Inshore brown and white shrimp relative abundance in Louisiana

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Overview

Brown and white shrimp relative abundance indices are developed from the Louisiana Department of Wildlife and Fisheries (LDWF) fishery-independent 16-foot inshore marine otter trawl survey. This survey is conducted at fixed sampling stations within each LDWF Coastal Study Area (CSA; Figure 1). Sampling gear is a 4.9 flat otter trawl with a body and cod-end consisting of 19 and 6.4 bar meshes, respectively. Samples are 10 minute tows. All captured shrimp are enumerated and a maximum of 50 randomly selected shrimp per species per sample are measured and placed in 5mm total length bins. When more than 50 shrimp per species per sample are captured, catch-at-size is derived as the product of total catch and the proportional subsample at size. In October 2010, additional fixed stations were added to this survey allowing more spatial coverage within each CSA. For abundance index development, samples from the surveys long-term stations (prior to October 2010) are combined with the samples from all stations beginning in October 2010.

Methodology

Annual abundance indices for brown shrimp are developed for three size categories using samples from the months of March – June only. The three size categories for the brown shrimp indices are small (TL <115.6mm), medium (TL ≥115.6 - ≤151.8mm), and large (TL ≥151.8mm). Catch per unit effort is defined as the number of brown shrimp in each size category caught per 10 minute trawl tow.

Annual abundance indices for white shrimp are developed for three size categories using samples from all months of the year. The three size categories for the white shrimp indices are small (TL <108.1mm), medium (TL ≥108.1 - ≤144.3mm), and large (TL >144.3mm). Catch per unit effort is defined as the number of white shrimp in each size category caught per 10 minute trawl tow.

A delta lognormal approach is used to develop the annual abundance indices of each shrimp species as:

$$I = c * p$$

where c are the estimated mean CPUE of positive catches in each year, assumed as lognormal distributions, and p are the estimated mean probabilities of capturing the species of interest in each year, assumed as binomial distributions. The lognormal component considers only those samples in which species of interest were captured (i.e., geometric mean of successful trawl tows only). The binomial component considers all of the samples (i.e., the proportion of trawl tows capturing the species and size category of interest). Each annual index is then computed from $I = c * p$ using the observed means with variances calculated as:

$$Var(XY) \approx \mu_Y^2\sigma_X^2 + \mu_X^2\sigma_Y^2 + 2\mu_X\mu_Y\rho\sigma_X\sigma_Y$$

where μ_Y is the binomial mean proportion of positive catches, μ_X is the geometric mean catch-per-unit-effort of successful tows, σ_Y^2 and σ_X^2 are the respective variances, and ρ is the correlation between X and Y.

Each index of abundance and corresponding variance estimates are presented (Tables 1-6 and Figures 2-7)

Tables

Table 1: Small brown shrimp relative abundance index and corresponding variance estimates along with the proportion of positive trawl tows and the geometric mean of the successful tows.

year	effort	Ppos	geomean	index	var_i	CV_i
1980	337	0.5816	21.5761	12.5487	0.3429	0.0467
1981	446	0.6592	31.3257	20.6497	0.5008	0.0343
1982	465	0.6430	37.8702	24.3509	0.7144	0.0347
1983	498	0.6084	18.4012	11.1959	0.1661	0.0364
1984	433	0.5958	34.4099	20.5029	0.6653	0.0398
1985	482	0.6390	39.7187	25.3804	0.7616	0.0344
1986	415	0.7398	47.4475	35.0997	1.0528	0.0292
1987	491	0.6151	32.8262	20.1904	0.5256	0.0359
1988	446	0.5942	18.9373	11.2520	0.1983	0.0396
1989	412	0.6481	23.6662	15.3371	0.3164	0.0367
1990	463	0.7127	30.7145	21.8915	0.4230	0.0297
1991	493	0.6491	18.9257	12.2845	0.1695	0.0335
1992	479	0.6597	21.6509	14.2832	0.2242	0.0332
1993	449	0.5702	24.1647	13.7776	0.3241	0.0413
1994	453	0.6623	16.9354	11.2155	0.1463	0.0341
1995	470	0.6979	26.5186	18.5066	0.3203	0.0306
1996	460	0.5261	46.5651	24.4973	1.1827	0.0444
1997	455	0.6352	37.1351	23.5869	0.7099	0.0357
1998	490	0.6163	41.8434	25.7892	0.8518	0.0358
1999	499	0.7976	29.5212	23.5460	0.2870	0.0228
2000	481	0.8773	21.5616	18.9168	0.1078	0.0174
2001	474	0.6772	23.1387	15.6699	0.2514	0.0320
2002	500	0.6040	18.9658	11.4554	0.1758	0.0366
2003	511	0.6849	25.7851	17.6610	0.2852	0.0302
2004	489	0.6994	30.6788	21.4563	0.4104	0.0299
2005	502	0.6853	27.4719	18.8254	0.3292	0.0305
2006	484	0.8202	35.1945	28.8682	0.3829	0.0214
2007	470	0.7404	32.5006	24.0642	0.4377	0.0275
2008	496	0.7258	32.6191	23.6752	0.4330	0.0278
2009	495	0.8404	33.8590	28.4552	0.3156	0.0197
2010	456	0.5373	48.6728	26.1510	1.2991	0.0436
2011	1094	0.7770	70.4346	54.7253	0.7895	0.0162
2012	1135	0.8529	38.3770	32.7303	0.1651	0.0124
2013	1123	0.6821	30.8044	21.0117	0.1856	0.0205
2014	576	0.6198	24.3597	15.0979	0.2466	0.0329
2015	549	0.6667	28.6997	19.1331	0.3379	0.0304
2016	547	0.7678	31.9336	24.5194	0.3371	0.0237
2017	575	0.8435	41.9039	35.3451	0.4074	0.0181
2018	547	0.7678	33.0445	25.3724	0.3608	0.0237
2019	539	0.4935	20.4870	10.1105	0.1978	0.0440
2020	537	0.7225	22.6934	16.3967	0.1963	0.0270
2021	538	0.6822	23.6315	16.1204	0.2294	0.0297
2022	462	0.7338	33.0893	24.2798	0.4689	0.0282

Table 2: Medium brown shrimp relative abundance index and corresponding variance estimates along with the proportion of positive trawl tows and the geometric mean of the successful tows.

year	effort	Ppos	geomean	index	var_i	CV_i
1980	337	0.0326	1.9915	0.0650	0.0006	0.3681
1981	446	0.1502	3.6498	0.5483	0.0041	0.1171
1982	465	0.1140	2.9337	0.3344	0.0022	0.1388
1983	498	0.1104	2.8800	0.3181	0.0019	0.1358
1984	433	0.1109	4.4216	0.4901	0.0047	0.1392
1985	482	0.0705	3.8090	0.2687	0.0021	0.1707
1986	415	0.1566	3.3287	0.5214	0.0039	0.1203
1987	491	0.1079	1.9769	0.2134	0.0011	0.1549
1988	446	0.1278	2.0467	0.2616	0.0016	0.1547
1989	412	0.1214	3.1529	0.3826	0.0030	0.1431
1990	463	0.1296	4.1386	0.5363	0.0045	0.1247
1991	493	0.0953	3.0249	0.2884	0.0019	0.1494
1992	479	0.0814	2.3359	0.1902	0.0011	0.1759
1993	449	0.0668	2.9602	0.1978	0.0014	0.1876
1994	453	0.0839	2.6227	0.2200	0.0014	0.1708
1995	470	0.0574	3.3433	0.1921	0.0014	0.1937
1996	460	0.0478	5.0624	0.2421	0.0027	0.2128
1997	455	0.0396	6.4538	0.2553	0.0035	0.2331
1998	490	0.0816	3.5542	0.2901	0.0022	0.1604
1999	499	0.0581	3.6500	0.2121	0.0016	0.1889
2000	481	0.1559	2.4737	0.3857	0.0023	0.1242
2001	474	0.1266	3.4672	0.4389	0.0031	0.1262
2002	500	0.1080	2.7918	0.3015	0.0019	0.1454
2003	511	0.1331	2.9385	0.3910	0.0024	0.1252
2004	489	0.1125	5.1309	0.5771	0.0057	0.1305
2005	502	0.0876	2.2666	0.1987	0.0011	0.1657
2006	484	0.1508	3.9105	0.5898	0.0044	0.1118
2007	470	0.1489	3.1328	0.4666	0.0030	0.1182
2008	496	0.0927	4.3126	0.4000	0.0034	0.1453
2009	495	0.1192	2.6869	0.3203	0.0019	0.1360
2010	456	0.0307	3.1080	0.0954	0.0007	0.2783
2011	1094	0.1490	4.7596	0.7092	0.0027	0.0739
2012	1135	0.2167	4.4055	0.9548	0.0031	0.0582
2013	1123	0.1024	3.9375	0.4032	0.0014	0.0915
2014	576	0.1233	2.7236	0.3357	0.0016	0.1203
2015	549	0.2004	3.5487	0.7110	0.0041	0.0898
2016	547	0.0969	3.8351	0.3716	0.0026	0.1359
2017	575	0.0922	3.2962	0.3038	0.0017	0.1375
2018	547	0.1225	3.0967	0.3793	0.0021	0.1218
2019	539	0.0260	2.2758	0.0591	0.0003	0.2933
2020	537	0.1266	3.5675	0.4518	0.0029	0.1191
2021	538	0.0595	2.6068	0.1550	0.0009	0.1886
2022	462	0.1450	3.3942	0.4922	0.0034	0.1187

Table 3: Large brown shrimp relative abundance index and corresponding variance estimates along with the proportion of positive trawl tows and the geometric mean of the successful tows.

year	effort	Ppos	geomean	index	var_i	CV_i
1980	337	0.0000	.	.	.	.
1981	446	0.0000	.	.	.	.
1982	465	0.0000	.	.	.	.
1983	498	0.0000	.	.	.	.
1984	433	0.0000	.	.	.	.
1985	482	0.0000	.	.	.	.
1986	415	0.0048	1.0892	0.0052	0.0000	0.9554
1987	491	0.0000	.	.	.	.
1988	446	0.0022	1.0000	0.0022	.	.
1989	412	0.0024	0.7500	0.0018	.	.
1990	463	0.0000	.	.	.	.
1991	493	0.0000	.	.	.	.
1992	479	0.0000	.	.	.	.
1993	449	0.0022	1.0000	0.0022	.	.
1994	453	0.0022	1.0000	0.0022	.	.
1995	470	0.0000	.	.	.	.
1996	460	0.0000	.	.	.	.
1997	455	0.0000	.	.	.	.
1998	490	0.0000	.	.	.	.
1999	499	0.0000	.	.	.	.
2000	481	0.0000	.	.	.	.
2001	474	0.0042	1.7970	0.0076	0.0000	0.7087
2002	500	0.0000	.	.	.	.
2003	511	0.0039	1.7720	0.0069	0.0000	0.7842
2004	489	0.0000	.	.	.	.
2005	502	0.0020	1.0000	0.0020	.	.
2006	484	0.0083	1.3376	0.0111	0.0000	0.6242
2007	470	0.0043	1.5556	0.0066	0.0000	0.8161
2008	496	0.0020	2.2000	0.0044	.	.
2009	495	0.0000	.	.	.	.
2010	456	0.0022	25.8899	0.0568	.	.
2011	1094	0.0009	1.8600	0.0017	.	.
2012	1135	0.0079	2.1072	0.0167	0.0000	0.3534
2013	1123	0.0000	.	.	.	.
2014	576	0.0000	.	.	.	.
2015	549	0.0000	.	.	.	.
2016	547	0.0000	.	.	.	.
2017	575	0.0000	.	.	.	.
2018	547	0.0000	.	.	.	.
2019	539	0.0000	.	.	.	.
2020	537	0.0000	.	.	.	.
2021	538	0.0000	.	.	.	.
2022	462	0.0000	.	.	.	.

Table 4: Small white shrimp relative abundance index and corresponding variance estimates along with the proportion of positive trawl tows and the geometric mean of the successful tows.

year	effort	Ppos	geomean	index	var_i	CV_i
1980	880	0.5705	11.5167	6.5697	0.0415	0.0310
1981	1008	0.5278	9.9210	5.2361	0.0279	0.0319
1982	1125	0.5324	9.8403	5.2394	0.0245	0.0299
1983	1082	0.5924	8.6303	5.1128	0.0197	0.0274
1984	989	0.5207	10.7856	5.6164	0.0329	0.0323
1985	1152	0.5599	10.0449	5.6241	0.0248	0.0280
1986	956	0.5952	12.5253	7.4549	0.0440	0.0282
1987	1047	0.6036	9.9056	5.9793	0.0261	0.0270
1988	1078	0.4527	7.0408	3.1873	0.0137	0.0368
1989	983	0.5392	6.8331	3.6842	0.0146	0.0328
1990	1156	0.4836	7.6020	3.6761	0.0151	0.0334
1991	1157	0.5713	10.1667	5.8083	0.0251	0.0273
1992	1075	0.5312	10.1693	5.4015	0.0273	0.0306
1993	1074	0.5978	11.2868	6.7468	0.0325	0.0267
1994	1082	0.6275	11.0423	6.9295	0.0305	0.0252
1995	1134	0.6367	11.5577	7.3586	0.0311	0.0240
1996	1120	0.4732	9.1916	4.3496	0.0219	0.0341
1997	1178	0.5458	10.5183	5.7413	0.0267	0.0285
1998	1247	0.6576	11.6506	7.6612	0.0280	0.0218
1999	1273	0.5672	11.1006	6.2959	0.0271	0.0261
2000	1247	0.6014	11.1436	6.7023	0.0273	0.0246
2001	1299	0.5535	9.2555	5.1230	0.0190	0.0269
2002	1281	0.5504	7.0792	3.8960	0.0120	0.0282
2003	1297	0.5729	9.4084	5.3897	0.0195	0.0259
2004	1243	0.6975	11.2793	7.8674	0.0250	0.0201
2005	1184	0.6461	11.7897	7.6175	0.0305	0.0229
2006	1276	0.7124	15.5536	11.0801	0.0432	0.0188
2007	1246	0.6677	15.6298	10.4366	0.0479	0.0210
2008	1292	0.7105	13.4319	9.5437	0.0323	0.0188
2009	1247	0.7265	18.3417	13.3261	0.0581	0.0181
2010	1175	0.6136	15.5128	9.5189	0.0530	0.0242
2011	2474	0.4503	8.6436	3.8920	0.0089	0.0242
2012	2579	0.5684	10.9410	6.2193	0.0131	0.0184
2013	2171	0.5348	9.1389	4.8873	0.0113	0.0218
2014	1376	0.4869	10.6912	5.2057	0.0235	0.0294
2015	1343	0.5808	10.9309	6.3486	0.0248	0.0248
2016	1357	0.6168	11.2805	6.9578	0.0255	0.0229
2017	1396	0.6096	9.0505	5.5172	0.0167	0.0234
2018	1312	0.4710	11.0794	5.2188	0.0264	0.0311
2019	1334	0.6087	9.2774	5.6471	0.0182	0.0239
2020	1312	0.6364	11.4880	7.3113	0.0268	0.0224
2021	1226	0.5799	12.1350	7.0375	0.0331	0.0258
2022	1116	0.6165	16.4724	10.1550	0.0629	0.0247

Table 5: Medium white shrimp relative abundance index and corresponding variance estimates along with the proportion of positive trawl tows and the geometric mean of the successful tows.

year	effort	Ppos	geomean	index	var_i	CV_i
1980	880	0.3773	3.4169	1.2891	0.0052	0.0558
1981	1008	0.3988	4.0736	1.6246	0.0059	0.0472
1982	1125	0.3209	3.3181	1.0648	0.0035	0.0557
1983	1082	0.3567	2.9182	1.0410	0.0032	0.0544
1984	989	0.3923	3.9480	1.5489	0.0057	0.0486
1985	1152	0.4375	3.7962	1.6608	0.0047	0.0414
1986	956	0.4006	4.7087	1.8864	0.0078	0.0469
1987	1047	0.3916	3.7828	1.4813	0.0053	0.0491
1988	1078	0.2672	2.7790	0.7424	0.0026	0.0693
1989	983	0.2584	2.7916	0.7213	0.0029	0.0749
1990	1156	0.2924	3.0427	0.8897	0.0030	0.0614
1991	1157	0.3328	3.1203	1.0383	0.0032	0.0543
1992	1075	0.3237	3.6241	1.1732	0.0041	0.0548
1993	1074	0.3194	3.1516	1.0065	0.0034	0.0576
1994	1082	0.3392	3.1091	1.0546	0.0033	0.0546
1995	1134	0.3783	3.6716	1.3890	0.0043	0.0473
1996	1120	0.2938	3.4232	1.0056	0.0035	0.0586
1997	1178	0.2861	3.0028	0.8590	0.0027	0.0603
1998	1247	0.3520	2.9472	1.0375	0.0027	0.0504
1999	1273	0.2506	3.1544	0.7905	0.0024	0.0616
2000	1247	0.3504	3.4984	1.2260	0.0036	0.0489
2001	1299	0.2956	2.5541	0.7550	0.0022	0.0615
2002	1281	0.3232	2.6507	0.8567	0.0023	0.0562
2003	1297	0.3570	3.1966	1.1411	0.0029	0.0476
2004	1243	0.4481	3.6690	1.6441	0.0041	0.0392
2005	1184	0.4780	4.2356	2.0248	0.0056	0.0371
2006	1276	0.5274	4.9936	2.6337	0.0068	0.0314
2007	1246	0.4583	4.4883	2.0569	0.0057	0.0366
2008	1292	0.5503	4.2503	2.3390	0.0053	0.0310
2009	1247	0.5485	4.6435	2.5470	0.0063	0.0312
2010	1175	0.4885	5.1413	2.5116	0.0075	0.0345
2011	2474	0.3791	4.6752	1.7726	0.0029	0.0305
2012	2579	0.3940	4.4292	1.7449	0.0026	0.0291
2013	2171	0.3538	3.7582	1.3295	0.0023	0.0361
2014	1376	0.2900	3.7456	1.0861	0.0032	0.0519
2015	1343	0.3641	4.5228	1.6468	0.0050	0.0431
2016	1357	0.3751	4.1882	1.5709	0.0044	0.0424
2017	1396	0.4255	4.6249	1.9679	0.0053	0.0369
2018	1312	0.3506	3.4128	1.1966	0.0033	0.0479
2019	1334	0.3283	3.1942	1.0488	0.0028	0.0501
2020	1312	0.3887	3.9321	1.5285	0.0042	0.0423
2021	1226	0.3613	3.7938	1.3709	0.0041	0.0467
2022	1116	0.5063	5.9568	3.0158	0.0104	0.0338

Table 6: Large white shrimp relative abundance index and corresponding variance estimates along with the proportion of positive trawl tows and the geometric mean of the successful tows.

year	effort	Ppos	geomean	index	var_i	CV_i
1980	880	0.0693	1.3611	0.0943	0.0006	0.2615
1981	1008	0.1101	1.6671	0.1836	0.0008	0.1535
1982	1125	0.0729	1.5254	0.1112	0.0005	0.2022
1983	1082	0.0397	1.4333	0.0570	0.0004	0.3490
1984	989	0.0809	1.6331	0.1321	0.0006	0.1794
1985	1152	0.0807	1.4700	0.1187	0.0005	0.1861
1986	956	0.1151	1.7474	0.2011	0.0010	0.1546
1987	1047	0.0630	1.8807	0.1186	0.0005	0.1837
1988	1078	0.0278	1.1774	0.0328	0.0002	0.4534
1989	983	0.0346	1.4230	0.0492	0.0003	0.3368
1990	1156	0.0554	1.3534	0.0749	0.0003	0.2438
1991	1157	0.0510	1.4141	0.0721	0.0003	0.2498
1992	1075	0.0419	1.4412	0.0603	0.0003	0.2826
1993	1074	0.0615	1.3900	0.0854	0.0004	0.2457
1994	1082	0.0453	1.5602	0.0707	0.0004	0.2963
1995	1134	0.0547	1.4789	0.0809	0.0004	0.2563
1996	1120	0.0750	1.4302	0.1073	0.0005	0.2045
1997	1178	0.0450	1.3551	0.0610	0.0003	0.2972
1998	1247	0.0537	1.3301	0.0715	0.0003	0.2577
1999	1273	0.0259	1.1650	0.0302	0.0002	0.4604
2000	1247	0.0513	1.3009	0.0668	0.0004	0.2896
2001	1299	0.0485	1.3654	0.0662	0.0003	0.2635
2002	1281	0.0539	1.2747	0.0687	0.0003	0.2631
2003	1297	0.0594	1.2963	0.0770	0.0003	0.2408
2004	1243	0.0579	1.4708	0.0852	0.0004	0.2308
2005	1184	0.0980	1.5796	0.1548	0.0006	0.1572
2006	1276	0.1763	2.1101	0.3721	0.0012	0.0933
2007	1246	0.1148	1.6214	0.1861	0.0007	0.1427
2008	1292	0.1362	1.7181	0.2340	0.0008	0.1231
2009	1247	0.1620	1.7130	0.2775	0.0009	0.1105
2010	1175	0.1549	2.1494	0.3329	0.0011	0.0991
2011	2474	0.1871	1.8719	0.3503	0.0006	0.0682
2012	2579	0.1338	1.8697	0.2501	0.0004	0.0796
2013	2171	0.0889	1.6888	0.1501	0.0003	0.1223
2014	1376	0.0690	1.6025	0.1106	0.0004	0.1786
2015	1343	0.0931	2.0106	0.1871	0.0006	0.1327
2016	1357	0.0582	1.6631	0.0968	0.0003	0.1870
2017	1396	0.0702	1.6121	0.1132	0.0003	0.1652
2018	1312	0.0663	1.4792	0.0981	0.0004	0.2045
2019	1334	0.0465	1.4115	0.0656	0.0003	0.2542
2020	1312	0.0663	1.8892	0.1253	0.0004	0.1690
2021	1226	0.0538	1.6637	0.0896	0.0003	0.2005
2022	1116	0.1317	2.1269	0.2802	0.0010	0.1138

Figures

Figure 1: Station locations of the LDWF inshore 16-foot marine otter trawl survey.

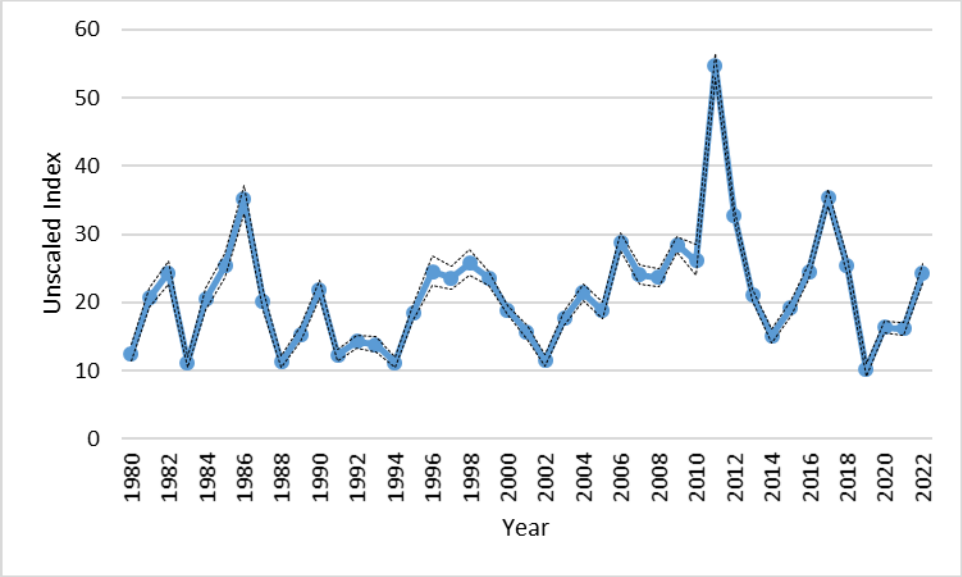

Figure 2: Small brown shrimp relative abundance index and 95% confidence intervals.

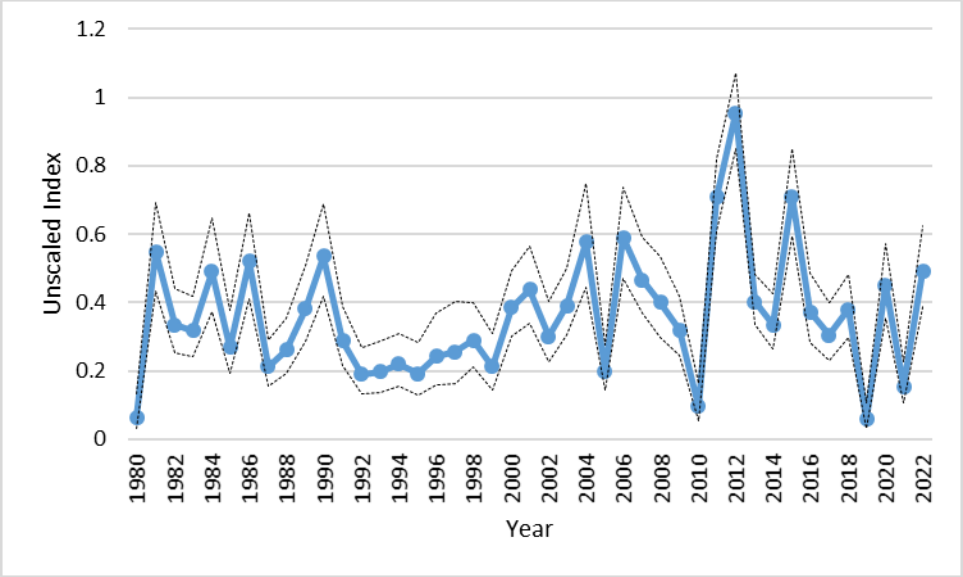

Figure 3: Medium brown shrimp relative abundance index and 95% confidence intervals.

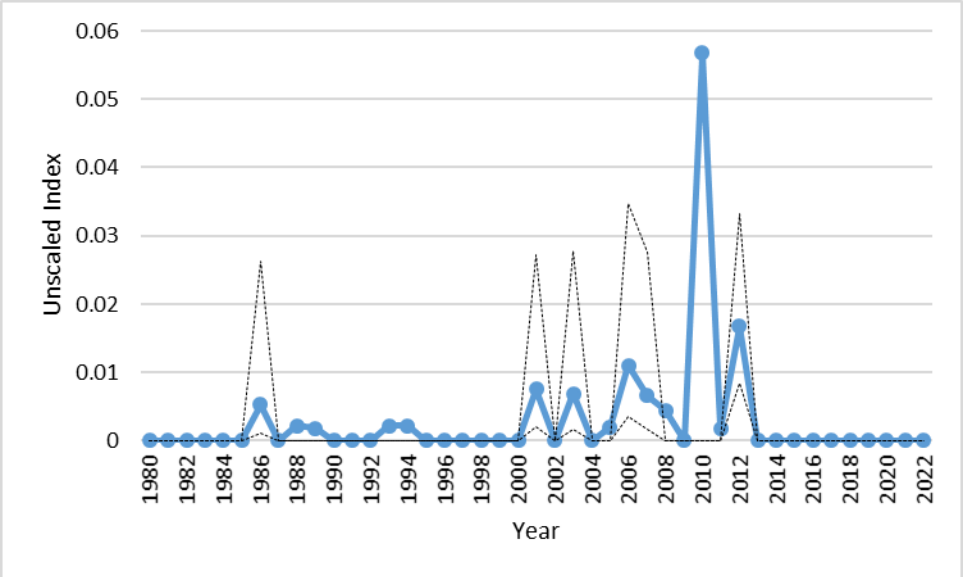

Figure 4: Large brown shrimp relative abundance index and 95% confidence intervals.

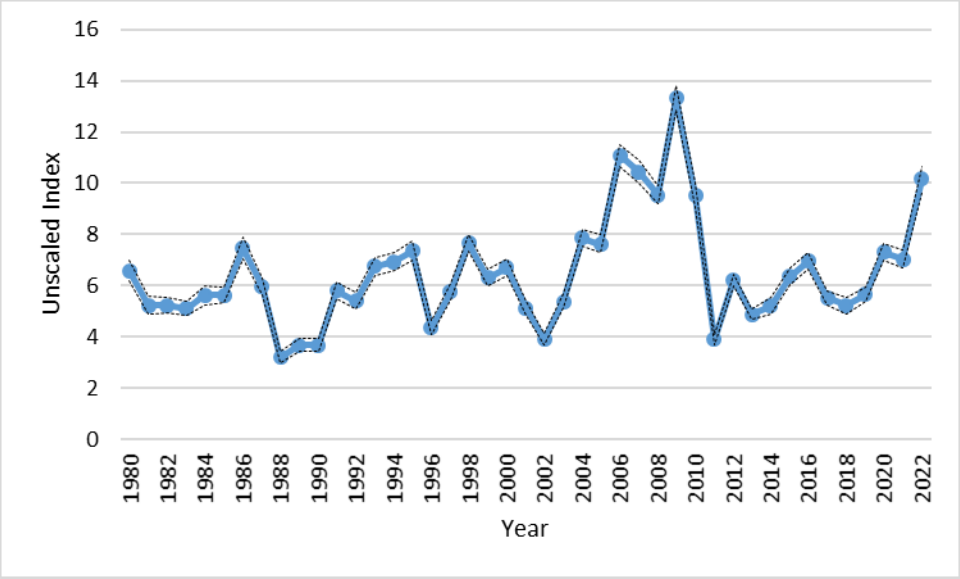

Figure 5: Small white shrimp relative abundance index and 95% confidence intervals.

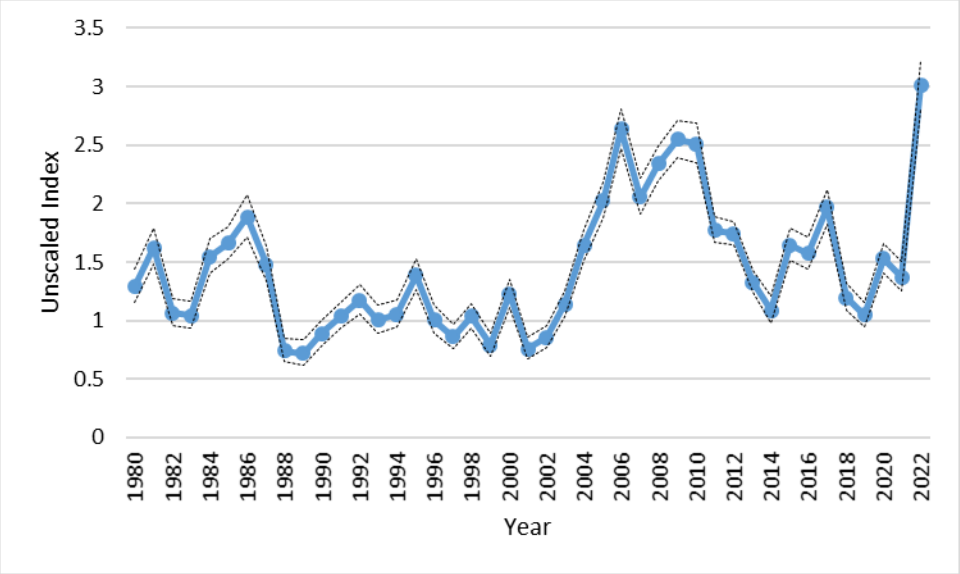

Figure 6: Medium white shrimp relative abundance index and 95% confidence intervals.

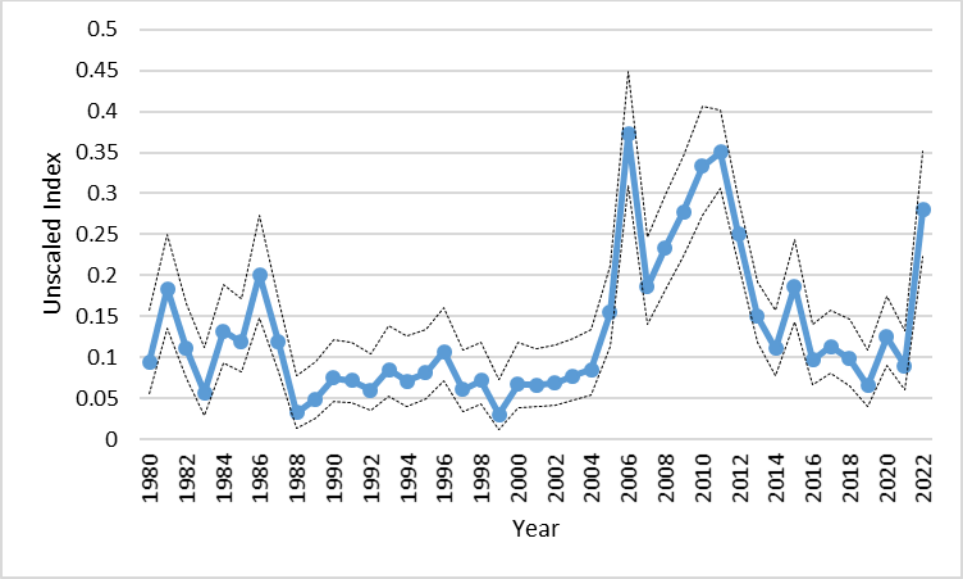

Figure 7: Large white shrimp relative abundance index and 95% confidence intervals.