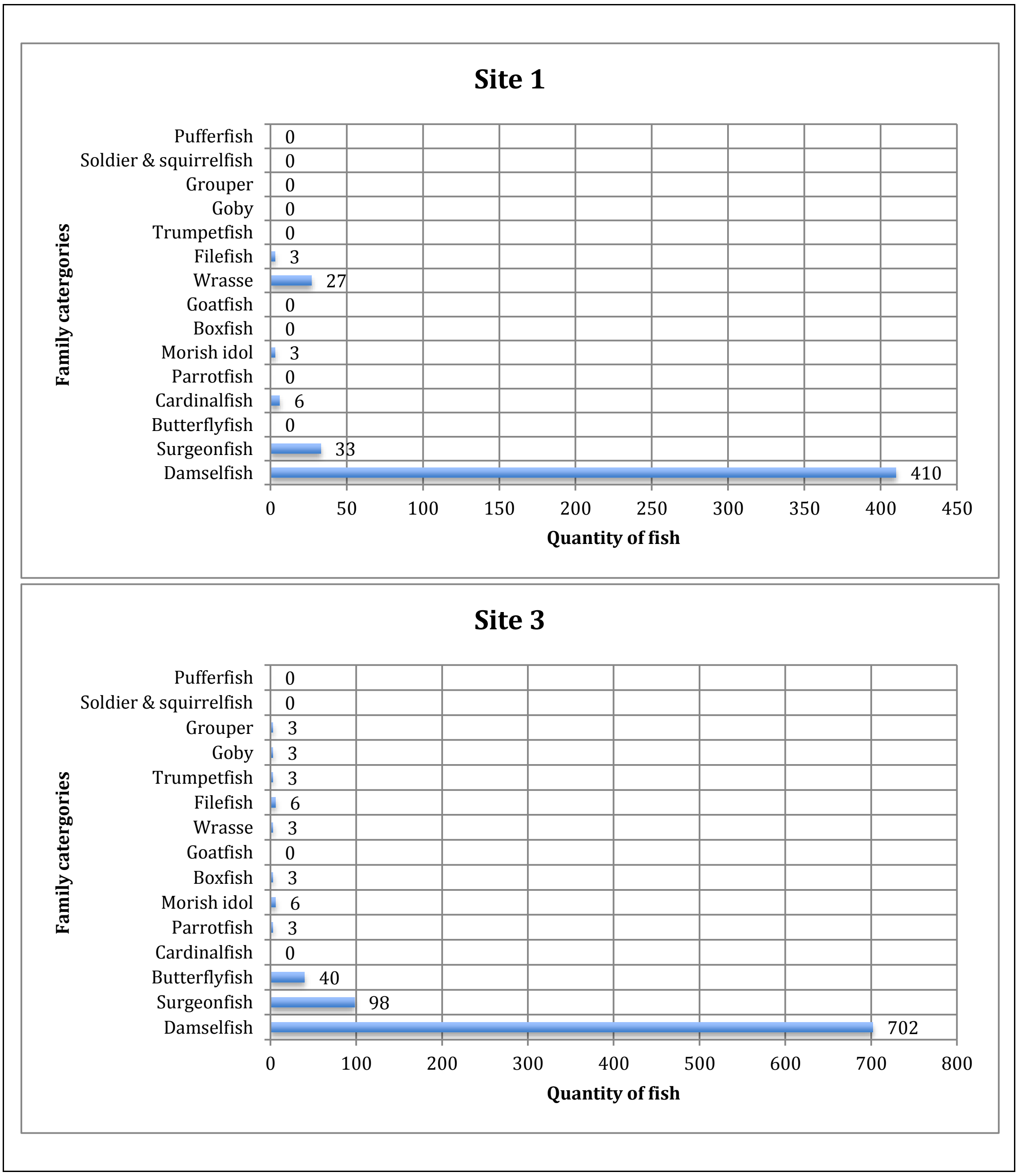
Figure 7. Fish assemblage across site five determined to species level and further categorised into families; *Pomacentridae* (Poma), *Mullidae* (Mulli), *Labridae* (Labri), *Acanthuridae* (Acan), *Aulostomidae* (Aulo), *Scaridae* (Scar), *Serranidae* (Serra), *Moncanthidae* (Monacanth), *Chaetodontidae* (Chaeto), Tetraodontidae (Tetra).

Table 5. Additional fish species identified during data collection within site five.

Common name	Scientific name	Family name
Seychelles butterflyfish **Racoon butterflyfish**	*Chaetodon madagaskariensis* *Chaetondon lunula*	*Chaetodontidae* *Chaetodontidae*
Bullethead parrot fish	*Chlorurus sordidus*	*Scaridae*
Yellow boxfish	*Ostracion Cubicus*	*Ostraciidae*
Clown triggerfish	*Balistoides conspicillum*	*Blastidae*
Barred thicklip	*Hemigymnus fasciatus*	*Labridae*
Luther's prawn goby	*Cryptocentrus lutheri*	*Gobiidae*
Three-spot dascyllus	*Dascyllus trimaculatus*	*Pomacentridae*
Network pipefish	*Corythoichthys flavofasciatus*	*Syngnathidae*

4.3.5 Analysis of family and species abundance across the four sites

Although there has not been enough data obtained to implement a full analysis, the acquired data from 2012 enabled a comparison in the abundance of fish found across the four sites to be made when grouped into family categories (Fig 8). Across all sites the family category damselfish was shown to be present in significantly high quantities with site five expressing the highest abundance of damselfish (911). However, site three and four was shown to have the highest variation in family abundance in comparison to other two sites. In particular the quantity of Surgeonfish (40) and Butterflyfish (98) was shown to be significantly higher in site 3 when compared to the other three sites.



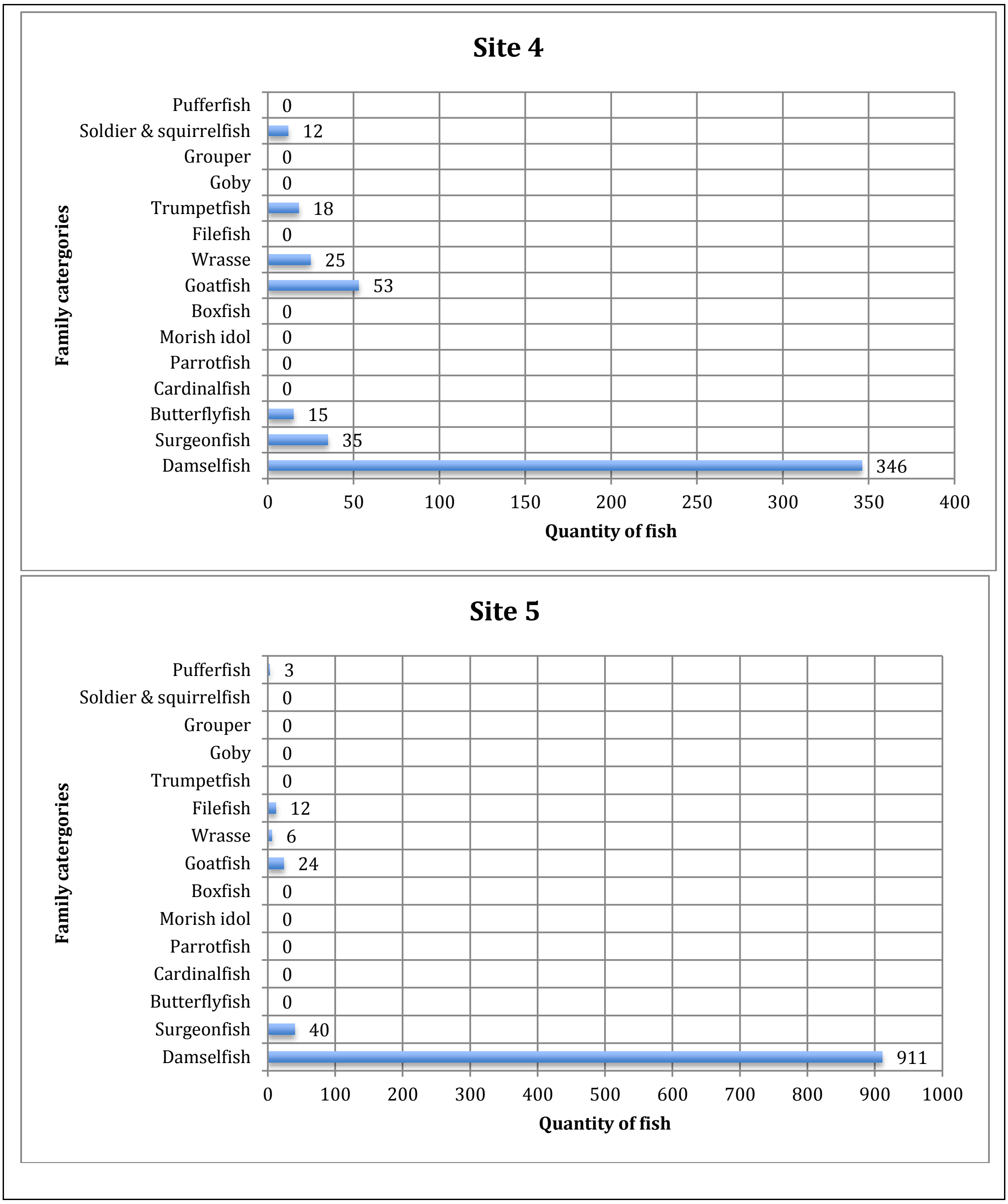


Figure 8. Analysis of fish abundance across the four sites determined to family level.

In order to further illustrate the distribution of the identified species across the varied sites, the data was allocated into family categories (fig 9). This would enable potential differences within the fish community composition to be further analysed. Overall, the data displayed in figure 9 shows site 3 to more abundant in terms of species diversity with nearly all families represented across the site in comparison to other surveyed areas. Ultimately, Damselfish, Surgeonfish, Butterflyfish and Wrasse were shown to have highest number of species distributed across all four sites. Furthermore, it should be noted that seven species of Butterflyfish were identified during surveys of site three in comparison to the other sites, which showed a lower number of species.

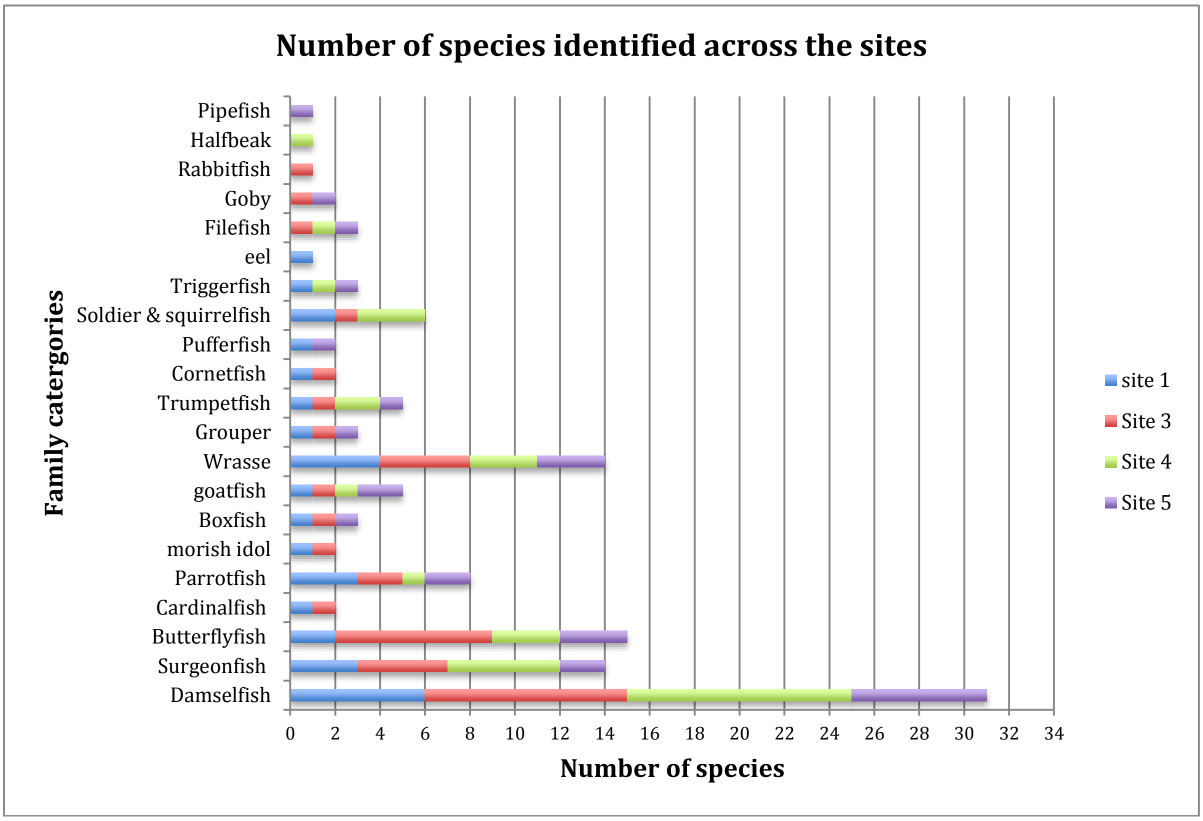


Figure 9. A comparative analysis in the number of species distributed across the four sites, which are further categorised up to family level.

Section 5.1 - Discussion

Although, the collated data from 2012 highlights a brief overview, a variation can be seen within the fish family assemblages across the four sites. The reason for these variations may be due to several factors, which include seasonal recruitment, feeding activities, habitat complexity and monthly variations in the lunar cycle (Sale, 1991, Williams and Hatcher, 1983, Letourneur, 2000). Galzin, (1987) highlighted temporal variations in fish assemblages around the corals reefs of French Polynesia over daily, monthly and yearly lunar cycles, with the maximum number of fish identified during the last quarter and full moon of the monthly period. In addition, differences between the wet and dry seasons may also fluctuate fish assemblages across the sites. In an attempt to minimise some of these factors the study was implemented and will be continually performed around the same period each year (January – February), with further consideration to the monthly changes of the lunar cycle being applied to future surveys. Conversely, feeding activities is one factor that was unable to be controlled and could contribute to the fluctuation in abundance amongst the fish assemblages across the sites. Reef fish have shown to be more active during the periods of sunrise and sunset, with some species roaming across large areas or displaying extensive home ranges as seen within some surgeonfish (Sale, 1991, Robertson and Gaines, 1986). However, the ability to conduct consistent surveys at the same time of day (sunrise and sunset periods) was not possible, as the surveys were limited to certain periods of the day, during the beginning of the slack tide when sea level around the lagoon was at its highest and the tidal currents were at their lowest. Therefore, these factors could limit the ability to record the maximum number of fish and result in significant variations of fish assemblages within any given site.

In analyzing the distribution of fish assemblages across the sites, it was evident that the family *Pomacentridae* (Damselfish) is widely distributed, with *S. nigricans* (Dusky gregory), *D. aruanus* (Humbug dascyllus) and *C. viridis* (Blue green chromis) being the most abundant species. Benthic species of Damselfish in particular *S. nigricans* and *D. aruanus* have shown to be site specific to an area and are known to be highly aggressive when defending feeding territories from conspecifics and other species of fish, due to their cultivated algae (Green and Bellwood, 2009, Ceccarelli, *et al*, 2011, Ceccarelli, *et al*, 2005). The high densities of damselfish displaying territories have shown to influence the population density of coral reef communities by varying the level of post larval recruitment and impacting the feeding ability of reef fish, in particular grazing species of scarids, siganids and acanthurids (Gibson, *et al*, 2001). Ultimately, these factors may contribute to influencing the spatial distribution of fish assemblages found across the four sites (Letourneur, 2000, Almany, 2002, Sale, 1991). For example, a high abundance of damselfish was identified across site five, with a high percentage of acropora branching formations, but a relatively low diversity of species (23 species identified).

Furthermore, personal observations also identified large quantities of macro algae smothering the branching formations of acropora across site five, these algal formations are thought to be promoted by territorial damselfish and may also contribute to the variation in species diversity by limiting the feeding opportunities for other identified families (Gibson, *et al*, 2001, Sale, 1991, Sale, 2002).

In comparison, site three highlighted the most diverse array of species, along with a high percentage of both acropora branching and table formations, which was similar to that identified within Kauppaymuthoo, (2010) report. These coral formations are likely to provide a form of habitat complexity through increased levels of rugosity, which have shown to play a fundamental role in increasing the diversity of fish species (Roberts and Ormond, 1987, Sale, 1991, Ferse, 2008). Gratwicke and Speight, (2005) research within the shallow reefs of the Caribbean showed a positive correlation in the diversity of fish species when presented with an increase in habitat complexity and the amount of live coral cover.

Kauppaymuthoo, (2010) report further highlighted various anthropogenic stressors present throughout the area of Lagon Bleu, these include illegal and artisanal net fishing, high levels of boat traffic and nutrient loading (fertilizers, untreated sewage and detergents) from the development of coastal settlements. A combination of these factors along with high percentages of macroalgae has shown to intensify the chance of reefs becoming increasingly susceptible to a potential phase shift from a predominately coral dominated environment, to an algae dominated environment. For example, some sites have displayed high quantities of macroalgae along with unmonitored levels of illegal overfishing. A combination of these two factors may increase the chances of a potential phase shift as seen within reefs around the Caribbean particularly Jamaica and Glovers reef in Belize (Mcmanus, *et al*, 2000, Mumby, 2009). Personal observations and Kauppaymuthoo, (2010) report has shown illegal fishing to be widely distributed throughout the region of Lagon Bleu. Therefore, continual monitoring is needed, with a primary focus on: algal growth and distribution across the sites, percentages of live coral cover, fish abundance relative to the area with a particular focus on herbivorous species that exhibit a grazing feeding preference, fishing activities around lagon bleu and surveys of the local fish markets, with a primary focus on the types of species caught and their functional basis within a reef system such as feeding preference (herbivorous, planktivorous, carnivorous and corallivores) and ecological role. Incorporating these approaches into a successful monitoring project would enable Eco Sud to take a more direct role in limiting the potential deterioration of coral health from anthropogenic disturbances.

Section 6.1 Preliminary study - Seagrass habitats

The preliminary assessment of site two found a large distribution of seagrass bedded habitats containing an array of coral bommies, which support a varied distribution of juvenile fish species. Coral bommies are defined within this report as small to medium coral formations showing post settlement of juvenile staged fish. Seagrass beds have shown to be fundamental in providing a nursery during the developmental stages of certain species of reef fish within the Indian Ocean (Morinière, *et al*, 2002, Dorenbosch, *et al*, 2007). These habitats have shown to promote the levels of juvenile post recruitment and settlement by providing a high abundance of food and shelter, which enables a reduction in predation pressure. Once at certain stage within their lifecycle the fish then migrate from their nursery habitats to the adjacent coral reefs (Lewis, 1997, Nagelkerken, *et al*, 2002). Across the area of site two a range of juvenile species were identified these include; *C. viridis* (Blue-green chromis), *D. aruanus* (Humbug dascyllus), *R. rectangulus* (Wedge Picasso fish), *D. trimaculatus* (Three-spotted dascyllus) and *O. cubicus* (Yellow boxfish)(fig 4). Furthermore, predatory fish; *P. antennata* (Spotfin lionfish), *G. nubilus* (Grey moray eel) and a juvenile *E. polyzona* (Barred moray) were also identified across the area with individuals shown to reside within medium sized coral formations (fig 4). These findings could potentially highlight the importance of seagrass beds in providing both a nursery habitat for the recruitment of juveniles and post migration of matured fish into reef communities throughout Lagon Bleu.

Figure 10. **(left)** *P. antennata* (Spotfin lionfish) clinging to the side of a coral bommie. **(right)** a juvenile *Pomacentridae spp*. residing within a small formation of branching acropora.

The implementation of additional surveys is suggested; in order to further examine the densities of juvenile fish species and determine what functional basis the seagrass beds may play as a nursery habitat for juvenile fish species.

Section 7.1 – Proposed recommendations for next phase

This report has discussed numerous avenues of research that need to be further enhanced in order develop a suitable criteria for the sustainable management of the coral reefs around Lagon Bleu. The proposed developments in the next phase of research are as follows:

- The provision of a transect tape with precise measurements (recorded to 1 cm precision) will enable a more direct assessment of substrate and coral cover estimation using the employed LIT methodology.

- A change in the benthic survey to incorporate the percentages of: algae coverage, sponge and soft coral formations and coral condition such bleaching/disease into the LIT methodology. Additionally, the use of quadrats may enable a direct assessment of algae formations/percentages in order to determine the likelihood of a potential phase shift.

- To establish a socio economic survey, which will record the number of fishing activities and the type of fishing methods used around the area of Lagon Bleu. These surveys will then be incorporated with surveys implemented around the local fish market in order to determine, which types of fish species are primarily overfished.

- To continue collecting data on the densities/types of fish species found within seagrass beds and determine whether these areas may provide functional role as a nursery habitat.

- To continue collecting long-term data on the abundance/species diversity of reef fish communities throughout the six sites, with the possible addition of other survey sites depending on the level of biodiversity/abundance, anthropogenic pressures and morphological reef features.

- Benthic composition surveys will continue to be coupled with fish surveys of abundance/species diversity in order to allow for a comparison between the benthic habitat and fish populations at each of the six sites, with the primary purpose to evaluate the results and determine any significant trends that can be made.

Section 8.1 - References

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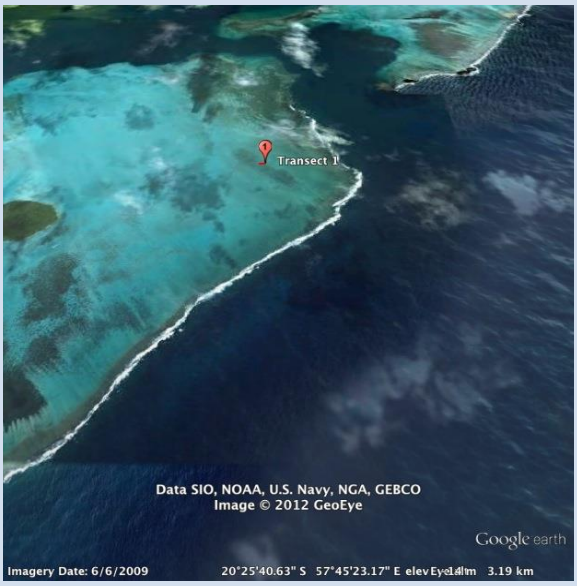
Section 9.1 - Appendices

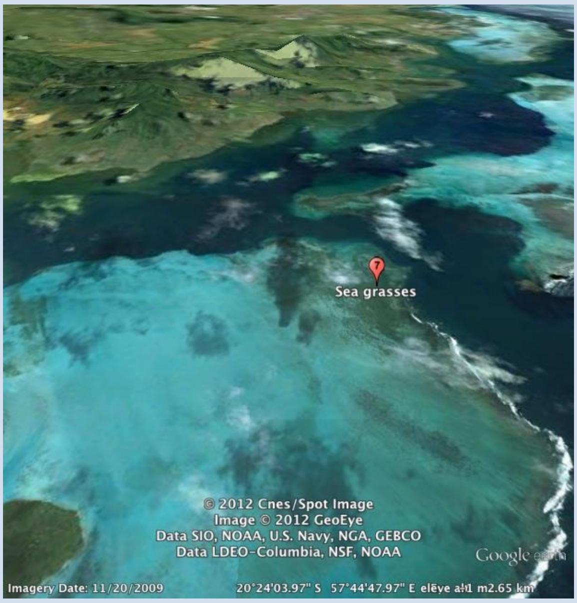
Appendix A: The location and description of site one.

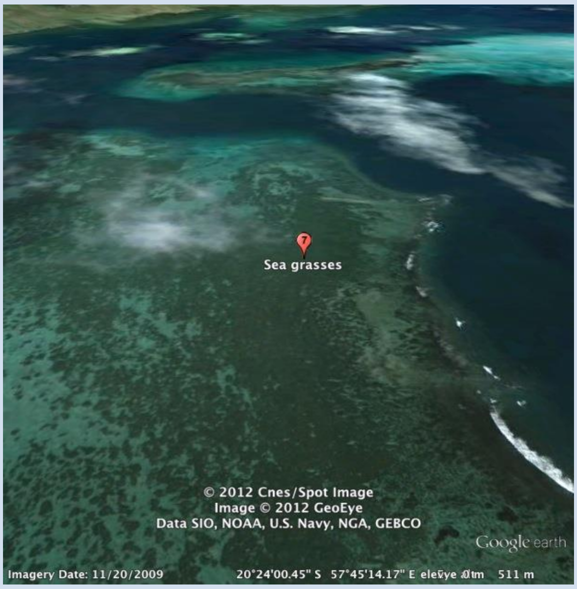
Site 1 – Transect 1
GPS location – Longitude Start Point: 20°24.756’ S Latitude Start Point: 57°45.246’ E
Site description – The site is located approximately 2 km from ile aux aigrettes and presents a strong current system during the onset of high tide.



Appendix B: The location and description of site two.

Site 2 – Transect 2
GPS location - Longitude Start Point: 20°24.' S Latitude Start Point: 57°45.' E
Site description – The site is located approximately 2.5km from ile aux aigrettes and 3.5 km from the coastline. The surrounding area has shown to harbour extensive seagrass meadows mainly consisting of *Thalassia*, *Halodule* and *Syringodium.*



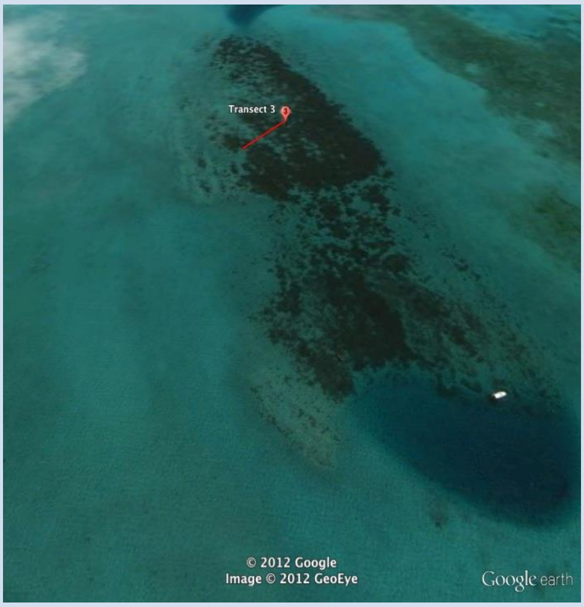


Appendix C: The location and description of site three.

Site 3 – Transect 3

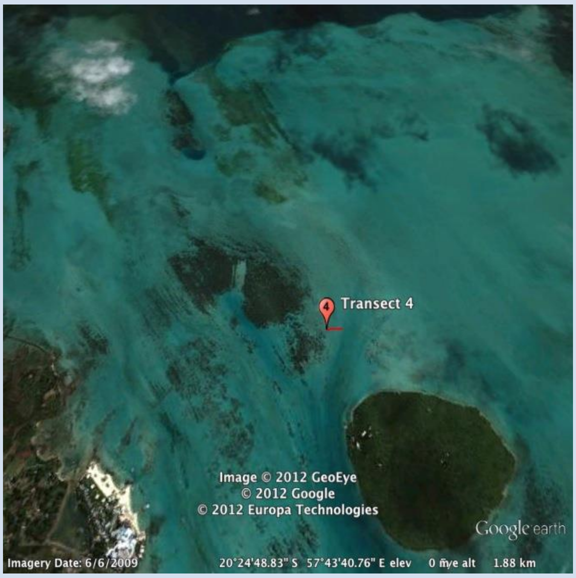
GPS location – Longitude Start Point: 20°24.170’ S
Latitude Start Point: 57°43.297’ E

Site description – The site is located 1.6km from ile aux aigrettes and 1.2 km from the coast line, with a relatively deep area due to the presence of a lagoon depression.



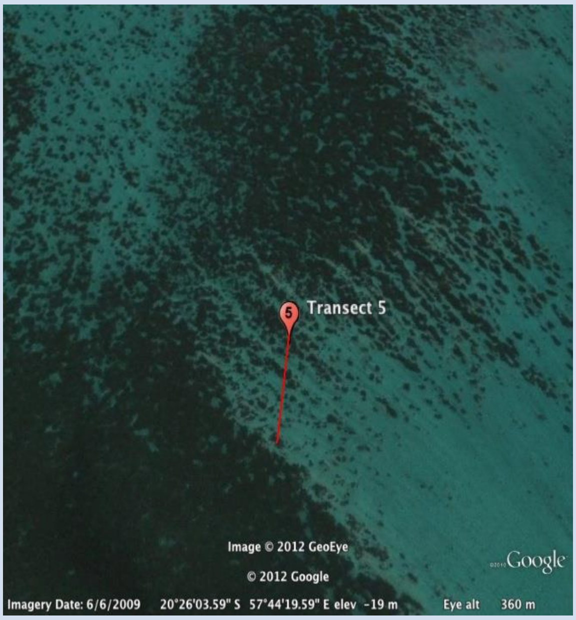
Appendix D: The location and description of site four.

Site 4 – Transect 4
GPS location - Longitude Start Point: 20°24.922 S Latitude Start Point: 57°43.775 E
Site description – The site is located approximately 260m from ile aux aigrette and 800m from the coastline, with a near by channel showing the presence of intense boat traffic.



Appendix E. The location and description of site five.

Site 5 – Transect 5
GPS location - Longitude Start Point: 20°26.079’ S Latitude Start Point: 57°44.327’ E
Site description – The site is approximately distributed 1.5km south of isle aux aigrettes and presents a strong current system during the onset of high tide.



Appendix F. The location and description of site six.

Site 6 – Transect 6

GPS location - Longitude Start Point: 20°26.349’ S
Latitude Start Point: 57°43.579’ E

Site description – The site is located approximately 1.8km south of isle aux aigrettes and a few metres from the coastline, with a high degree of boat traffic present around the area.