RESULTS

Coral and General Benthic Composition

The results are based upon over 26,000 observations recorded from the video transects. These have been further supplemented by individual frames of coral species (40 genera identified) and algae, as well as general views of the benthos in the vicinity of each transect.

Results of the survey suggest that there is a strong east west gradient of coral development, probably determined by level of wave exposure on Aldabran reefs which affects the benthic community composition. There is also a distinctive contrast between the coral communities at shallow depths (<10m) and those deeper (>20m) with respect to the general benthic cover, percent coral cover and coral morphological composition.

The topography of reefs visited on the northern coast (sites 2-5; see Figure 7) of Aldabra varies very little. Characteristically there is a very short reef flat that slopes gently down to 10 m, from where the reef drops at an incline of approximately 35-45 degrees. At between 20 and 25 m the reef shelves off to form a sandy ledge with patches of coral growth, dropping off steeply at between 35 and 40 m. The western coast (sites 1, 6 and 7) differs in that the reef flats and sandy ledges are considerably wider. South of the Western Channels the sandy ledge begins at approximately 15 m.

Reef structure changes steadily from the western coast to the northeastern side of the atoll. Moving in an easterly direction the substrate becomes less consolidated (moving from site 6 to 5; Figure 7) with many areas of coral rubble and patches of sand, reaching its extreme at the northeastern tip of the atoll where the reef slope consists almost entirely of coral rubble. This change is to be expected as it coincides with the change from the less exposed western coast to the more exposed eastern coast (Barnes et al., 1971).

General comparisons of benthic composition between sites 1-4 and 6-7 displayed a range of percent cover of live coral (11-27% ±6% (± 1 standard deviation)) and of dead coral (11-30% ±7%). The percent cover of live coral growth was strongly correlated with depth. From the shallow depths of 5-10 m to >15 m represents an increase of 10-20% of live coral growth. Contrastingly, dead coral coverage tended to be higher in the shallow waters (<10 m) surveyed (44%), but as depth increased (>20 m) coral mortality declined to a level where it was 10-20% of the coral cover.

There is a general increasing trend for percent cover of both live and dead coral of the whole atoll from east to west (Figure 7). This coincided with decreasing levels of exposure to strong hydrodynamic conditions moving in the same direction. The least exposed sites with the highest mean live coral cover were sites 1 (25%), 2 (24%), 6 (16%) and 7 (21%) (Figure 7). Note that Site 5, at the high exposed eastern corner of the atoll, was treated separately from other sites as it was a distinctly different area to others surveyed, dominated by a high percentage of a sand, rubble and rock matrix (56%) and macroalgae, primarily *Halimeda* spp. (40%). Site 5 did have isolated coral bommies but only 1.5% live coral and 2.0% dead coral of the total substrate cover.

Across the range of the sites examined *Halimeda* spp. was the dominant macroalga, with localised high concentrations of *Dictyota* spp., *Caulerpa* spp. and *Lobophora* spp. *Halimeda* increases by 30% from west to east with a dramatic increase in coverage (+20%) between

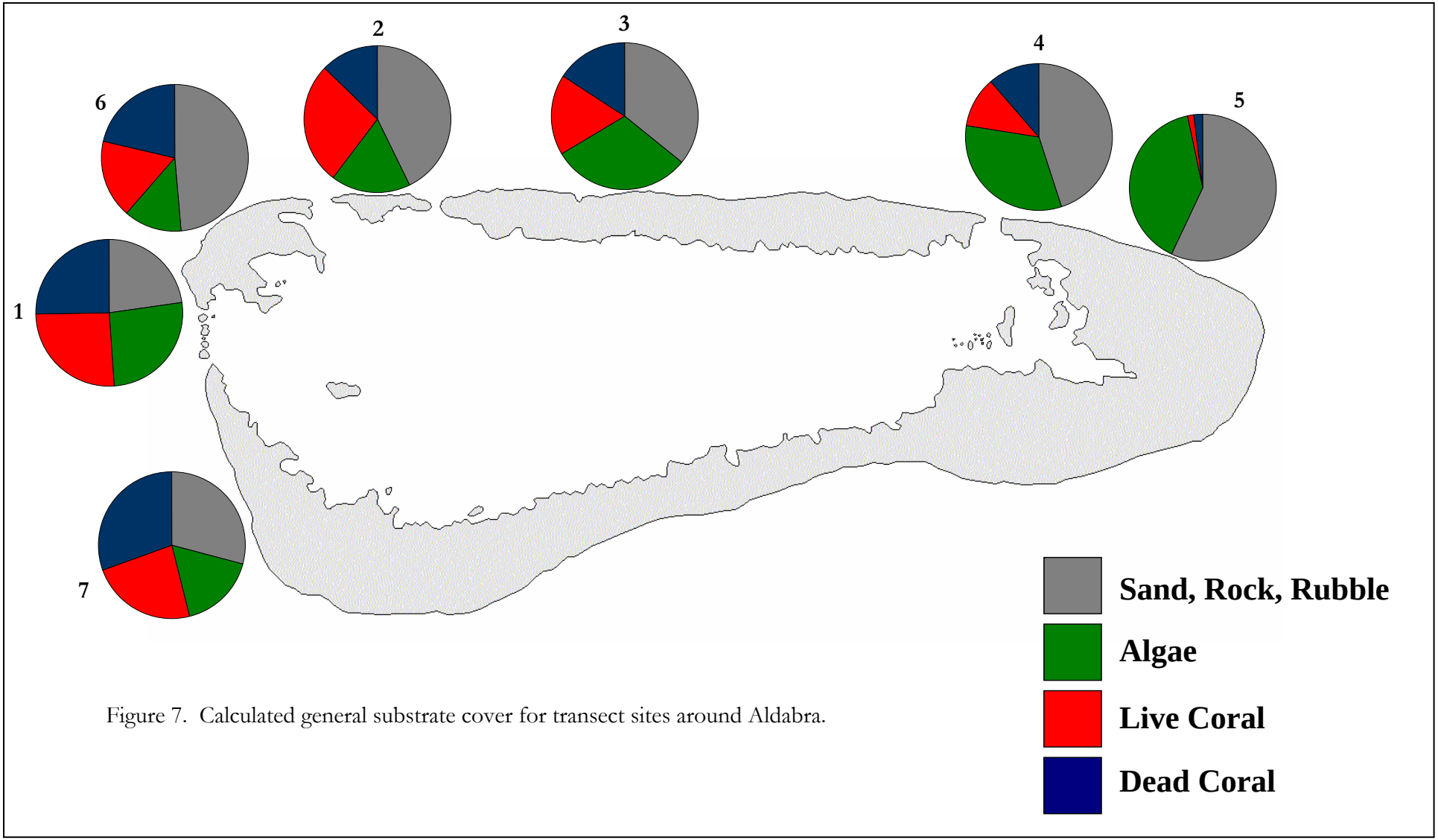


Figure 7. Calculated general substrate cover for transect sites around Aldabra.

site 2 and 3. *Thalassodendron* spp. was present but was not considered to be a major component of the outer reef slopes. In most areas red encrusting coralline algae were observed especially where incidences of dead upright coral and coral rubble were present. On massive coral species small patches of red encrusting algae were beginning to colonise in presumed bleaching related dead areas.

Soft coral species (*Sinularia* spp., *Lobophytum* spp. and *Sarcophyton* spp.) were present in small isolated colonies and comprised no more than 5% of the substrate at any given location. Soft corals show a slight increase in abundance moving east along the northern coast.

Massive, branching, encrusting and foliose are the dominant live coral growth forms at both shallow and deep sites (Table 1). The majority of the live branching corals found at both shallow and deep sites is dominated by *Pocillopora* and *Porites* spp. It represents 20% of the total live coral cover. No live tabular coral species were encountered at any of the sites surveyed, but were noted at the seaward edge of the western channels to the lagoon.

Partial mortality of *Platygyra* spp., characteristic of many massive coral species at Aldabra, with adjacent live colony of *Pocillopora* spp.

Massive species were dominant at depth (63% of total live coral coverage) compared to that of 45% in shallow waters. Interestingly, live massive coral coverage was dominated by *Physogyra* sp. (65% of the massive spp.) on the deeper transect but was virtually absent (3%) from the 10 m depth sites. Other massive genera which were prominent were *Favia*, *Favites*, *Galaxea*, *Gardineroseris*, *Goniastrea*, *Leptoria*, *Lobophyllia* and *Porites*.

Foliose (*Echinopora*, *Pachyseris*, *Turbinaria* spp.) and encrusting coral species (*Montipora* spp.) were also common live coral growth forms at each site, but foliose genera were almost exclusive to deeper waters. Incidences of *Millepora* and *Heliopora* were rare at all sites and depths amounting to <4% of total live coral growth. Evidence of extensive *Millepora* stands, albeit dead, were observed at site 4 as deep as 23 m.

Although mortality was not as high in massive coral species, there was evidence of tissue death which was spatially patchy on individual coral heads. In some cases live tissue remained on the

sides or underside of the colony. In sites where branching corals have survived it is often the case that the colony has suffered only partial mortality. It is noteworthy that plate and fine branching corals were not abundant at any of the sites visited, likely due to relatively high hydrodynamic activity present in the vicinity of the atoll. It is also possible that the structural integrity of these growth forms, with the onset of mortality, would be rapidly compromised in the first incidence of high wave action.

A colony of *Physogyra* sp., dominant coral species of the deep reef areas of Aldabra with giant clam (*Tridacna* spp.).

Partial mortality of *Favites flexuosa* and *Acropora* spp. colonies at 20 m depth with black tip grouper (*Epinephelus fasciatus*) and evidence of the macroalgae *Halimeda* spp. in the lower left corner. This photo illustrates well the variability of mortality on the reefs of Aldabra.

Table 1. General description and summary of 10m and 20m transects. For specific site locations see Figures 2 and 7.

Site	General Description	Dominant Genera Deep (>20m)	Dominant Genera Shallow (<10m)
1	Coral cover high down to 40 m. <10 m evidence of extensive coral mortality but many colonies with small patches of living tissue were observed. Reef slope had many gorgonians with few large *Antipathes* spp. Dominant coral genus at 40 m was *Pachyseris*, but gave way, up the reef slope, to abundant *Physogyra* colonies.	40 m - *Pachyseris*, *Porites*, *Echinopora*, *Physogyra* (very abundant), *Lobophyllia*, *Pocillopora* and *Acanthastrea* 20 m - *Porites* (some entire colonies dead), *Pocillopora* (many colonies dead or with partial mortality), *Physogyra*, *Acropora* (scarce), *Goniastrea*, *Lobophyllia* (many dead colonies), *Fungia*.	High mortality observed in many dead *Lobophyllia*, *Platygyra* and *Acropora* species, with large areas of dead *Acropora palifera* Isolated living colonies of *Porites Pocillopora*, *Acropora* and *Fungia* were present.
2	Substrate less consolidated than western sites with many areas of coral rubble and patches of sand. >10 m the reef appeared to be in very good health with relatively little mortality. > 20 m a plateau with large patches of hard coral and gorgonians were present. High mortality in shallow water but live isolated branching and massive colonies were observed.	*Physogyra* (most abundant genus), *Porites*, *Sarcophyton*, *Millepora* (branching and encrusting), *Acropora* (plate species).	*Acropora palifera* most abundant species. Live *Acropora*, *Pocillopora*, *Echinopora*, *Porites* and *Sinularia* present. Shallower water - many *Porites* colonies which were alive.
3	Increased abundance of *Halimeda* and soft corals (*Sarcophyton* and *Sinularia*). Coral mortality most evident <10 m. *Porites* was the most abundant genus on the slope and shallows. Large patches of coral rubble were poorly consolidated throughout.	*Physogyra*, *Millepora* (branching and encrusting), *Astreopora*, *Podabacia* plates, *Porites* (branching and massive), *Montipora* (encrusting), *Acropora* (branching), *Pocillopora*, *Hydnophora*, *Sinularia and Sarcophyton.*	*Acropora palifera*, *Porites*, *Heliopora*, *Sinularia* and *Sarcophyton.* Some dead colonies of *Acropora palifera*, *Porites* and *Heliopora.*
4	High mortality in shallower water, but there were a number of dead branching *Millepora* colonies as deep as 23m. Transect similar to Transect 3 but with increasing coverage of rubble and *Halimeda.*	*Physogyra*, *Montipora*, *Astreopora*, *Goniastrea*, *Pachyseris* (very abundant), *Scolymia*, *Pocillopora*, *Mycedium* and *Porites.* Steep slope with a loose rubble and sand matrix. High concentrations of *Halimeda.*	*Acropora palifera*, *Acropora* (branching), *Millepora*, *Pocillopora*, *Favia*, *Heliopora*, *Porites*, *Sinularia* and *Sarcophyton*. Rubble with evidence of dead massive colonies. <7 m reef is consolidated with heavy red algal calcification. Evidence of coral mortality present.
5	High-energy environment site with substrate consisting almost entirely of coral rubble with the occasional coral bommie. Coral diversity on the bommies was high. The environment was dominated by *Halimeda* (sand at the base of the reef slope was clearly *Halimeda* generated). Few corals were established on the rubble slope.	Sand (composed of dead Halimeda) Coral rubble and *Halimeda* spp.	Consolidated substrate heavily encrusted with coralline algae and interspersed patches of seagrass. Evidence of dead *Porites*, *Heliopora*, *Pocillopora*, *Lobophyllia* and *Acropora palifera.* Large live isolated *Porites* and *Goniopora* colonies.
6	Evidence of dead *Acropora palifera*, Transect is exposed to strong currents (2-3 knots). Below 20m were many *Tubastraea micrantha* colonies suggesting a high current environment. More *Montipora* and *Acropora* colonies at depth.	*Pocillopora*, *Porites* (branching and massive), *Tubastraea micrantha*, *Mycedium*, *Physogyra*, *Montipora*, *Acropora* (plates), *Turbinaria*, *Favia*, *Pectinia*, gorgonians, *Echinopora*, *Millepora Astreopora, Galaxea*, *Acanthastrea*, *Dendronepthia* (soft coral associated with currents) and *Sarcophyton*.	*Pocillopora*, *Acropora*, *Porites*, *Favia*, *Fungia*, *Millepora* (branching), *Echinopora.* Evidence of dead favids, *Acropora palifera*, *Porites* and *Pocillopora*, interspersed with live *Favia*, *Lobophyllia* and other massive colonies.
7	A long shallow reef flat followed by a steep drop from 5m to 19m to a sandy shelf. Evidence of extensive coral mortality at all depths.	Sand	*Acropora* spp. (branching), *Acropora palifera*, *Pocillopora*, *Lobophyllia*, *Physogyra*, *Porites*, *Astreopora*, *Sarcophyton*, *Sinularia*, *Dendronepthia*, *Pocillopora.* Evidence of very high coral mortality.

Sites 1, 2, 4 and 7 were sites which had previously been surveyed by the SSARP in April 1998 close to the peak of the coral bleaching event (Figures 2 and 4) (Spencer et al., in press). At 10 m depth, although some recovery of coral (+7%) was noted, the majority of the bleached corals had suffered subsequent mortality, translating into an increase of 22% in dead coral cover by November 1999 (Figure 8). Though bleaching was documented as being higher in deeper water (20m) in 1998 (Figure 9), rates of recovery were much better with an increase of 52% of live coral coverage, from 14% in 1998 to 66% in November 1999 (Figure 9).

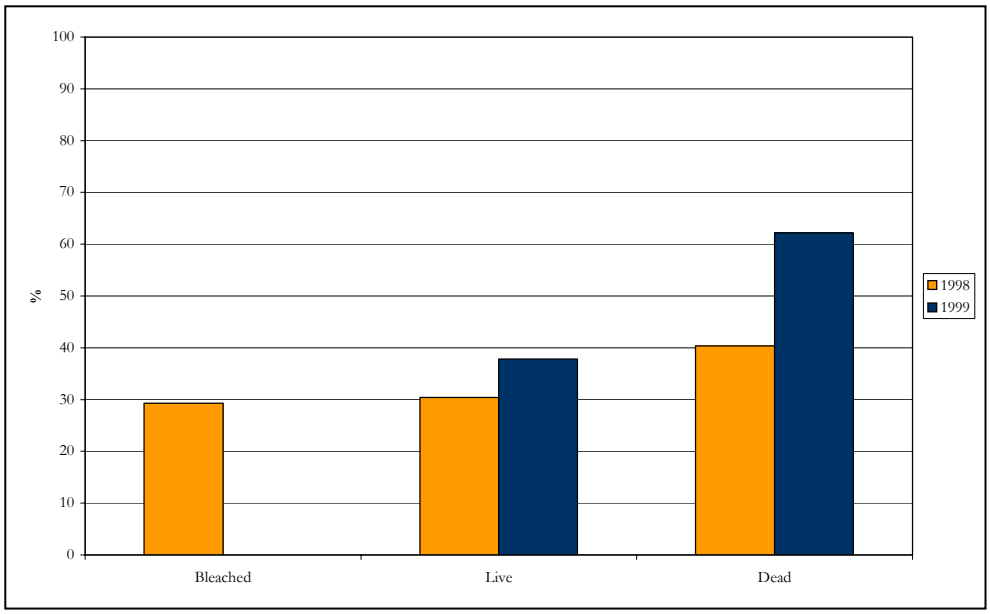


Figure 8. Comparison of % coral cover in Aldabra at 10m depth at sites 1, 2, 4 and 7 in April 1998 and November 1999 (note no bleached coral in 1999).

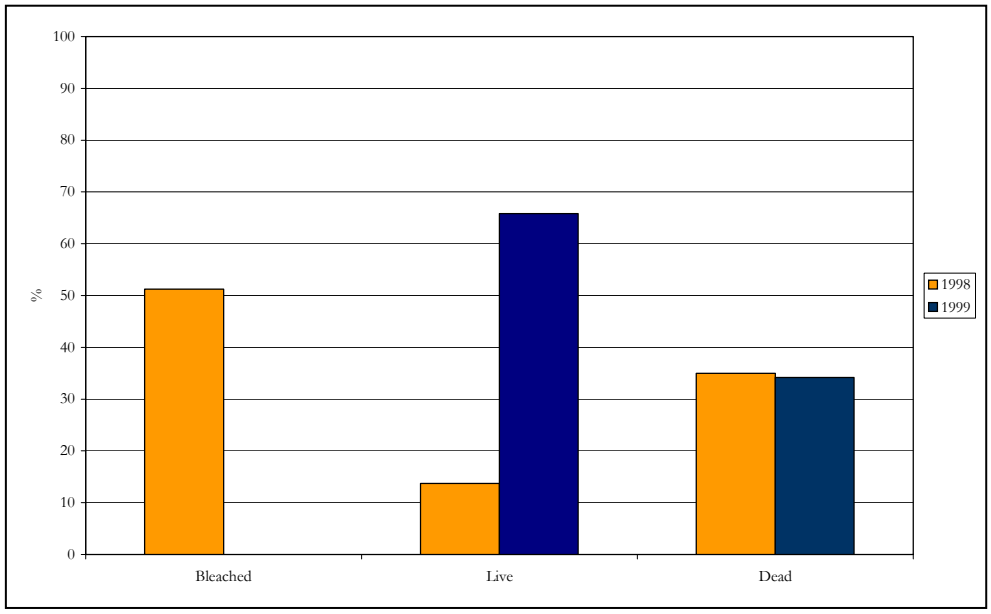


Figure 9. Comparison of % coral cover in Aldabra at 20m depth at sites 1, 2, 4 and 7 in April 1998 and November 1999 (note no bleached coral in 1999).

Fish Communities

The results of the fish surveys are summarised in Figure 10. They have been condensed to 3 grouped size categories. The surveys gave quantitative information on 164 species representing 27 families. Qualitative surveys amounted to 48 species and 6 families, giving a total of 212 species for November 1999 at Aldabra.

The number of fishes counted in 100 m^2 of transect area ranged from 352 fish from 33 species and 16 families at site 5, to 7162 fish from 90 species and 23 families at site 6. The number and species of fish at site 5, near the eastern end of Aldabra Atoll, were clearly different from the six other sites along the northern shoreline and at the western end of the atoll. Disregarding site 5, there was little variation in families of the fish in the surveys at the other transect sites. The lowest number of fishes in 100 m^2 of survey area at sites 1-4, 6, and 7 was 645 fish from 70 species at site 3. The large differences in the number of fish in the transects resulted from large schools of a few species from the families Serranidae (groupers and basslets), Apogonidae (cardinalfishes) and Pomacentridae (damselfishes). When the number of fishes in 100 m^2 of survey area exceeded 1000, these three families accounted for 80 - 94% of the fishes.

The sizes of the fishes in the transects at sites 2-7 were dominated by those in the 0-10 cm total length category, which contained from 86 - 98% of the fishes surveyed. At site 1, 72% of the fishes were in the 11-20 cm total length group, due to an unusually large school of Caesionidae (fusiliers) that contributed 63% of the total fishes in this size group. The abundance of fishes in the 0-10 cm category was caused primarily by large numbers of small-sized species, and secondarily by juvenile life-stages.

There was no significant correlation between either the total number of species ($R^2 = 0.35$), or the total number of fishes ($R^2 = 0.02$), surveyed at sites 1-7, and their respective juxtapositions from east to west along the shoreline of Aldabra Atoll. There was no significant correlation between either the total number of species, nor the total number of fishes, surveyed at sites 1-7, and the amounts of live coral (species: $R^2 = 0.47$, number: $R^2 = 0.02$) and dead coral (species: $R^2 = 0.53$, number: $R^2 = 0.41$) at each site.

However, the families Chaetodontidae, Labridae, and Serranidae each have several species that are commonly associated with live corals and habitat structure formed by erect dead corals. The number of species, and the number of fishes, in each of these families that were surveyed at sites 1-7, were evaluated in relation to live coral and dead coral habitat at each site. A significant positive correlation was found between both the species and the number of Chaetodontids, and live coral habitat (species: $R^2 = 0.88$, number: $R^2 = 0.71$). There was also significant positive correlation between the number of Labrids ($R^2 = 0.61$), and the species of Serranids ($R^2 = 0.59$), and live coral habitat.

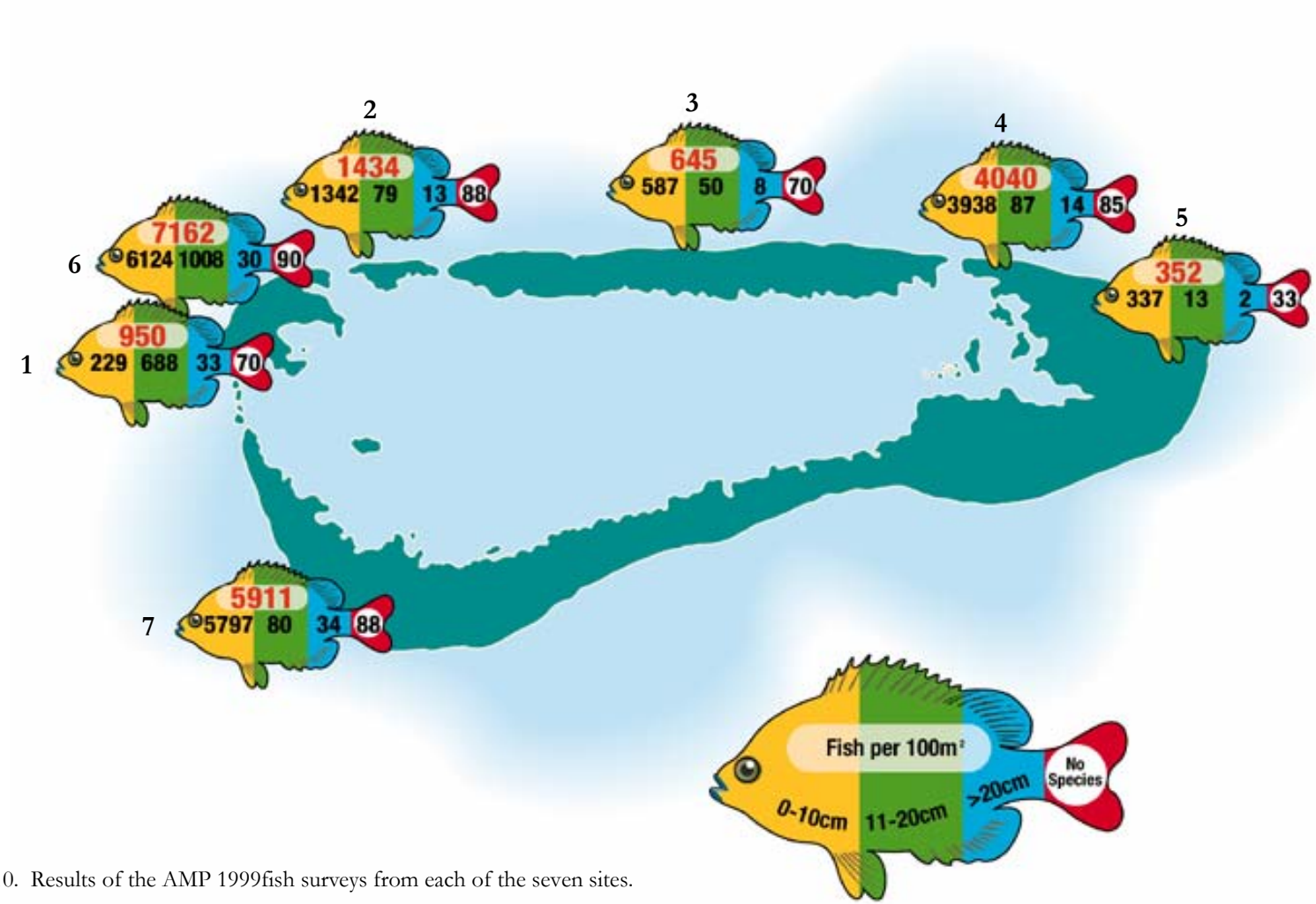


Figure 10. Results of the AMP 1999fish surveys from each of the seven sites.

DISCUSSION

The 1998 coral bleaching event had pronounced effects upon the reef complex. Shallower species suffered the greatest mortality and recovery of intact colonies has been low thus far. The combination of long periods of exposure to high SST's lead to the current situation as seen earlier in the SST record (Figure 4). Although bleaching was greater at 20 m at the time of the 1998 survey, recovery was high in 1999. It is thought that penetration of warmer SST's to deep water sites took longer and may have had a shorter residence time than what was experienced in the shallows. Shorter duration and magnitude of anomalous temperatures may have lead to high recovery at depth (see Brown, 1997). Also, as the 1998 survey occurred at the end of the anomalous period and bleaching coverage was high, it suggests that coral bleaching was recent and the previous three months of anomalous SST's in 1998 had had little effect.

A live *Physogyra* sp. colony characteristic of the dominant coral species at the deep water sites of Aldabra.

Although coral life on the reefs of Aldabra has incurred heavy damage as a result of the bleaching event, especially in the shallower depths (< 10 m). There are several coral species which now appear to dominate the reefs in Aldabra. *Acropora palifera* is the most abundant species in shallow water, while *Physogyra* sp. is abundant at 15-25 m and *Pachyseris* below 20-25 m. In areas where currents were strong, particularly the channel exits, *Tubastraea micrantha* is abundant. The dominance of *Physogyra* sp. across all deep water sites suggests a particular robustness of this species to the perturbation of the ambient environment.

There is no evidence that the death of large numbers of corals has led to an explosion of macroalgae, as these were not abundant on dead coral surfaces. Dead corals had been covered or partially covered by red encrusting algae which will not only cement and maintain the structural integrity of the coral, but may also create suitable substrate for coral larval settlement. It is essential that the substrate be fixed and/or consolidated for coral development to occur.

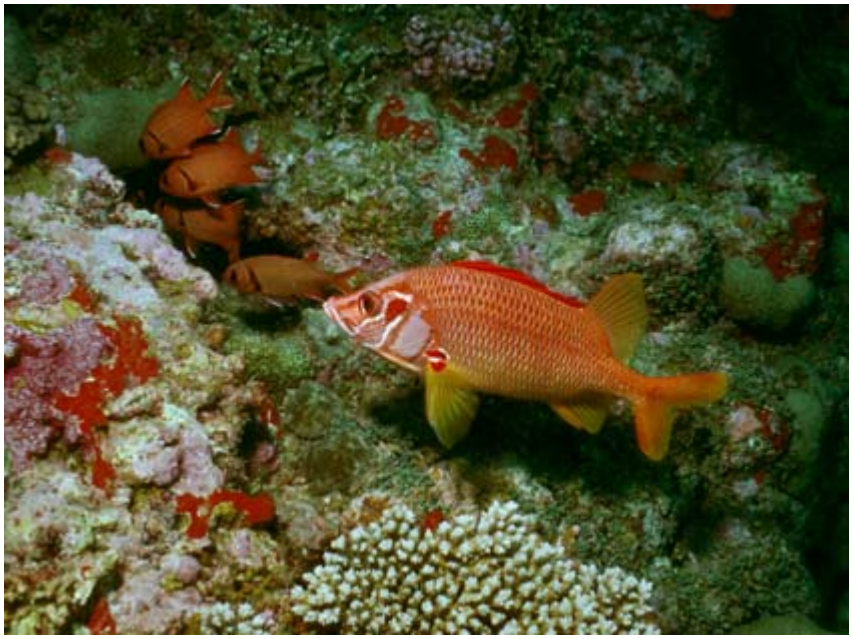
The recovery of reefs at Aldabra from the bleaching event is underway. In areas where coral had died there was evidence of acroporid and pocilloporid recruits up to 3cm in diameter. Many dead corals also have live patches, and they will be monitored to assess whether these will

continue to grow to recolonise dead areas. With live coral colonies on the deeper outer slopes, and in the lagoon and channels, local coral larval recharge may occur. It is hoped that retrieval of settlement plates will provide insight to coral recruitment levels in and around Aldabra, and to further monitor and understand the recovery process. The tiles are to be left on site 4-5 months before collection for counting coral recruits. This preliminary study will provide information necessary to estimate the optimal orientation of tiles, number of tiles and sites necessary for a full recruitment study.

There is generally good agreement between the lists of fish species and families found at Aldabra Atoll in November 1999 (212 species and 33 Families) and in April - May 1998 (287 species from 35 Families) (M. Spalding, University of Cambridge, unpublished). The differences may well be due to natural temporal and spatial variability, or surveying techniques.

The diversity of fish species and families found in coral reef ecosystems is indicative of the productivity or health of the system (Sale, 1991). The vertical relief and three dimensional complexity of the reef habitat provided by both live coral and erect dead coral structures is not only crucial for fish survival, but is also an aggregation attractant for reef fishes. This habitat complexity is often positively correlated to the diversity of fishes found on the reef (see Ebeling and Hixon, 1991; Sebens, 1991; Williams, 1991; Turner et al., 1999). Alterations and reorganisations of the reef structure following a bleaching related mortality event will, in turn, have varied spatial affects through a range of temporal scales on the other non reef dwelling fishes in the system.

There is often a lag-time in the responses of reef fishes to the loss of live coral habitat (Turner et al., 1999). The November 1999 surveys may have captured essentially pre-bleaching-event diversity of the fishes at Aldabra Atoll. This makes the quantified baseline information from these surveys exceedingly valuable for long-term monitoring of the natural recovery of this remote coral and reef fish ecosystem. Future surveys of the transects at sites 1-7, and possibly of additional sites, will be critical to fully understand the responses of the ecosystem, and for developing a comprehensive management plan for this and similar coral reefs.



Squirrelfish (*Sargocentron spiniferum*) at a typical deep reef site with some live species of coral (Acropora spp. and Millepora spp.).

ALDABRA MARINE PROGRAMME 2000 AND BEYOND

The Aldabra Marine Programme will continue to make annual visits to Aldabra as funding permits, not only to continue the much needed and valuable marine monitoring programme, but to improve our understanding of the linkages between coral reefs, lagoons, seagrass beds and mangroves. A key element would be the training of Aldabra rangers to maintain and develop this programme long into the future.

Future research plans include the following:

- continuation of fish and coral monitoring, and to establish more long term sites, simultaneously enhancing marine species inventory;
- coral recruitment studies of the Aldabra lagoon and outer reef slopes;
- physical marine monitoring (i.e. water temperature and tidal levels);
- lagoonal and channel surveys;
- initiation of studies of mangrove ecosystem dynamics and linkages between mangroves, lagoon and outer reef system productivity.

These studies are required to facilitate the formation of a long term marine science programme for Aldabra. This would include both the establishment of marine habitat mapping and inventory studies (GIS and remotely sensed image based).

Passe Dubois, one of the Western Channels leading into the lagoon. Note the presence of seagrass at the bottom of the photo, characteristic of the shallower sides of theses channel.

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UNITED KINGDOM

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UNITED STATES

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REFERENCES

Arnoult, J., Bauchot-Boutin, M.L. and Roux-Estève, R. 1958. Les poissons de l'Ile Aldabra. Annales de l'Institut Océanographique 34:47-90.

Barnes, J., Bellamy, D.J., Jones, D.J., Whitton, B., Drew, E., Kenyon, L., Lythgoe, J.N. and Rosen, B.R. 1971. Morphology and ecology of the reef front of Aldabra. Symposium of the Zoological Society of London, 28:87-114.

Brown, B.E. 1997. Coral bleaching: causes and consequences. Coral Reefs 16:S129-S138.

Brown, B.E. and Ogden, J.C. 1993. Coral Bleaching. Scientific American 268:64-70.

Bryant, D., Burke, L., McManus, J. and Spalding, M. 1998. Reefs at risk: a map-based indicator of threats to the world's coral reefs. World Resources Institute, Washington, D.C. p. 56.

Burnett, B. and Teleki, K.A. 1999. Shoals of Capricorn Programme underway in Republic of Seychelles. Reef Encounter 25:16.

COI. 1998. Project de lutte contre les déversements d'hydrocarbures Seminaire de haut niveau. 20-21 May 1998, Seychelles, Commission de l'Océan Indien (COI), Quatre Bournes, Mauritius. p. 128.

Drew, E.A. 1977. A photographic survey down the seaward reef-front of Aldabra Atoll. Atoll Research Bulletin 193.

Ebeling, A.W. and M.A. Hixon. 1991. Tropical and temperate reef fishes: comparisons of community structures. In P.F. Sale (ed.) The Ecology of Fishes on Coral Reefs. Academic Press, Inc., London, p. 509-563.

English, S., Wilkinson, C. and Baker, V. 1997. Survey Manual for Tropical Marine Resources, (2nd Edition). Australian Institute of Marine Science, Townsville. p. 390.

Fagoonee, I., Wilson, H.B., Hassell, M.P. and Turner, J.R. 1999. The dynamics of zooxanthellae populations: a long-term study in the field. Science 283:843-845.

Ginsburg, R.N., Kramer, P., Lang, J., Sale, P. and Steneck, R. 1998. Revised rapid assessment protocol (RAP). Atlantic and Gulf Reef Assessment (AGRA). http://coral.amol.noaa.gov/agra/rap-revised.html. p. 13.

Goreau, T.J. and Hayes, R.L. 1994. Coral bleaching and ocean hot-spots. Ambio 23:176-180.

Herminie, W.E. 1999. Seychelles Minister of Social Affairs and Manpower Development speech to the International Conference on Population and Development, 8-12 February, The Hague Forum.

Hodgson, G. 1999. A global assessment of human effects on coral reefs. Marine Pollution Bulletin 38(5): 345-355.

IOTC (Indian Ocean Tuna Commission). 1998. Report of the Seventh Expert Consultation on Indian Ocean Tunas. Victoria, Mahé, Seychelles, 9-14 November 1988. IOTC and FAO Report.

Jatzow, R. and Lenz, H. 1899. Fische von Ost-Afrika, Madagaskar und Aldabra. Abhandlungen der Senckenbergischen naturforschenden Gesellschaft 21:497-531.

Jennings, S., Marshall, S. M., Cuet, P. and Naim, O. *in press*. The Seychelles. In: T. McClanahan, C. Sheppard, D. Obura (eds.) The Coral Reefs of the Indian Ocean, Oxford University Press.

Lindén, O. and Sporrong, N. 1999. Coral reef degradation in the Indian Ocean: status reports and project presentations 1999. CORDIO and SAREC Marine Science Program, Department of Zoology, Stockholm University, Sweden. p. 108.

McPhaden, M.J. 1999. The child prodigy of 1997 - 98. Nature 398, 559-562.

Nicholson, S.E. 1997. An analysis of the ENSO signal in the tropical Atlantic and western Indian Oceans. International Journal of Climatology 17:345-375.

Osborne, K. and Oxley, W.G. 1997. Sampling benthic communities using video transects. In S. English, C. Wilkinson and V. Baker (eds.) Survey Manual for Tropical Marine Resources (2nd edition). AIMS, Cape Ferguson. p. 363-376.

Polunin, N.V.C. 1984. Marine fishes of the Seychelles. In D.R. Stoddart (ed.) Biogeography and ecology of the Seychelles Islands. W. Junk Publishers, Netherlands. pp. 171-191.

Pomerance, R. 1999. Coral Bleaching, Coral Mortality, And Global Climate Change: Report presented by, Deputy Assistant Secretary of State for the Environment and Development to the U.S. Coral Reef Task Force, 5 March 1999, Maui, Hawaii.

Potts, G.W. 1973. The ethology of *Labroides dimidiatus* (Cuv. & Val.) (Labridae, Pisces) on Aldabra. Animal Behavior 21:250-291.

Regan, C.T. 1912. New fishes from Aldabra and Assumption collected by Mr. J.C.F. Fryer. Percy Sladen Expedition Reports 4. Transactions of the Linnean Society, London Ser. 2, Zoology 15:301-302.

Robertson, D.R., Polunin, N.C.V. and Leighton, K. 1979. The behavioral ecology of three Indian Ocean surgeonfishes (*Acanthurus lineatus*, *A. leucosternon* and *Zebrasoma scopas*): their feeding strategies, and social and mating systems. Environmental Biology of Fishes 4(2):125-170.

Rowan, R., Knowlton, N., Baker, A. and Jara, J. 1997. Landscape ecology of algal symbionts creates variation in episodes of coral bleaching. Nature 365:836-838.

Saji, N.H., Goswami, B.N., Vinayachandran, P.N. and Yamagata, T. 1999. A dipole mode in the tropical Indian Ocean. Nature 401:360-363.

Sale, P.F. 1991. Introduction. In P.F. Sale (ed.) The Ecology of Fishes on Coral Reefs. Academic Press, Inc., London, 3-15.

Salm, R. V., Muthiga, N. and Muhando, C. 1996. The Developing Western Indian Ocean Coral Reef Programme. International Coral Reef Initiative (ICRI) Report.

Salm, R.V. 1996. The Status of the Coral Reefs in the Western Indian Ocean - with notes on related ecosystems. Working Paper I, International Coral Reef Initiative (ICRI) Western Indian Ocean Workshop, 29 March - 2 April 1996, Seychelles. p. 27.

Sebens, K.P. 1991. Habitat structure and community dynamics in marine benthic systems. In S.S. Bell, E.D. McCoy and H.R. Mushinsky (eds.) Habitat Structure – The Physical Arrangement of Objects in Space. Chapman and Hall, London, 211-234.

Shah, N.J. 1994. Environmental protection and marine research in the Seychelles. In J. van der Land (ed.) The Netherlands Indian Ocean Programme. National Museum of Natural History, Leiden, The Netherlands. p. 25-32.

Shah, N. J. 1995. Coastal Zone Management in the Seychelles. In C.G. Lundin and O. Lindén (eds) Proceedings of the National Workshop on Intergrated Coastal Zone Management in the Seychelles 20-24 February 1995. The World Bank and Sida, p. 158.

Shah, N. J. 1997. Integrated Coastal Zone Management in the Seychelles. In O. Lindén and C.G. Lundin (eds) The Jounrney from Arusha to Seychelles: Success and failures of integrated coastal zone management in Eastern Africa and island states. The World Bank and Sida, p. 298.

Shah, N.J. 1998. Marine Science Country Profiles: Seychelles. Intergovernmental Oceanographic Comission and Western Indian Ocean Marine Science Association. p. 31.

Shapiro, D.Y. 1977. Social organization and sex reversal of the coral reef fish *Anthias squamipinnis* (Peters). University of Cambridge Ph.D. Thesis. p. 386.

Slingo, J. 1998. The 1997/1998 El Niño. Weather 53:274-281.

Smith, J.L.B. and Smith, M.M. 1969. Fishes of the Seychelles (2nd edition). Rhodes University Institute of Ichthyology , Grahamstown.

Spalding, M.D. and Grenfell, A.M. 1997. New estimates of global and regional coral reef areas. Coral Reefs 16(4): 225-230.

Spencer, T., Teleki, K.A., Bradshaw, C. and Spalding, M.D. *in press*. Coral Bleaching in the Southern Seychelles during the 1997-98 Indian Ocean warm event. Marine Pollution Bulletin.

Stevens, J.D. 1984. Life-history and ecology of sharks at Aldabra Atoll. Proceedings Royal Society of London B 222:79-106.

Stoddart, D.R. 1968. The conservation of Aldabra. The Geographical Journal, 134(4):472-486.

Stoddart, D.R. 1971. Scientific Studies of Aldabra and neighbouring Islands. Philosophical Transactions of the Royal Society of London B. 260:5-29.

Stoddart, D.R. 1979. Aldabra and the Aldabra Research Station. Philosophical Transactions of the Royal Society of London B. 286:3-10.

Stoddart, D.R. 1983. Spatial and temporal variability of rainfall on Aldabra Atoll. Atoll Research Bulletin 273.

Stoddart, D.R. 1984. Coral reefs of the Seychelles and adjacent islands. In D.R. Stoddard (ed.) Biogeography and Ecology of the Seychelles Islands. W. Junk Publishers, The Hague, 68-31.

Stoddart, D.R. 1997. Bibliography of Aldabra Atoll, 3rd Edition. Seychelles Islands Foundation, London and Mahe. p. 89.

Stoddart, D.R. and Mole, L.U. 1977. Climate of Aldabra Atoll. Atoll Research Bulletin 202.

Stoddart, D. R., Taylor, J. D., Fosberg, F. R. and Farrow, G. E. 1971. Geomorphology of Aldabra Atoll. Pages 31-66. A Discussion on the results of the Royal Society Expedition to Aldabra 1967-68. Royal Society of London, London, United Kingdom.

Teleki, K.A., Spencer, T., Bradshaw, C. and Spalding, M.D. 1998. Coral Bleaching in the Western Indian Ocean – a sign of the times? International Society for Reef Studies – European Meeting, 1-4 September, Ecole Pratique des Hautes Etudes, Universite de Perpignan.

Teleki, K.A., Bradshaw, C., Spalding, M.D. and Tittley, I. 1999. Report from the Thalassi/Shoals of Capricorn Expedition to Cöetivy Island, St. Pierre and Alphonse Atoll, 22 February - 14 March 1999. Unpublished, p. 80.

Tourre, Y.M. and White, W.B. 1995. ENSO signals in global upper-ocean temperature. Journal of Physical Oceanography 25:1317-1332.

Tourre, Y.M. and White, W.B. 1997. Evolution of the ENSO signal over the Indo-Pacific domain. Journal of Physical Oceanography 27: 683-696.

Turner, J.S., Thrush, S.F., Hewitt, J.E., Cummings, V.J. and Funnell, G. 1999. Fishing impacts and the degradation or loss of habitat structure. Fisheries Management and Ecology 6:401-420.

UNDP. 1997. Country cooperation frameworks and related matters: First country cooperation for the Seychelles (1997-1999). Executive board of the United Nations Development Programme and the United Nations Population Fund, New York. Report Number 9718446.

UNEP. 1999. Western Indian Ocean - Environment Outlook. United Nations Environment Programme. p. 79.

Viles, H., Spencer, T., Teleki, K. and Cox, C. 2000. 16 years of microfloral recolonisation from limestone surfaces, Aldabra Atoll, Indian Ocean: implications for biological weathering. Proceedings of the RGS-IBG Annual Conference, 4 - 7January 2000, Sussex University.

Webster, P.J., Moore, A.M., Loschnigg, J.P. and Leben, R.R. 1999. Coupled ocean-atmosphere dynamics in the Indian Ocean during 1997-98. Nature 401: 356-360.

Wilkinson, C.R. (1998). The 1997 - 1998 mass bleaching event around the world. In Status of coral reefs of the world: 1998 (C.R. Wilkinson, ed.), pp. 15-38. AIMS, Cape Ferguson.

Williams, D.McB. 1991. Patterns and processes in the distribution of coral reef fishes. In P.F. Sale (ed.) The Ecology of Fishes on Coral Reefs. Academic Press, Inc., London, 437-474.