SEDAR 94: Florida Hogfish

Review Workshop

Florida Keys/East Florida



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USF | FWC-FWRI Marine Fisheries Research

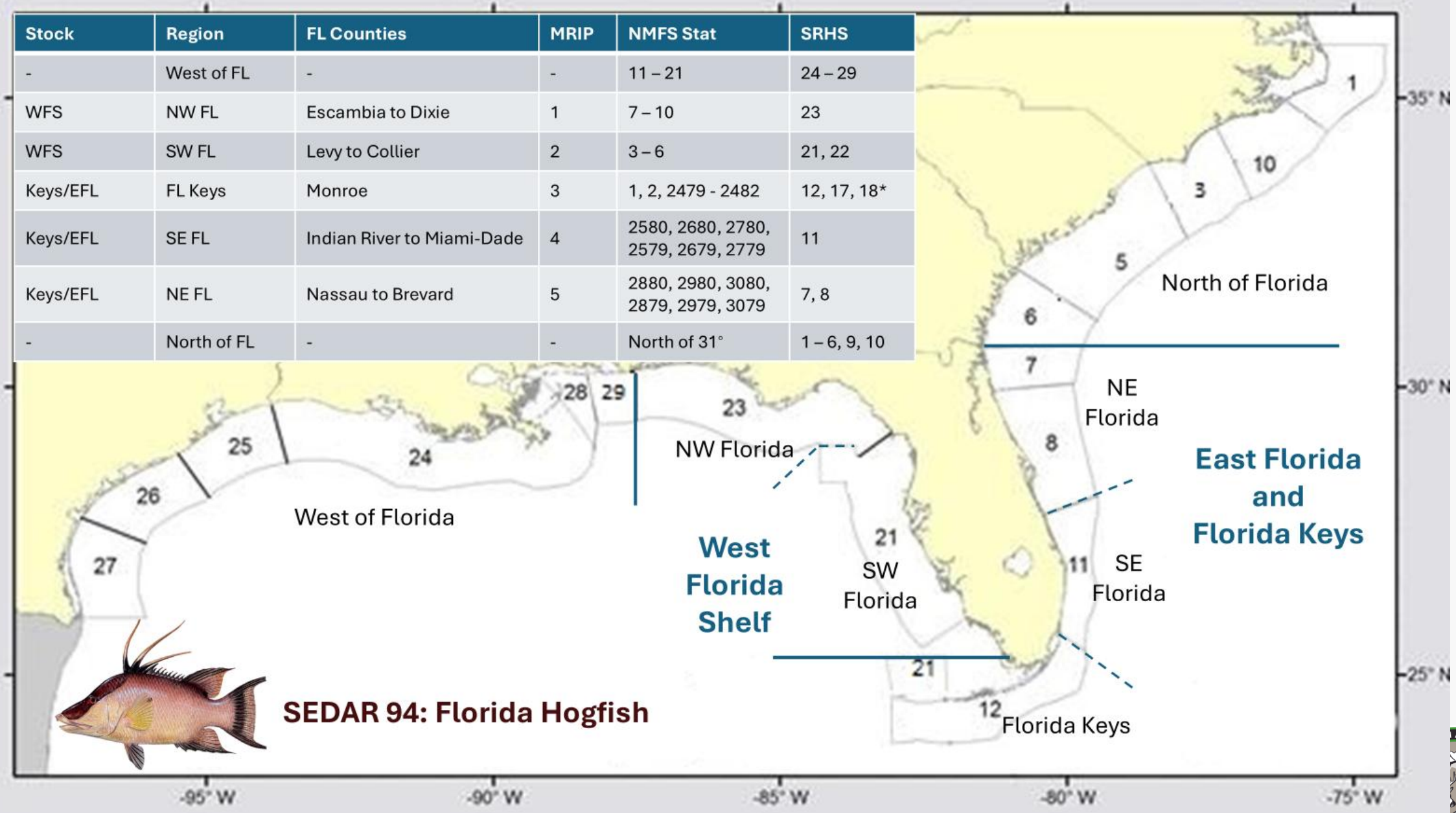
July 14 – 17, 2026

Goals

- Data Input
  - Life history
  - Fishery landings and releases
  - Indices of abundance
  - Length compositions
  - Conditional age-at-length
- Base Model Configuration
  - Stock Synthesis
- Base Model Results
  - Fits to the data
  - Population estimates



Stock	Region	FL Counties	MRIP	NMFS Stat	SRHS
-	West of FL	-	-	11 – 21	24 – 29
WFS	NW FL	Escambia to Dixie	1	7 – 10	23
WFS	SW FL	Levy to Collier	2	3 – 6	21, 22
Keys/EFL	FL Keys	Monroe	3	1, 2, 2479 - 2482	12, 17, 18*
Keys/EFL	SE FL	Indian River to Miami-Dade	4	2580, 2680, 2780, 2579, 2679, 2779	11
Keys/EFL	NE FL	Nassau to Brevard	5	2880, 2980, 3080, 2879, 2979, 3079	7, 8
-	North of FL	-	-	North of 31°	1 – 6, 9, 10

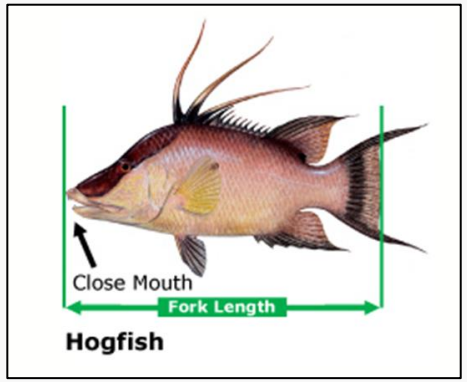


SEDAR 94: Florida Hogfish

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Data: Life History





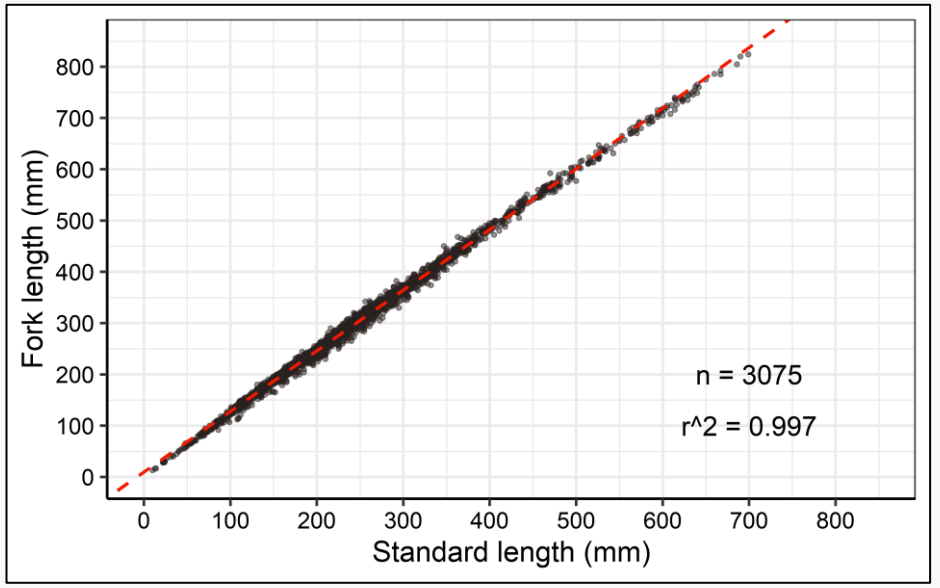
Morphometrics

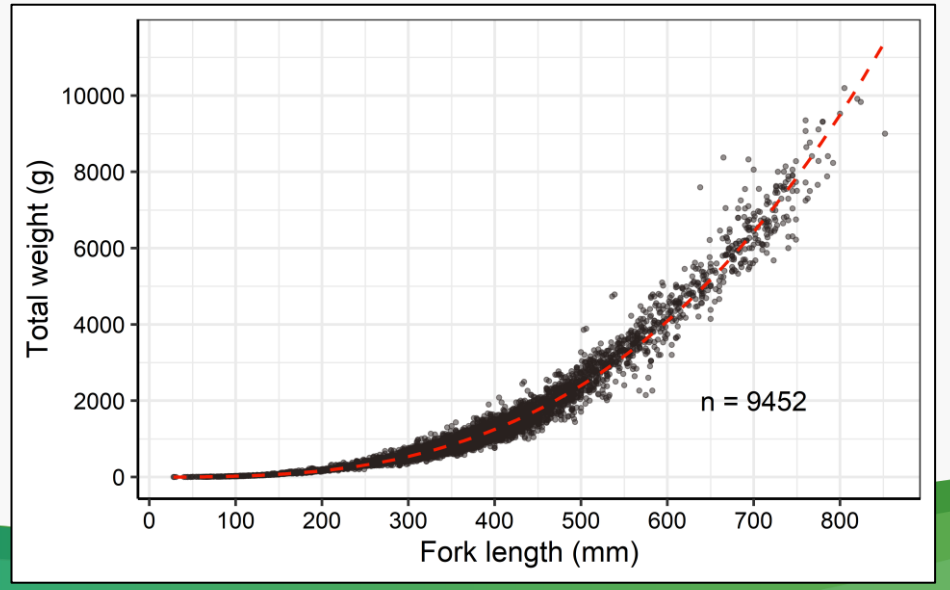
33,832 total observations

- Standard: 3,652
- Fork: 14,945
- Total ‘relaxed’: 3,430
- Total ‘max’: 1,927
- Total (whole) weight: 8,834
- Gutted weight: 1,044

Conversions (see Table 2.12.1 in DW)

- Length-length: $Y = a + bX$
- Length-weight: $W = aL^b$
- Gutted weight to total weight: 1.11

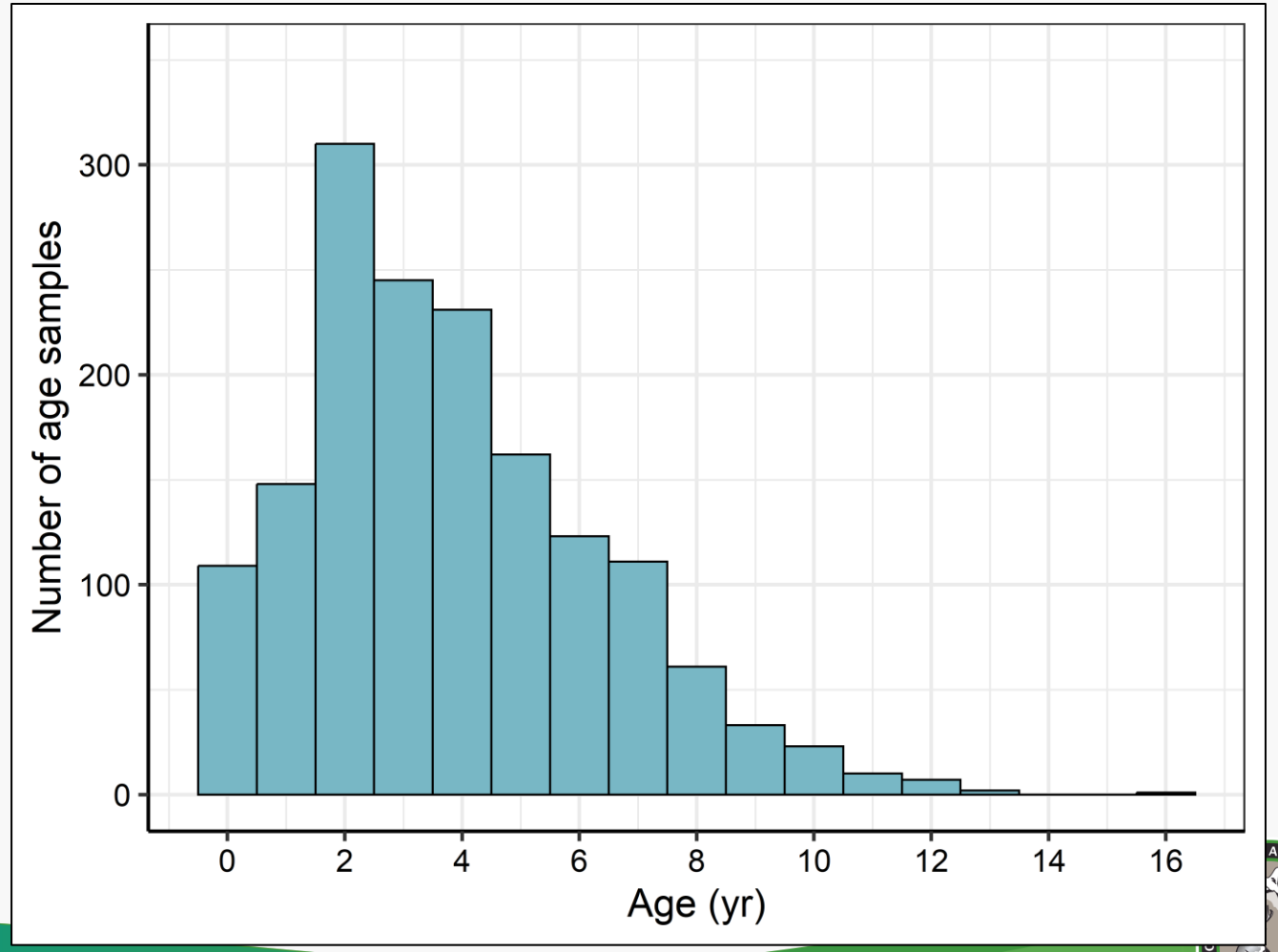




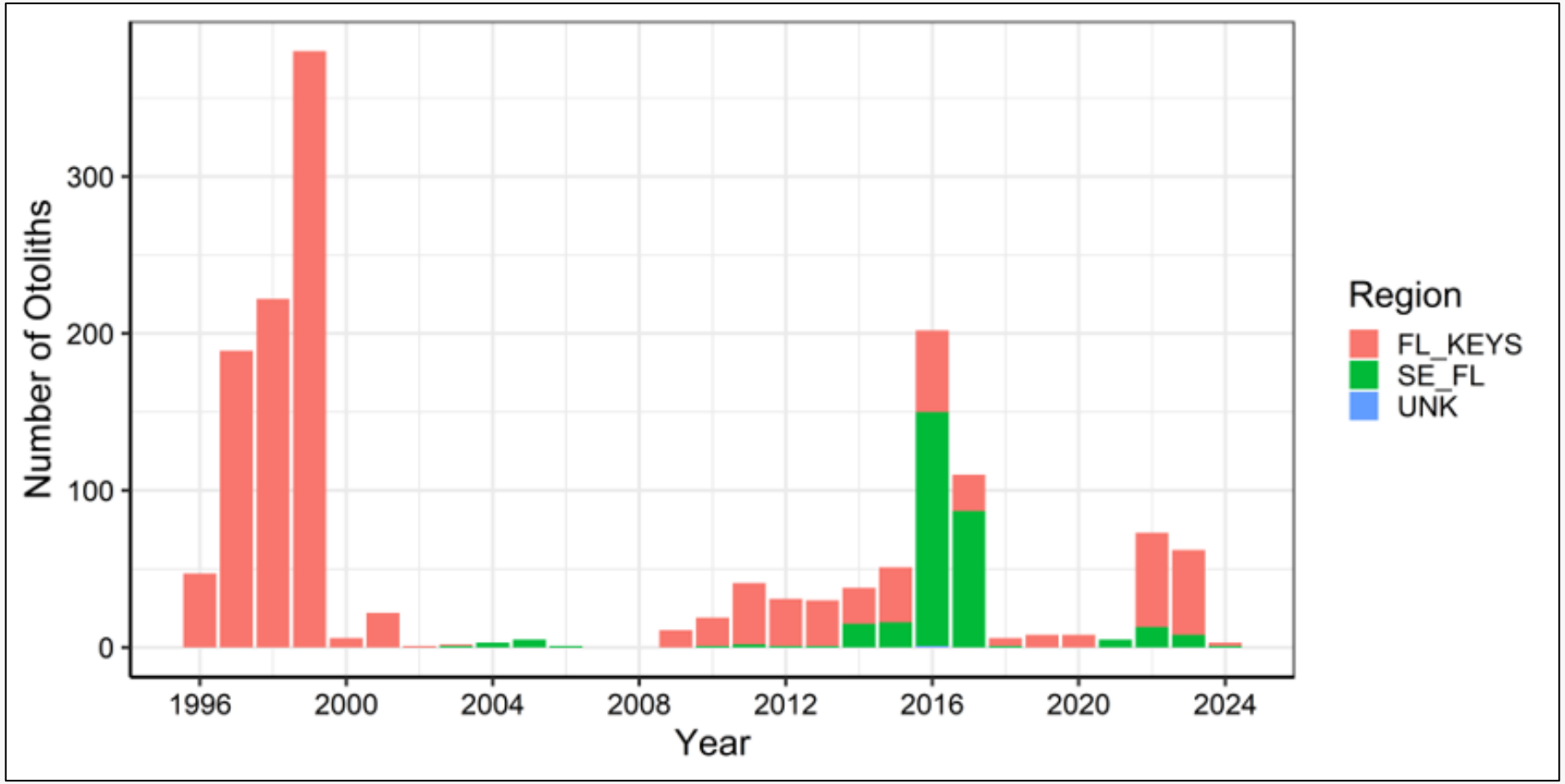
Otolith Samples: Overview

Quantile	0%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Age	0	0	1	1	2	2	2	2	3	3	3	4	4	4	5	5	6	7	7	8	16

- 27 years of data: **1996 – 2024**
- **1,576 otoliths**
- Maximum age **16 years**
  - No change from SEDAR 37
- 95% fish are <=8 years old
  - 35% of observed max age on WFS (23 yrs.)



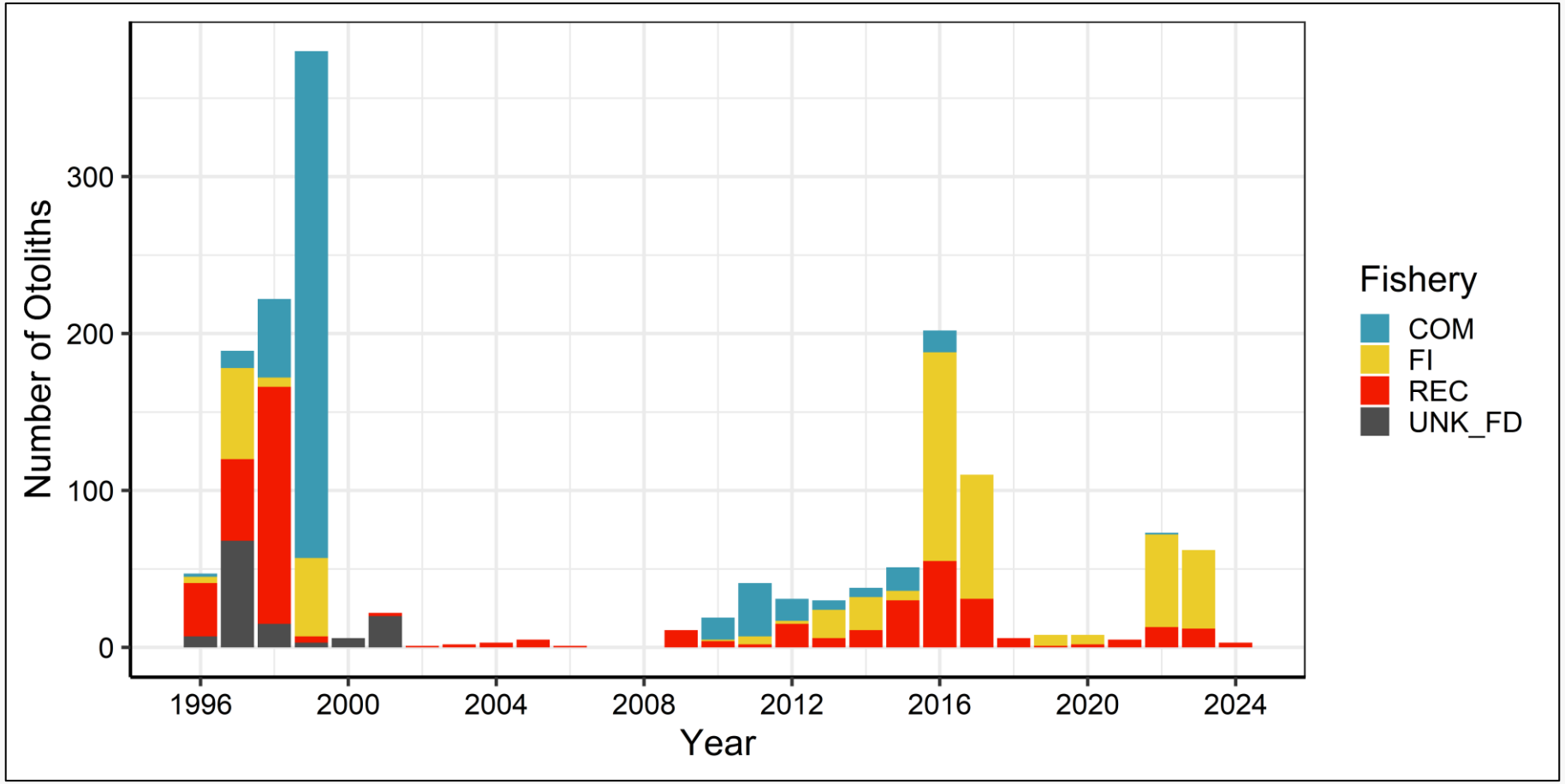
Otolith Samples: Region



DW Report
Figure 2.13.3a

Fishery	n	%
Florida Keys	1,265	80.3
Southeast Florida	310	19.7

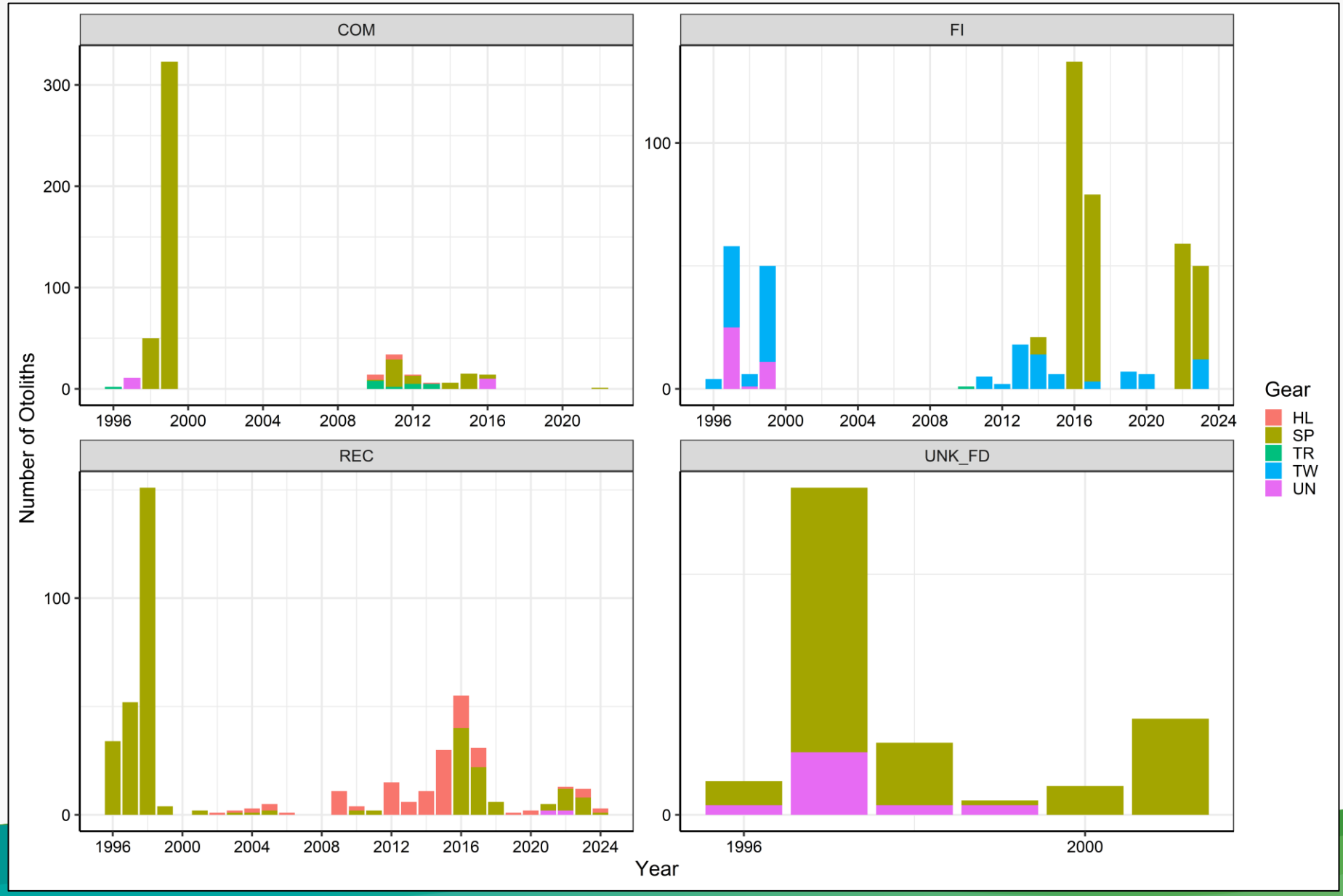
Otolith Samples: Fishery



DW Report
Figure 2.13.4a

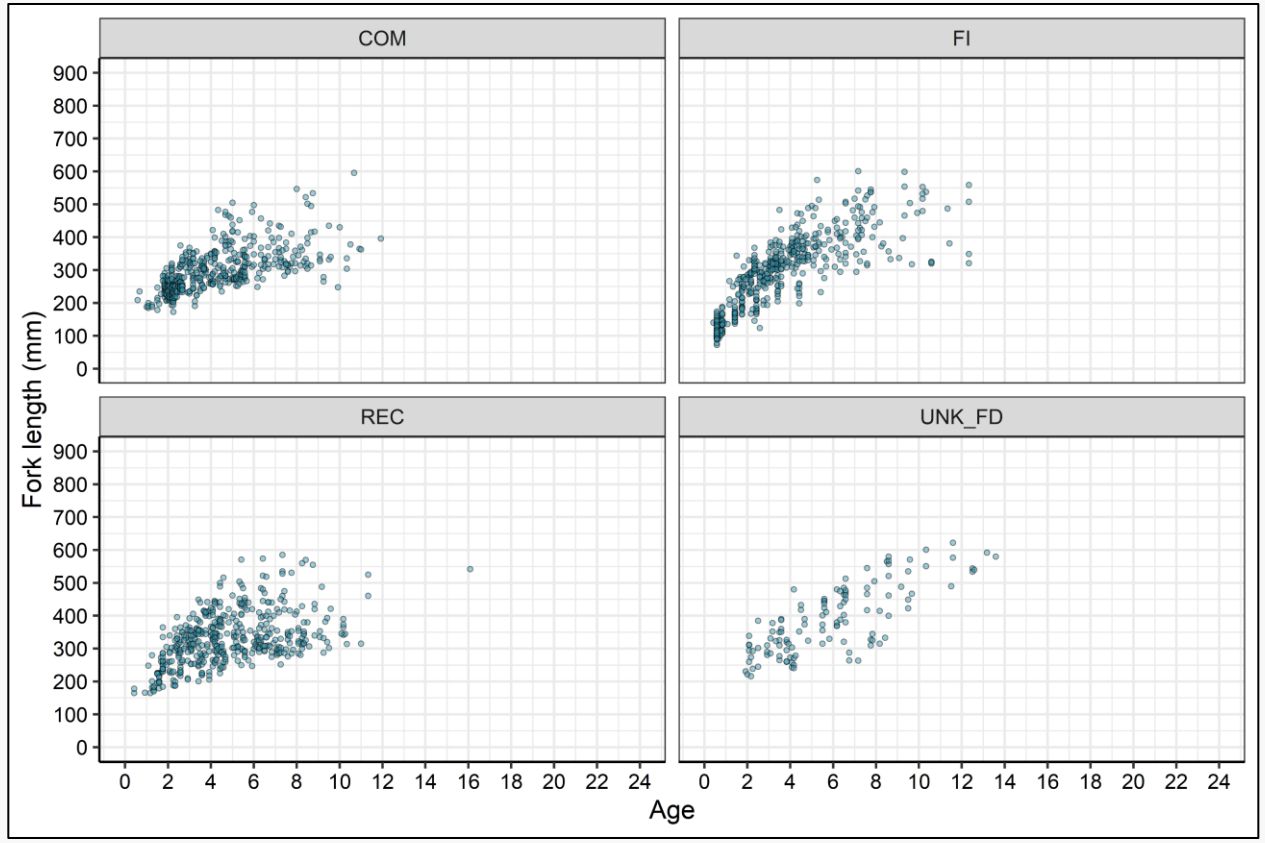
Fishery	n	%
Commercial	490	31.1
Recreational	462	29.3
Fishery-Independent	505	32.0
Unknown FD	119	7.6

Otolith Samples: Fishery and Gear

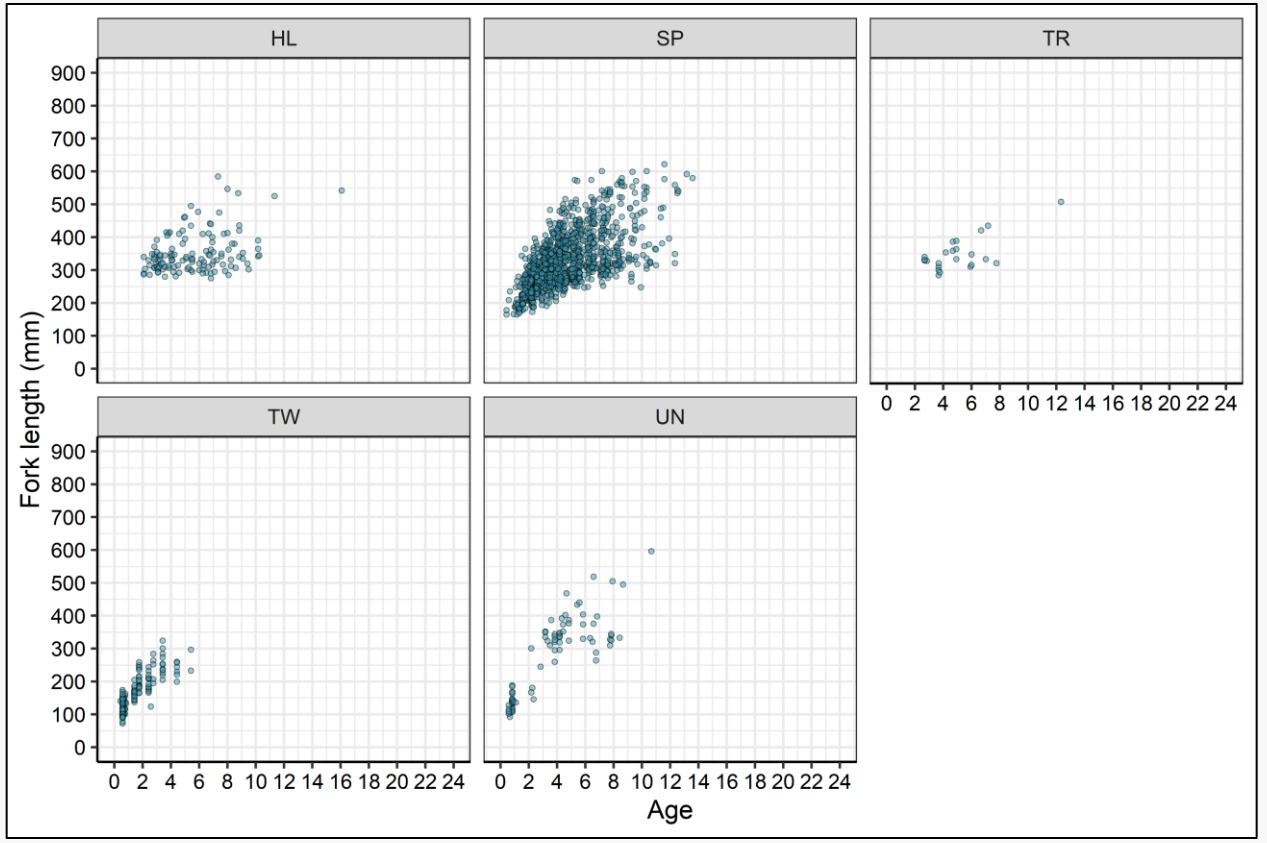


Length-at-age: Fishery and Gear

DW Report
Figure 2.13.27

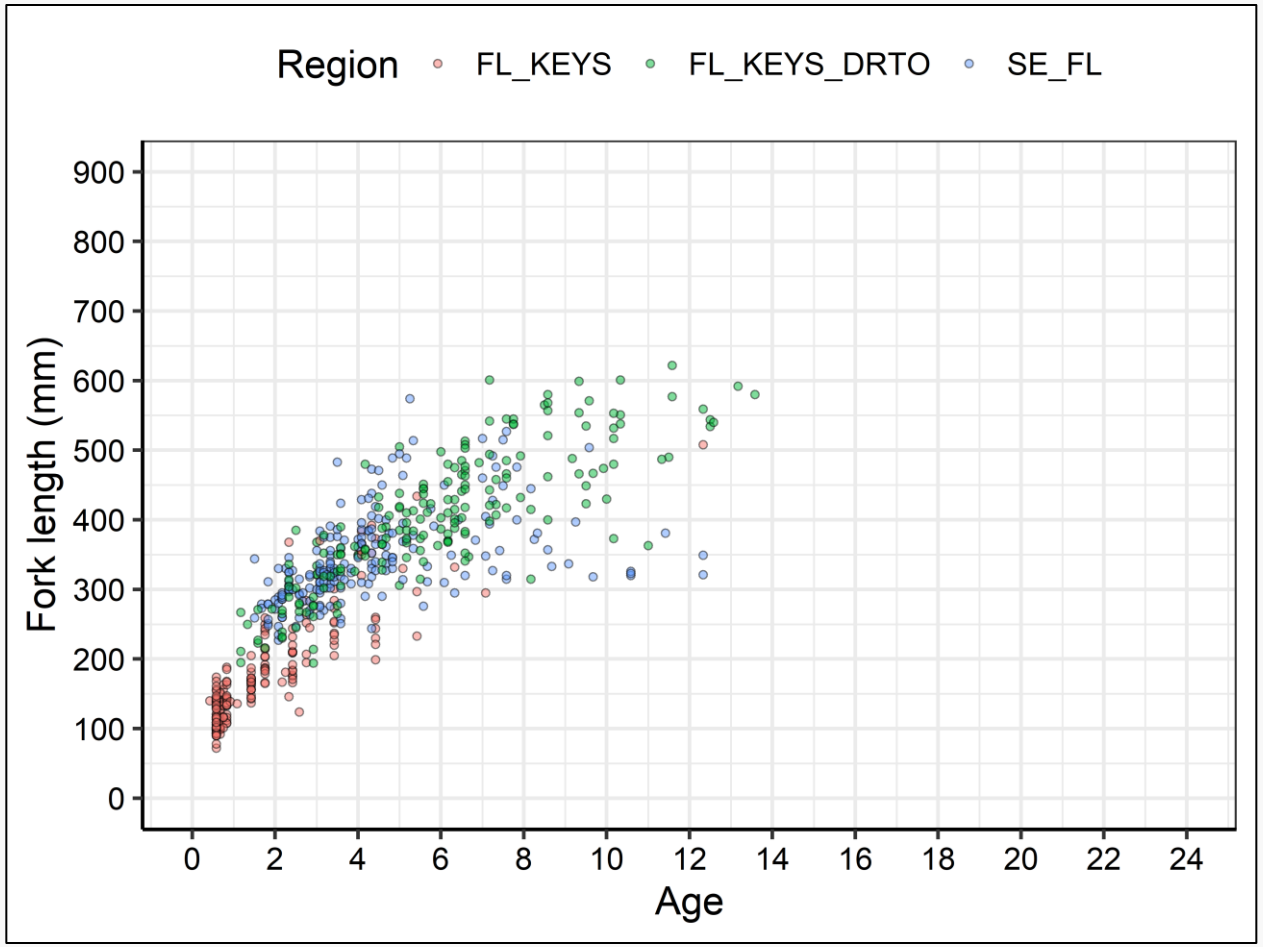


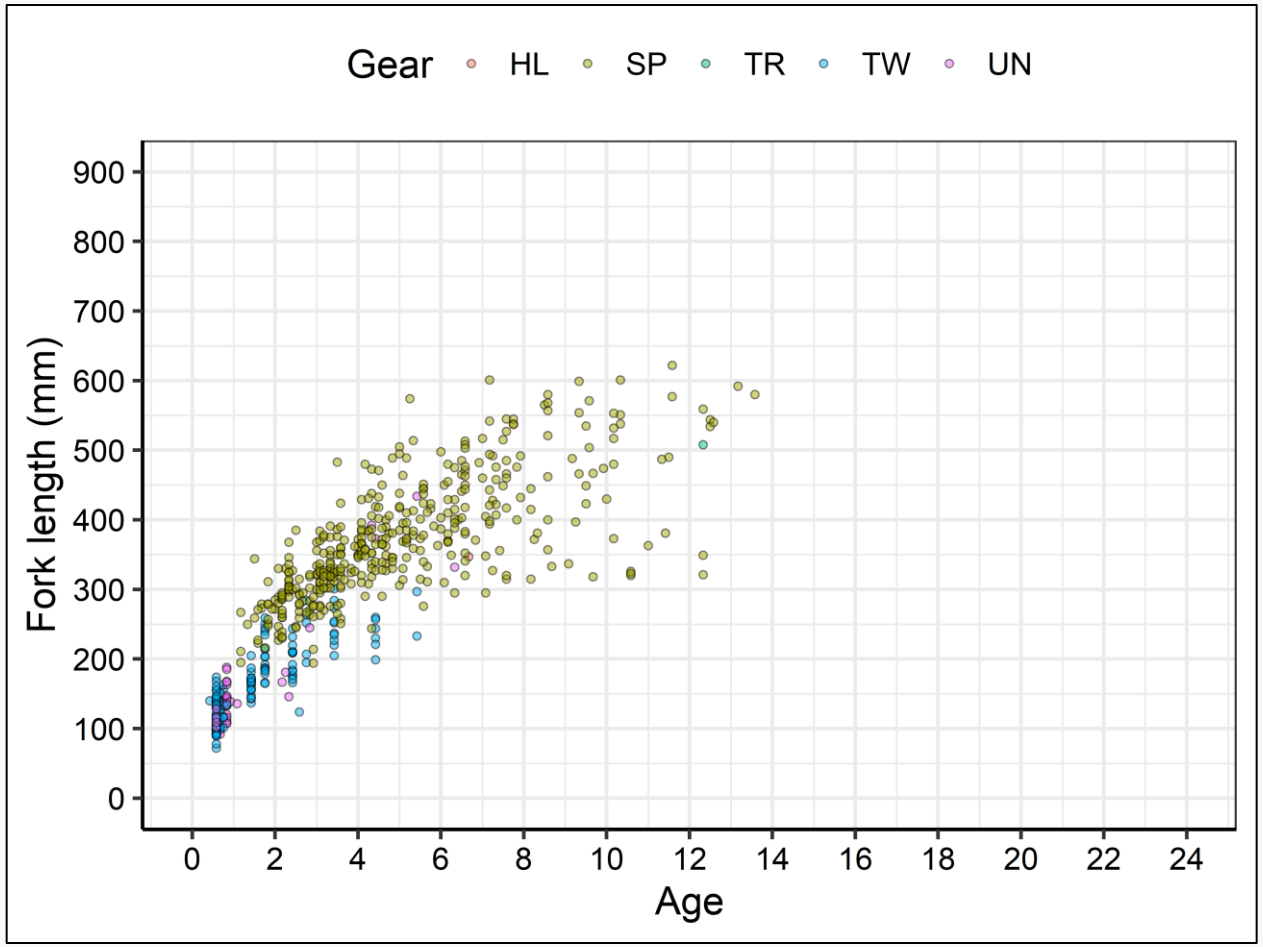
DW Report
Figure 2.13.28



Length-at-age: External Growth Model

DW Report
Figure 2.13.29a-b

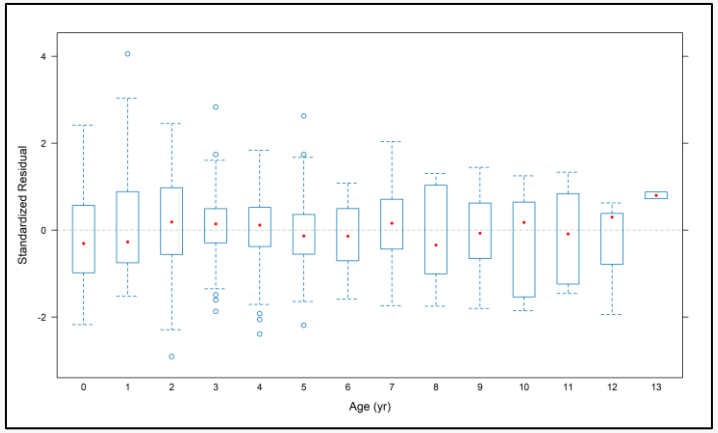


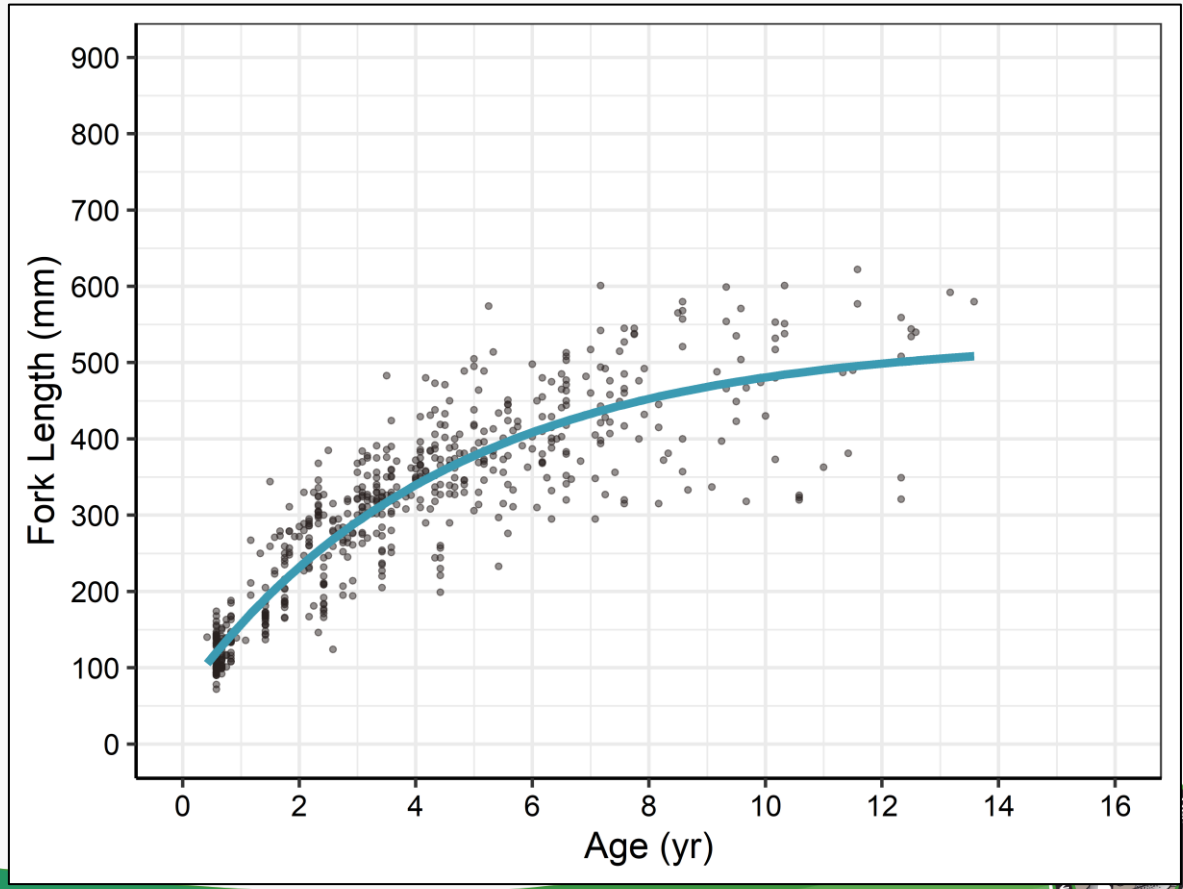


- Data isolated by fishery-independent sources and from the Dry Tortugas
  - n = 593 otoliths
  - Predominantly spear (assumed flat-topped selectivity) and Trawl

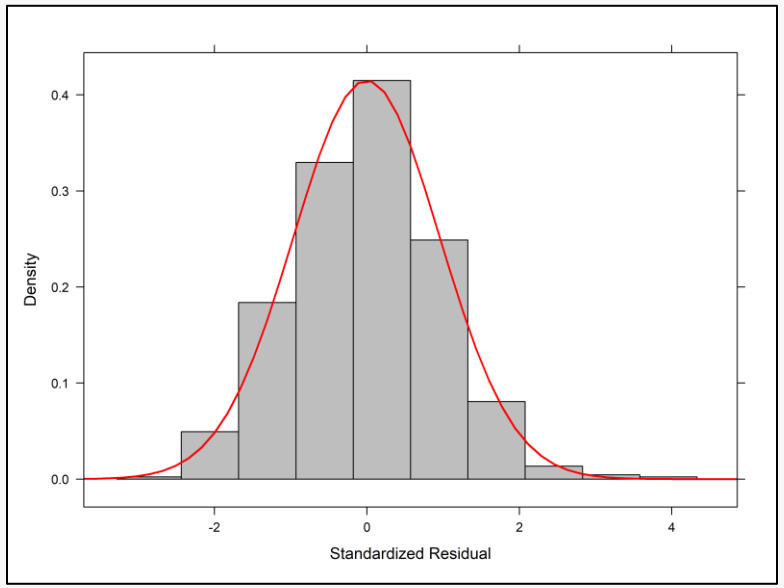
External Growth Model

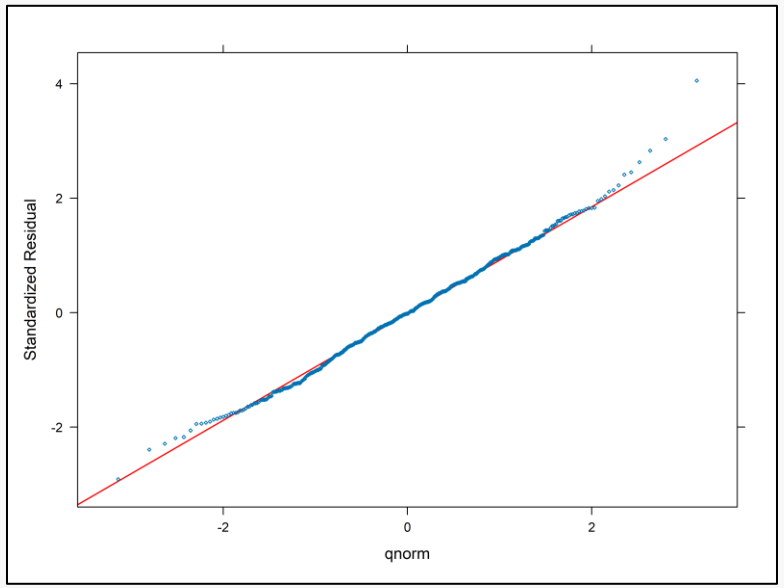
- Growth model
  - Size-truncated von Bertalanffy growth model (Diaz et al. 2004)
    - SAFMC minimum size limits
  - L_{inf} = 53.1 cm FL
  - k = 0.223
  - t_0 = -0.571
  - Parameters used as initial values in assessment model
  - No sexual dimorphism
    - Females first then males follow same growth curve

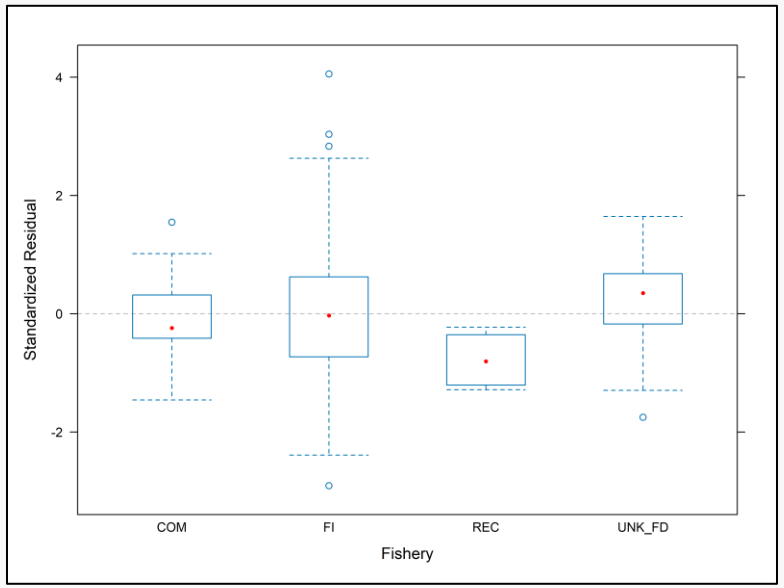


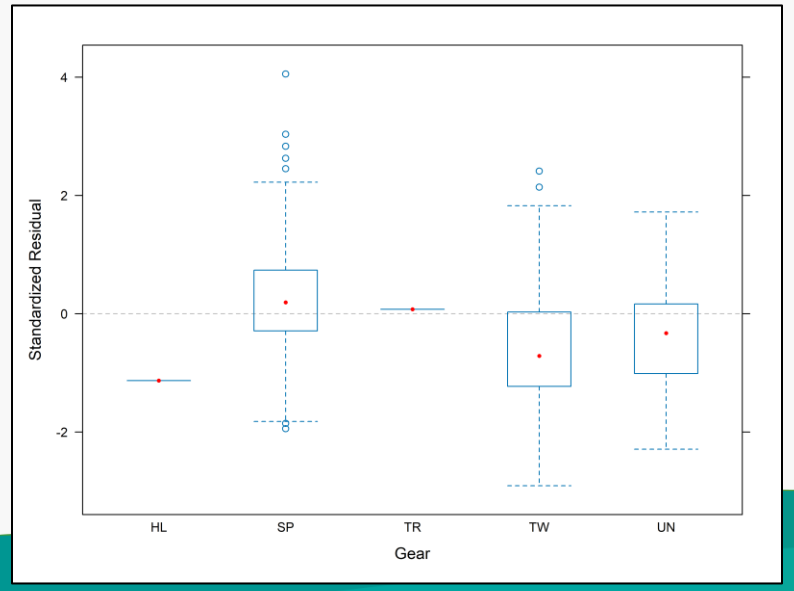


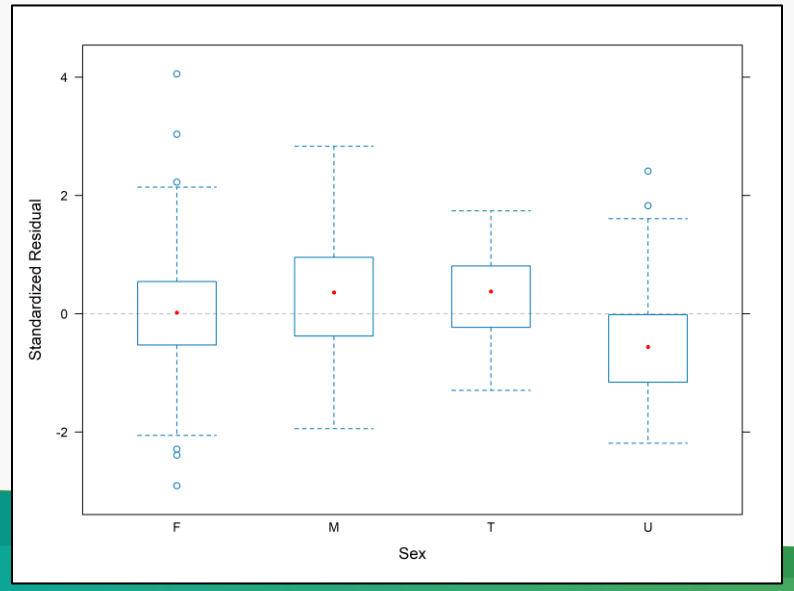
External Growth Model

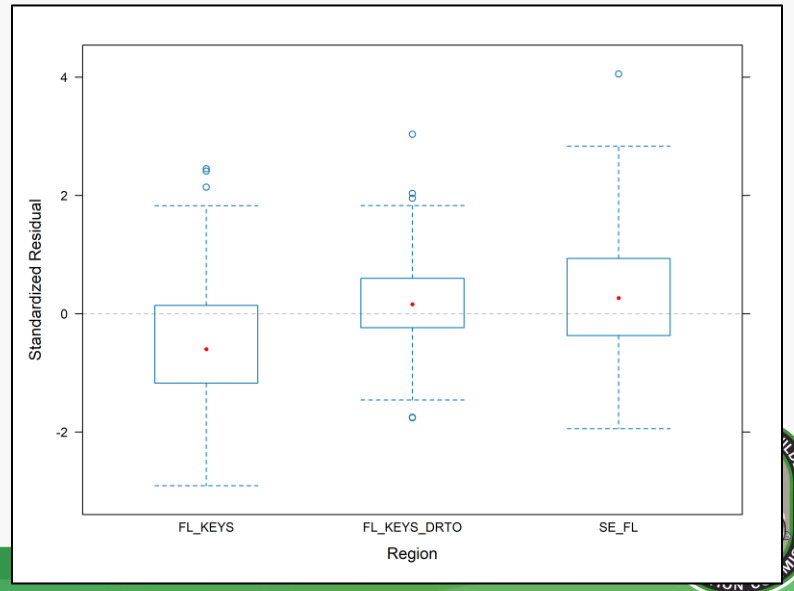








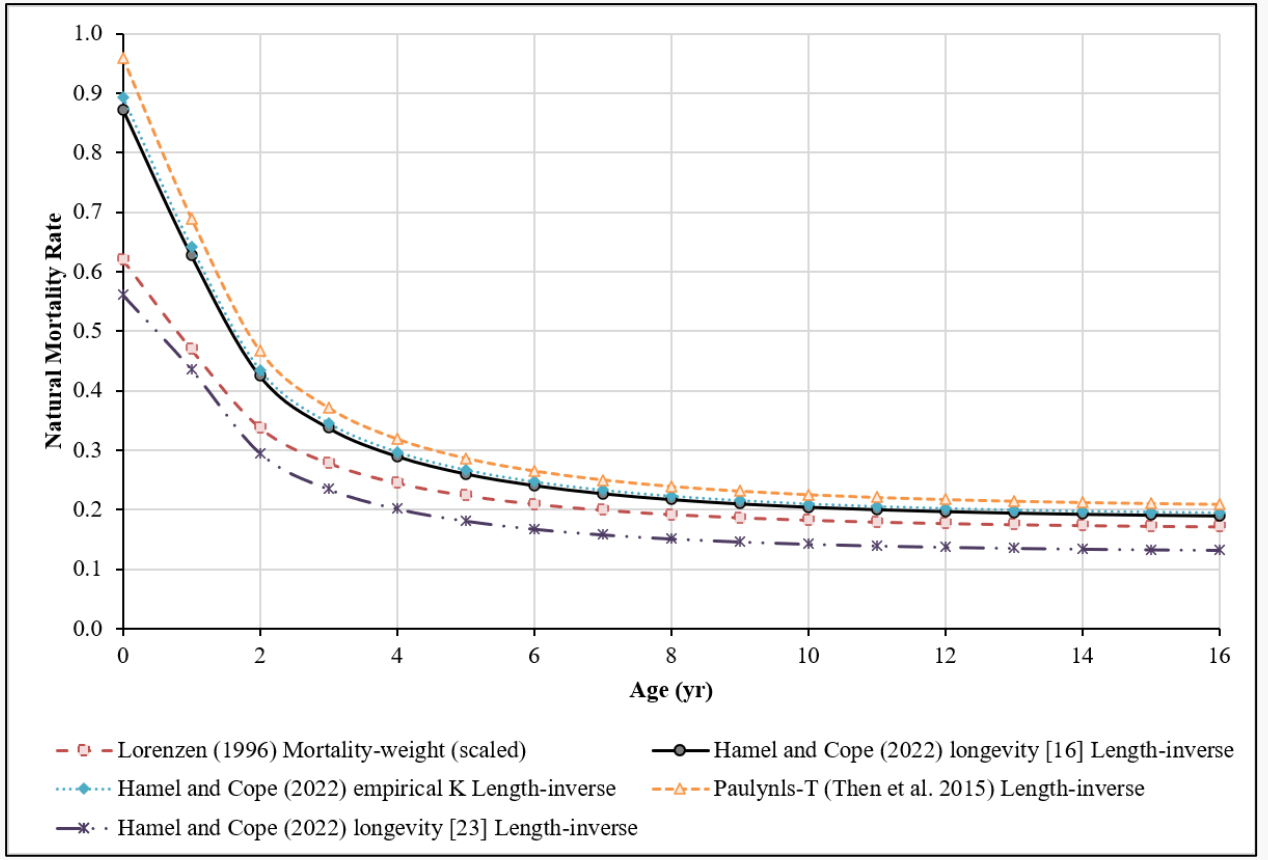




Natural Mortality

- Natural mortality inversely related to fish length
- Lorenzen (1996) mortality-at-weight (red circles)
  - Utilizes length-weight relationship
    - Circumvents uncertainty in maximum age: one fish aged 16, no samples aged 14 or 15, two aged 13
  - Converted to mortality-at-age via external growth model
    - Used as fixed vector in assessment model
- Other models explored as sensitivity runs
  - Hamel and Cope (2022) longevity model (M = 0.338 yr^{-1})

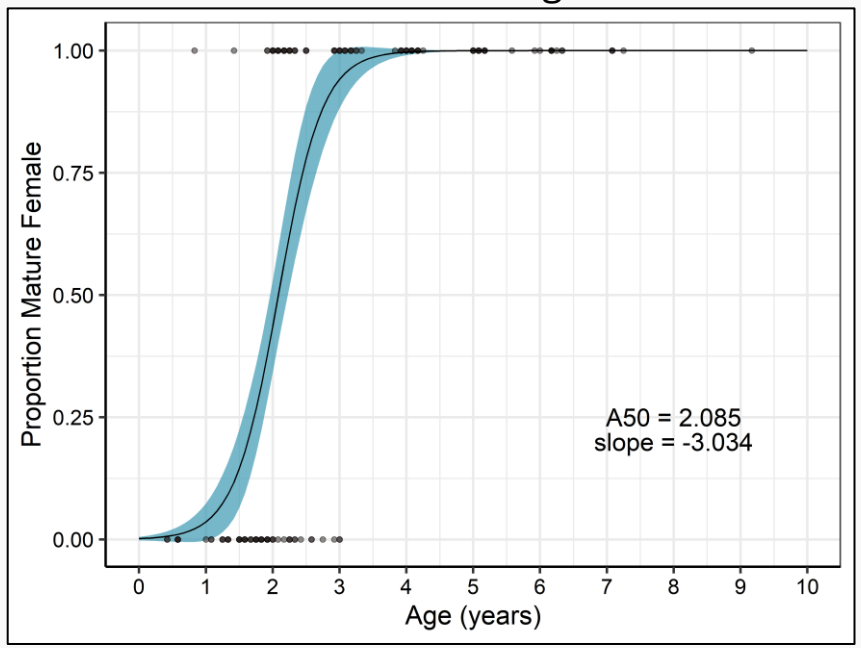
DW Report
Figure 2.13.40

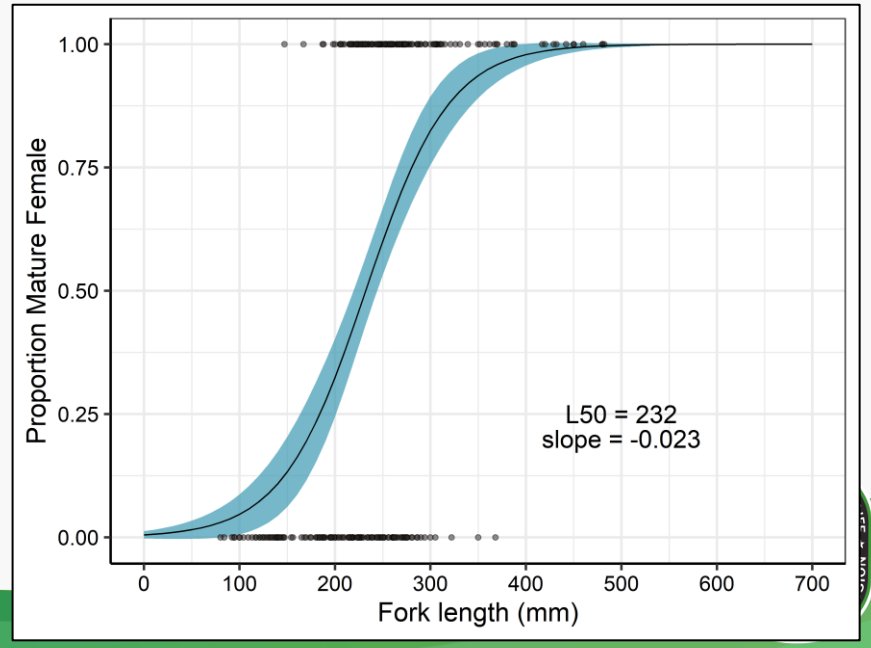


Female Maturity

DW Report
Figure 2.13.42a-b

- No new data since last assessment
  - Re-analyzed according to updated approach
    - Lowerre-Barbieri et al. (2022), Lowerre-Barbieri and Friess (2023)
  - All months given protracted spawning seasonality
    - Spawning occurs in the afternoon as often as daily for as long as 11 months of the year
  - Reproductive phases follow McBride and Johnson (2007)
- Histologically confirmed phases
  - Immature females (class 1) = 0
  - Mature active spawning females (class 3) = 1
- Logistic regression (binomial glm with logit link function)
  - **A_{50} = 2.08 years (n = 231)**
  - L_{50} = 23.2 cm FL (n = 285)

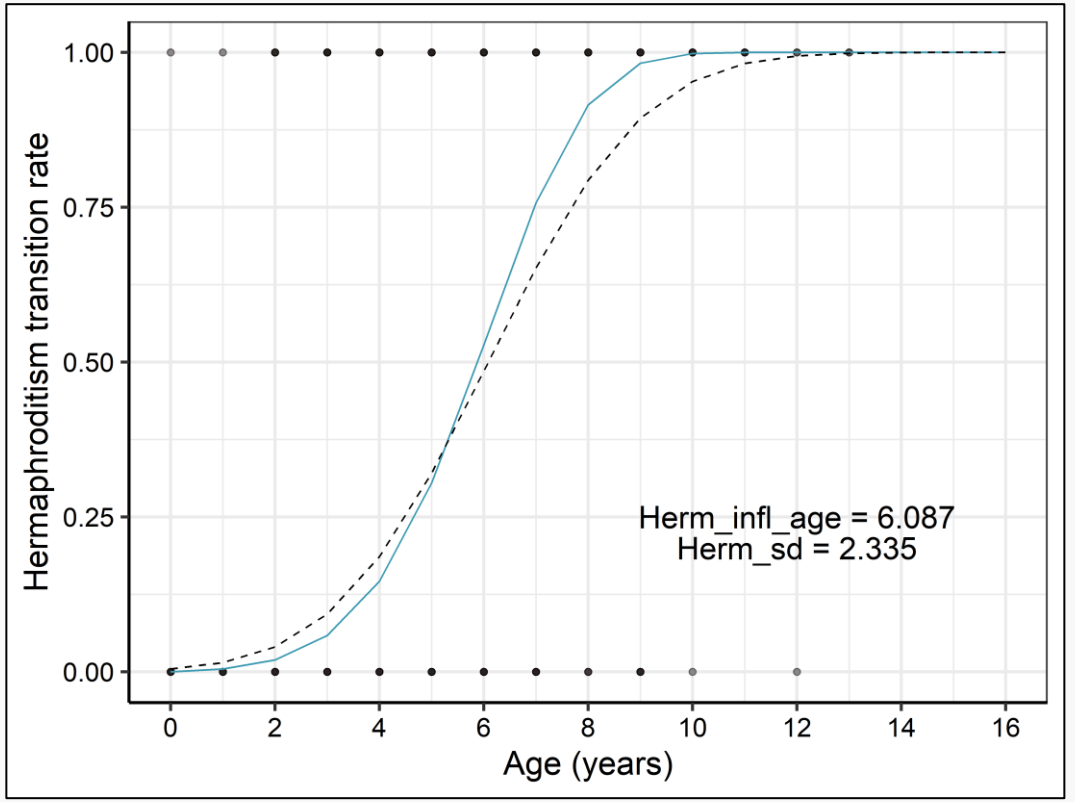




Male Transition

- Hermaphroditism
  - Monandric, protogynous (female to male)
  - Territorial males and female-biased harems
    - Single male maintains 5 – 15 females
  - Sexual transition socially and environmentally mediated
    - Transition takes several months where male removal has potential to significantly disrupt harem stability
- Repro classes (n = 721)
  - 1 – 4 (imm./mature females)
  - 5 – 10 (transitionals, imm./mature males)
- Transition probabilities
  - Cumulative normal distribution
    - Defines proportion that *change* sex in a time step, not proportion that *are* each sex
  - First fully male age was 11 years.
  - **Herm. infl. age = 6.09 years**

DW Report
Figure 2.13.44a



SEDAR 94: Florida Hogfish

Data: Landings and Releases



Commercial Landings

Florida's Marine Fisheries Trip Ticket and NOAA Fisheries' Accumulated Landings System (ALS)

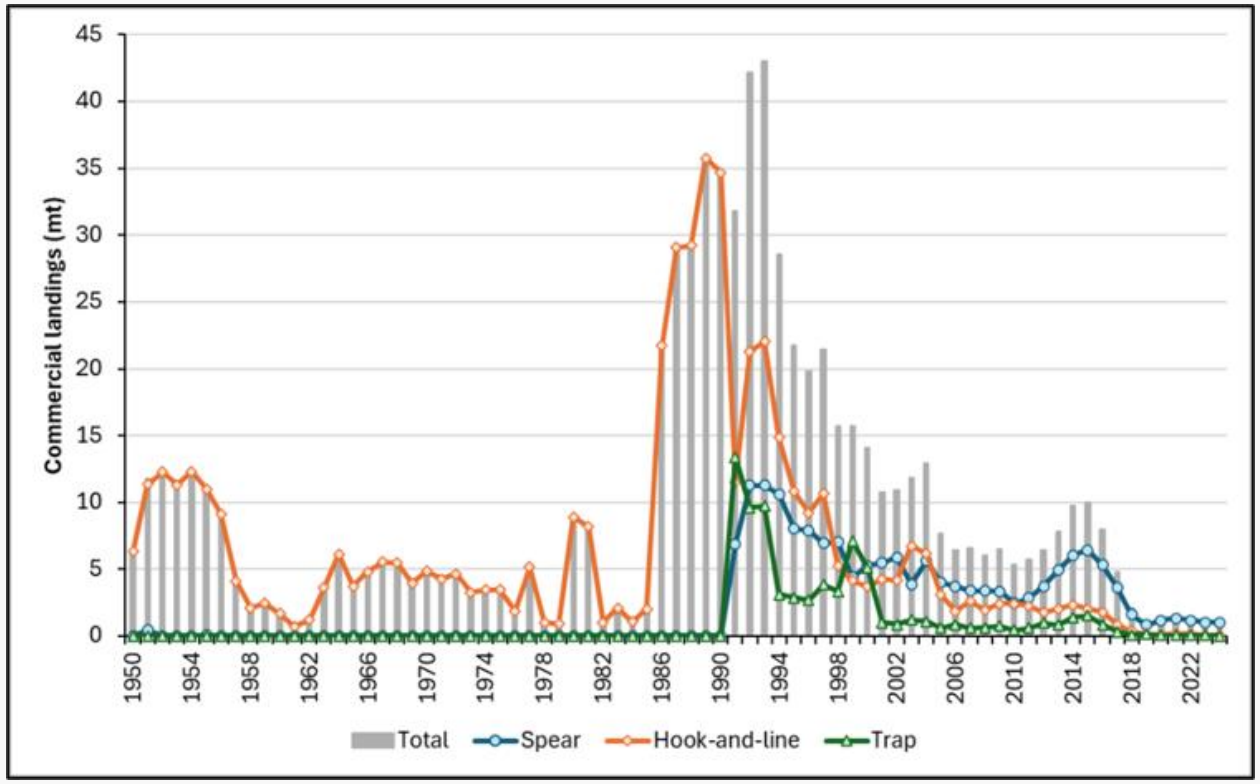


Figure 3.2

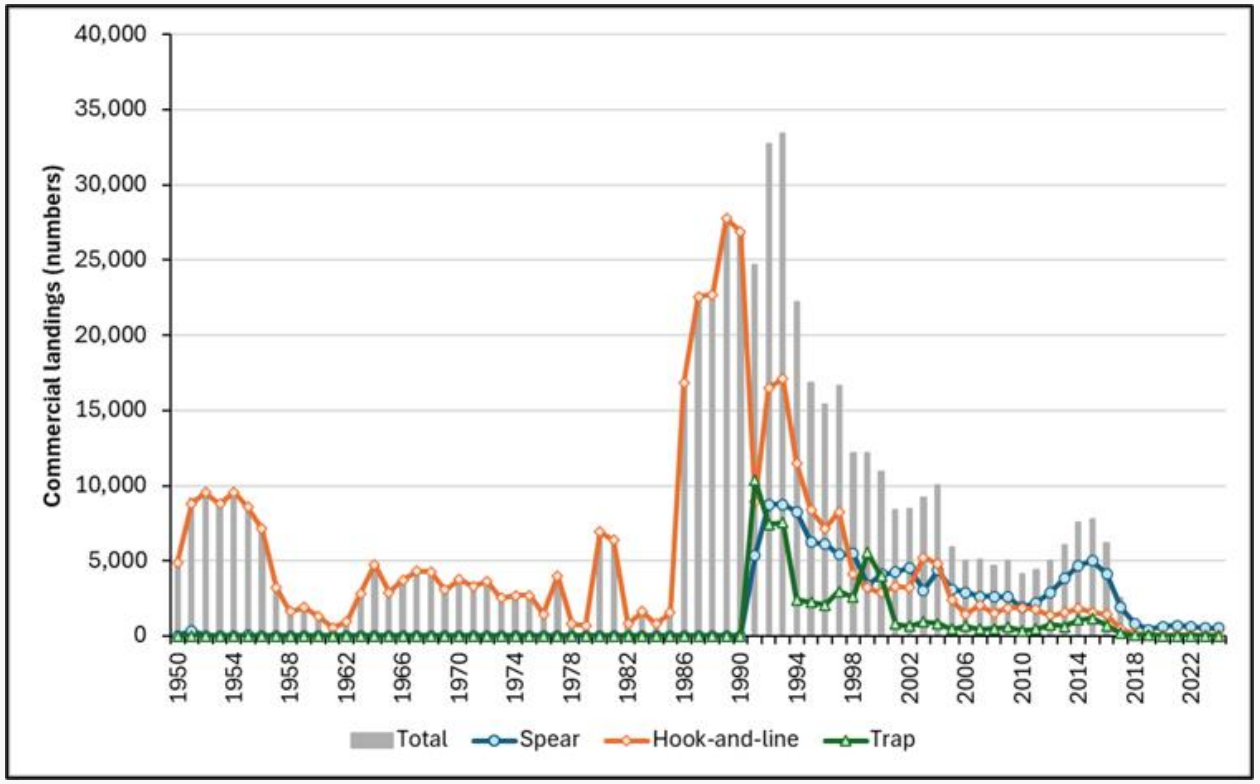


Figure 3.3

Years	CV
1950 – 1961	0.25
1962 – 1977	0.20
1978 – 1985	0.10
1986 – 2024	0.05

Recreational Landings

Full SRFS Combined: 1981 – 2024

- Florida's State Reef Fish Survey (SRFS)
  - Private mode from 2021 – 2024
  - SRFS ratio-calibrated private mode from 1981 – 2020
  - SRFS (numbers) ratio = 0.684511198
- Marine Recreational Information Program (MRIP) from 1981 – 2024
  - Charter and shore modes
- Southeast Region Headboat Survey (SRHS)
  - Headboat mode from 1981 – 2024
- Predominant gears
  - Spear and hook-and-line
- CVs often above 30 – 50%

- Flagged years by the Data Workshop
  - 1981 and 1984
    - 1.285 million fish and 6.644 million fish, respectively
  - Replaced using geometric mean of six surrounding years (3 prior, 3 after)
    - 295,197 fish in 1981 and 239,962 fish in 1984

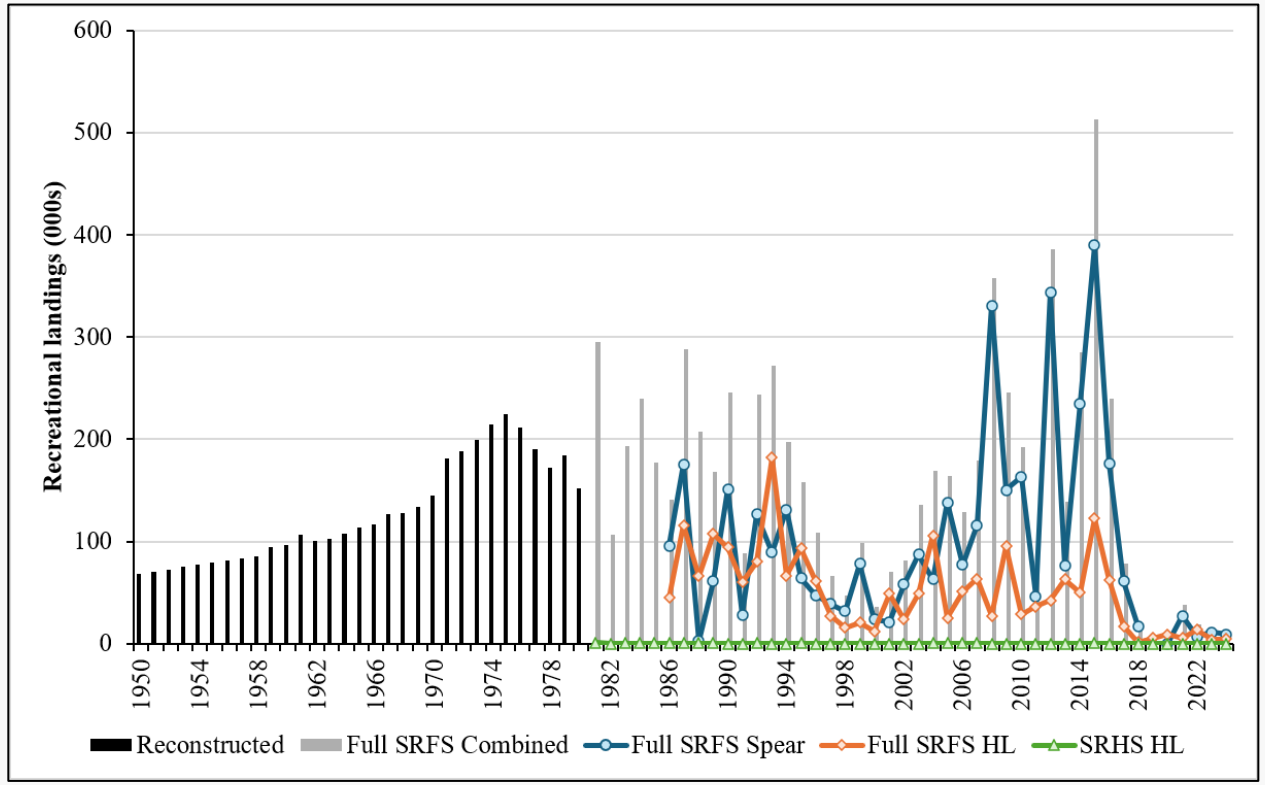
Recreational Landings

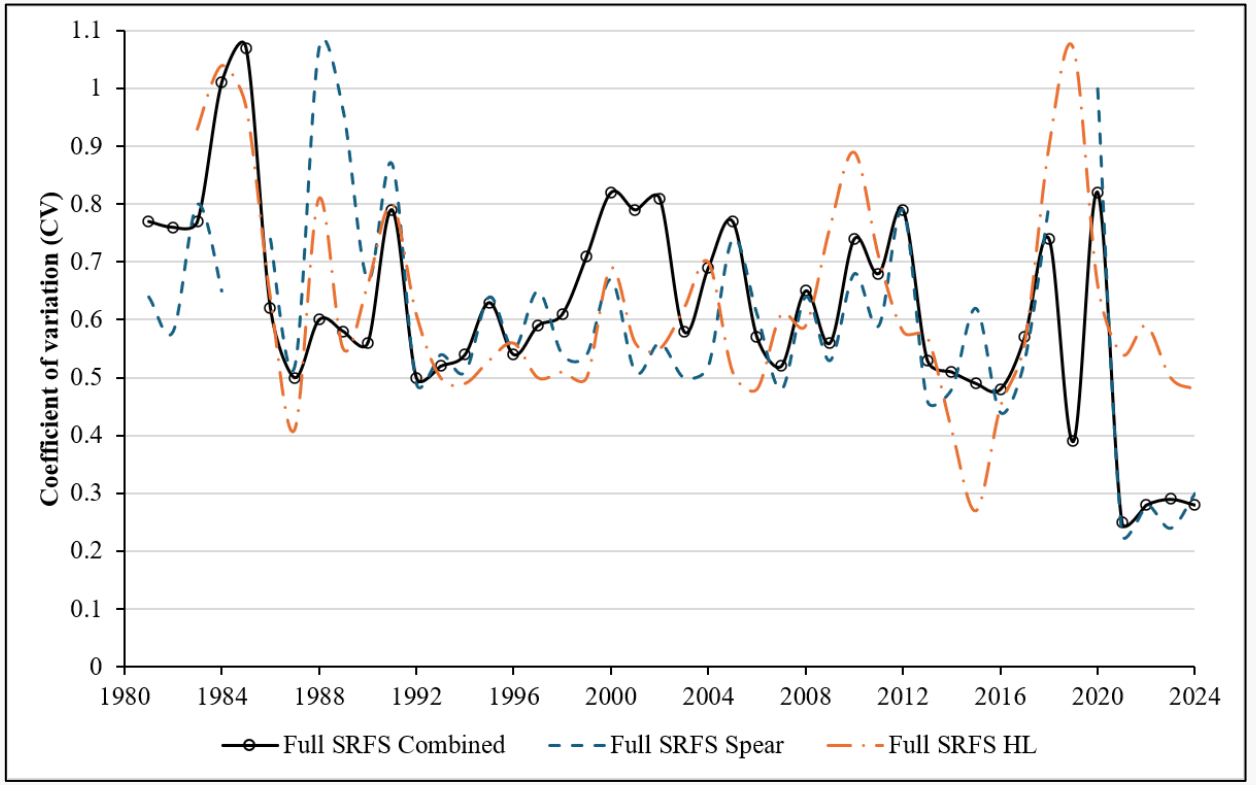
Reconstructed landings: 1950 – 1980

- Annually estimated number of saltwater anglers in Florida from 1950 – 2012 from National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR)
  - Multiplied by geometric mean percentage of landings within FLK/EFL region from 1981 – 1985 (0.976097) to generate estimated number of anglers within FLK/EFL region
- Generate CPUE (SRFS landings/number of FLK/EFL saltwater anglers)
  - Average CPUE for years 1982, 1983, and 1985 = 0.263904
    - Years 1981 and 1984 omitted due to flagging at DW and overinflated CPUEs
- Reconstructed landings = number of FLK/EFL saltwater anglers * CPUE
- Gear combined following AW panel discussion on fleet configuration

Recreational Landings

Figure 3.4



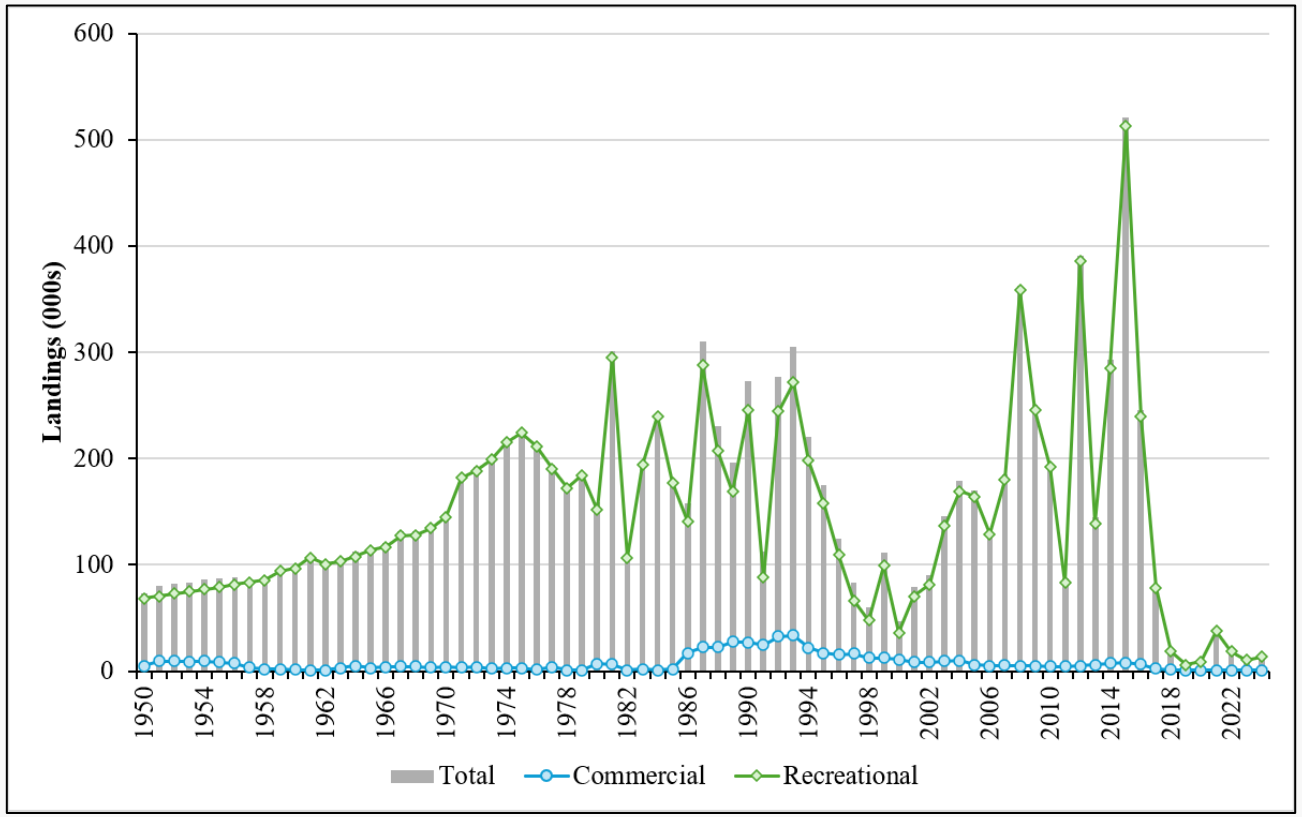


AW panel decision points:

- Combine the SRHS landings with Full SRFS hook-and-line as was done in SEDAR 37
- Later decided to combine all recreational modes and gears into single fleet given data uncertainty, paucity in length composition data, and model parsimony

Landings Comparison

Figure 3.6



- Removals dominated by recreational landings
  - Commercial landings averaged 5.75%

Recreational Discards

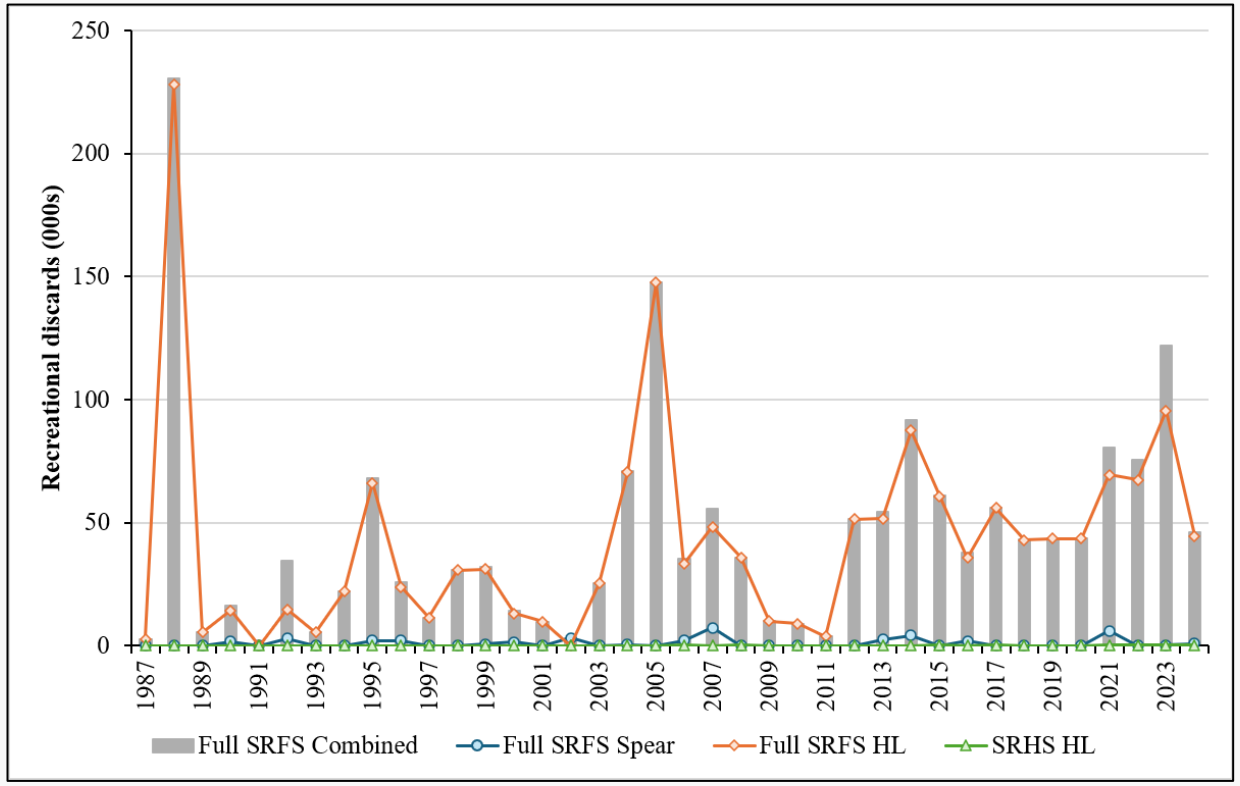
<u>Full SRFS Combined: 1987 – 2024</u>

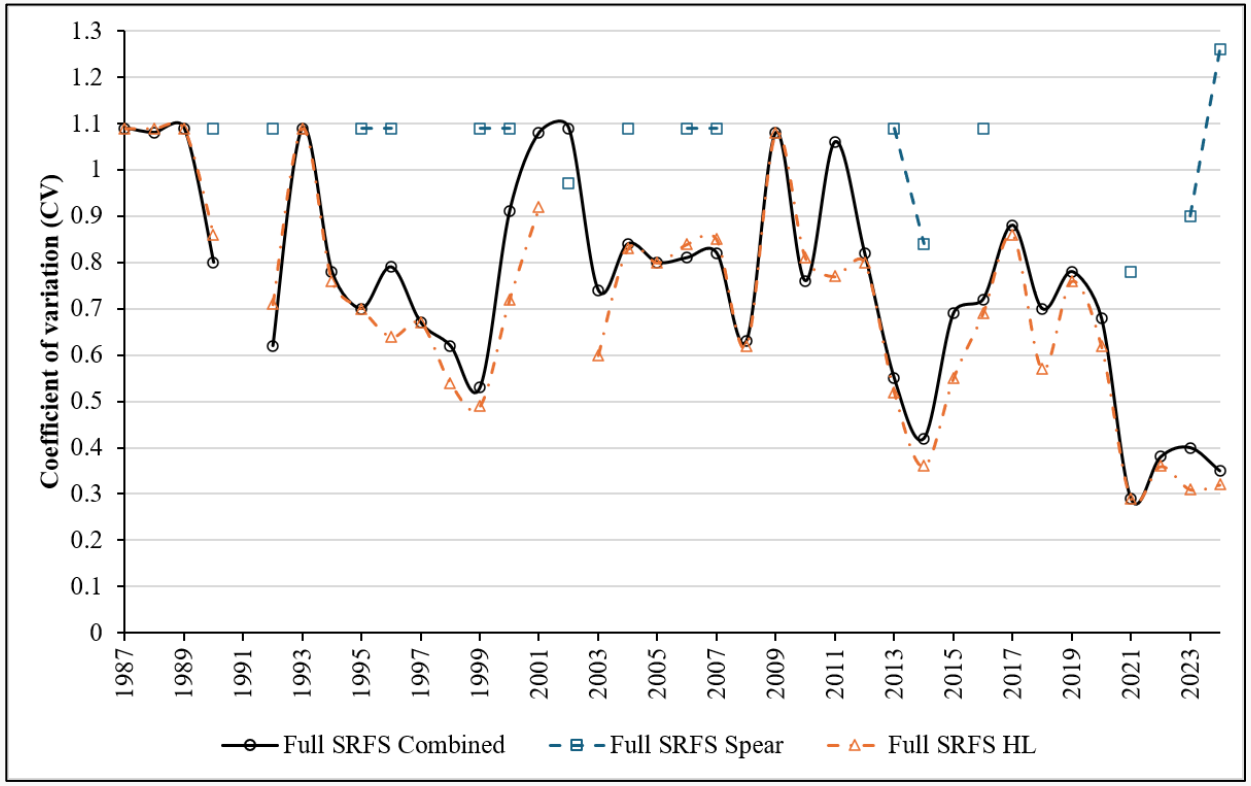
- Florida's State Reef Fish Survey (SRFS)
  - Private mode from 2021 – 2024
  - SRFS ratio-calibrated private mode from 1987 – 2020
  - SRFS (numbers) ratio = 0.966161479
- Marine Recreational Information Program (MRIP) from 1987 – 2024
  - Charter and shore modes
- Southeast Region Headboat Survey (SRHS)
  - Headboat mode from 1987 – 2024
- Predominant gears
  - Hook-and-line with some spear
- CVs often above 50%

- *No commercial discards available*

Recreational Discards

Figure 3.5



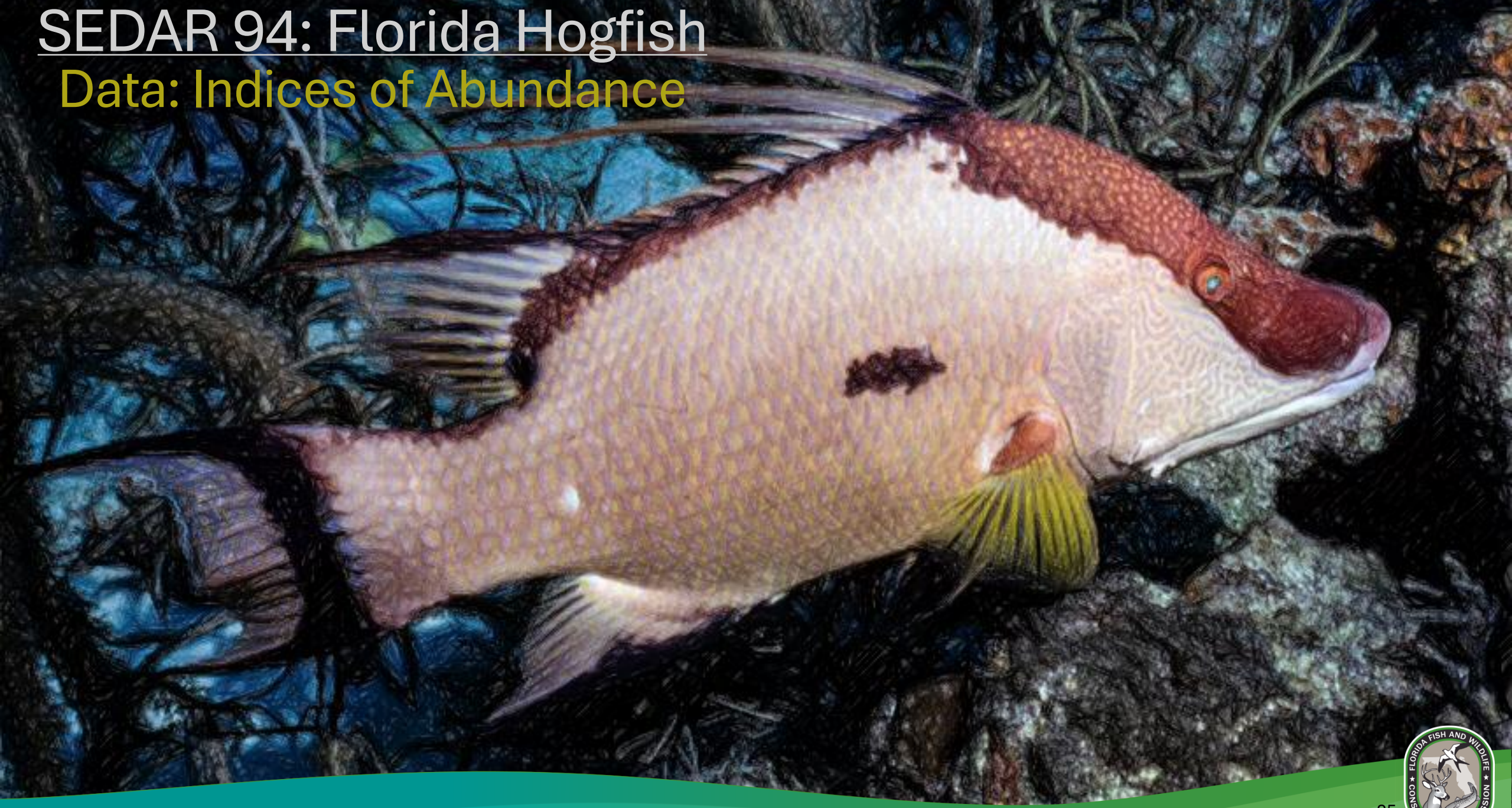


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SEDAR 94: Florida Hogfish

Data: Indices of Abundance



Reef Fish Visual Census (RVC)

SEDAR 94 DW-22: Standardized Reef Visual Census indices for Hogfish, Lachnolaimus maximus, for Southeast Florida (2013 – 2024), the Florida Keys (1997 – 2024), and Dry Tortugas (1999 – 2024)

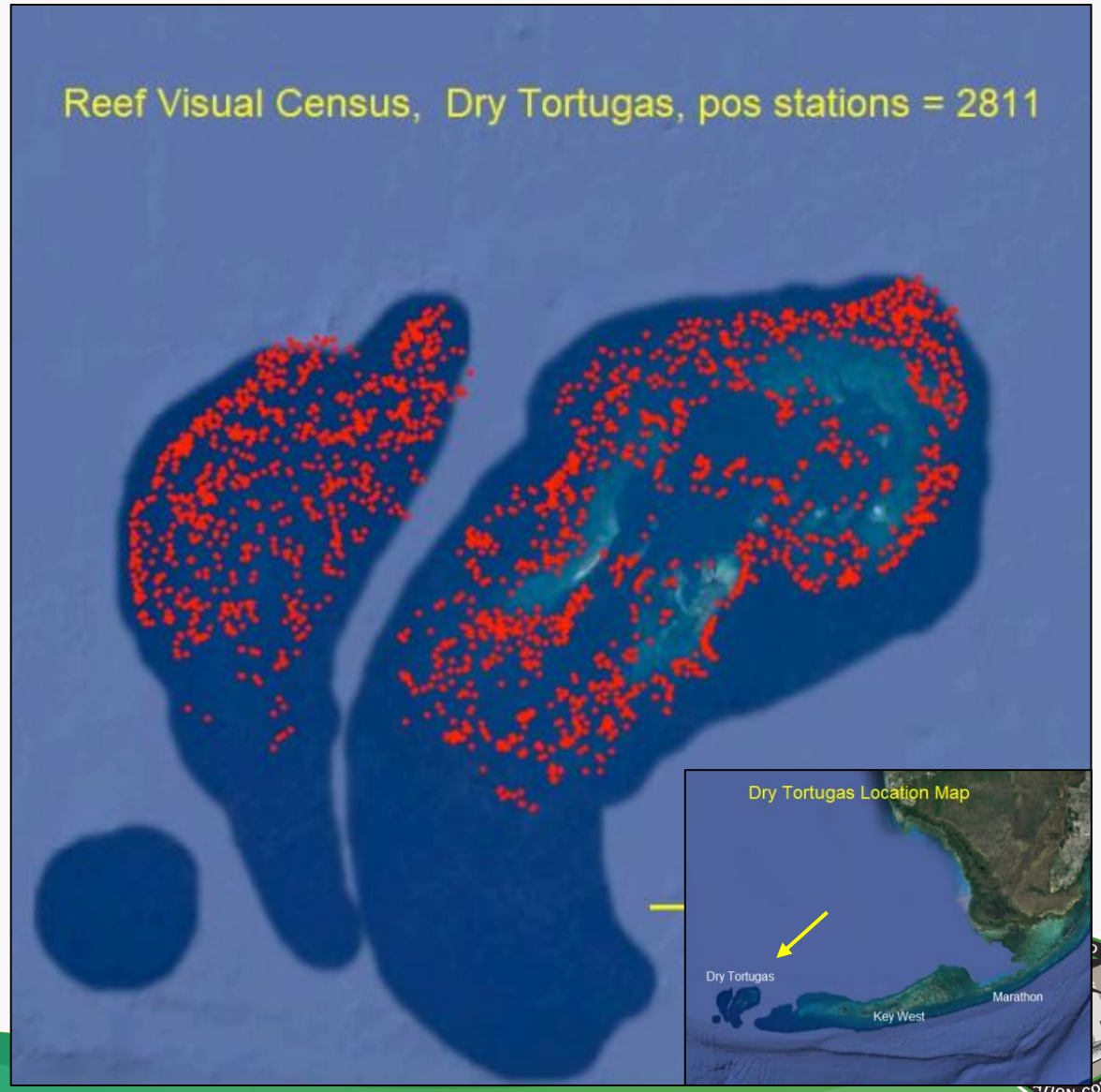
- Two-stage SRS design
  - One-stage design change in 2021
  - SSU (diver cylinder)
- Gear
  - Visual survey using paired divers.
- Spatial Coverage
  - Florida Keys and Dry Tortugas (Southeast Florida not recommended by AW panel)
  - Depths from <30m
- Years
  - Florida Keys: 1999 – 2012, biennially 2014 – 2018, 2022, 2024
  - Dry Tortugas: 1999, 2000, biennially 2004 – 2018, 2021, 2023, 2024
- Months
  - Florida Keys: June through Sept
  - Dry Tortugas: May through July

- Length composition data only
  - Florida Keys: YOY, sub-adult, adult
  - Dry Tortugas: sub-adult, adult

Reef Fish Visual Census (RVC)

Figure 1 from SEDAR 94 DW-22





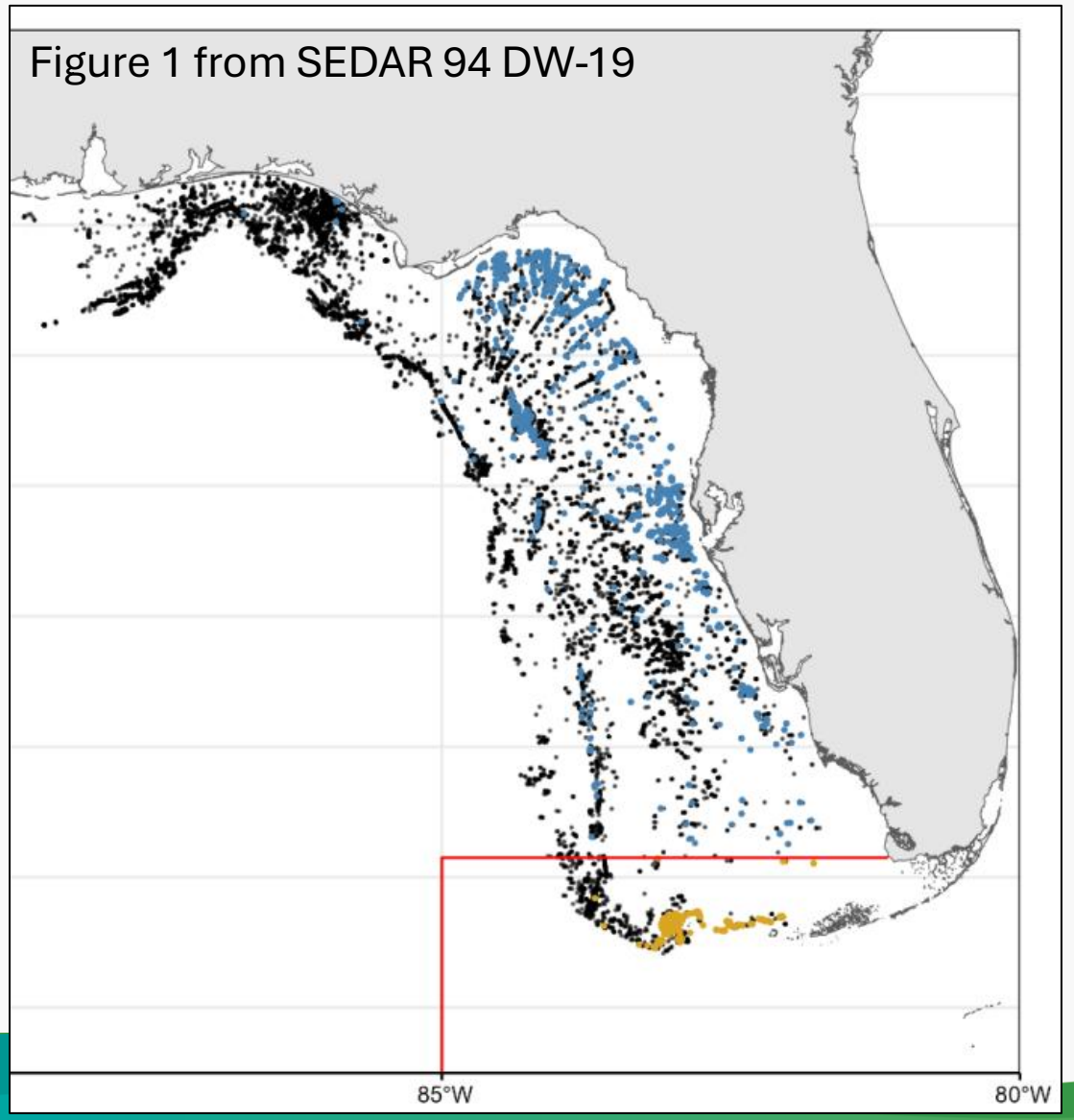
Combined Video Survey

SEDAR 94 DW-19: Indices of abundance for Gulf and Atlantic Hogfish (Lachnolaimus maximus) using data from multiple video surveys

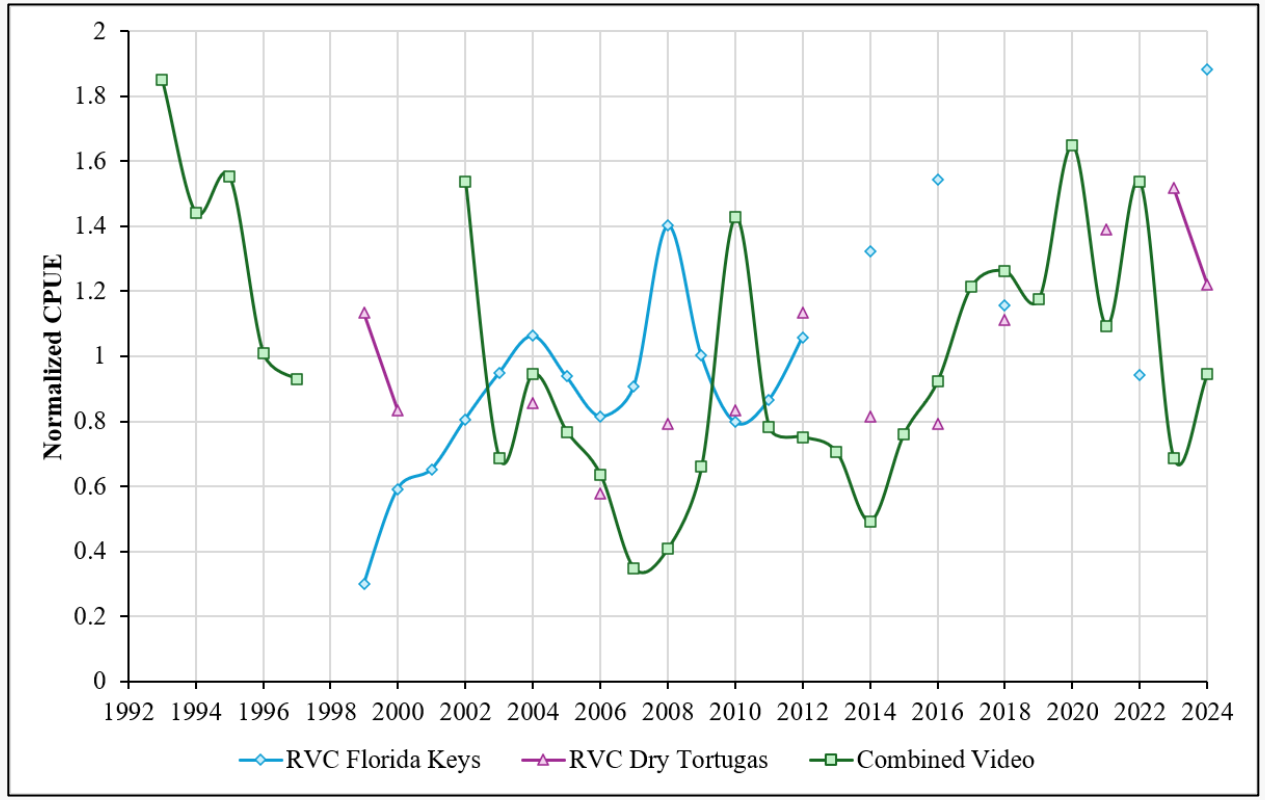
- Stationary video surveys with SRS design
  - NMFS SEAMAP reef fish video survey (SRFV)
  - NMFS Panama City Lab (starting year 2006)
  - Florida Fish and Wildlife Research Institute survey (FWRI, starting year 2008)
  - After 2020, unified survey design under G-FISHER
- Gear
  - Paired stereo-imaging cameras
    - Sites selected at random from known reef areas identified through habitat mapping (multi-beam and side-scan sonar) and were deployed.
- Spatial Coverage
  - North of Dry Tortugas and south of Cape Sable
  - Depths from 10 – 180m
- Years
  - SRFV: 1992-1997, 2002, 2004 – 2019
  - PC: 2006 – 2019
  - FWRI: 2008 – 2019
  - G-FISHER: 2020-2024
- Months
  - Daylight hours between April through September

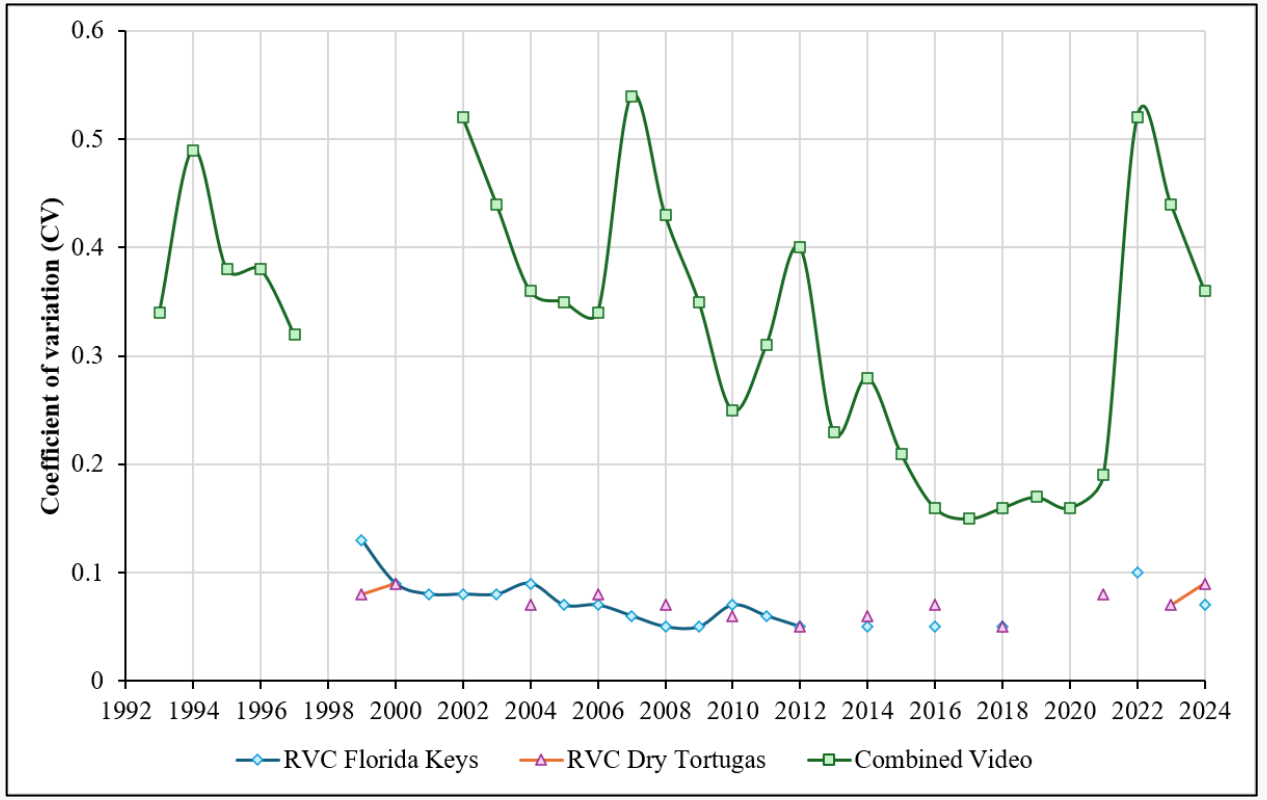
- Length composition data only (subadult, adult)

Combined Video Survey



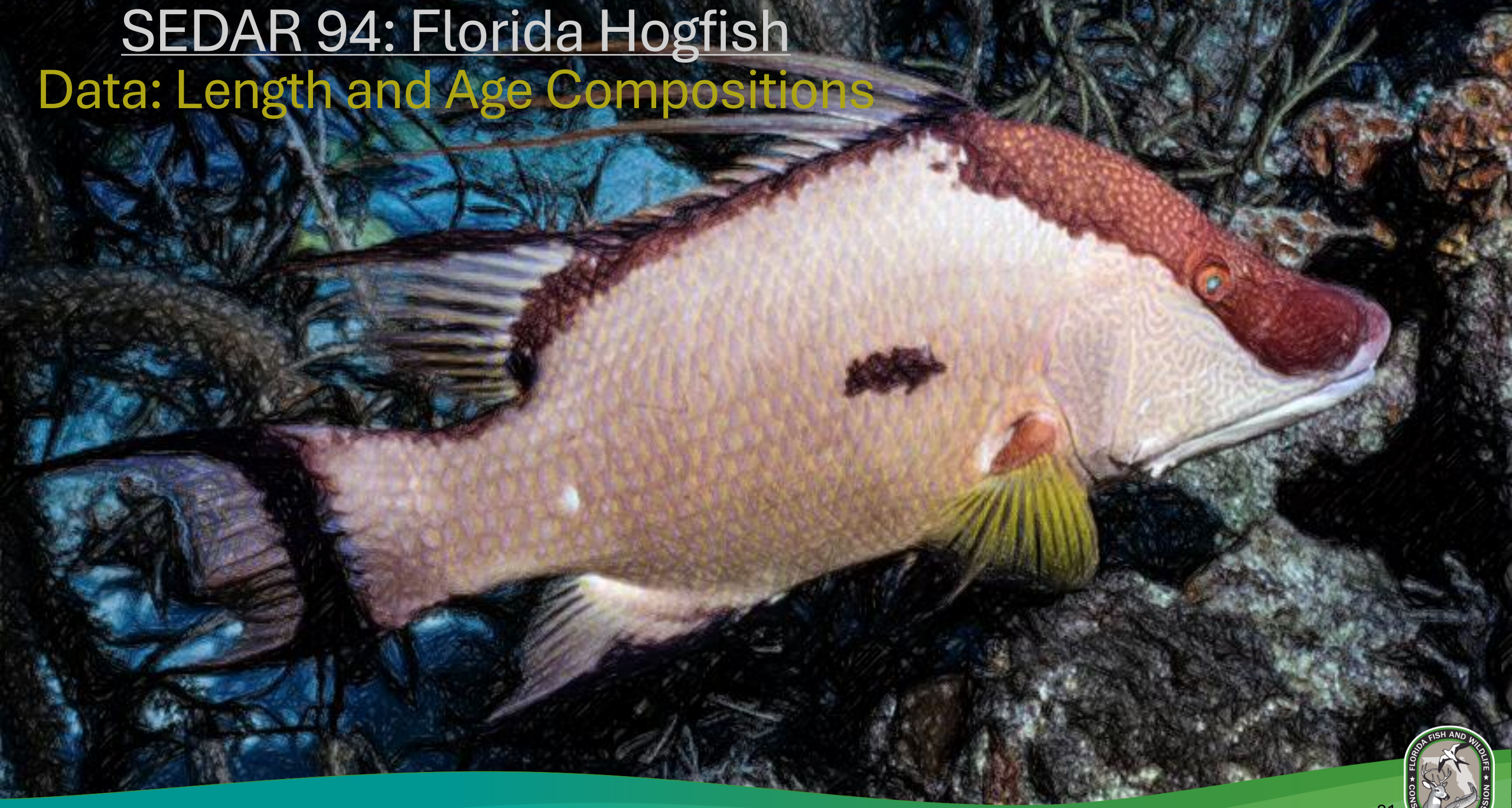
Indices of Abundance





SEDAR 94: Florida Hogfish

Data: Length and Age Compositions



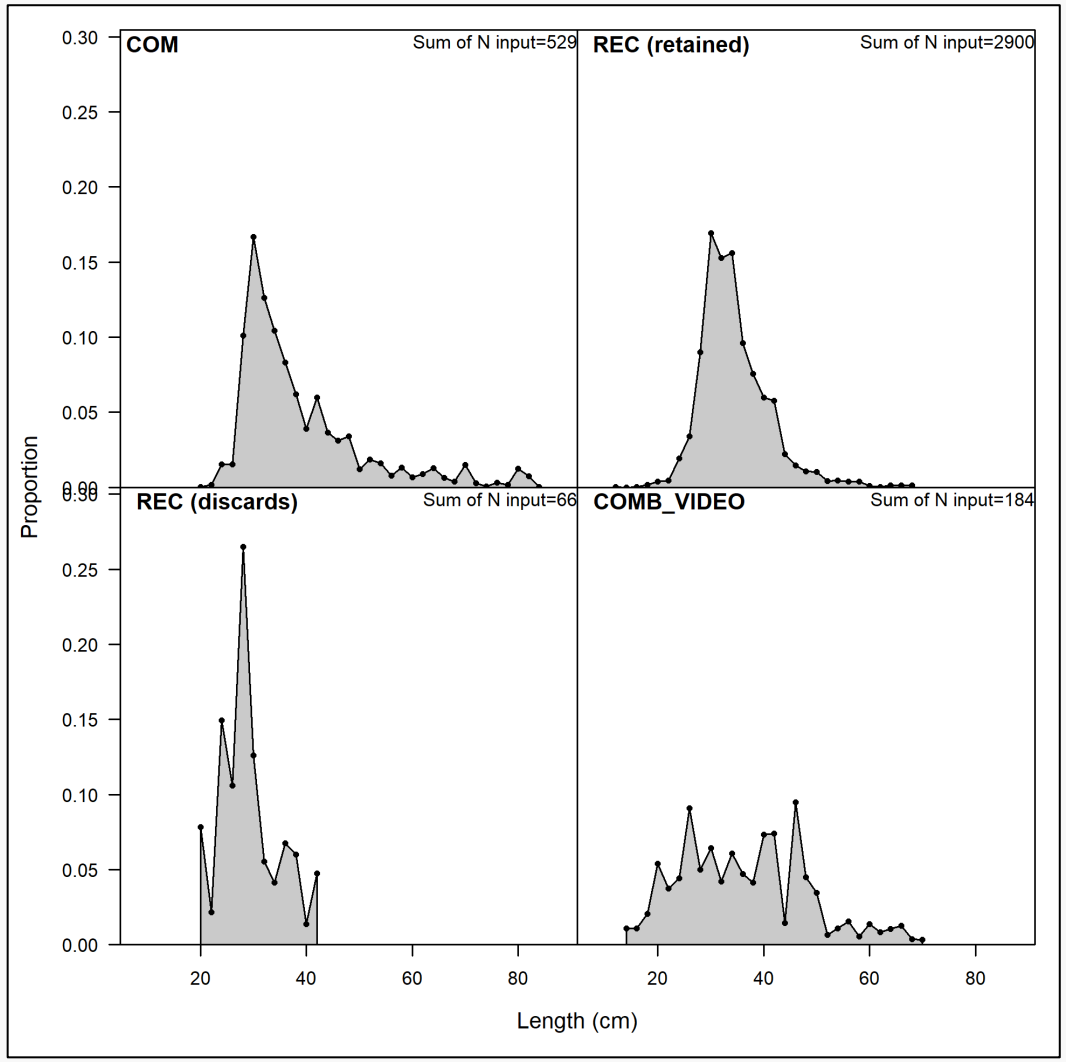
Fishery Length Compositions

Fleet	Partition	Years	Number of Positive Annual Trips	Super-periods (pos. trips)
Commercial	Landings	1989 – 2023	avg. = 15 (q1 = 6, median = 11, q3 = 19)	1989 – 1994 (48), 1995 – 2017 (457), 2018 – 2024 (24)
Recreational	Landings	1981 – 2024	avg. = 66 (q1 = 34, median = 62, q3 = 89)	1981 – 1985 (230), 1986 – 1994 (555), 1995 – 2004 (749), 2005 – 2017 (1,247), 2018 – 2024 (119)
Recreational	Live Releases	2005 – 2007, 2011 – 2024	avg. = 4 (q1 = 2, median = 3, q3 = 6)	2005 – 2017 (23), 2018 – 2024 (43)

Index Length Compositions

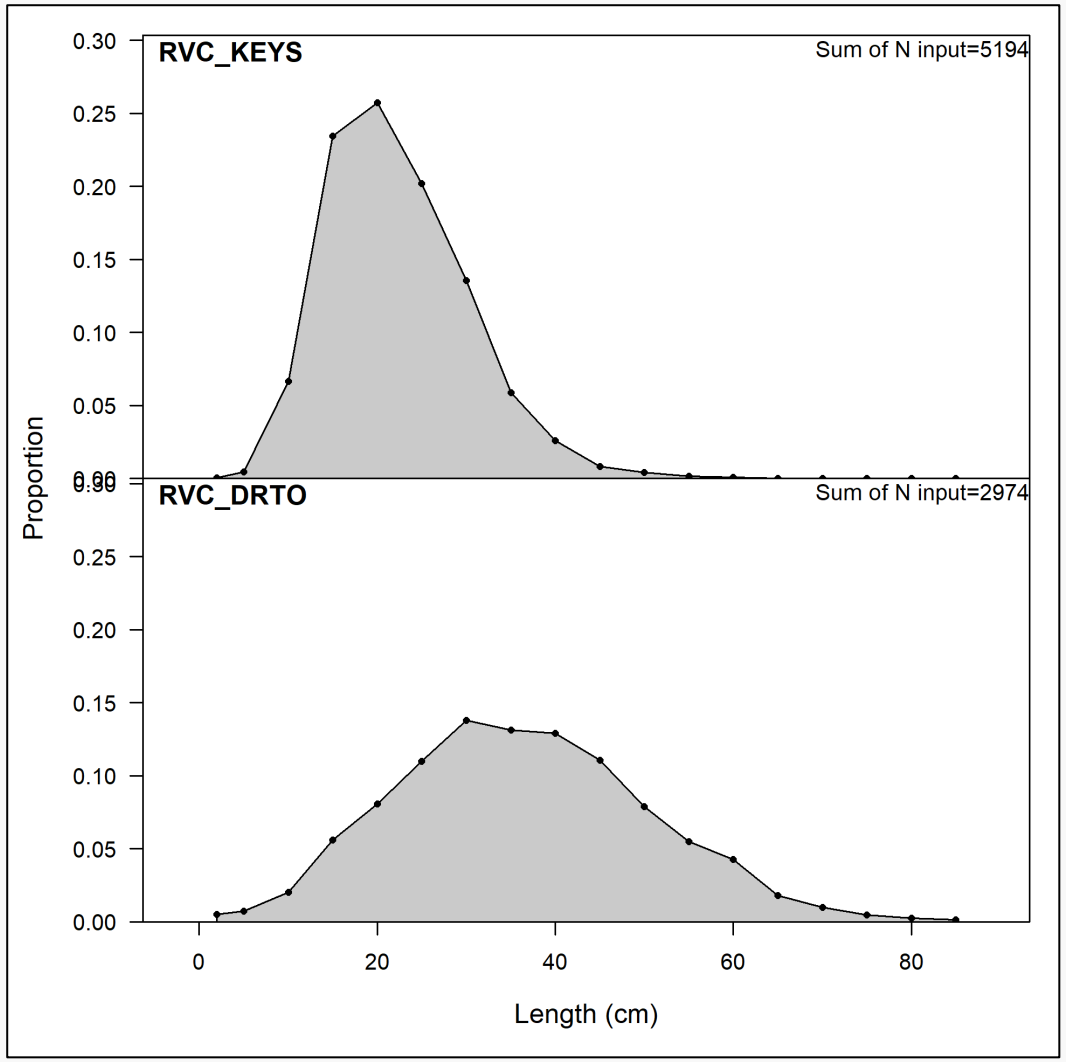
Fleet	Partition	Years	Number of Positive Annual Sets	Super-periods (pos. trips)
Combined Video	Index	2002, 2004, 2008, 2009, 2011 – 2024	avg. = 12 (q1 = 3, median = 11, q3 = 17)	2002 – 2024 (184)
RVC Florida Keys	Index	~1999 – 2024	Avg. = 273 (q1 = 158, median = 244, q3 = 407)	--
RVC Dry Tortugas	Index	~1999 – 2024	Avg. = 229 (q1 = 155, median = 216, q3 = 304)	--

Length Compositions

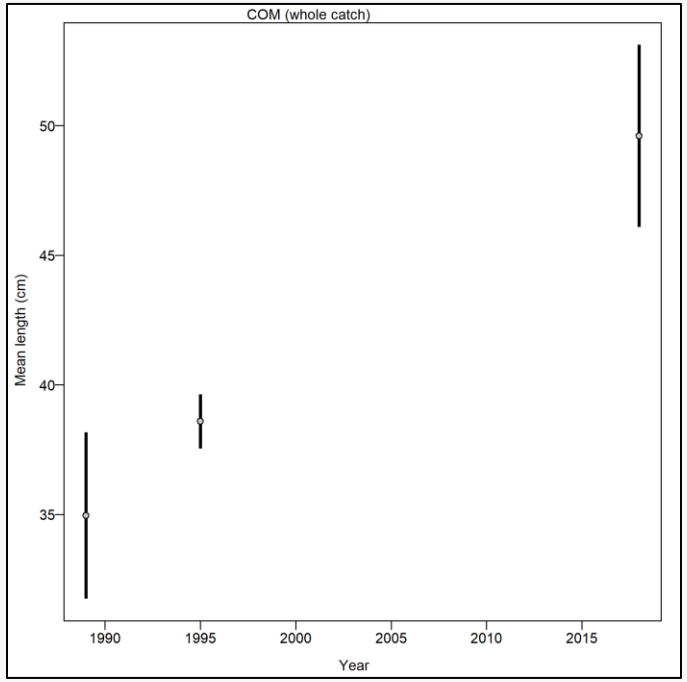


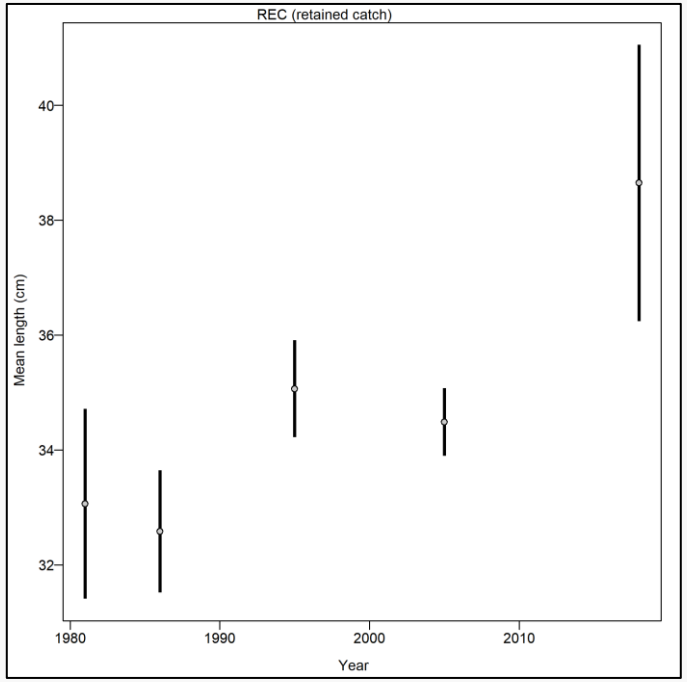
- Fork length (2 cm bins)
  - 2 – 86 cm
  - Largely unimodal distributions with noise
- Fishery length comps weighted by catch or live releases
  - Distributions more dome-shaped with larger individuals captured by the commercial fishery
    - Spatial differences (FL Keys vs. NE FL)
  - Retained lengths generally followed changes to minimum size limits
    - Supplemented with Biscayne Bay Creel Survey
  - Discards were largely below minimum size limits
- Combined video lengths more uniform in distribution

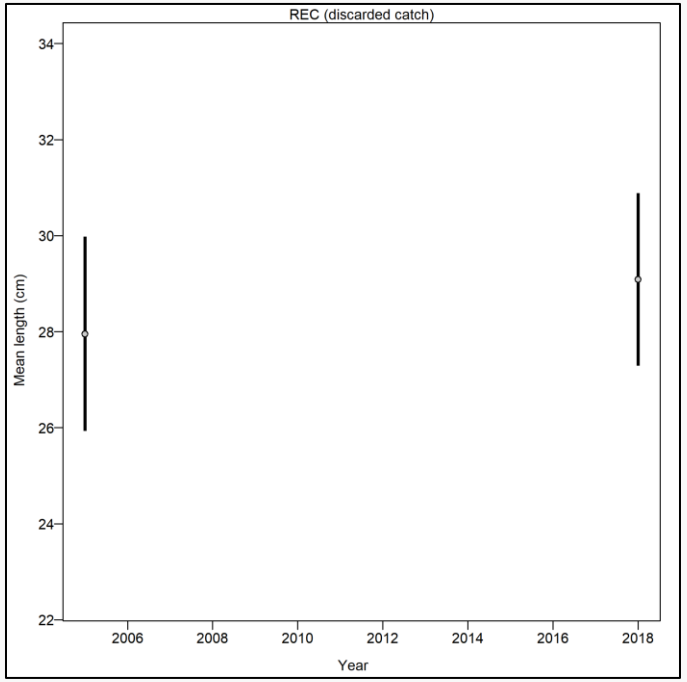
Length Compositions

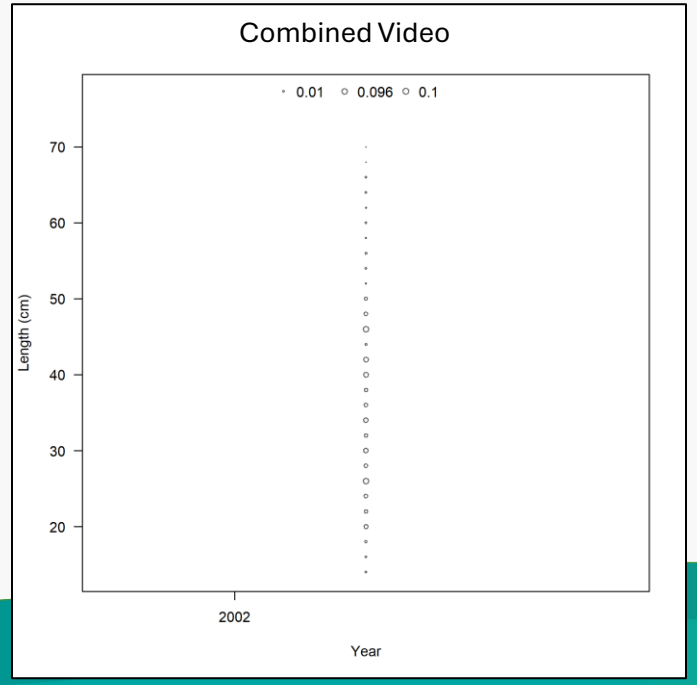


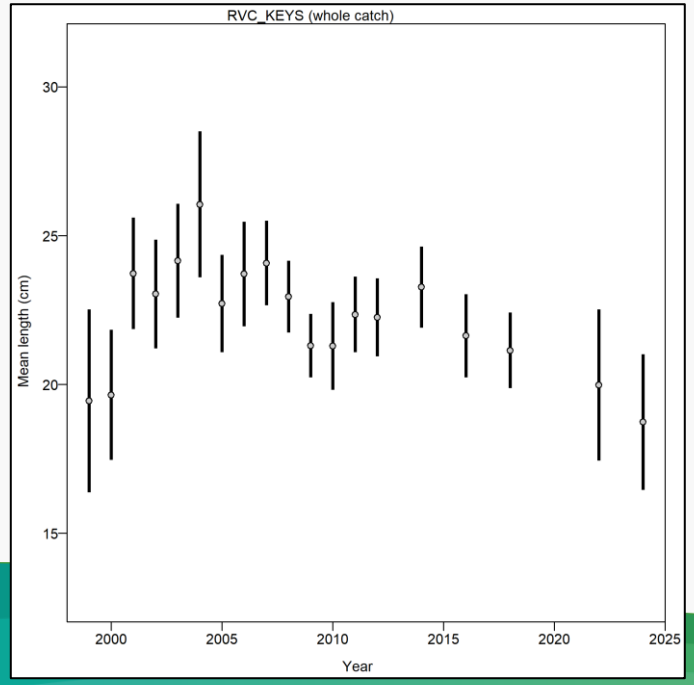
- Fork length (5 cm bins)
  - 5 – 85 cm
  - Noisier at 2 cm bins with signs of digit bias
  - Unimodal distributions
- RVC lengths weighted by indices
  - Distributions dome-shaped, limited by survey sampling depths
    - Reflect differences in survey area and fishing intensities
  - Input to model as general size composition data

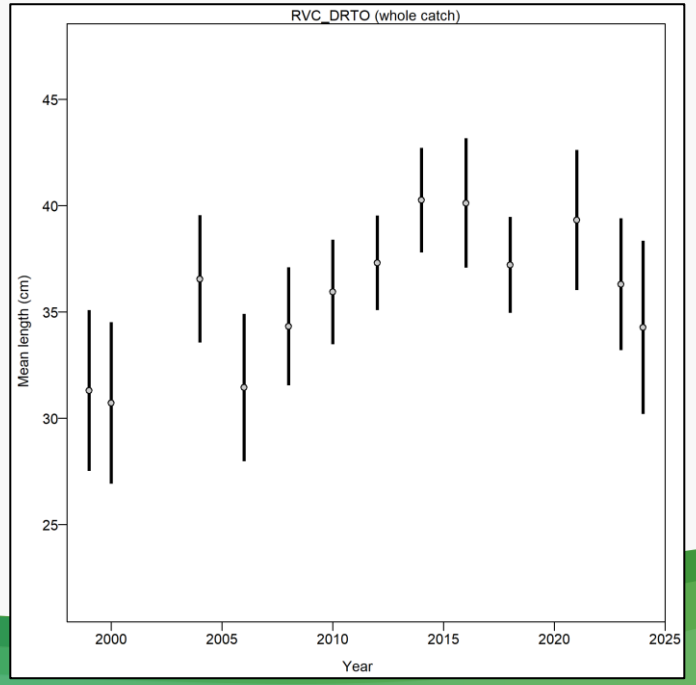

COM (whole catch)
Mean length (cm)
Year


REC (retained catch)
Mean length (cm)
Year


REC (discarded catch)
Mean length (cm)
Year


Combined Video
0.01
0.096
0.1
Length (cm)
2002
Year


RVC_KEYS (whole catch)
Mean length (cm)
Year


RVC_DRTO (whole catch)
Mean length (cm)
Year

Conditional Age-at-Length

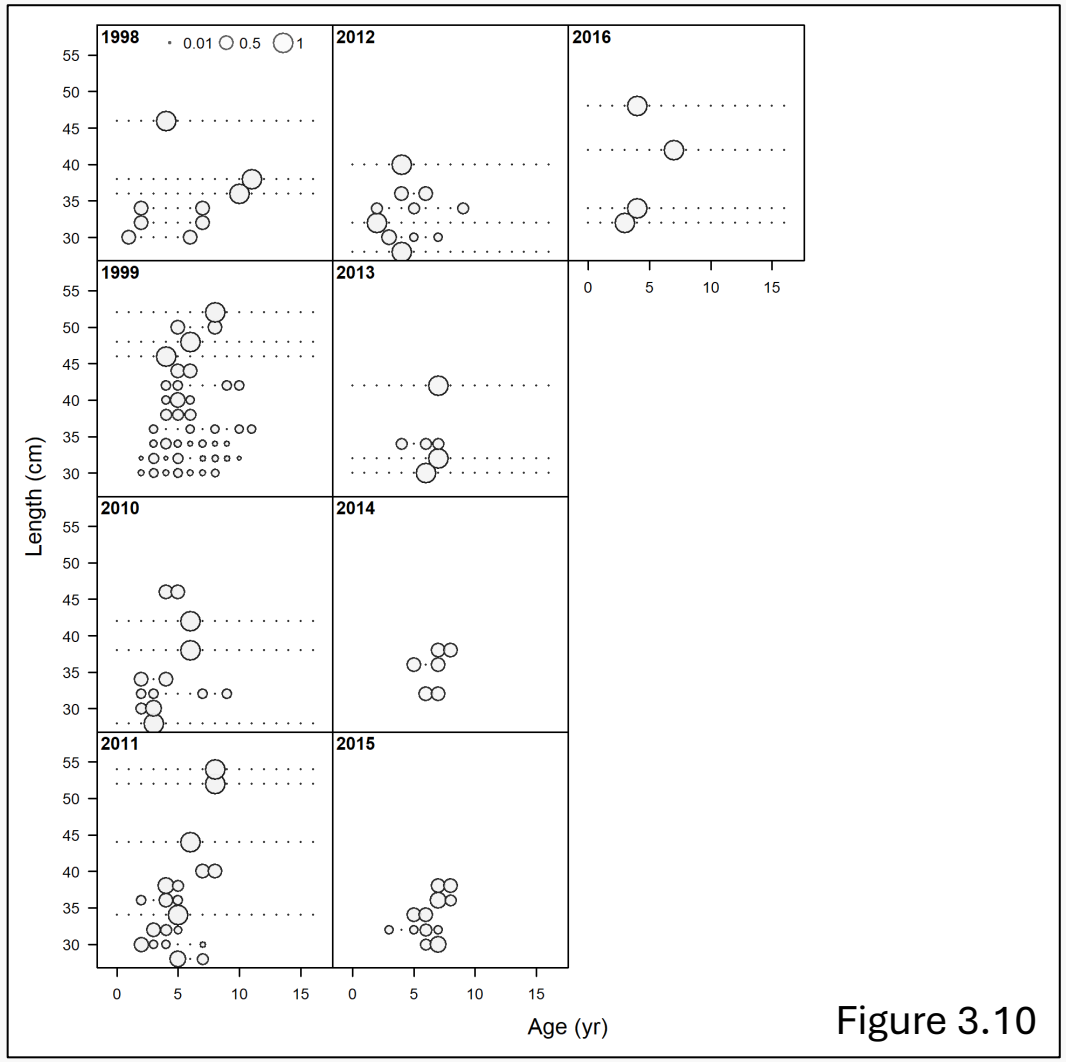


Figure 3.10

- Commercial
  - Largely from TIP/FWRI
    - McBride samples (1998 – 1999)
  - 2 cm FL bins
  - Increased sample sizes and larger/older fish earlier in timeseries

- More data limited
  - 8 years of sampling
    - Large gaps between years
    - No sampling during most recent regulatory time block (2017+)

Conditional Age-at-Length

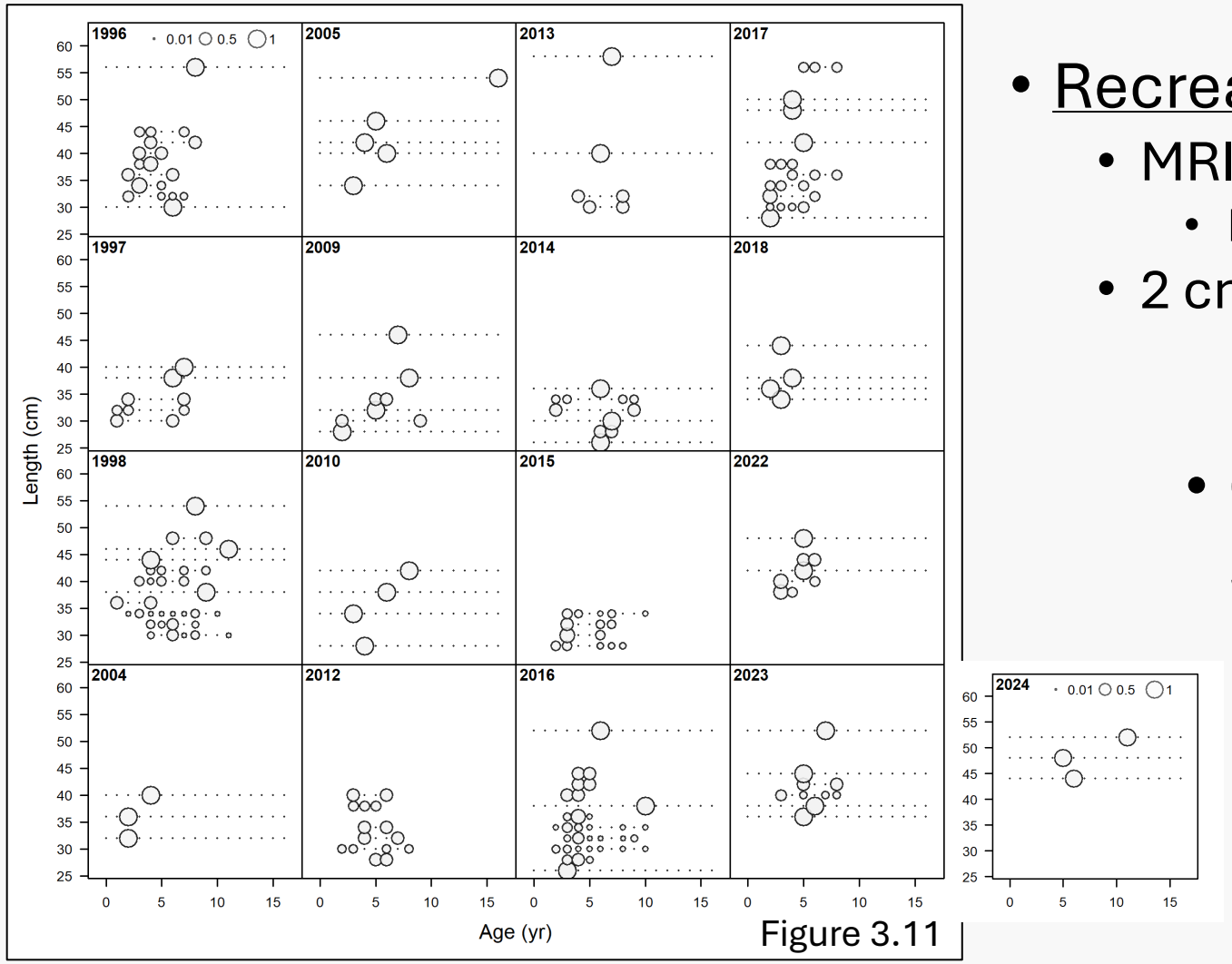


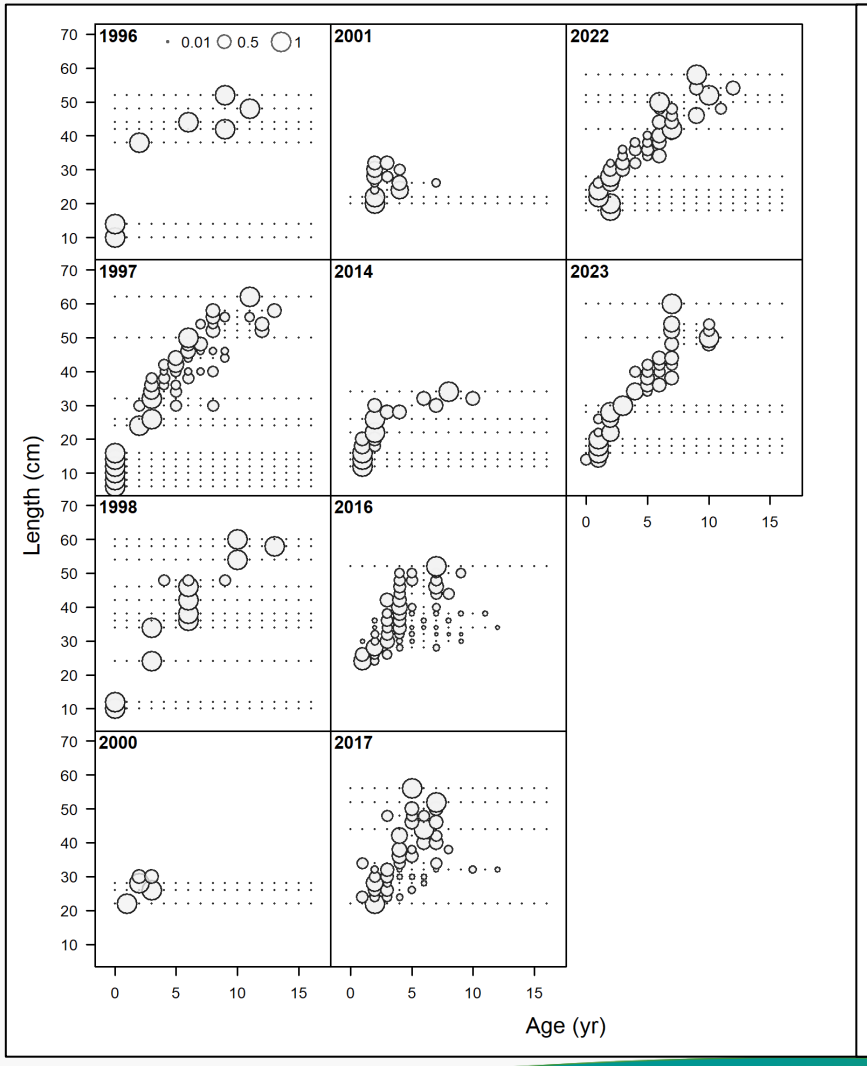
Figure 3.11

- Recreational
  - MRIP/FWRI
    - McBride (1996 – 1998), Towne (2016 – 2017)
  - 2 cm FL bins

- Comparatively greater annual sampling frequency…
  - Still irregular during years without targeted research studies
    - e.g., 2004 – 2015
  - Some latter years without samples
    - E.g., 2019 – 2021

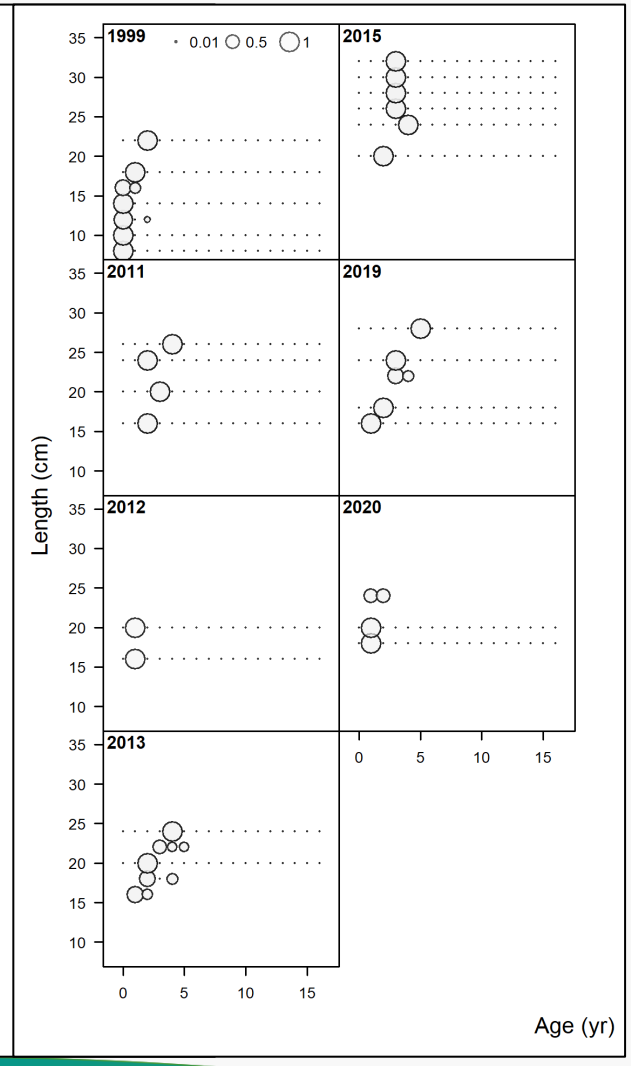
Conditional Age-at-Length

Figure 3.12



SPEAR

Figure 3.13



TRAWL

- Fishery-independent research
  - McBride (1996 – 2001)
    - Keys Reef Tract, Dry Tortugas
  - SEAMAP (2011 – 2020)
  - Towne (2014, 2016 – 2017)
    - Southeast FL
  - Faletti (2017)
    - Near the Dry Tortugas
  - Morley (2022 – 2023)
    - Dry Tortugas
- Data parsed by gear
  - Spear and trawl
  - 2 cm FL bins
- Purpose to better inform internal estimation of growth
  - Not linked to any fleet

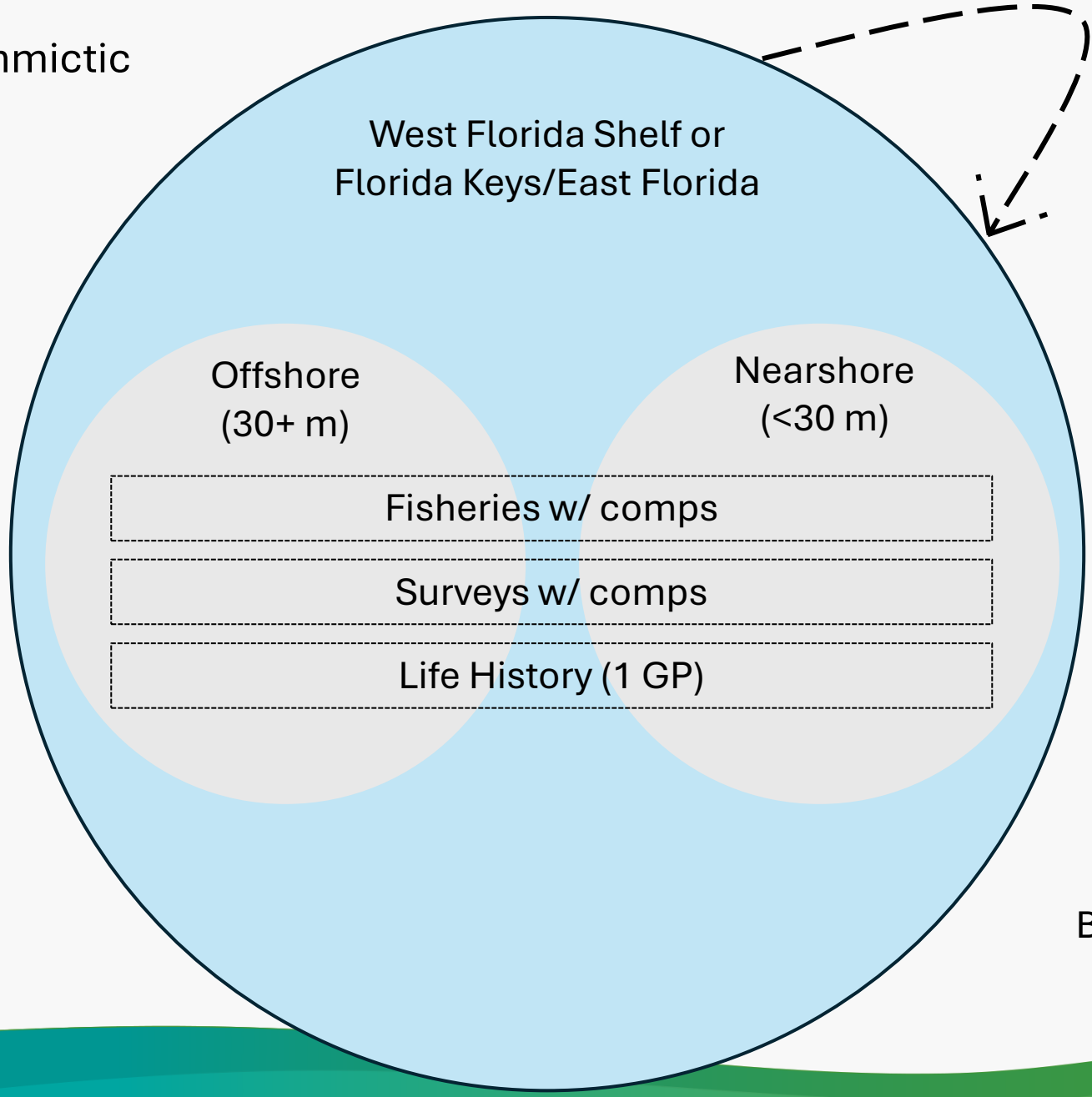


SEDAR 94: Florida Hogfish

KEYS Base Model Configuration

Population Structure:

Spatially aggregated panmictic



Based on Goethel et al. (2023)

KEYS Base Model Configuration

Assessment Model

- **Stock Synthesis v.3.30.24**
  - SCA in the integrated analysis class
- Moderate complexity

Spatio-temporal

- Years: 1950 – 2024
- 1 season (annual), 1 area (stock)
- Spawning: January 1
  - Core season: Dec – Apr
- Settlement: one event on Feb 1 at age-0
  - Pelagic larval period ca. 34 days
- Time-blocks: follow min size/bag limits
  - 1950-1994, 1995-2017, 2018-2024
    - 2018-2024 (bag limit reduction)

Life History

- VB growth estimated internally
  - Initial values from Data Workshop
    - L_{inf}: 53.1 cm FL; k = 0.223
  - Platoons: 5
    - Distribution: 0.031 0.237 0.464 0.237 0.031
- Ages: 0 – 16
- Mortality-at-weight using Lorenzen (1996)
  - M(a) = 0.621 – 0.172
- Length-weight: fixed params
- Female maturity: fixed age-logistic
- Fecundity: spawning biomass at length
- Two-sex model:
  - Female to male hermaphroditism based on stock-specific functions
  - Management quantities based on combined SSB

KEYS Base Model Configuration

Fishing Fleets

- Commercial
  - Combined gear: SP, HL, TR
  - Landings (mt)
    - Fit exactly
  - No discards
- Recreational (all modes)
  - Combined gear: SP and HL
  - Landings and discards (000s)
    - Flexibility in fit following observation error

Surveys

- RVC Florida Keys
  - Number of fish/diver ‘cylinder’
- RVC Dry Tortugas
  - Number of fish/diver ‘cylinder’
- Combined Video Survey
  - Weighted mean of Max N (numbers)

KEYS Base Model Configuration

- Length Composition Data (2 cm bins)
  - Commercial
    - Landings
      - super-periods applied following time blocks
  - Recreational
    - Landings and discards
      - super-periods applied following time blocks
  - Combined Video
    - Single super-period applied
- General Size Composition Data (5 cm bins)
  - RVC Florida Keys, RVC Dry Tortugas
    - Annual size compositions
- Conditional Age at Length (CAAL)
  - Commercial landings
  - Recreational landings
  - Fishery-independent spear
    - Life history research
  - Fishery-independent trawl
    - Life history research

KEYS Base Model Configuration

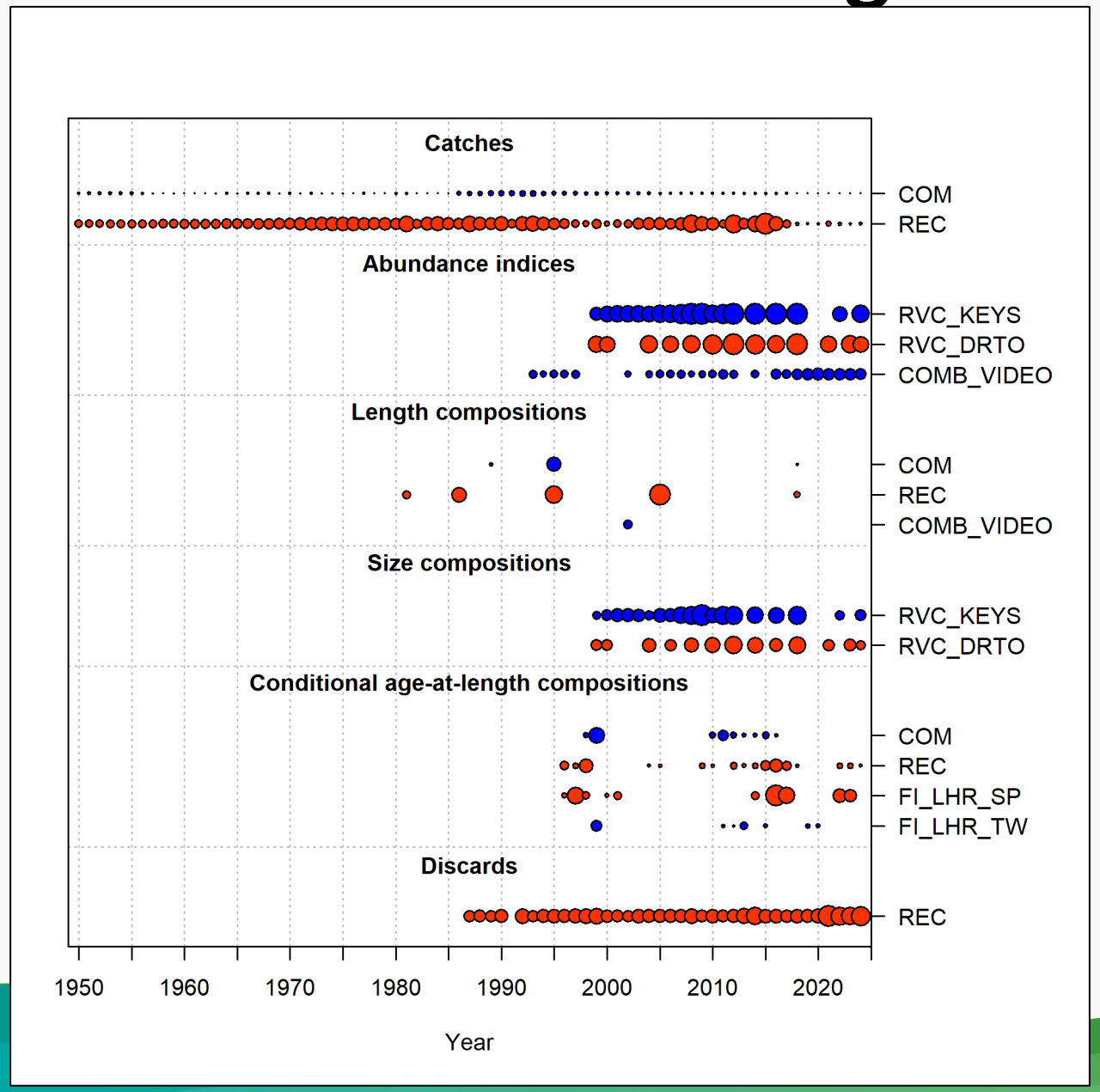


Figure 3.1

KEYS Base Model Configuration

Fleet Selectivity (length-based)

- Commercial
  - Double normal (domed w/ flexibility)
  - No discards available
    - Selectivity functions as retention
- Recreational
  - Double normal (domed w/ flexibility)
  - Estimated retention (flat-topped)
    - Time-varying: 1950-1994, 1995-2017, 2018-2024
  - Discard mortality = 41.4%

Index Selectivity (length-based)

- RVC Florida Keys
  - Double normal (domed w/ flexibility)
- RVC Dry Tortugas
  - Double normal (domed w/ flexibility)
- Combined Video Survey
  - Single logistic (flat-topped)

KEYS Base Model Configuration

Recruitment Dynamics

- Beverton-Holt stock-recruitment model
  - Virgin recruitment in log-space (*ln(R0)*), *steepness*, and standard deviation of log of recruitment (*sigmaR*) estimated within model
- Simple recruitment deviations
  - Sum-to-zero constraint
- Main recruitment deviations
  - **1981** – **2021** (period of higher data-richness)
    - 2022 – 2024 follow BH curve
      - Model process added to address elevated recruitment in terminal years causing retrospective
  - No early recruitment deviations
    - recruitment 1950 – 1985 follows BH curve
- Bias adjustments (following Methot and Taylor 2011)

KEYS Base Model Configuration

Parameters

- 165 out of 272 parameters estimated
  - *Life history: 24*
  - *S-R: 5*
  - *Annual recruitment deviations: 41*
  - *Annual fleet-specific Fs: 150*
  - *Catchability: 3*
  - *Selectivity: 44*
  - *Dirichlet-Multinomial: 5*

Reported Fishing Mortality Rates

- Exploitation rate
  - Dead biomass/total age_1+ biomass
    - Accounts for females and males
    - Consistent with tracking M/F SSB
  - Utilized in SEDAR 37 and cited for multiple fleet selectivities

KEYS Base Model Configuration

Model Convergence Criteria

- Total likelihood (sum of individual data source component's likelihoods)
- Invertible Hessian matrix
- Maximum gradient <0.0001

Error Structure

- Assumed log-normal for all landings, discards, and index data

Multinomial Distribution

- Length/size composition data of landings, discards, and indices
- Conditional age-at-length data of landings and fishery-independent sources

- ## Weighting
  - Length and size composition data
    - Number of positive trips which measured a fish as input sample size
  - Dirichlet-multinomial
    - N(0, 1.813) prior applied
  - *ln(theta)* values < 5
  - Theta ratios (θ/1+θ) < 1

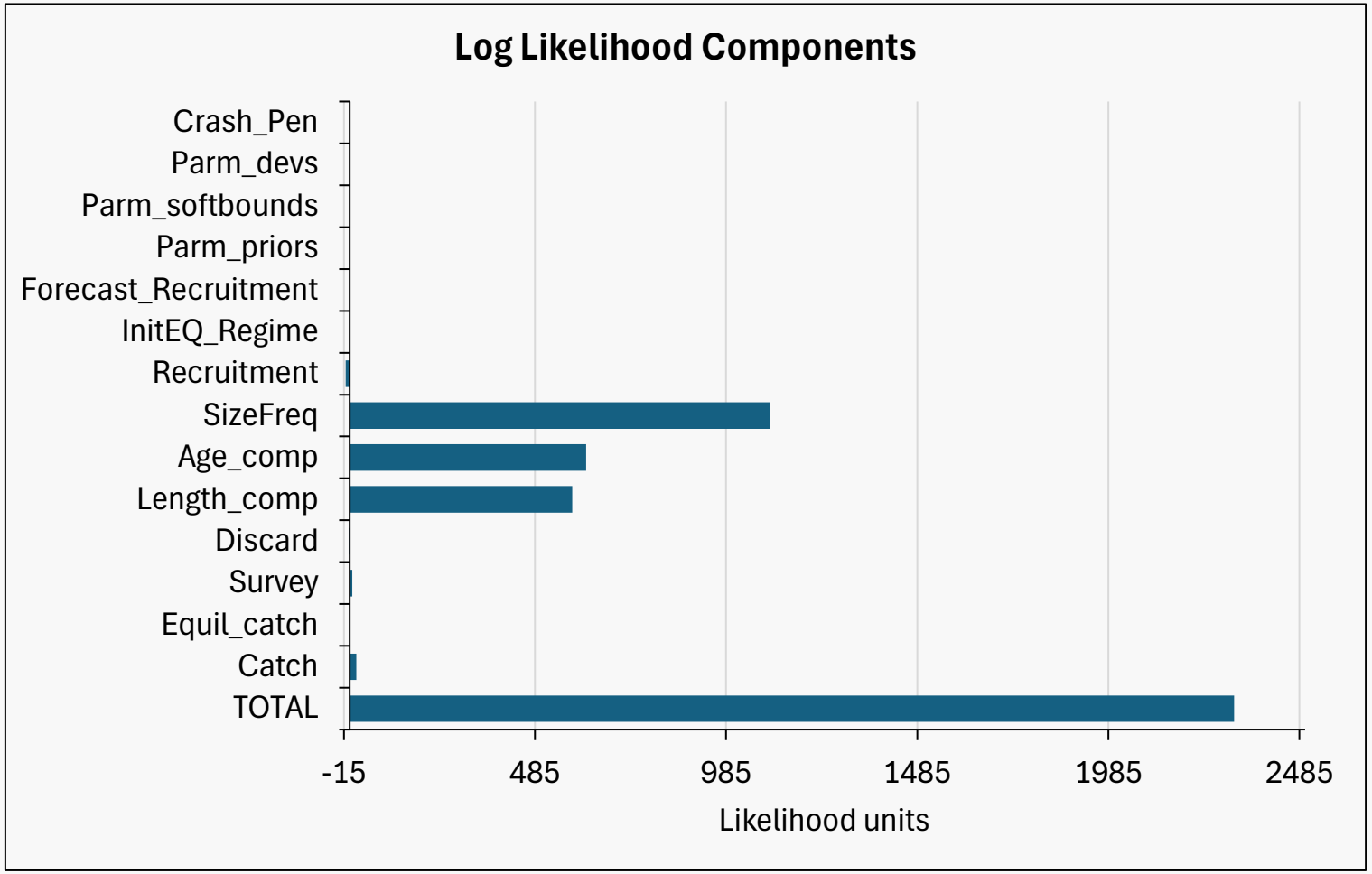
SEDAR 94: Florida Hogfish

KEYS Base Model Results



Model Likelihood components

Total Log Likelihood = 2314.27



Internal Estimation of Growth

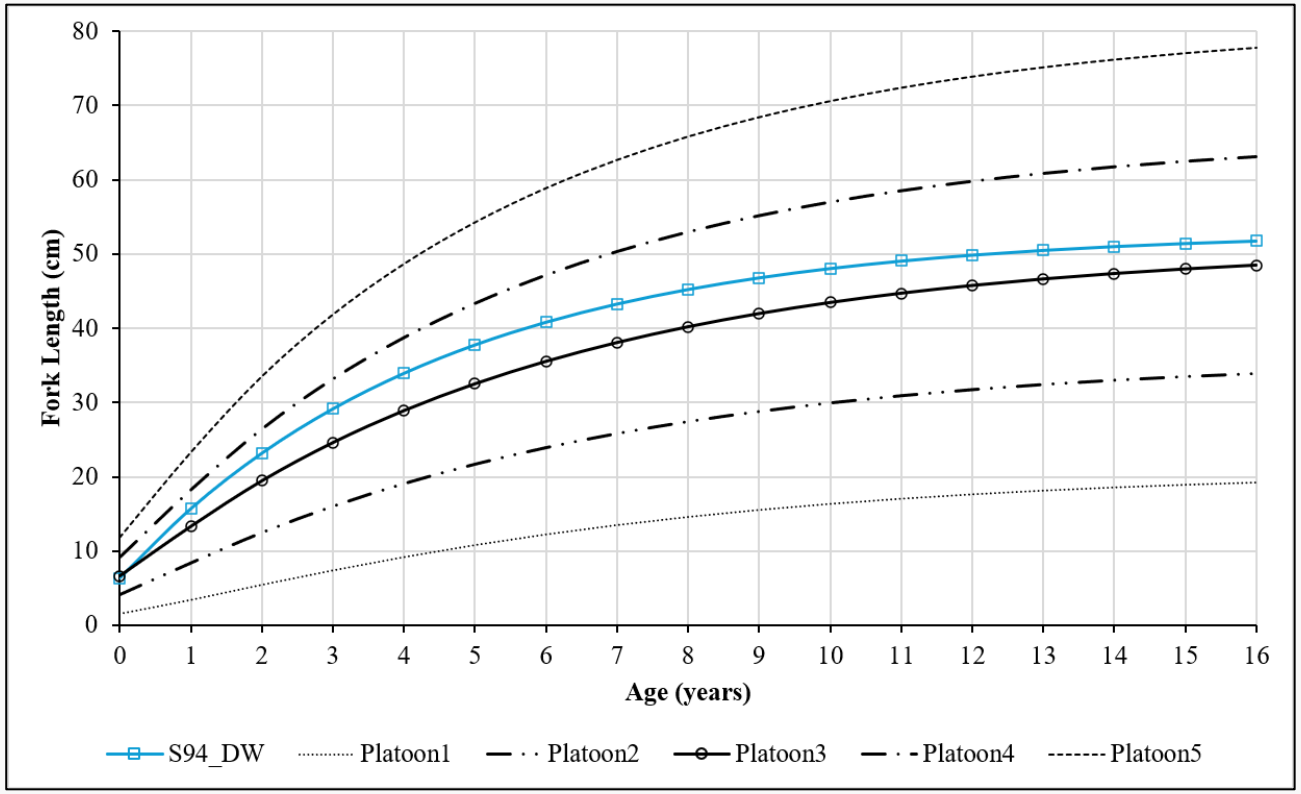


Figure 3.14

- Von Bertalanffy
  - L_{inf} = 51.2 cm FL
  - k = 0.177
  - Platoon 3 follows growth parameters
- Platoons
  - Number of age-0 recruits partitioned annually according to a normal distribution
    - 0.031, 0.237, 0.464, 0.237, 0.031
  - *Platoon_sd_ratio* = 0.73
    - Values > 2 indicate no meaningful shift in mean size-at-age
    - Values < 0.5 considered unrealistic

Landings

Figure 3.15

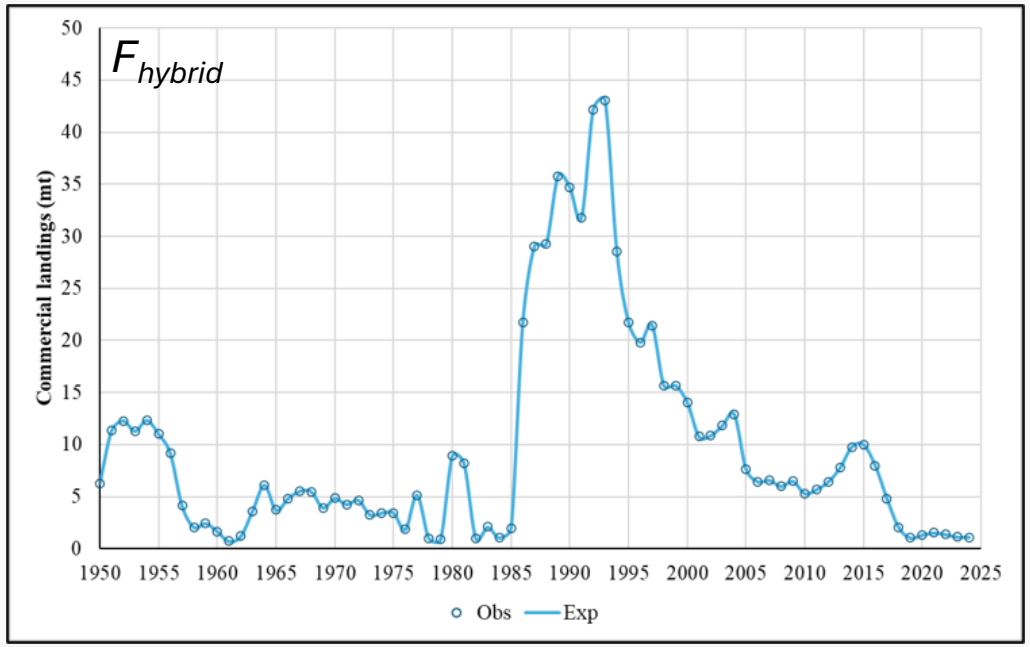
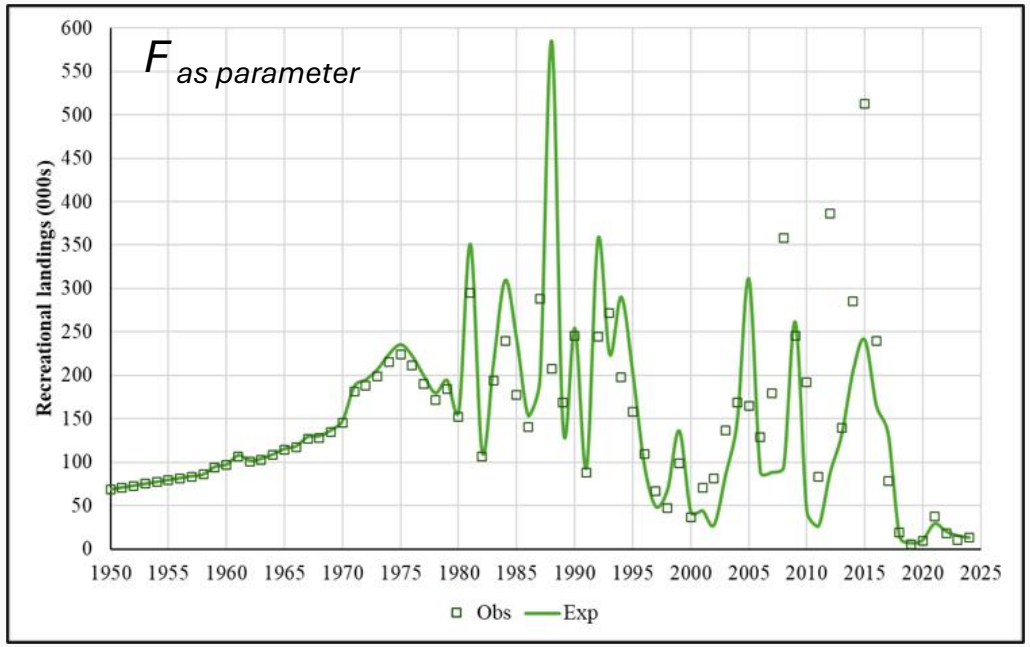


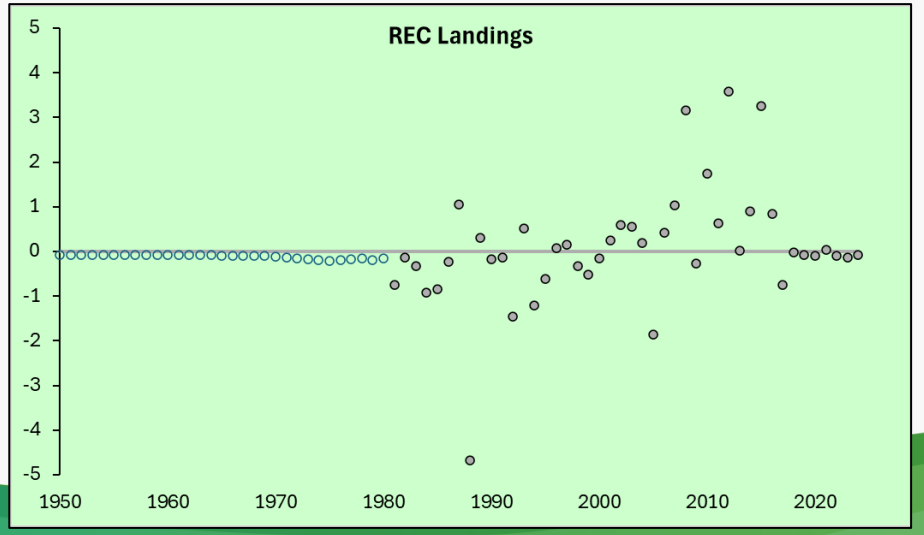
Figure 3.16



Since the p-value (for the exact test) is greater than .05, we conclude that the pattern is random, and so there is no autocorrelation

RUNS TEST: 1981 - 2024

n1	22
n2	22
n	44
mean	23
var	10.74419
stdev	3.277833
runs	20
tails	2
zstat	0.915239
pvalue	0.360066



Landings

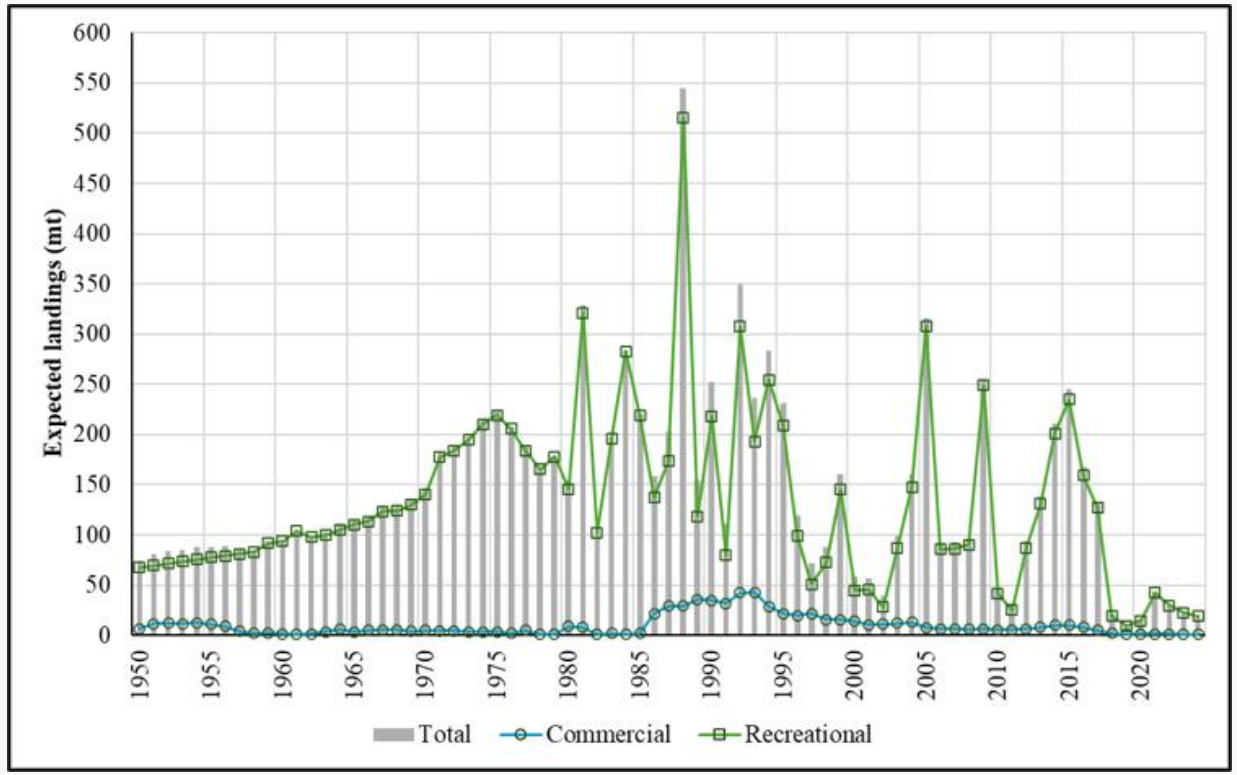


Figure 3.17

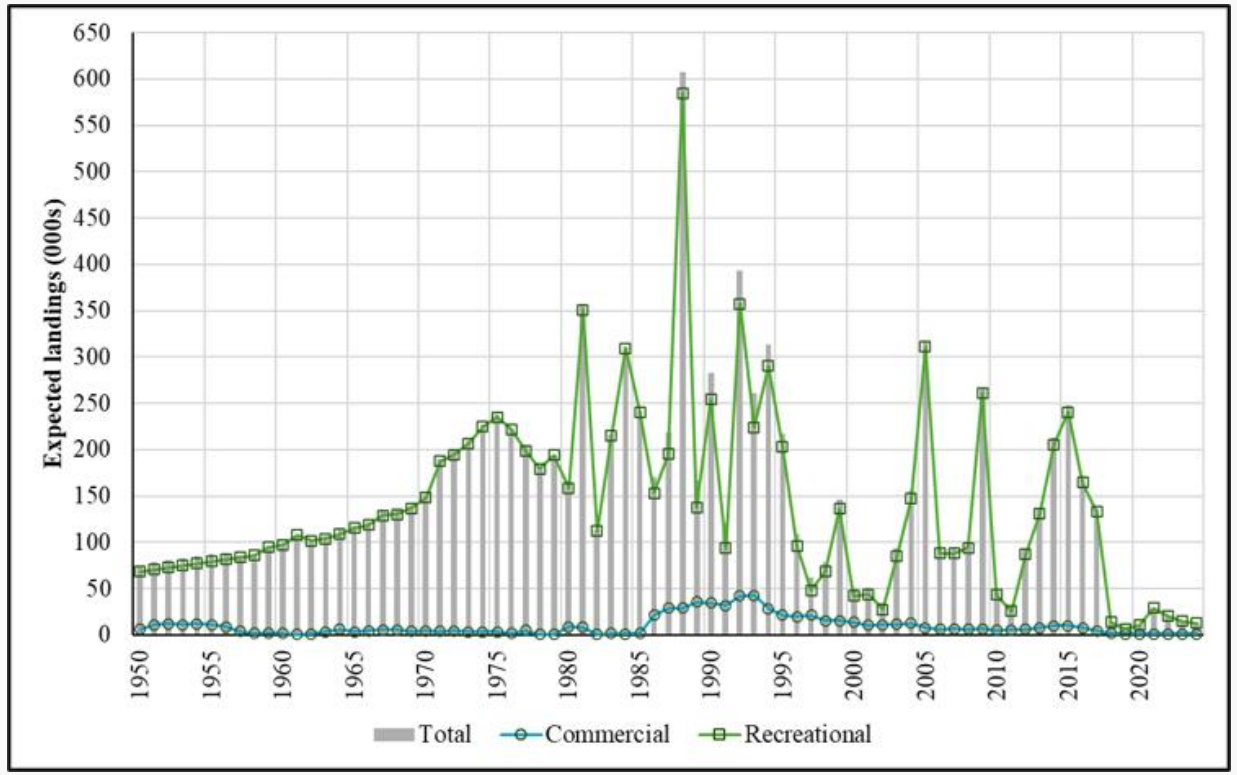
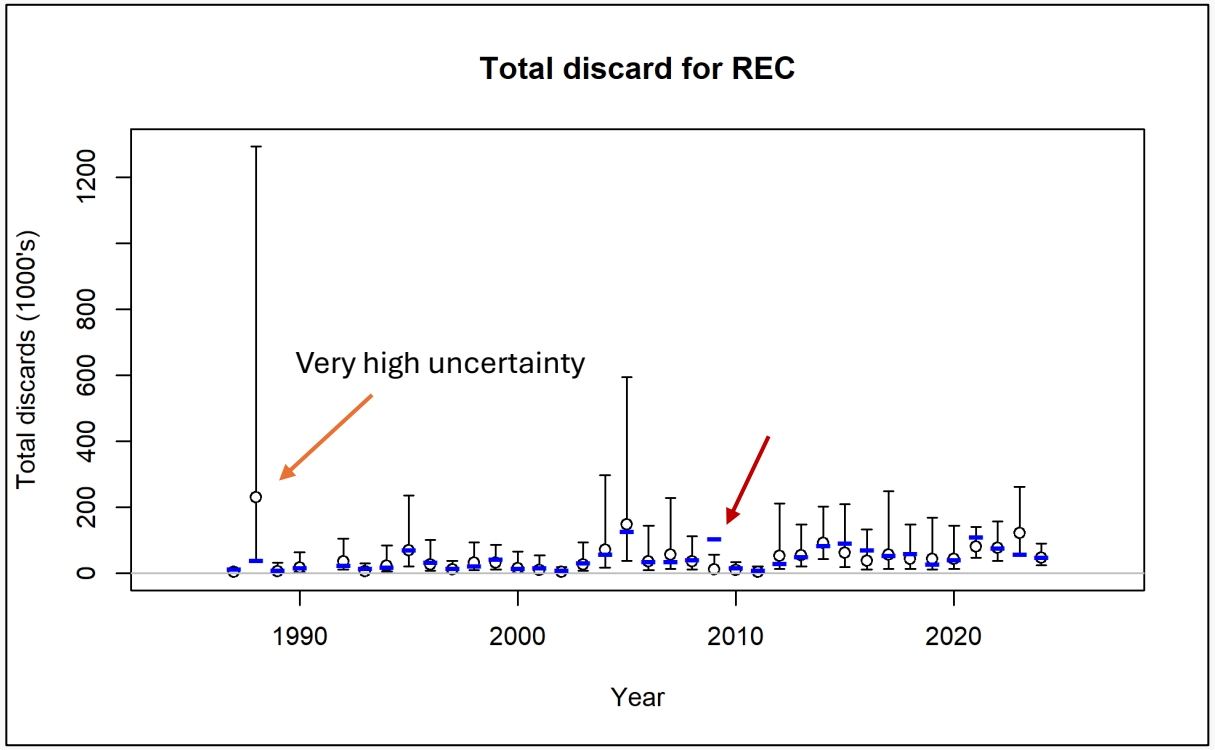


Figure 3.18

Discards



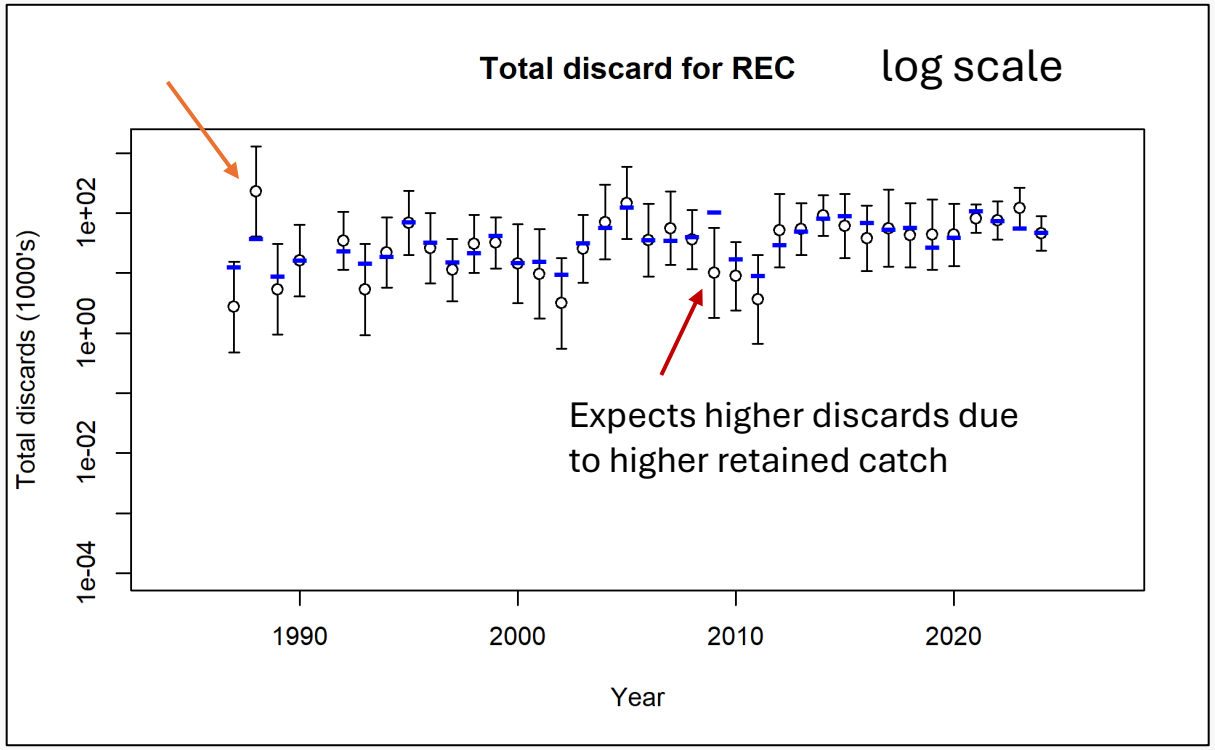
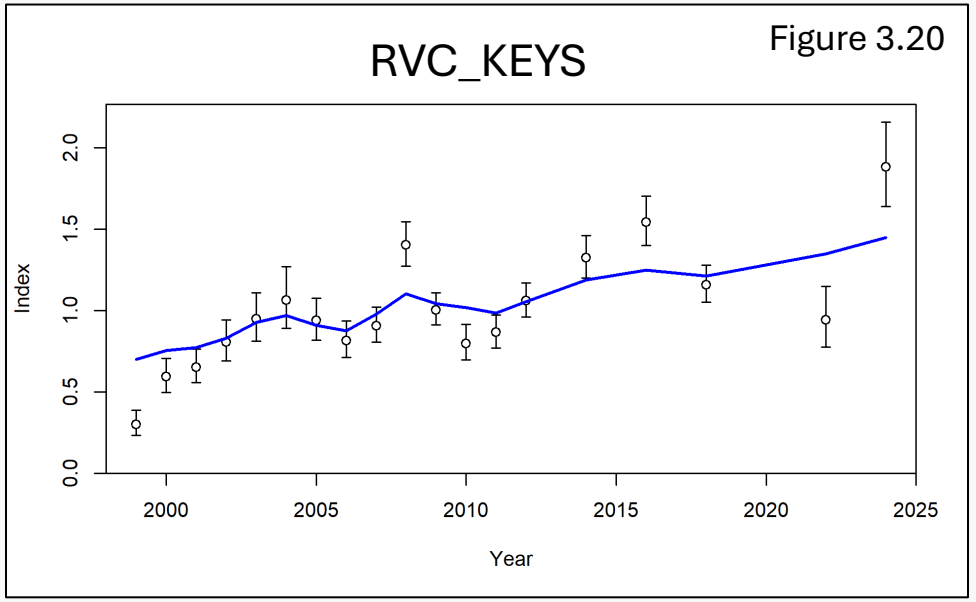
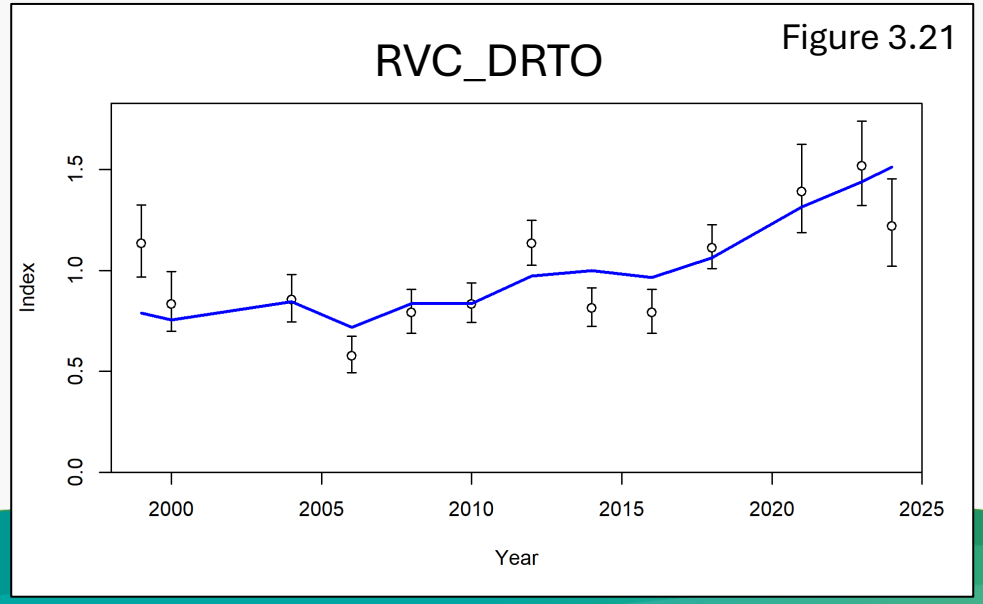
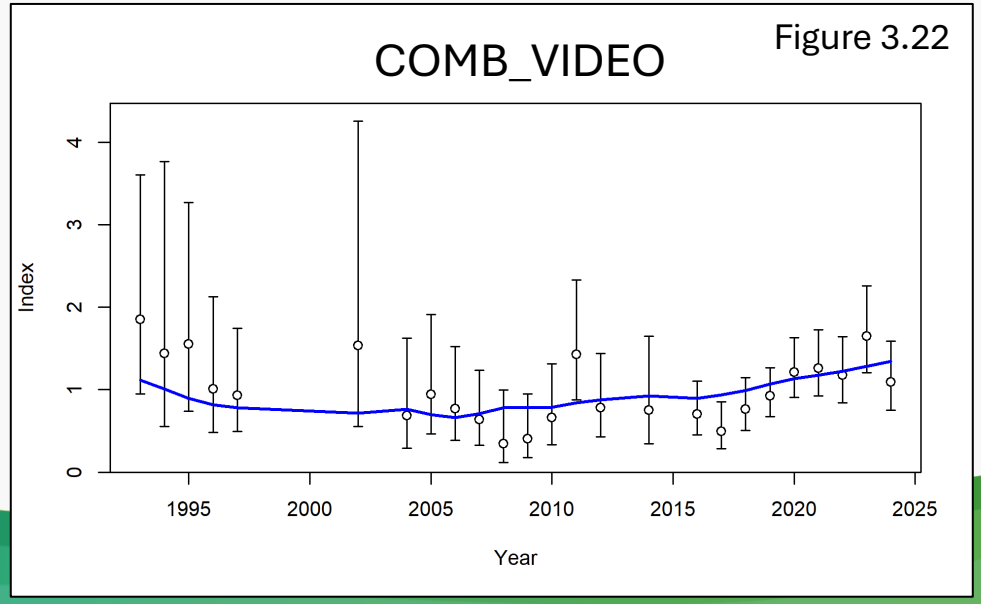


Figure 3.19

Indices of Abundance







Index Residuals

INDEX	RUNS.P	TEST	SIGMA3.LO	SIGMA3.HI	TYPE
RVC_KEYS	0.136	Passed	-0.525	0.525	cpue
RVC_DRTO	0.197	Passed	-0.408	0.408	cpue
COMB_VIDEO	0.077	Passed	-0.865	0.865	cpue

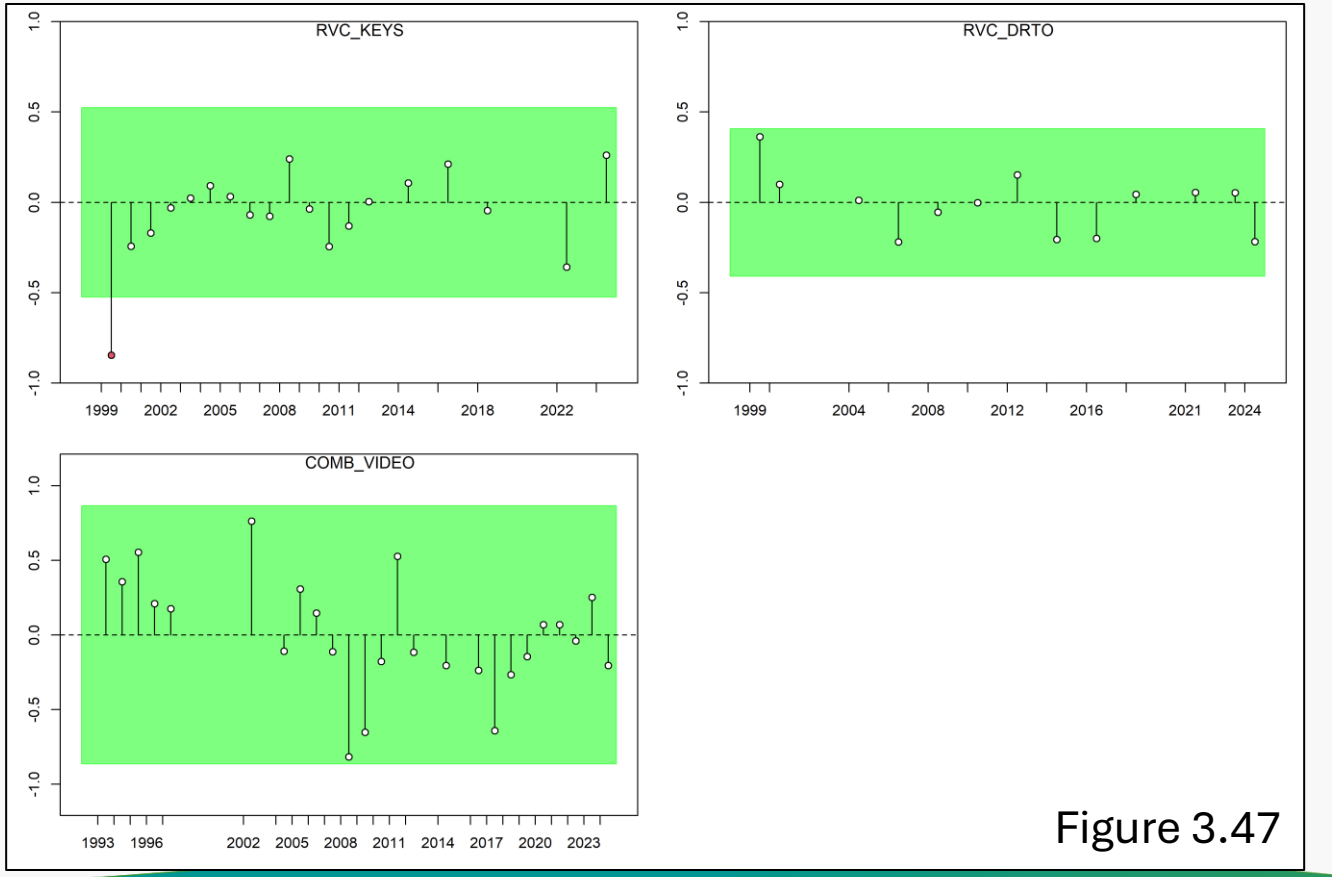
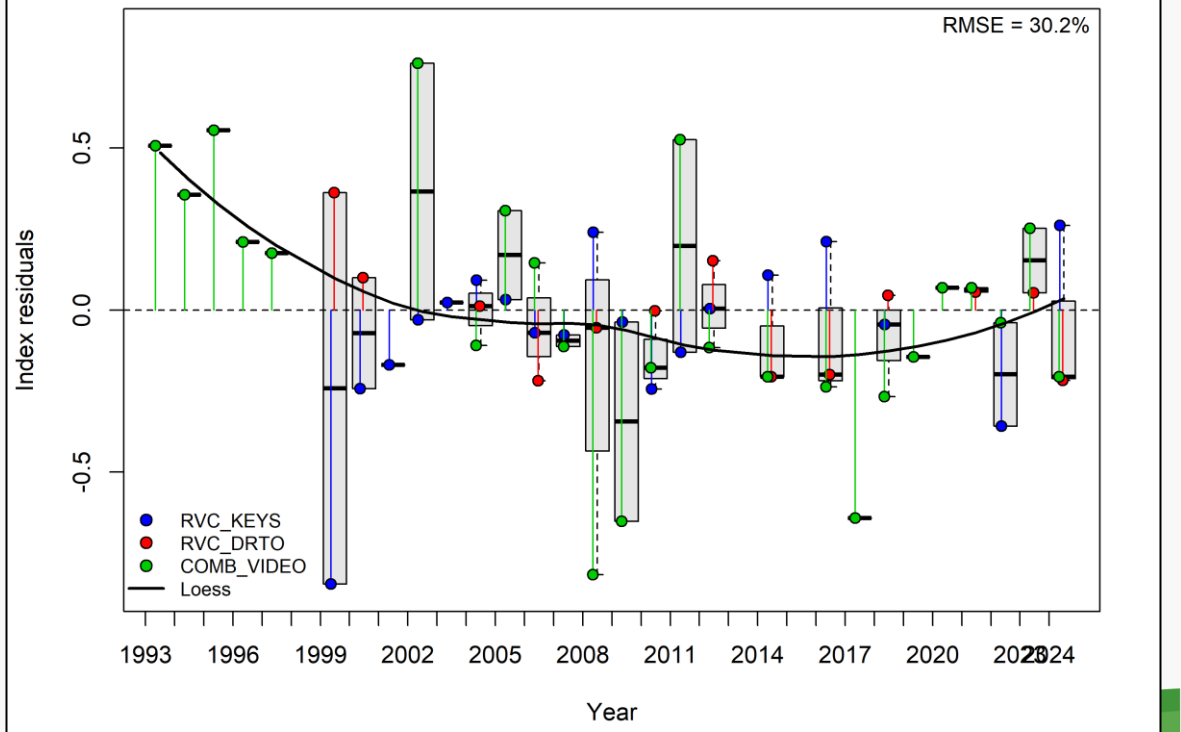


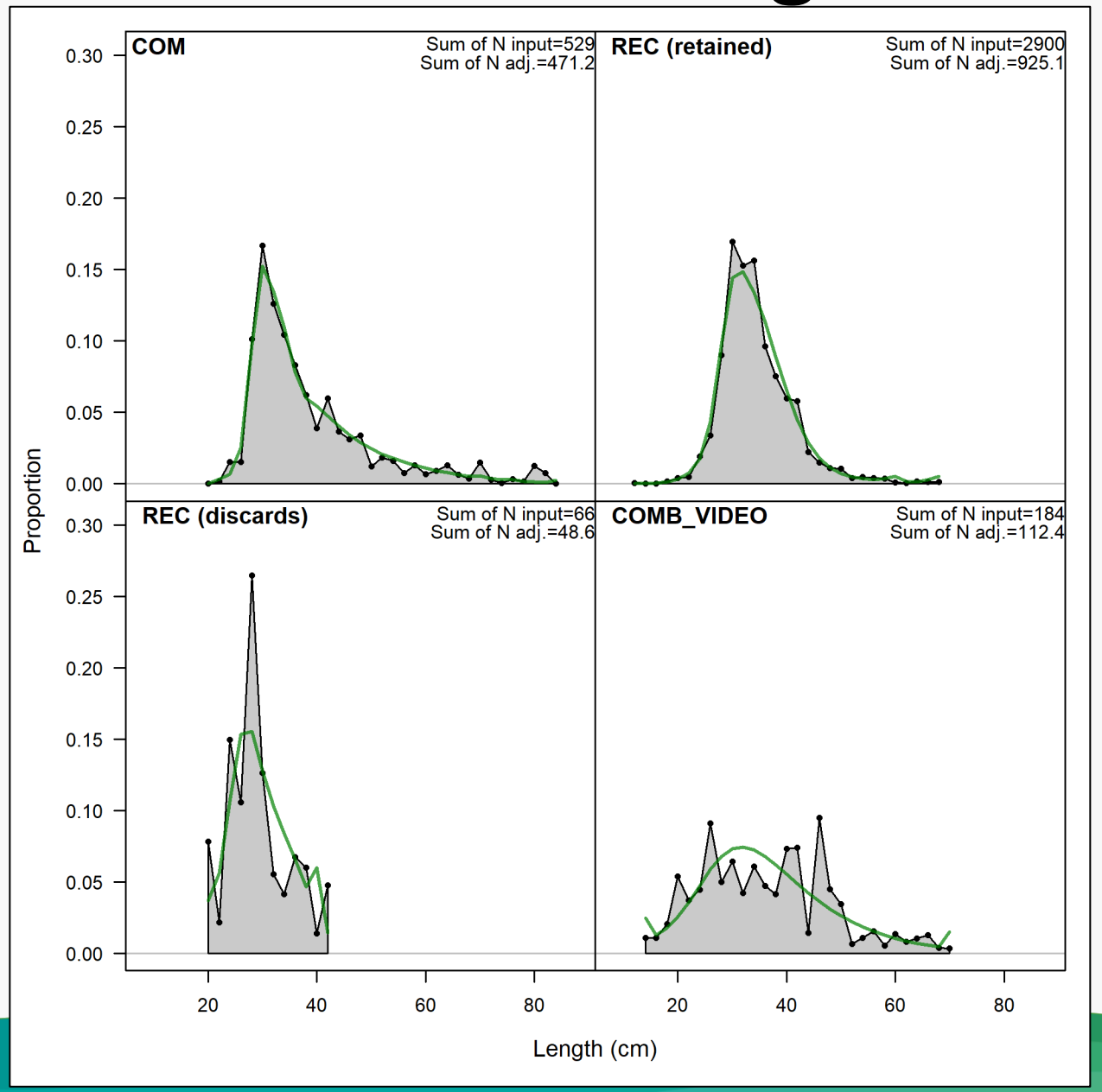
Figure 3.47

INDICES	RMSE %	Nobs
RVC_KEYS	25.3	19
RVC_DRTO	16.5	13
COMB_VIDEO	38	25
Combined	30.2	57

Figure 3.46a



Length Composition



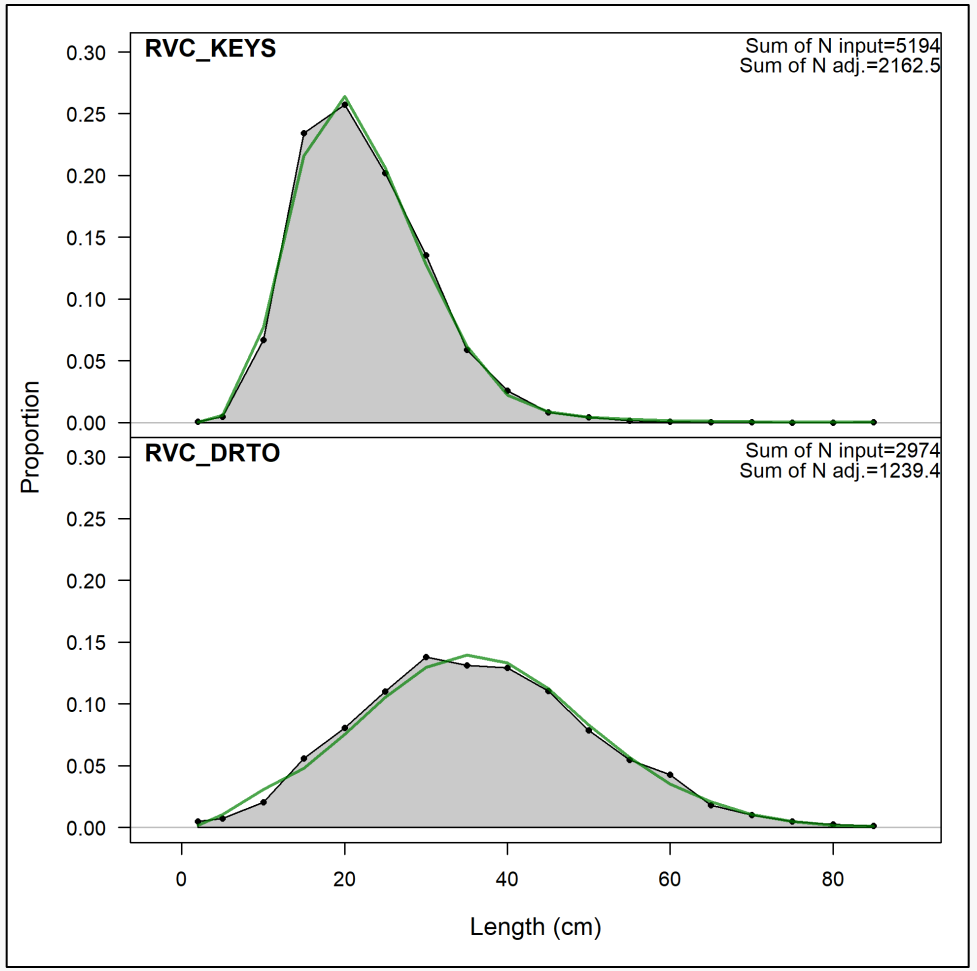


Figure 3.23

Length Composition

Commercial | Recreational retained | Recreational discards

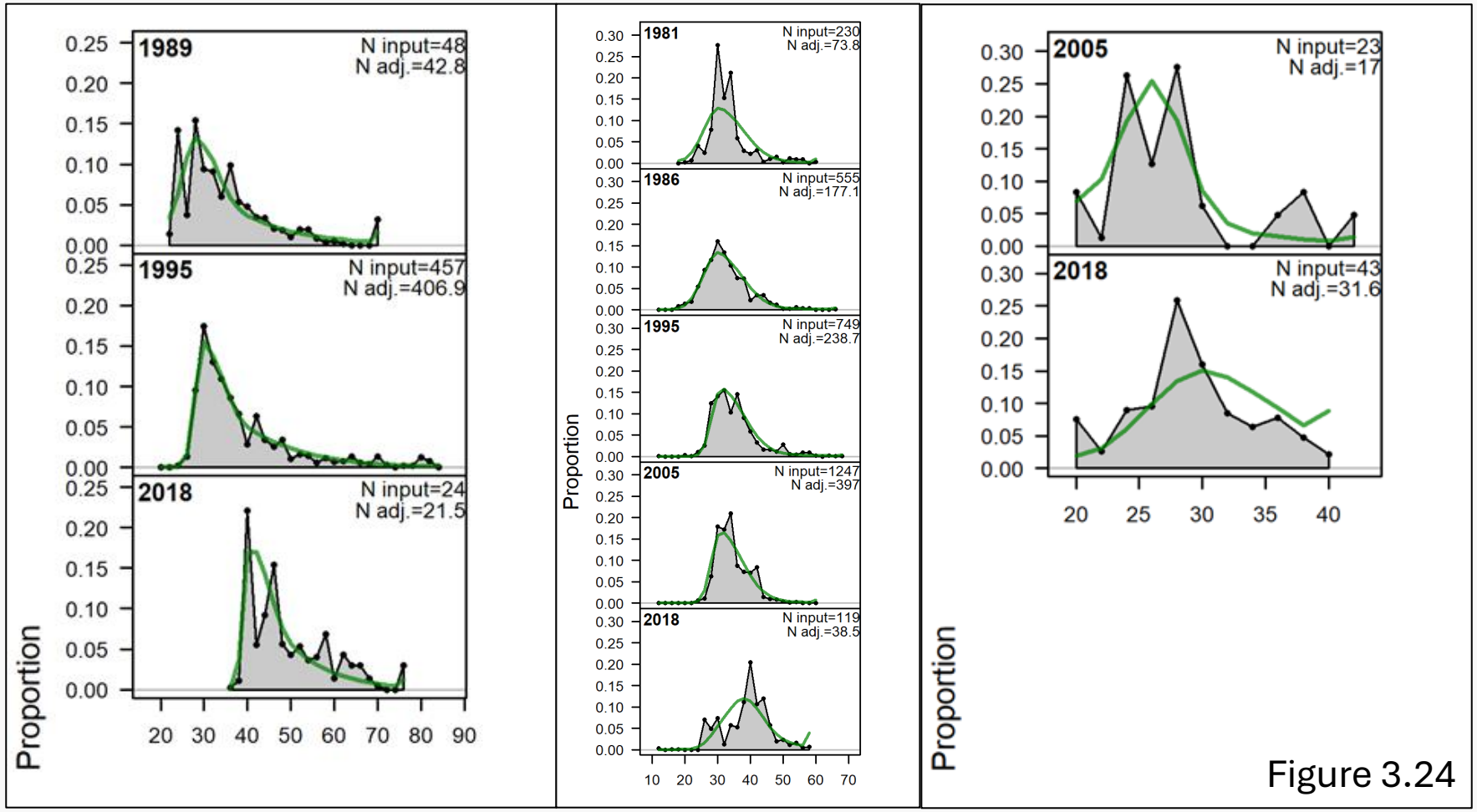


Figure 3.24

Length Composition Residuals

FLEET	RUNS.P	TEST	SIGMA3.LO	SIGMA3.HI	TYPE
REC	0.793	Passed	-0.06324	0.063237	length

FLEET	RMSE %	Nobs
COM	2.7	3
REC	2.1	5
COMB_VIDEO	0.3	1
Combined	2.3	9

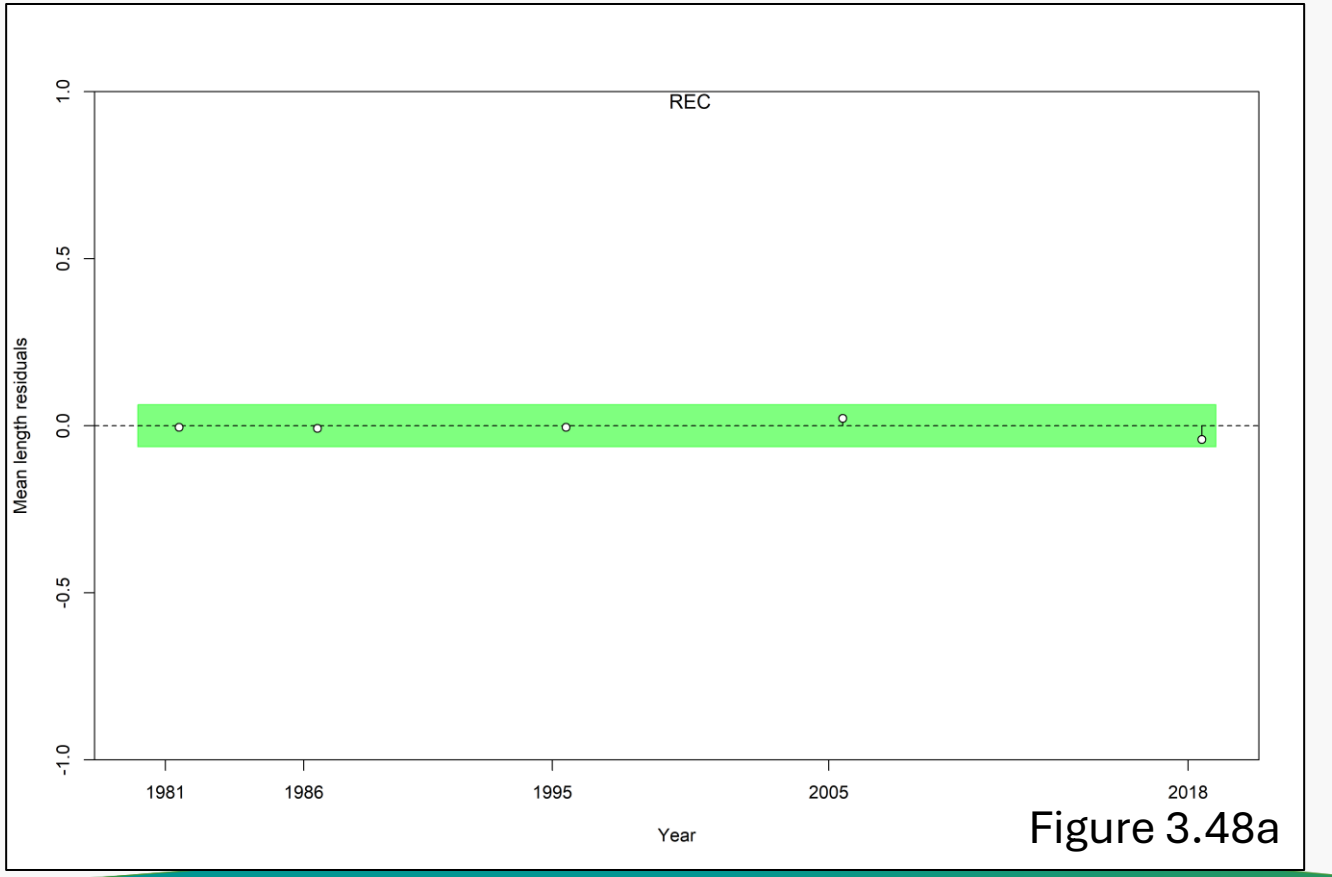
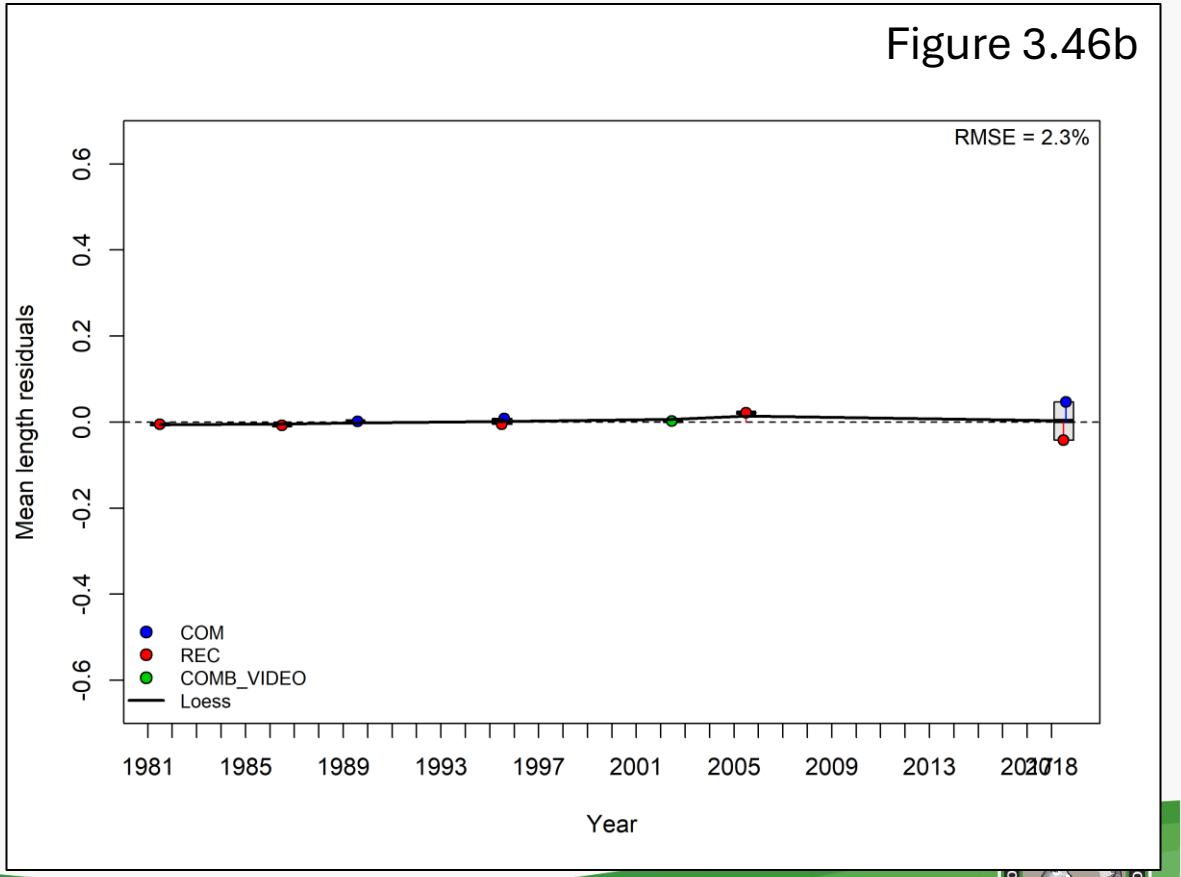


Figure 3.48a

Figure 3.46b



Length Composition

RVC Florida Keys

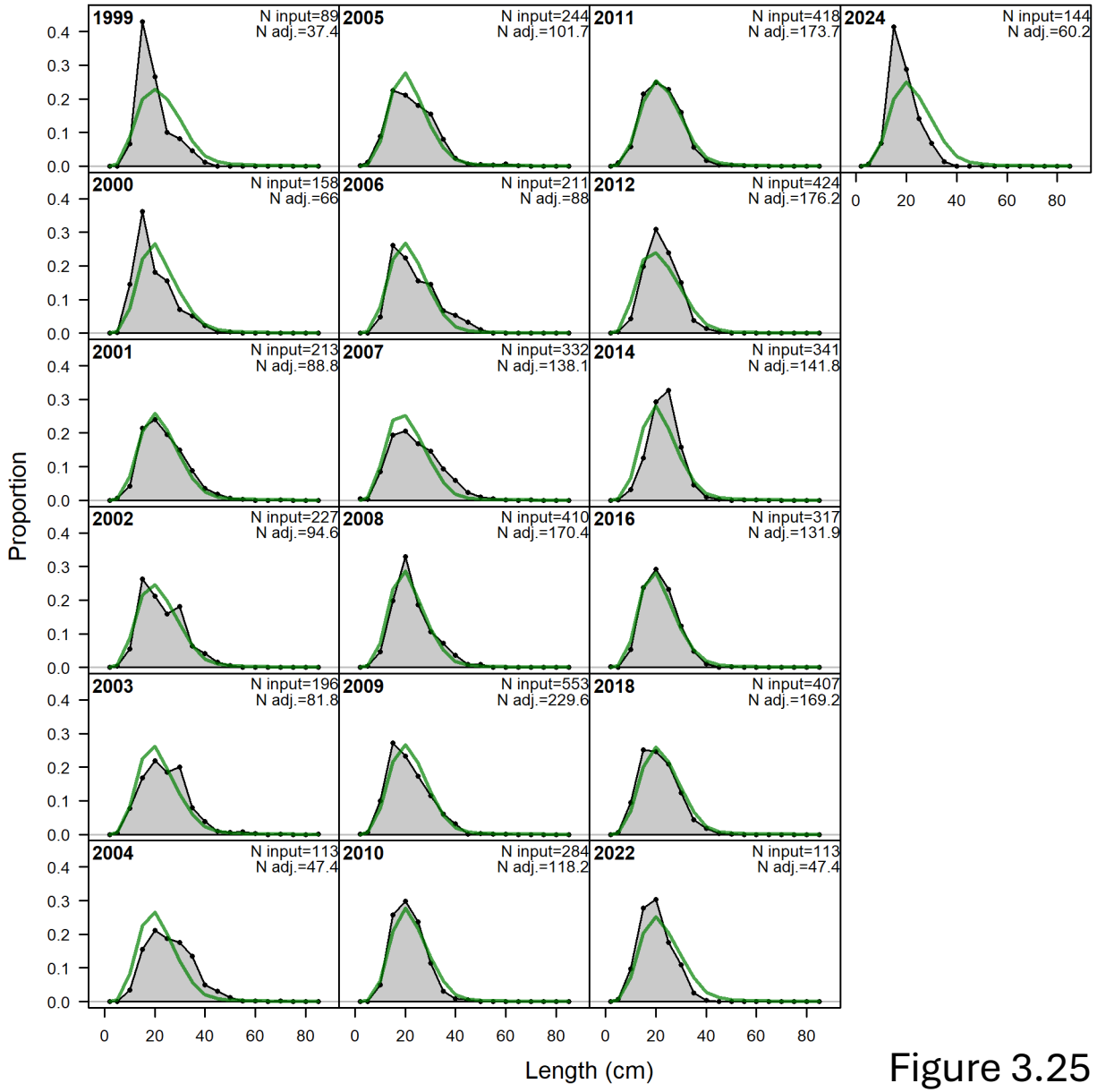


Figure 3.25

RVC Dry Tortugas

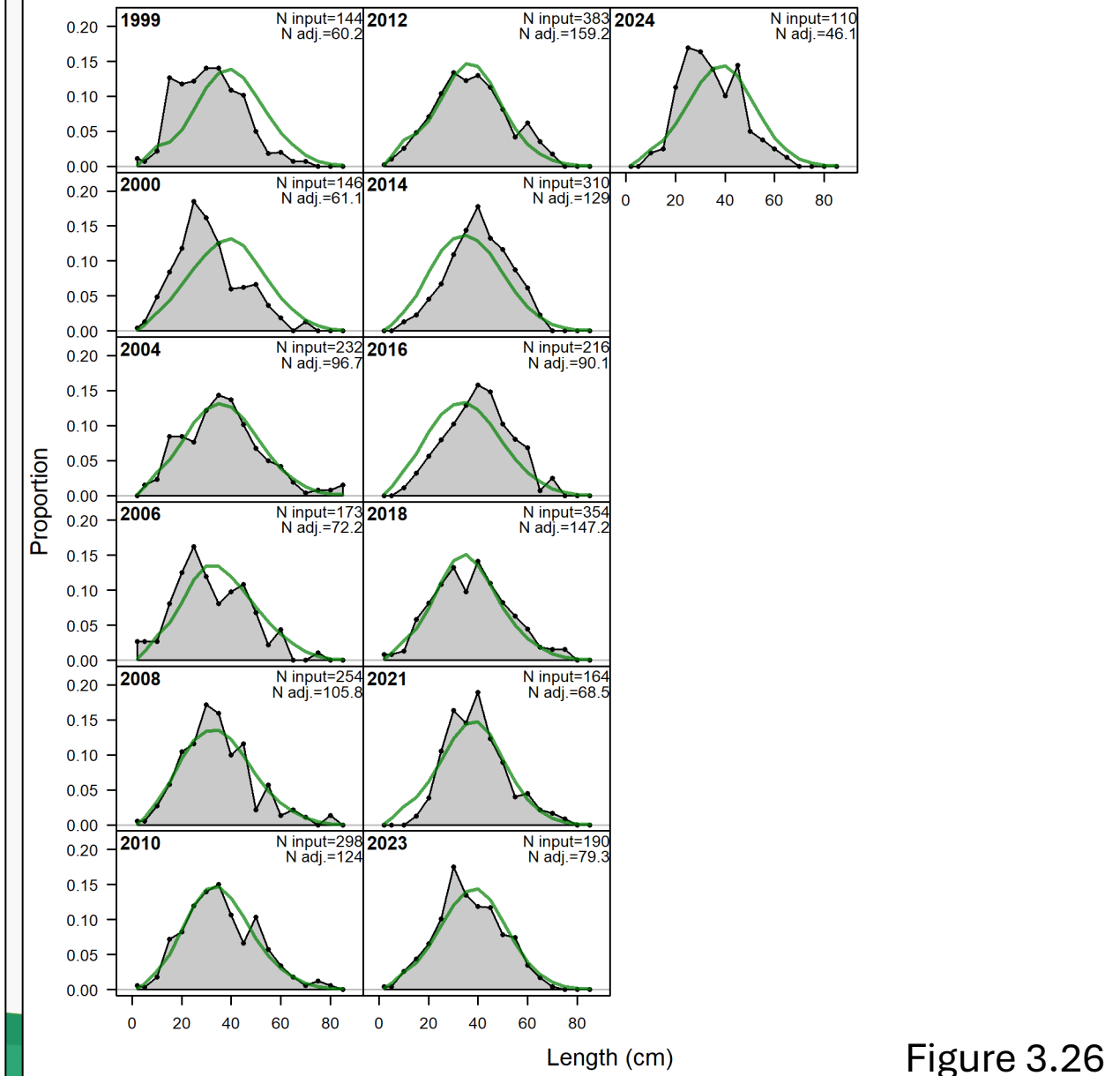


Figure 3.26

Length Composition Residuals

FLEET	RUNS.P	TEST	SIGMA3.LO	SIGMA3.HI	TYPE
RVC_KEYS	0.005	Failed	-0.16373	0.163727	size
RVC_DRTO	0.005	Failed	-0.19726	0.197261	size

FLEET	RMSE %	Nobs
RVC_DRTO	11.4	13
RVC_KEYS	9.9	19
Combined	10.5	32

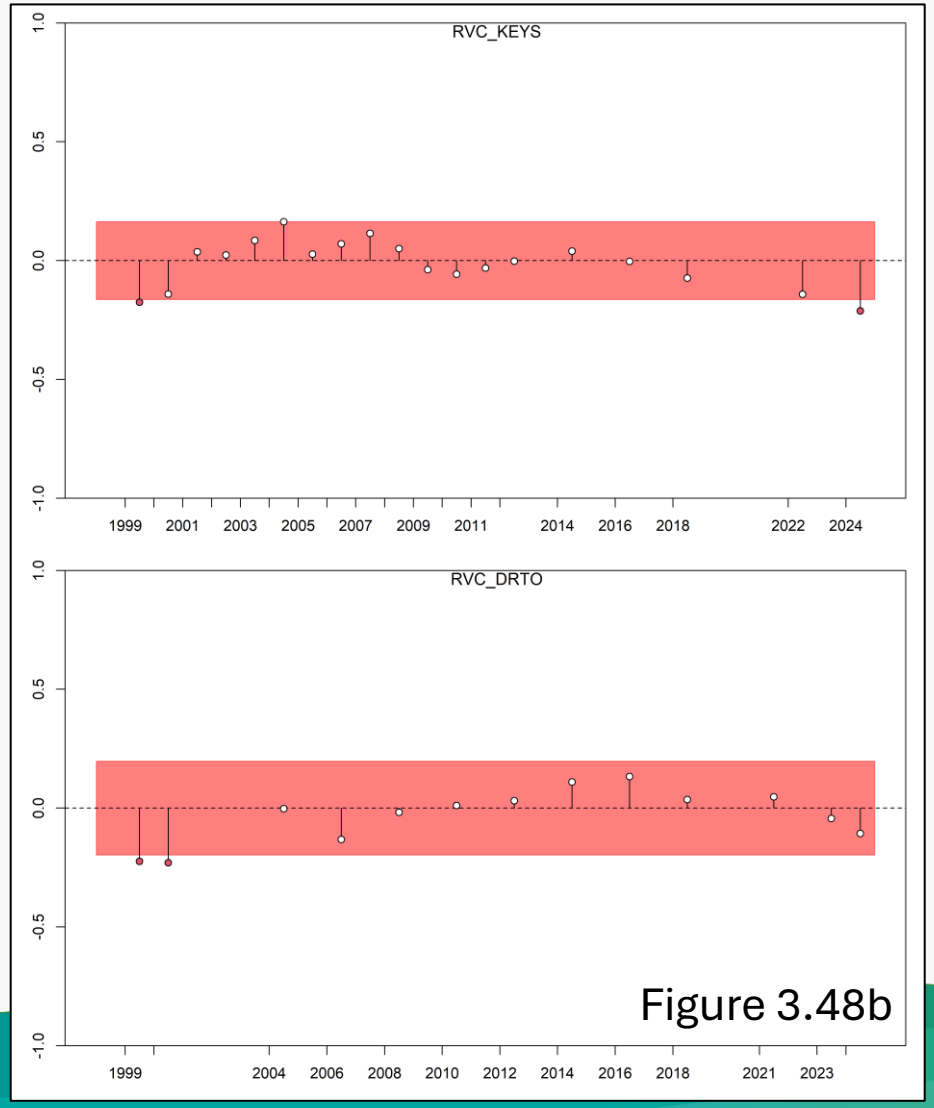
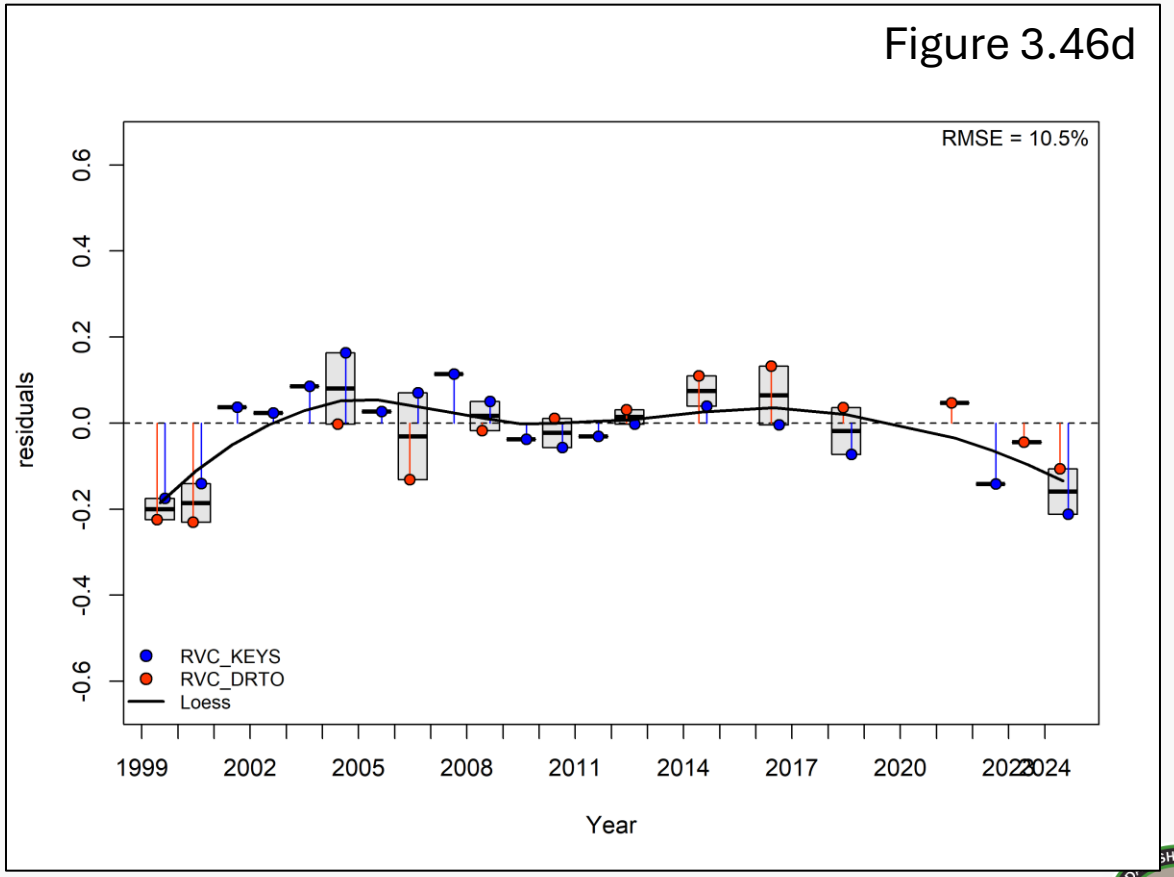


Figure 3.48b

Figure 3.46d



Conditional Age-at-Length

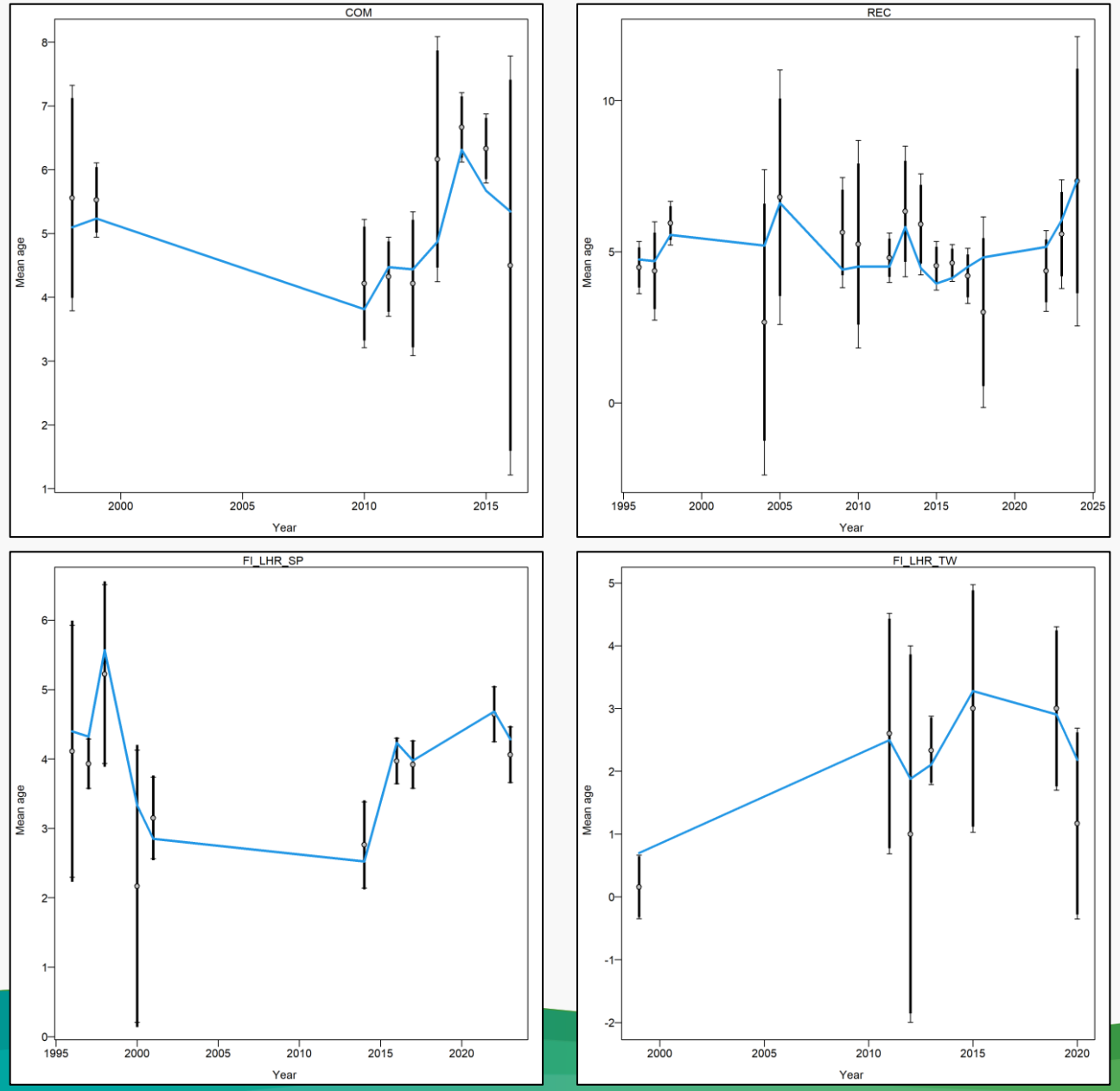
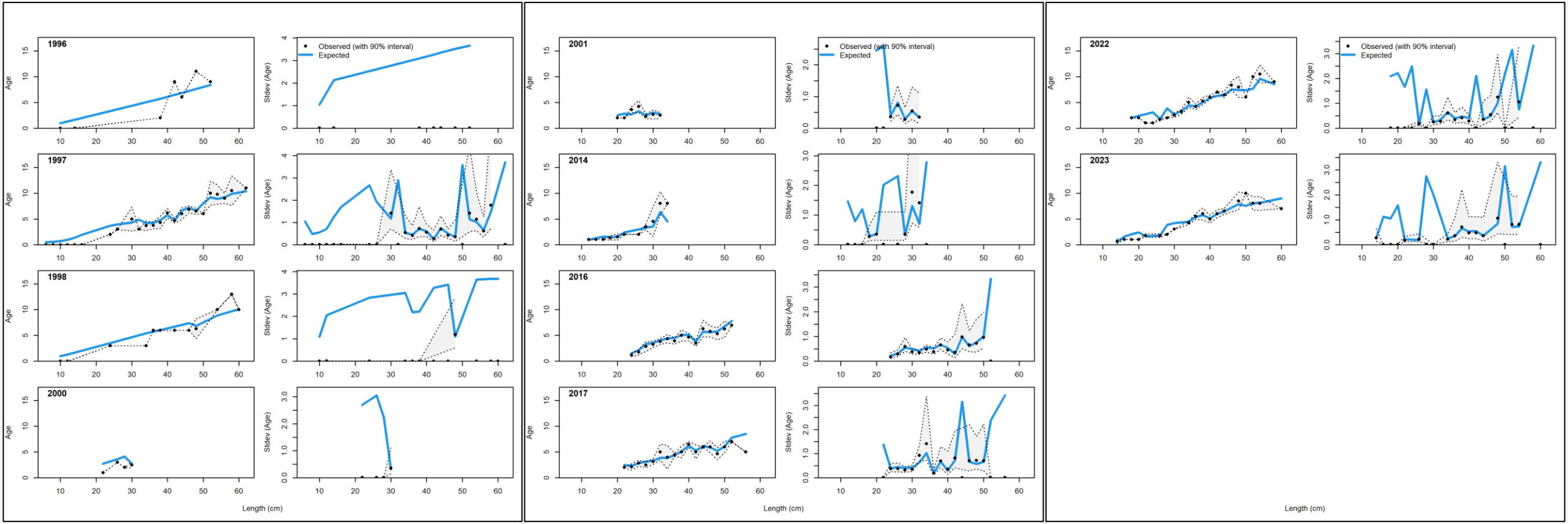


Figure 3.28

Conditional Age-at-Length

Fishery-independent Spear data



Adapted from Figure 3.31

Conditional Age-at-Length

FLEET	RUNS.P	TEST	SIGMA3.LO	SIGMA3.HI	TYPE
COM	0.207	Passed	-0.344	0.344	con
REC	0.012	Failed	-0.476	0.476	con
FI_LHR_SP	0.087	Passed	-0.230	0.230	con
FI_LHR_TW	0.985	Passed	-1.733	1.733	con

FLEET	RMSE %	Nobs
COM	11.7	9
FI_LHR_SP	15.1	10
FI_LHR_TW	65.7	7
REC	23.4	17
Combined	31.6	43

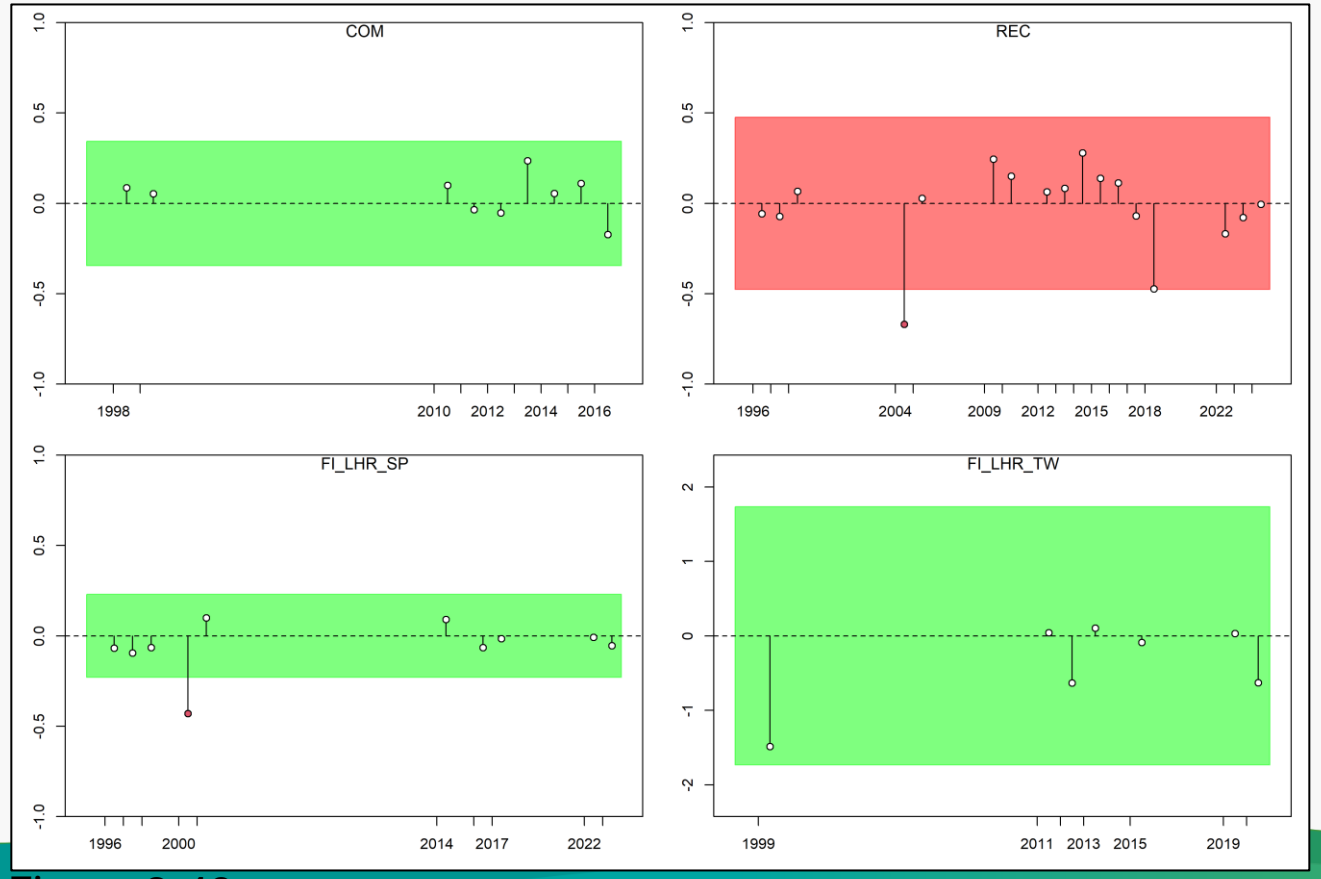
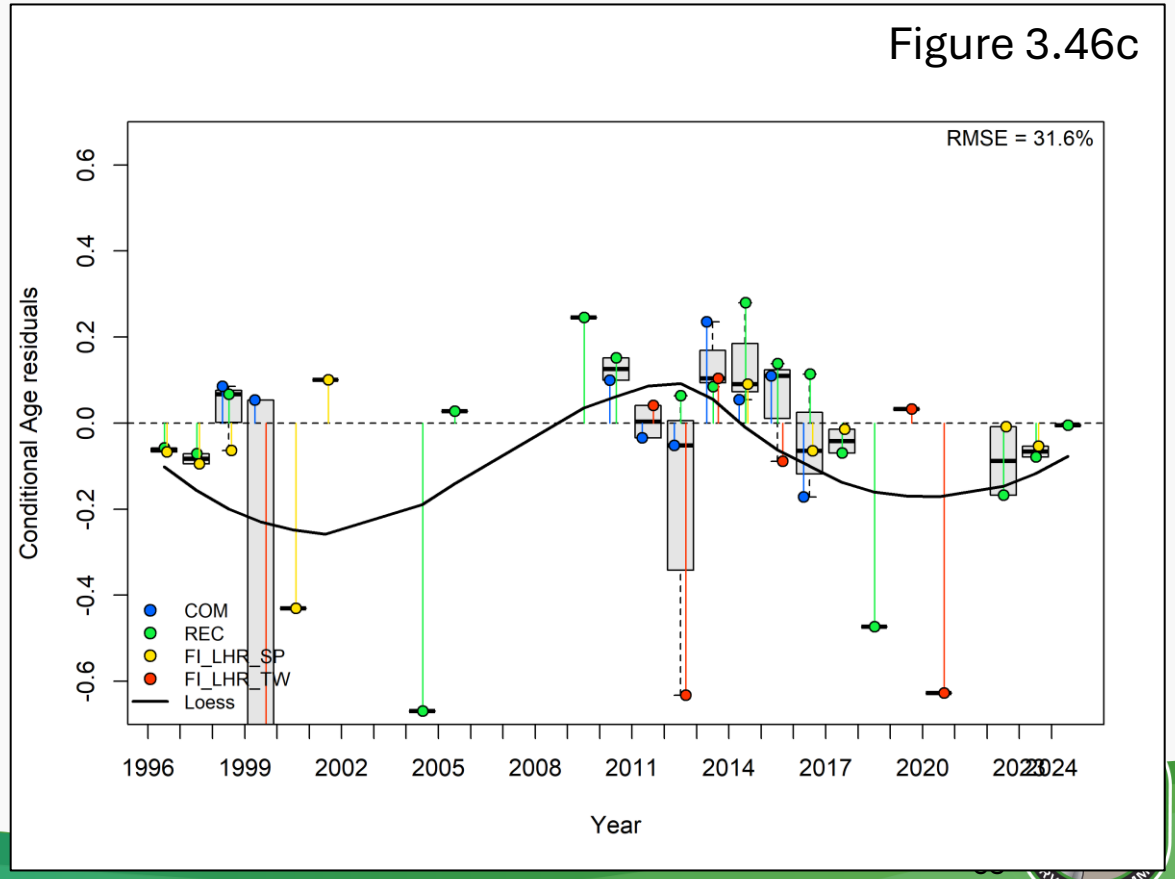


Figure 3.49

Figure 3.46c



Spawning Stock Biomass (males and females)

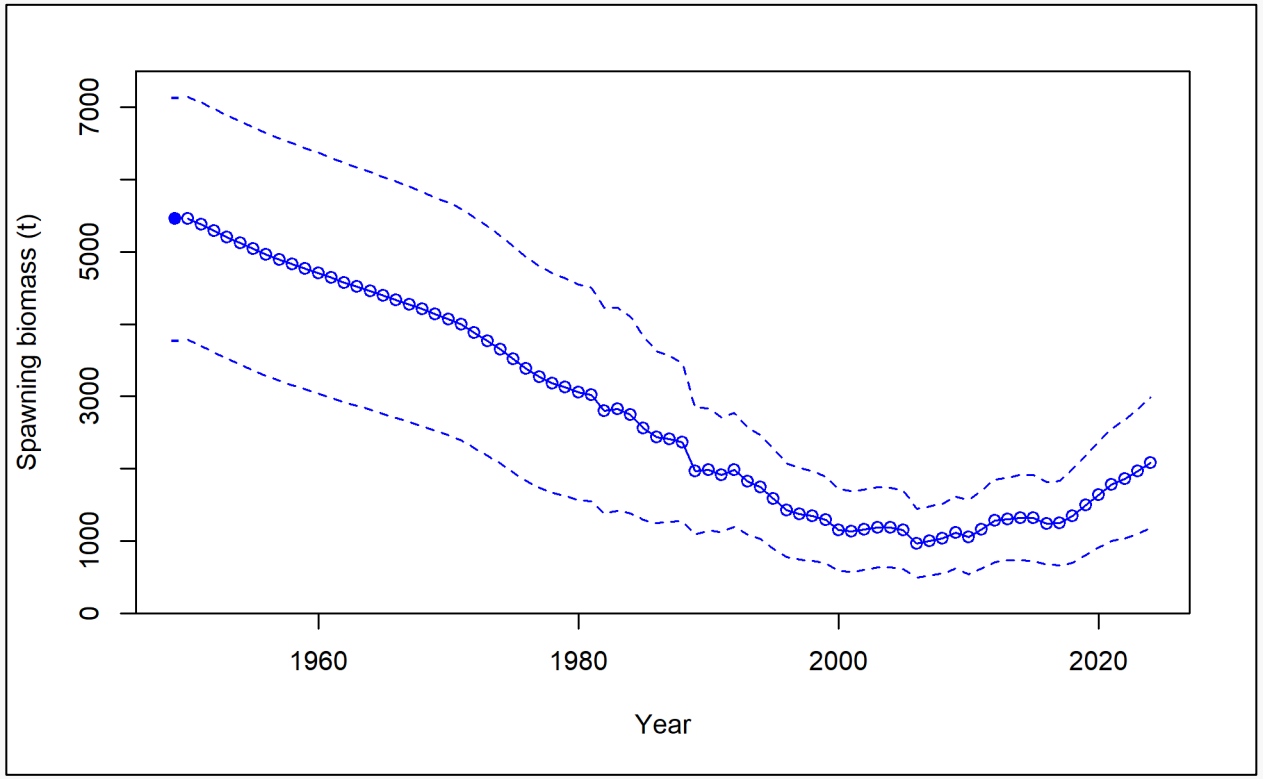


Figure 3.34a

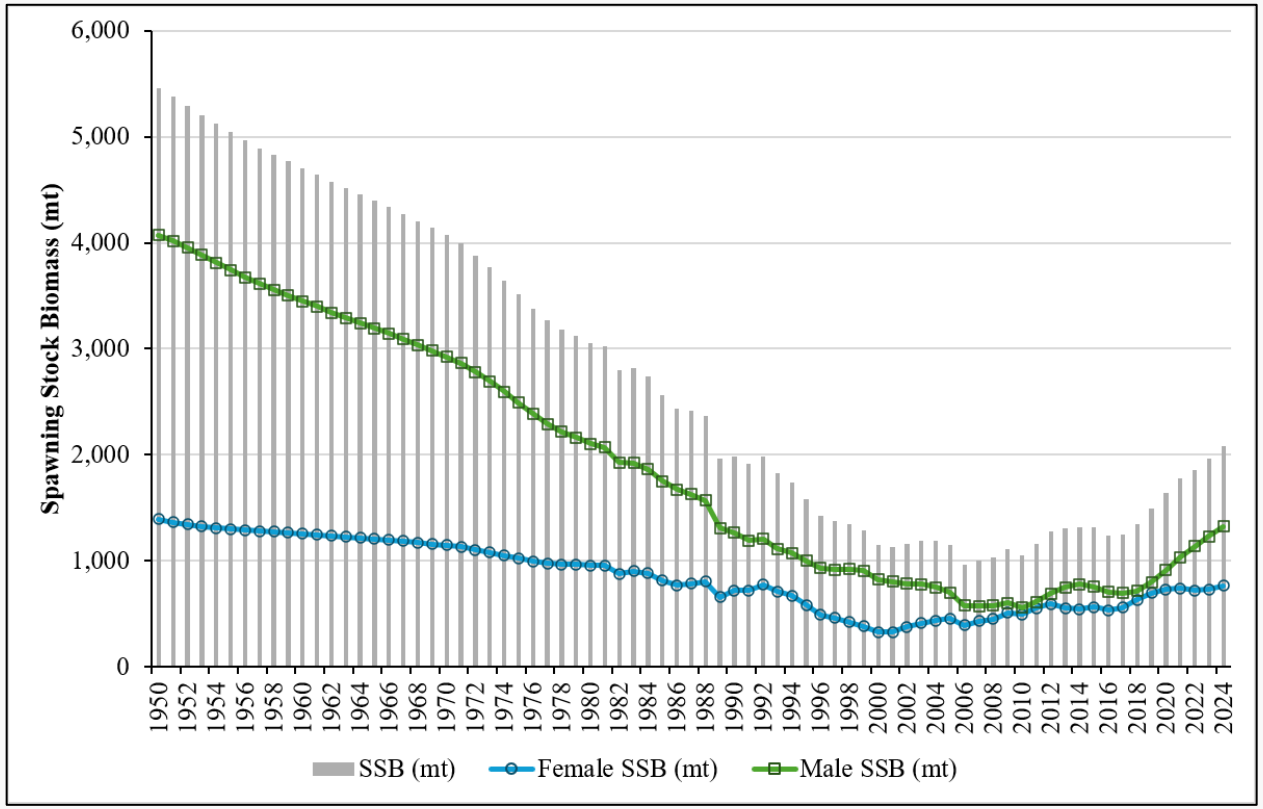


Figure 3.34b

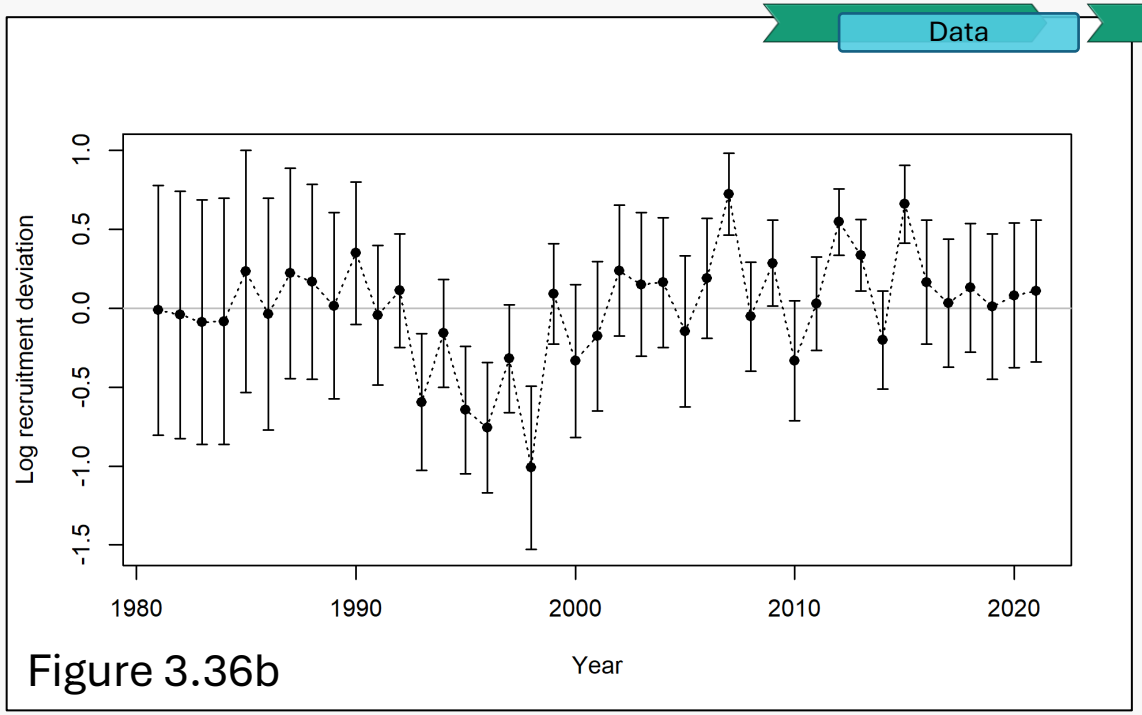


Figure 3.36b

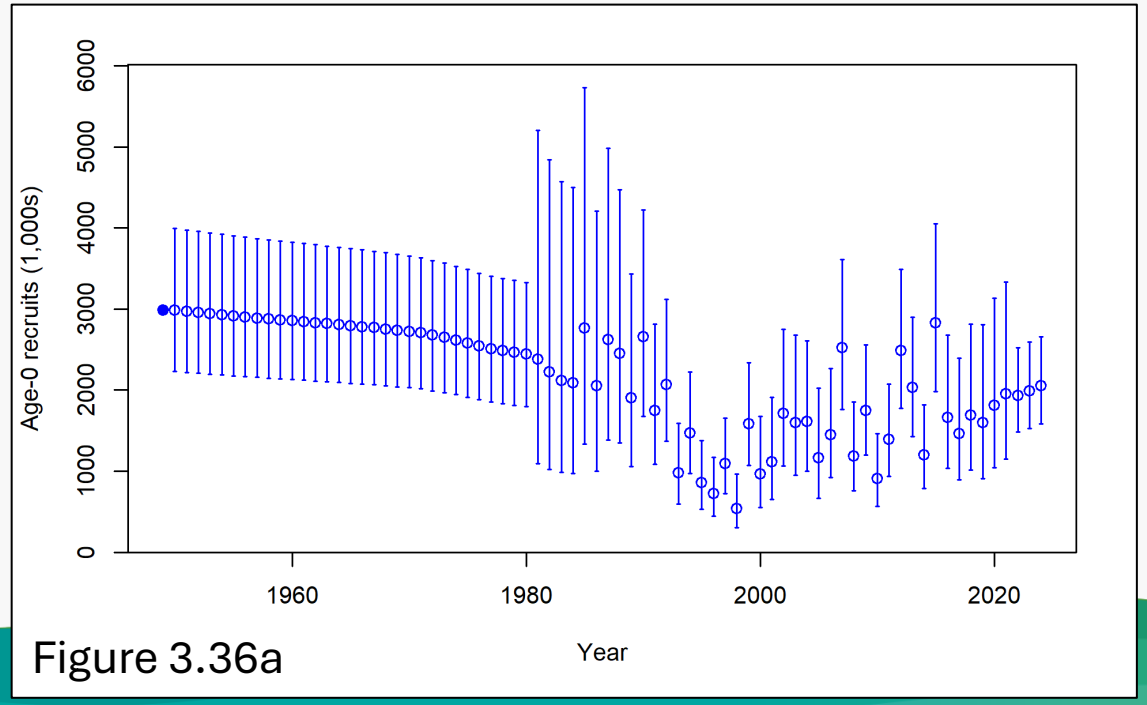


Figure 3.36a

Stock-Recruitment Dynamics

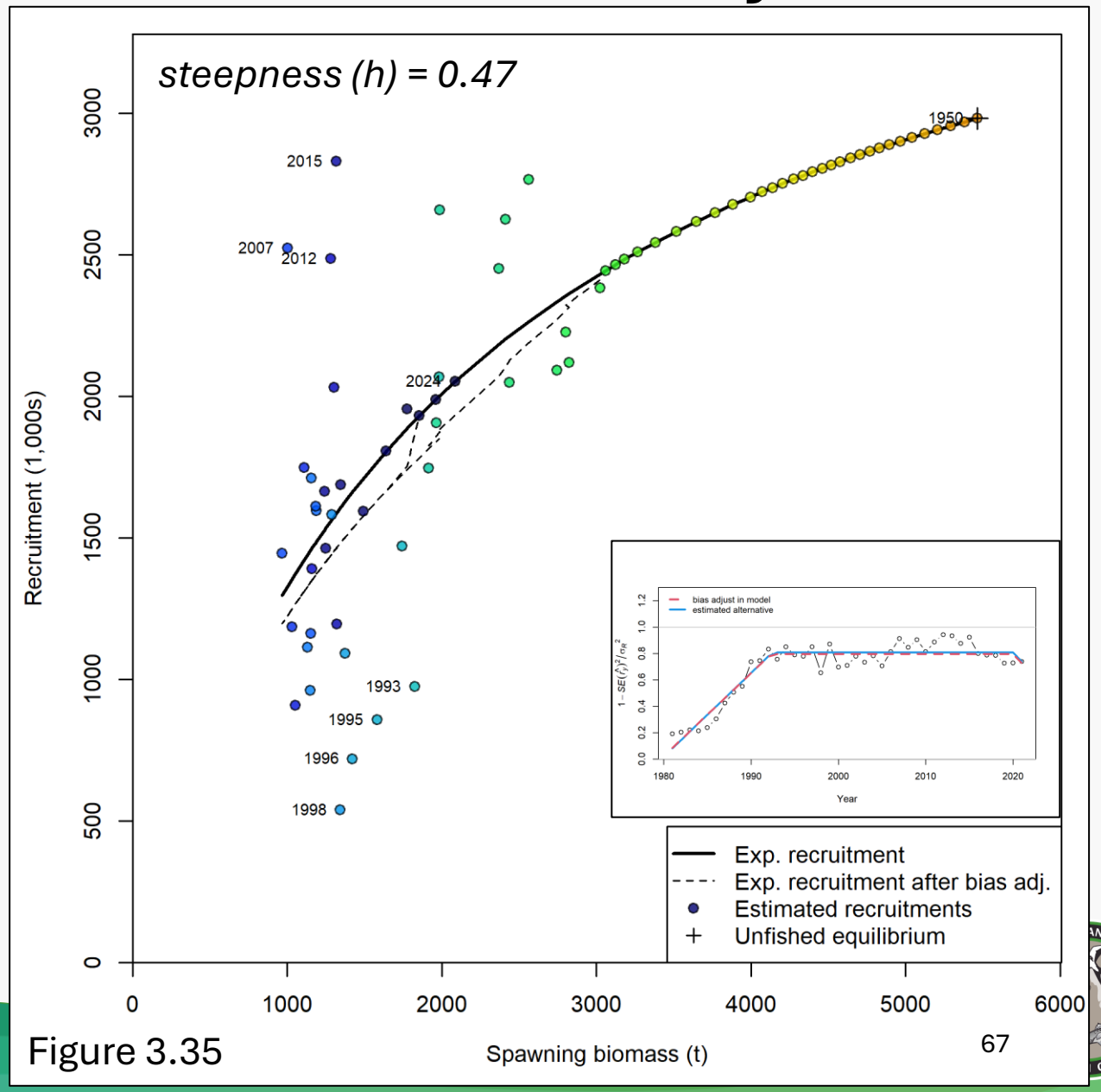


Figure 3.35

Fishing Mortality Rates

Exploitation rates

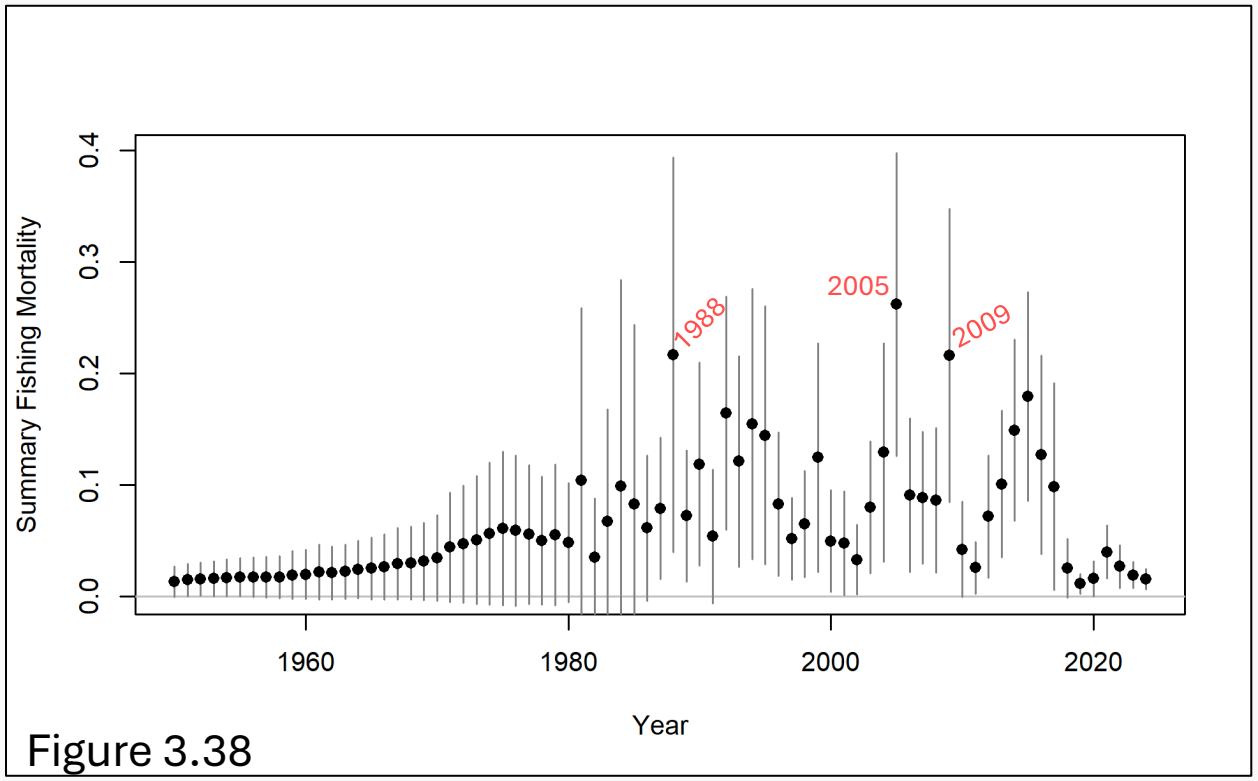


Figure 3.38

Apical fishing mortality rates

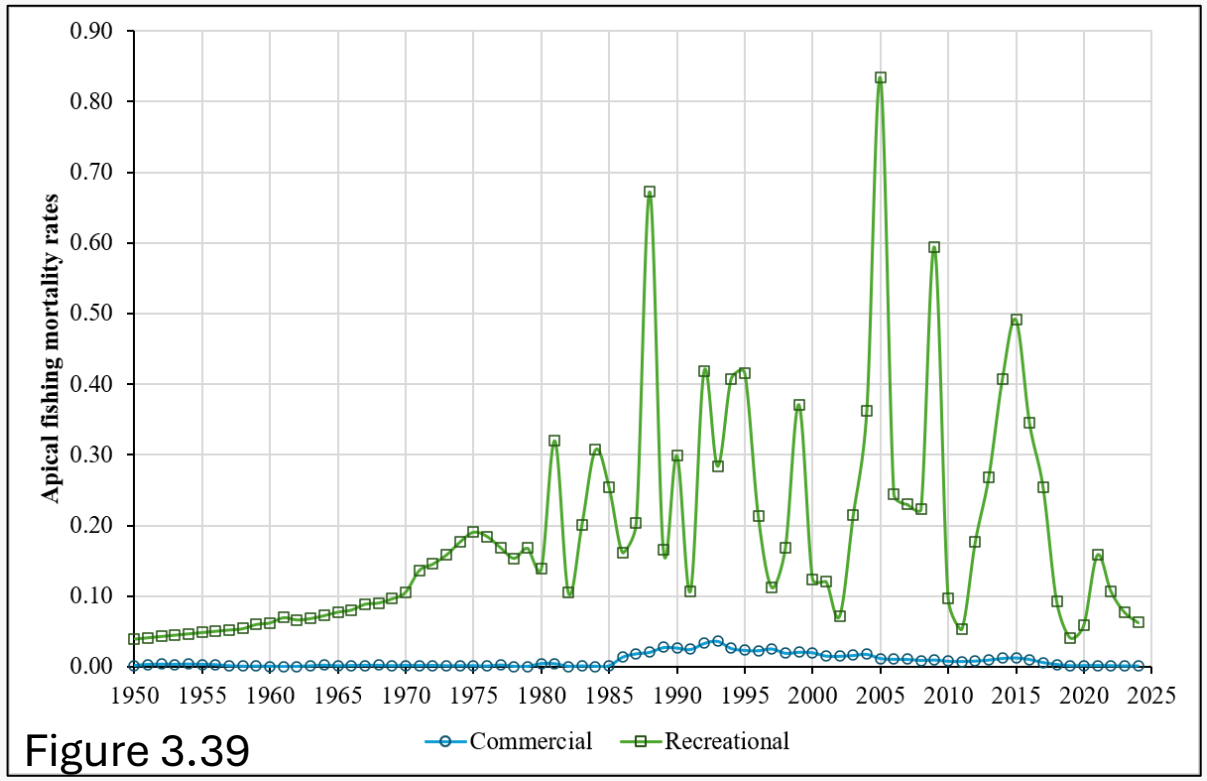


Figure 3.39

Selectivity: Commercial

Figure 3.40

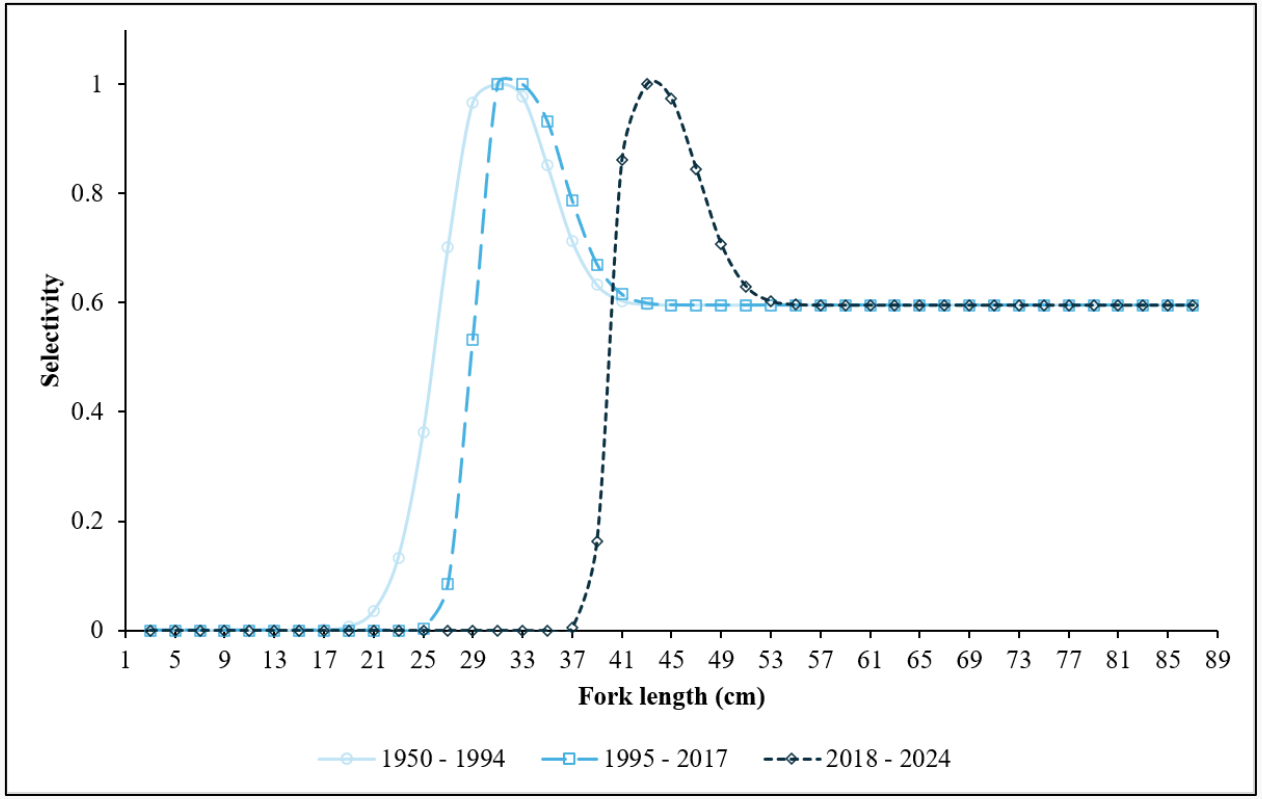
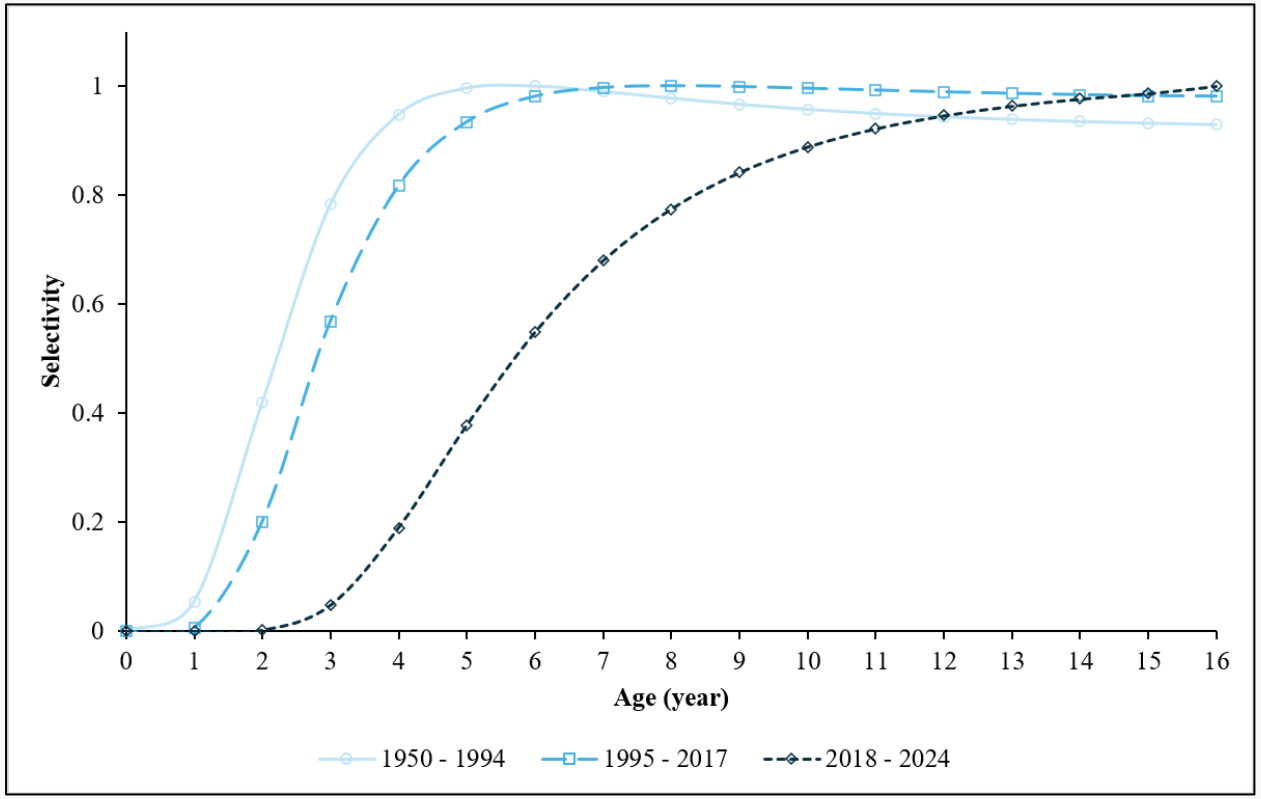


Figure 3.43

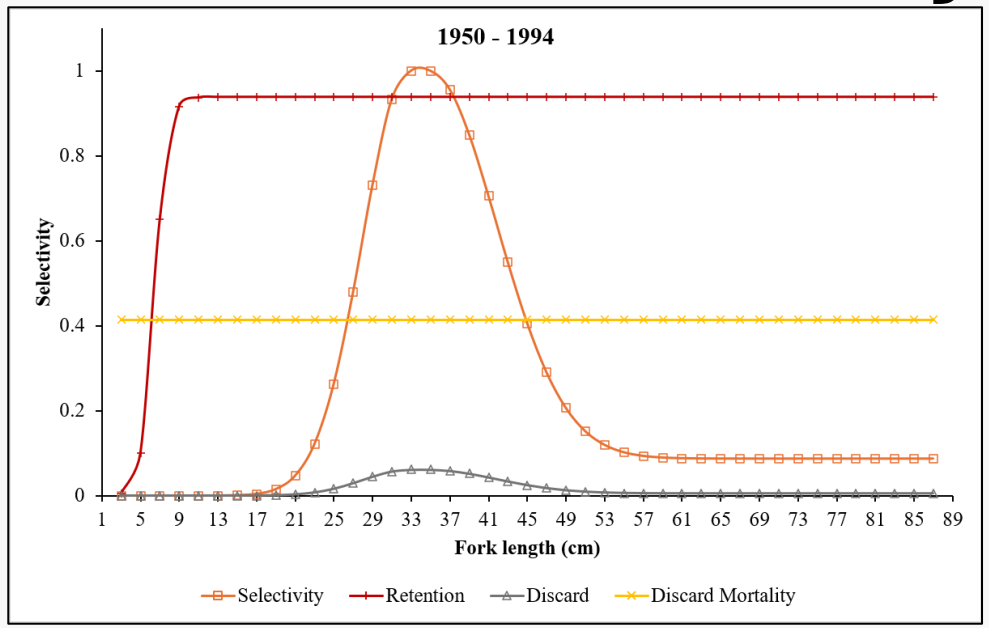


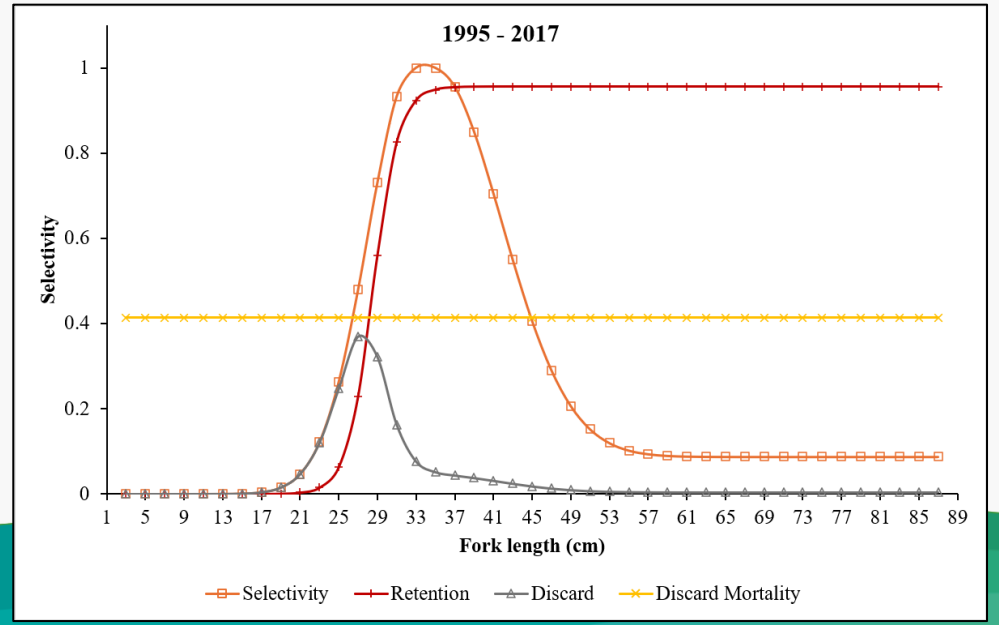
Time Blocks:

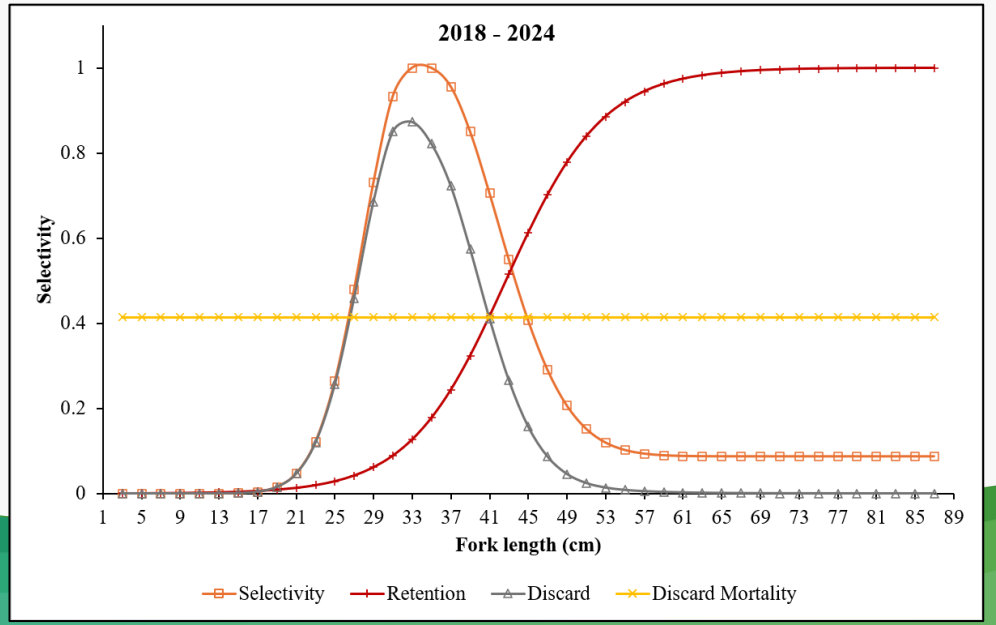
- 1950 – 1994: No minimum size limits
- 1995 – 2017: 12” (305 mm) FL minimum size, 5 fish bag limit
- 2018 – 2024: 16” (406 mm) FL minimum size, 1 fish bag limit

Selectivity: Recreational

Adapted from Figure 3.41







Time Blocks:

- 1950 – 1994: No minimum size limits
- 1995 – 2017: 12” (305 mm) FL minimum size, 5 fish bag limit
- 2018 – 2024: 16” (406 mm) FL minimum size, 1 fish bag limit

Selectivity: Indices

Figure 3.42

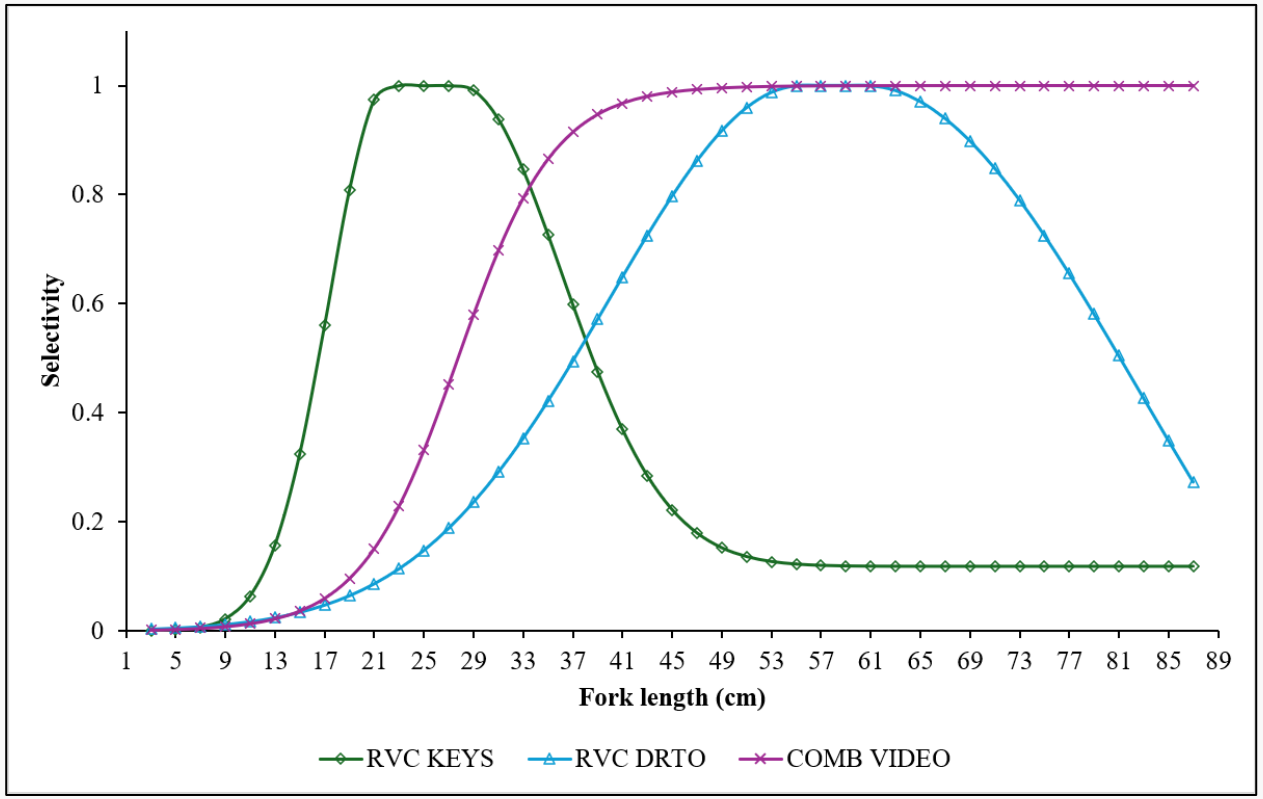
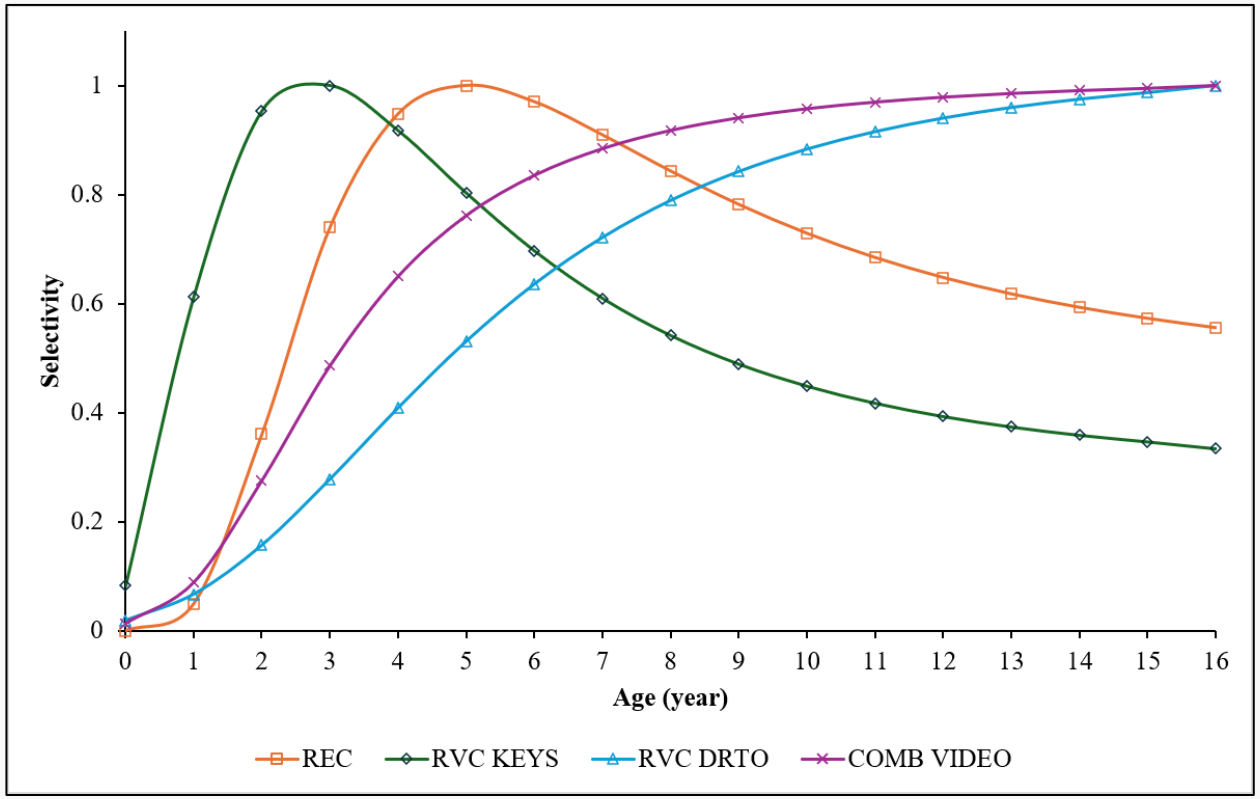


Figure 3.44



Thank You!

