Gag Fishery-Independent Index of Abundance and Age/Length Compositions in US South Atlantic Waters Based on a Chevron Trap Survey (1990-2019)

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Abstract

Fishery-independent measures of catch and effort with standard gear types and the deployment strategies are valuable for monitoring the status of stocks, interpreting fisheries landings data, performing stock assessments, and developing regulations for managing fish resources. This report presents a summary of the fishery-independent monitoring of Gag in the US South Atlantic region and includes data from three monitoring programs (MARMAP, SEAMAP-SA, and SEFIS, known collectively as SERFS). Specifically, it presents annual nominal catch per unit effort (CPUE) of Gag, *Mycteroperca microlepis*, in chevron traps from 1990 to 2019. Also included are annual CPUE estimates for chevron trap catches over this same time period that are standardized by a zero-inflated negative binomial model (ZINB) to account for the effects of potential covariates on these estimates. The ZINB model produced standardized CPUE estimates which show a slight increase since 2018 but have remained below the time series mean since a decrease in 2012.

Background

The Marine Resources Monitoring, Assessment, and Prediction program (MARMAP) has conducted fishery-independent research on reef fish species of the continental shelf and shelf edge between Cape Hatteras, North Carolina, and St. Lucie Inlet, Florida, for over 40 years. Although the MARMAP program has used various gear types and methods of deployment since its inception, starting in 1990, the chevron trap has been the primary gear deployed to allow for analyses of long-term changes in relative abundance, age compositions, length frequencies, and other information regarding reef fish species on live-bottom and/or hard-bottom habitats. In 2008, with a first field season in 2009, the Southeast Area Monitoring and Assessment Program, South Atlantic Region (SEAMAP-SA) provided funding to assist with the expansion of the geographical sampling coverage of the MARMAP fishery-independent chevron trap survey. Again in 2010, with the formation of the Southeast Fishery-Independent Survey (SEFIS), additional funds were provided to, among other things, expand the geographical coverage and sampling intensity of the MARMAP fishery-independent chevron trap survey. Collectively, we now refer to these three surveys combined reef fish monitoring efforts from 2010 to present as the Southeast Reef Fish Survey (SERFS).

Objective

This report presents a standardized relative abundance index of Gag derived from the MARMAP/SERFS chevron trap survey during the years 1990-2019. The standardized index accounts for annual sampling distribution shifts with respect to covariates that affect catch of Gag in chevron traps. Also provided are annual age and length compositions of Gag captured by chevron trap. This information is critical at informing the selectivity pattern at age of Gag by chevron traps. Data presented in this report are based on the combined SERFS database accessed on September 23, 2020.

Methods

Survey Design and Gear

(see Smart et al. 2015 for full description)

Sampling area

- Cape Hatteras, NC, to St. Lucie Inlet, FL

Sampling season

- May through September
  - Limited earlier and later sampling in some years

Survey Design

- Simple random sample survey design
  - Annually, randomly selected stations from a chevron trap universe of confirmed live-bottom and/or hard-bottom habitat stations
  - No two stations are randomly selected that are closer than 200 m from each other
    - Minimum distance is typically closer to 400 m
- Traps deployed on suspected live-bottom and/or hard-bottom in a given year (reconnaissance) are evaluated based on catch and/or video or photographic evidence of bottom type for inclusion in the universe in subsequent years
  - If added to the known habitat universe, data from the reconnaissance deployment is included in index development

Sampling Gear – Chevron Traps

(see Collins 1990 and MARMAP 2009 for more detailed descriptions)

- Arrowhead shaped, with a total interior volume of 0.91 m^3
- Constructed of 35 x 35 mm square mesh plastic-coated wire with a single entrance funnel ("horse neck")
- Baited with a combination of whole or cut clupeids (*Brevoortia* or *Alosa* spp., family Clupeidae), with *Brevoortia* spp. most often used
  - Four whole clupeids on each of four stringers suspended within the trap
  - Approximately 8 clupeids placed loose in the trap
- Soak time of approximately 90 minutes
- Daylight hours

Oceanographic Data

- Hydrographic data collected via CTD during soaking of a "set" (typically 6 traps, but may be less) of chevron traps deployed at the same time and same reef patch
  - Bottom temperature (^oC) is defined as the temperature of the deepest recording within 5 m of the bottom

Data Filtering/Inclusion

Chevron trap data (Gear = 324) were limited to:

- Projects conducting monitoring efforts

    - P05 – MARMAP
    - T59 – SEAMAP-SA
    - T60 – SEFIS
- Reef fish monitoring samples
    - Data source ≠ "Tag-MARMAP" – represents special historic MARMAP cruises that were used to tag various species of fish
        - Because standard sampling procedures were not consistently used (e.g. not all fish were measured for length frequency) these samples are excluded from index development
- Traps that fished properly (i.e., appropriate catch IDs)
    - 0 – no catch
    - 1 – catch with finfish
    - 2 – catch without finfish
    - 8 - Species catch subsampled for Length Frequency
- Traps on live-bottom and/or hard-bottom habitat (i.e., appropriate station types)
    - Random –randomly-selected live-bottom stations
    - NonRandom – non-randomly sampled live-bottom station (a.k.a haphazard or opportunistic sample)
    - ReconConv – reconnaissance deployments that were subsequently converted into live-bottom chevron trap stations
    - Null – traps for which there is no station code value
        - Use of station codes is fairly new, with MARMAP historically using only the catch ID (see above) to indicate randomly-selected stations
    - Monitoring - Station whose sampling selection (random, nonrandom) is not known, but is part of overall station universe
- Traps with soak times that were neither extremely short nor long which often indicates an issue with the deployment not captured elsewhere (included 45-150 minutes)
    - SERFS targets a soak time of 90 minutes for all chevron trap deployments
- Excluded any chevron trap samples missing covariate information
- Excluded all traps sampled prior to 1990

Standardized Index Model Formulation

Model Basics

- Response variable
    - Catch per trap
- Offset term
    - Soak time
- Dependent variables
    - Year
    - Covariates
        - 4 covariates explored
            - Depth – Continuous variable

        - Latitude (°N) - Continuous variable
        - Bottom temperature (°C) - Continuous variable
        - Day of year (DOY) - Continuous variable
    - Modelled with polynomials
        - Maximum allowed polynomial order set using preliminary generalized additive models (GAMs)
            - Limited polynomial to maximum of fourth order for biological relevance
    - Due to widely differing scales, the covariates were centered and scaled
        - Centered – subtract covariate mean
        - Scaled – divided centered values by their standard deviation prior to the GAMs
- Model structure – Zero-inflated negative binomial, zero-inflated Poisson, negative binomial, and Poisson error distributions were explored
    - Mixture model for both zero-inflated error structures
    - Two parts to the model, with Bayesian Information Criteria (BIC) used to select the best model from each of the 2 zero-inflated error distributions
        - Presence/absence (binomial sub-model)
        - Catch (count sub-model)
    - Sub-models optimized using a two-step approach due to computational demands
        - Count sub-model was optimized with all covariates removed from the zero-inflation sub-model
        - Binomial sub-model was optimized using fixed count sub-model covariates obtained in previous step
        - Allows for different covariates to be included in the two sub-models
    - Bayesian Information Criteria (BIC) also used to select the best model from the negative binomial and Poisson error distribution models
    - Final model was selected amongst the best models from each of the 4 error distributions using BIC
- Annual year effect coefficients of variation (CVs) and standard errors (SE) computed using bootstrapping
    - 5,000 bootstraps
- Software used
    - R (Version 3.6.1; R Development Core Team 2019)

Age Composition

- Aging methods – sagittal otoliths were removed from Gag to serve as the aging structure
    - Ages presented here are calendar age based on increment counts with an estimated increment formation on September 1 (See SEDAR71-WP01 for calendar age assignment)
    - Only fish caught in chevron traps that had age samples taken were included in the age compositions
    - Selection of fish retained for aging was complete (100% retained)

Results

Sampling area

- General increase in sampling intensity (# of annual chevron trap deployments) through time (Table 1 and Fig. 1)
- Gradual shift regarding the spatial density of samples through time (Table 1 and Fig. 1)
    - More dense geographic coverage in southern and northern latitudes in later years
- Chevron trap sampling depths range from 13 to 115 m (Table 1 and Fig. 2)
    - Generally less than 100 m

Sampling season

- May through September (Table 1 and Fig. 2)

Data Filtering/Inclusion

- Included traps (n = 19,681; Table 1)

Standardized Index Model Formulation

Model Basics

- Dependent variables
    - Covariates (Inclusion and polynomial order in sub-models available Table 2)
        - The effect on positive catches, both raw and modelled was determined (Figures 2 and 3)
        - Depth, latitude, and day of year were included in the final model (Fig. 4)
- Model structure
    - Final model selected was ZINB (Table 2)
        - Selected over non-zero inflated models due to high proportion of zero counts (Fig. 5)
- Coefficients of variation (CVs) and variances stabilized within the 5,000 bootstraps (Fig. 6)
- Annual standardized and normalized (relative to the long-term mean) index values for Gag, including CVs showed trends from 1990-2019 (Table 3 and Figure 7)

Age Composition

- Calendar ages caught by chevron traps in 1990-2019 (Tables 4 and 5)

Length Composition

- Lengths presented here are total length (TL) in 10 mm bins centered around the integer
    - Meristic conversions from fork length (FL) where needed were calculated in cm using this equation developed from the SERFS database
      TL=1.0360*FL-0.1260, r2 = 0.998, n = 4125 (Glasgow et al. 2020)
- Length compositions were produced for chevron traps (Tables 6 and 7)
- All measured fish were included in the length compositions

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Table 1. Sampling summary table for the MARMAP/SERFS fishery-independent chevron trap survey. Provided are the average and range of all the covariates by year.

	Depth (m)		Latitude (°N)		Temperature (°C)		Day of Year	
Year	Avg	Range	Avg	Range	Avg	Range	Avg	Range
1990	33.9	17-93	32.5	30.4-33.8	22	18.2-27.8	150	114-222
1991	34.1	17-95	32.6	30.8-34.6	24.9	15.9-27.5	217	163-268
1992	34	17-62	32.8	30.4-34.3	21.3	15.3-24.5	155	92-227
1993	34.9	16-94	32.4	30.4-34.3	22.8	17.8-28.5	176	131-226
1994	39.2	16-93	32.4	30.7-33.8	22.8	18.2-26.9	174	130-300
1995	33.8	16-60	32.1	29.8-33.7	24.6	20.1-28.4	198	124-299
1996	38.2	14-100	32.4	27.9-34.3	22	14.2-27.0	188	121-261
1997	39.4	15-97	32	27.9-34.6	22.6	15.0-28.0	195	126-273
1998	39.6	14-92	32.1	27.4-34.6	21.5	9.5-28.6	178	126-231
1999	35.8	15-75	32	27.3-34.6	22.9	17.9-28.8	199	153-272
2000	36.3	15-101	32.3	29.0-34.3	23.9	18.0-28.5	201	138-294
2001	38.5	14-91	32.3	27.9-34.3	23.5	16.0-29.2	204	144-298
2002	37.7	13-94	31.9	27.9-34.0	24.2	15.2-28.3	207	169-268
2003	39.8	16-92	32.1	27.4-34.3	18.9	13.4-25.1	203	155-266
2004	40.6	14-91	32.3	29.0-34.0	20.9	16.7-25.8	175	127-303
2005	38.5	15-69	32.1	27.3-34.3	23	18.0-28.5	191	124-273
2006	38.1	15-94	32.3	27.3-34.4	22.4	15.0-26.6	203	158-272
2007	37.9	15-92	32.2	27.3-34.3	23.2	15.3-28.9	201	142-268
2008	38	15-92	32.2	27.3-34.6	21.9	15.2-27.2	195	127-275
2009	36.3	14-91	32.2	27.3-34.6	22.6	15.4-27.2	203	127-282
2010	38.5	14-92	31.4	27.3-34.6	22.2	12.3-29.4	221	125-301
2011	40.7	14-93	30.9	27.2-34.5	21.6	14.8-28.8	210	140-300
2012	40.8	15-106	31.9	27.2-35.0	22.1	12.9-27.8	195	116-285
2013	38.2	15-110	31.3	27.2-35.0	22.1	12.4-28.1	197	115-278
2014	39.2	15-110	31.9	27.2-35.0	23.3	16.1-29.3	192	114-295
2015	39.2	16-110	31.9	27.3-35.0	22.6	13.6-28.4	187	112-296
2016	40.9	17-115	32.1	27.2-35.0	23.8	15.5-29.3	217	126-302
2017	40.5	15-114	32	27.2-35.0	22.6	14.8-28.2	187	117-273
2018	40.3	16-114	32	27.2-35.0	22.5	13.6-28.4	177	116-278
2019	40.1	16-113	32	27.2-35.0	23.2	15.0-29.5	184	121-269

Table 2. Model error structure comparison, including covariates that were included and their polynomial level for both the count and binomial sub-models. Polynomial values of "0" indicate that the covariate was not included in the final model. Negative binomial and Poisson models only had the count sub-model. The best model (highlighted) was chosen based on Bayesian Information Criteria (BIC).

	Count Sub-model					Binomial Sub-model				
Model Error Structure	**Year**	**Lat**	**Depth**	**Temp**	**DOY**	**Lat**	**Depth**	**Temp**	**DOY**	**BIC**
Zero-Inflated Negative Binomial	1	3	1	0	0	3	1	0	0	3397
Zero-Inflated Poisson	1	3	1	0	0	4	4	0	0	3450
Negative Binomial	1	3	1	0	0	—	—	—	—	3467
Poisson	1	3	1	0	0	—	—	—	—	3668

Table 3. The annual summary of data informative to index development and the results of the standardization. The data includes number of collections included in index development, the number of positive collections for Gag, the proportion of those positive collections in relation to the included collections, the total number of Gag caught, and these totals for the survey. The results show the normalized nominal and standardized chevron trap catch of Gag from the MARMAP/SERFS fishery-independent chevron trap survey which meet criteria to be included in the standardization process. The zero-inflated negative binomial (ZINB) standardized catch also includes a coefficient of variation (CV) calculated from a bootstrapping procedure.

					Nominal CPUE	ZINB Standardized CPUE	
Year	Included Collections	Positive	Proportion Positive	Total Fish	Normalized	Normalized	CV
1990	313	16	0.05	22	3.81	3.95	0.28
1991	272	7	0.03	7	1.4	1.16	0.37
1992	288	6	0.02	7	1.32	1.34	0.47
1993	392	7	0.02	9	1.25	1.61	0.4
1994	387	7	0.02	10	1.4	1.79	0.41
1995	361	5	0.01	5	0.75	0.97	0.46
1996	361	9	0.02	12	1.8	2.02	0.39
1997	406	4	0.01	4	0.53	0.45	0.54
1998	426	4	0.01	4	0.51	0.52	0.57
1999	233	5	0.02	5	1.16	0.97	0.45
2000	298	8	0.03	10	1.82	1.93	0.44
2001	245	4	0.02	4	0.89	1.15	0.5
2002	244	1	0	1	0.22	0.33	0.96
2003	224	0	0	0	0	0	0.29
2004	282	2	0.01	2	0.38	0.55	0.65
2005	303	3	0.01	3	0.54	0.58	0.57
2006	297	1	0	1	0.18	0.18	1.04
2007	337	3	0.01	3	0.48	0.53	0.59
2008	303	1	0	1	0.18	0.19	0.88
2009	404	2	0	2	0.27	0.21	0.67
2010	725	15	0.02	16	1.2	1.4	0.34
2011	726	21	0.03	27	2.02	3.09	0.28
2012	1174	30	0.03	39	1.8	0.89	0.28
2013	1360	16	0.01	23	0.92	0.65	0.28
2014	1472	23	0.02	28	1.03	0.96	0.24
2015	1463	15	0.01	17	0.63	0.5	0.3
2016	1484	24	0.02	31	1.13	0.68	0.25
2017	1541	19	0.01	20	0.7	0.38	0.28
2018	1736	17	0.01	21	0.66	0.42	0.29
2019	1624	21	0.01	30	1	0.6	0.25

Table 4. Annual age composition by calendar age of Gag caught in the MARMAP/SERFS fishery-independent chevron trap survey. This value is in numbers of fish from 1990-2019. Total fish caught and deployments are summarized by year.

Calendar Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	16	3	1	0	0	0	0	0	0	4	3	0	1	1	0	0	0	0	1	1	11	8	6	2	4	16		1	20
2	1	2	0	0	2	0	0	0	1	0	1	2	0	0	1	0	0	0	0	5	1	12	6	14	5	7	16	1	6
3	0	0	7	2	1	0	1	0	0	0	1	1	0	0	0	0	1	0	1	2	5	15	4	6	7	3	3	15	
4	2	0	1	4	5	0	0	2	0	1	0	0	0	1	0	0	0	1	0	2	2	6	2	1	3	2	1	2	5
5	3	1	0	2	0	1	4	0	0	0	0	0	0	0	1	0	0	0	1	0	3	2	2	3	0	2	1	0	0
6	0	0	1	1	0	0	3	0	2	1	3	1	0	0	0	0	0	0	0	5	4	1	1	3	1	0	1	1	0
7	0	0	0	0	0	0	5	2	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1	0	2	0	0	0	0
8	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
9	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
10	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deployments	19	8	7	7	7	3	11	5	4	6	9	4	1	2	3	1	3	1	3	18	21	34	15	24	19	24	21	17	22
Fish	25	8	10	9	10	3	15	6	4	6	11	4	1	2	3	1	3	1	3	19	27	47	22	29	22	31	22	21	31

Table 5. Annual age composition by calendar age of Gag caught in the MARMAP/SERFS fishery-independent chevron trap survey. This value is in percentage of fish from 1990-2019. Total fish caught and deployments are summarized by year.

Calendar Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	64.00	37.50	10.00	0.00	0.00	0.00	0.00	0.00	0.00	66.67	27.27	0.00	100.00	50.00	0.00	0.00	0.00	0.00	33.33	5.26	40.74	17.02	27.27	6.90	18.18	51.61	0.00	4.76	64.52
2	4.00	25.00	0.00	0.00	20.00	0.00	0.00	0.00	25.00	0.00	9.09	50.00	0.00	0.00	33.33	0.00	0.00	0.00	0.00	26.32	3.70	25.53	27.27	48.28	22.73	22.58	72.73	4.76	19.35
3	0.00	0.00	70.00	22.22	10.00	0.00	6.67	0.00	0.00	0.00	9.09	25.00	0.00	0.00	0.00	0.00	33.33	0.00	33.33	10.53	18.52	31.91	18.18	20.69	31.82	9.68	13.64	71.43	0.00
4	8.00	0.00	10.00	44.44	50.00	0.00	0.00	33.33	0.00	16.67	0.00	0.00	0.00	50.00	0.00	0.00	0.00	100.00	0.00	10.53	7.41	12.77	9.09	3.45	13.64	6.45	4.55	9.52	16.13
5	12.00	12.50	0.00	22.22	0.00	33.33	26.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33	0.00	0.00	0.00	33.33	0.00	11.11	4.26	9.09	10.34	0.00	6.45	4.55	0.00	0.00
6	0.00	0.00	10.00	11.11	0.00	0.00	20.00	0.00	50.00	16.67	27.27	25.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.32	14.81	2.13	4.55	10.34	4.55	0.00	4.55	4.76	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	33.33	33.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.53	0.00	2.13	4.55	0.00	9.09	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.67	25.00	0.00	9.09	0.00	0.00	0.00	0.00	0.00	33.33	0.00	0.00	0.00	0.00	2.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	9.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	0.00	0.00	3.23	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.76	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Deployments	19	8	7	7	7	3	11	5	4	6	9	4	1	2	3	1	3	1	3	18	21	34	15	24	19	24	21	17	22
Fish	25	8	10	9	10	3	15	6	4	6	11	4	1	2	3	1	3	1	3	19	27	47	22	29	22	31	22	21	31

Table 6. Annual length composition in total length of Gag caught in the MARMAP/SERFS fishery-independent chevron video trap survey by centered cm bins. Total fish caught and positive deployments are summarized by year.

Total Length	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
22	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
26	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
28	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
29	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	1	0	0	2
30	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	4	0	0	2
31	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0
32	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	1	0	0	1	1	0	0	3
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	0	0	2
34	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	4	0	0	4
35	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0	2
36	2	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	1
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0	0	0	2
38	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	1	0	0	1	1	1	0	1
39	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0
41	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0
42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	1	0	0	2	0	0
44	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	3	0	0	2	0	1
45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	0	0	0
46	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	2	1	1	1
47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	1	0	0	0	0	0
48	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3	0	0	0	1	0	0
49	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	3	0	3	0	0	1	0	0
50	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	2	0	1	0	2	1	2	0
51	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	2	1	0	2	0	1	1	0
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	1	0	0	0	1	1
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	1	0
54	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	1	1	0
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	0
57	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	1	0
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	1	0	2	0
59	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	1	0	0	1	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	1	0	0
61	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0
62	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	1	0
63	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
64	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	1	0
67	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
68	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	1	0
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	1
71	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
72	1	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0
73	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	2	1	1	0	0	0	0
75	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	1	0	0	0	1	0
76	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0
77	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
78	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1
79	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1	0	0	0	0	0
80	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	1	0	0	0
81	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1
82	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	1	0
83	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
84	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0
85	0	0	0	0	0	1	0	1	1	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
86	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	1	0	0
87	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
93	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
94	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
96	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
98	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
101	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
109	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deployments	19	8	7	7	7	5	12	5	4	6	9	4	1	2	3	1	3	1	3	18	21	34	16	24	19	24	21	17	22
Fish	25	8	10	9	10	5	15	6	4	6	11	4	1	2	3	1	3	1	3	19	27	47	23	29	22	31	22	21	31

Table 7. Annual length composition in total length of Gag caught in the MARMAP/SERFS fishery-independent chevron video trap survey by centered cm bins. Total percentage of fish caught and positive deployments are summarized by year.

Total Length	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
22	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.23
26	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	4.00	12.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.23
28	12.00	12.50	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.23	0.00	4.76	3.23
29	4.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	8.70	0.00	0.00	3.23	0.00	0.00	6.45
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.35	3.45	4.55	12.90	0.00	0.00	6.45
31	0.00	12.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.35	0.00	4.55	3.23	0.00	0.00	0.00
32	0.00	12.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.41	2.13	0.00	0.00	4.55	3.23	0.00	0.00	9.68
33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	3.45	0.00	6.45	0.00	0.00	6.45
34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.55	12.90	0.00	0.00	12.90
35	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	4.35	0.00	0.00	6.45	0.00	0.00	6.45
36	8.00	12.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.45	9.09	0.00	3.23
37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	4.26	4.35	0.00	0.00	0.00	0.00	0.00	6.45
38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.41	2.13	0.00	0.00	4.55	3.23	4.55	0.00	3.23
39	0.00	12.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.41	0.00	4.35	0.00	0.00	0.00	0.00	0.00	0.00
41	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.26	0.00	2.13	0.00	0.00	4.55	0.00	0.00	0.00	0.00
42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.55	0.00	3.23
43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	4.26	0.00	3.45	0.00	0.00	9.09	0.00	0.00
44	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.26	3.70	0.00	0.00	10.34	0.00	0.00	9.09	0.00	3.23
45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	3.45	0.00	6.45	0.00	0.00	0.00
46	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00	0.00	6.90	0.00	6.45	4.55	4.76	3.23
47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.53	3.70	2.13	0.00	3.45	0.00	0.00	0.00	0.00	0.00
48	0.00	0.00	10.00	11.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.41	0.00	13.04	0.00	0.00	0.00	4.55	0.00	0.00
49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.09	25.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.26	0.00	6.38	0.00	10.34	0.00	0.00	4.55	0.00	0.00
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	0.00	0.00	25.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.26	0.00	3.45	0.00	6.45	4.55	9.52	0.00
51	0.00	0.00	0.00	11.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33	0.00	0.00	4.26	4.35	0.00	9.09	0.00	4.55	4.76	0.00
52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00	8.70	3.45	0.00	0.00	0.00	4.76	3.23
53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	4.35	0.00	4.55	3.23	0.00	4.76	0.00
54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00	0.00	3.45	0.00	0.00	4.55	0.00	0.00
55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.90	9.09	0.00	4.55	4.76	0.00
56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.55	3.23	4.55	9.52	0.00
57	0.00	0.00	10.00	0.00	10.00	0.00	6.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33	0.00	0.00	0.00	0.00	0.00	0.00	3.45	0.00	0.00	4.55	4.76	0.00
58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	6.90	0.00	3.23	0.00	9.52	0.00
59	0.00	0.00	0.00	11.11	0.00	0.00	0.00	16.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	5.26	0.00	0.00	0.00	3.45	4.55	0.00	0.00	4.76	0.00
60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.26	4.35	3.45	0.00	0.00	4.55	0.00	0.00
61	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.26	0.00	0.00	9.09	0.00	0.00	0.00	0.00
62	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	2.13	4.35	0.00	0.00	0.00	0.00	4.76	0.00
63	0.00	0.00	0.00	0.00	0.00	0.00	6.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	0.00	0.00	0.00	4.55	0.00	0.00
64	8.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	4.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	6.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00
66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33	0.00	0.00	0.00	0.00	0.00	0.00	2.13	4.35	0.00	0.00	0.00	0.00	4.76	0.00
67	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	0.00	0.00	0.00	0.00	0.00	3.23
68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	0.00	4.55	0.00	4.55	4.76	0.00
70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.26	0.00	2.13	0.00	0.00	4.55	0.00	0.00	0.00	3.23
71	4.00	0.00	10.00	11.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	0.00	0.00	0.00	0.00	0.00	3.23
72	4.00	0.00	0.00	0.00	10.00	20.00	6.67	0.00	0.00	16.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33	0.00	0.00	2.13	0.00	0.00	0.00	0.00	0.00	4.76	0.00
73	0.00	0.00	0.00	0.00	10.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33	0.00	0.00	0.00	0.00	0.00	0.00	2.13	8.70	3.45	4.55	0.00	0.00	0.00	0.00
75	0.00	12.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.11	0.00	4.35	3.45	0.00	0.00	0.00	4.76	0.00
76	0.00	0.00	0.00	11.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00	0.00	0.00	4.55	0.00	4.55	0.00	0.00
77	4.00	0.00	0.00	11.11	0.00	0.00	0.00	16.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00	4.35	0.00	0.00	0.00	0.00	0.00	0.00
78	0.00	0.00	0.00	0.00	10.00	0.00	13.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	3.45	0.00	0.00	0.00	0.00	3.23
79	0.00	0.00	0.00	11.11	0.00	20.00	6.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33	0.00	0.00	5.26	3.70	0.00	0.00	3.45	0.00	0.00	0.00	0.00	0.00
80	0.00	0.00	10.00	0.00	0.00	0.00	13.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.53	3.70	0.00	0.00	0.00	0.00	3.23	0.00	0.00	0.00
81	0.00	0.00	0.00	11.11	0.00	0.00	0.00	0.00	25.00	16.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.35	0.00	4.55	0.00	0.00	0.00	3.23
82	0.00	0.00	0.00	0.00	0.00	0.00	6.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.26	0.00	2.13	4.35	0.00	0.00	0.00	0.00	4.76	0.00
83	0.00	12.50	0.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	3.45	0.00	0.00	0.00	0.00	0.00
84	0.00	0.00	0.00	11.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.53	0.00	0.00	0.00	0.00	0.00	3.23	0.00	0.00	0.00
85	0.00	0.00	0.00	0.00	0.00	20.00	0.00	16.67	25.00	0.00	18.18	25.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
86	0.00	0.00	0.00	0.00	0.00	0.00	6.67	0.00	0.00	0.00	9.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.26	3.70	2.13	0.00	0.00	0.00	0.00	4.55	0.00	0.00
87	0.00	0.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.53	0.00	0.00	0.00	3.45	0.00	0.00	0.00	0.00	0.00
90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	0.00	4.55	0.00	0.00	0.00	0.00
93	0.00	0.00	0.00	0.00	0.00	0.00	6.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.23	0.00	0.00	0.00
94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.55	0.00	0.00	0.00	0.00
95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33	0.00	0.00	9.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
99	0.00	0.00	0.00	0.00	0.00	0.00	6.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
101	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
102	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
105	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.76	0.00
107	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.26	0.00	2.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
109	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
111	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	5.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
115	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Deployments	19	8	7	7	7	5	12	5	4	6	9	4	1	2	3	1	3	1	3	18	21	34	16	24	19	24	21	17	22
Fish	25	8	10	9	10	5	15	6	4	6	11	4	1	2	3	1	3	1	3	19	27	47	23	29	22	31	22	21	31

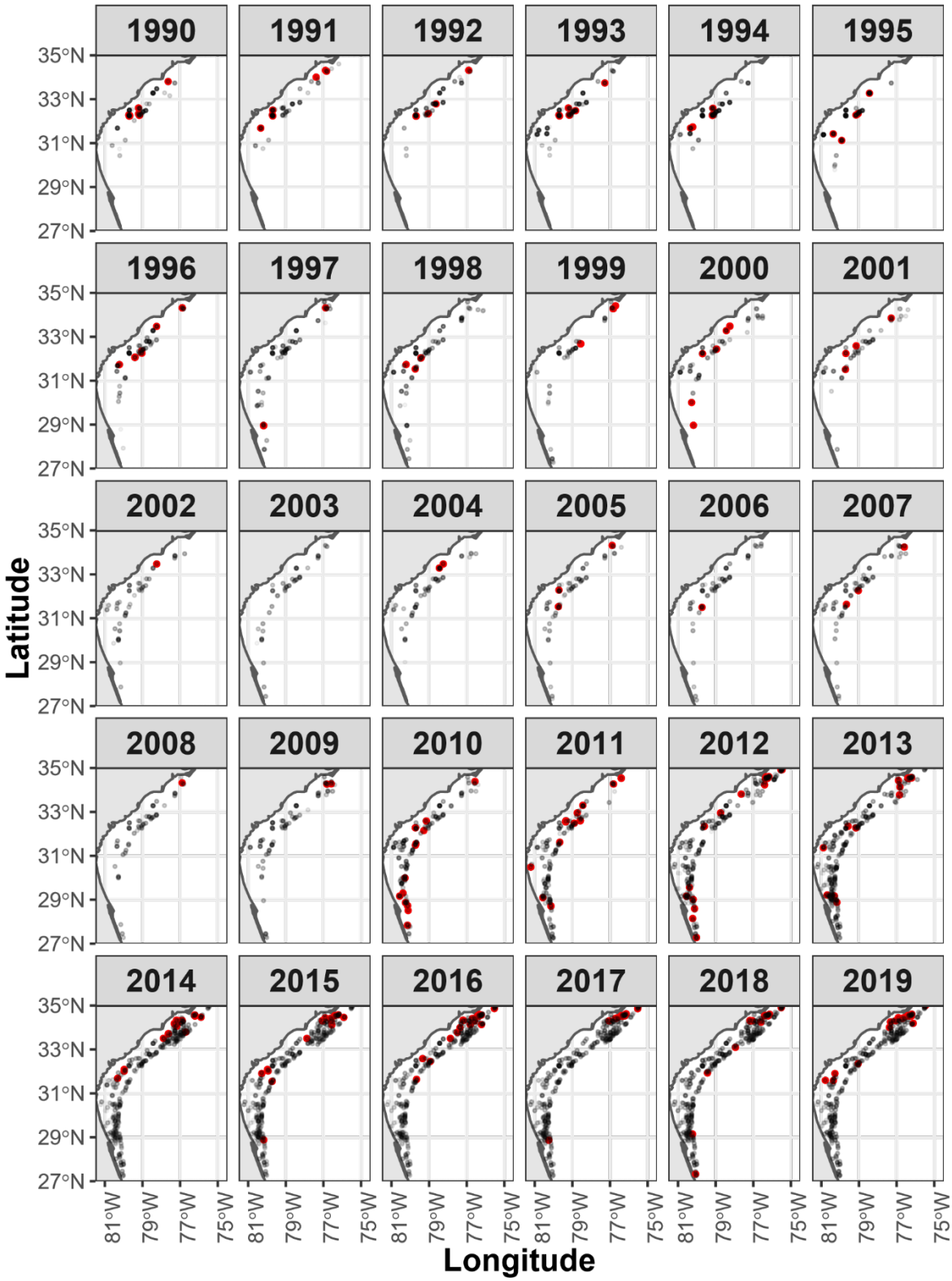

Figure 1. Sampling distribution of all collections by year of the MARMAP/SERFS fishery-independent chevron trap survey. Red circles indicate positive collections for Gag, while black circles represent no catch of Gag.

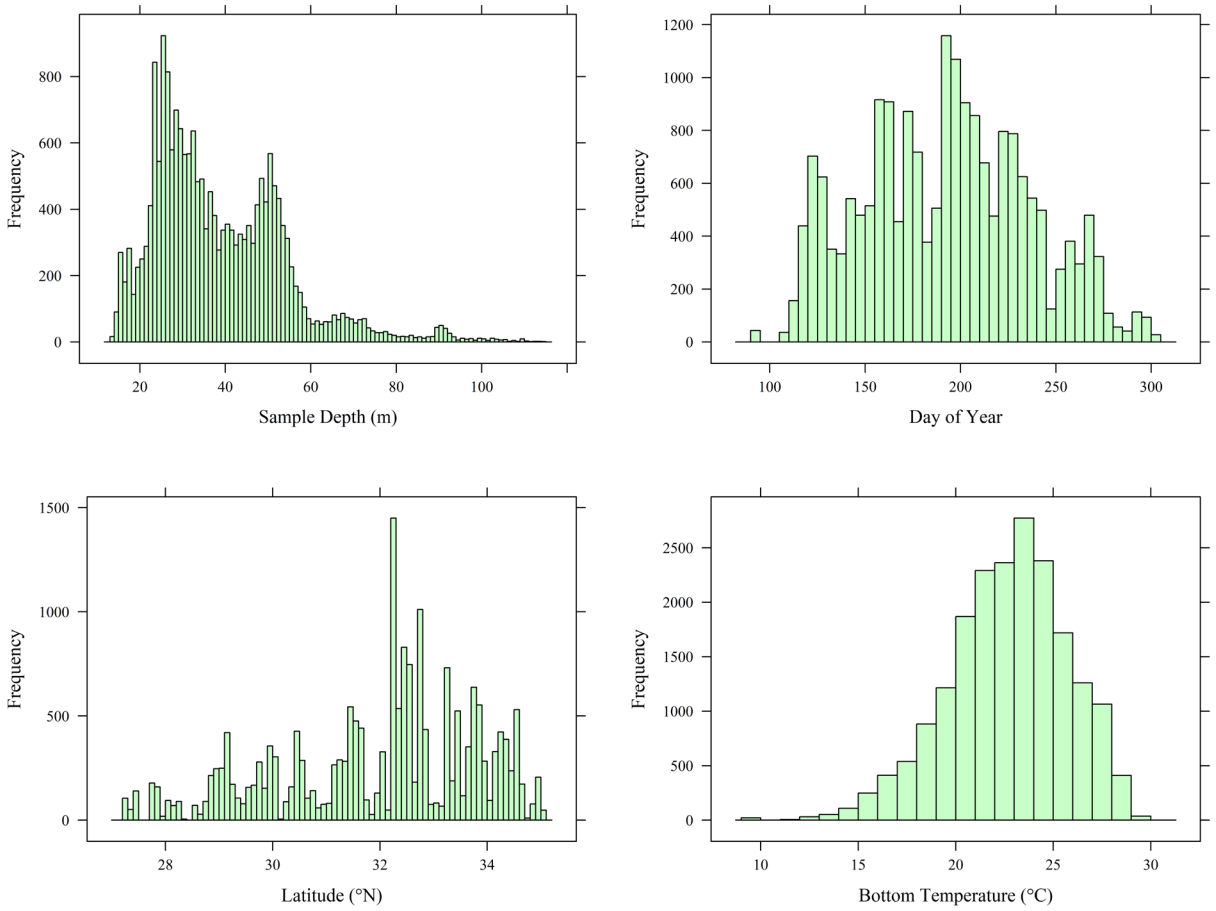

Figure 2. Sample distribution of covariate data from MARMAP/SERFS fishery-independent chevron trap survey collections for depth (A), day of year (B), latitude (C), and bottom temperature (D).

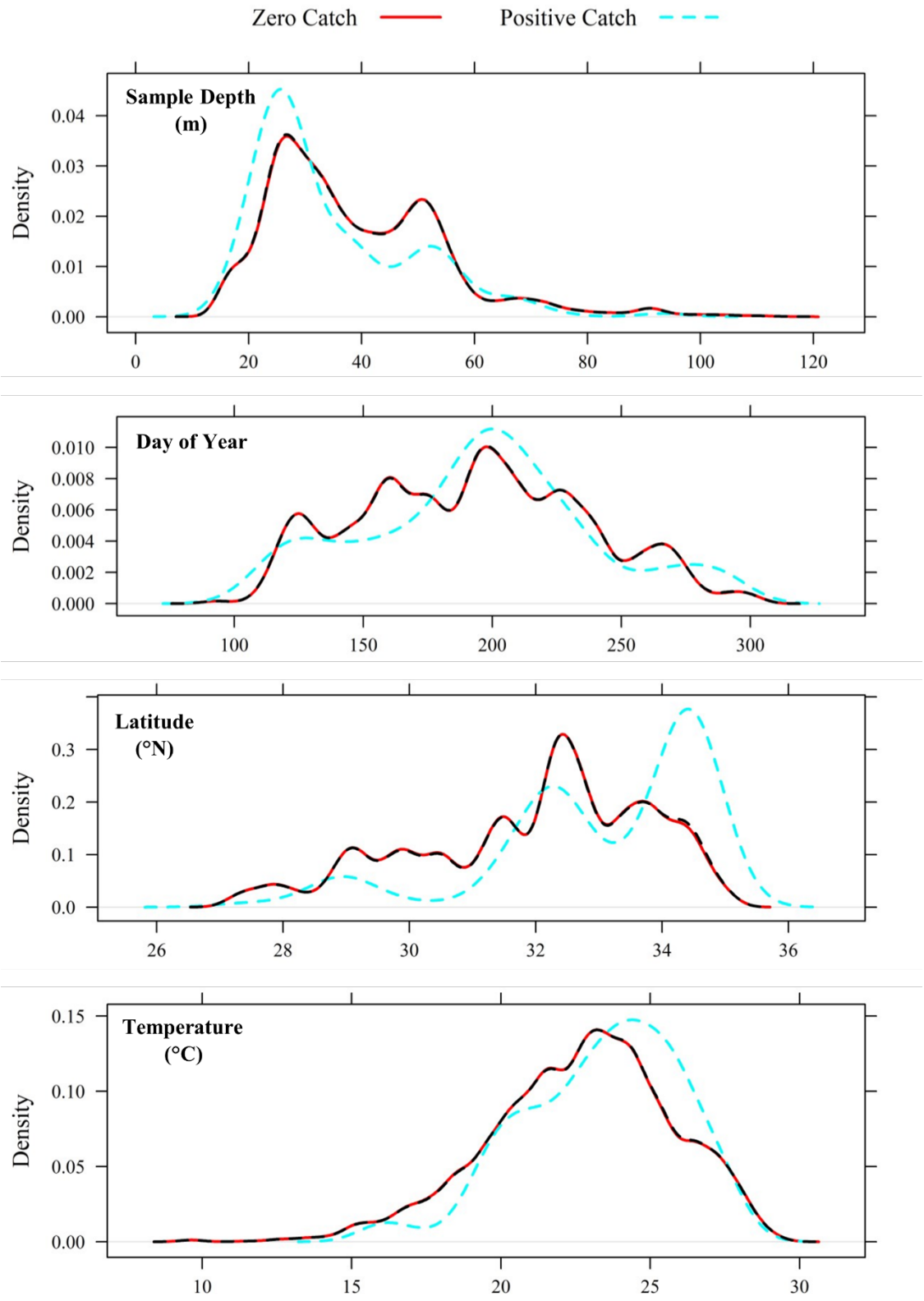

Figure 3. Sample distribution of catch of Gag and effects by covariate on positive and zero catches.

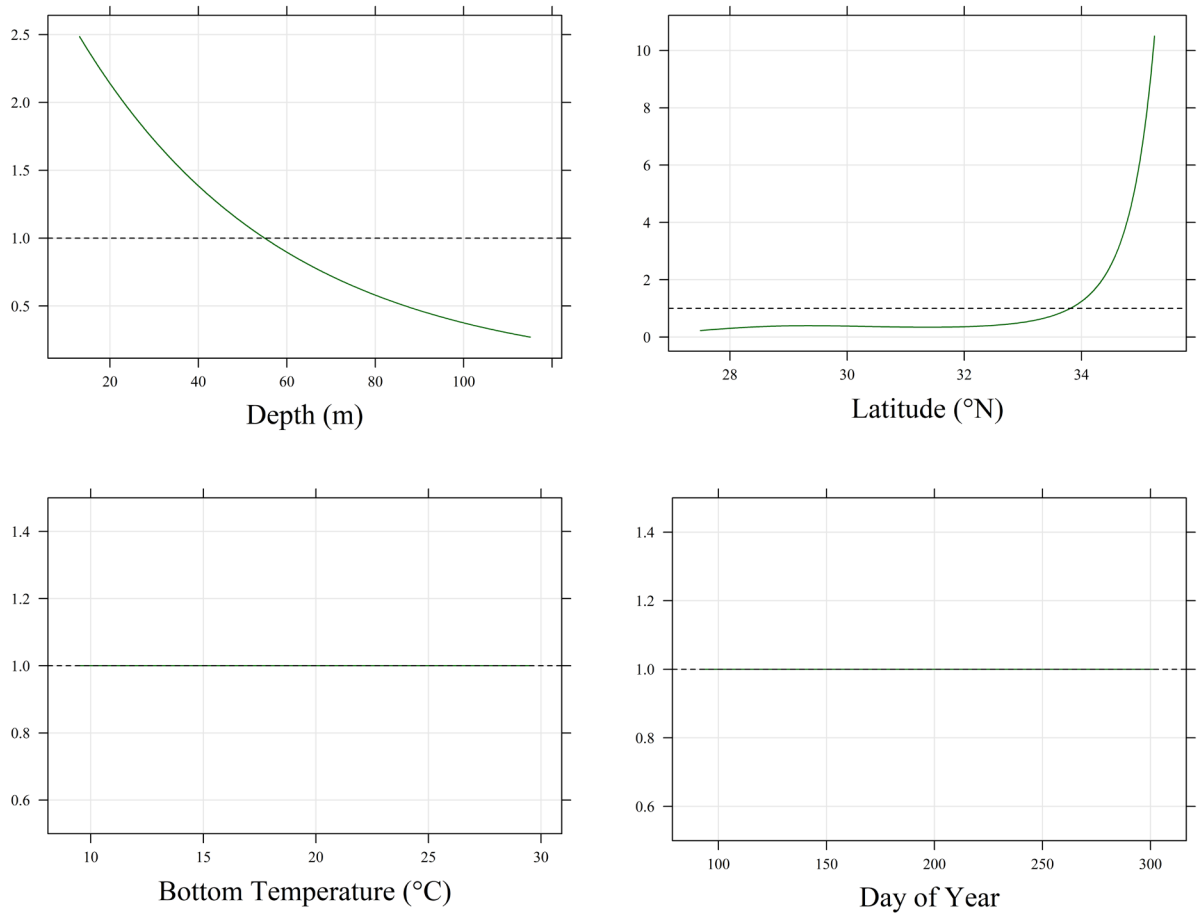

Figure 4. Modelled final covariate effects on catch of Gag from the ZINB standardization. Bottom temperature and day of year were not included in the final model.

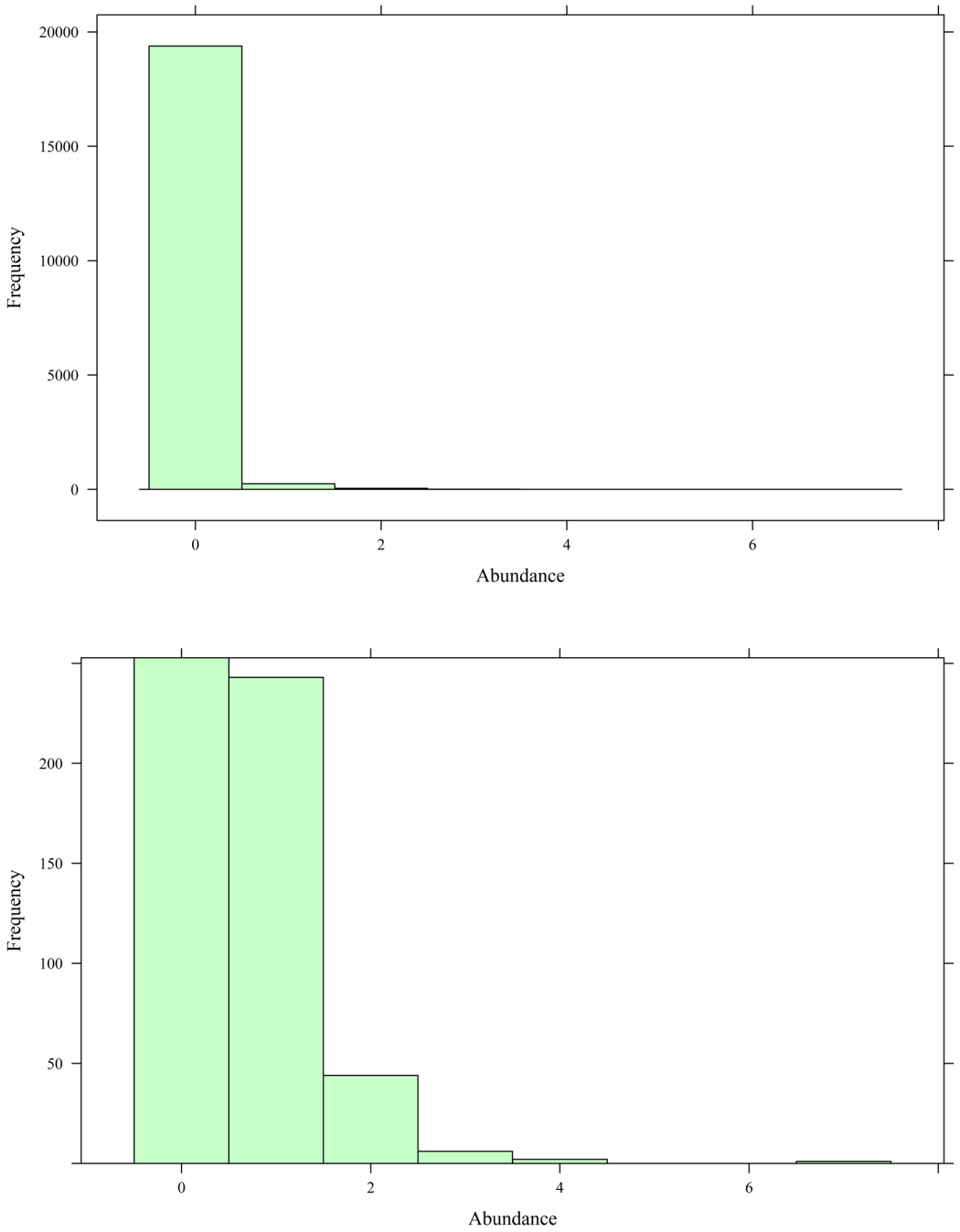

Figure 5. Count distribution of Gag catch from MARMAP/SERFS fishery-independent chevron trap survey showing full range of the distribution (A) and a truncated y-axis (B) to better show positive catches.

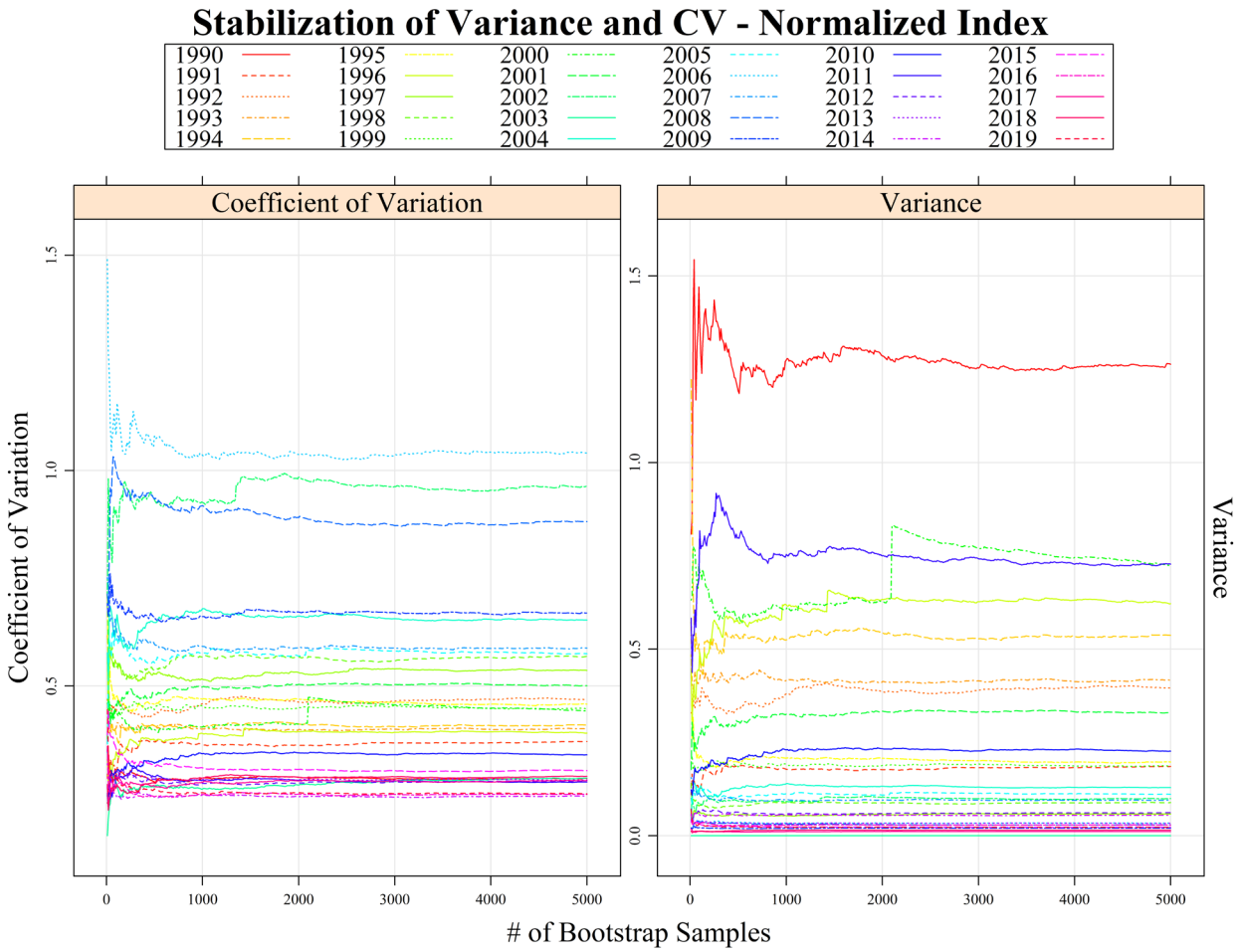

Figure 6. Stability of coefficient of variation and variance by bootstrap run during fishery-independent chevron video trap survey index development.

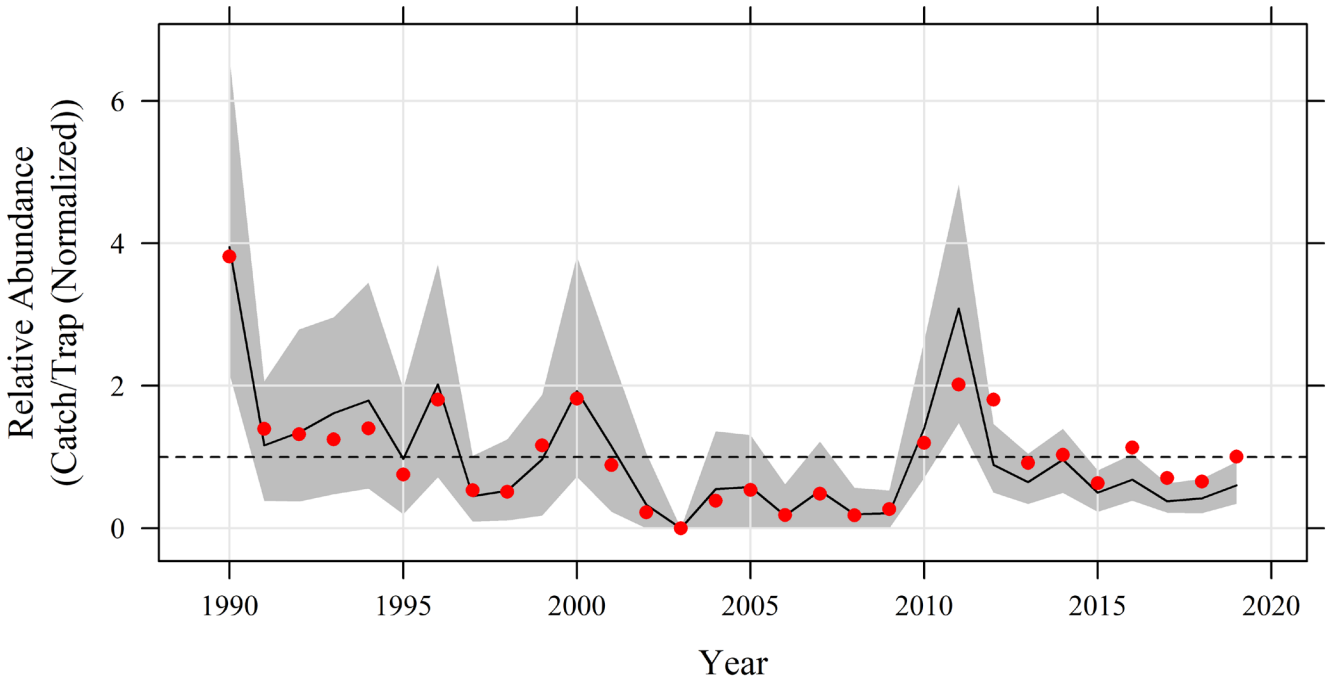

Figure 7. Normalized and standardized index (solid line) with 2.5% and 97.5% confidence intervals (gray) and the nominal index (red dots) for Gag in the MARMAP/SERFS fishery-independent chevron trap survey.