

The following supplement accompanies the article

# Impact of two sequential super typhoons on coral-reef communities in Palau

Marine Gouezo\*, Yimnang Golbuu, Robert van Woesik, Lincoln Rehm, Shirley Koshiba, Christopher Doropoulos

\*Corresponding author: mgouezo@picrc.org

Marine Ecology Progress Series 540: 73–85 (2015)

**Table S1.** Categories used to quantify benthic community composition with CPCe

<b>CORAL (C)</b>	Lobophyllia (LOBOPH)
Acanthastrea (ACAN)	Merulina (MERU)
Acropora (ACROP)	Millepora (MILL)
Alveopora (ALVEO)	Montastrea (MONT)
Anacropora (ANAC)	Montipora (MONTI)
Astreopora (ASTRP)	Mycedium (MYCED)
Caulastrea (CAUL)	Oulophyllia (OULO)
Coral Unknown (CRUNK)	Oxypora (OXYP)
Coscinaraea (COSC)	Pachyseris (PACHY)
Ctenactis (CTEN)	Pavona (PAV)
Cyphastrea (CYPH)	Pectinia (PECT)
Diploastrea (DIPLO)	Physogyra (PHYSO)
Echinophyllia (ECHPHY)	Platygyra (PLAT)
Echinopora (ECHPO)	Plerogyra (PLERO)
Euphyllia (EUPH)	Plesiastrea (PLSIA)
Favia (FAV)	Pocillopora (POC)
Faviid (FAVD)	Porites (POR)
Favites (FAVT)	Porites-massive (PORMAS)
Fungia (FUNG)	Porites-rus (PORRUS)
Galaxea (GAL)	Psammocora (PSAM)
Gardinioseris (GARD)	Sandalolitha (SANDO)
Goniastrea (GON)	Scapophyllia (SCAP)
Goniopora (GONIO)	Seriatopora (SERIA)
Heliopora (HELIO)	Stylocoeniella (STYLC)
Herpolitha (HERP)	Stylophora (STYLO)
Hydnophora (HYD)	Symphyllia (SYMP)
Isopora (ISOP)	Turbinaria (TURBIN)
Leptastrea (LEPT)	<b>SOFT CORAL (SC)</b>
Leptoria (LEPTOR)	Soft Coral (SC)
Leptoseris (LEPTOS)	

<b>OTHER INVERTEBRATES (OI)</b>
Anenome (ANEM)
Ascidian (ASC)
Cup Sponge (CUPS)
Discosoma (DISCO)
Dysidea Sponge (DYS)
Gorgonians (G)
Not Identified Invertebrate (NOIDINV)
Olive Sponge (OLV)
Sponges (SP)
Terpios Sponge (TERPS)
Zoanthids (Z)
<b>MACROALGAE (MA)</b>
Asparagopsis (ASP)
Bluegreen (BG)
Boodlea (BOOD)
Bryopsis (BRYP)
Caulerpa (CLP)
Chlorodesmis (CHLDES)
Dictosphyrea (DYCTY)
Dictyota (DICT)
Galaxura (GLXU)
Halimeda (HALI)
Liagora (LIAG)
Lobophora (LOBO)
Mastophora (MAST)
Microdictyton (MICDTY)
Neomeris (NEOM)
Not ID Macroalgae (NOIDMAC)
Padina (PAD)
Sargassum (SARG)
Schizothrix (SCHIZ)
Turbinaria (TURB)
Tydemanina (TYDM)
<b>SEAGRASS (SG)</b>
C.rotundata (CR)
C.serrulata (CS)
E. acroides (EA)
H. minor (HM)
H. ovalis (HO)
H. pinifolia (HP)
H. univervis (HU)
S. isoetifolium (SI)
Seagrass (SG)
T. ciliatum (TC)
T.hemprichii (TH)

<b>BRANCHING CORALLINE ALGAE (BCA)</b>
Amphiroa (AMP)
Branching Coralline general (BCA)
Jania (JAN)
<b>CRUSTOSE CORALLINE ALGAE (CCA)</b>
Crustose Coralline (CCA)
<b>CARBONATE (CAR)</b>
Carbonate (CAR)
<b>SAND (S)</b>
Sand (SAND)
<b>RUBBLE (R)</b>
Rubble (RUBBLE)
<b>FLESHY CORALLINE ALGAE (FCA)</b>
Fleshy-Coralline (FCA)
<b>CHRYSOPHYTE (CHRS)</b>
Brown Chrysophyte (CHRYOBRN)
<b>TURF ALGAE (T)</b>
Turf (TURF)

**Table S2.** List of commercially important fish species quantified on surveys

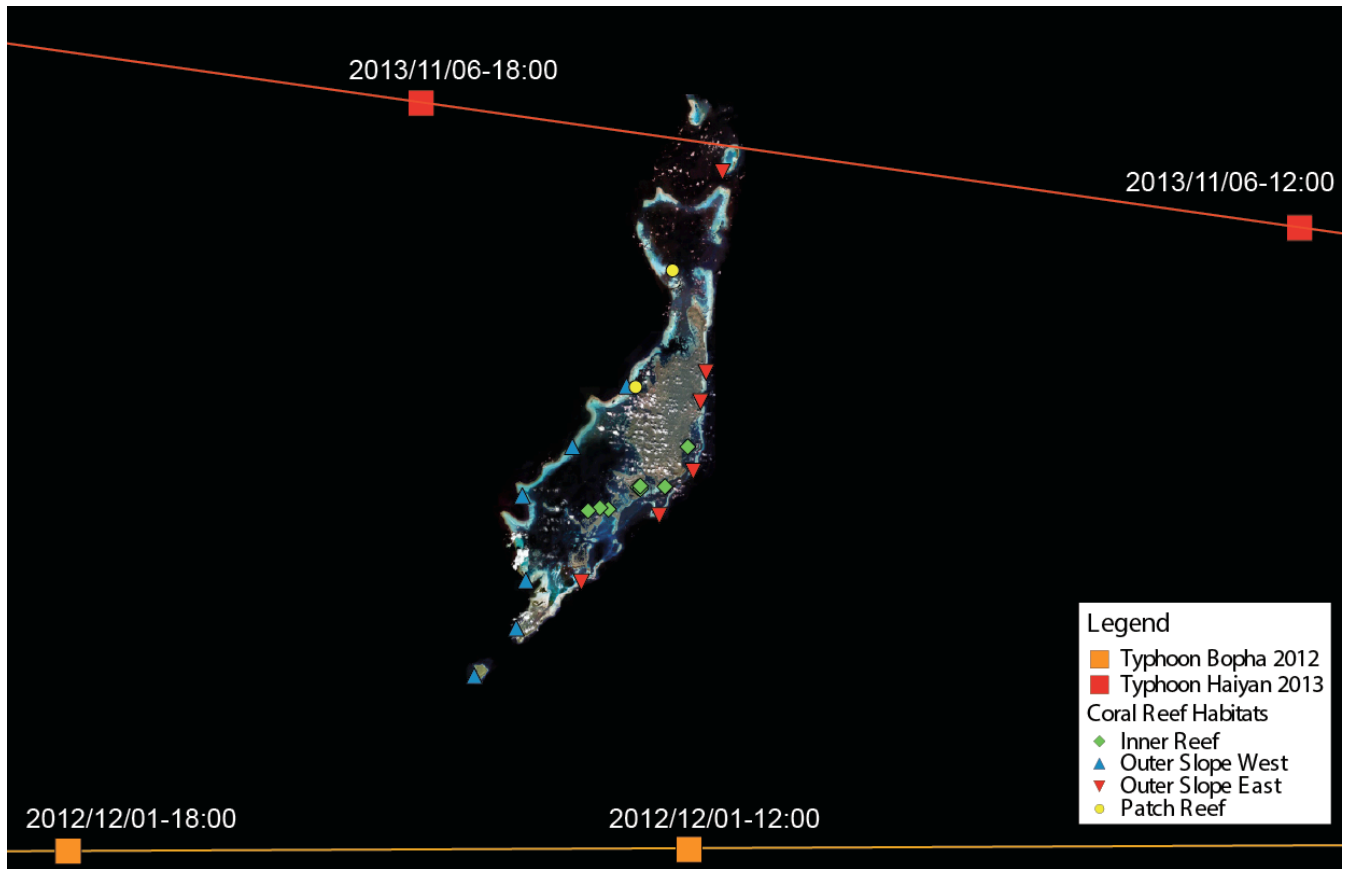
<b>Fish family</b>	<b>Scientific name</b>	<b>Common name</b>
Acanthuridae	<i>Naso unicornis</i> <i>Naso lituratus</i>	Bluespine unicornfish Orangspine unicornfish
Carangidae	<i>Caranx ignobilis</i> <i>Caranx melampygus</i>	Giant trevally Bluefin trevally
Lethrinidae	<i>Lethrinus olivaceus</i> <i>Lethrinus obsoletus</i> <i>Lethrinus rubrioperculatus</i> <i>Lethrinus xanthochilis</i>	Longface emperor Orangestripe emperor Red gill emperor Yellowlip emperor
Lutjanidae	<i>Lutjanus argentimaculatus</i> <i>Lutjanus bohar</i> <i>Lutjanus gibbus</i>	River snapper Red snapper Humpback snapper
Scaridae	<i>Cetoscarus bicolor</i> <i>Hipposcarus longiceps</i> <i>Scarus microhinos</i> <i>Cetoscarus/Scarus/Chlorurus Species</i>	Bicolor parrotfish Pacific longnose parrotfish Pacific steephead parrotfish All parrotfish
Serranidae	<i>Epinephelus fuscoguttatus</i> <i>Epinephelus polyphekadion</i> <i>Plectropomus areolatus</i> <i>Plectropomus laevis</i> <i>Plectropomus leopardus</i>	Brown-marbled grouper Marbled grouper Squaretail grouper Saddleback grouper Leopard grouper
Siganidae	<i>Siganus argenteus</i> <i>Siganus fuscescens</i> <i>Siganus lineatus</i> <i>Siganus puellus</i> <i>Siganus punctatus</i>	Forketail rabbitfish Dusky rabbitfish Lined rabbitfish Masked rabbitfish Goldspotted rabbitfish

**Table S3.** Mean percentage coral cover with standard errors at the 22 surveyed sites and habitats

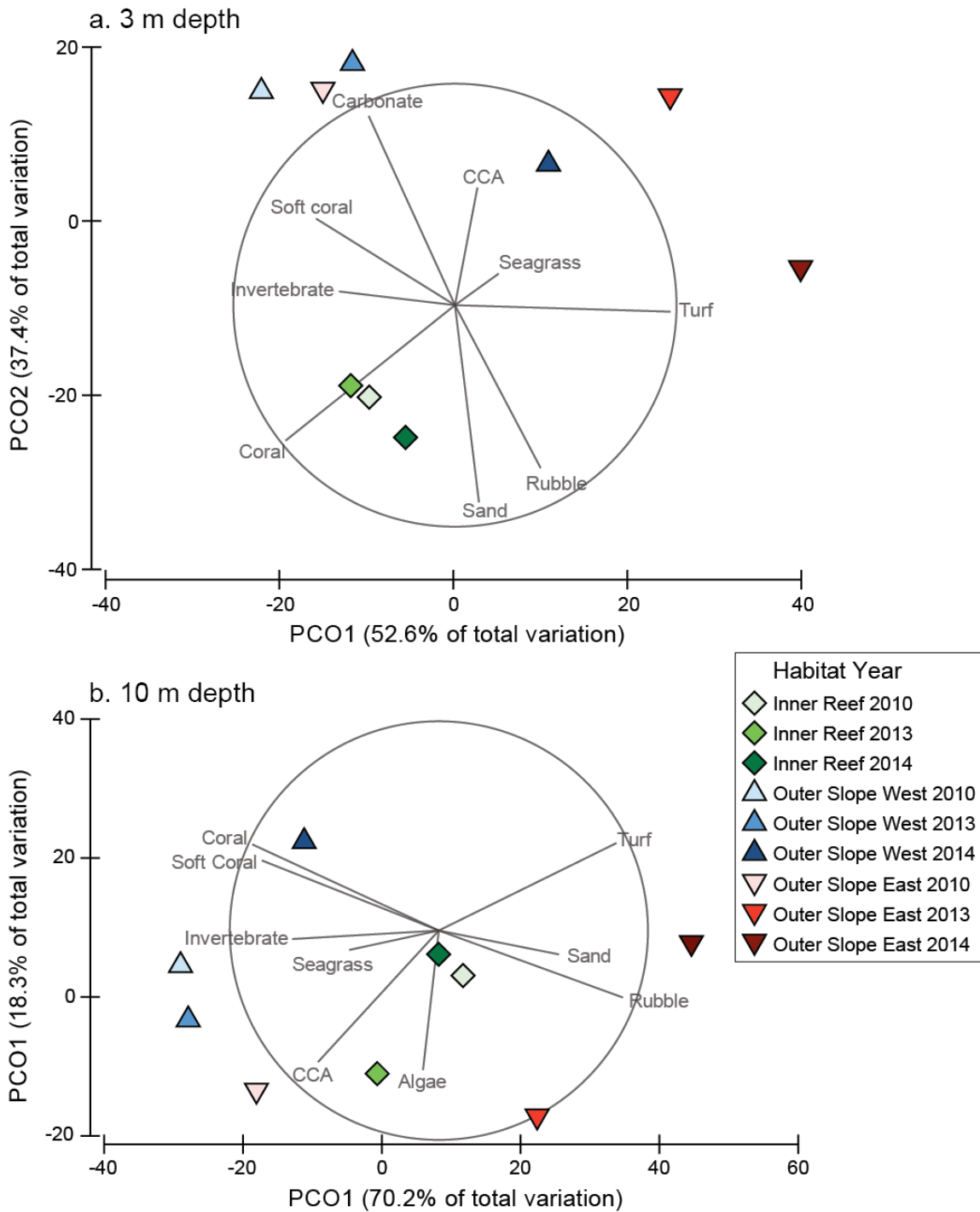
Habitat	Site	Depth (m)	n	2010		2013		2014	
				Mean Coral (%)	± SEM	Mean Coral (%)	± SEM	Mean Coral (%)	± SEM
<b>Inner Reef</b>	<b>All</b>	<b>3</b>	<b>40</b>	<b>51</b>	<b>3</b>	<b>49</b>	<b>15</b>	<b>49</b>	<b>8</b>
	Airai	3	5	37	5	2	1	1	2
	Ngelukes	3	5	17	6	23	7	19	7
	Nikko_1	3	5	63	4	69	4	73	6
	Nikko_2	3	5	61	4	65	6	68	3
	Nikko_3	3	5	75	3	75	2	82	2
	Taoch_1	3	5	63	5	62	5	50	3
	Taoch_2	3	5	63	3	65	5	72	4
	Taoch_3	3	5	28	3	35	5	25	2
<b>Outer Slope East</b>	<b>All</b>	<b>3</b>	<b>30</b>	<b>30</b>	<b>4</b>	<b>5</b>	<b>5</b>	<b>6</b>	<b>5</b>
	Kayangel*	3	5	30	1	24	3	26	2
	Melekeok	3	5	41	5	2	1	8	13
	Ngaraard*	3	5	3	0	2	5	0	0
	Ngerchong	3	5	61	3	0	0	0	0
	Ngetngod	3	5	18	2	0	0	1	2
	Uchelbeluu	3	5	29	1	3	2	1	1
<b>Outer Slope West</b>	<b>All</b>	<b>3</b>	<b>30</b>	<b>34</b>	<b>3</b>	<b>27</b>	<b>8</b>	<b>29</b>	<b>5</b>
	Angaur	3	5	26	7	20	2	38	5
	Ngaremlengui	3	5	31	5	24	4	18	3
	Ngediluches	3	5	21	5	7	1	25	8
	Ngemelis	3	5	37	4	41	3	43	5
	Peleliu	3	5	23	4	29	3	10	1
	Siaes	3	5	67	3	44	2	41	2
<b>Patch Reef</b>	<b>All</b>	<b>3</b>	<b>10</b>	<b>29</b>	<b>5</b>	<b>43</b>	<b>7</b>	<b>35</b>	<b>7</b>
	Ngarem_PR	3	5	30	8	46	3	50	6
	Ngerchelong	3	5	27	9	39	8	20	5
<b>Inner Reef</b>	<b>All</b>	<b>10</b>	<b>40</b>	<b>32</b>	<b>3</b>	<b>33</b>	<b>12</b>	<b>32</b>	<b>7</b>
	Airai	10	5	9	1	10	3	5	1
	Ngelukes	10	5	10	1	13	4	8	3
	Nikko_1	10	5	54	6	59	3	57	6
	Nikko_2	10	5	45	4	56	5	58	5
	Nikko_3	10	5	59	2	59	4	65	2
	Taoch_1	10	5	23	2	19	5	22	2
	Taoch_2	10	5	36	5	30	2	22	7
	Taoch_3	10	5	17	3	16	2	20	4
<b>Outer Slope East</b>	<b>All</b>	<b>10</b>	<b>30</b>	<b>32</b>	<b>2</b>	<b>11</b>	<b>10</b>	<b>6</b>	<b>2</b>
	Kayangel*	10	5	46	2	39	4	19	4
	Melekeok	10	5	25	3	3	2	4	3
	Ngaraard*	10	5	22	1	12	3	1	1
	Ngerchong	10	5	46	1	0	0	0	0
	Ngetngod	10	5	23	2	2	1	1	1
	Uchelbeluu	10	5	28	2	10	3	9	2

				2010		2013		2014	
Habitat	Site	Depth (m)	n	Mean Coral (%)	± SEM	Mean Coral (%)	± SEM	Mean Coral (%)	± SEM
<b>Outer Slope West</b>	<b>All</b>	<b>10</b>	<b>30</b>	<b>56</b>	<b>2</b>	<b>50</b>	<b>7</b>	<b>55</b>	<b>4</b>
	Angaur	10	5	48	2	51	7	49	4
	Ngaremlengui	10	5	57	1	53	6	55	2
	Ngediluches	10	5	47	2	41	5	48	3
	Ngemelis	10	5	75	3	61	3	75	3
	Peleliu	10	5	48	2	38	3	47	2
	Siaes	10	5	59	5	55	3	55	2
<b>Patch Reef</b>	<b>All</b>	<b>10</b>	<b>10</b>	<b>14</b>	<b>3</b>	<b>20</b>	<b>6</b>	<b>21</b>	<b>4</b>
	Ngarem_PR	10	5	10	1	24	13	25	2
	Ngerchelongs	10	5	19	6	16	3	16	6

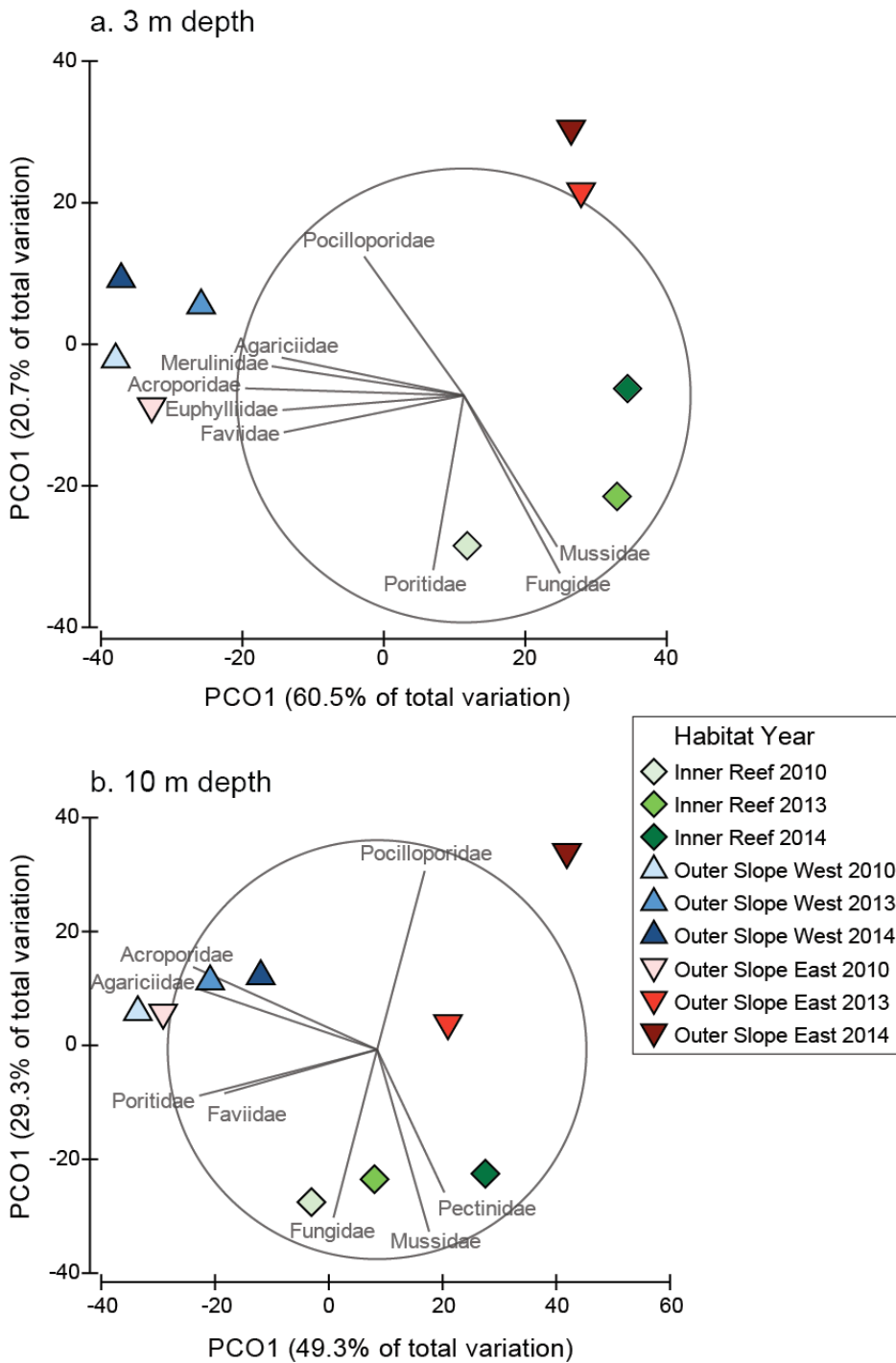
\* indicates the sites located on the northeastern reefs affected by typhoon Haiyan



**Fig. S1.** Map of the archipelago of Palau showing the location of the 22 monitoring sites in their habitats (different colored circles) and the paths of the two typhoons: Bopha in 2012 (in orange) and Haiyan in 2013 (in red). Green diamonds = inner reef; upward pointing blue triangles = outer slope west; downward facing red triangles = outer slope east; yellow circles = patch reef. Typhoon track coordinates from the Japan Meteorological Agency: <http://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/trackarchives.html>

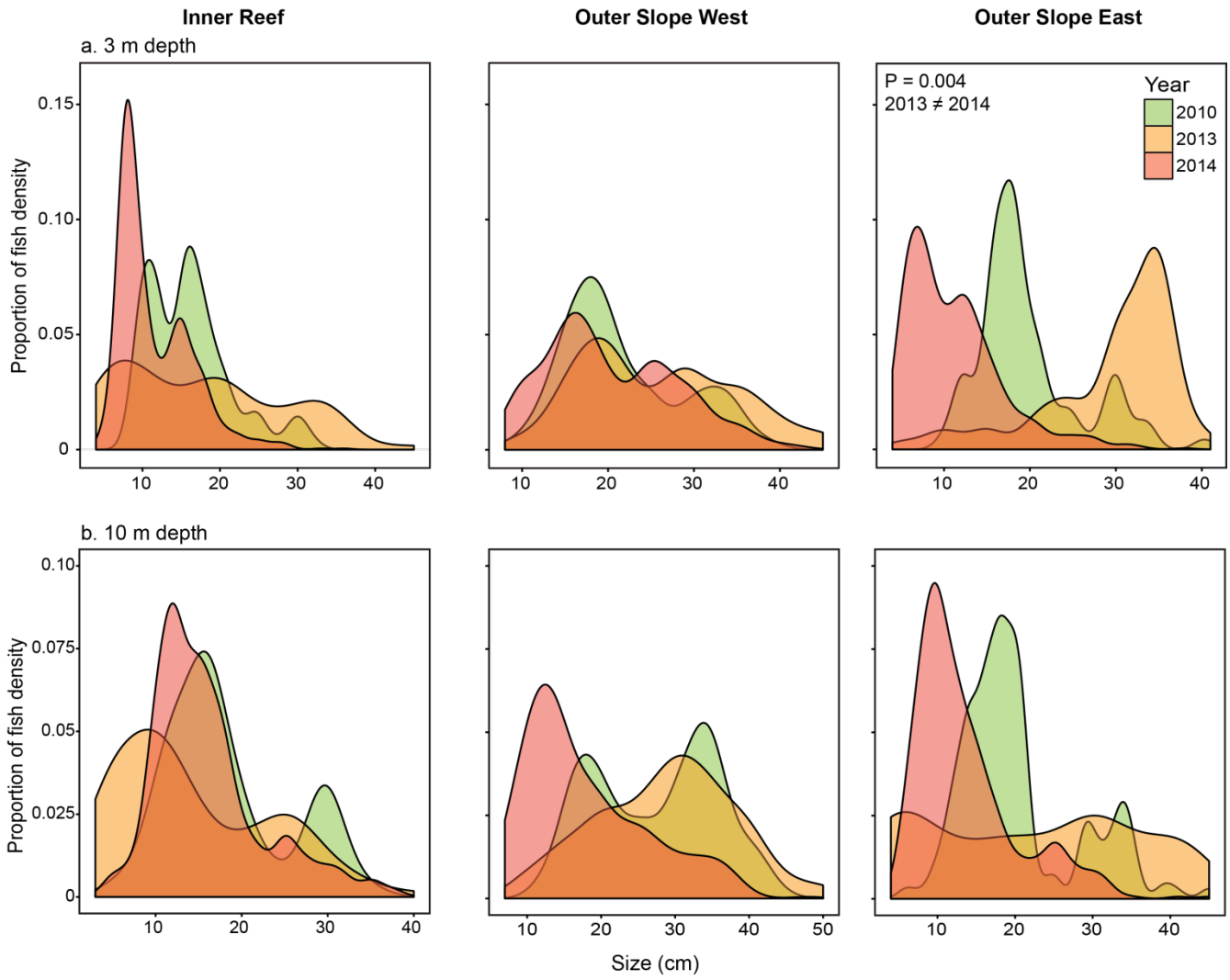


**Fig. S2.** PCO of benthic community structure (broad categories) among habitats and time at (a) 3 m and (b) 10 m depth. Green diamonds = inner reef; upward pointing blue triangles = outer slope west; downward facing red triangles = outer slope east. Light shades = 2010; medium shades = 2013; dark shades = 2014. Vector overlays represent correlations  $>0.7$  based on Pearson ranking



**Fig. S3.** PCO of coral recruit community structure among habitats and time at (a) 3 m and (b) 10 m depth. Green diamonds = inner reef; upward pointing blue triangles = outer slope west; downward facing red triangles = outer slope east. Light shades = 2010; medium shades = 2013; dark shades = 2014. Vector overlays represent correlations  $>0.7$  based on Pearson ranking





**Fig. S4.** Density curves of Scaridae sizes among habitats and time at (a) 3 m depth and (b) 10 m depth. Only significant differences in skewness are displayed within each panel