APPENDIX A: MATERIALS AND METHODS

Appendix A-1. Trawl station locations and characteristics in the southern California Bight 2008 Regional Survey, July-October 2008

				Station Coordinates[a]													
	Trwl	Date		Nominal Trawl				Trawl Start					Depth	Dist.	Dur.	Spd[d]	
Station	No.[b]	(2008)	Ag[c]	Lat N (dm)		Long W (dm)		Lat N (dm)		Long W (dm)		Time	(m)	(m)	(min)	(m/s)	FC[e]
6028	1	8/15	WS	32	37.85	-117	7.35	32	37.81	-117	7.29	10:07	3.5	319	5	1.06	-
6031	1	8/15	WS	32	37.93	-117	8.19	-	-	-	-	23:59	-		0	-	P
6071	1	8/15	WS	32	39.49	-117	8.66	32	39.51	-117	8.67	9:01	4	294	5	0.98	-
6080	1	8/15	WS	32	39.89	-117	9.00	32	39.95	-117	9.04	8:26	4	357	5	1.19	-
6083	-	1/1	WS	32	40.20	-117	9.30	-	-	-	-	23:59	-		0	-	T
6084	1	8/15	WS	32	40.21	-117	8.20	32	40.21	-117	8.19	7:59	4	286	5	0.95	-
6090	-	1/1	WS	32	40.40	-117	8.19	-	-	-	-	23:59	-		0	-	T
6093	1	8/14	WS	32	40.52	-117	8.63	32	40.55	-117	8.65	14:21	4	320	5	1.07	-
6106	-	1/1	WS	32	40.87	-117	8.73	-	-	-	-	23:59	-		0	-	T
6138	1	8/14	WS	32	42.07	-117	13.59	32	42.04	-117	13.63	10:42	12.5	336	5	1.12	-
6139	1	8/15	WS	32	42.11	-117	10.72	32	42.16	-117	10.72	7:12	3.5	306	5	1.02	-
6152	1	8/14	WS	32	42.90	-117	10.98	32	42.91	-117	10.98	13:28	11	316	5	1.05	-
6172	1	8/14	WS	32	43.45	-117	10.97	32	43.46	-117	10.93	12:37	4	304	5	1.01	-
6188	1	8/14	WS	32	45.46	-117	15.15	32	45.47	-117	15.19	8:30	7	319	5	1.06	-
6212	1	8/14	WS	32	46.04	-117	14.50	32	46.09	-117	14.47	8:05	5.5	315	5	1.05	-
6217	1	8/14	WS	32	47.06	-117	12.93	32	47.09	-117	12.84	7:10	3	297	5	0.99	-
6294	1	8/11	WS	33	12.46	-117	23.84	33	12.47	-117	23.86	13:15	6.5	309	5	1.03	-
6295	1	8/11	WS	33	12.49	-117	23.74	33	12.55	-117	23.73	13:55	5.5	304	5	1.01	-
6325	1	8/11	WS	33	27.64	-117	42.33	33	27.56	-117	42.27	8:53	6.5	276	5	0.92	-
6386	1	9/16	HY	33	42.72	-118	15.47	33	42.75	-118	15.53	10:35	17.5	342	5	1.14	-
6387	1	9/16	HY	33	42.81	-118	14.50	33	42.83	-118	14.42	9:46	24	354	5	1.18	-
6404	1	9/18	HY	33	43.45	-118	13.45	33	43.51	-118	13.39	8:28	15	319	5	1.06	-
6444	1	9/18	HY	33	44.54	-118	9.18	33	44.56	-118	9.21	9:56	10.5	306	5	1.02	-
6448	1	9/18	HY	33	44.65	-118	10.12	33	44.65	-118	10.16	10:53	11.7	247	5	0.82	-
6478	1	9/18	HY	33	45.58	-118	9.76	33	45.51	-118	9.73	11:56	6.5	349	5	1.16	-
6566	1	8/15	WS	32	37.82	-117	6.76	32	37.78	-117	6.75	10:56	2.5	308	5	1.03	-
7000	1	8/11	SD	32	32.24	-117	8.50	32	32.05	-117	8.48	11:29	16	438	10	0.73	-
7002	1	7/23	SD	32	33.05	-117	11.96	32	32.91	-117	11.94	12:07	36	493	10	0.82	-
7005	1	7/23	SD	32	34.52	-117	9.55	-	-	-	-	23:59	-		0	-	M
7008	1	7/28	SD	32	35.14	-117	20.47	32	34.93	-117	20.41	11:12	201	545	11	0.83	-
7009	1	7/25	SD	32	35.36	-117	15.82	32	35.29	-117	15.81	11:06	57.5	571	12	0.79	-
7014	1	7/29	SD	32	35.86	-117	21.08	32	35.82	-117	21.04	8:35	185	554	10	0.92	-
7019	1	7/28	SD	32	36.40	-117	16.65	32	36.27	-117	16.59	8:12	70.5	523	10	0.87	-
7021	1	7/24	SD	32	36.80	-117	10.67	32	36.63	-117	10.51	12:05	21	453	11	0.69	-
7024	1	7/24	SD	32	37.29	-117	8.48	32	37.10	-117	8.46	9:57	9	519	10	0.87	-
7029	1	8/5	SD	32	38.18	-117	25.05	32	37.94	-117	24.99	9:17	152		10	0.00	H
7030	1	8/11	SD	32	38.21	-117	21.66	32	37.97	-117	21.66	9:08	200	545	11	0.83	-
7032	1	7/29	SD	32	38.62	-117	20.46	32	38.42	-117	20.40	11:04	136	488	8	1.02	-
7044	1	7/24	SD	32	39.81	-117	12.01	32	39.74	-117	12.05	8:20	10	524	10	0.87	-
7064	2	8/5	SD	32	41.63	-117	23.75	32	41.62	-117	23.79	12:48	381	592	11	0.90	-
7068	1	7/31	SD	32	42.62	-117	18.59	32	42.64	-117	18.59	9:30	75	636	11	0.96	-
7069	1	8/6	SD	32	42.68	-117	23.27	32	42.61	-117	23.28	9:04	415	416	9	0.77	-
7081	1	8/6	SD	32	44.99	-117	22.33	32	45.13	-117	22.39	12:42	198	515	9	0.95	-
7091	1	7/31	SD	32	47.78	-117	15.94	32	47.56	-117	15.85	11:12	10.5	570	10	0.95	-
7093	1	7/31	SD	32	48.47	-117	20.65	32	48.36	-117	20.67	12:33	86	505	9	0.94	-
7095	1	8/7	SD	32	49.52	-117	21.96	32	49.42	-117	22.00	9:08	190	571	10	0.95	-

Appendix A-1. Continued

				Station Coordinates[a]													
				Nominal Trawl				Trawl Start									
Station	Trwl No.[b]	Date (2008)	Ag[c]	Lat	N (dm)	Long W (dm)		Lat N (dm)		Long W (dm)		Time	Depth (m)	Dist. (m)	Dur. (min)	Spd[d] (m/s)	FC[e]
7098	1	8/7	SD	32	50.98	-117	21.27	32	50.81	-117	21.33	10:56	198	524	10	0.87	-
7113	-	1/1	VR	32	59.93	-117	17.82	-	-	-	-	23:59	-		0	-	M
7122	1	8/25	VR	33	5.28	-117	21.06	33	5.02	-117	20.88	13:32	70	781	10	1.30	-
7123	1	9/8	WS	33	5.62	-117	25.03	33	5.48	-117	24.97	9:37	421	1346	23	0.98	-
7128	1	8/25	VR	33	6.31	-117	21.71	33	6.08	-117	21.55	14:13	81.5	779	10	1.30	-
7145	1	8/12	WS	33	9.13	-117	22.86	33	9.10	-117	22.84	7:50	40	607	10	1.01	-
7158	1	8/26	VR	33	13.24	-117	30.72	33	13.05	-117	30.55	8:50	195	749	10	1.25	-
7159	-	8/26	VR	33	13.37	-117	25.04	-	-	-	-	-	-		-	-	N
7165	1	7/16	OC	33	15.74	-117	33.89	33	15.71	-117	33.79	11:32	144	625	10	1.04	-
7166	1	7/16	OC	33	15.93	-117	32.04	33	15.80	-117	31.89	12:57	61	569	10	0.95	-
7167	1	7/16	OC	33	16.19	-117	33.89	33	16.06	-117	33.67	14:07	77	569	10	0.95	-
7174	1	7/16	OC	33	18.95	-117	38.32	33	18.97	-117	38.35	15:39	355	570	10	0.95	-
7183	-	8/26	VR	33	22.54	-117	36.28	-	-	-	-	-	-		-	-	M
7185	1	9/3	SV	33	24.36	-117	40.71	33	24.35	-117	40.70	8:00	64.1	602	10	1.00	-
7186	1	9/5	SV	33	25.10	-118	1.35	33	25.23	-118	1.26	10:55	355	932	17	0.91	-
7193	2	9/3	SV	33	25.82	-117	44.71	33	25.75	-117	44.62	11:41	439	1264	23	0.92	-
7194	1	8/26	VR	33	25.84	-117	40.61	33	25.92	-117	40.78	13:39	22	863	11	1.31	-
7201	1	8/11	WS	33	27.31	-117	41.57	33	27.32	-117	41.56	7:59	5	308	5	1.03	-
7208	1	7/16	OC	33	27.86	-117	45.75	33	27.79	-117	45.58	7:24	-		0	-	J
7208	2	7/16	OC	33	27.86	-117	45.75	33	27.83	-117	45.72	7:59	28.5		4	0.00	R
7210	1	9/4	SV	33	28.52	-118	5.98	33	28.52	-118	6.03	12:01	485	1247	23	0.90	-
7215	1	7/16	OC	33	29.95	-117	45.17	33	29.83	-117	45.08	9:43	24.5	564	10	0.94	-
7231	1	7/16	OC	33	31.28	-117	46.19	33	31.18	-117	46.12	8:43	15.5	625	10	1.04	-
7236	1	9/5	SV	33	32.21	-117	50.91	33	32.19	-117	50.83	7:57	348	1103	19	0.97	-
7240	1	7/28	OC	33	32.87	-117	51.18	33	32.85	-117	51.10	7:37	209	550	10	0.92	-
7241	1	9/4	SV	33	33.08	-118	6.12	33	33.02	-118	6.20	9:09	324	868	15	0.96	-
7253	1	7/28	OC	33	34.77	-118	8.36	33	34.82	-118	8.32	9:38	76	596	10	0.99	-
7269	1	7/28	OC	33	36.11	-118	3.39	33	36.04	-118	3.27	11:08	37.5	675	10	1.13	-
7287	1	8/12	LA	33	37.26	-118	11.70	33	37.27	-118	11.84	13:53	43	552	10	0.92	-
7293	1	7/28	OC	33	37.67	-117	59.23	33	37.66	-117	59.22	12:48	13	568	10	0.95	-
7298	1	8/12	LA	33	38.37	-118	9.96	33	38.37	-118	10.12	13:14	33	553	10	0.92	-
7300	1	8/12	LA	33	38.58	-118	4.70	33	38.66	-118	4.87	10:09	28	537	10	0.89	-
7301	1	8/12	LA	33	38.88	-118	8.97	33	38.86	-118	9.08	12:40	31	546	10	0.91	-
7304	1	8/12	LA	33	39.38	-118	9.07	-	-	-	-	-	-		-	-	N
7305	1	8/12	LA	33	39.57	-118	7.84	33	39.60	-118	8.11	10:52	28.5	547	10	0.91	-
7310	1	8/12	LA	33	40.55	-118	9.84	33	40.55	-118	10.02	12:05	27	538	10	0.90	-
7312	1	8/12	LA	33	40.75	-118	8.42	33	40.82	-118	8.69	11:28	25.5	522	10	0.87	-
7313	1	8/14	LA	33	40.91	-118	11.58	33	40.93	-118	11.77	8:09	24	557	10	0.93	-
7320	1	8/14	LA	33	41.64	-118	20.79	33	41.56	-118	20.66	10:52	286	515	10	0.86	-
7321	1	8/14	LA	33	41.72	-118	17.77	33	41.78	-118	18.03	9:07	28	525	10	0.88	-
7324	1	8/14	LA	33	42.12	-118	18.23	33	42.10	-118	18.20	9:54	20.5	524	10	0.87	-
7325	1	8/12	LA	33	42.17	-118	4.96	33	42.29	-118	5.14	9:10	12	534	10	0.89	H
7355	1	8/12	LA	33	43.98	-118	7.29	33	43.91	-118	7.11	8:30	7.5		10	0.00	-
7395	1	8/14	LA	33	46.01	-118	27.63	33	45.89	-118	27.54	12:32	136	477	10	0.79	-

Appendix A-1. Continued

				Station Coordinates[a]													
	Trwl	Date		Nominal Trawl				Trawl Start					Depth	Dist.	Dur.	Spd[d]	
Station	No.[b]	(2008)	Ag[c]	Lat N (dm)		Long W (dm)		Lat N (dm)		Long W (dm)		Time	(m)	(m)	(min)	(m/s)	FC[e]
7403	1	8/14	LA	33	50.12	-118	28.19	33	50.24	-118	28.23	13:35	94.5	505	10	0.84	-
7409	1	9/23	HY	33	50.87	-118	27.98	33	50.73	-118	27.82	8:43	78.5	457	10	0.76	-
7410	-	8/28	HY	33	50.87	-118	34.07	-	-	-	-	-	-		-	-	S
7415	1	8/28	HY	33	51.38	-118	30.96	33	51.35	-118	31.25	11:25	68.5		10	0.00	S
7417	1	8/28	HY	33	51.62	-118	26.88	33	51.52	-118	26.68	9:30	58.5	518	10	0.86	-
7426	-	8/28	HY	33	53.61	-118	35.05	-	-	-	-	-	-		-	-	S
7428	2	9/25	HY	33	53.86	-118	39.41	33	53.99	-118	39.43	13:01	393	582	12	0.81	-
7446	1	9/23	HY	33	55.57	-118	28.88	33	55.60	-118	28.89	12:11	34.5	503	10	0.84	-
7448	1	8/12	HY	33	55.72	-118	28.97	33	55.60	-118	28.89	11:51	35	543	10	0.90	-
7453	1	9/23	HY	33	56.09	-118	32.39	33	56.14	-118	32.41	10:55	57	603	10	1.00	-
7458	2	9/25	HY	33	56.33	-118	33.51	33	56.35	-118	33.51	9:00	77	563	10	0.94	-
7461	1	8/12	HY	33	56.62	-118	31.19	33	56.68	-118	31.19	10:20	48	624	11	0.94	-
7467	2	8/19	HY	33	57.43	-118	35.58	33	57.35	-118	35.52	11:59	152	535	11	0.81	-
7474	1	8/19	HY	33	57.75	-118	28.57	33	57.85	-118	28.64	7:38	15	552	10	0.92	-
7477	4	8/27	HY	33	58.03	-118	38.86	33	57.99	-118	38.69	11:28	195	405	10	0.68	-
7479	4	8/26	HY	33	58.25	-118	43.66	33	58.19	-118	43.58	11:06	380	474	11	0.72	-
7499	1	8/12	AB	33	59.96	-119	0.83	33	59.98	-119	0.84	13:08	88.5		4	0.00	S
7502	1	9/18	VR	34	0.14	-118	55.08	34	0.23	-118	55.16	10:01	50.5	804	10	1.34	-
7507	1	9/18	VR	34	0.71	-119	1.24	34	0.73	-119	1.37	11:50	87	531	9	0.98	-
7517	1	8/19	HY	34	1.39	-118	35.57	34	1.45	-118	35.77	9:32	23	532	10	0.89	-
7522	1	8/26	AB	34	2.20	-118	55.01	34	2.15	-118	55.15	9:34	15	540	10	0.90	-
7526	1	8/13	AB	34	2.47	-119	11.83	34	2.31	-119	11.79	13:13	386	701	10	1.17	-
7528	1	8/12	AB	34	2.64	-119	3.33	34	2.59	-119	3.47	15:16	225	808	10	1.35	-
7537	1	8/12	AB	34	3.19	-119	3.77	34	3.29	-119	3.93	17:40	144	843	10	1.40	-
7544	1	8/13	AB	34	4.00	-119	12.36	34	4.18	-119	12.23	14:45	97.5	618	10	1.03	-
7550	1	8/13	AB	34	4.40	-119	8.34	34	4.31	-119	8.43	10:20	102	722	10	1.20	-
7557	1	8/26	AB	34	4.80	-119	3.59	34	4.82	-119	3.70	11:18	18	706	10	1.18	-
7572	1	8/26	AB	34	6.07	-119	9.05	34	6.08	-119	9.07	13:05	14	620	10	1.03	-
7579	1	8/1	MB	34	6.43	-119	19.14	34	6.34	-119	18.94	8:49	197	290	10	0.48	-
7590	1	9/19	VR	34	7.09	-119	37.73	34	7.09	-119	38.14	11:58	258	895	10	1.49	-
7592	1	8/1	MB	34	7.37	-119	19.88	34	7.34	-119	19.83	11:17	141	649	10	1.08	-
7596	1	8/26	AB	34	7.50	-119	11.56	34	7.53	-119	11.67	14:34	14.5	789	10	1.32	-
7603	1	8/1	MB	34	7.96	-119	22.19	34	7.91	-119	21.80	15:17	151	598	10	1.00	-
7604	1	8/1	MB	34	7.97	-119	22.78	34	7.97	-119	22.74	16:54	175	641	10	1.07	-
7607	1	8/1	MB	34	8.32	-119	20.74	34	8.26	-119	20.66	13:17	63	654	10	1.09	-
7609	1	9/20	VR	34	8.62	-120	10.69	34	8.65	-120	10.82	16:25	427	744	9	1.38	-
7611	1	9/19	VR	34	8.74	-119	46.21	34	8.80	-119	46.27	15:45	365	839	10	1.40	-
7615	2	9/20	VR	34	9.07	-119	48.04	34	9.11	-119	48.23	9:24	387	721	10	1.20	-
7617	1	9/20	VR	34	9.50	-119	49.66	34	9.55	-119	49.85	12:28	407	756	10	1.26	-
7619	1	9/21	VR	34	9.67	-120	19.17	34	9.52	-120	19.28	8:02	386	505	8	1.05	-
7620	1	9/19	VR	34	9.73	-119	39.86	34	9.75	-119	40.33	13:34	313	1009	10	1.68	-
7625	1	9/19	VR	34	10.20	-119	31.98	34	10.12	-119	32.34	10:00	227	884	11	1.34	-
7629	1	8/5	MB	34	10.72	-119	20.81	34	10.93	-119	20.97	11:16	27	713	10	1.19	-
7632	2	9/21	VR	34	10.99	-120	21.08	34	11.13	-120	21.31	11:35	456	591	8	1.23	-
7637	1	9/21	VR	34	11.76	-120	25.03	34	11.97	-120	25.27	13:31	433	636	8	1.33	-
7641	1	8/5	MB	34	12.40	-119	34.05	34	12.55	-119	34.17	9:10	140	721	10	1.20	-

Appendix A-1. Continued

				Station Coordinates[a]													
				Nominal Trawl				Trawl Start									
	Trwl	Date											Depth	Dist.	Dur.	Spd[d]	
Station	No.[b]	(2008)	Ag[c]	Lat N (dm)		Long W (dm)		Lat N (dm)		Long W (dm)		Time	(m)	(m)	(min)	(m/s)	FC[e]
7645	1	8/5	MB	34	12.80	-119	35.46	34	12.95	-119	35.68	7:42	152	786	10	1.31	-
7647	1	8/2	MB	34	13.13	-119	21.28	34	13.18	-119	21.30	7:57	23.5	641	10	1.07	-
7668	1	9/19	VR	34	15.23	-119	43.78	34	15.12	-119	43.98	7:46	203	891	12	1.24	-
7678	1	8/4	MB	34	16.67	-119	43.10	34	16.96	-119	43.39	14:39	202	830	10	1.38	-
7681	1	8/2	MB	34	17.03	-119	21.29	-	-	-	-	-	-		0	-	K
7684	1	9/22	VR	34	17.13	-120	16.81	34	17.15	-120	16.99	9:04	425	420	7	1.00	-
7686	1	9/21	VR	34	17.23	-120	27.33	34	17.36	-120	27.63	15:42	431	438	6	3.50	-
7688	1	8/2	MB	34	17.45	-119	26.63	34	17.24	-119	26.27	10:28	42	786	10	1.31	-
7697	1	9/22	VR	34	18.47	-120	13.82	34	18.56	-120	14.20	11:59	438	538	8	1.12	-
7699	1	9/22	VR	34	18.83	-119	53.05	34	18.85	-119	53.15	16:21	401	303	6	0.84	-
7700	1	9/22	VR	34	18.86	-120	16.94	34	18.96	-120	17.22	10:43	383		4	0.00	G
7701	1	8/4	MB	34	19.00	-119	43.44	34	19.11	-119	43.80	16:04	131	833	10	1.39	-
7708	1	8/2	MB	34	20.64	-119	33.75	34	20.74	-119	33.31	13:54	44	738	10	1.23	-
7709	1	9/22	VR	34	20.65	-120	22.12	34	20.86	-120	22.44	7:37	285	614	8	1.28	-
7714	1	8/2	MB	34	21.73	-119	35.12	34	21.54	-119	34.85	15:02	41	813	10	1.36	-
7716	1	9/22	VR	34	21.76	-120	0.62	34	21.79	-120	0.75	14:22	449	546	6	1.52	-
7717	1	8/2	MB	34	21.97	-119	27.56	34	21.64	-119	27.36	12:33	11	693	10	1.15	-
7728	1	8/2	MB	34	23.72	-119	39.73	34	23.81	-119	39.45	16:13	26	677	10	1.13	-
7732	1	8/3	MB	34	23.86	-120	4.29	34	23.81	-120	3.89	11:53	172	887	10	1.48	-
7735	1	8/3	MB	34	23.90	-119	51.89	34	23.90	-119	51.71	9:27	28	499	10	0.83	-
7741	1	8/3	MB	34	24.06	-119	49.97	34	24.05	-119	49.74	8:30	30	715	10	1.19	-
7743	1	8/3	MB	34	24.23	-119	48.73	34	24.24	-119	48.54	7:31	16	585	10	0.97	-
7744	1	8/4	MB	34	24.31	-120	19.15	34	24.49	-120	18.86	9:15	173	629	10	1.05	-
7750	1	8/3	MB	34	24.81	-120	13.36	34	24.76	-120	12.97	14:14	183	676	10	1.13	-
7751	1	8/4	MB	34	26.14	-120	22.76	34	26.09	-120	22.83	7:27	22	490	10	0.82	-
7752	1	8/3	MB	34	26.31	-120	17.10	34	26.33	-120	17.06	16:04	50	494	10	0.82	-
7753	1	8/3	MB	34	26.72	-120	25.58	34	26.63	-120	25.40	17:53	15.5		10	0.00	M

Dur. = Duration; Dist. = Distance, Trwl No. = Trawl number

[a]Station Coordinates
- Lat N (dm) = Latitude North (degree and minutes)
- Long W (dm) = Longitude West (degree and minutes)

[b]Ag = Agency (SCCWRP served as the QAQC agency)
- AB = Aquatic Bioassay and Consulting Laboratories
- HY = City of Los Angeles, Environmental Monitoring Division
- LA = County Sanitation Districts of Los Angeles County
- MB = Marine Biological Consultants
- OC = Orange County Sanitation Districts
- SCCWRP = Southern California Coastal Water Research
- SD = City of San Diego, Metropolitan Wastewater Department
- SV = Sea Ventures
- VR = Vantuna Research Group
- WS = Westion Solutions

[e]FC = Fail Code
- G = Fouled Net
- H = Torn Net
- J = Improper Distance/Time
- K = Irregular Bottom
- M = Kelp Bed
- N = Obstructions
- R = Abandoned
- S = Rocky Bottom
- T = Pre abandoned

Appendix A-2. Subpopulation designation and area-weights of successful trawls sampled in the southern Calfornia Bight 2008 Regional Survey, July-October 2008

Station	Shelf Zone	Region[a]	Area-Weights[b]
6028	Bays and Harbors[c]	Southern	3.6528
6071	Bays and Harbors	Southern	3.6528
6080	Bays and Harbors	Southern	3.6528
6084	Bays and Harbors	Southern	2.411
6093	Bays and Harbors	Southern	2.411
6138	Bays and Harbors	Southern	2.411
6139	Bays and Harbors	Southern	3.6528
6152	Bays and Harbors	Southern	2.411
6172	Bays and Harbors	Southern	2.411
6188	Bays and Harbors	Southern	0.2835
6212	Bays and Harbors	Southern	0.2835
6217	Bays and Harbors	Southern	6.231
6294	Bays and Harbors	Southern	Not assigned
6295	Bays and Harbors	Southern	Not assigned
6325	Bays and Harbors	Southern	Not assigned
6386	Bays and Harbors	Central	5.4433
6387	Bays and Harbors	Central	5.4433
6404	Bays and Harbors	Central	5.4433
6444	Bays and Harbors	Central	5.4433
6448	Bays and Harbors	Central	5.4433
6478	Bays and Harbors	Central	5.4433
6566	Bays and Harbors	Southern	3.6528
7000	Inner Shelf[d]	Southern	35.4428
7002	Middle Shelf (31-120 m)	Southern	61.1922
7008	Outer Shelf (121-200 m)	Southern	26.2971
7009	Middle Shelf (31-120 m)	Southern	61.1922
7014	Outer Shelf (121-200 m)	Southern	26.2971
7019	Middle Shelf (31-120 m)	Southern	61.1922
7021	Inner Shelf	Southern	35.4428
7024	Inner Shelf	Southern	35.4428
7030	Outer Shelf (121-200 m)	Southern	26.2971
7032	Outer Shelf (121-200 m)	Southern	26.2971
7044	Inner Shelf	Southern	35.4428
7064	Upper slope (200-500 m)	Southern	94.8366
7068	Middle Shelf (31-120 m)	Southern	61.1922
7093	Middle Shelf (31-120 m)	Southern	61.1922
7095	Outer Shelf (121-200 m)	Southern	26.2971

Appendix A-2. Continued

Station	Shelf Zone	Region[a]	Area-Weights[b]
7069	Upper slope (200-500 m)	Southern	94.8366
7081	Outer Shelf (121-200 m)	Southern	26.2971
7091	Inner Shelf	Southern	35.4428
7098	Outer Shelf (121-200 m)	Southern	26.2971
7122	Middle Shelf (31-120 m)	Southern	61.1922
7123	Upper slope (200-500 m)	Southern	94.8366
7128	Middle Shelf (31-120 m)	Southern	61.1922
7145	Middle Shelf (31-120 m)	Southern	61.1922
7158	Outer Shelf (121-200 m)	Southern	26.2971
7165	Outer Shelf (121-200 m)	Southern	26.2971
7166	Middle Shelf (31-120 m)	Southern	61.1922
7167	Middle Shelf (31-120 m)	Southern	61.1922
7174	Upper slope (200-500 m)	Southern	94.8366
7185	Middle Shelf (31-120 m)	Southern	61.1922
7186	Upper slope (200-500 m)	Central	94.8366
7193	Upper slope (200-500 m)	Central	94.8366
7194	Inner Shelf	Southern	35.4428
7201	Inner Shelf	Southern	0.131
7210	Upper slope (200-500 m)	Central	94.8366
7215	Inner Shelf	Central	35.4428
7231	Inner Shelf	Central	35.4428
7236	Upper slope (200-500 m)	Central	94.8366
7240	Upper slope (200-500 m)	Central	94.8366
7241	Upper slope (200-500 m)	Central	94.8366
7253	Middle Shelf (31-120 m)	Central	61.1922
7269	Middle Shelf (31-120 m)	Central	61.1922
7287	Middle Shelf (31-120 m)	Central	61.1922
7293	Inner Shelf	Central	35.4428
7298	Middle Shelf (31-120 m)	Central	61.1922
7300	Inner Shelf	Central	35.4428
7301	Middle Shelf (31-120 m)	Central	61.1922
7305	Inner Shelf	Central	35.4428
7310	Inner Shelf	Central	35.4428
7312	Inner Shelf	Central	35.4428
7313	Inner Shelf	Central	35.4428
7320	Upper slope (200-500 m)	Central	94.8366
7321	Inner Shelf	Central	35.4428
7324	Inner Shelf	Central	35.4428

Appendix A-2. Continued

Station	Shelf Zone	Region[a]	Area-Weights[b]
7355	Inner Shelf	Central	35.4428
7395	Outer Shelf (121-200 m)	Central	26.2971
7403	Middle Shelf (31-120 m)	Central	61.1922
7409	Middle Shelf (31-120 m)	Central	61.1922
7417	Middle Shelf (31-120 m)	Central	61.1922
7428	Upper slope (200-500 m)	Central	94.8366
7446	Middle Shelf (31-120 m)	Central	61.1922
7448	Middle Shelf (31-120 m)	Central	61.1922
7453	Middle Shelf (31-120 m)	Central	61.1922
7458	Middle Shelf (31-120 m)	Central	61.1922
7461	Middle Shelf (31-120 m)	Central	61.1922
7467	Outer Shelf (121-200 m)	Central	26.2971
7474	Inner Shelf	Central	35.4428
7477	Outer Shelf (121-200 m)	Central	26.2971
7479	Upper slope (200-500 m)	Central	94.8366
7502	Middle Shelf (31-120 m)	Northern	61.1922
7507	Middle Shelf (31-120 m)	Northern	61.1922
7517	Inner Shelf	Central	35.4428
7522	Inner Shelf	Northern	35.4428
7526	Upper slope (200-500 m)	Northern	94.8366
7528	Upper slope (200-500 m)	Northern	94.8366
7537	Outer Shelf (121-200 m)	Northern	26.2971
7544	Middle Shelf (31-120 m)	Northern	61.1922
7550	Middle Shelf (31-120 m)	Northern	61.1922
7557	Inner Shelf	Northern	35.4428
7572	Inner Shelf	Northern	35.4428
7579	Outer Shelf (121-200 m)	Northern	26.2971
7590	Upper slope (200-500 m)	Northern	94.8366
7592	Outer Shelf (121-200 m)	Northern	26.2971
7596	Inner Shelf	Northern	35.4428
7603	Outer Shelf (121-200 m)	Northern	26.2971
7604	Outer Shelf (121-200 m)	Northern	26.2971
7607	Middle Shelf (31-120 m)	Northern	61.1922
7609	Upper slope (200-500 m)	Northern	94.8366
7611	Upper slope (200-500 m)	Northern	94.8366
7615	Upper slope (200-500 m)	Northern	94.8366
7617	Upper slope (200-500 m)	Northern	94.8366
7619	Upper slope (200-500 m)	Northern	94.8366
7620	Upper slope (200-500 m)	Northern	94.8366

Appendix A-2. Continued

Station	Shelf Zone	Region[a]	Area-Weights[b]
7625	Upper slope (200-500 m)	Northern	94.8366
7629	Inner Shelf	Northern	35.4428
7632	Upper slope (200-500 m)	Northern	94.8366
7637	Upper slope (200-500 m)	Northern	94.8366
7641	Outer Shelf (121-200 m)	Northern	26.2971
7645	Outer Shelf (121-200 m)	Northern	26.2971
7647	Inner Shelf	Northern	35.4428
7668	Upper slope (200-500 m)	Northern	94.8366
7678	Upper slope (200-500 m)	Northern	94.8366
7684	Upper slope (200-500 m)	Northern	94.8366
7686	Upper slope (200-500 m)	Northern	94.8366
7688	Middle Shelf (31-120 m)	Northern	61.1922
7697	Upper slope (200-500 m)	Northern	94.8366
7699	Upper slope (200-500 m)	Northern	94.8366
7701	Outer Shelf (121-200 m)	Northern	26.2971
7708	Middle Shelf (31-120 m)	Northern	61.1922
7709	Upper slope (200-500 m)	Northern	94.8366
7714	Middle Shelf (31-120 m)	Northern	61.1922
7716	Upper slope (200-500 m)	Northern	94.8366
7717	Inner Shelf	Northern	35.4428
7728	Inner Shelf	Northern	35.4428
7732	Outer Shelf (121-200 m)	Northern	26.2971
7735	Inner Shelf	Northern	35.4428
7741	Inner Shelf	Northern	35.4428
7743	Inner Shelf	Northern	35.4428
7744	Outer Shelf (121-200 m)	Northern	26.2971
7750	Outer Shelf (121-200 m)	Northern	26.2971
7751	Inner Shelf	Northern	35.4428
7752	Middle Shelf (31-120 m)	Northern	61.1922

Total Area=6,922 km^2.

[a]Northern = Point Conception to Point Dume; Central = Point Dume to Dana Point;
Southern = Dana Point to U.S.-Mexico International Border

[b]Area-Weights = Area represented by trawl station.

[c]Bays & Harbors (2-30 m);

[d] Inner Shelf (Coast= 2-30 m);

Appendix A-3. Fish Response Index (FRI) pollution gradient position (p_i) values by shelf zone for fish species collected at depths of 9-215 m on the southern California shelf and upper slope, July-October 2008 (from Allen *et al*. 2001a)

Species Name[b]	p_i by shelf zone[a]		
	9-40 m	30-120 m	100-215 m
Anoplopoma fimbria		56.97	93.25
Argentina sialis		-4.50	-22.52
Cephaloscyllium ventriosum		10.20	
Chilara taylori	181.26	-13.10	-2.46
Chitonotus pugetensis	25.10	12.38	
Citharichthys fragilis		6.06	11.83
Citharichthys sordidus	59.29	19.29	-21.71
Citharichthys stigmaeus	24.83	29.81	
Citharichthys xanthostigma	10.71	-13.87	17.41
Cymatogaster aggregata	169.84	160.68	
Engraulis mordax	15.87	63.14	-29.61
Eopsetta jordani		1.51	-4.18
Genyonemus lineatus	58.20	54.39	42.07
Glyptocephalus zachirus		17.88	71.27
Hippoglossina stomata	24.50	17.31	30.56
Hydrolagus colliei		66.81	98.73
Icelinus filamentosus			-25.00
Icelinus quadriseriatus	17.59	1.66	34.29
Icelinus tenuis		-7.92	-66.58
Kathetostoma averruncus		120.76	55.12
Lepidogobius lepidus	41.35	1.79	-10.43
Lycodes cortezianus			87.00
Lycodes pacificus		21.66	43.34
Lyconema barbatum			27.98
Lyopsetta exilis		16.83	32.28
Merluccius productus		-18.77	13.51
Microstomus pacificus	102.34	70.58	87.20
Odontopyxis trispinosa		18.96	
Ophiodon elongatus		2.53	29.16
Paralabrax nebulifer	10.60	9.08	
Paralichthys californicus	11.62	20.87	
Parophrys vetulus	49.63	48.13	-10.29
Peprilus simillimus		17.42	
Phanerodon furcatus	72.37		
Physiculus rastrelliger			105.45
Plectobranchus evides			39.28
Pleuronichthys coenosus	121.93		
Pleuronichthys decurrens	92.94	71.21	
Pleuronichthys ritteri	13.12	78.46	
Pleuronichthys verticalis	21.12	16.29	-2.34
Porichthys myriaster	10.47	33.91	
Porichthys notatus	17.89	21.54	22.10
Raja binoculata	22.20	31.61	
Raja inornata	11.13	20.13	-13.32
Rathbunella hypoplecta		-8.02	

Appendix A-3. Continued

	p_i by shelf zone[a]		
Species Name[b]	9-40 m	30-120 m	100-215 m
Rhacochilus vacca	137.71		
Rhinogobiops nicholsii[c]		-18.40	
Scorpaena guttata	26.07	86.99	7.59
Sebastes auriculatus	18.99	29.71	
Sebastes caurinus	11.59	18.43	
Sebastes chlorostictus		-25.76	-0.12
Sebastes dallii	11.59	50.23	45.40
Sebastes diploproa		-11.77	68.00
Sebastes elongatus		-10.16	36.56
Sebastes eos		-21.71	4.83
Sebastes goodei	169.84	108.27	
Sebastes hopkinsi		86.25	87.58
Sebastes jordani		191.72	86.45
Sebastes levis		44.31	57.83
Sebastes macdonaldi			105.48
Sebastes miniatus	90.18	46.66	
Sebastes paucispinis		20.73	86.21
Sebastes rosaceus		13.66	
Sebastes rosenblatti		18.24	36.41
Sebastes rubrivinctus		9.89	
Sebastes saxicola	65.88	44.38	49.19
Sebastes semicinctus		9.86	-19.36
Sebastolobus alascanus		33.38	53.18
Seriphus politus	35.83		
Symphurus atricaudus	37.14	3.33	35.62
Synodus lucioceps	16.23	27.24	-5.21
Torpedo californica		118.08	
Xeneretmus latifrons		10.05	22.27
Xeneretmus triacanthus		6.38	-7.07
Xystreurys liolepis	13.55	32.12	
Zalembius rosaceus	49.94	28.92	-19.96
Zaniolepis frenata		10.27	16.19
Zaniolepis latipinnis	21.71	30.19	-11.28

[a]Range of depth categories are those of Allen *et al*. (2001a).
[b]See Appendix E for common names of fish species.
[c]Genus changed from Coryphopterus to Rhinogobiops since Allen et al. (2001a). See Nelson *et al.* (2004)

Appendix A-4. Megabenthic Invertebrate Response Index (MIRI) pollution-gradient position (pi) values for invertebrate species collected at depths of 9-215 m on the southern California shelf and upper slope, July-October 2008 (from Allen *et al.* 2001a)

Species*	p_i	Species*	p_i
Acanthodoris brunnea	41.90	*Gorgonocephalus eucnemis*	-14.86
Adelogorgia phyllosclera	9.45	*Hamatoscalpellum californicum*	22.86
Allocentrotus fragilis	25.34	*Havelockia benti*	21.80
Amphichondrius granulatus	20.21	*Hemisquilla californiensis*	7.45
Amphiodia urtica	25.38	*Henricia leviuscula*	12.24
Amphiura arcystata	-1.40	*Heptacarpus stimpsoni*	36.71
Antiplanes catalinae	39.91	*Heterocrypta occidentalis*	32.02
Armina californica	38.69	*Kelletia kelletii*	9.39
Asterina miniata	64.72	*Lamellaria diegoensis*	17.60
Astropecten armatus	65.56	*Laqueus californianus*	-23.45
Astropecten ornatissimus	9.89	*Leptasterias hexactis*	-2.61
Astropecten verrilli	21.79	*Leptopecten latiauratus*	7.97
Babelomurex oldroydi	-10.50	*Leucilla nuttingi*	7.87
Brisaster latifrons	21.29	*Loligo opalescens*	34.04
Brissopsis pacifica	23.90	*Lophogorgia chilensis*	38.39
Calinaticina oldroydii	86.17	*Lopholithodes foraminatus*	56.22
Calliostoma tricolor	18.35	*Lophopanopeus bellus*	41.52
Calliostoma turbinum	21.91	*Lovenia cordiformis*	0.20
Cancellaria cooperii	12.91	*Loxorhynchus crispatus*	3.40
Cancellaria crawfordiana	52.40	*Loxorhynchus grandis*	35.83
Cancer antennarius	107.89	*Luidia armata*	18.78
Cancer anthonyi	112.19	*Luidia asthenosoma*	15.75
Cancer gracilis	56.13	*Luidia foliolata*	23.99
Cancer jordani	9.30	*Lytechinus pictus*	9.42
Cancer productus	99.75	*Mediaster aequalis*	7.11
Chlamys hastata	5.22	*Megasurcula carpenteriana*	20.81
Cidarina cidaris	-23.45	*Metacrangon spinosissima*	38.63
Ciona intestinalis	14.53	*Metridium farcimen*	28.46
Conus californicus	137.47	*Nassarius insculptus*	84.58
Corynactis californica	45.28	*Nassarius perpinguis*	55.11
Crangon alaskensis	55.51	*Neocrangon communis*	37.61
Crangon nigromaculata	98.80	*Neocrangon resima*	41.59
Crepidula onyx	130.41	*Neocrangon zacae*	39.87
Crossata californica	1.70	*Neosimnia loebbeckeana*	32.12
Diaulula sandiegensis	-20.44	*Nymphon pixellae*	19.39
Doriopsilla albopunctata	9.16	*Octopus californicus*	22.96
Dromalia alexandri	32.70	*Octopus rubescens*	25.05
Erileptus spinosus	23.14	*Ophionereis eurybrachiplax*	-19.71
Eugorgia rubens	20.98	*Ophiopholis bakeri*	6.07
Euspira draconis	72.51	*Ophiopteris papillosa*	12.39
Euvola diegensis	6.72	*Ophiothrix spiculata*	17.19
Flabellina iodinea	29.04	*Ophiura luetkenii*	24.27
Florometra serratissima	-3.02	*Paguristes bakeri*	1.89
Fusinus barbarensis	-4.43	*Paguristes turgidus*	16.07

Appendix A-4. Continued

Species*	p_i	Species*	p_i
Paguristes ulreyi	12.35	*Pteropurpura vokesae*	84.29
Pagurus spilocarpus	29.21	*Ptilosarcus gurneyi*	13.32
Pandalus danae	54.58	*Pycnopodia helianthoides*	26.45
Pandalus jordani	65.87	*Pyromaia tuberculata*	27.38
Pandalus platyceros	54.61	*Randallia ornata*	39.91
Paraconcavus pacificus	22.08	*Rathbunaster californicus*	31.25
Paracyathus stearnsii	9.29	*Renilla koellikeri*	36.56
Paralithodes californiensis	20.57	*Rossia pacifica*	42.97
Paralithodes rathbuni	27.47	*Schmittius politus*	44.05
Parapagurodes laurentae	2.42	*Sclerasterias heteropaes*	-7.86
Parapagurodes makarovi	4.48	*Sicyonia ingentis*	61.65
Parastichopus californicus	27.64	*Spatangus californicus*	13.49
Philine alba	-2.15	*Spirontocaris holmesi*	83.56
Phimochirus californiensis	5.88	*Spirontocaris sica*	54.51
Pisaster brevispinus	25.55	*Strongylocentrotus franciscanus*	9.79
Platymera gaudichaudii	87.05	*Strongylocentrotus purpuratus*	27.25
Pleurobranchaea californica	52.98	*Stylasterias forreri*	16.88
Podochela hemphillii	28.18	*Stylatula elongata*	39.07
Podochela lobifrons	14.92	*Triopha maculata*	3.54
Pododesmus macrochisma	24.77	*Tritonia diomedea*	33.84
Portunus xantusii	69.88	*Virgularia agassizi*	19.53
Protula superba	-6.29	*Virgularia californica*	24.87

**See Appendix E for common name of invertebrate species.*

Appendix A-5. Trawl Response Index (TRI) pollution-gradient position (p_i) values for fish (F) and invertebrate (I) species collected at depths of 9-215 m on the southern California shelf and upper slope, July-October 2008 (from Allen *et al.* 2001a)

Species*	Type	p_i	Species*	Type	p_i
Acanthodoris brunnea	I	60.65	*Doriopsilla albopunctata*	I	18.72
Adelogorgia phyllosclera	I	4.80	*Dromalia alexandri*	I	46.88
Allocentrotus fragilis	I	18.53	*Engraulis mordax*	F	36.59
Amphichondrius granulatus	I	5.63	*Eopsetta jordani*	F	2.93
Amphiodia urtica	I	13.86	*Erileptus spinosus*	I	36.88
Amphiura arcystata	I	-3.08	*Eugorgia rubens*	I	15.64
Anoplopoma fimbria	F	159.40	*Euspira draconis*	I	121.87
Antiplanes catalinae	I	34.54	*Euvola diegensis*	I	14.77
Argentina sialis	F	20.63	*Flabellina iodinea*	I	24.43
Armina californica	I	41.23	*Florometra serratissima*	I	-35.88
Asterina miniata	I	89.94	*Fusinus barbarensis*	I	-31.13
Astropecten armatus	I	62.34	*Genyonemus lineatus*	F	89.95
Astropecten ornatissimus	I	-4.74	*Glyptocephalus zachirus*	F	40.47
Astropecten verrilli	I	24.51	*Gorgonocephalus eucnemis*	I	-33.61
Babelomurex oldroydi	I	-2.25	*Hamatoscalpellum*	I	25.91
Brisaster latifrons	I	14.64	*Havelockia benti*	I	19.83
Brissopsis pacifica	I	18.26	*Hemisquilla californiensis*	I	-5.74
Calinaticina oldroydii	I	107.45	*Henricia leviuscula*	I	-28.38
Calliostoma tricolor	I	23.83	*Heptacarpus stimpsoni*	I	59.13
Calliostoma turbinum	I	17.57	*Heterocrypta occidentalis*	I	27.97
Cancellaria cooperii	I	8.55	*Hippoglossina stomata*	F	38.15
Cancellaria crawfordiana	I	41.57	*Hydrolagus colliei*	F	95.33
Cancer antennarius	I	129.86	*Icelinus filamentosus*	F	-9.07
Cancer anthonyi	I	139.62	*Icelinus quadriseriatus*	F	30.08
Cancer gracilis	I	74.77	*Icelinus tenuis*	F	-43.72
Cancer jordani	I	59.41	*Kathetostoma averruncus*	F	109.63
Cancer productus	I	130.57	*Kelletia kelletii*	I	18.34
Cephaloscyllium ventriosum	F	45.54	*Lamellaria diegoensis*	I	32.41
Chilara taylori	F	41.26	*Laqueus californianus*	I	-54.84
Chitonotus pugetensis	F	28.50	*Lepidogobius lepidus*	F	30.45
Chlamys hastata	I	7.17	*Leptasterias hexactis*	I	-21.11
Cidarina cidaris	I	-54.84	*Leptopecten latiauratus*	I	28.10
Ciona intestinalis	I	28.75	*Leucilla nuttingi*	I	6.28
Citharichthys fragilis	F	25.02	*Loligo opalescens*	I	36.87
Citharichthys sordidus	F	15.57	*Lophogorgia chilensis*	I	52.36
Citharichthys stigmaeus	F	39.53	*Lopholithodes foraminatus*	I	57.62
Citharichthys xanthostigma	F	18.04	*Lophopanopeus bellus*	I	82.99
Conus californicus	I	158.70	*Lovenia cordiformis*	I	19.72
Corynactis californica	I	51.92	*Loxorhynchus crispatus*	I	3.57
Crangon alaskensis	I	63.46	*Loxorhynchus grandis*	I	29.15
Crangon nigromaculata	I	106.01	*Luidia armata*	I	18.12
Crepidula onyx	I	188.00	*Luidia asthenosoma*	I	9.87
Crossata californica	I	-0.67	*Luidia foliolata*	I	17.73
Cymatogaster aggregata	F	167.49	*Lycodes cortezianus*	F	84.65
Diaulula sandiegensis	I	21.96	*Lycodes pacificus*	F	63.66

Appendix A-5. Continued

Species*	Type	p_i	Species*	Type	p_i
Lyconema barbatum	F	14.32	*Platymera gaudichaudii*	I	114.80
Lyopsetta exilis	F	43.36	*Plectobranchus evides*	F	33.57
Lytechinus pictus	I	1.90	*Pleurobranchaea californica*	I	61.12
Mediaster aequalis	I	8.01	*Pleuronichthys coenosus*	F	188.57
Megasurcula carpenteriana	I	17.41	*Pleuronichthys decurrens*	F	94.67
Merluccius productus	F	50.57	*Pleuronichthys ritteri*	F	27.47
Metacrangon spinosissima	I	21.25	*Pleuronichthys verticalis*	F	28.78
Metridium farcimen	I	18.31	*Podochela hemphillii*	I	39.86
Microstomus pacificus	F	64.82	*Podochela lobifrons*	I	4.22
Nassarius insculptus	I	136.72	*Pododesmus macrochisma*	I	30.30
Nassarius perpinguis	I	53.49	*Porichthys myriaster*	F	30.06
Neocrangon communis	I	40.03	*Porichthys notatus*	F	34.85
Neocrangon resima	I	31.53	*Portunus xantusii*	I	141.94
Neocrangon zacae	I	33.59	*Protula superba*	I	-12.96
Neosimnia loebbeckeana	I	47.35	*Pteropurpura vokesae*	I	119.07
Nymphon pixellae	I	26.83	*Ptilosarcus gurneyi*	I	8.20
Octopus californicus	I	18.61	*Pycnopodia helianthoides*	I	55.54
Octopus rubescens	I	19.11	*Pyromaia tuberculata*	I	34.23
Odontopyxis trispinosa	F	28.14	*Raja binoculata*	F	28.50
Ophiodon elongatus	F	37.60	*Raja inornata*	F	29.96
Ophionereis eurybrachiplax	I	-32.88	*Randallia ornata*	I	24.49
Ophiopholis bakeri	I	-15.68	*Rathbunaster californicus*	I	26.50
Ophiopteris papillosa	I	-3.62	*Rathbunella hypoplecta*	F	-10.92
Ophiothrix spiculata	I	17.37	*Renilla koellikeri*	I	15.09
Ophiura luetkenii	I	18.31	*Rhacochilus vacca*	F	141.97
Paguristes bakeri	I	-20.33	*Rhinogobiops nicholsii*	F	9.33
Paguristes turgidus	I	-0.14	*Rossia pacifica*	I	39.80
Paguristes ulreyi	I	28.97	*Schmittius politus*	I	19.10
Pagurus spilocarpus	I	23.52	*Sclerasterias heteropaes*	I	-34.33
Pandalus danae	I	85.48	*Scorpaena guttata*	F	57.51
Pandalus jordani	I	71.70	*Sebastes auriculatus*	F	44.41
Pandalus platyceros	I	58.24	*Sebastes caurinus*	F	38.22
Paraconcavus pacificus	I	-24.35	*Sebastes chlorostictus*	F	23.68
Paracyathus stearnsii	I	-9.29	*Sebastes constellatus*	F	-2.54
Paralabrax nebulifer	F	34.53	*Sebastes dallii*	F	36.47
Paralichthys californicus	F	28.52	*Sebastes diploproa*	F	79.98
Paralithodes californiensis	I	6.68	*Sebastes elongatus*	F	41.36
Paralithodes rathbuni	I	37.64	*Sebastes eos*	F	9.45
Parapagurodes laurentae	I	-13.45	*Sebastes goodei*	F	140.69
Parapagurodes makarovi	I	-11.47	*Sebastes hopkinsi*	F	92.95
Parastichopus californicus	I	27.05	*Sebastes jordani*	F	119.31
Parophrys vetulus	F	53.32	*Sebastes levis*	F	71.98
Peprilus simillimus	F	44.71	*Sebastes macdonaldi*	F	155.20
Phanerodon furcatus	F	73.80	*Sebastes miniatus*	F	68.81
Philine alba	I	-26.20	*Sebastes paucispinis*	F	95.45
Phimochirus californiensis	I	8.23	*Sebastes rosaceus*	F	12.28
Physiculus rastrelliger	F	120.65	*Sebastes rosenblatti*	F	46.58
Pisaster brevispinus	I	20.99	*Sebastes rubrivinctus*	F	2.19

Appendix A-5. Continued

Species*	Type	p_i	Species*	Type	p_i
Sebastes saxicola	F	66.08	*Syngnathus exilis*	F	-13.96
Sebastes semicinctus	F	28.19	*Synodus lucioceps*	F	36.37
Sebastolobus alascanus	F	46.81	*Torpedo californica*	F	120.94
Seriphus politus	F	60.93	*Triopha maculata*	I	20.69
Sicyonia ingentis	I	73.77	*Tritonia diomedea*	I	42.84
Spatangus californicus	I	7.38	*Virgularia agassizi*	I	14.12
Spirontocaris holmesi	I	93.46	*Virgularia californica*	I	21.80
Spirontocaris sica	I	68.89	*Xeneretmus latifrons*	F	43.30
Strongylocentrotus	I	8.75	*Xeneretmus triacanthus*	F	6.70
Strongylocentrotus purpuratus	I	27.59	*Xystreurys liolepis*	F	39.52
Stylasterias forreri	I	1.75	*Zalembius rosaceus*	F	36.95
Stylatula elongata	I	39.86	*Zaniolepis frenata*	F	28.27
Symphurus atricaudus	F	31.44	*Zaniolepis latipinnis*	F	33.40

*See Appendix E for common names of fish species; see Appendix E for common names of *invertebrate species.*

Appendix A-6. Data Analysis Methods

Description of Populations

Data Adjustments

As in the 2003 regional survey (Allen *et al.* 2007), some stations in the 2008 regional survey were trawled for 5 min rather than 10 min because of inadequate space (e.g., in a bay or harbor). The following approach used in Allen *et al.* (2002) was also used in the present study. To compare the 5- and 10-minute trawl data, the following two options were considered: 1) adjust catch information to catch per minute and then adjust catch by minutes of trawling, or 2) adjust the catch to a 10-minute trawl and double the 5-minute trawl catch. The following two points were considered: 1) the time that the net is actually on the bottom during a trawl is uncertain (Diener and Rimer 1993), and 2) the distribution of the fish and invertebrates in the trawl path varies by species, ranging from random to clumped. Thus, a per-minute adjustment of catch did not seem warranted, although it was clear that a 10-minute trawl had a higher catch than a 5-minute trawl. Fish and invertebrate abundance and biomass values of 5-minute trawls were adjusted to 10-minute trawl values by doubling the 5-minute trawl values. Numbers of fish and invertebrate species between 5- and 10-minute trawls were adjusted by multiplying species by 1.4. This latter adjustment was used for calculating subpopulation mean values. However, to determine the total species in a subpopulation, unadjusted species (or taxa) counts were used. This approach was also used to perform the diversity index calculations.

Population Attributes

The population attributes examined included abundance, biomass, number of species, and Shannon-Wiener diversity (Shannon and Weaver 1949), all expressed per haul. The Shannon-Wiener diversity index (H ‘) is calculated using Equation 1.

$$H' = -\sum_{j=1}^{s} \frac{n_j}{N} \ln \frac{n_j}{N} \qquad \textbf{Equation 1}$$

where:

- n_j = Number of individuals of the species *j* in sample.
- S = Total number of species in sample.
- N = Total number of individuals in sample.

Population Summary Statistics

Trawl data were expressed as values per standard trawl haul (i.e., “per haul”). In this survey, the area sampled per trawl haul was estimated to be 3,014 m^2 based on trawl opening, default boat speed and default bottom time. Because a stratified random survey design was used, different weighting factors were assigned to stations in some subpopulations (Appendix A-2). These weighting factors were used in percent of area calculations (including medians) and in adjustment of mean values, standard deviations, and confidence limits. If it is stated that *x* percent of the area had a particular attribute value, this should be interpreted as meaning that the value is likely to occur in a standard trawl haul from *x* percent of the area. Population data were analyzed in two ways: 1) calculation of medians, means, and 95% confidence intervals for population attributes in the SCB and in various subpopulations; and 2) assessment of the percent of area within each subpopulation above the SCB median. Mean parameter values were calculated using a ratio estimator (Thompson 1992; Equation 2).

$$m = \frac{\sum_{i=1}^{n}(p_i * w_i)}{\sum_{i=1}^{n} w_i}$$ **Equation 2**

where:

m = Mean parameter value for population j.
p_i = Parameter value at station i.
w_i = Weighting factor for station i, equal to the inverse of the inclusion probability of the site.
n = Number of stations sampled in population j.

Weighting factors for each station are provided in Appendix A-2. The ratio estimator was used in lieu of a stratified mean because an unknown fraction of each stratum could not be sampled (e.g., hard bottom). Thus, the estimated area was used as a divisor in place of the unknown true area. The standard deviation of the mean response was calculated as follows:

$$\text{Standard Deviation} = \sqrt{\frac{\sum_{i=1}^{n}(p_i - m)^2 \cdot w_i}{\sum_{i=1}^{n} w_i}}$$ **Equation 3**

The standard error of the mean response was calculated as follows:

$$\text{Standard Error} = \sqrt{\frac{\sum_{i=1}^{n}\left((p_i - m) \cdot w_i\right)^2}{\left(\sum_{i=1}^{n} w_i\right)^2}}$$ **Equation 4**

The 95% confidence intervals were calculated as 1.96 times the standard error. The ratio estimator for the standard error approximates joint inclusion probabilities among samples and assumes a negligible spatial covariance, an assumption that appears warranted. However, the assumption is conservative because its violation would lead to overestimation of the confidence interval (Stevens and Kincaid 1997).

Percent of Area and Medians

As with the 1994, 1998, and 2003 surveys, the 2008 study was specifically designed to address questions regarding the spatial distribution of the data. These issues included the determination of cumulative distribution frequencies (CDFs; Stevens and Olsen 1991). The CDFs provide graphical information on the percent of the survey area that lies below a given indicator value. A population attribute (e.g., abundance) value from a station has an associated weighting factor (Appendix A-2). To calculate a CDF, indicator values were ranked from low to high. The weighting factors for stations with a given indicator value were then accumulated, giving a cumulative sum of weight at each ranked indicator value. Then each cumulative sum of weight was divided by the total area weight to give a cumulative frequency distribution (with proportions adding up to 1.0). Medians can be determined from CDFs and compared among subpopulations and to those of the SCB as a whole. The median was the value of an attribute at which 50% of the area of a subpopulation lies above or below. This median thus differs from observation medians, defined as the value at which 50% of the observations lie above or below. Confidence limits of medians for population attribute data were determined by calculating 95% confidence limits of means on log-transformed data and back-transforming.

Regional Comparisons between 1994, 1998, 2003, and 2008 Survey Results

Comparisons of population attribute values and percent of area between surveys were done when appropriate. Some survey years did not sample similar strata. For instance, the 1994 survey (Allen *et al.* 1998) did not sample bays/harbors and upper slope. To further complicate the comparison, some mainland subpopulation boundaries differed between surveys, thus affecting area weighting values among surveys. In addition, there were slight modifications in depth zone subpopulation boundaries between surveys. Thus, to make comparisons between the periods, the 1994 data were reclassified to 2008 subpopulation boundaries. The original 1994 area weights were maintained for 1994 stations used in the 2008 comparison. Hence, 1994 stations falling within the 2008 middle shelf subpopulation boundaries were compared to 2003 middle shelf stations. Medians were calculated for middle shelf subpopulations (regarded as reference areas) in 1994, 1998, and 2003. Comparisons between the 1998, 2003 and 2008 surveys were straightforward.

Assemblage Analysis

Recurrent Group Analysis

Recurrent groups were determined independently for fish and invertebrates by first calculating the index of affinity of Fager (1963) and Fager and McGowan (1963) for all species pairs. The index is based on the occurrence of each species and co-occurrence of the two species being compared, and is defined by Equation 5.

$$I.A. = \frac{c}{\sqrt{ab}} - \frac{1}{2\sqrt{b}}$$ **Equation 5**

where:

I.A. = Index of affinity.

a = Number of samples in which Species A occurred.

b = Number of samples in which Species B occurred.
c = Number of joint occurrences of Species A and B.

In this equation, b is always greater than or equal to a. The first term is the ratio of joint occurrences of both species to the geometric mean of their individual occurrences. The second term is a correction factor to give weight to values of the first term based upon high occurrences of the more frequently occurring species.

The index was calculated for all pairs of species. Pairs of species with a predetermined level of affinity (e.g., I.A. = 0.50) were grouped following rules described in Fager (1957). A recurrent group was required to satisfy the following criteria: 1) All species in a group must have positive affinities with all other members of the group; 2) the group must contain the largest possible number of species; 3) if several possible groups containing the same number of species can be formed, those that contain the largest number of groups without species in common are chosen; and 4) if two or more groups with the same number of species and with members in common can be formed, the group that occurs most frequently will be chosen.

Species were grouped at an index of affinity of 0.50 (i.e., 0.495 or greater). Associates were defined as species that had positive affinities with one or more members of a recurrent group but not with all members of the group. A connex value defines the level of relationship. This number is the proportion of possible positive affinities (e.g., I. A. = 0.50 or greater) between members of two groups or between a group and an associate. The connex value is shown in recurrent group diagrams next to a line connecting different groups to each other or associate species to groups.

Cluster Analysis

Abundance-based site and species groups were defined using cluster analysis. Prior to conducting the cluster analysis, the data were screened to reduce the confounding effect of very rare species, which do not facilitate comparison between stations. The screening process had two criteria: 1) each taxa had to have an abundance of 10 or more individuals and these must have occurred in five or more stations; and 2) each station had to have five or more individuals to be included in the cluster analysis. A separate analysis was conducted for fish, invertebrates, and combined fish and invertebrate data.

After the selection criteria were met, the abundance data were square-root transformed and standardized. The square-root transformation is generally applied to count data to reduce the importance of the most abundant taxa (Sokal and Rohlf 1981, Clarke and Green 1988, Smith *et al.* 1988). The data were standardized by dividing species abundance at a given otter trawl station by the mean abundance of that species over all stations. The benefit of standardization is that it has the effect of equalizing extreme abundance values and facilitates relative comparisons among species (Clarke 1993). The Bray-Curtis measure was used to convert the species composition and abundance data into a dissimilarity matrix (Bray and Curtis 1957, Clifford and Stephenson 1975). The clustering method was an agglomerative, hierarchical, flexible sorting method (SAS Institute 1989). The sorting coefficient Beta was set at the standard value of -0.25 (Tetra Tech 1985).

Each cluster analysis on abundance data for fish, invertebrates, or combined fish and invertebrates involved two approaches. First, a cluster procedure was used to identify groups of stations that exhibit similar species abundance patterns. Second, a cluster procedure was conducted to identify groups of species that occur in similar habitats (stations). In each approach, the results of the cluster analysis were used to produce a dendrogram, a structured two-dimensional hierarchical display of similar station and species groups. Furthermore, the station and species clusters for each taxonomic group were used to produce a two-way coincidence table, a matrix of species-importance values which optimally displays the patterns identified in the cluster analyses by the dendrograms (Kikkawa 1968; Clifford and Stephenson 1975; CSDOC 1996; Allen *et al.* 1998, 2002). The end result is a summary two-way table of observations, which corresponds to the order of similar station groups along one axis and similar species groups along the other axis. Major clusters were determined by evaluating the patterns and abundances that were summarized by the two-way table. This evaluation started with the most significant dendrogram separating dissimilar clusters. If the species abundance patterns showed that this separation was reflected in the two-way table, then this was considered a major cluster separation point. The evaluation continued to the next major separation point and the evaluation was continued until dendrogram separation points were not evident in the two-way table. All clusters not clearly evident as distinct in the two-way table were not considered as major cluster groupings and were not separated further into additional clusters.

The discussion for each cluster analysis begins with an overview of the analytical results, followed by a more detailed description of the site clusters, followed by the discussion of the species clusters, and finally followed by a comparison with the 1994 SCBPP regional cluster analysis. Throughout the discussion, whenever a number cluster is being discussed (i.e., Cluster 2), this is referring to the site clusters; and whenever a letter cluster is being discussed (i.e., Cluster F), this is referring to a species cluster.

Assemblage Biocriteria Analysis

The assessment of anthropogenic impact to fish and invertebrate assemblages requires that biocriteria be identified to describe reference (or normal) conditions to distinguish these from nonreference conditions. This assessment is enhanced if indicators are also identified that respond to impacted (or altered) conditions. While individual indicators are important in identifying anthropogenically altered habitats, a more valuable indicator of impacts to fish assemblages can be developed by combining these indicators into an index.

Since the 1994 regional survey (Allen *et al.* 1998), several biointegrity indices have been produced that can be applied to the data (Allen *et al.* 2001, 2002, 2007). These include a fish response index (FRI), invertebrate response index (IRI), trawl response index (TRI), and fish foraging guild (FFG) index. The name IRI of Allen *et al.* (2001) is changed here to MIRI (megabenthic invertebrate index) to avoid confusion with the IRI (index of relative importance) of Pinkas *et al.* (1971). The first three are based on a multivariate-weighted-average approach, the same used to develop a successful benthic response index for the 1994 regional survey (Smith *et al.* 2001). The FFG index was based on foraging guilds from Allen (1982) and the multimetric approach (Weisberg *et al.* 1997, Gibson *et al.* 2000). Detailed methods and testing of these indices are given in Allen *et al.* (2001).

The multivariate weighted-average indices (FRI, MIRI, and TRI) were produced from an ordination analysis of calibrated (i.e., index development) species abundance data (Allen *et al.* 2001, 2007). These ordination analyses determined a vector in ordination space that corresponded to the pollution gradient. Then all calibration observations were projected onto the pollution-effects gradient vector in the biological ordination space, rescaled, and species-tolerance scores (i.e., species positions along the gradient vector) were determined. From this, the index value for an observation (station-time) is the abundance-weighted-average pollution tolerance of all species in the observation. The index value is calculated using Equation 6.

$$I_s = \frac{\sum_{i=1}^{n} a_{si}^{f}}{\sum_{i=1}^{n} a_{si}^{f}}$$ **Equation 6**

where:

I_s = The index value for observation *s*
n = The number of species in the observation *s*
P_i = The position for species I on the pollution gradient (an indicator of pollution tolerance of the species)
a_{si} = The abundance of species *I* in observation *s*
f = The exponent *f* allows for transformation of the abundance weights to prevent overemphasis on extreme abundances. FRI *f* values as as follows: 9-40 m: 0, 30-120 m: 0.25, 100-215 m: 0.50. If the observation (station) overlaps two of the above depth zones, *I* equals the mean of the two numerator portions of *I* (obtained by using the two corresponding *f* values) divided by the mean of the two denominators, this value differs from the average of the two overall *I*'s calculated using the two corresponding f values. The MIRI and TRI *f* value = 0.25.

The application of these indices requires that species be from a similar area and habitat (i.e., the mainland shelf of southern California) as those used in developing the index. The new species abundance values are multiplied by the p_i determined in the index development analysis. Appendices A-3, A-4, and A-5 give pi values by species for FRI, MIRI, and TRI indices. The response level values for reference condition were as follows: FRI less than or equal to 45; MIRI less than or equal to 46; and TRI less than or equal to 51.

With the multivariate approach producing the FFG index, 31 population and assemblage metrics were tested to determine metrics that differed significantly between reference and impact sites (Allen *et al.* 2001). Combinations of responsive metrics were then scored and combined to form indices. Each index was the mean of the metric scores of the index (i.e., the sum of the scores of each component metric divided by the number of metrics in the index), calculated using Equation 7.

$$MI = \frac{\sum_{i=0}^{n} MS}{n}$$ **Equation 7**

where:

MI = Multimetric index
MS = Metric score
n = Number of metrics in index

The foraging guilds that, in combination, formed the best index for the middle shelf, were the bottom-living benthic extractors (turbot guild, 2D1a); bottom-living pelagobenthivores (sanddab guild, 2B); and bottom-living pelagivores (benthic ambushers guild, 2A). Guild designations were based on Allen (1982). The turbot guild included C-O sole (*Pleuronichthys coenosus*), curlfin sole (*Pleuronichthys decurrens*), diamond turbot (*Pleuronichthys guttulatus*), Dover sole (*Microstomus pacificus*), hornyhead turbot (*Pleuronichthys verticalis*), rock sole (*Lepidopsetta bilineata*), and spotted turbot (*Pleuronichthys ritteri*). The sanddab guild included Gulf sanddab (*Citharichthys fragilis*), longfin sanddab (*Citharichthys xanthostigma*), slender sole (*Lyopsetta exilis*), Pacific sanddab (*Citharichthys sordidus*), speckled sanddab (*Citharichthys stigmaeus*), and small (≤11 cm) California halibut (*Paralichthys californicus*) and petrale sole (*Eopsetta jordani*). The benthic ambushers guild included California lizardfish (*Synodus lucioceps*), bigmouth sole (*Hippoglossina stomata*), lingcod (*Ophiodon elongatus*), and large (>11 cm) California halibut and petrale sole.

The turbot guild had high abundance in impacted areas and low abundance in reference areas, whereas the sanddab and benthic ambusher guilds were in low abundance at impacted areas and high abundance in reference areas.

To apply this index, the guilds receive the following scores at different abundance levels in a 10- minute trawl:

- Guild 2D1a – score 1 (>32 fish); score 3 (32-11 fish); score 5 (10-0 fish).
- Guild 2B – score 1 (0-15 fish); score 3 (16-29 fish); score 5 (>29 fish).
- Guild 2A – score 1 (0 fish); score 3 (1 fish); score 5 (> 1 fish).

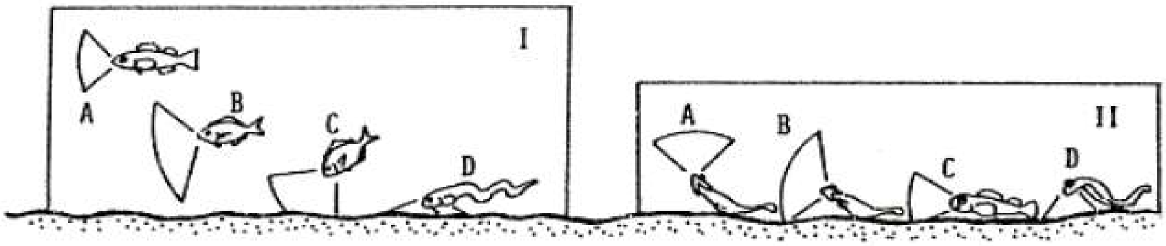
This guild tested successfully for use on the middle shelf of southern California. The FFG response level value for reference condition was greater than 3.67; impacted condition value was less than 1.83; values in between represent non-reference conditions.

Allen *et al.* (2001) noted that based on overall performance in this study, the FRI index appeared to be an effective fish index, particularly in the middle shelf zone. The FFG index may have value in interpreting the ecological meaning of the FRI index response. The FFG index measures the relative importance of benthic pelagivore, benthic pelagobenthivore, and benthic extracting benthivore guilds along the pollution gradient, which in turn reflect changes in the relative abundance of polychaetes and pericarid crustaceans (mysids and gammaridean amphipods) along the gradient. Although the MIRI and TRI indices performed less well, they are the only attempt to produce indices for southern California using megabenthic invertebrates and fishes combined. Their relatively diminished performance was likely due to anomalous species abundances following the 1982-1983 El Niño.

In this study, we focused on the FRI index as the primary index for assessing percent of area that was not reference (or exhibiting expected conditions) because it could be applied across most of the study area and because it showed the best test results in the index development study (Allen *et al.* 2001). The other indices give different perspectives of reference areas from the invertebrate, fish and invertebrate, and fish-foraging guild perspectives.

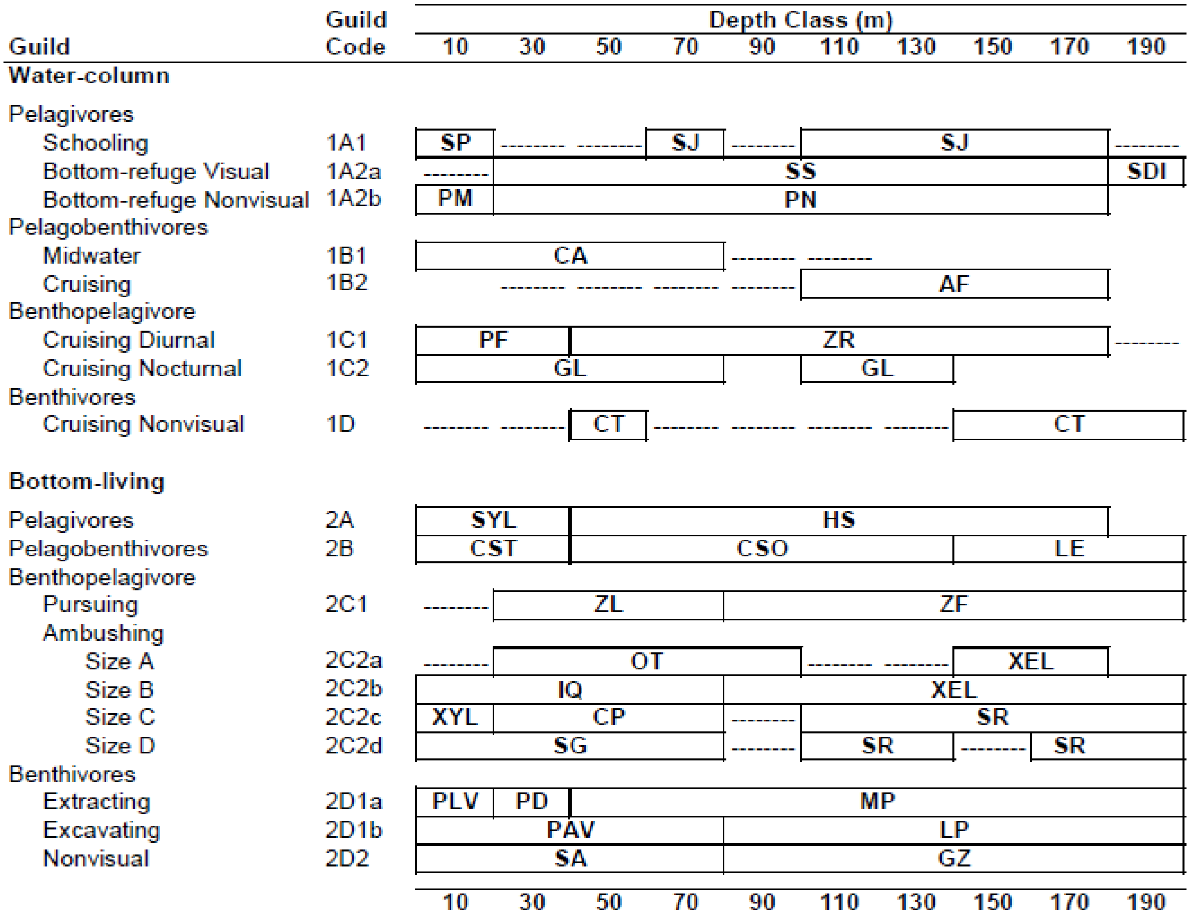
Functional Organization of Fish Assemblage Analysis

The functional organization of the demersal fish assemblages identified in the 1994 survey was based on the methods used in Allen (1982), which described the functional organization of demersal fish communities on the central portion of the southern California shelf at depths of 10-200 m in 1972-1973. This organization was based on 342 trawl samples collected in the same manner as those in the 1994, 1998, and 2004 regional surveys. It identified 15 basic foraging guilds of demersal fishes on the soft-bottom habitat of the mainland shelf, with one guild consisting of four size divisions (bringing the total possible guild categories to 18; Figure II-3). Each guild consisted of two to four species, each dominant in a different depth zone. The functional structure of the community at a given depth is described in terms of the numbers and types of feeding guilds, whereas the species composition is described in terms of the dominant species of each guild (Figure II-4). Species were sorted into 18 predefined foraging guilds. The guild classification of the most common species is defined in Allen (1982). The guild classification of other species was based on their known foraging behavior or on that inferred from their morphology and/or feeding habits. If more detailed information were available, some of the rarer species might be more appropriately classified into specialized guilds not defined in the above study. However, they are conservatively included here in the more general foraging orientation guilds. The functional organization of the demersal fish assemblages in 2003 was described at 20-m depth intervals. This organization was compared to the model of functional organization for 1972-1973 (Allen 1982), 1994 (Allen *et al.* 1998), 1998 (Allen *et al.* 2002), and 2003 (Allen *et al.* 2007) to assess how the organization of the community has changed during three decades.



- I. Water-column Fishes
  - A. Pelagivores
    - 1. Schooling
    - 2. Bottom-refuge
      - a. Visual
      - b. Nonvisual
  - B. Pelagobenthivores
  - C. Benthopelagivores (Cruising)
    - 1. Diurnal
    - 2. Nocturnal
  - D. Benthivores (Cruising Nonvisual)
- II. Bottom-living Fishes
  - A. Pelagivores
  - B. Pelagobenthivores
  - C. Benthopelagivores
    - 1. Pursuing
    - 2. Ambushing
  - D. Benthivores
    - 1. Visual
      - a. Extracting
      - b. Excavating
    - 2. Nonvisual

Figure A6-1. Foraging guilds of soft-bottom fishes on the southern California shelf (from Allen 1982, 2006a).



Size Classes (mouth length): A = 1-4 mm; B = 5-8 mm; C = 9-26 mm; and D ≥ 27 mm.

AF = *Anoplopoma fimbria*
CA = *Cymatogaster aggregata*
CP = *Chitonotus pugetensis*
CSO = *Citharichthys sordidus*
CST = *Citharichthys stigmaeus*
CT = *Chilara taylori*
GL = *Genyonemus lineatus*
GZ = *Glyptocephalus zachirus*
HS = *Hipposlossina stomata*
IQ = *Icelinus quadriseriatus*
LE = *Lyopsetta exilis*
LP = *Lycodes pacificus*
MP = *Microstomus pacificus*
OT = *Odontopyxis trispinosa*
PAV = *Parophrys vetulus*
PD = *Pleuronichthys decurrens*
PF = *Phanerodon furcatus*
PLV = *Pleuronichthys verticalis*
PM = *Porichthys myriaster*
PN = *Porichthys notatus*
SA = *Symphurus atricaudus*
SDI = *Sebastes diploproa*
SG = *Scorpaena guttata*
SJ = *Sebastes jordani*
SP = *Seriphus politus*
SR = *Sebastes rosenblatti*
SS = *Sebastes saxicola*
SYL = *Synodus lucioceps*
XEL = *Xeneretmus latifrons*
XYL = *Xystreurys liolepis*
ZF = *Zaniolepis frenata*
ZL = *Zaniolepis latipinnis*
ZR = *Zalembius rosaceus*

Boxes indicate where guild occurred in 20% or more of stations in depth class.
Dotted lines define areas where guild occurred in less than 20% of stations in depth class.
Dominant species in guild is identified by abbreviations.

Figure A6-2. Functional structure and species composition of soft-bottom fish communities of the mainland shelf of southern California in 1972-1973 (modified from Allen 1982, 2006a).