Fishery-independent surveys of juvenile gag grouper in the Gulf of America (1994-2024)

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To develop abundance indices for age-0 gag grouper in the Gulf of America, three available databases were analyzed. In the following sections, each database is briefly outlined along with the survey methodology. Next, the statistical approach used to develop the indices is presented. The analyses herein follow those detailed in Ingram (2021).

1. FSU estuarine gag survey

- **Gear:** 5-m otter trawl towed for 5 minutes at ~2 km/h covering approximately a 150 m transect. The number of gag grouper caught is standardized by tow time and estimates of the area covered.
- **Areas covered:** St. Andrew Bay, St. Joe Bay, Turkey Point, Big Bend (Keaton Beach, Cedar Key), Crystal River, Anclote Key, Sarasota Bay, Sanibel, primarily in seagrass habitat. The 35 sampling locations in this survey were lumped into 9 sampling regions similar to those of Brown et al. (2000).
- **Index years:** 1991-1999, 2003-2009, 2011
- **Index value based upon:** Number of gag grouper per 100-m tow
- **Noteworthy:** Gag is the target species, primarily captured during summer months in the post-settlement juvenile stage. In the early years, 1991 and 1993, survey efforts were limited to the Turkey Point area, and no sampling was conducted in 2000, 2001, or 2003. While this is currently one of the longer-term age-0 surveys, the hiatus in sampling during those years meant it was not recommended during the data workshop for use in the SEDAR 10 assessment (which included data up to 2005).
- **Pertinent references:** Koenig and Coleman 1998 a & b, Brown et al. 2000.

2. NMFS PC Lab St. Andrew Bay survey

- **Gear:** Weekly sampling, May-November, 16 (50 m) tows taken using 1 m beam trawl ("crab scrape") at 5 fixed locations pre-determined to be settlement areas. Area covered is precisely measured.
- **Areas covered:** St. Andrew Bay, Florida, principally 1-2 meters depth in conjunction with seagrass habitat
- **Index years:** 1998-2014.
- **Index value based upon:** Catch per meter2
- **Noteworthy:** Gag, grey snapper, and lane snapper are the target species; fish are primarily sampled soon after settlement into seagrass habitats. This survey has not been used previously as an assessment index for gag.
- **Principal contacts:** Stacey Harter, (Stacey.Harter@noaa.gov) NMFS Panama City
- **Pertinent references:** Harter 2008, 2009, NOAA-FWC 2009

3. State of Florida FWC estuarine (FIM) survey

- **Gear:** 183-m haul seine, a component of the Fishery Independent Monitoring Program (FIM); and 183-m haul seine and 6.1 m otter trawl, components of a polyhaline seagrass survey.

- **Areas covered:** Apalachicola Bay, Cedar Key, Tampa Bay, Charlotte Harbor, in estuarine near-shore habitats (~0.5 m depth).
- **Index years:** 1996-2024
- **Index value based upon:** Catch per haul
- **Noteworthy:** While the FIM survey includes several gear types, the 183-m haul seine catches the most gag juveniles, typically later in the year (about ¾ of a year old) and closer to period of movement to deeper water. Similar-sized fish are collected in the 183-m haul seine and 6.1 m otter trawl gears of the recently initiated polyhaline seagrass survey. There was a 2008 expansion to St. Andrew Bay, Big Bend, and Apalachicola Bay, resulting in increased coverage of seagrass habitats likely to hold juvenile gag. There was a programmatic change in 2019 in which the haul seine was discontinued, and the effort was converted into additional trawl effort for the polyhaline seagrass survey. The reason for this was to gain more statistical power, and major size differences between gears for gag and other reef fishes were not observed.
- **Data Updates:** The FWC data were updated through 2024 and limited in the following manner to ensure the inclusion of only age-zero gag grouper juveniles:
    - Exclude > 200 mm SL between May and July
    - Exclude > 250 mm SL between August and September
    - Exclude > 300 mm SL between October and November
- **Principal contacts:** Ted Switzer (Ted.Switzer@MyFWC.com), FWC St. Petersburg
- **Pertinent references:** Casey et al. 2005, Ingram et al. 2005, NOAA-FWC 2009

4. Methodology

To develop standardized indices of annual abundance of juvenile gag from Florida estuaries and coastal waters in the Gulf of America, data from the above-described surveys were combined following the methods of Ingram (2021). This was accomplished by first calculating the overall mean catch rate for each dataset, then scaling each dataset to a mean of 1. Because the FWC data included two gear types, each gear type was treated as a separate dataset, and a database code was assigned to each dataset to model differences between them. Next, sampling locations in each dataset were lumped into the 9 sampling regions (Table 4.1 and Figure 4.1). The weight for each region was based on the seagrass coverage area within each region, at water depths between 0 and 6 feet (Figure 4.1). This depth range was said to be that in which the majority of juvenile gag are captured. The area between 0 and 6 feet of water depth was estimated in each region using a NOAA medium-scale bathymetric model, and the seagrass aerial coverage for each region was estimated using a GIS dataset compiled from statewide seagrass data across various agencies and scales. The seagrass data were cross-referenced with the bathymetry data to estimate the seagrass coverage area in each region (Figure 4.1).

A delta-lognormal model, as described by Lo et al. (1992), was employed for each index. The seagrass area was used to develop sample weights for each region (Table 4.2). The GLMMIX and MIXED procedures in SAS were used to obtain yearly index values for the binomial and lognormal sub-models, respectively. A backward stepwise selection procedure was employed to develop both sub-models. The parameters tested for inclusion in each sub-model were categorical variables of year, database code, region code, and season [if month in (1, 2, 3, 4, 11, 12) then they were deleted; if month=6 or 7 then season=Early Summer; if month=4 or 5 then season=Spring; if month=8 or 9 then season=Late Summer; if month=10 or 11 then season=Fall). Section 5 contains the outputs of each model run.

Table 4.1. Sampling location and corresponding region codes for data used in these analyses.

Location	Site_code	Region	Region_code
Cedar Key	CED	Cedar Key region	CKR
Crystal River	CRY	Cedar Key region	CKR
Homasassa	HOM	Cedar Key region	CKR
Suwanee Sound	SUS	Cedar Key region	CKR
Waccasassa	WAC	Cedar Key region	CKR
Captiva Pass	CAP	Charlotte Harbor region	CHR
Fisherman Key	FIK	Charlotte Harbor region	CHR
Jug Creek Shoal	JUG	Charlotte Harbor region	CHR
Punta Rassa	PUN	Charlotte Harbor region	CHR
Redfish Pass	RED	Charlotte Harbor region	CHR
Sanibel	SAN	Charlotte Harbor region	CHR
Smokehouse Bay	SHB	Charlotte Harbor region	CHR
Ussepa Island	USI	Charlotte Harbor region	CHR
Wulford Pass	WUP	Charlotte Harbor region	CHR
Cape Romano	CPR	Marco Island region	MIR
Horseshoe Beach	HSB	Mid Big Bend region	MBB
Keaton Beach	KEB	Mid Big Bend region	MBB
St Marks	SMK	Mid Big Bend region	MBB
Steinhatchee	STE	Mid Big Bend region	MBB
Longboat Pass	LBP	Sarasota Bay region	SBR
New Pass	NWP	Sarasota Bay region	SBR
Sarasota Bay	SAR	Sarasota Bay region	SBR
Crooked Is Sound	CIS	St. Andrew Bay region	SAR
St Andrew Bay	SAB	St. Andrew Bay region	SAR
St Joe Bay	SJB	St. Joe Bay region	SJR
Anclote	ANC	Tampa Bay region	TBR
Aripeka	ARI	Tampa Bay region	TBR
Bunces Pass	BPN	Tampa Bay region	TBR
Egmont Key	EGM	Tampa Bay region	TBR
Mullet Key	MUL	Tampa Bay region	TBR
NE Anna Maria	NAM	Tampa Bay region	TBR
Tampa Bay	TPB	Tampa Bay region	TBR
Dog Is Shoal	DIS	Turkey Pt region	TPR
Lanark	LAN	Turkey Pt region	TPR
Turkey Point	TUP	Turkey Pt region	TPR

Figure 4.1. Nine sampling regions were used in this study. The green areas indicate seagrass coverage at water depths between 0 and 6 feet. Seagrass coverage in acres for each region is listed.

Table 4.2. Seagrass weights by region.

Region Code	Weight
CHR	0.101042608
CKR	0.499869815
MBB	0.256997217
MIR	0.004115772
SAR	0.016522925
SBR	0.012819538
SJR	0.014491722
TBR	0.069601021
TPR	0.024539381

5. Results
5.1. Sample sizes and nominal standardized catch rates.

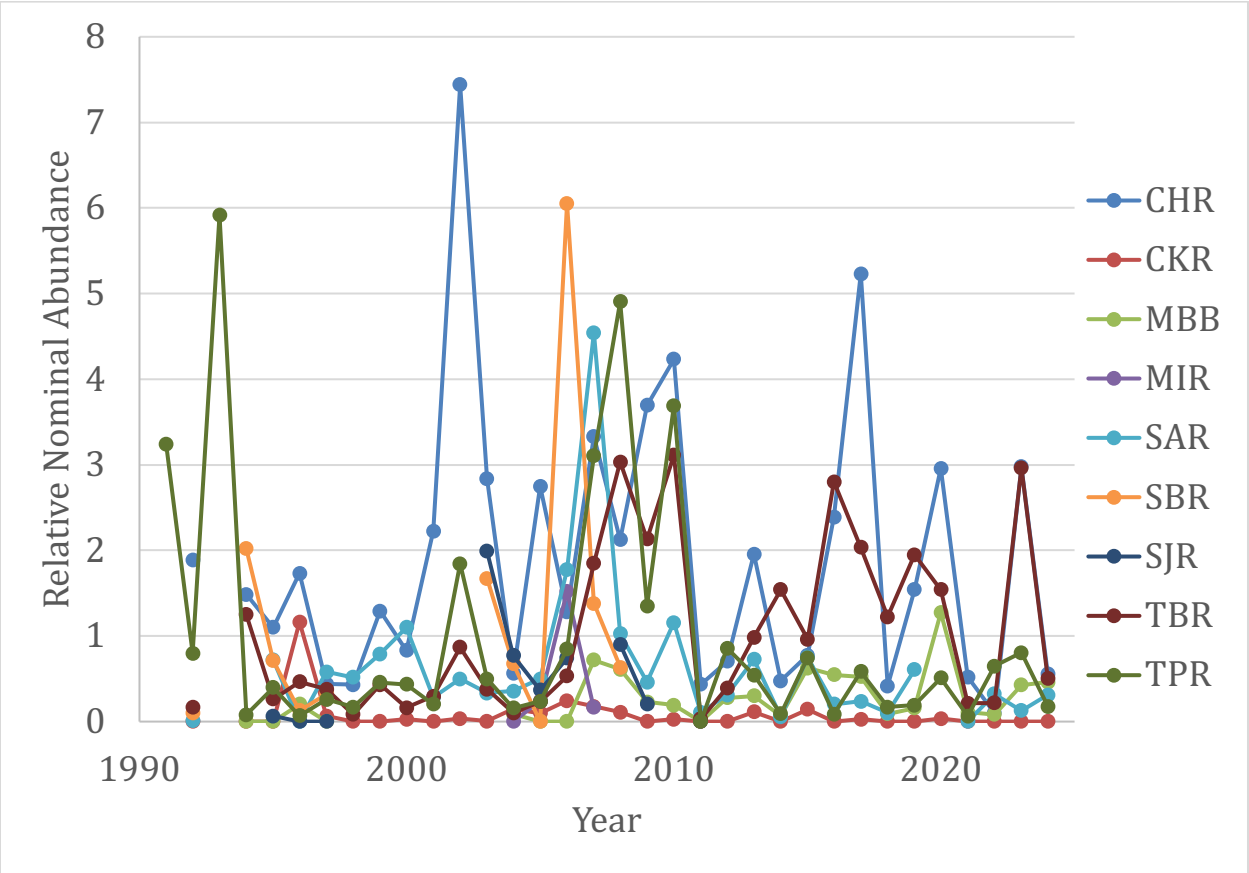


Figure 5.1.1. Nominal relative abundance per region. Region codes are described in Table 4.1.

Table 5.1.1. Number of samples per region.

Year	CHR	CKR	MBB	MIR	SAR	SBR	SJR	TBR	TPR
1991									434
1992	65	16			51	26		38	55
1993									13
1994	20	6	4			8		15	73
1995	40	10	10		179	10	10	47	31
1996	200	15	45		55	15	15	215	66
1997	236	110	20		20	20	20	235	20
1998	161	85			5			170	149
1999	156	138			43			177	209
2000	136	128			32			160	192
2001	136	248			15			166	144
2002	136	218			232			165	144
2003	161	133			204	17	13	182	158
2004	195	145	7	5	135	17	20	192	154
2005	210	159	9	7	209	5	30	183	173
2006	204	170	6	14	195	5	22	191	173
2007	200	144	6	7	202	9		185	149
2008	318	139	291		220	5	5	322	233
2009	252	128	225		133		5	289	233
2010	234	128	210		63			295	228
2011	249	138	225		183	5	5	305	233
2012	234	128	210		59			295	228
2013	234	128	210		160			295	228
2014	234	128	210		152			291	228
2015	234	128	210		63			279	228
2016	220	128	180		54			262	216
2017	220	128	180		54			262	216
2018	220	128	180		45			262	216
2019	256	128	180		72			304	240
2020	162	112	90					212	159
2021	255	128	180		72			304	240
2022	256	128	180		72			304	240
2023	256	128	180		72			304	240
2024	256	128	180		72			304	240

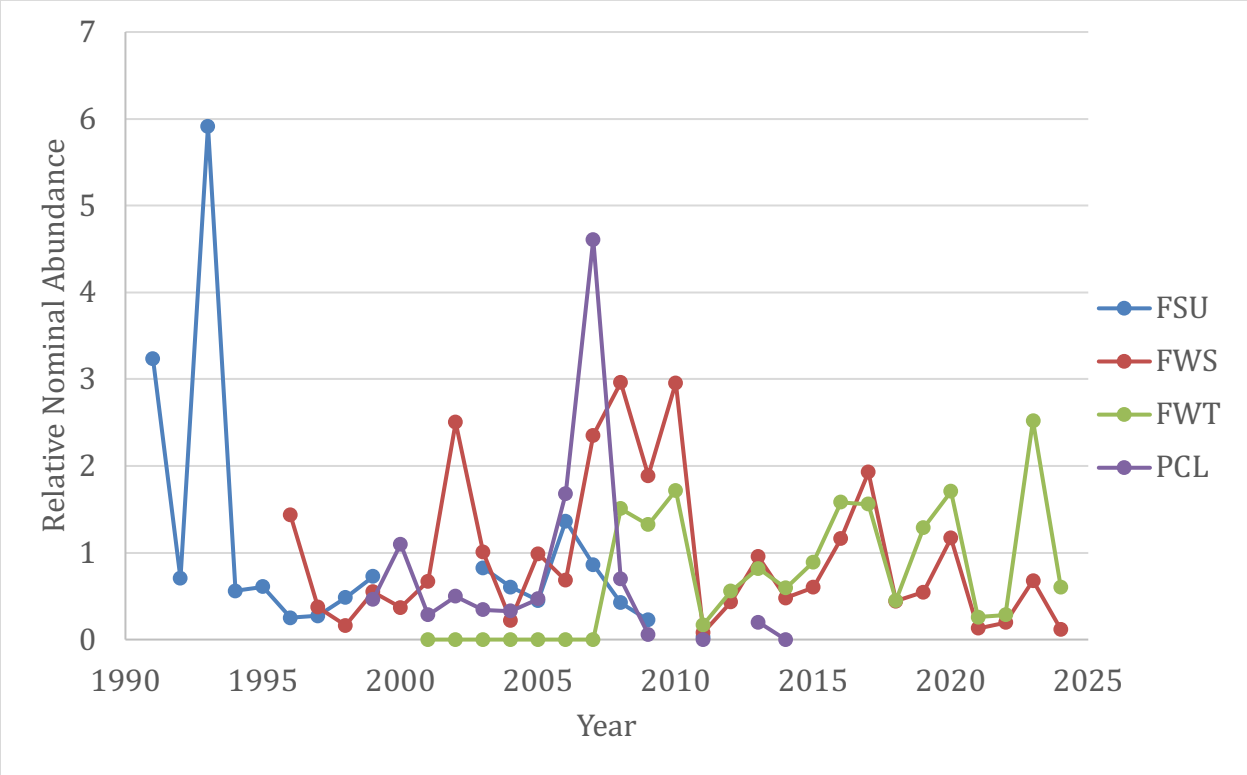


Figure 5.1.2. Nominal relative abundance per survey.

Table 5.1.2. Number of samples per survey.

Row Labels	FSU	FWS	FWT	PCL
1991	434			
1992	251			
1993	13			
1994	126			
1995	337			
1996	351	275		
1997	305	376		
1998	55	515		
1999	74	616		33
2000		616		32
2001		568	126	15
2002		568	95	232
2003	104	574	7	183
2004	119	616	10	125
2005	170	616	8	191
2006	169	616	10	185
2007	78	616	10	198
2008	77	770	535	151
2009	25	726	444	70
2010		708	450	
2011	70	708	450	115
2012		707	447	
2013		708	450	97
2014		708	446	89
2015		708	434	
2016		688	372	
2017		688	372	
2018		685	366	
2019		568	612	
2020		465	270	
2021		568	611	
2022		568	612	
2023		568	612	
2024		568	612	

5. Results

5.2. Juvenile Gag Indices from FWC Data Only (1996-2024)

Parameters Used

Class Level Information

Class	*Levels*	*Values*
Year	29	1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024
season	4	Early_Summer Fall Late_Summer Spring
Region_Code	6	CHR CKR MBB SAR TBR TPR
database_code	2	FWS FWT

Type 3 Tests of Fixed Effects (Binomial Submodel)

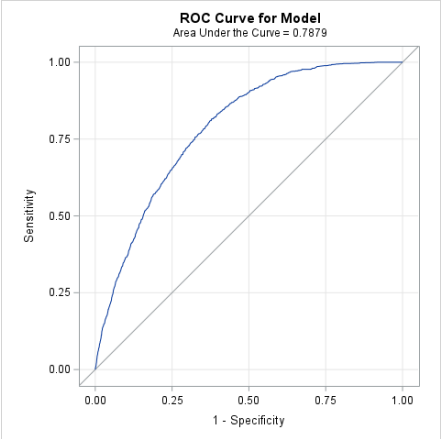
Type 3 Tests of Fixed Effects

Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*
Year	28	26E3	396.51	14.16	<.0001	<.0001
Season	3	26E3	266.43	88.81	<.0001	<.0001
Region_Code	5	26E3	1105.50	221.10	<.0001	<.0001
database_code	1	26E3	64.13	64.13	<.0001	<.0001

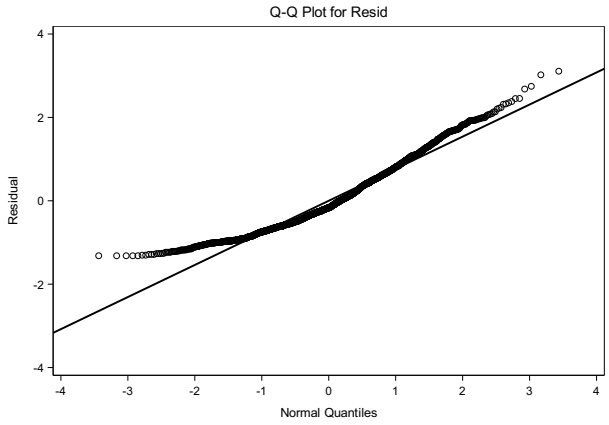
Type 3 Tests of Fixed Effects (Lognormal Submodel)

Type 3 Tests of Fixed Effects

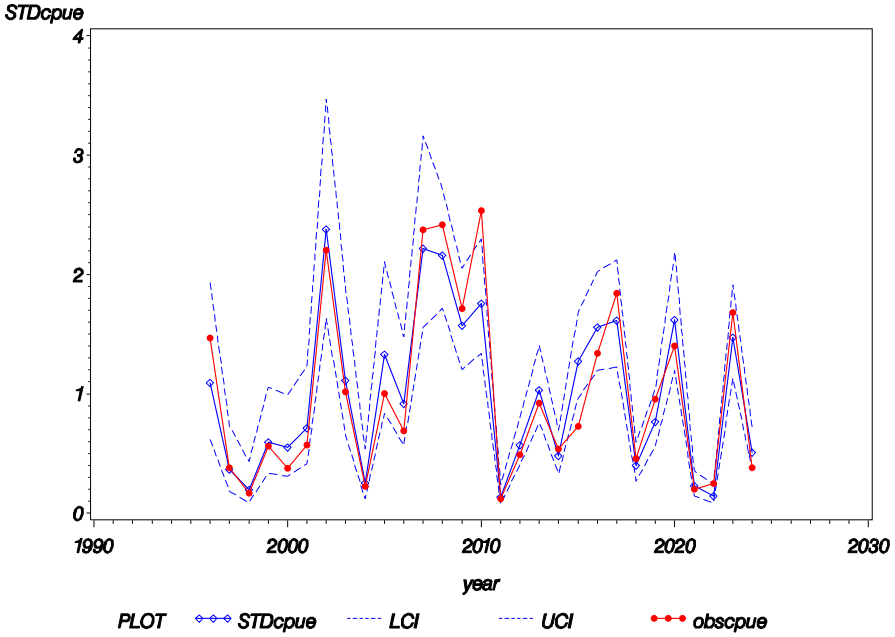
Effect	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	28	2077	4.72	<.0001
season	3	2077	5.85	0.0006
Region_Code	5	2077	15.95	<.0001
database_code	1	2077	1.15	0.2833



ROC for Binomial Submodel.



Q-Q plot for Lognormal Submodel



Indices by year with 95 % CI. Obcpue=nominal index values.

Index values for FWC Data Only (1996-2024).

Year	*Nominal Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
1996	0.08727	266	0.32457	1.09081	0.29152	0.61614	1.93115
1997	0.04255	363	0.10875	0.36547	0.35829	0.18239	0.73234
1998	0.02524	512	0.05822	0.19568	0.41391	0.08833	0.43345
1999	0.05032	611	0.17675	0.59401	0.29415	0.33387	1.05685
2000	0.03571	612	0.16459	0.55314	0.29749	0.30896	0.99031
2001	0.03746	673	0.21260	0.71450	0.27848	0.41363	1.23420
2002	0.10256	650	0.70824	2.38023	0.19059	1.63137	3.47285
2003	0.05680	574	0.33014	1.10950	0.26899	0.65396	1.88237
2004	0.02236	603	0.07536	0.25326	0.39045	0.11923	0.53796
2005	0.05609	606	0.39551	1.32920	0.23334	0.83868	2.10661
2006	0.06070	616	0.27255	0.91597	0.24175	0.56869	1.47532
2007	0.12460	621	0.65996	2.21795	0.17870	1.55580	3.16193
2008	0.15862	1298	0.64268	2.15987	0.11499	1.71743	2.71631
2009	0.13846	1160	0.46725	1.57032	0.13390	1.20283	2.05009
2010	0.13817	1155	0.52224	1.75512	0.13534	1.34056	2.29786
2011	0.02159	1154	0.04016	0.13497	0.29072	0.07636	0.23860
2012	0.06932	1147	0.16997	0.57123	0.17042	0.40724	0.80127
2013	0.08290	1153	0.30720	1.03243	0.15589	0.75731	1.40750
2014	0.06153	1146	0.14269	0.47954	0.18639	0.33137	0.69398
2015	0.08669	1135	0.37851	1.27208	0.13959	0.96350	1.67948
2016	0.12264	1055	0.46296	1.55590	0.13215	1.19591	2.02426
2017	0.10943	1055	0.48005	1.61332	0.13821	1.22530	2.12422
2018	0.05899	1046	0.11868	0.39885	0.20023	0.26829	0.59296
2019	0.09237	1173	0.22824	0.76707	0.15471	0.56396	1.04333
2020	0.11973	728	0.48154	1.61835	0.15147	1.19744	2.18721
2021	0.03223	1171	0.06758	0.22712	0.22602	0.14534	0.35493
2022	0.03305	1170	0.04253	0.14294	0.26899	0.08425	0.24251
2023	0.14153	1171	0.43806	1.47221	0.13235	1.13112	1.91616
2024	0.05763	1168	0.15144	0.50894	0.16921	0.36369	0.71220

5.3. Juvenile Gag Indices from FWC and NMFS Data (1996-2024)

Parameters Used

Class Level Information

Class	*Levels*	*Values*
Year	29	1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024
season	4	Early_Summer Fall Late_Summer Spring
Region_Code	6	CHR CKR MBB SAR TBR TPR
database_code	3	FWS FWT PCL

Type 3 Tests of Fixed Effects (Binomial Submodel)

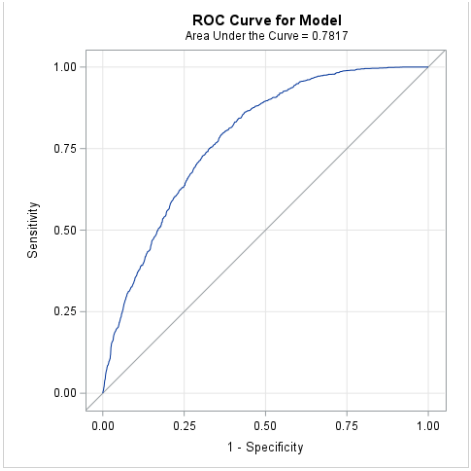
Type 3 Tests of Fixed Effects

Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*
Year	28	28E3	430.48	15.37	<.0001	<.0001
Season	3	28E3	287.32	95.77	<.0001	<.0001
Region_Code	5	28E3	1180.20	236.04	<.0001	<.0001
database_code	2	28E3	75.35	37.67	<.0001	<.0001

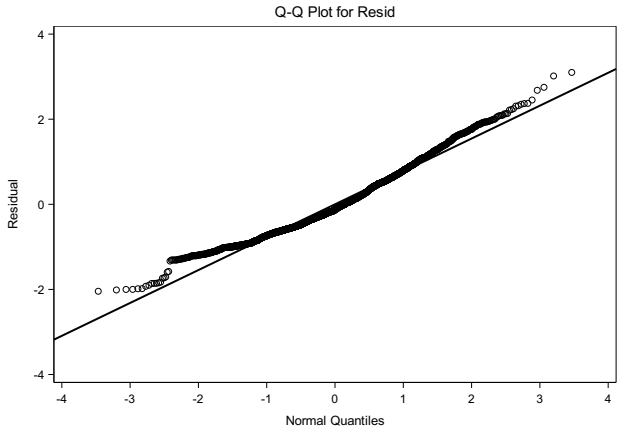
Type 3 Tests of Fixed Effects (Lognormal Submodel)

Type 3 Tests of Fixed Effects

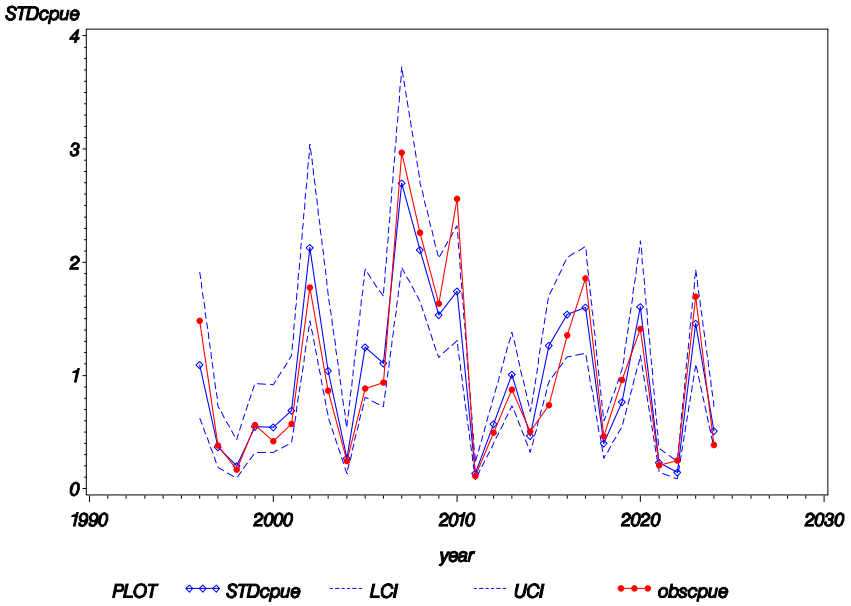
Effect	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	28	2332	5.81	<.0001
season	3	2332	5.63	0.0008
Region_Code	5	2332	18.20	<.0001
database_code	2	2332	2.20	0.1108



ROC for Binomial Submodel.



Q-Q plot for Lognormal Submodel



Indices by year with 95 % CI. Obcpue=nominal index values.

Index values for FWC and NMFS Data (1996-2024).

Year	*Nominal Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
1996	0.08727	266	0.40743	1.09144	0.28595	0.62301	1.91208
1997	0.04255	363	0.13749	0.36831	0.35003	0.18661	0.72695
1998	0.02524	512	0.07406	0.19839	0.40339	0.09126	0.43130
1999	0.07550	644	0.20335	0.54476	0.27189	0.31933	0.92931
2000	0.07407	644	0.20238	0.54215	0.26830	0.31998	0.91859
2001	0.04372	688	0.25820	0.69169	0.26956	0.40726	1.17477
2002	0.09832	882	0.79350	2.12567	0.18128	1.48357	3.04568
2003	0.05890	757	0.38872	1.04133	0.25263	0.63320	1.71253
2004	0.02796	728	0.09955	0.26667	0.36239	0.13209	0.53838
2005	0.05890	796	0.46644	1.24952	0.22153	0.80653	1.93580
2006	0.10604	801	0.41363	1.10805	0.21548	0.72363	1.69668
2007	0.19782	819	1.00761	2.69925	0.16247	1.95452	3.72775
2008	0.15385	1449	0.78776	2.11030	0.12315	1.65113	2.69716
2009	0.13145	1230	0.57302	1.53503	0.14185	1.15749	2.03571
2010	0.13817	1155	0.65053	1.74267	0.14405	1.30839	2.32109
2011	0.01964	1269	0.04921	0.13182	0.28690	0.07511	0.23135
2012	0.06932	1147	0.21285	0.57020	0.17613	0.40199	0.80881
2013	0.07968	1250	0.37540	1.00564	0.16070	0.73071	1.38400
2014	0.05712	1235	0.17391	0.46587	0.18947	0.32000	0.67825
2015	0.08669	1135	0.47236	1.26539	0.14791	0.94285	1.69826
2016	0.12264	1055	0.57521	1.54091	0.14095	1.16400	2.03986
2017	0.10943	1055	0.59694	1.59913	0.14658	1.19466	2.14053
2018	0.05899	1046	0.14901	0.39917	0.20348	0.26682	0.59719
2019	0.09237	1173	0.28490	0.76320	0.16248	0.55262	1.05402
2020	0.11973	728	0.59922	1.60521	0.15591	1.17739	2.18850
2021	0.03223	1171	0.08489	0.22741	0.22788	0.14500	0.35666
2022	0.03305	1170	0.05361	0.14362	0.26794	0.08482	0.24318
2023	0.14153	1171	0.54449	1.45862	0.14208	1.09938	1.93524
2024	0.05763	1168	0.18985	0.50857	0.17567	0.35886	0.72074

5.4. Juvenile Gag Indices from All Data (1994-2011)

Parameters Used

Class Level Information

Class	*Levels*	*Values*
Year	18	1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
season	4	Early_Summer Fall Late_Summer Spring
Region_Code	8	CHR CKR MBB SAR SBR SJR TBR TPR
database_code	4	FSU FWS FWT PCL

Type 3 Tests of Fixed Effects (Binomial Submodel)

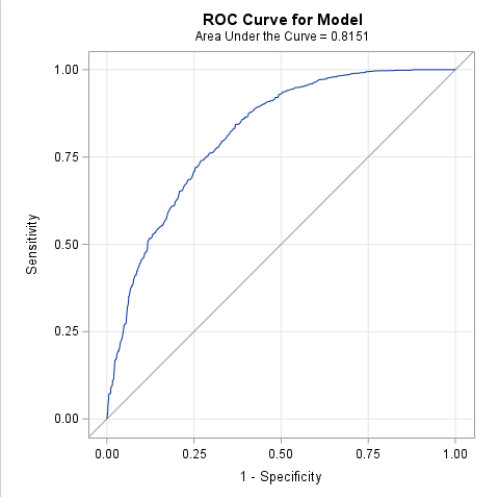
Type 3 Tests of Fixed Effects

Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*
Year	17	15E3	386.54	22.74	<.0001	<.0001
season	3	15E3	195.04	65.01	<.0001	<.0001
Region_Code	7	15E3	912.01	130.29	<.0001	<.0001
database_code	3	15E3	935.00	311.67	<.0001	<.0001

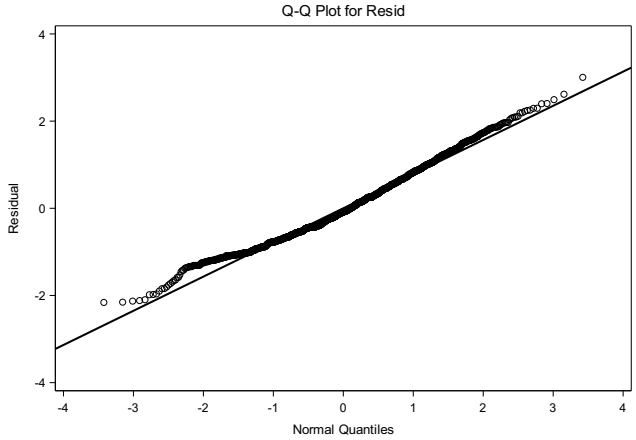
Type 3 Tests of Fixed Effects (Lognormal Submodel)

Type 3 Tests of Fixed Effects

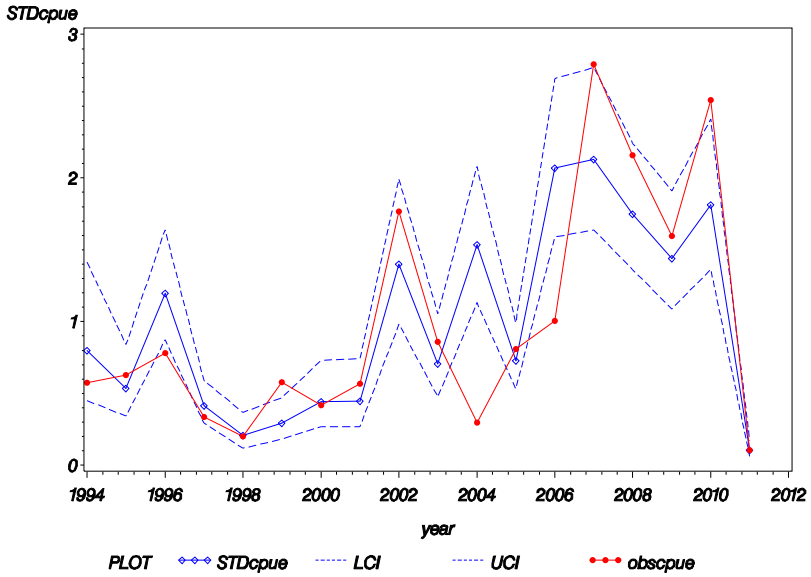
Effect	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	17	1987	6.15	<.0001
season	3	1987	4.30	0.0050
Region_Code	7	1987	11.99	<.0001
database_code	3	1987	526.22	<.0001



ROC for Binomial Submodel.



Q-Q plot for Lognormal Submodel



Indices by year with 95 % CI. Obcpue=nominal index values.

Index values for All Data (1994-2011).

Year	*Nominal Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
1994	0.34921	126	0.22011	0.79665	0.29228	0.44935	1.41239
1995	0.50742	337	0.14808	0.53594	0.22788	0.34173	0.84053
1996	0.15974	617	0.33039	1.19580	0.15856	0.87255	1.63881
1997	0.13363	668	0.11438	0.41400	0.17696	0.29139	0.58819
1998	0.05965	567	0.05744	0.20789	0.28968	0.11783	0.36677
1999	0.11065	718	0.08079	0.29239	0.24193	0.18147	0.47111
2000	0.07407	644	0.12233	0.44274	0.25347	0.26878	0.72928
2001	0.04372	688	0.12309	0.44551	0.25849	0.26789	0.74089
2002	0.09832	882	0.38649	1.39886	0.17841	0.98181	1.99308
2003	0.11866	861	0.19544	0.70736	0.20084	0.47524	1.05285
2004	0.10173	842	0.42381	1.53393	0.15308	1.13140	2.07968
2005	0.12883	959	0.20102	0.72756	0.15667	0.53286	0.99342
2006	0.19462	956	0.57153	2.06855	0.13252	1.58877	2.69322
2007	0.23575	890	0.58814	2.12869	0.13197	1.63673	2.76853
2008	0.16765	1526	0.48271	1.74708	0.12507	1.36175	2.24146
2009	0.13360	1255	0.39805	1.44068	0.14184	1.08637	1.91054
2010	0.13817	1155	0.50090	1.81294	0.14292	1.36417	2.40934
2011	0.02159	1339	0.02857	0.10342	0.26277	0.06168	0.17340

5.5. Juvenile Gag Indices from FWC and NMFS Data (2012-2024)

Parameters Used

Class Level Information

Class	*Levels*	*Values*
Year	13	2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024
season	4	Early_Summer Fall Late_Summer Spring
Region_Code	6	CHR CKR MBB SAR TBR TPR
database_code	3	FWS FWT PCL

Type 3 Tests of Fixed Effects (Binomial Submodel)

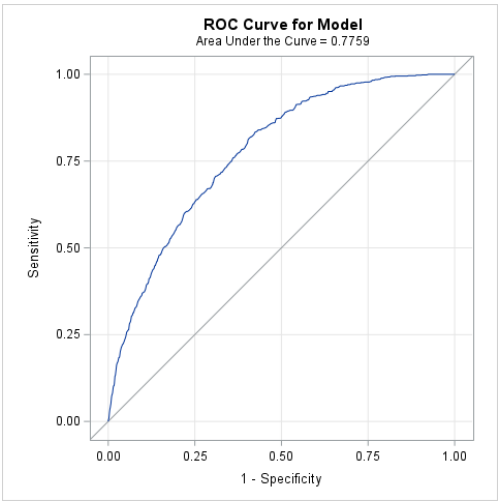
Type 3 Tests of Fixed Effects

Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*
Year	12	15E3	189.49	15.79	<.0001	<.0001
season	3	15E3	136.42	45.47	<.0001	<.0001
Region_Code	5	15E3	535.52	107.10	<.0001	<.0001
database_code	2	15E3	65.15	32.57	<.0001	<.0001

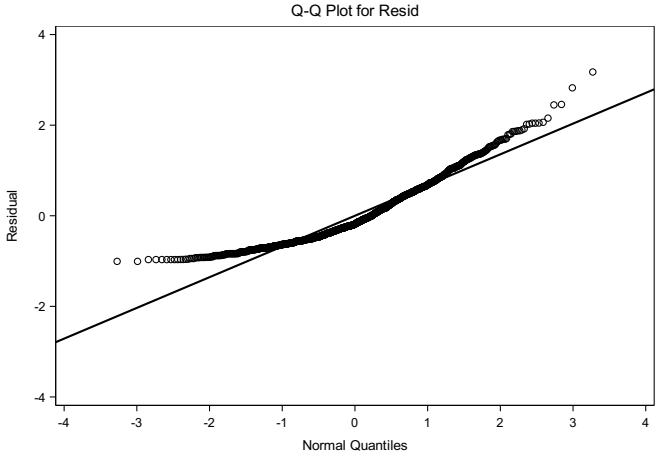
Type 3 Tests of Fixed Effects (Lognormal Submodel)

Type 3 Tests of Fixed Effects

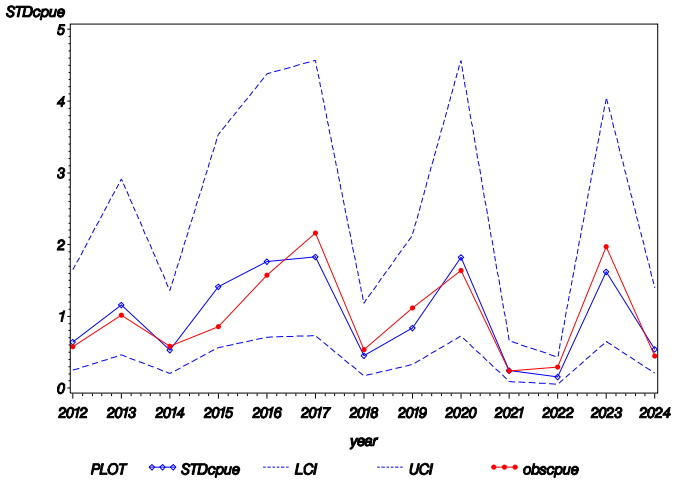
Effect	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	12	1142	5.48	<.0001
season	3	1142	1.55	0.2004
Region_Code	5	1142	7.33	<.0001
database_code	2	1142	0.08	0.9238



ROC for Binomial Submodel.



Q-Q plot for Lognormal Submodel

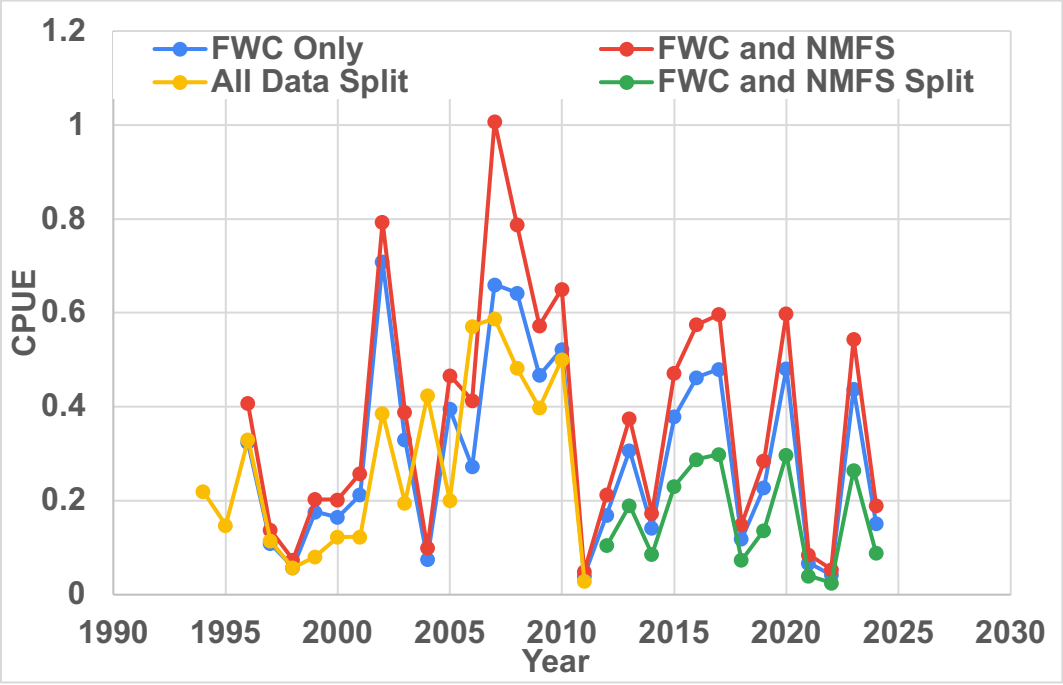


Indices by year with 95 % CI. Obcpue=nominal index values.

Index values for FWC and NMFS Data (2012-2024).

Year	Nominal Frequency	N	Index	Scaled Index	CV	LCL	UCL
2012	0.06932	1147	0.10480	0.64067	0.49996	0.24909	1.64783
2013	0.07968	1250	0.18989	1.16088	0.48584	0.46232	2.91494
2014	0.05712	1235	0.08616	0.52671	0.50191	0.20411	1.35920
2015	0.08669	1135	0.23103	1.41242	0.48402	0.56425	3.53556
2016	0.12264	1055	0.28842	1.76325	0.47925	0.71018	4.37785
2017	0.10943	1055	0.29895	1.82764	0.48320	0.73115	4.56853
2018	0.05899	1046	0.07354	0.44958	0.51374	0.17078	1.18352
2019	0.09237	1173	0.13669	0.83565	0.49459	0.32787	2.12981
2020	0.11973	728	0.29768	1.81984	0.48533	0.72538	4.56565
2021	0.03223	1171	0.04003	0.24473	0.52647	0.09101	0.65813
2022	0.03305	1170	0.02531	0.15472	0.54736	0.05558	0.43072
2023	0.14153	1171	0.26523	1.62150	0.48251	0.64944	4.04849
2024	0.05763	1168	0.08872	0.54240	0.50114	0.21046	1.39785

5.6. Comparison of all Juvenile Gag Indices



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Addendum

The indices group asked me to rerun the models with updated seagrass areas. I've rerun all the above models. I also ran all the above models without the weighting factors. Below are the resulting outputs.

Table A.1. Updated seagrass weights by region.

Region Code	**Weight**
CHR	0.058166548
CKR	0.594962983
MBB	0.271167467
MIR	0.001463228
SAR	0.012003126
SBR	0.009771373
SJR	0.006031618
TBR	0.032097108
TPR	0.014336550

Table A.2. Index values for FWC Data Only (1996-2024), updated seagrass areas.

Year	*Nominal Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
1996	0.08727	266	0.31797	1.11501	0.34709	0.56797	2.18891
1997	0.04255	363	0.09205	0.32280	0.43183	0.14118	0.73808
1998	0.02524	512	0.05318	0.18648	0.48883	0.07389	0.47065
1999	0.05032	611	0.15326	0.53742	0.35023	0.27219	1.06113
2000	0.03571	612	0.17813	0.62463	0.31330	0.33872	1.15189
2001	0.03746	673	0.16738	0.58695	0.32669	0.31046	1.10968
2002	0.10256	650	0.61089	2.14215	0.21328	1.40492	3.26625
2003	0.05680	574	0.29113	1.02088	0.31772	0.54905	1.89817
2004	0.02236	603	0.06914	0.24246	0.45741	0.10141	0.57974
2005	0.05609	606	0.43608	1.52918	0.25505	0.92556	2.52644
2006	0.06070	616	0.32799	1.15013	0.26709	0.68037	1.94424
2007	0.12460	621	0.73484	2.57680	0.18437	1.78761	3.71439
2008	0.15862	1298	0.62377	2.18733	0.11955	1.72362	2.77579
2009	0.13846	1160	0.37672	1.32102	0.14995	0.98036	1.78007
2010	0.13817	1155	0.41286	1.44774	0.14834	1.07781	1.94464
2011	0.02159	1154	0.03178	0.11144	0.33839	0.05769	0.21530
2012	0.06932	1147	0.17750	0.62242	0.17732	0.43778	0.88493
2013	0.08290	1153	0.31086	1.09007	0.16411	0.78678	1.51027
2014	0.06153	1146	0.11159	0.39132	0.21442	0.25608	0.59797
2015	0.08669	1135	0.45495	1.59534	0.13669	1.21527	2.09428
2016	0.12264	1055	0.41562	1.45741	0.14140	1.09994	1.93105
2017	0.10943	1055	0.43854	1.53780	0.14507	1.15225	2.05236
2018	0.05899	1046	0.09289	0.32575	0.23242	0.20590	0.51536
2019	0.09237	1173	0.19183	0.67266	0.17340	0.47676	0.94906
2020	0.11973	728	0.53771	1.88554	0.15522	1.38489	2.56719
2021	0.03223	1171	0.06626	0.23235	0.24719	0.14276	0.37816
2022	0.03305	1170	0.04423	0.15510	0.28585	0.08855	0.27166
2023	0.14153	1171	0.37313	1.30844	0.14761	0.97551	1.75499
2024	0.05763	1168	0.17777	0.62338	0.17093	0.44397	0.87530

Table A.3 Index values for FWC and NMFS Data (1996-2024), updated seagrass areas.

Year	*Nominal Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
1996	0.08727	266	0.38978	1.11190	0.34008	0.57375	2.15481
1997	0.04255	363	0.11367	0.32426	0.42182	0.14434	0.72843
1998	0.02524	512	0.06607	0.18849	0.47670	0.07625	0.46594
1999	0.07550	644	0.16843	0.48049	0.31748	0.25853	0.89298
2000	0.07407	644	0.21512	0.61368	0.28269	0.35245	1.06851
2001	0.04372	688	0.19677	0.56132	0.31460	0.30365	1.03764
2002	0.09832	882	0.67395	1.92253	0.20227	1.28807	2.86950
2003	0.05890	757	0.33398	0.95274	0.29525	0.53440	1.69857
2004	0.02796	728	0.09042	0.25795	0.41967	0.11526	0.57727
2005	0.05890	796	0.49415	1.40965	0.24146	0.87568	2.26921
2006	0.10604	801	0.47711	1.36103	0.23512	0.85583	2.16446
2007	0.19782	819	1.08444	3.09354	0.16752	2.21798	4.31472
2008	0.15385	1449	0.74781	2.13325	0.13050	1.64500	2.76642
2009	0.13145	1230	0.45239	1.29050	0.15965	0.93964	1.77238
2010	0.13817	1155	0.50376	1.43705	0.15916	1.04734	1.97176
2011	0.01964	1269	0.03797	0.10832	0.33414	0.05651	0.20764
2012	0.06932	1147	0.21693	0.61882	0.18546	0.42838	0.89392
2013	0.07968	1250	0.37101	1.05836	0.17108	0.75354	1.48649
2014	0.05712	1235	0.13273	0.37862	0.21802	0.24606	0.58261
2015	0.08669	1135	0.55395	1.58022	0.14838	1.17635	2.12274
2016	0.12264	1055	0.50505	1.44074	0.15264	1.06356	1.95167
2017	0.10943	1055	0.53314	1.52088	0.15603	1.11527	2.07400
2018	0.05899	1046	0.11386	0.32480	0.23602	0.20389	0.51744
2019	0.09237	1173	0.23408	0.66776	0.18255	0.46490	0.95915
2020	0.11973	728	0.65306	1.86297	0.16155	1.35141	2.56817
2021	0.03223	1171	0.08119	0.23162	0.25020	0.14149	0.37915
2022	0.03305	1170	0.05436	0.15507	0.28622	0.08847	0.27181
2023	0.14153	1171	0.45341	1.29341	0.15916	0.94266	1.77466
2024	0.05763	1168	0.21736	0.62005	0.18032	0.43357	0.88675

Table A.4. Index values for All Data (1994-2011), updated seagrass areas.

Year	*Nominal Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
1994	0.34921	126	0.11637	0.52716	0.34974	0.26723	1.03992
1995	0.50742	337	0.09126	0.41341	0.26617	0.24498	0.69763
1996	0.15974	617	0.41950	1.90042	0.16722	1.36333	2.64909
1997	0.13363	668	0.10888	0.49324	0.19518	0.33505	0.72612
1998	0.05965	567	0.03787	0.17155	0.35429	0.08624	0.34124
1999	0.11065	718	0.04695	0.21267	0.29183	0.12006	0.37673
2000	0.07407	644	0.10348	0.46879	0.27621	0.27256	0.80629
2001	0.04372	688	0.06050	0.27405	0.31634	0.14777	0.50825
2002	0.09832	882	0.22479	1.01832	0.21399	0.66694	1.55480
2003	0.11866	861	0.13966	0.63269	0.23441	0.39839	1.00480
2004	0.10173	842	0.52023	2.35670	0.15383	1.73568	3.19994
2005	0.12883	959	0.14478	0.65590	0.17361	0.46469	0.92578
2006	0.19462	956	0.50907	2.30617	0.14552	1.72644	3.08057
2007	0.23575	890	0.50198	2.27404	0.14270	1.71189	3.02079
2008	0.16765	1526	0.35533	1.60968	0.14621	1.20341	2.15312
2009	0.13360	1255	0.25433	1.15213	0.17263	0.81781	1.62313
2010	0.13817	1155	0.32220	1.45963	0.17003	1.04137	2.04589
2011	0.02159	1339	0.01621	0.07345	0.31759	0.03951	0.13654

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Table A.5. Index values for FWC and NMFS Data (2012-2024), updated seagrass areas.

Year	*Nominal Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
2012	0.06932	1147	0.10766	0.67981	0.55211	0.24230	1.90732
2013	0.07968	1250	0.18930	1.19536	0.53718	0.43667	3.27225
2014	0.05712	1235	0.06644	0.41955	0.56308	0.14688	1.19842
2015	0.08669	1135	0.27550	1.73969	0.52939	0.64378	4.70117
2016	0.12264	1055	0.25412	1.60470	0.53257	0.59069	4.35938
2017	0.10943	1055	0.26985	1.70398	0.53498	0.62474	4.64762
2018	0.05899	1046	0.05710	0.36054	0.57796	0.12321	1.05502
2019	0.09237	1173	0.11401	0.71993	0.55209	0.25661	2.01981
2020	0.11973	728	0.33190	2.09583	0.53302	0.77092	5.69779
2021	0.03223	1171	0.03890	0.24561	0.58566	0.08290	0.72768
2022	0.03305	1170	0.02611	0.16489	0.60477	0.05398	0.50364
2023	0.14153	1171	0.22432	1.41651	0.53893	0.51596	3.88890
2024	0.05763	1168	0.10351	0.65360	0.55088	0.23343	1.83008

Table A.6. Index values for FWC Data Only (1996-2024), unweighted.

Year	*Nominal Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
1996	0.08727	266	0.38438	0.98801	0.26352	0.58844	1.65892
1997	0.04255	363	0.15681	0.40306	0.31625	0.21737	0.74737
1998	0.02524	512	0.06858	0.17629	0.34692	0.08983	0.34596
1999	0.05032	611	0.23791	0.61152	0.23092	0.38765	0.96469
2000	0.03571	612	0.18874	0.48514	0.27060	0.28508	0.82559
2001	0.03746	673	0.27802	0.71462	0.24974	0.43695	1.16875
2002	0.10256	650	0.96023	2.46819	0.16168	1.79000	3.40333
2003	0.05680	574	0.40447	1.03965	0.22460	0.66711	1.62022
2004	0.02236	603	0.09477	0.24359	0.33504	0.12687	0.46771
2005	0.05609	606	0.37284	0.95835	0.21925	0.62133	1.47819
2006	0.06070	616	0.28566	0.73425	0.21077	0.48390	1.11413
2007	0.12460	621	0.91128	2.34237	0.15447	1.72297	3.18443
2008	0.15862	1298	1.02743	2.64090	0.10093	2.15926	3.22997
2009	0.13846	1160	0.73554	1.89065	0.11105	1.51513	2.35923
2010	0.13817	1155	0.92768	2.38451	0.11171	1.90839	2.97941
2011	0.02159	1154	0.05799	0.14906	0.25342	0.09050	0.24551
2012	0.06932	1147	0.23121	0.59430	0.14943	0.44149	0.79999
2013	0.08290	1153	0.39188	1.00729	0.13817	0.76508	1.32618
2014	0.06153	1146	0.21192	0.54473	0.15756	0.39826	0.74508
2015	0.08669	1135	0.36924	0.94911	0.13665	0.72306	1.24582
2016	0.12264	1055	0.54779	1.40805	0.12231	1.10350	1.79664
2017	0.10943	1055	0.57086	1.46733	0.12813	1.13682	1.89394
2018	0.05899	1046	0.18272	0.46965	0.16740	0.33680	0.65490
2019	0.09237	1173	0.31582	0.81178	0.13340	0.62241	1.05877
2020	0.11973	728	0.46903	1.20559	0.14636	0.90104	1.61307
2021	0.03223	1171	0.07441	0.19127	0.20948	0.12637	0.28950
2022	0.03305	1170	0.08550	0.21976	0.20720	0.14584	0.33117
2023	0.14153	1171	0.59092	1.51891	0.11318	1.21211	1.90337
2024	0.05763	1168	0.14864	0.38207	0.16228	0.27676	0.52745

Table A.7. Index values for FWC and NMFS Data (1996-2024), unweighted.

Year	*Nominal Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
1996	0.08727	266	0.47071	0.96553	0.26192	0.57681	1.61624
1997	0.04255	363	0.19492	0.39982	0.31489	0.21617	0.73950
1998	0.02524	512	0.08689	0.17823	0.34587	0.09099	0.34910
1999	0.07550	644	0.24242	0.49726	0.18678	0.34335	0.72016
2000	0.07407	644	0.24538	0.50333	0.18974	0.34555	0.73316
2001	0.04372	688	0.29464	0.60438	0.22873	0.38473	0.94942
2002	0.09832	882	0.77396	1.58758	0.14343	1.19340	2.11196
2003	0.05890	757	0.40192	0.82443	0.19296	0.56245	1.20845
2004	0.02796	728	0.13952	0.28619	0.27476	0.16685	0.49088
2005	0.05890	796	0.39519	0.81063	0.18797	0.55843	1.17672
2006	0.10604	801	0.71794	1.47268	0.14759	1.09800	1.97522
2007	0.19782	819	2.05761	4.22066	0.11351	3.36588	5.29252
2008	0.15385	1449	1.15057	2.36011	0.09827	1.93991	2.87132
2009	0.13145	1230	0.81946	1.68092	0.11193	1.34471	2.10119
2010	0.13817	1155	1.11552	2.28821	0.11378	1.82384	2.87081
2011	0.01964	1269	0.06115	0.12543	0.25308	0.07620	0.20645
2012	0.06932	1147	0.28027	0.57491	0.15112	0.42568	0.77646
2013	0.07968	1250	0.42121	0.86401	0.13620	0.65881	1.13313
2014	0.05712	1235	0.22233	0.45606	0.15800	0.33314	0.62432
2015	0.08669	1135	0.44753	0.91800	0.13857	0.69672	1.20958
2016	0.12264	1055	0.66282	1.35960	0.12433	1.06129	1.74176
2017	0.10943	1055	0.68624	1.40765	0.13008	1.08638	1.82393
2018	0.05899	1046	0.22234	0.45607	0.16885	0.32614	0.63777
2019	0.09237	1173	0.37791	0.77518	0.13608	0.59122	1.01639
2020	0.11973	728	0.56814	1.16539	0.14640	0.87093	1.55941
2021	0.03223	1171	0.08983	0.18427	0.21103	0.12138	0.27974
2022	0.03305	1170	0.10399	0.21331	0.20874	0.14113	0.32240
2023	0.14153	1171	0.70740	1.45104	0.11613	1.15120	1.82899
2024	0.05763	1168	0.17995	0.36912	0.16448	0.26623	0.51178

Table A.8. Index values for All Data (1994-2011), unweighted.

Year	*Nominal Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
1994	0.34921	126	0.25953	0.56733	0.23279	0.35834	0.89819
1995	0.50742	337	0.35442	0.77474	0.15852	0.56536	1.06168
1996	0.15974	617	0.14009	0.30623	0.15821	0.22361	0.41939
1997	0.13363	668	0.13337	0.29154	0.16117	0.21164	0.40159
1998	0.05965	567	0.13820	0.30211	0.23096	0.19149	0.47663
1999	0.11065	718	0.26175	0.57216	0.15769	0.41821	0.78279
2000	0.07407	644	0.20206	0.44170	0.18329	0.30707	0.63536
2001	0.04372	688	0.23536	0.51450	0.22405	0.33048	0.80097
2002	0.09832	882	0.61473	1.34376	0.13957	1.01785	1.77404
2003	0.11866	861	0.38677	0.84546	0.14180	0.63759	1.12110
2004	0.10173	842	0.24863	0.54350	0.15158	0.40206	0.73471
2005	0.12883	959	0.29147	0.63714	0.12901	0.49277	0.82381
2006	0.19462	956	0.84509	1.84733	0.10607	1.49511	2.28253
2007	0.23575	890	1.44912	3.16771	0.09588	2.61609	3.83564
2008	0.16765	1526	0.91437	1.99878	0.09097	1.66692	2.39671
2009	0.13360	1255	0.70498	1.54106	0.10681	1.24540	1.90691
2010	0.13817	1155	1.00577	2.19857	0.10958	1.76702	2.73551
2011	0.02159	1339	0.04866	0.10637	0.23720	0.06662	0.16984

Table A.9. Index values for FWC and NMFS Data (2012-2024), unweighted.

Year	*Nominal Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
2012	0.06932	1147	0.14120	0.73774	0.23760	0.46170	1.17883
2013	0.07968	1250	0.23972	1.25245	0.21880	0.81270	1.93014
2014	0.05712	1235	0.12142	0.63437	0.23505	0.39895	1.00871
2015	0.08669	1135	0.22174	1.15854	0.22930	0.73669	1.82194
2016	0.12264	1055	0.33169	1.73297	0.22021	1.12145	2.67794
2017	0.10943	1055	0.34796	1.81797	0.22408	1.16769	2.83038
2018	0.05899	1046	0.10952	0.57223	0.24987	0.34979	0.93611
2019	0.09237	1173	0.17917	0.93612	0.22811	0.59663	1.46879
2020	0.11973	728	0.27655	1.44490	0.23430	0.91000	2.29423
2021	0.03223	1171	0.04212	0.22006	0.27962	0.12712	0.38094
2022	0.03305	1170	0.04959	0.25912	0.27829	0.15006	0.44743
2023	0.14153	1171	0.34408	1.79772	0.21514	1.17480	2.75093
2024	0.05763	1168	0.08342	0.43583	0.24657	0.26810	0.70849

Figure A.1. Comparisons between weighted (updated) and unweighted indices.