RESULTS

Effects of Recent COTS Outbreaks

Differences in abundance between mid-shelf reefs which had suffered recent outbreaks of *A. planci* and reefs which had not were evident for several taxa (Table 5, Appendix 2). The direction and magnitude of those differences, however, differed among taxa and often differed between habitats or among regions within taxa. Indeed, the main effect of COTS history was significant and independent of other effects for only six taxa of fish (Fig. 2). No reef-wide effects of COTS history were common to all regions for any of the 21 benthic taxa examined.

Table 5: Summary results of tests by univariate ANOVA for the effects of recent *A. planci* infestation [**COTS, C**], Habitat [**H**], Region [**R**], and reefs [**r(CR)**] and their interactions. *, -: statistical significance and non-significance respectively at $\alpha_c=\beta$, given the ES described in the text. Bold asterisks indicate the terms in analyses that were interpretable without ambiguity. Shaded columns indicate those terms that might indicate effects of *A planci* over more than single reefs.

A: Fishes.

	SOURCE OF VARIATION								
TAXON	Cots	Habitat	Region	H*C	R*C	R*H	R*H*C	r(RC)	H*r(RC)
Large Fishes									
Total Acanthurids	*	-	*	-	-	-	-	-	-
Z. scopas	-	*	*	-	-	*	-	-	-
Other Acanthurids	*	-	*	-	-	-	-	*	-
All Chaetodons	-	-	*	-	-	-	-	-	*
C. aureofasciatus	-	-	*	-	-	-	-	*	-
C. baronessa	-	*	-	-	*	-	-	*	*
C. plebeius	-	-	*	-	*	-	-	-	*
C. trifasciatus	-	-	*	-	-	-	-	*	-
C. vagabundus	-	-	*	-	-	-	-	*	-
Other Chaetodons	-	-	*	-	*	-	-	-	-
All Lutjanids	*	-	*	-	-	-	-	-	-
L. carponotatus	-	-	*	-	-	-	-	*	-
Plectropomus spp	-	*	*	-	*	-	*	-	-
Small Fishes									
A. curacao	-	-	-	-	-	-	-	*	*
C. atripectoralis	*	*	*	-	-	*	-	*	-
C. rollandi	-	*	-	-	-	-	-	*	*
Recruit *C.r.*	-	-	*	*	*	-	-	-	-
P. lacrymatus	-	-	*	-	-	-	-	*	*
P. moluccensis	*	-	*	-	-	-	-	*	-
Recruit *P.m.*	*	-	*	-	-	*	-	-	-
T. lunare	-	-	*	-	-	-	-	-	*

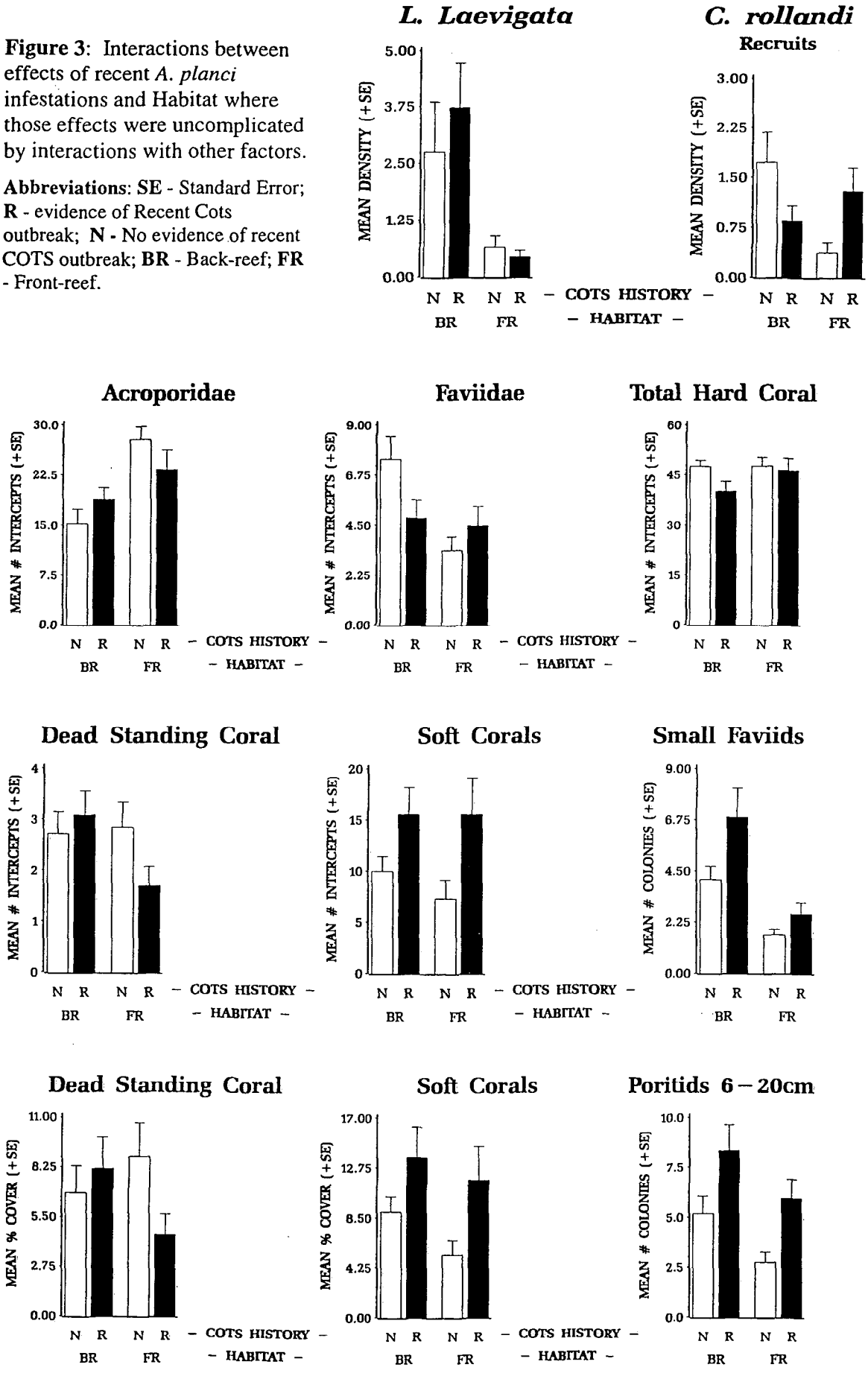
Table 5 (continued):

B: Benthic Organisms

TAXON	SOURCE OF VARIATION								
	Cots	Habitat	Region	H*C	R*C	R*H	R*H*C	r(RC)	H*r(RC)
Small Corals									
Small Acroporids	-	-	-	-	-	-	-	-	*
Small Faviids	-	*	-	*	-	-	-	*	*
Small Pocilloporids	-	-	-	-	-	-	-	-	-
Misc. Small Hard	-	*	-	-	-	-	-	-	*
Small Soft Corals	-	-	-	-	-	-	-	-	-
Poritid Counts									
Poritids < 6cm	-	-	-	-	-	-	-	*	*
Poritids 6-20cm	-	-	-	*	-	-	-	-	*
Poritids 21-50cm	-	-	*	-	-	-	-	-	-
Poritids 51-100cm	-	-	-	-	-	-	-	-	*
Poritids >100cm	-	-	-	-	-	*	-	*	-
% Coverage									
Total Hard Coral	-	-	-	-	-	-	-	*	*
Acroporidae	-	*	-	-	-	*	-	*	*
Faviidae	-	*	-	-	-	-	-	-	-
Pocilloporidae	-	-	-	-	-	-	-	*	-
Poritidae	-	-	-	-	-	*	-	*	-
Misc. Hard Coral	-	*	-	-	*	-	-	*	-
Dead Stand Coral	-	-	-	*	-	-	-	*	-
Soft Corals	-	-	-	*	-	-	-	-	*
Sponges	-	-	-	-	-	-	-	-	-
# Intercepts									
Total Hard Coral	-	-	-	*	*	-	-	*	-
Acroporidae	-	*	-	*	*	-	-	-	-
Faviidae	-	*	-	*	-	-	-	*	*
Pocilloporidae	-	*	-	-	*	-	-	*	-
Poritidae	-	*	-	-	-	*	-	*	-
Misc. Hard Coral	-	-	-	-	*	-	-	*	-
Dead Stand Coral	-	-	-	*	-	-	-	*	-
Soft Corals	-	-	-	*	-	-	-	-	*
Sponges	-	-	-	-	-	-	-	-	*
Misc. Benthos									
Tridacna spp	-	-	*	*	-	*	*	-	-
L. laevigata	-	*	*	*	-	*	-	-	-

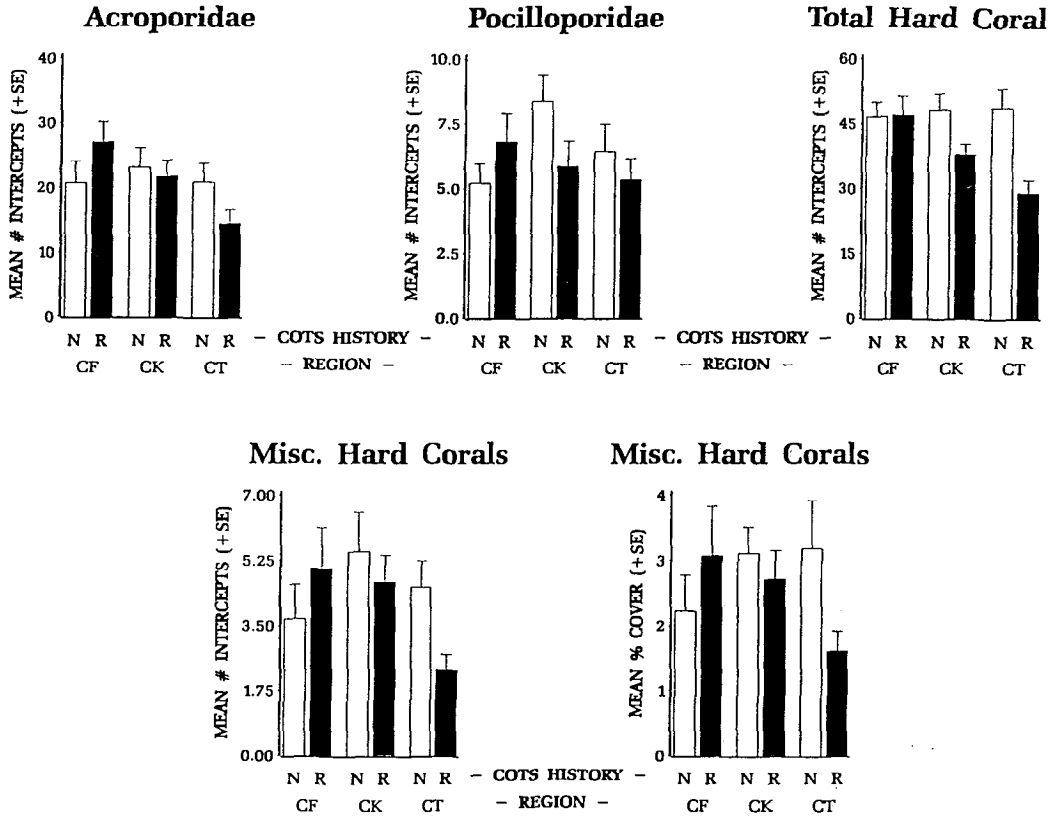
Figure 3: Interactions between effects of recent *A. planci* infestations and Habitat where those effects were uncomplicated by interactions with other factors.

Abbreviations: **SE** - Standard Error; **R** - evidence of Recent Cots outbreak; **N** - No evidence of recent COTS outbreak; **BR** - Back-reef; **FR** - Front-reef.



For all sessile benthic taxa showing significant interaction between COTS history and Region, the measures of abundances (coverage or number of patches) were ranked lower on COTS unaffected reefs in the northern region (off Cape Flattery), but lower on COTS affected reefs in the central and southern regions (Fig. 5). Both percent coverage and numbers of patches of miscellaneous hard corals were significantly higher (by a factor of 2) on COTS unaffected reefs in the Cairns-Cape Tribulation (southern) region, but neither differed significantly between reef type in the central and northern regions, although the rank of the means changed in the northern region (Fig. 5). Apparent differences in the number of pocilloporid colonies were not statistically significant off Cape Flattery and Cape Tribulation, but in the central region there were significantly more colonies per 20m on COTS unaffected reefs than on COTS affected reefs (Fig. 5). When the total numbers of all hard corals were analysed, apparent differences were significant in the central and southern regions, but the effect of recent COTS outbreaks did not affect total coral coverage in the northern region (Fig. 5).

Figure 5: Interactions between COTS history and Region on corals on mid-shelf reefs.
Abbreviations: **SE** - Standard Error; **R** - evidence of Recent Cots outbreak; **N** - No evidence of recent COTS outbreak; **CF** - Cape Flattery; **CK** - Cooktown; **CT** - Cape Tribulation.

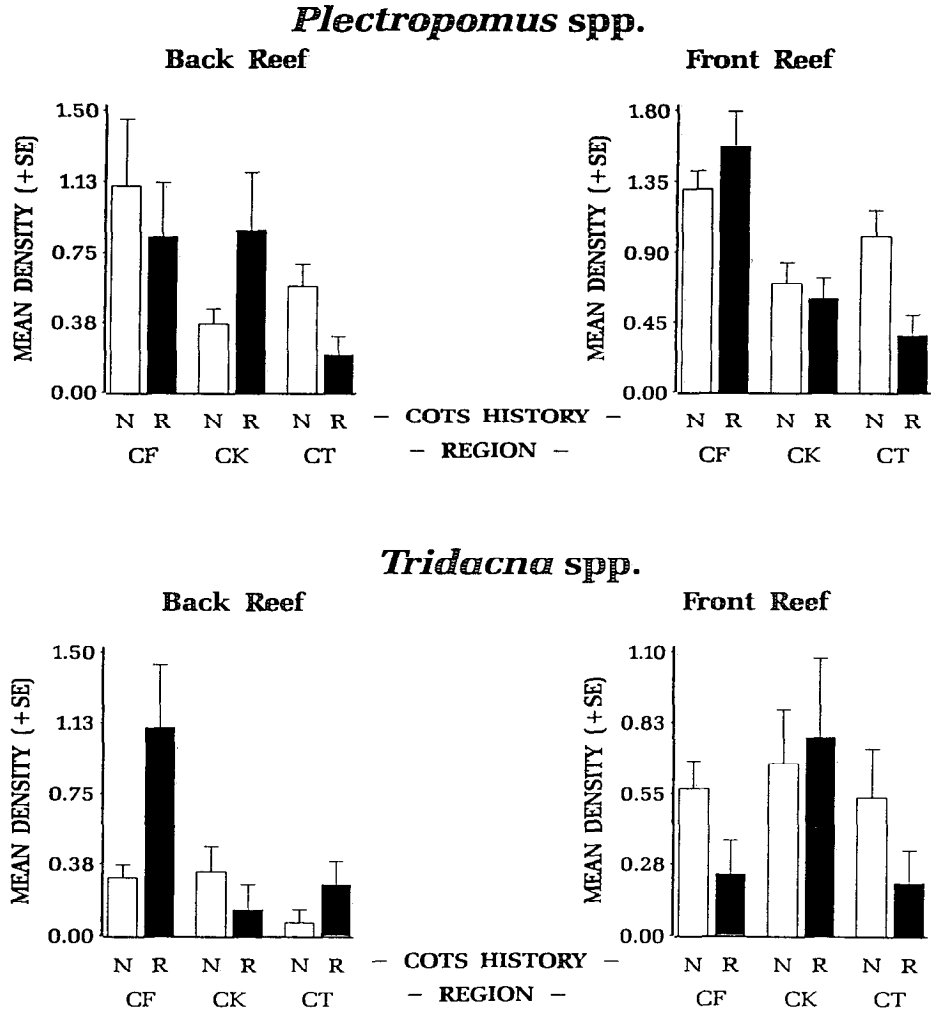


Effects of A. planci Related to Habitat and Region

Plectropomus spp and *Tridacna* spp each exhibited three way interactions between the effects of COTS history, Habitat, and Region (Table 5). Differences in density between COTS affected and unaffected reefs were significant in both habitats off Cape Flattery for *Tridacna* spp., and both habitats off Cape Tribulation for *Plectropomus* spp. COTS effects were also significant for *Plectropomus* spp. in back-reef habitats off Cooktown (Fig. 6). For neither genus, however, were the significant COTS effects consistent among regions or habitats. *Tridacna* spp. were more abundant on the back-reefs of COTS affected reefs than on the back-reefs of COTS unaffected

reefs (off Cape Flattery), but the reverse was true when front-reef habitats were considered (Fig. 6). Although coral trout were more abundant in both habitats on COTS unaffected reefs off Cape Tribulation, the reverse was so in back-reef habitats off Cooktown (Fig. 6).

Figure 6: Interactions between COTS history, Habitat, and Region on *Plectropomus* spp. and *Tridacna* spp. on mid-shelf reefs.
Abbreviations: **SE** - Standard Error; **R** - evidence of Recent Cots outbreak; **N** - No evidence of recent COTS outbreak; **CF** - Cape Flattery; **CK** - Cooktown; **CT** - Cape Tribulation.



Summary

In summary, the effects of recent COTS infestation could not be said to be consistent across taxa or even across regions and habitats within most taxa. Although conspicuous differences between COTS affected and COTS unaffected reefs were apparent for some corals, effects of recent COTS outbreaks on most corals were relatively slight when the reefs in the Cairns section were surveyed early in 1990. Some persistent effects were suggested for a few fish taxa.

Comparison of Counts of *A. planci* with Data from Manta Tows

Counts of *A. planci* on the reefs we surveyed were consistently low. We saw a total of only 11 individuals, and no more than 4 on any one reef (Table 6). *A. planci* were observed on 1-2 mid-shelf reefs in each region (Table 6), but not on any outer-shelf reefs. Eight of the 11 individuals were found in back-reef habitats.

The AIMS team observed 2 individuals during manta tows of the same reefs. Our surveys recorded *A. planci* on four reefs where none was recorded on manta tow surveys, whereas the AIMS team recorded one individual on one reef where we saw none. All *A. planci* seen by either team were greater than 15cm in diameter.

Table 6: Total counts of *A. planci* in three size classes (**< 20cm, 21-50cm, >50cm** diameter) from underwater visual searches (**UVS**, this project) and manta tow surveys (**MT**, AIMS) on the 24 reefs we surveyed. Only those reefs where at least one *A. planci* was seen by either team are included. Note that COTS are counted in only two size classes by MT observers, ≤15cm & >15cm diameter. Individuals greater than 15cm were put in the 21-50cm size class below.

			Acanthaster Planci							
			< 20cm		21-50cm		>50cm		TOTAL	
REGION	REEF	HABITAT	UVS	MT	UVS	MT	UVS	MT	UVS	MT
Cape Tribulation	Hastings	Front-reef	0	0	3	0	0	0	3	0
Cooktown	Boulder	Back-reef	0	0	1	0	0	0	1	0
	Egret	Back-reef	0	0	2	0	2	0	4	0
Cape Flattery	Eyrie	Back-reef	0	0	2	1	0	0	2	1
	Helsdon	Back-reef	0	0	0	1	0	0	0	1
	Lizard	Back-reef	0	0	1	0	0	0	1	0
TOTAL			**0**	**0**	**9**	**2**	**2**	**0**	**11**	**2**

Effects of Habitat

Habitat effects were common in these datasets. For all but one fish (*C. rollandi*), Habitat effects were dependent on other factors, such as Region and Shelf Position, but for several sessile taxa Habitat effects were significant and consistent across other strata.

General Effects of Habitat

The main effects of Habitat were significant, and uncomplicated by interactions with other fixed effects, for *C. rollandi*, counts of dead standing coral, faviids, and juvenile poritids, and both counts and percent coverage of miscellaneous hard corals (Table 7, Fig. 7). In all these cases, abundances were at least 50% greater on back-reefs than on front-reefs (Fig. 7). This was true also for pocilloporid corals (counts), acroporid corals (counts), small faviids, and small miscellaneous corals when only mid-shelf reefs were analysed to consider the effects of COTS infestations. *Chaetodon baronessa* also showed Habitat effects on mid-shelf reefs, but were more abundant on the front-reefs than back-reefs.

Table 7: Summary results of tests by univariate ANOVA for the effects of Shelf Position [**S**], Habitat [**H**], Region [**R**], and reefs [**r(RS)**] and their interactions on abundances of biota. Reef selection for analyses was standardised with respect to COTS history across shelf positions within each region. *, - = statistical significance and non-significance respectively at $\alpha_c=\beta$, given the effect sizes described in the text. Bold asterisks indicate the terms in analyses that were interpretable without ambiguity.

A: Fishes

	SOURCE OF VARIATION								
TAXON	Habitat	Region	Shelf	H*R	H*S	R*S	H*R*S	r(RS)	H*r(RS)
Large Fishes									
Total Acanthurids	*	*	*	-	*	*	-	*	*
Z. scopas	*	*	*	*	*	*	*	*	-
Other Acanthurids	*	*	*	-	*	*	-	*	*
All Chaetodons	-	*	-	*	-	*	*	*	-
C. aureofasciatus	-	*	*	-	-	*	-	*	-
C. baronessa	-	*	*	-	*	*	*	-	*
C. plebeius	*	*	-	-	*	-	-	-	-
C. trifasciatus	*	*	*	*	*	-	*	*	-
C. vagabundus	*	-	*	-	-	*	*	*	-
Other Chaetodons	*	*	*	-	*	-	-	*	*
All Lutjanids	*	*	*	*	-	-	-	-	-
L. carponotatus	-	*	*	-	-	*	-	*	-
Plectropomus spp	-	*	*	*	*	-	*	-	-
Small Fishes									
A. curacao	*	-	*	-	*	-	-	*	*
C. atripectoralis	-	*	*	*	*	*	-	-	-
C. rollandi	*	-	*	-	-	-	-	*	*
Recruit *C.r.*	*	*	*	*	*	*	*	-	-
P. lacrymatus	-	*	*	*	*	-	-	*	*
P. moluccensis	-	*	*	*	-	*	*	*	-
Recruit *P.m.*	-	*	*	*	*	*	*	-	-
T. lunare	-	*	*	-	*	*	-	-	-

Table 7: (Continued)

B: Sessile Benthos

TAXON	SOURCE OF VARIATION								
	Habitat	Region	Shelf	H*R	H*S	R*S	H*R*S	r(RS)	H*r(RS)
Small Corals									
Small Acroporids	*	*	*	*	*	*	-	*	*
Small Faviids	*	*	-	*	-	*	-	*	*
Small Pocilloporids	*	*	*	-	*	*	-	*	-
Misc. Small Hard	*	*	*	*	*	*	*	*	-
Small Soft Corals	-	*	*	-	-	*	-	*	*
Poritid Counts									
Poritids < 5cm	*	-	*	-	-	*	-	*	*
Poritids 6-20cm	-	-	*	-	-	*	-	*	*
Poritids 21-50cm	-	-	*	-	*	*	-	-	-
Poritids 51-100cm	*	-	-	-	*	*	*	-	-
Poritids >100cm	*	-	-	-	*	*	*	-	-
% Coverage									
Total Hard Coral	-	-	-	*	*	-	-	*	-
Acroporidae	*	-	-	*	-	-	-	*	*
Faviidae	*	-	-	-	*	-	-	-	-
Pocilloporidae	*	-	*	*	*	*	*	-	-
Poritidae	*	-	-	-	*	-	*	-	*
Misc. Hard Coral	*	-	-	-	-	-	-	*	*
Dead Stand Coral	*	*	*	-	*	*	-	-	*
Soft Corals	-	-	-	-	*	-	-	*	*
Sponges	*	-	*	-	*	-	-	-	*
# Intercepts									
Total Hard Coral	*	*	*	*	*	-	-	*	-
Acroporidae	*	*	*	-	*	-	-	*	*
Faviidae	*	-	-	-	-	*	-	*	*
Pocilloporidae	*	*	*	*	*	*	*	-	-
Poritidae	*	-	*	*	*	*	*	-	*
Misc. Hard Coral	*	-	-	-	-	-	-	*	*
Dead Stand Coral	*	*	*	-	*	*	-	-	*
Soft Corals	-	-	-	-	*	-	-	*	-
Sponges	*	-	*	-	*	-	-	*	*
Misc. Benthos									
Tridacna spp	*	*	*	*	*	-	*	-	-
L. laevigata	*	*	*	*	*	*	*	-	-