Size and age information Red Grouper, *Epinephelus morio*, collected in association with fishery-dependent projects along Florida's Gulf of Mexico coast

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Size and age information for Red Grouper, *Epinephelus morio*, collected in association with fishery-dependent projects along Florida's Gulf of Mexico coast

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Introduction:

The Fishery Dependent Monitoring subsection (FDM) of the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWRI) monitors commercial and recreational fishing in marine environments along the Florida coast in association with several fishery-dependent research and monitoring projects. FDM administers two federal surveys, the Marine Recreational Information Program (MRIP) for the recreational sector and the Trip Interview Program (TIP) for the commercial sector. Additionally, FDM conducts several unique surveys of recreational anglers that allow for the collection of supplemental biological data. Each fishery-dependent research or monitoring project that contributed to the age and length data provided to the Life History Group is described below. Because fish must be returned to anglers quickly during fishery-dependent surveys, priority was given to collecting the left otolith if both otoliths could not be removed.

Commercial Fishery Data

Trip Interview Program (TIP)

The commercial fishery is sampled via the NOAA Trip Interview Program (TIP) in which Florida participates. The primary focus of the TIP program is collecting random size frequency data and biological samples from commercial marine species. Samplers take information from harvested fish being offloaded from commercial fishing vessels. Length measurements include fork length and natural total length (mm). Weight measurements are whole weight or gutted weight (kg), dependent upon on the status of the fish upon landing. Typically, a single otolith is extracted below the operculum to retain filet integrity. Length and weight data are provided as part of a single federal dataset. For this assessment, Red Grouper length, weight, and age data have been provided in the TIP dataset and are not included in the GulfFIN data delivery.

Recreational Fishery Data

At-Sea Observer Sampling of For-Hire Fisheries

In 2005, at-sea observer survey coverage started on headboats operating from the Gulf coast of Florida from the panhandle through the Florida Keys. The at-sea headboat survey was funded by the Gulf Fisheries Information Network (GulfFIN) continuously through 2007 and was discontinued in 2009. In June of 2009, the state of Florida secured alternative funds to continue

at-sea observer coverage in the northwest panhandle and central peninsula and expanded coverage to include charter boats in these regions. In 2010, sampling coverage in the Florida Keys was re-initiated for both headboat and charter vessels through the present, with the exception of a sampling hiatus in 2014. In 2014, representative at-sea observer data was only collected from charter vessels in the Florida Keys. Data from headboats and charter vessels in northwest and southwest Florida were a small subset of the for-hire fleet and may not be representative of the fleet as a whole in that year. For the survey, both headboats and charter boats were randomly selected weekly throughout the year. Biological data was collected from harvested Red Grouper dockside after observed trips, including midline length (mm), whole weight (kg), and whenever possible, a left otolith was extracted from sampled fish. Measurements and otoliths collected from observer coverage represent supplemental sampling separate of the dockside sampling conducted for the Southeast Regional Headboat Survey (SRHS).

State Reef Fish Survey of Recreational Fishers

The State Reef Fish Survey (SRFS) has run continuously on the Florida Gulf coast since May 2015 when it was previously named Gulf Reef Fish Survey. Expanding state-wide in 2020, it was renamed to SRFS. This survey is a directed effort to collect data from offshore private recreational anglers who target reef fish species. Anglers wishing to harvest certain reef fish species, including Red Grouper, on Florida's coast are required to have a State Reef Fish Angler designation on their fishing license. The State Reef Fish Survey is composed of two survey components: a mail-in survey and a dockside intercept survey. The mail-in survey is sent to randomly selected anglers with the State Reef Fish Angler designation to collect data on angler effort. The dockside intercept survey stations biologists at sampling sites to interview anglers on angler catches and fishing practices. Interview assignments are drawn from a subset of sampling sites known to have offshore fishing activity to intercept fishers that target reef fish. Data collected during dockside assignments include information regarding fishing depths, distances from shore while fishing for offshore species, number of harvested fish, and self-reported estimates of fish released during the fishing day. A subset of harvested fish are measured (fork length in mm) and weighed (in kilograms) during the survey.

Opportunistic Biological Sampling

Between 2000 and 2018 opportunistic biological sampling was conducted at angler intercept sites along the Gulf coast of Florida, supported by a limited amount of funding from GulfFIN. Sampling assignments were conducted opportunistically to maximize the number of biological samples collected, primarily from busy charter landing sites. While the sampling sites were not selected using a randomized methodology, the fish sampled were not sampled in a biased manner. Biological sampling of intercepted fish included collection of length measurements (midline length in mm), whole weight (in kg) and collection of aging structures (otoliths or spines).

Representative Biological Sampling Program

The Representative Biological (RepBio) sampling program conducts supplemental biological sampling along the Gulf coast of the Florida peninsula (Escambia to Collier County) and the Florida Keys (Monroe). The survey began a pilot phase in 2018 and was fully implemented by 2019 along the entire Gulf coast of Florida. A randomized draw process is used to ensure representative collection of biological samples, along with a species list that prioritizes collection of biological samples from data-poor, state-managed, and federally managed species when encountered. Interviews of recreational anglers are conducted at fishing access points identified via the MRIP Site Register and assigned via a weekly draw by sub-region. Biological sampling of harvested species includes collection of length measurements (midline length in mm), whole weight (in kg) and collection of aging structures (otoliths or spines).

Ageing Protocols:

The sagittal otolith was the primary ageing structure for Red Grouper (Moe 1969). Sagittal otoliths were removed from the head, cleaned, dried, and stored in vials. Samples in this collection were aged using either whole or sectioned otoliths; the methodology was determined independently for every sample based on the potential of individual otoliths to be successfully aged whole. To determine ages using whole otoliths, the otolith was submerged in a water-filled black petri dish on a stereo microscope, concave side up, and illuminated with reflected light (Lombardi-Carlson et al. 2008). If the sample demonstrated a clear ageing plane with defined opaque bands from core to edge, typically along the central dorsoventral axis, then the sample

was aged whole. However, if the sample was too thick to see individual opaque zones, the opaque zones were stacked along the edge (and difficult to discern), or the ageing plane was disrupted, then the sample was set aside for sectioning (Lombardi-Carlson et al. 2008). For sectioned otoliths, the left otolith was processed for age determination unless it was broken through the core, in which case the right otolith was processed. The core of the otolith was marked with pencil and the whole otolith was mounted on card stock using hot glue. Otoliths were processed on a Buehler Isomet low speed saw that was equipped with four equally spaced diamond wafering blades. With this multi-blade technique, one transverse cut yielded three ~400μm thick sections that encompassed both the core and the entire region surrounding the core (VanderKooy et al. 2020). After processing, sections were mounted on glass slides with Flo-texx, a chemical mounting medium. Like whole otoliths, sectioned otoliths were also examined on a stereo microscope for ageing, but these were illuminated using transmitted light.

Regardless of ageing methodology, each otolith was examined with at least two blind reads. These readings were conducted either by two readers working independently, or by a single reader examining the otolith two separate times. When age estimates did not agree between reads, a third read was conducted to resolve the discrepancy. For the purposes of independent reading, when a whole otolith was marked for sectioning, any age that was determined from the whole otolith was removed for that sample, and only the sectioned ages were recorded. Whole otolith ageing was conducted along the central dorsoventral axis from the core to the dorsal edge. Sectioned otolith ageing was also conducted on the dorsal lobe of the otolith, but along an axis near the sulcal groove of the section, from the core to the edge.

Annual ages were calculated using annulus count (number of opaque zones), degree of marginal completion, average date of otolith increment deposition, and date of capture. This traditional method is based on a calendar year instead of time since spawning (Jerald 1983; VanderKooy et al. 2020). Previous studies of Red Grouper in the Gulf of Mexico determined that annulus formation is complete by early summer (Moe 1969; Lombardi-Carlson et al. 2008) Using these criteria, the annulus count was advanced by one year if a large translucent zone was visible on the margin and the capture date was between January 1 and June 30. For all fish collected after June 30, age was assigned to be annulus count, because opaque zone formation is typically complete (Moe 1969; Lombardi-Carlson et al. 2008). Calendar ages were converted to

fractional, or monthly biological, ages by adding or subtracting the fraction of a year calculated between the assumed May 15 birth date and month of capture (Moe 1969; Collins et al. 2002).

The FWRI Marine Fisheries Age and Growth Laboratory began ageing Red Grouper in 2009 but did not start ageing samples from Fishery Dependent until the collection year 2015. This expansion of the ageing program at FWRI occurred coincident with a cooperative agreement and in-person Red Grouper age training from expert agers from the National Marine Fisheries Panama City Laboratory (PCLAB). Prior to ageing Red Grouper samples, each reader reviewed training materials and read through an in-house reference set of otoliths representing a range of age classes, seasons, sexes, and collection locations (Campana 2001). This was completed to calibrate ageing technique, particularly identification and interpretation of the first annulus and margin type. Quality control subsets were read each sampling year by all active readers to estimate precision. Furthermore, the in-house reference collections from FWRI and PCLAB were exchanged prior to SEDAR 42, SEDAR 61 and SEDAR 88. In all cases, the ages from the reference collections were highly precise within and between labs (Palmer et al. 2014; Lombardi 2018).

The total number of otoliths aged from FWRI sampling along the Gulf coast of Florida was 2,464. Collection years span from 2015 to 2022, and during that time, three individual readers contributed to ageing these otoliths; however, one primary reader has aged nearly all the samples since 2017. The average percent error (APE) on all first and second reads was 0.57%, which is considered highly precise (Campana 2001); moreover, there was a 92% age agreement between all first and second reads, and a 99% agreement +/- 1 year. The vast majority of samples were aged whole (n=2,425, age range 1–15 years) with a 0.5% APE on all first and second reads. The otoliths selected for sectioning (n=39, age range 5–23 years) were less precise, with a 2.5% APE, which was likely due to the age and difficulty of these samples. All age data provided for SEDAR88 included increment count, calendar age and fractional age; however, the summaries including ages in this report were based on adjusted calendar age. Additionally, the summaries only included data from FDM's recreational surveys and removed special projects and outliers, equating to 2,422 fish.

Results:

Fishery-Dependent Results: Age and length composition

All fishery-dependent age data have been provided to the life history workgroup; what follows is a summary of the calendar ages and lengths of aged Red Grouper. The following summaries were performed using all fish that were landed at Gulf of Mexico Florida ports. Data are presented in two ways, as a single time unit and presented by individual collection year. Length and bag limits have remained stable since collections began with recreational length limit set at 20” TL.

Age data are summarized for a total of 2,422 individuals. All age samples were obtained from surveys of the recreational sector, including 517 samples from private recreational boat trips, 1,617 from charter trips, and 236 from headboats (Table 1). Mean and standard deviation of length and age was very consistent among fleets (Table 1). Private boats landed a larger proportion of smaller fish (Figure 3) whereas charter vessels landed higher proportions of older fish (Figure 2).

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Fishing Fleet	# Fish Age	Mean age (y)	Mean FL (mm)
CHARTER	1617	6.87 ± 2.53	569.29 ± 72.10
HEADBOAT	236	6.75 ± 2.35	570.38 ± 75.66
PRIVATE	517	6.56 ± 2.76	560.07 ± 79.61
UNKNOWN	52	7.37 ± 2.63	605.12 ± 87.78
TOTAL	2422	6.80 ± 2.57	568.22 ± 74.71

Table 1. Numbers of fish aged, mean (± SD) age, and length landed in Florida by fishing fleet (2015-2022) and total for all fleets combined.

Fleet	Year	N	Mean Age (Y)	Mean FL (mm)	SD Age	SD FL (mm)
CHARTER	2015	205	7.692682927	585.7268293	2.242240459	73.91107211
CHARTER	2016	205	6.887804878	565.6617647	2.247459909	73.43800917
CHARTER	2017	115	7.104347826	561.6173913	3.09321247	74.35153376
CHARTER	2018	171	7.292397661	589.5588235	2.885440243	76.77624108
CHARTER	2019	365	6.578082192	559.6246575	2.919724818	69.31671179
CHARTER	2020	158	6.360759494	563.5189873	2.305403109	84.78678553
CHARTER	2021	254	6.57480315	564.1456693	2.062347122	58.85527269
CHARTER	2022	144	6.777777778	573.0902778	1.893841489	65.83396292
HEADBOAT	2015	32	7.34375	595.90625	1.557694222	75.60097259
HEADBOAT	2016	71	6.845070423	571.5211268	1.924636421	85.85517027
HEADBOAT	2017	20	8.15	611.85	2.852053738	74.89169373
HEADBOAT	2018	29	7.413793103	577.5517241	3.076608074	81.49258783
HEADBOAT	2019	48	6.270833333	549.625	2.687556696	62.89593736
HEADBOAT	2020	5	5.6	583	0.547722558	40.2492236
HEADBOAT	2021	18	5.166666667	541.6666667	1.098126747	51.28811352
HEADBOAT	2022	13	5.538461539	533.0769231	1.808101427	30.57085087
PRIVATE	2015	64	6.90625	559.2833333	2.381934321	71.10271674
PRIVATE	2016	75	6.826666667	572.24	2.580453204	83.71700076
PRIVATE	2017	83	6.674698795	556.902439	2.590359396	93.2976929
PRIVATE	2018	42	6.619047619	577.6904762	2.921346006	89.86371473
PRIVATE	2019	98	6.448979592	551.3571429	2.893727482	74.32365138
PRIVATE	2020	87	6.413793103	553.8705882	3.112434642	75.28023649
PRIVATE	2021	50	6.26	564.48	2.77606387	67.78514677
PRIVATE	2022	18	5.666666667	549.7777778	2.520504151	75.63189147
UNKNOWN	2015	17	7.235294118	603.1764706	1.601928984	102.4055878
UNKNOWN	2016	9	7	613.7777778	2.783882181	88.76482662
UNKNOWN	2017	12	7	606.5	2.558408596	90.94403874
UNKNOWN	2018	5	8.2	645.2	2.774887385	61.60519459
UNKNOWN	2019	9	8	576	4.123105626	70.32780389

Table 2. Numbers of fish aged mean & SD age and length landed by fishing fleet by year 2015-2022.

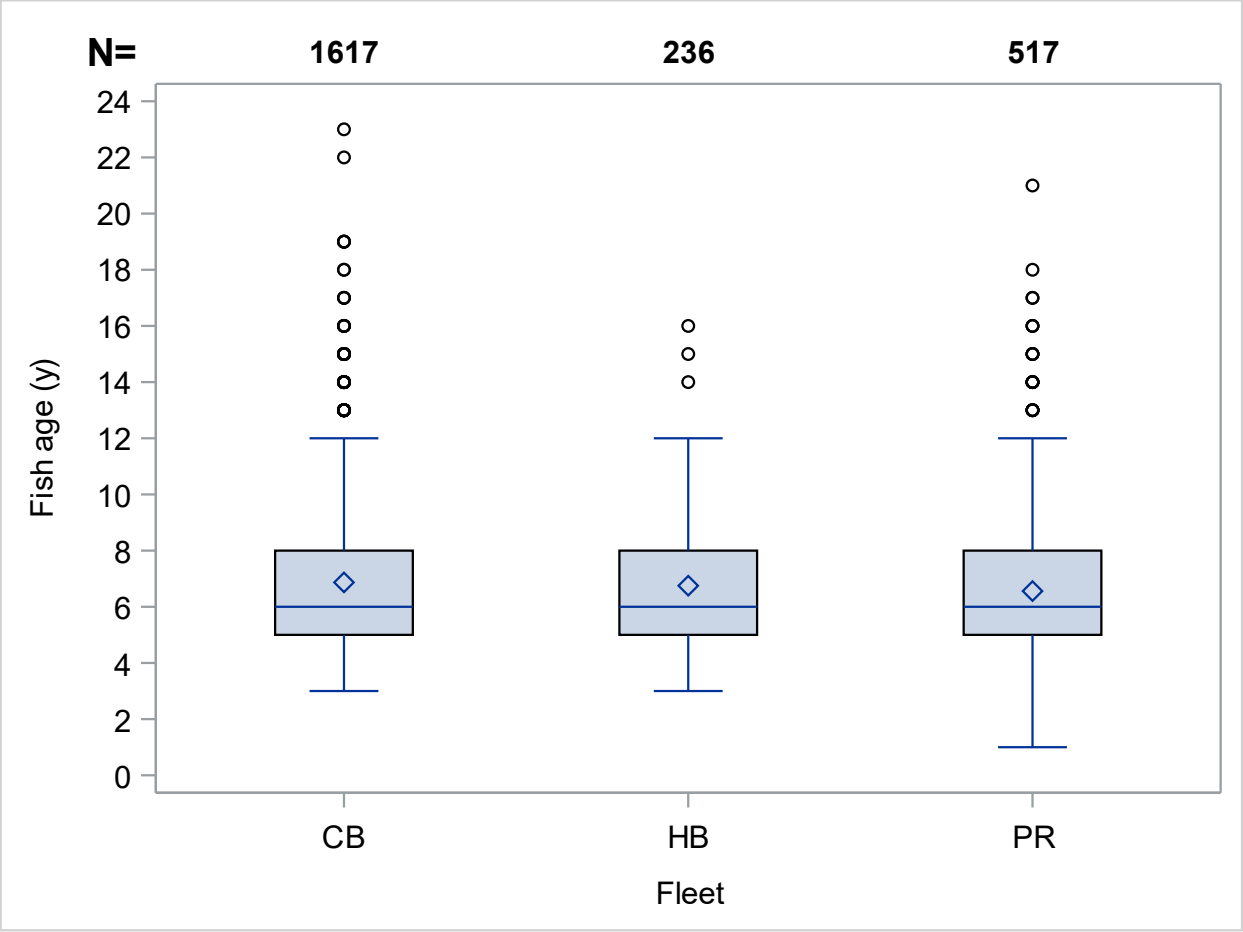

Figure 1. Age distribution by fishing fleet. N = total numbers of samples included in each box.

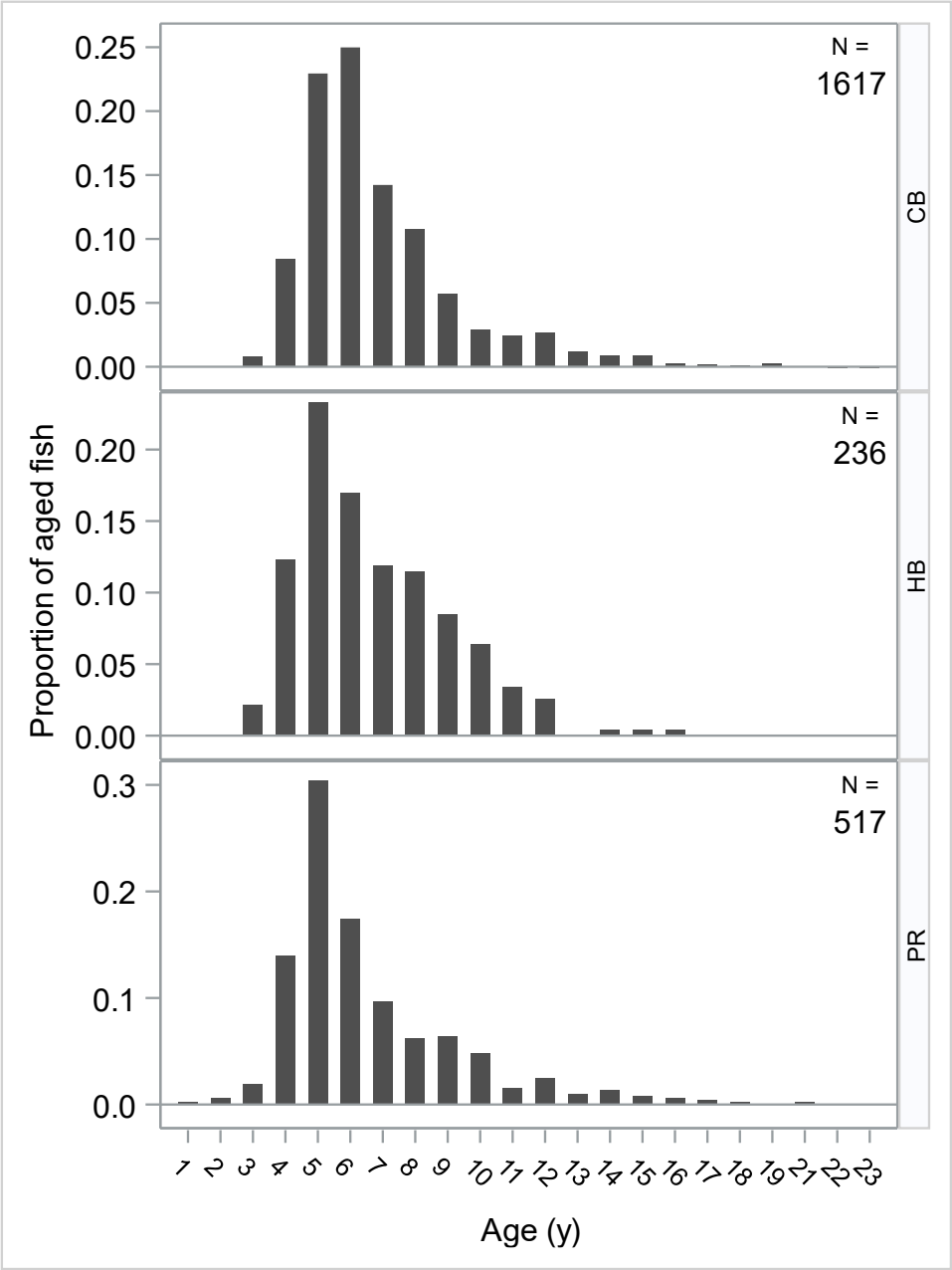

Figure 2. Proportional age distribution of Red Grouper by fleet.

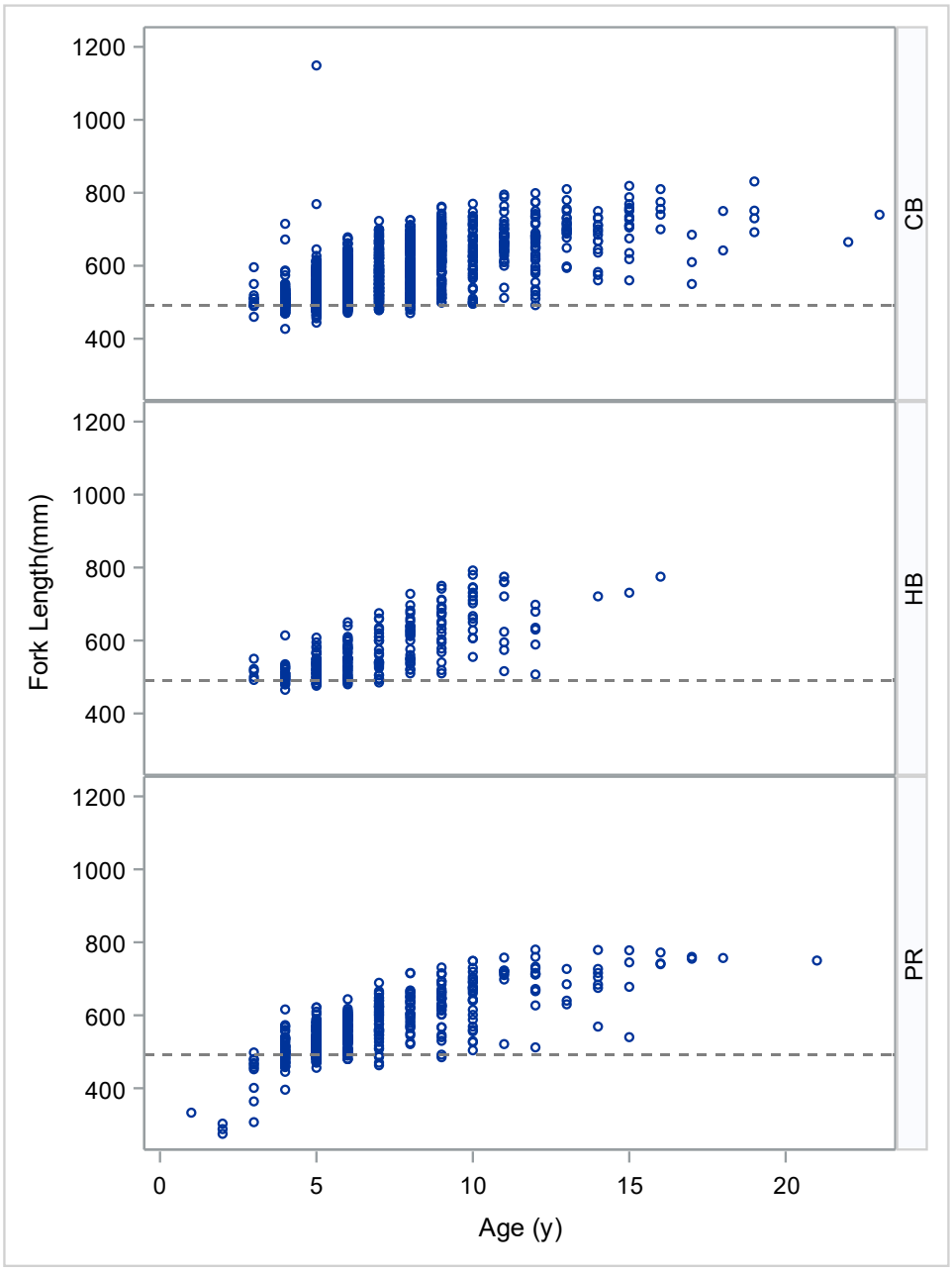

Figure 3. Fork length as a function of age in each fleet. The dashed line represents 20” TL converted to FL using FL = 5.35 + TL *0.95 (Lombardi-Carlson, L. 2014) for recreational fleets, the minimum size since 1990.

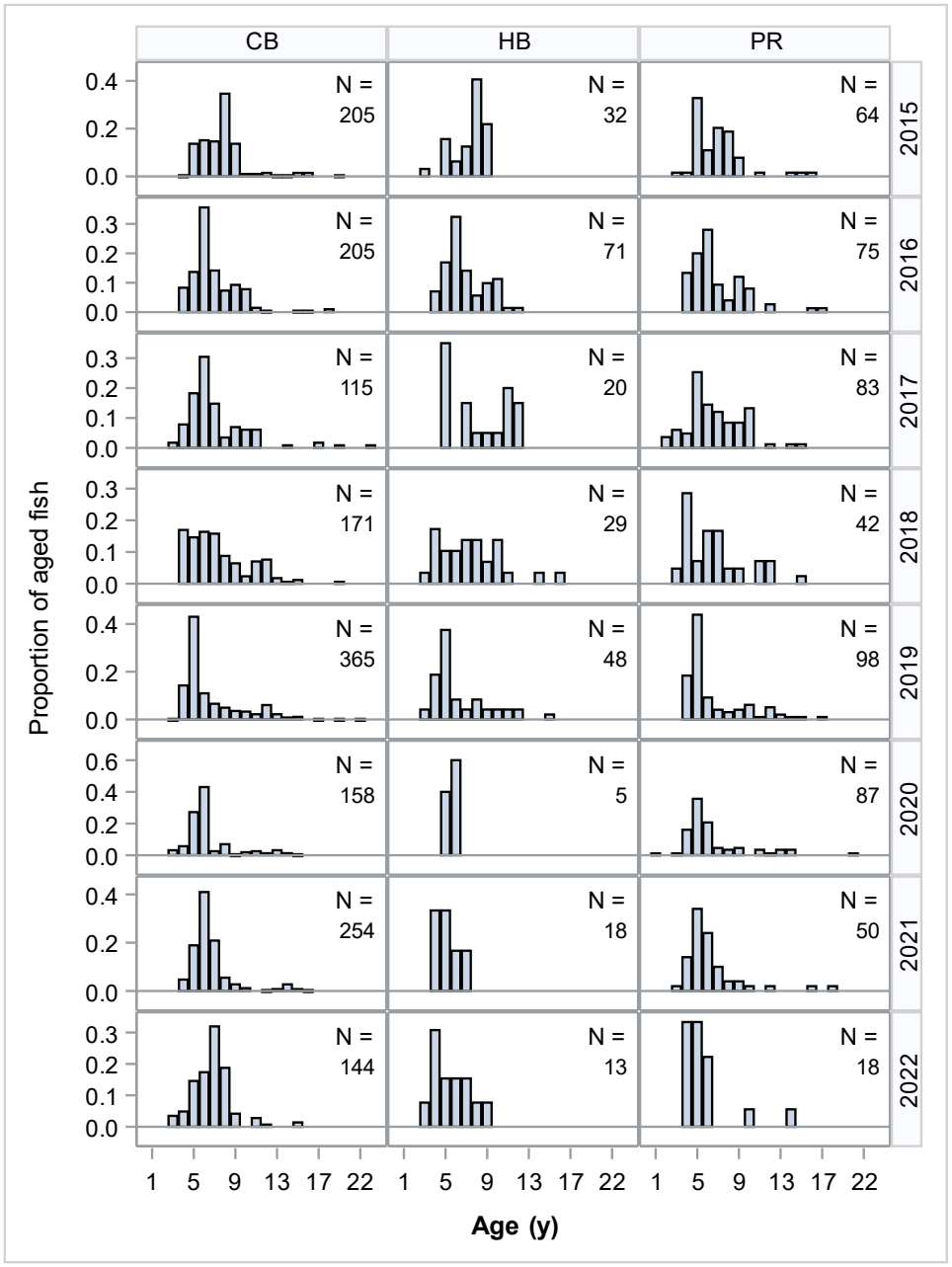

Figure 4. Proportions of estimated ages by mode and year.