SEDAR 79: Mutton Snapper
Review Workshop – Day 1

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FWRI Stock Assessment Group, St. Petersburg, FL

9/10-12/2024

Goals

- Intro/Management History
- Data Inputs
  - Life History Inputs
  - Landings and Releases
  - Indices
  - Length Comps
  - Conditional Age-at-Length
- Base Model Configuration
- Base Model Fits

Life History Overview

- Tropical reef species associated with coral reef areas in the western Atlantic Ocean.
    - Maryland to southeastern Brazil.
    - Populations from U.S. waters are believed to belong to a single stock. Most abundant in South FL.
- Juveniles inhabit nearshore bays, seagrass beds, and mangroves before shifting to reefs.
- Observed maximum age = 42 years.
- Forms large spawning/pre-spawning aggregations, peaking April through July
- Primarily hook & line fishery
    - Targeted by commercial and recreational anglers in both state and federal waters
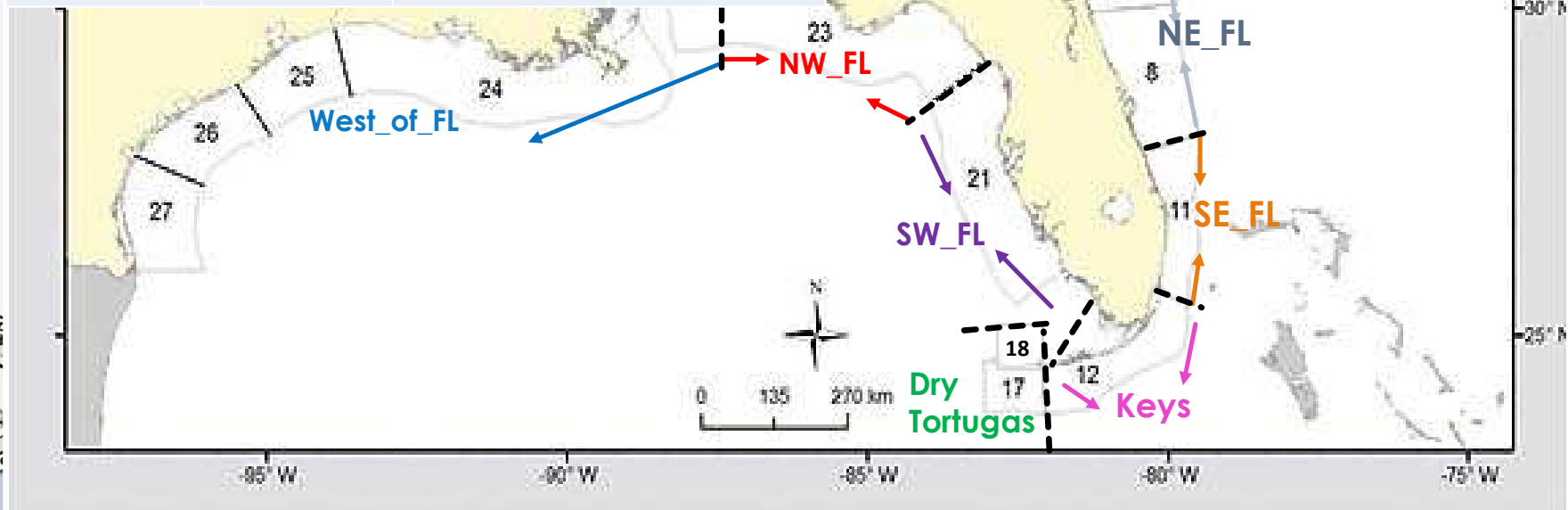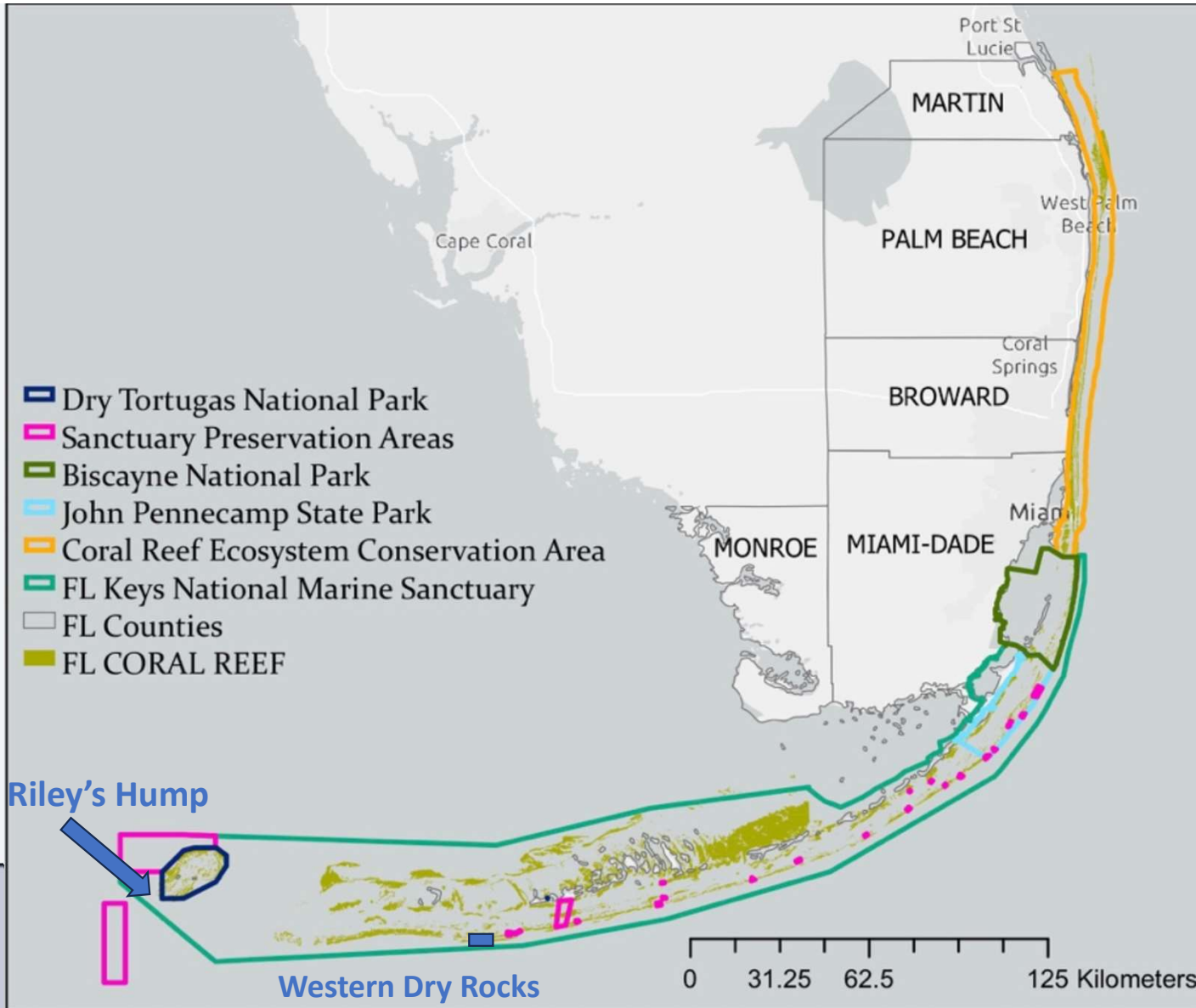

UF Nick Haddad

3

Management History in the U.S.

- Managed as separate stock units by two councils (SAFMC, GMFMC)
  - Boundary is U.S. Highway 1 in the Florida Keys west to the Dry Tortugas
  - State of Florida also manages in state waters

- SEDAR assessments have treated this species as a single stock for the Councils to determine apportionment
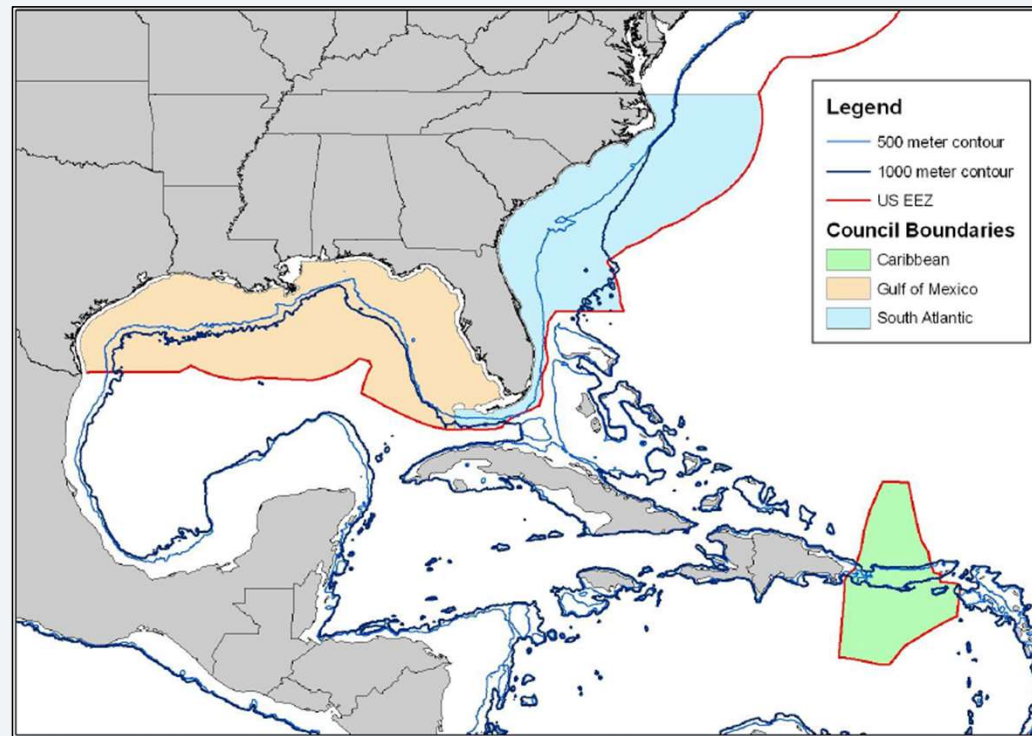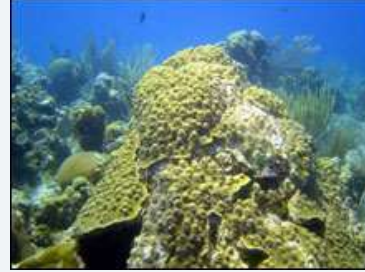
Region Caught	Statistical Grids	SRHS	FL Counties
West_of_FL	11 - 21	24 -29	
NW_FL	7-10	~23	Escambia-Dixie
SW_FL	3-6	21, old 22	Levy - Collier
Dry Tortugas	2	Old 17, old 18	Monroe
Keys	1, 2479-2482	12 (pre-2013 definition)	Monroe
SE_FL	2580,2680,2780, 2579,2679,2779	11	Indian River – Miami-Dade
NE_FL	2880,2980,3080, 2879,2979,3079	7, 8	Nassua - Brevard
North_of_FL	North of 31°	1 – 6, 9,10	

Legend:
- Dry Tortugas National Park
- Sanctuary Preservation Areas
- Biscayne National Park
- John Pennecamp State Park
- Coral Reef Ecosystem Conservation Area
- FL Keys National Marine Sanctuary
- FL Counties
- FL CORAL REEF

Riley's Hump

Western Dry Rocks

Zuercher et al. 2020

Spatial Closures

- Dry Tortugas:
  - Riley's Hump: 1994 – 2002: May 1 – June 30
  - Tortugas Reserve: 2002 – Present: year-round
  - Pulley Ridge: 2006 – Present: bottom gears prohibited year-round
  - Research Natural Area within Dry Tortugas National Park: 2007 – Present: fishing and anchoring prohibited inside 46-square-mile marine sanctuary
- FL Keys
  - Western Dry Rocks (10 mi SW of Key West): 2021 – Present: April 1 – July 31

Tortugas Reef Survey
(Photo: FKNMS)

Size Limit History

South Atlantic Federal (3 - 200 Miles)

- 12" (30.5 cm) TL (1/1992 – 1/1995)
- 16" (40.6 cm) TL (1/1995 – 2/2018)
- 18" (45.7 cm) TL (2/2018 – present)

Gulf Federal (10 -200 Miles)

- 12" (30.5 cm) TL (2/1990 – 11/1999)
- 16" (40.6 cm) TL (11/1999 – 7/2018)
- 18" (45.7 cm) TL (7/2018- present)

FL State Waters South Atlantic (0 - 3 Miles) **& Gulf** (0 -10 Miles)

- 12" (30.5 cm) TL (7/1985 – 2/1994)
- 16" (40.6 cm) TL (3/1994 – 12/2016)
- 18" (45.7 cm) TL (1/2017 – present)

Trip Limit History – Federal Waters

South Atlantic (3 - 200 Miles)

Commercial

- 5 fish per person/day limit from April – June and 500-pound commercial vessel limit for July – March (2/2018 – present)

Recreational

- Included in the aggregate daily bag limit of 10 snappers (1/1992 – present)

- 5 fish per person per day included in the aggregate daily bag limit of 10 snappers (2/2018 – present)

Gulf (10 -200 Miles)

Commercial

- None

Recreational

- 10 snapper aggregate in the 20-reef fish aggregate (1/1984 – 7/2018)

- 5 fish per person per day included in the aggregate daily bag limit of 10 snappers (7/2018 – present)

Trip Limit History – FL State Waters

Commercial - Trip Limit Per Boat/Day

- Restricts all harvest in May and June to the bag limit (12/1992 – 1/2017)
- **South Atlantic** (0 - 3 Miles): 5 fish per person/day limit from April – June and 500-pound commercial vessel limit for July – March (1/2017 – present)

Recreational - Bag Limit Per Person/Day

- Included in the aggregate daily bag limit of 10 snappers (1/1992 – present)
- Restricts all harvest in May and June to the bag limit (12/1992 – 1/2017)
- 5 fish per person per day included in the aggregate daily bag limit of 10 snappers (2/2017 – present)

Quota History (CHTS units)

South Atlantic

Commercial ACL

- 157,707 lbs (4/2012 – 2/2018)
- 104,231 lbs (2/2018 – 12/2018)
- 107,981 lbs (1/2019 – 12/2019)
- 111,354 lbs (1/2020 – present)

Recreational ACL

- 768,893 lbs (4/2012 – 2/2018)
- 121,318 fish (2/2018 – 12/2018)
- 124,766 fish (1/2019 – 12/2019)
- 127,115 fish (1/2020 – present)

Gulf

Combined ACL

- 203,000 lbs (1/2012 – 12/2017)
- 134,424 lbs (1/2018 – 12/2018)
- 139,392 lbs (1/2019 – 12/2019)
- 143,694 lbs (1/2020 – present)

Assessment History

SEDAR 15A Benchmark

- ASAP v2 – Statistical Catch-At-Age Model

- **1981-2006**, Single Stock, Ages 1 – 25+

- 5 fleets – All Dome Shaped Selectivity
  - Commercial Hook and Line, Commercial Longline, Commercial Other, Headboat, General Rec (MRFSS)

- 11 Indices of Abundance
  - 5 FD – Selectivity linked to fleets
  - 6 FI – Dome shaped selectivity

Base Model Results: not overfished, overfishing is not occurring

SEDAR 15AU Update

- ASAP v3 – Statistical Catch-At-Age Model

- **1981-2013**, Single Stock, Ages 1 – 25+

- 4 fleets – Com: flat top, Rec: dome shaped
  - Commercial Hook and Line/Other, Commercial Longline, Headboat, General Rec (MRFSS)

- 7 Indices of Abundance
  - 4 FD – Selectivity linked to fleets
  - 3 FI – Dome shaped selectivity

Base Model Results: not overfished, overfishing is not occurring

Base Model Data Inputs

Base Model Data Inputs

- Stock structure and management unit
- Life history Age and growth
  - Natural mortality
  - Maturity
  - Fecundity
  - Sex ratio
- Landings Commercial Longline (metric tons):
  - Commercial Other (metric tons): 1981 – 2023
  - Recreational East (thousands of fish): 1981 – 2023
  - Recreational West (thousands of fish): 1981 – 2023
- Releases (thousands of fish) Release mortality
  - Commercial Other: 1993 – 2023
  - Recreational East: 1981 – 2023
  - Recreational West: 1981 – 2023

- Length composition of landings (8:96 cm Maximum Total Length [Max TL], 4 cm Max TL bins)
  - Commercial Longline: 1991 – 2022
  - Commercial Other: 1989 – 2022
  - Recreational East: 1981 – 2022
  - Recreational West: 1981 – 2022
- Conditional age-at-length (1-year age bins starting at age 1, plus group for ages 40 and older)
  - Commercial Longline landings: 2001 – 2022
  - Commercial Other landings: 1992 – 2022
  - Recreational East: 1981 – 2022
  - Recreational West: 1981 – 2022
  - Fishery-independent sources: 1998-2002, 2021-2022
- Length composition of releases (8:96 cm Maximum Total Length [Max TL], 4 cm Max TL bins)
  - Commercial Other: 2013-2017
  - Recreational East: 2005 – 2023
  - Recreational West: 2005 – 2023

Base Model Data Inputs (cont.)

- Abundance indices
  - Fishery-independent
    - RVC Dry Tortugas: 1999-2000, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2021, 2023
    - RVC FL Keys: 1997, 2000 – 2012, 2014, 2016, 2018, 2022
    - RVC SE FL: 2013 – 2016, 2018, 2021-2022
    - FIM YOY: 1999 – 2022
    - Combined Gulf Video: 1996-1997, 2002, 2004-2012, 2014, 2016-2022
    - SERFS Video: 2011-2019, 2021-2022
  - Fishery-dependent
    - Commercial longline: 1993 – 2010

- Length composition from abundance indices (8:96 cm Maximum Total Length [Max TL], 4 cm Max TL bins)
  - GOM Combined Video: 2004-2021 (all years combined)
  - Commercial longline retained lengths

- Length composition from abundance indices (10:95 cm Maximum Total Length [Max TL], 5 cm Max TL bins)
  - RVC Dry Tortugas: 1999-2000, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2021, 2023
  - RVC FL Keys: 1997, 2000 – 2012, 2014, 2016, 2018, 2022
  - RVC SE FL: 2013 – 2016, 2018, 2021-2022

Data Inputs through 2023

Commercial Landings

- Due to time constraints, commercial landings from outside of FL in 2023 were not included (these have contributed at most 11.87% of the commercial landings with an average contribution of 2.33%).

Commercial Releases

- 2023 interpolated as average of 2020-2022.

Recreational Landings and Releases (including SRFS/SRFS-calibrated private mode)

RVC Dry Tortugas Index and Length Comps

SCRFA.org

Life History

Genetic Studies

Shulzitski et al. (2009)

- Samples from Jupiter, Dry Tortugas, Puerto Rico, Belize, and Honduras
- Genetic data: microsatellites
- Determine population structure

- Results
  - **Genetically homogenous**

Portnoy and Gold (2013); Carson et al. (2011)

- Samples from Dry Tortugas, Puerto Rico, St. Thomas, and St. Croix
- Genetic data: microsatellites and mitochondrial DNA
- Determine population structure, long-term connectivity, effective population size

- Results
  - **Genetically homogenous**
  - Possible demographic independence among localities based on different effective population sizes
  - Possible differing responses to exploitation

Larval transport

Domeier (2004)

- Drifter vials released at spawning sites in Riley's Hump
  - Red zone = range of drifters recovered within first 45 days
  - Gray areas = percent of recoveries per 20km of coastline
- Indirect evidence of a recruitment pathway from the Dry Tortugas that may deliver larvae to the Florida reef tract and to nursery habitats as far north as Palm Coast, Florida
  - Closest region with significant vial recovery was the Middle Keys (>200 km away)
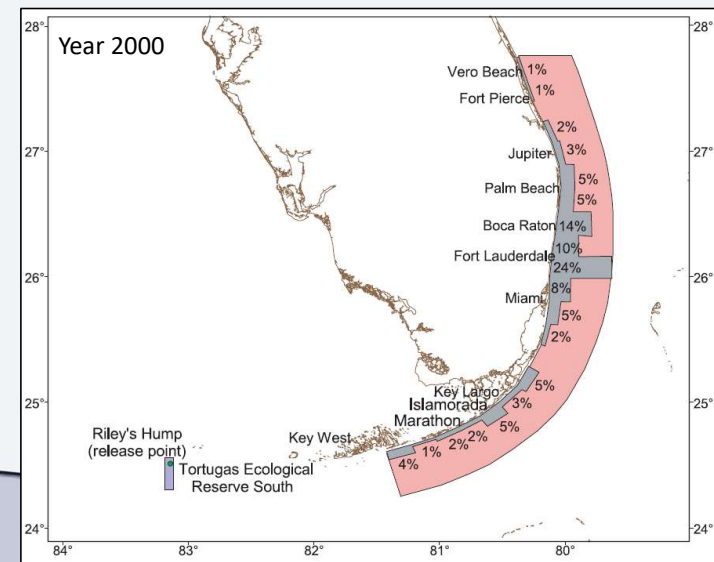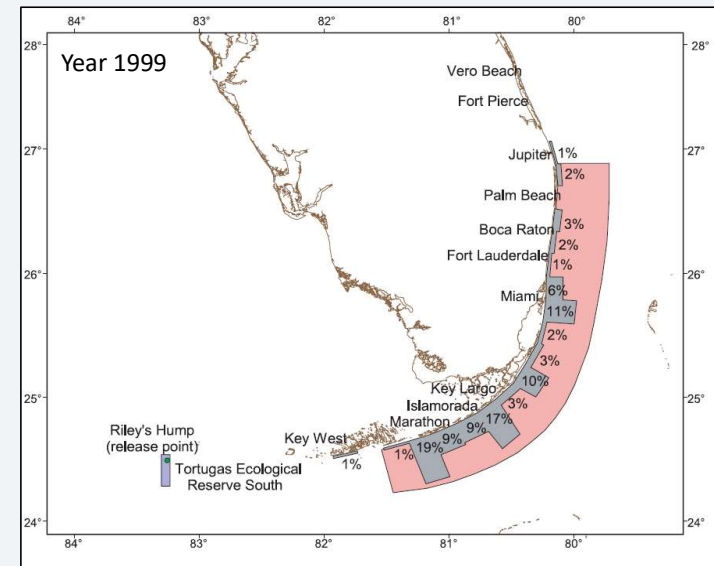
Larval transport

Paris et al. 2005; Kough et al. 2016; Lindeman et al. 2001

- Modeled larval dispersal reveals larval emigration from Cuba (particularly from western and northwestern regions) to southeastern Florida *may* occur
- Contribution is low in terms of the total number of advected larvae over the planktonic larval duration of ca. 30 days

Kough et al. 2016

b) Mutton   Paris et al. 2005
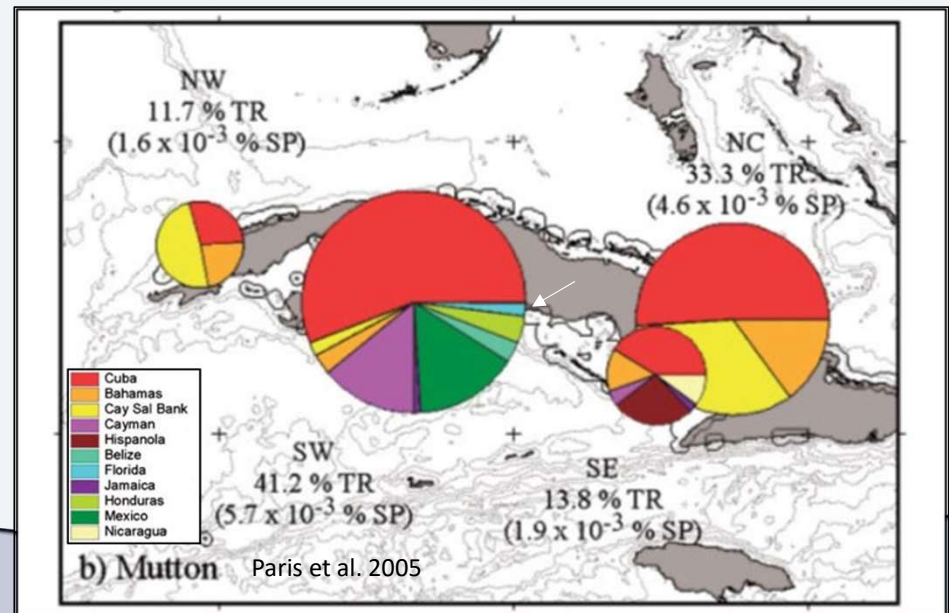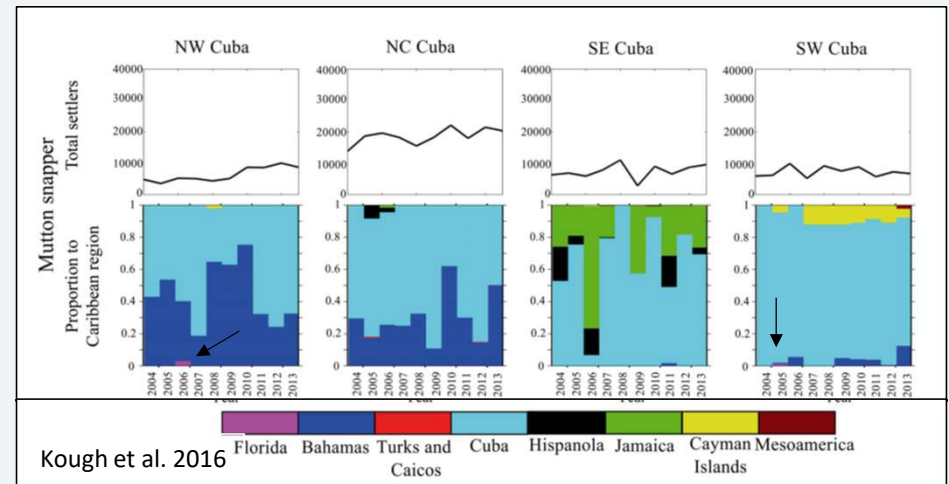
Larval transport

D'Alessandro et al. 2010

- Larvae occurrence was even across the SOF, but larvae were more abundant in the eastern SOF and more than twice as concentrated
- Growth was significantly greater on the eastern SOF compared to the west
  - Greater prey availability in the east
- General agreement with the modeling and drifter vial results in that Mutton Snapper larvae are found more frequently on either sides of the Florida Current and less frequently towards the middle of this current.

Fig. 1. Study area. (●) The 17 stations across the Straits of Florida, sampled monthly from 2003 to 2004
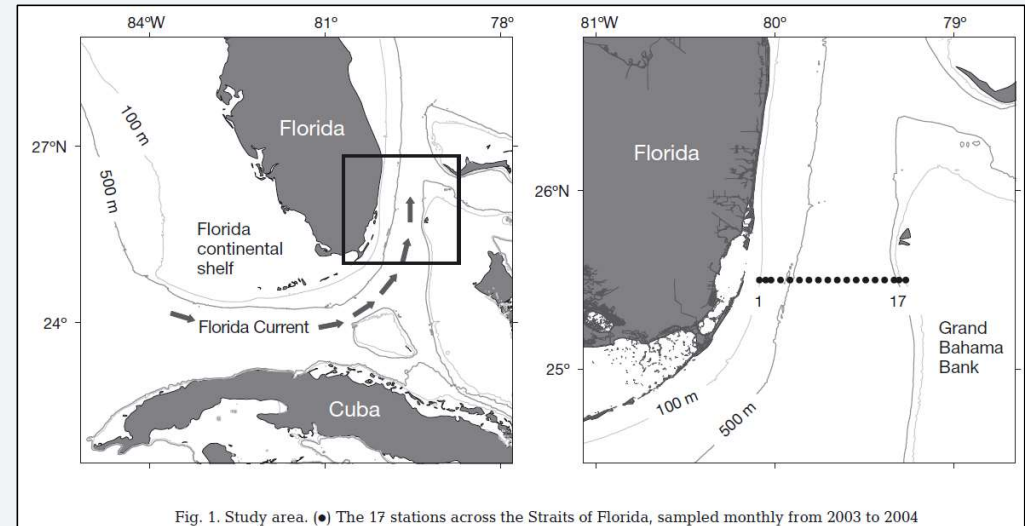
Summary

- The Florida Current may serve as an effective barrier to recruitment of Mutton Snapper to the Florida Keys and Southeast Florida from populations in Cuban waters and other parts of the Caribbean Sea, and the level of genetic connectivity with those areas is likely to be low.

- For these reasons, SEDAR 79 and past assessments have assumed a single closed population in the SAFMC and GMFMC jurisdictions for the purpose of stock assessment and management (SEDAR 15A 2008, SEDAR 15A Update 2015).
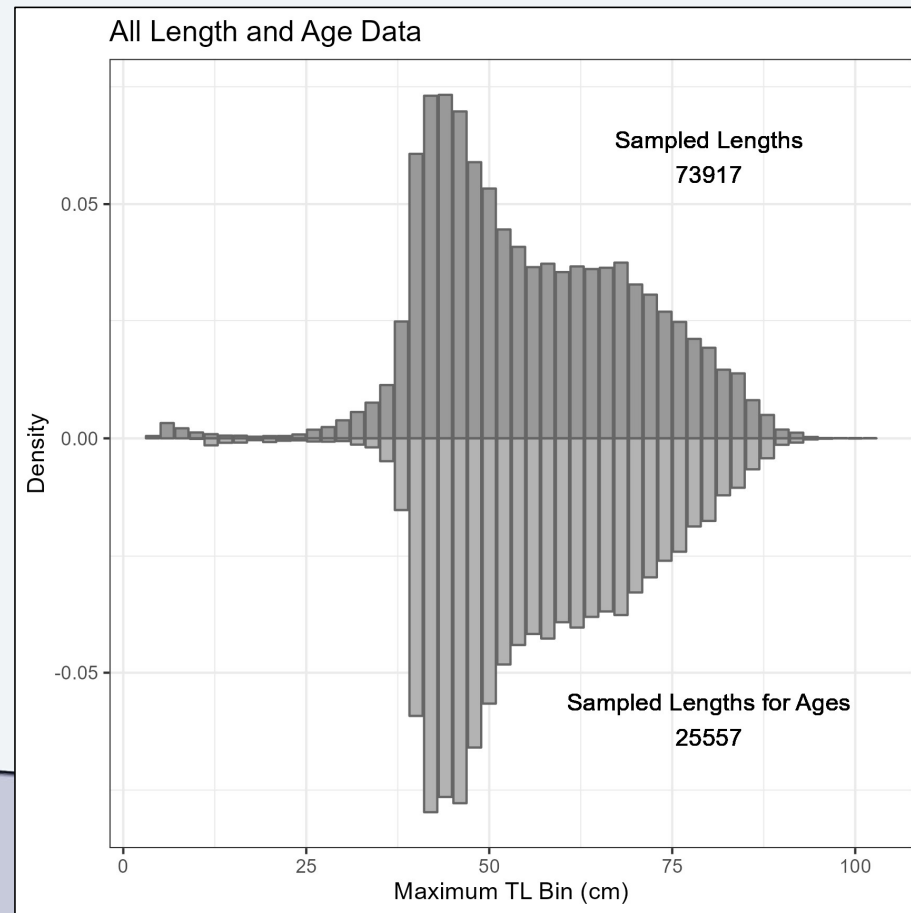
Main Data Inputs: Life History

- Gutted Weight to Whole weight (Com Landings)
  - Whole weight = 1.11*Gutted Weight
- Length – Length
  - E.g. MaxTL (mm) = 15.5 + 1.07*FL (mm)

- Length – Weight Relationship
  - Whole Weight (kg) = $6.63E{-}06*\text{MaxTL (cm)}^{3.1601}$
- Sex Ratio ≈ 1:1
- Fecundity (eggs) = SSB
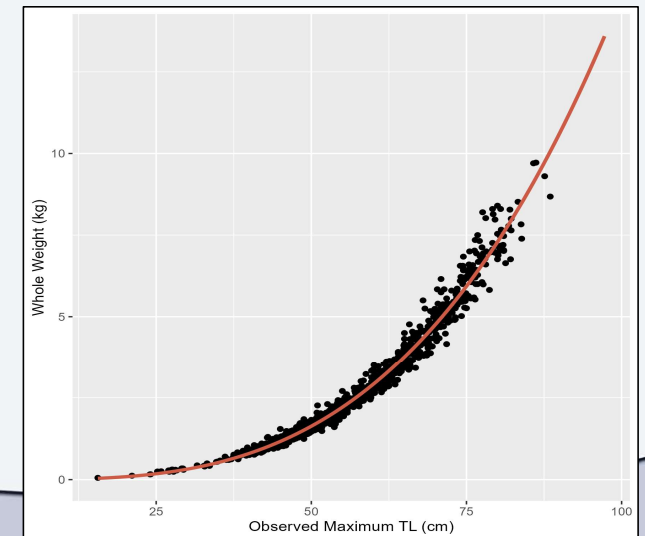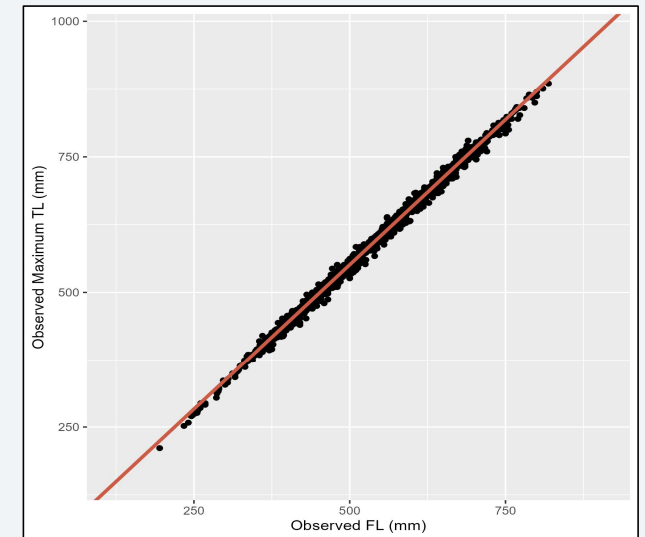
# Sampled Lengths vs Sampled Lengths for Ages

All Length and Age Data

Sampled Lengths
73917

Sampled Lengths for Ages
25557

Density

Maximum TL Bin (cm)

Length vs Age by Region
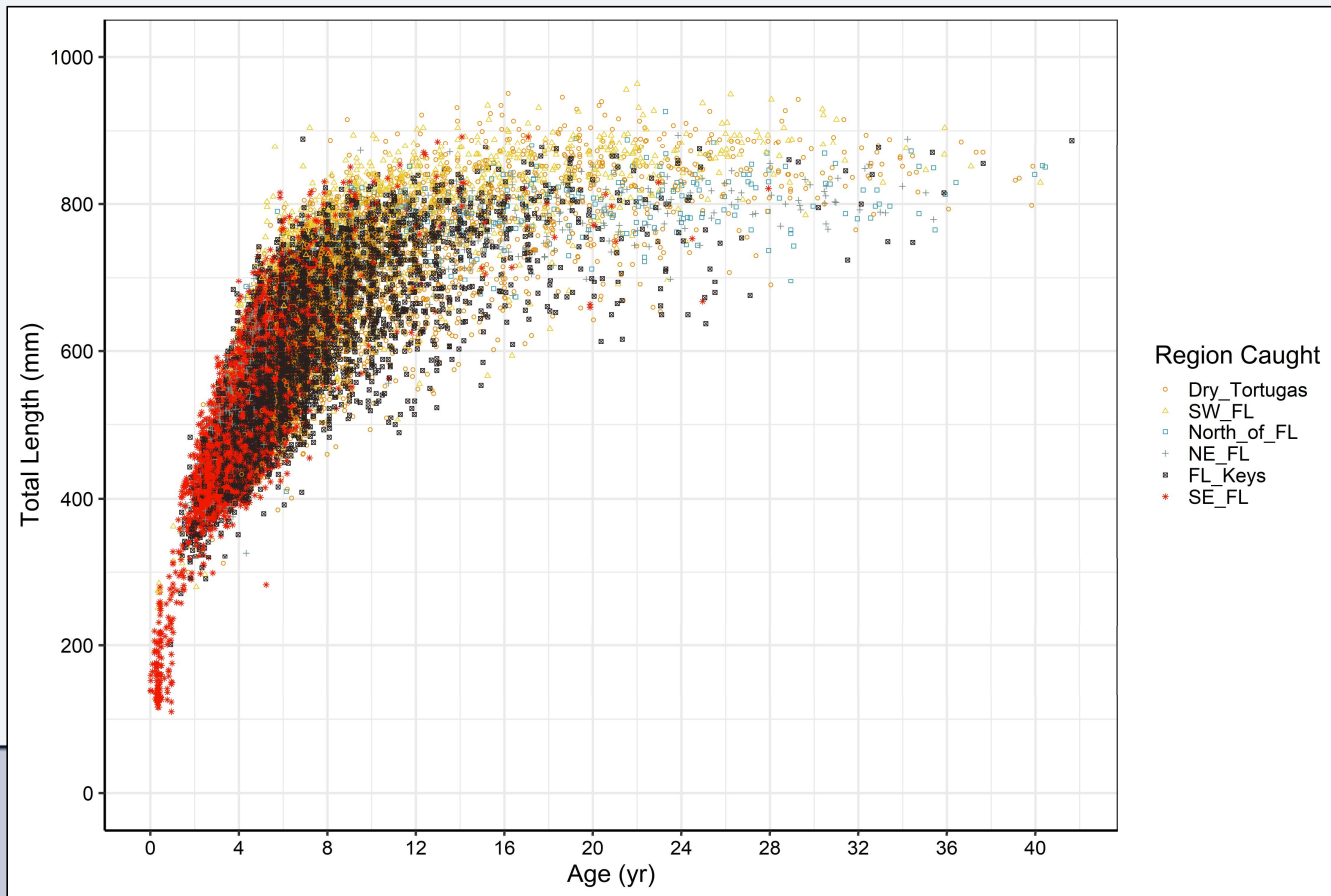
Main Data Inputs: Life History

- Initial Values for Growth
  - Based on size-truncated von Bertalanffy model (DW-22; n = 24,234 otoliths; 1977 – 2022)
    - L_{inf} = 847 mm Max TL, k = 0.163, t0 = -1.12
- No Sexual Dimorphism
- Natural Mortality
  - Hamel and Cope (2022) longevity-based constant M
    - M = 0.129
  - Inversely related to fish length following Lorenzen (2022) scaled to ages 3 – 42 (SAR Table 2.13.10)
    - M = 0.235 at age 3
- Release Mortality
  - Commercial: 30% with 15% and 45% sensitivities
  - Recreational: 30% with 15% and 45% sensitivities
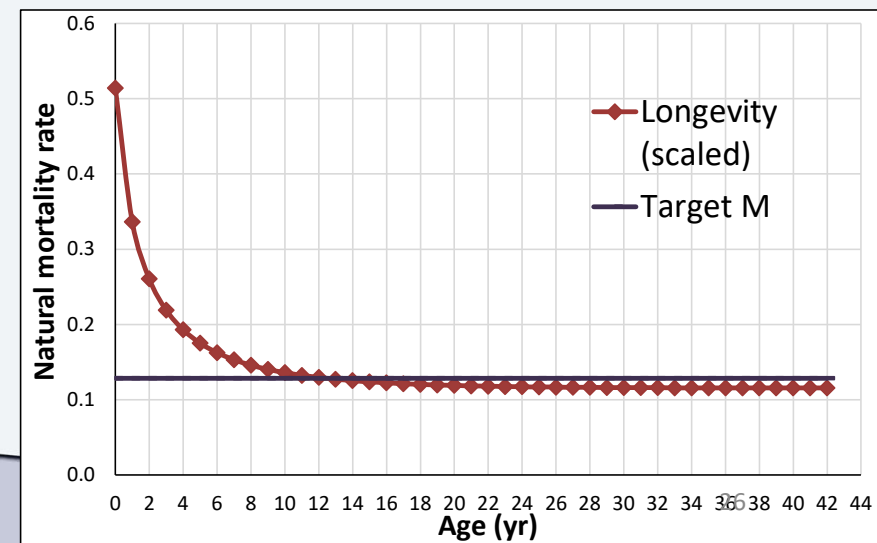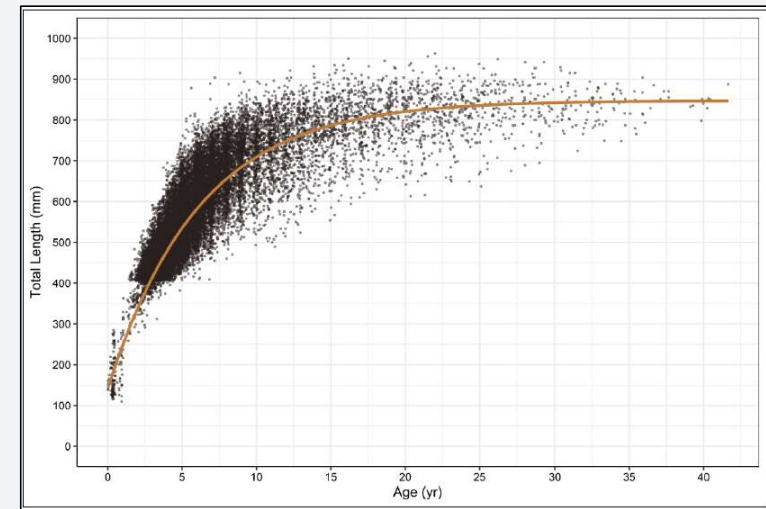
Main Data Inputs: Life History

- Size/Age at Maturity (DW-12)
  - Logistic Regression that includes all sampling months and spawning capable or actively spawning females assigned through histology or macroscopic staging in the mature group.

- L50 = 422 mm natural TL; se = 198 mm
- Slope = 0.126; se = 0.042
- Intercept = -53.021 mm nat TL; se = 17.497 mm
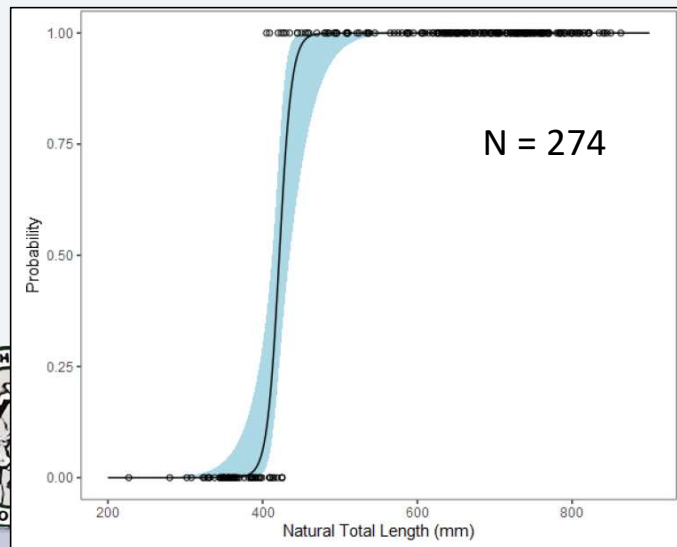
- A50 = 3.5 years; se = 1.1 years
- Slope = 2.535; se = 0.787
- Intercept = -6.1 years; se = 2.1 years

N = 274

N = 240
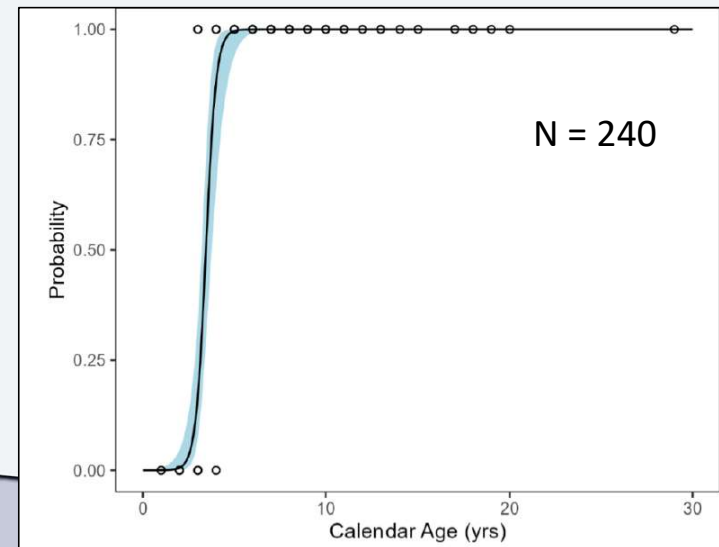
SCRFA.org

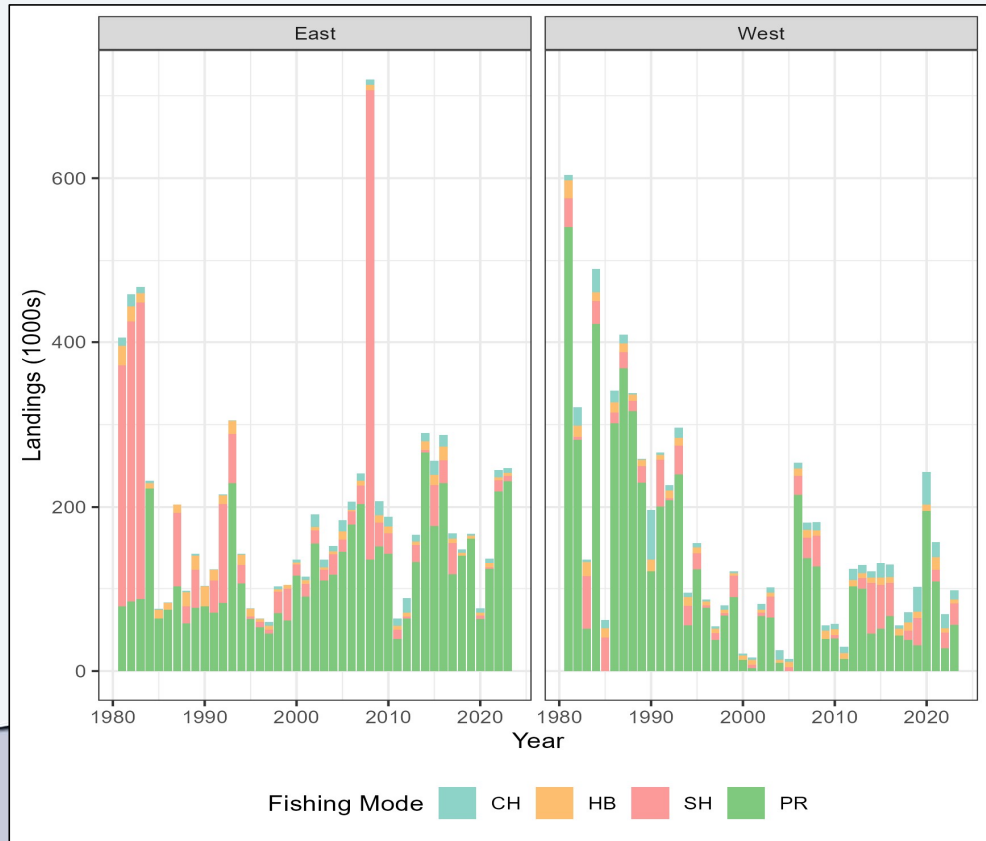# Landings and Releases

Rec data including FL SRFS

Rec Landings and Releases incorporating SRFS includes:

- Headboat data from SRHS
- Charter data from MRIP-FHS
- Shore mode data from MRIP-FES
- Non-FL Private mode data from MRIP-FES
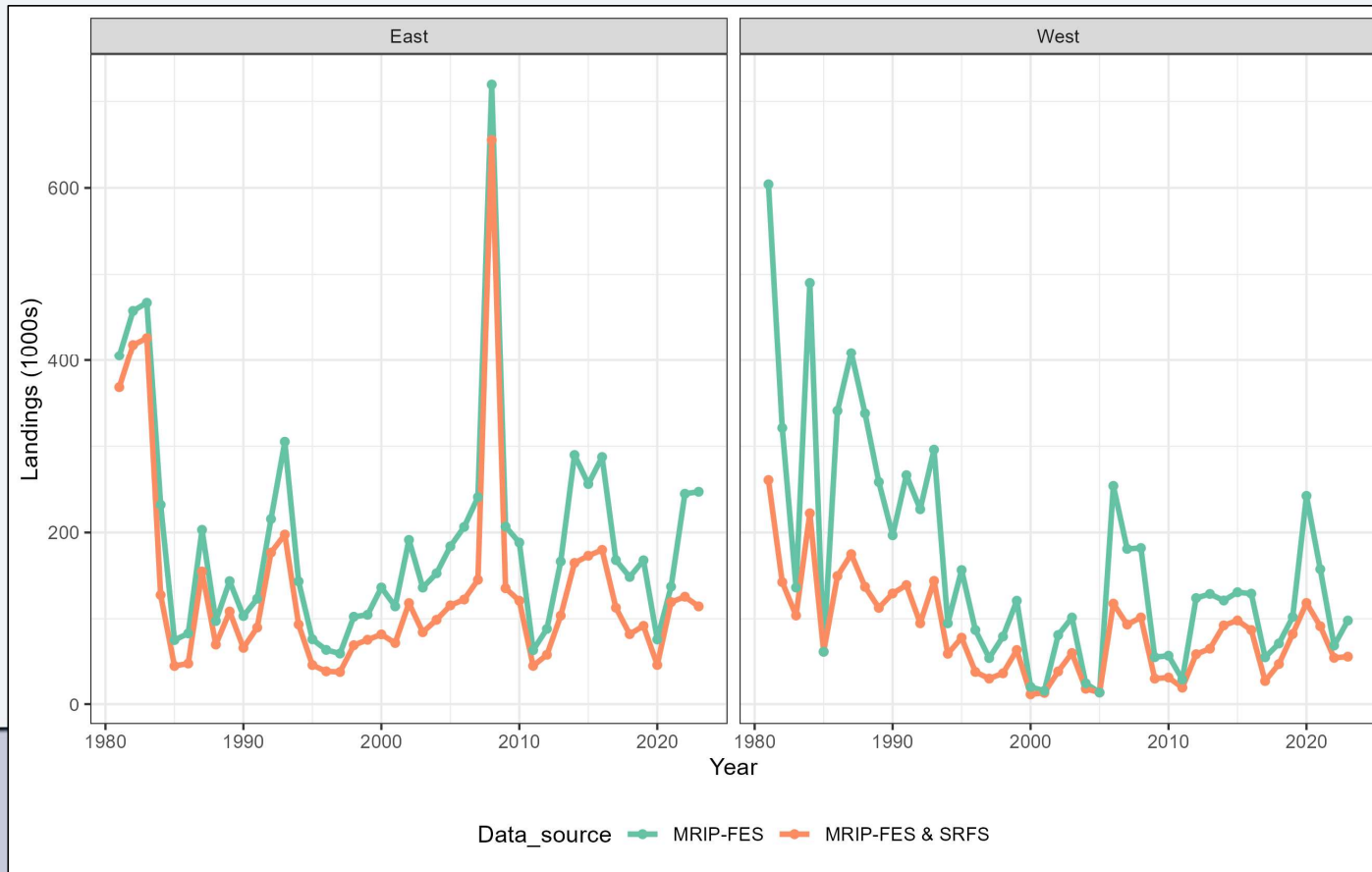- FL Private mode data from SRFS (2021-2023) & MRIP-FES calibrated to SRFS (1981-2020)
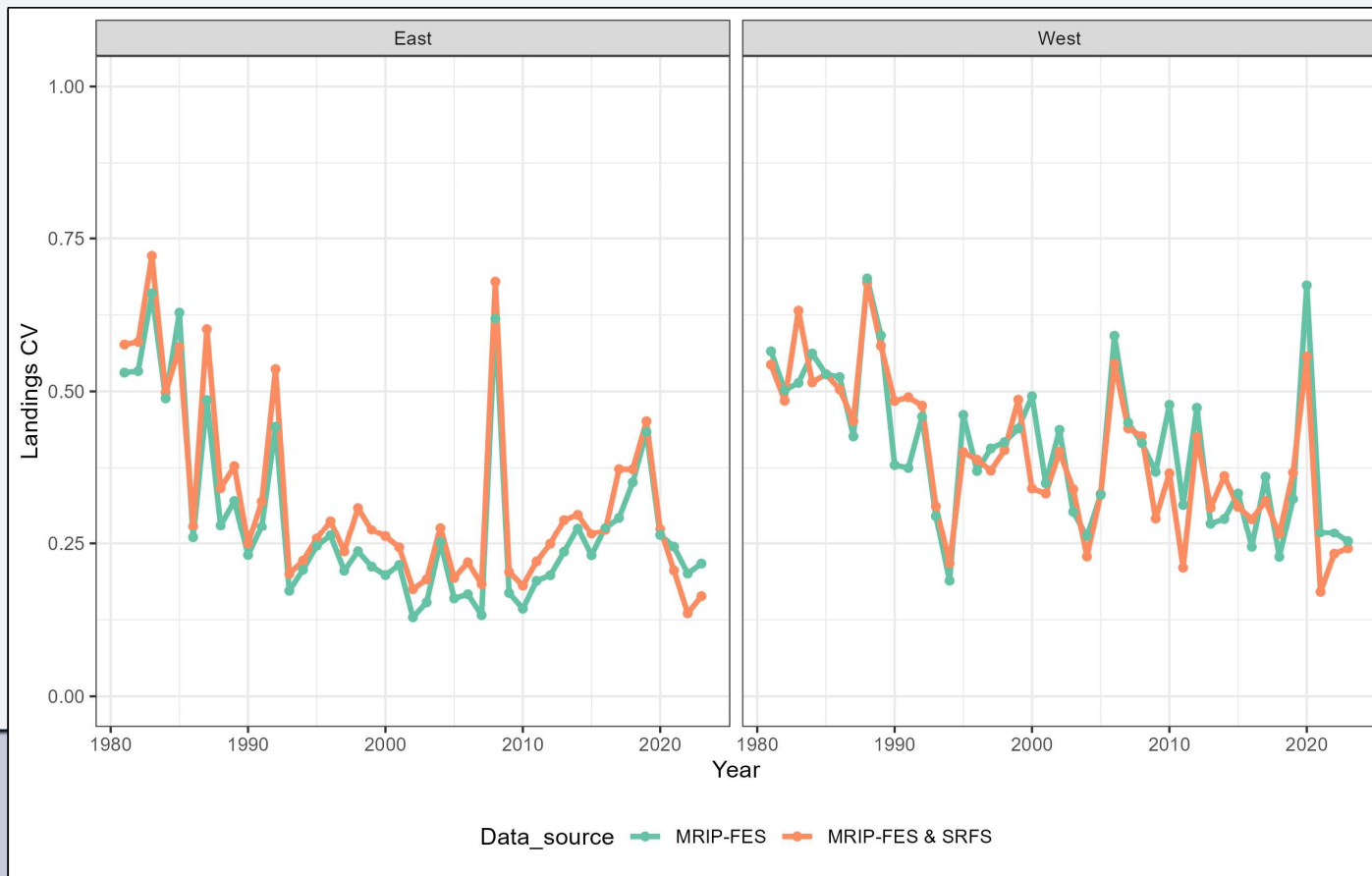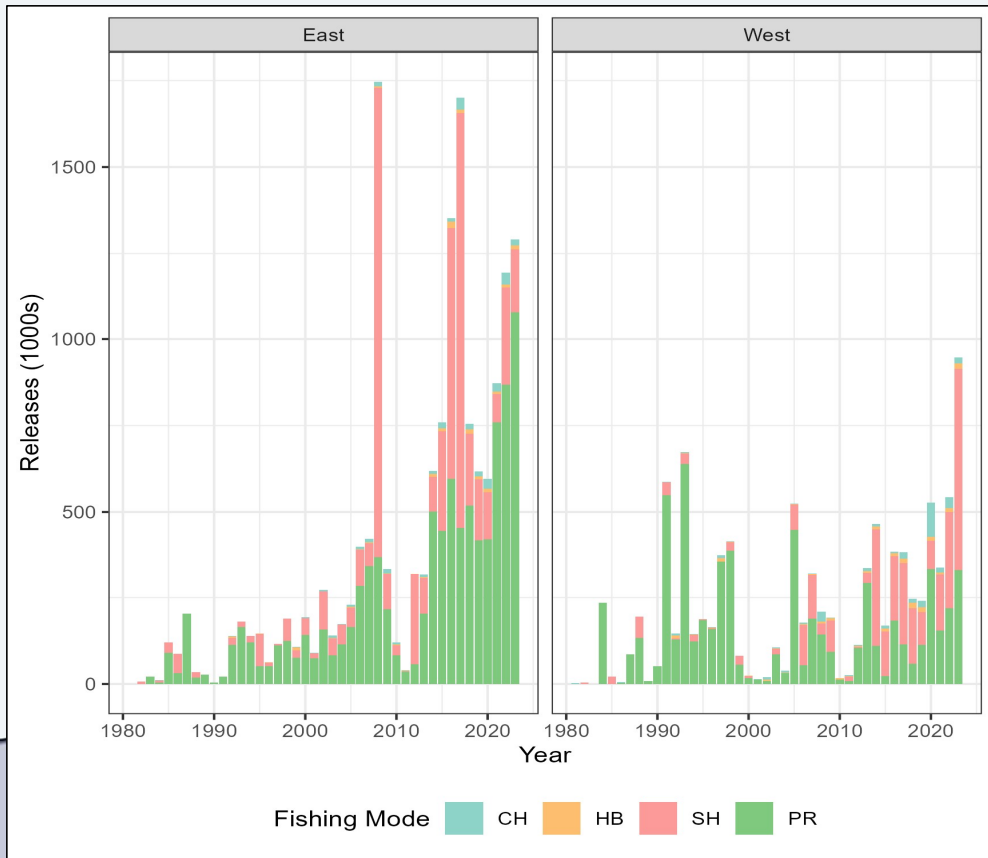
MRIP-FES Landings

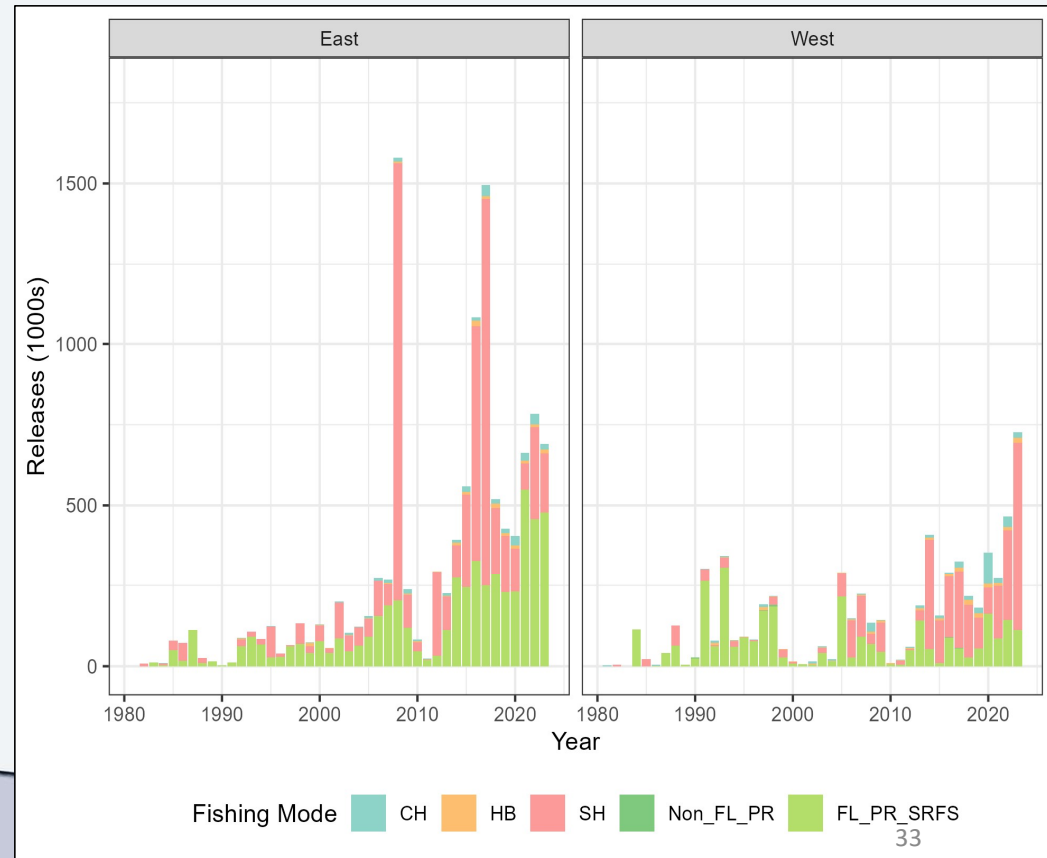SRFS-calibrated Landings

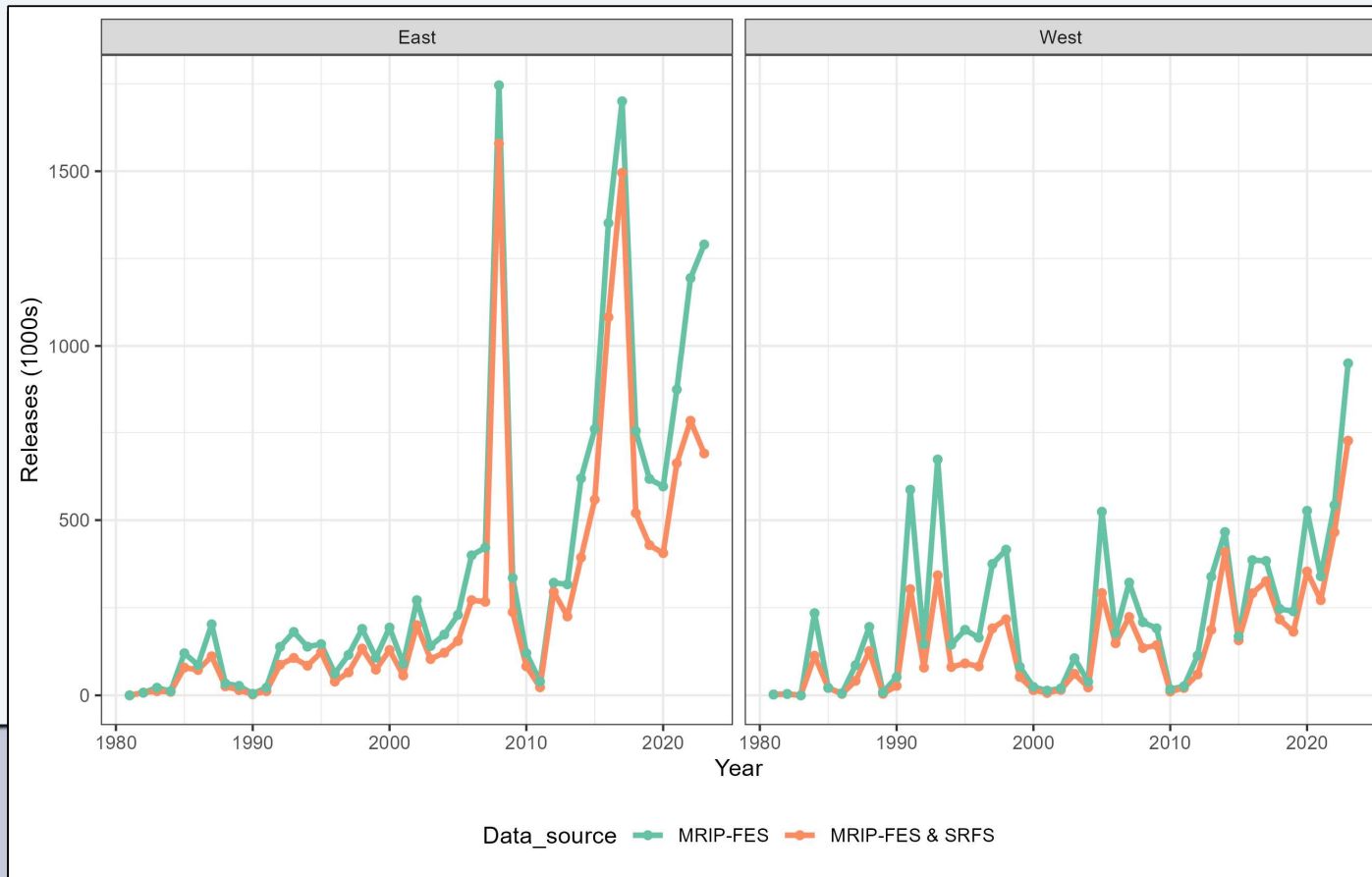30
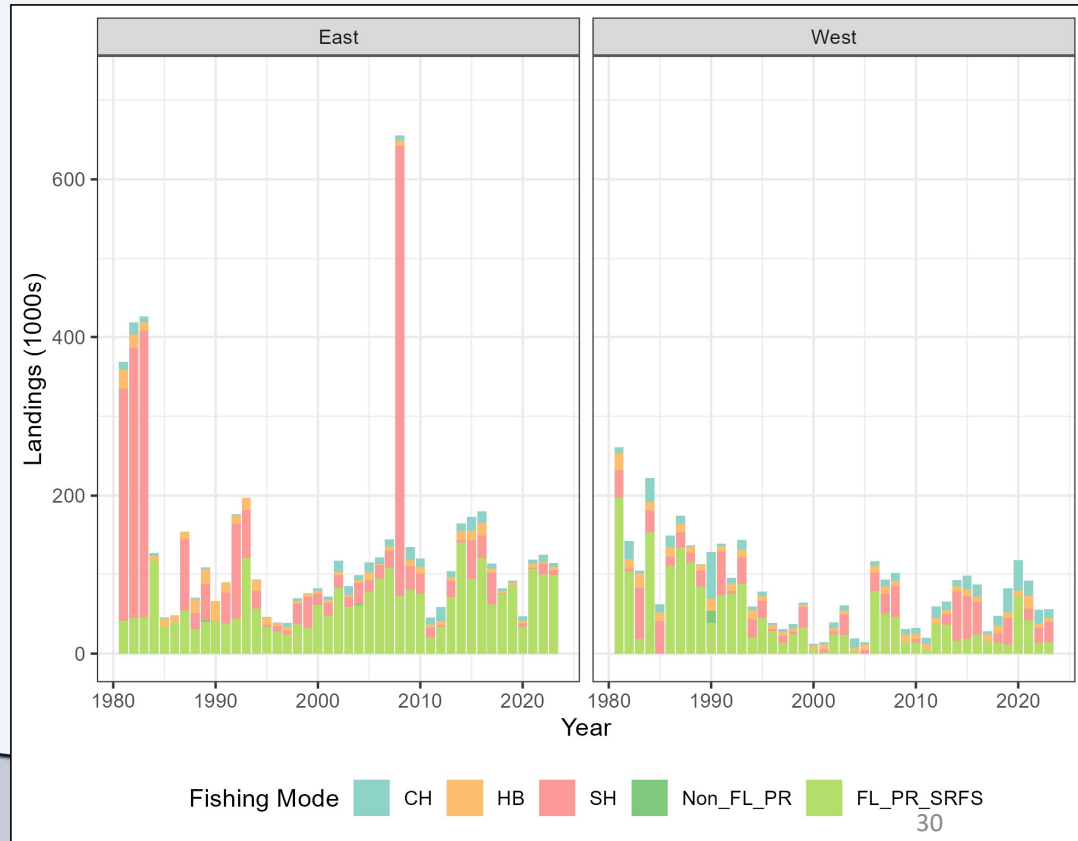
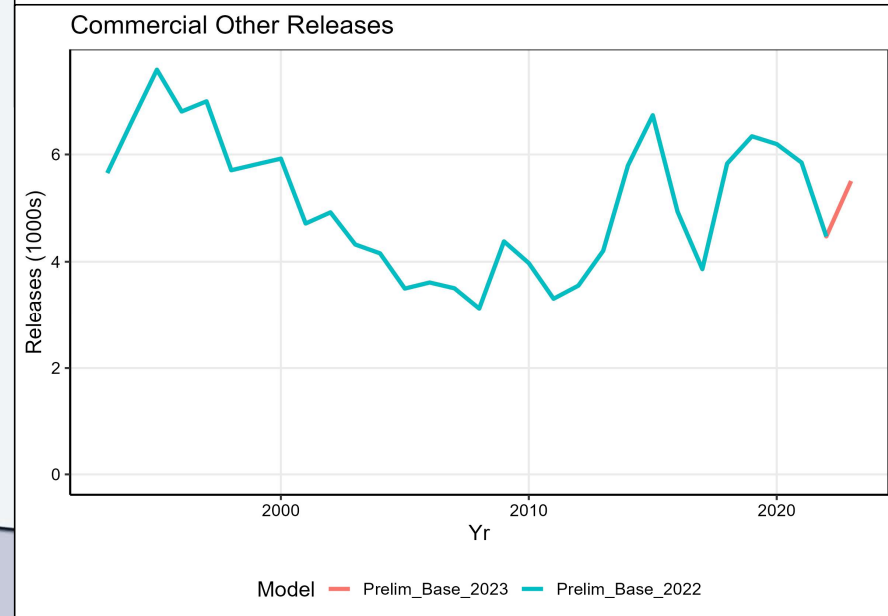# Rec Total Landings (1000s)

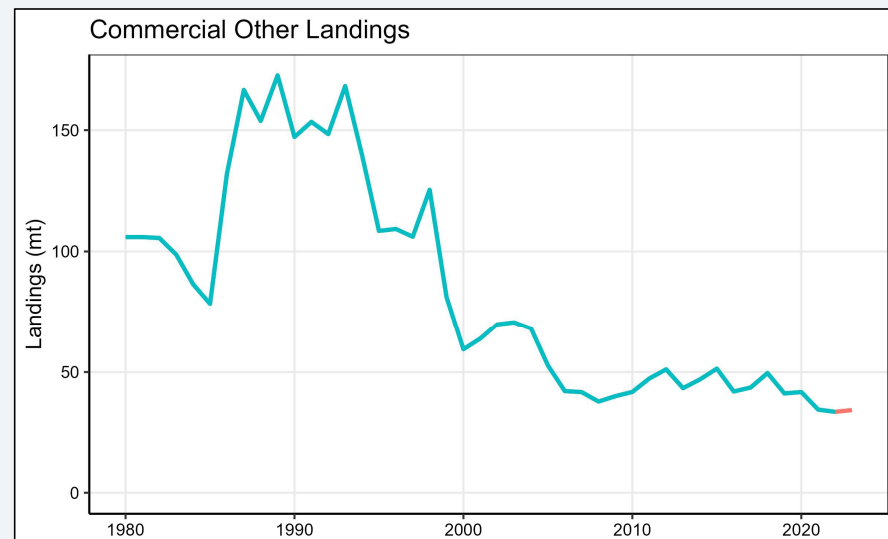# Rec Landings CVs

MRIP-FES Releases
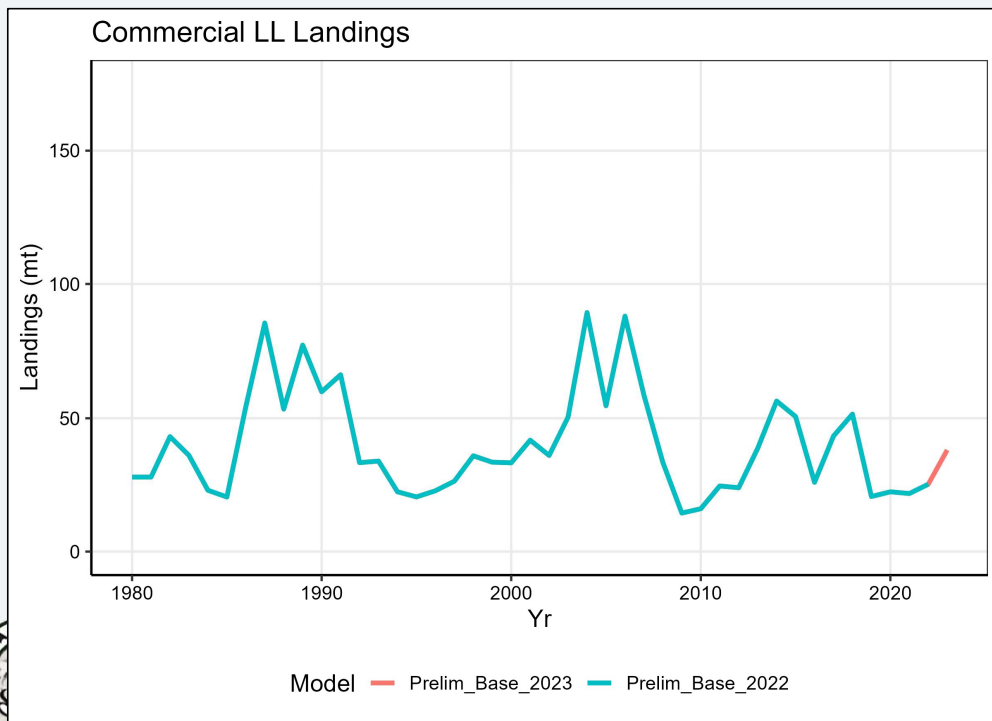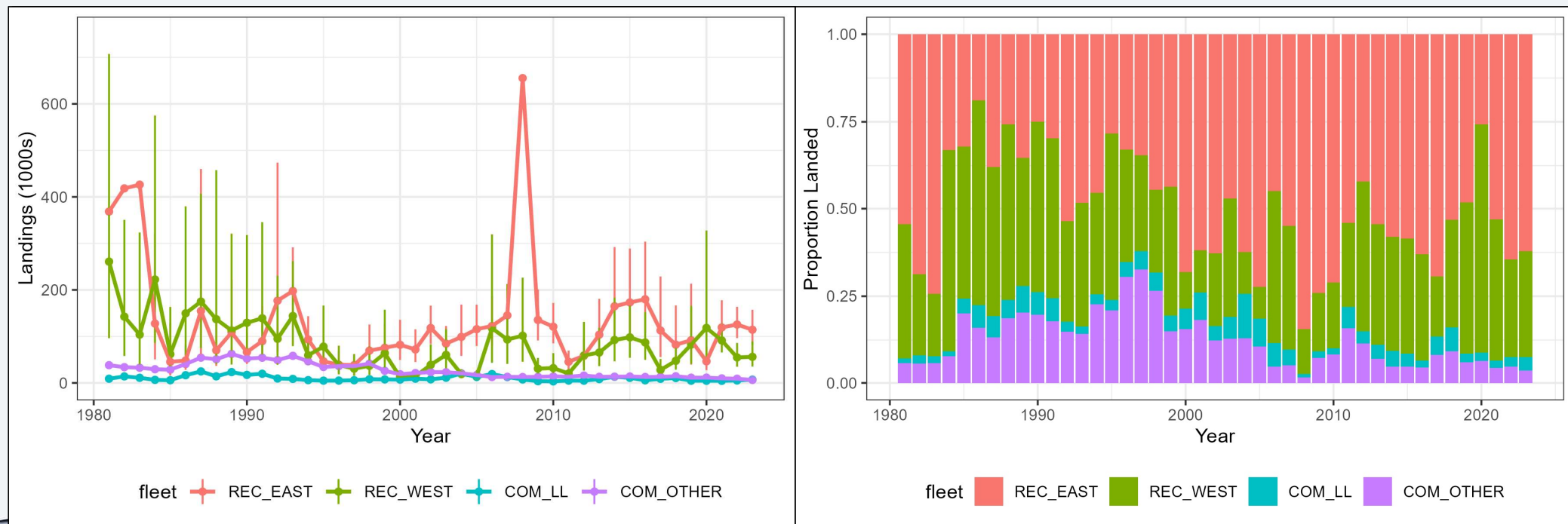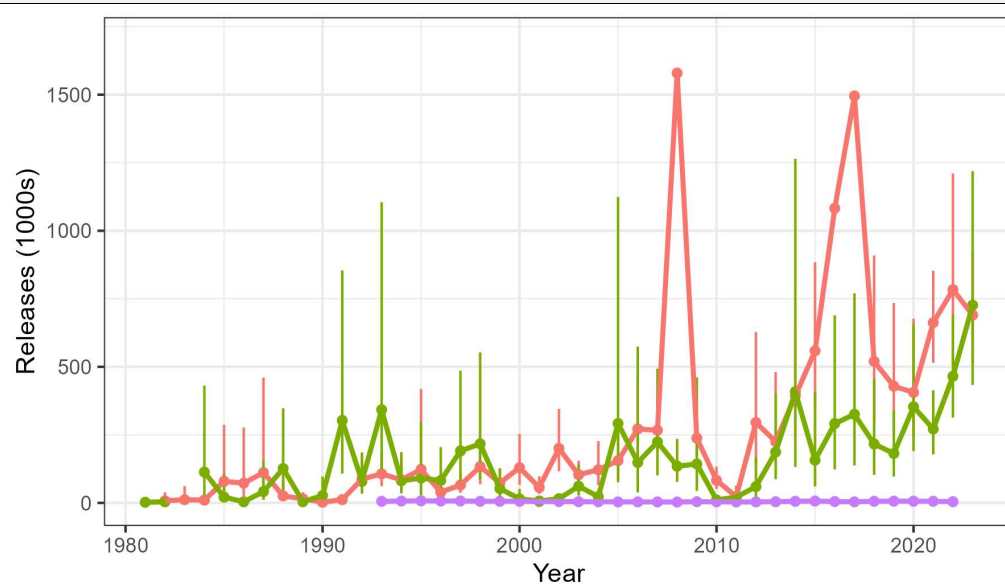
SRFS-calibrated Releases

Rec Total Releases (1000s)

Rec Releases CVs

Commercial Landings and Releases

Landings (1000s) by Fleet (inc SRFS)

Releases (1000s) by Fleet (inc SRFS)
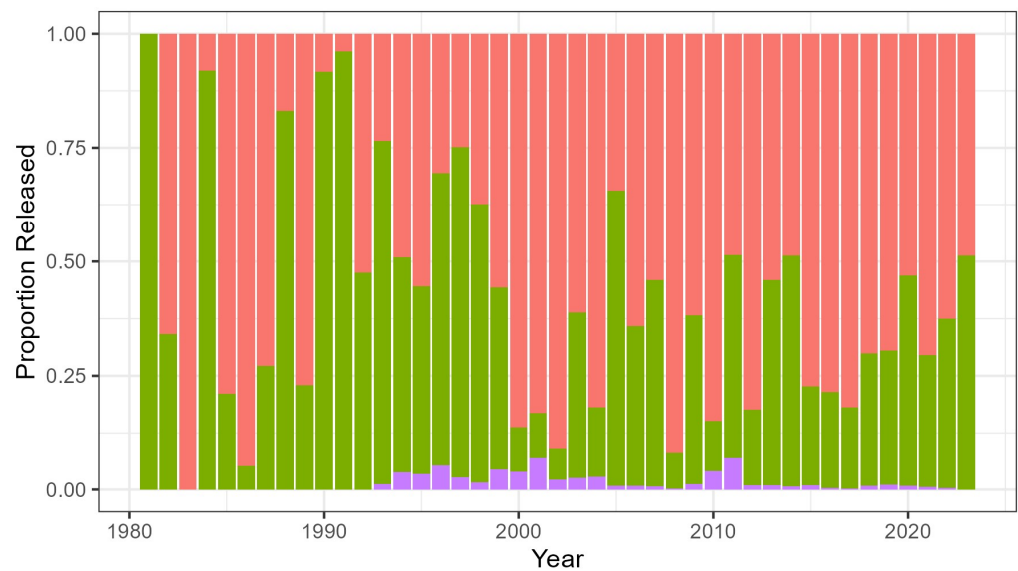
SCRFA.org

Indices

Main Data Inputs: Indices

Index	Dependent or Independent	~Time Series	Number of Years	Targets	Lengths (Y/N)	Ages (Y/N)	Gear	Standardization Method
SERFS Video	Independent	2010-2022	12	Post YOY	No	No	Video	Model-Based
FIM Indian River Lagoon	Independent	1999-2022	24	YOY	Yes	Yes (few)	183-m haul seine	Model-Based
RVC (SE FL, FL Keys, Dry Tortugas)	Independent	1997-2023	(7, 19, 12)	Post YOY	Yes	No	Diver Survey	Model-Based
Combined Gulf Video	Independent	1996-2022	20	Post YOY	Yes	No	Video	Design-Based with CART
Commercial Longline	Dependent	1993-2010	17	Adults	Yes	Yes	Bottom Longline	Model-Based

Index Spatial Coverage

SERFS Video

FIM Inshore Seine

RVC Diver Survey (SE FL, FL Keys and Dry Tortugas)

GOM Combined Video

Commercial Longline

RVC SEFCRI

Riley's Hump

Western Dry Rocks

Dry Tortugas National Park
Sanctuary Preservation Areas
Biscayne National Park
John Pennecamp State Park
Coral Reef Ecosystem Conservation Area
FL Keys National Marine Sanctuary
FL Counties
FL CORAL REEF

Zuercher et al. 2020
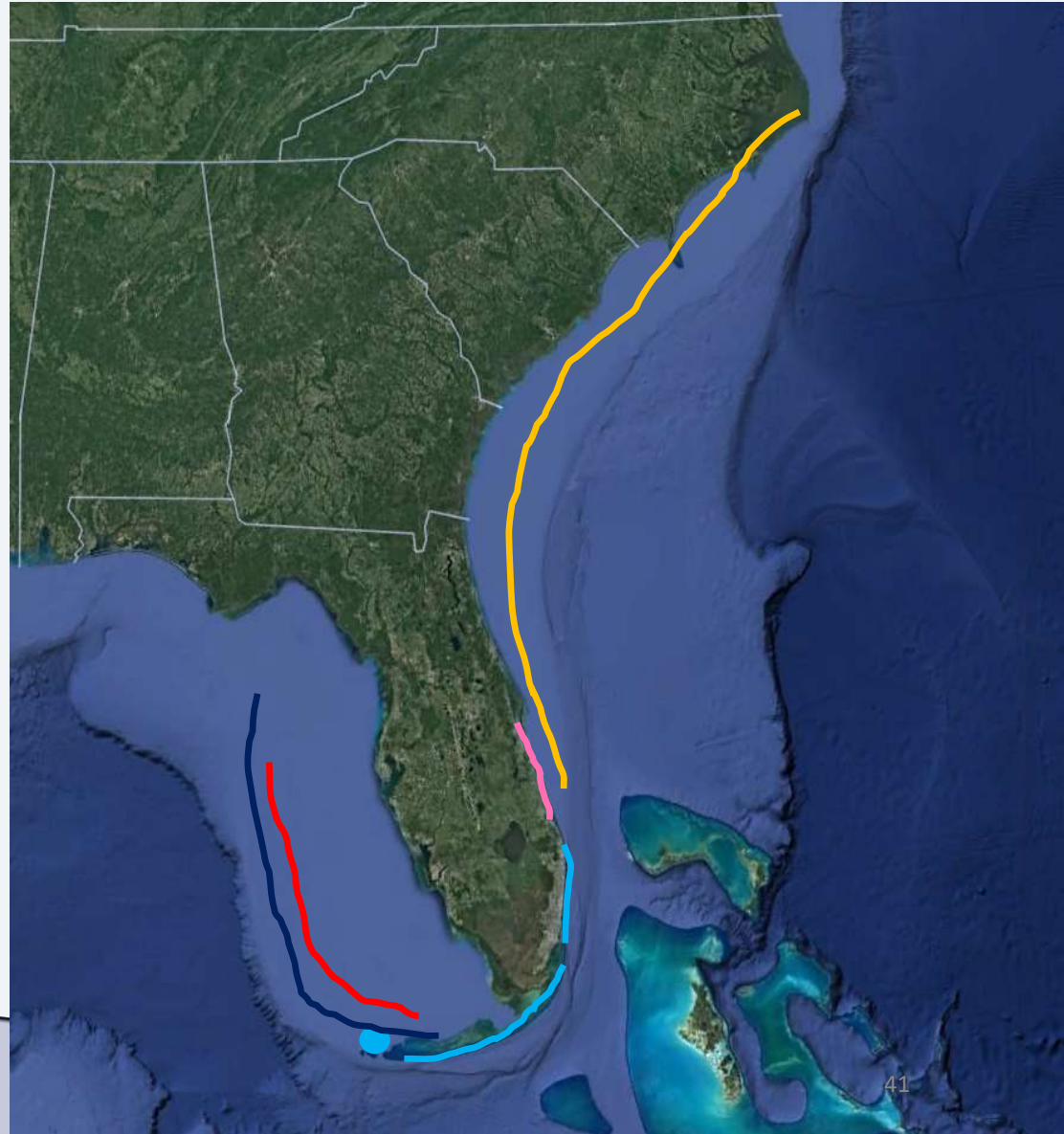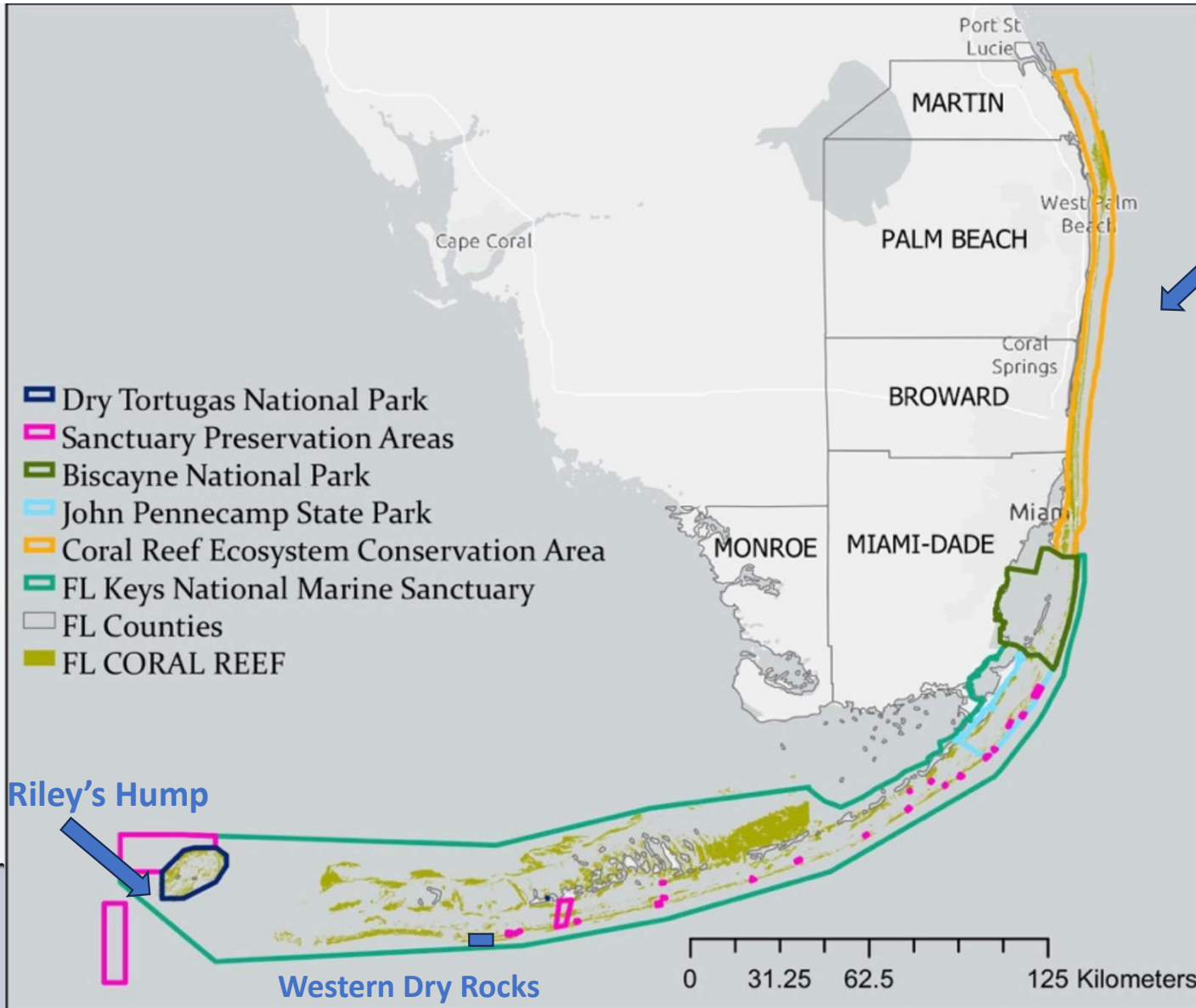
Main Data Inputs: Indices
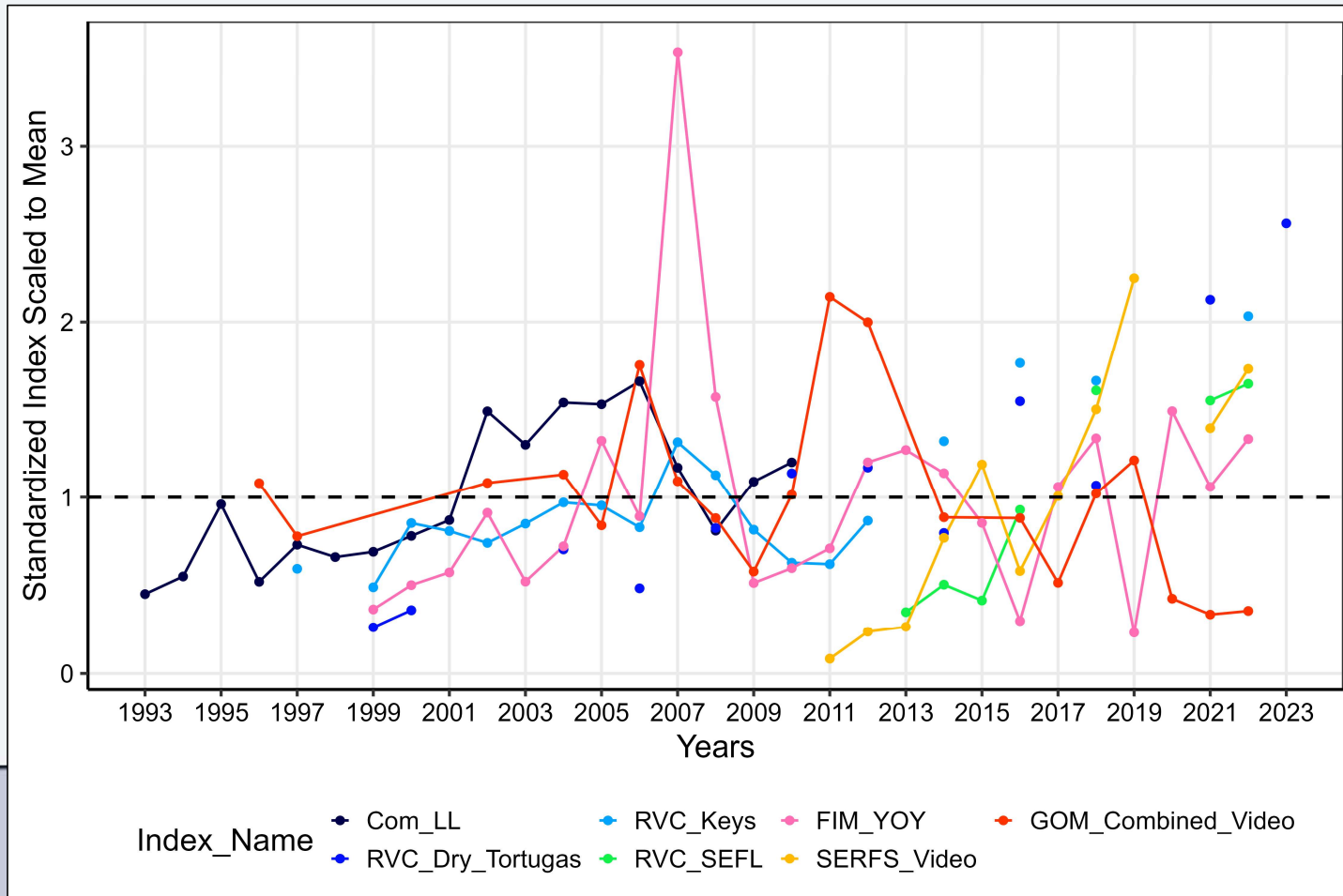
Indian River YOY Index
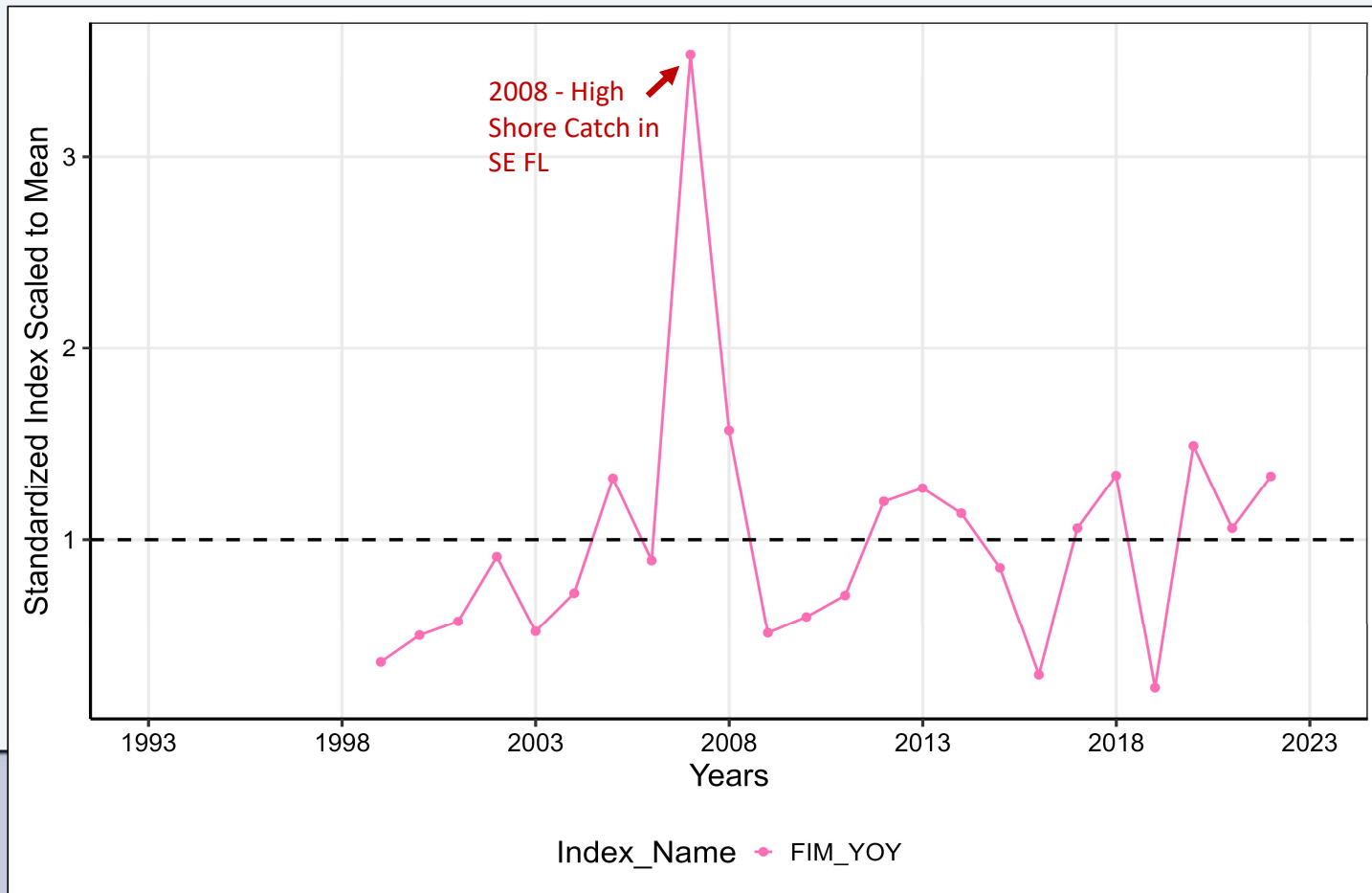
FL Keys/East Coast Post YOY Indices
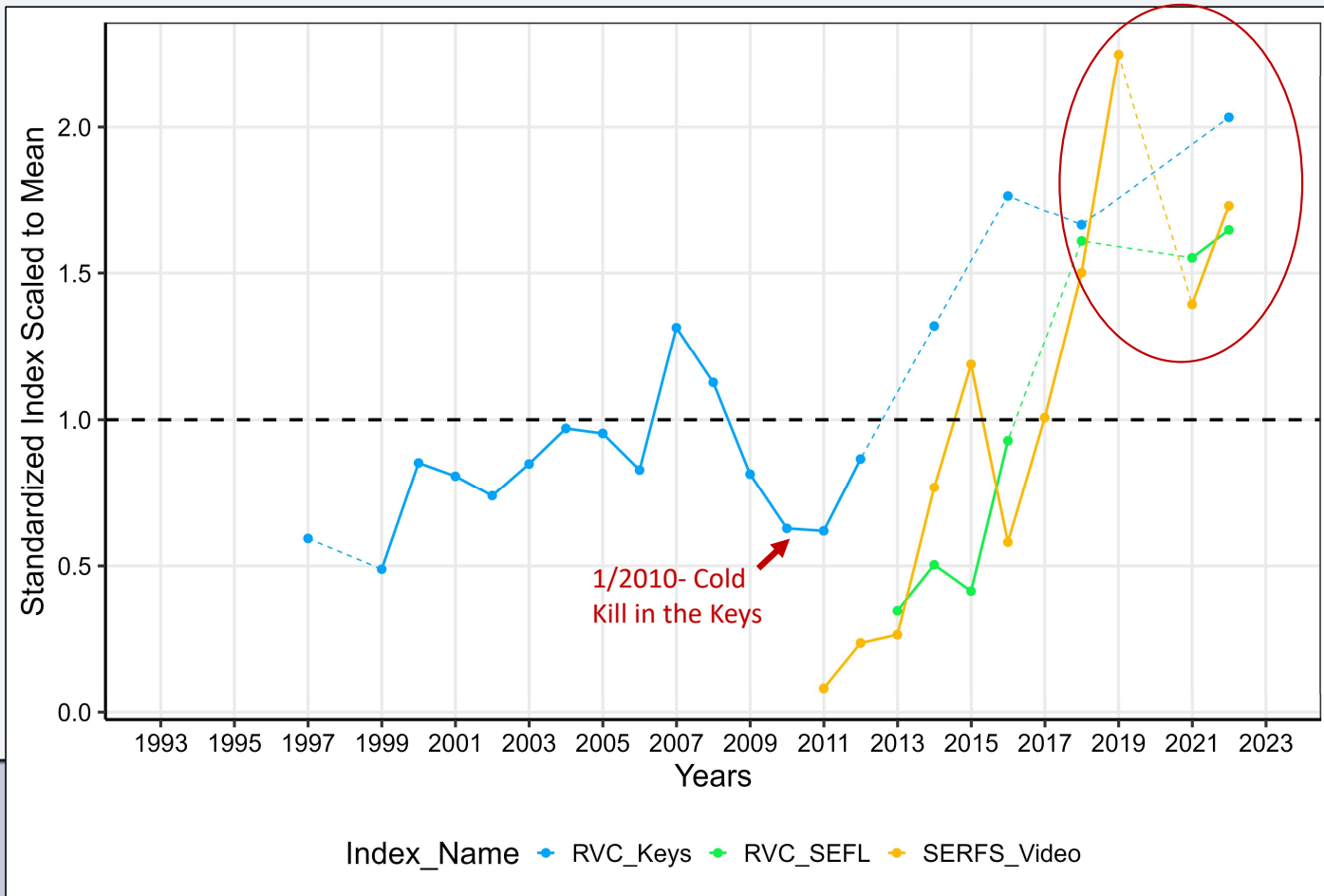
GOM/Dry Tortugas Post YOY Indices
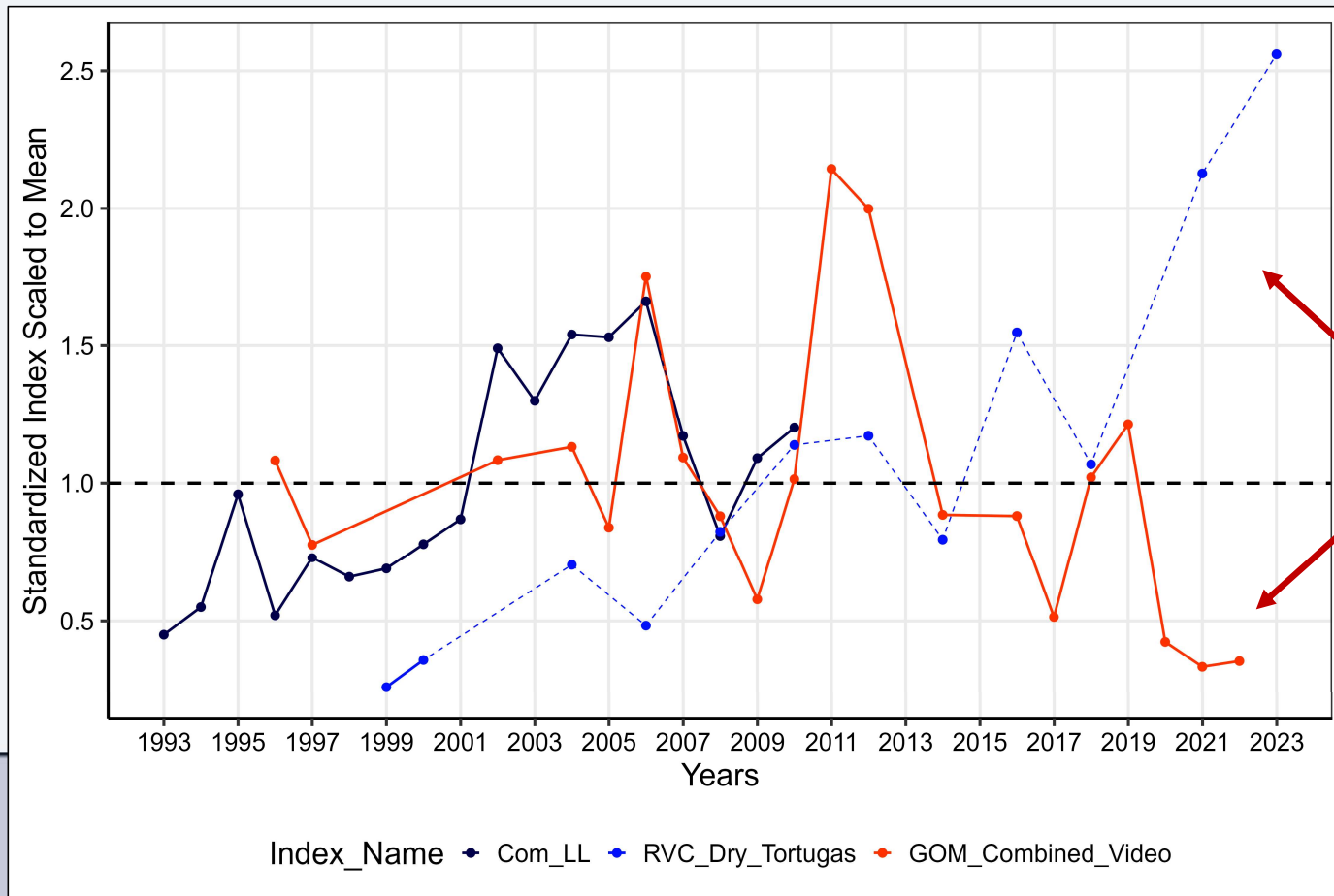
Main Data Inputs: Index CVs
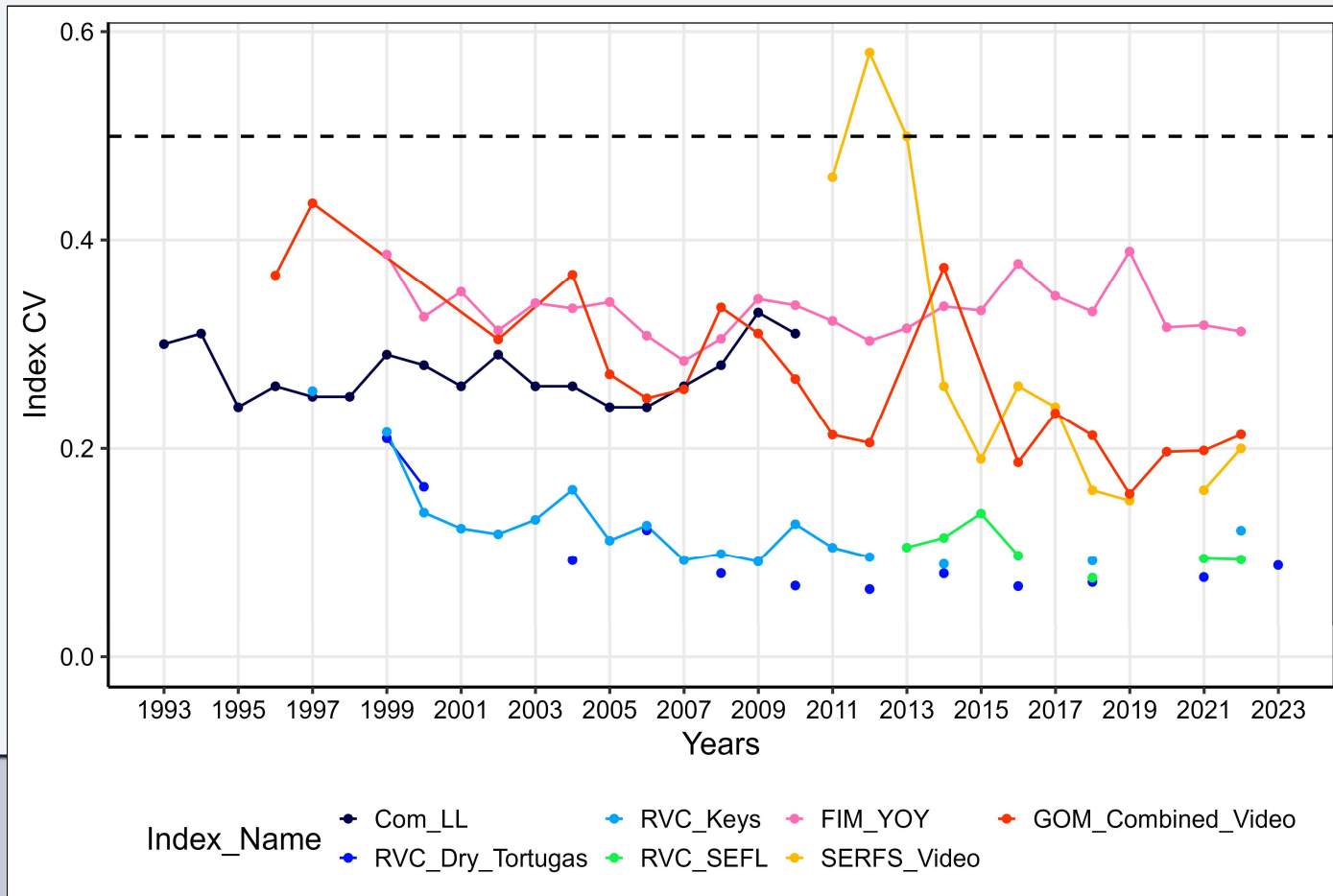
Feeley et al. 2018

Gulf Combined Video Survey

Spatial Coverage

- Natural Habitat only
- Stat zones 2-5
- Less than 110 m
- SEAMAP (SRFV) 1993-2019
- FWRI 2010-2015
  - Zones 4 and 5
- FWRI 2016-2019
  - Zones 2-5
- FWRI 2020 - Present
  - G-FISHER design
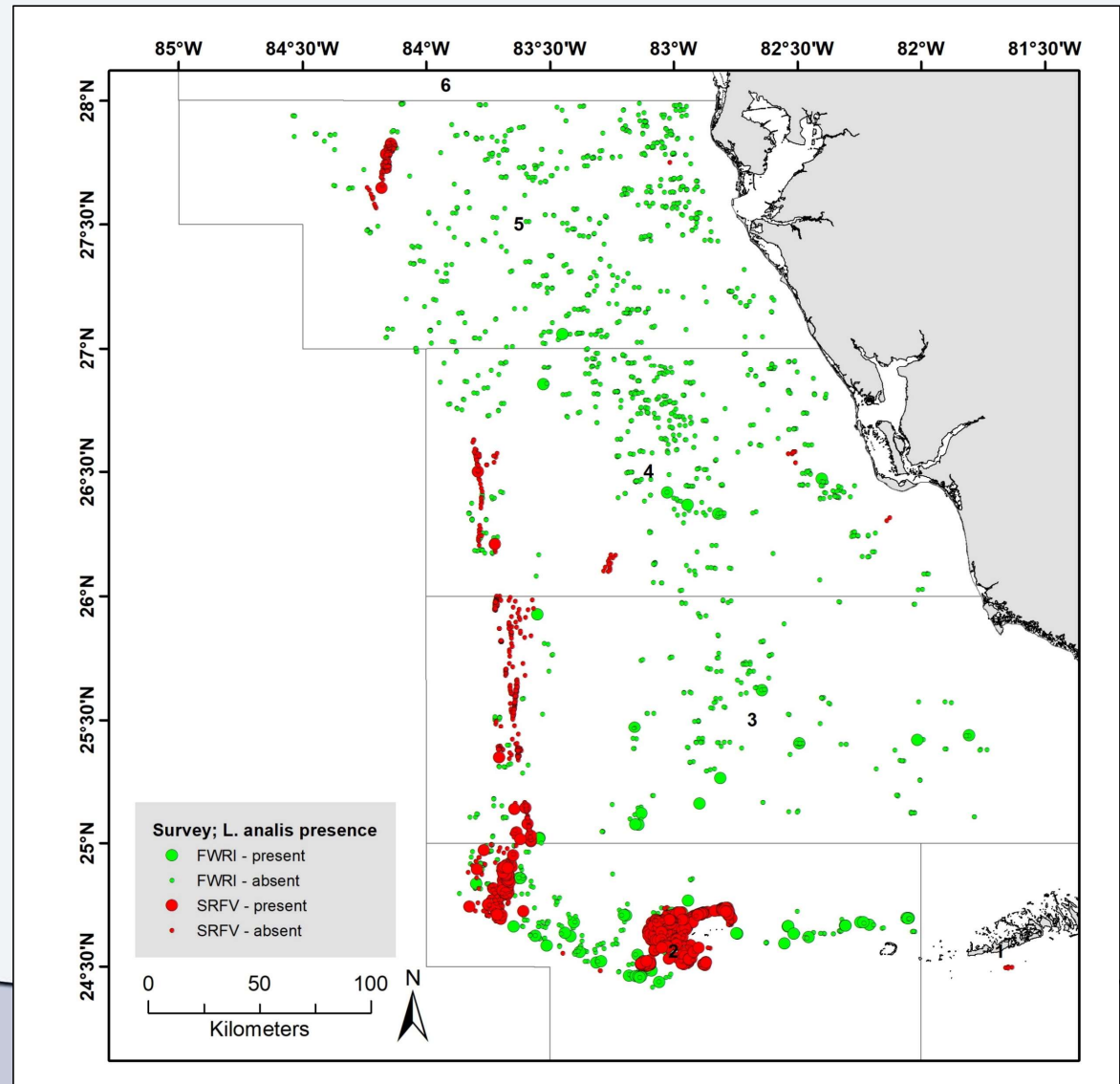
Mean MaxN by Lab, Habitat, and Year
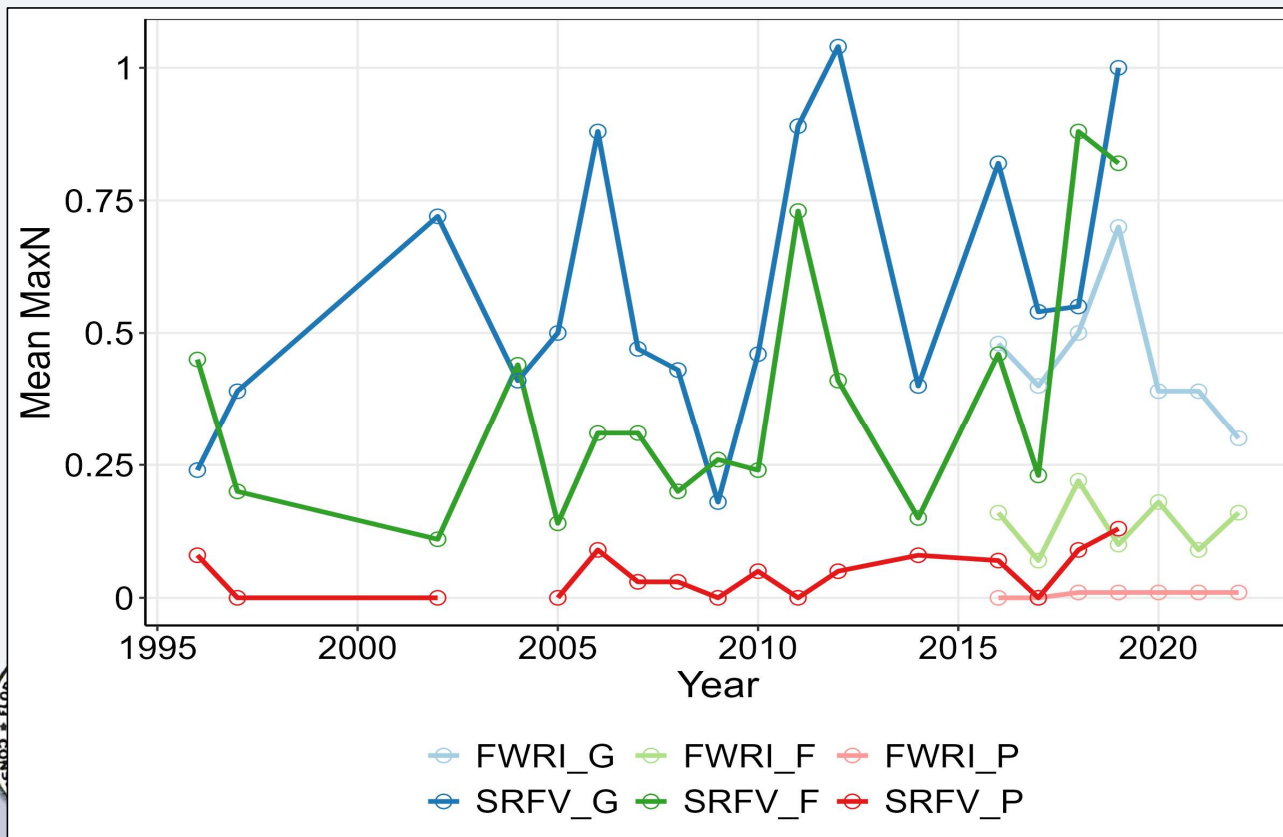
GOM Video Index vs Normalized Nominal Means
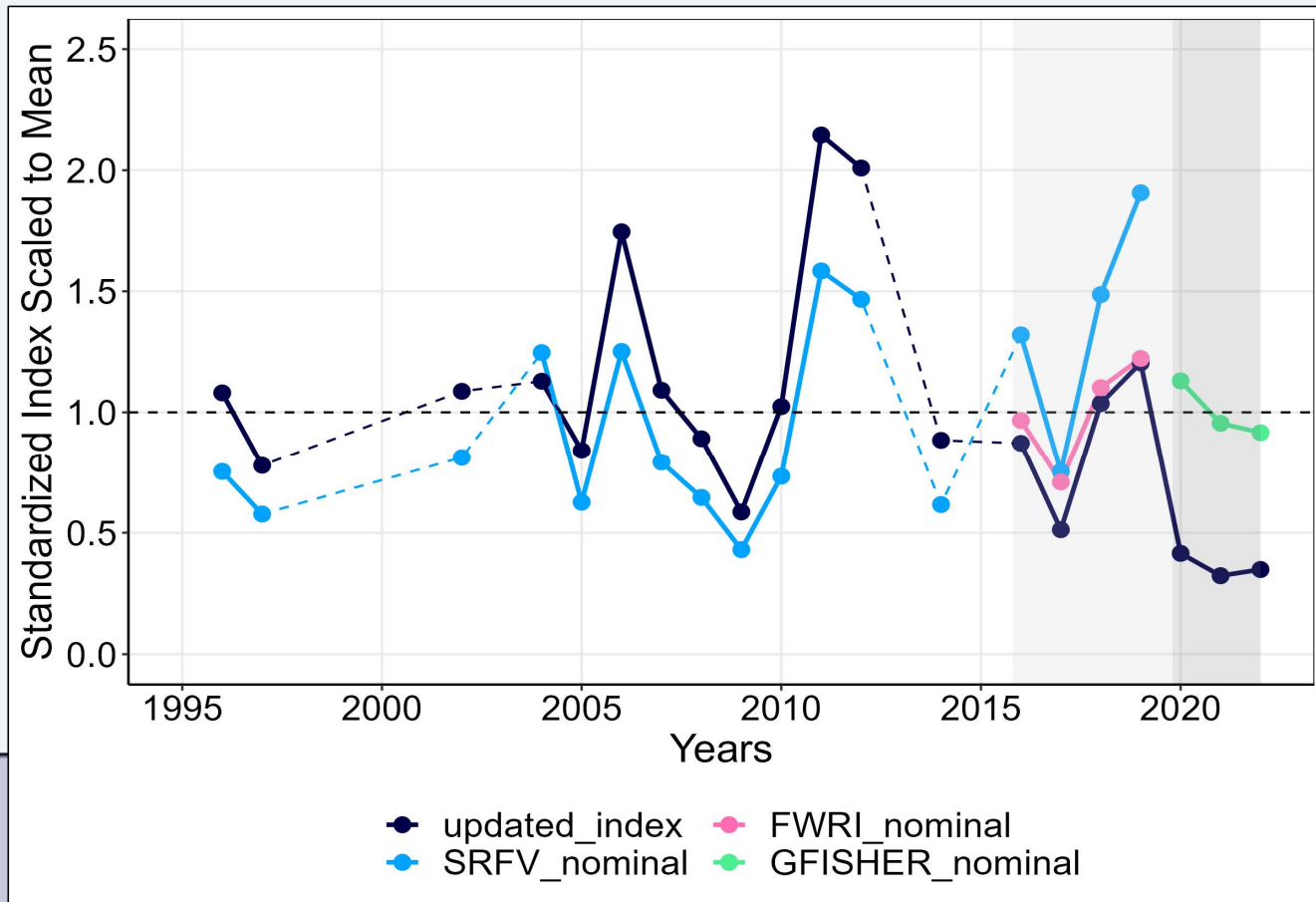
Assessment Panel Recommendations

- Allow for a decrease in survey catchability (q) to account for the increased spatial coverage in mostly poor Mutton habitat in the FWRI and GFISHER surveys.
  - In the Base Model, allow for a change in catchability (q) from 2016-2019 (FWRI) and from 2020-2022 (GFISHER).

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Length Comps

Main Data Inputs: Retained Length Compositions

- Commercial LL (1984 – 2022)
  - Central 80th Percentile of Max Total Lengths: 55 – 85 cm
- Commercial Other (1981 – 2022)
  - Central 80th Percentile of Max Total Lengths: 42 – 77 cm
- Rec West (1981 – 2022)
  - Central 80th Percentile of Max Total Lengths: 41 – 70 cm
- Rec East (1981 – 2022)
  - Central 80th Percentile of Max Total Lengths: 41 – 53 cm

Main Data Inputs: Released Length Compositions

- Commercial Other (n_trips=14)
  - RFOP vertical line trip data (2009 – 2021)
  - Max Total Lengths: 26 – 40 cm

- Recreational East & West (n_trips=1,159)
  - Charter/Headboat At-Sea Observers (2005 – 2022)
  - Max Total Lengths: 18 – 54 cm

Max TL
(4 cm bins)

- Fleet length comps are catch-weighted
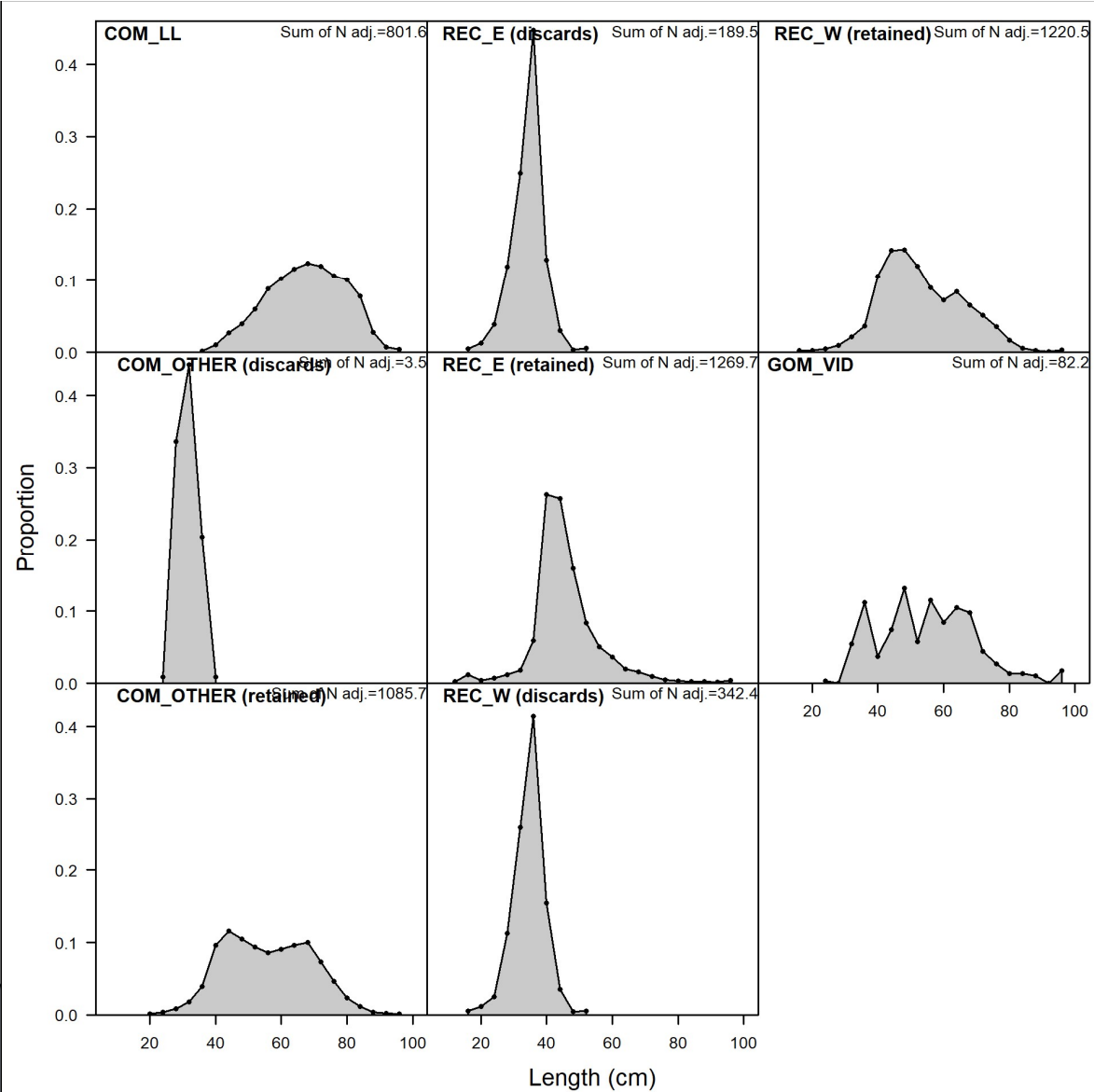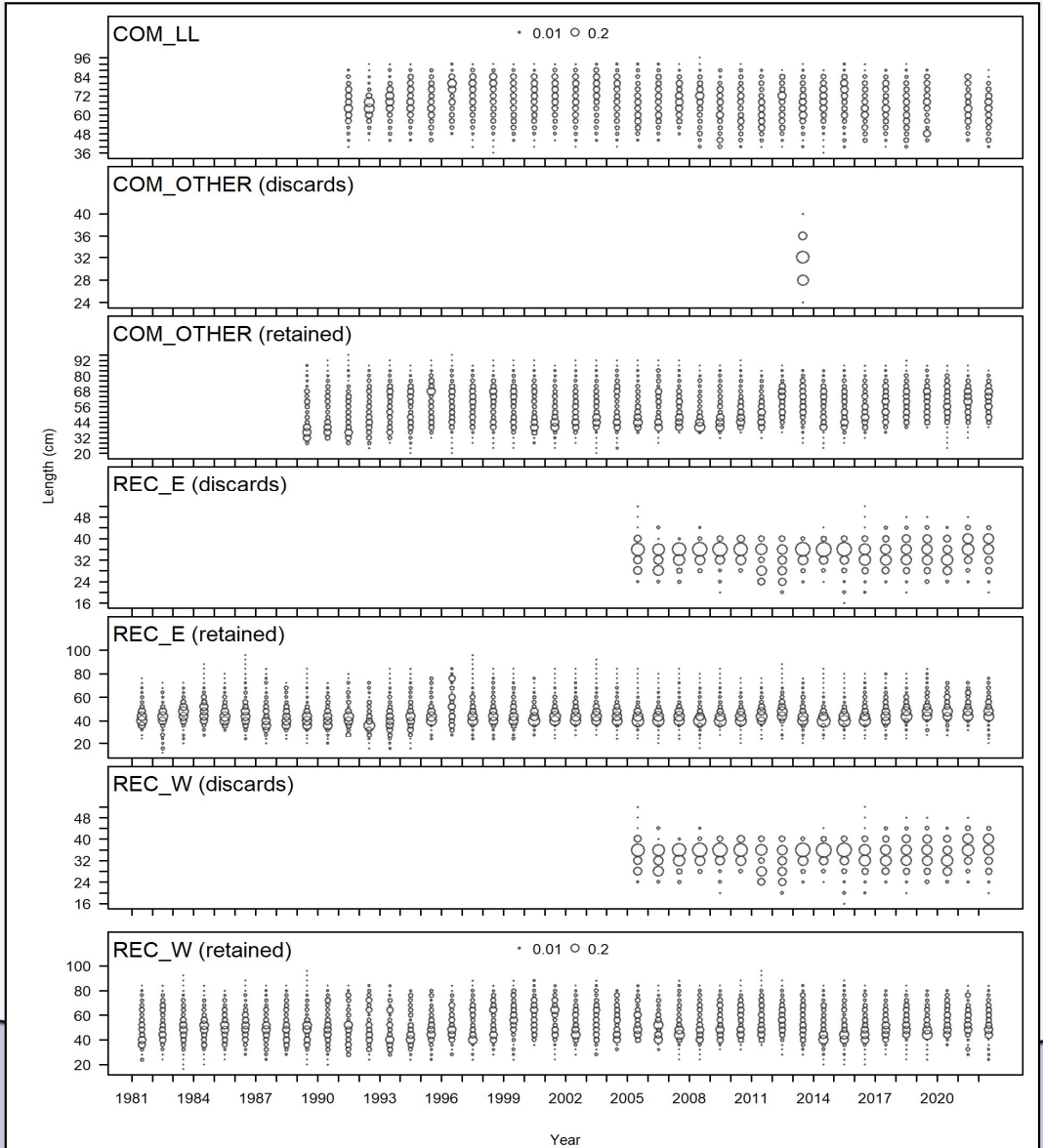
Main Data Inputs: FI Index Length Compositions

- GOM Combined Video Index (1996 – 2021)
  - Interquartile Range of Max Total Lengths: 46 - 66 cm (full range: 27 - 105 cm)
- RVC Dry Tortugas (1999 – 2021)
  - Interquartile Range of Max Total Lengths: 44 - 62 cm (full range: 15 to 101 cm)
- RVC FL Keys (1997 – 2022)
  - Interquartile Range of Max Total Lengths: 36 -50 cm (full range: 4 - 87 cm)
- RVC SE FL (2013 – 2022)
  - Interquartile Range of Max Total Lengths: 33 - 42 cm (full range: 3 - 82 cm)

Max TL
(5 cm bins)

- Index length comps are index-weighted
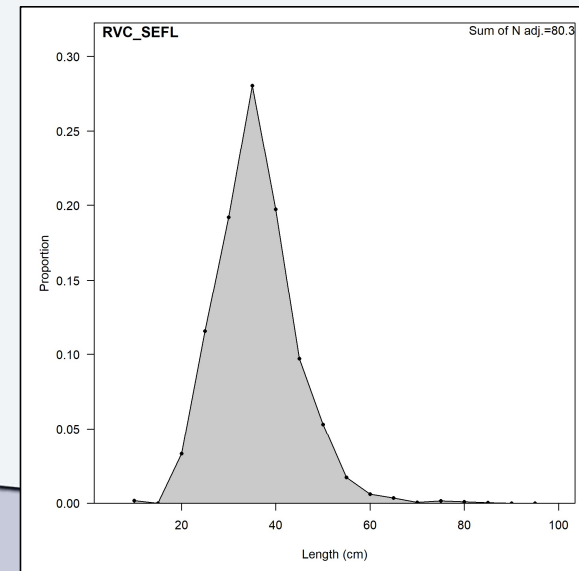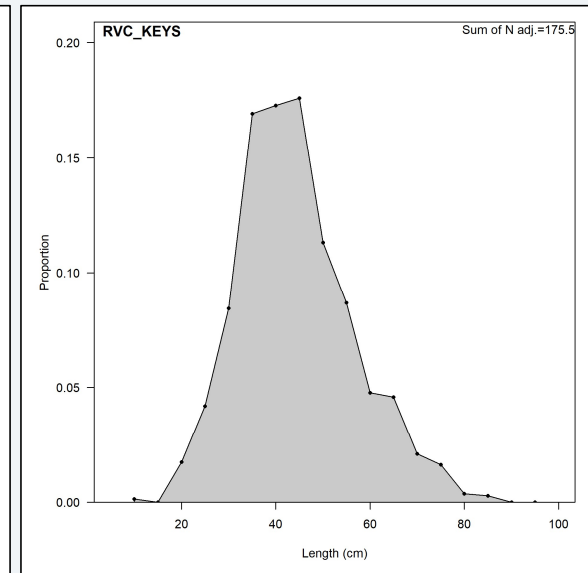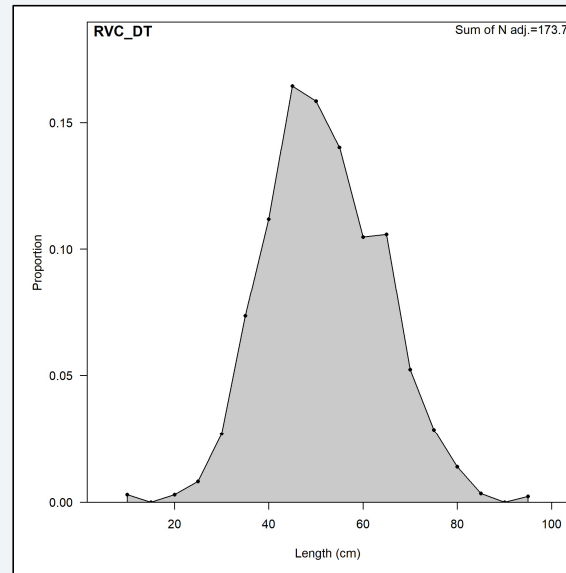
Dry Tortugas RVC

FL Keys RVC

SE FL RVC

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Conditional Age-at-Length

Commercial Longline

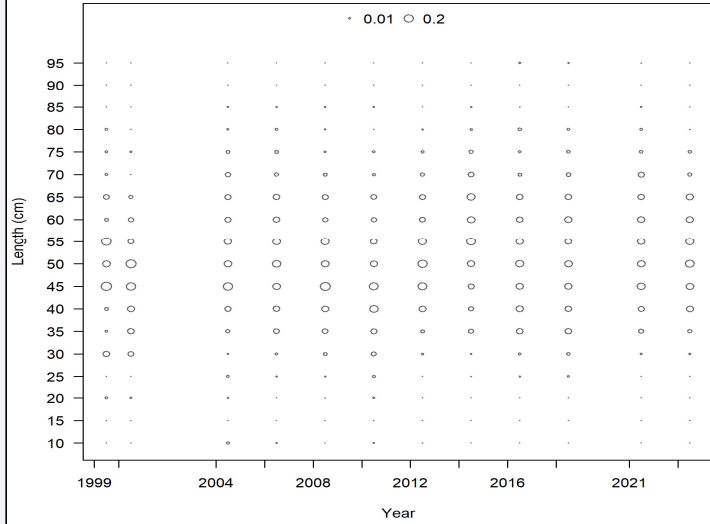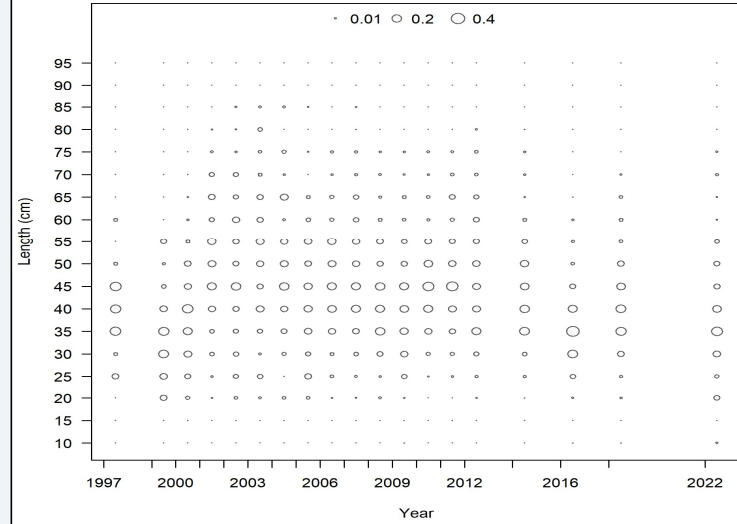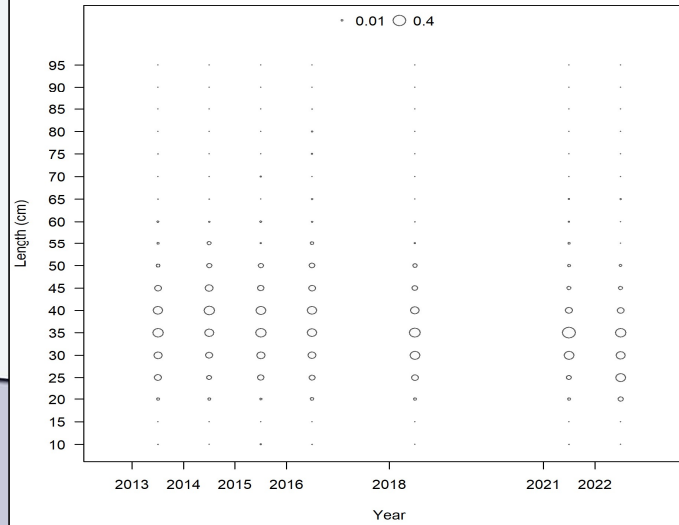|											Max TL Bins (4 cm)												
Year	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	N
1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	4	1	2	1	0	0	0	11
1994	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	2	0	1	0	0	0	5
1995	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	3
1997	0	0	0	0	0	0	0	0	0	0	2	4	3	1	4	3	1	2	4	0	0	0	0	24
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	3
1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	3	0	0	0	5
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	2	1	1	0	0	9
2001	0	0	0	0	0	0	0	0	0	0	1	2	4	7	2	4	3	5	9	9	3	3	0	52
2002	0	0	0	0	0	0	0	0	0	1	4	5	6	10	9	10	6	8	10	15	8	1	0	93
2003	0	0	0	0	0	0	0	0	0	5	7	7	5	7	7	9	6	12	19	32	21	7	0	144
2004	0	0	0	0	0	0	0	0	1	4	12	14	7	9	12	11	11	8	17	15	11	3	0	135
2005	0	0	0	0	0	0	0	0	0	3	7	15	22	20	17	20	13	15	11	12	9	2	0	166
2006	0	0	0	0	0	0	0	0	0	6	14	24	47	45	47	41	44	36	39	40	14	4	0	401
2007	0	0	0	0	0	0	0	0	0	0	7	12	25	23	27	33	36	20	23	18	5	1	0	230
2008	0	0	0	0	0	0	0	0	7	8	18	13	15	16	18	31	31	19	17	10	4	0	1	208
2009	0	0	0	0	0	0	0	0	6	14	7	9	10	20	11	17	12	16	6	3	5	0	0	136
2010	0	0	0	0	0	0	0	0	5	16	24	28	44	34	29	40	47	40	21	23	14	0	0	365
2011	0	0	0	0	0	0	0	0	2	9	15	28	28	29	27	27	17	12	16	12	5	0	0	227
2012	0	0	0	0	0	0	0	0	1	5	13	22	30	27	26	27	46	23	19	20	1	0	0	260
2013	0	0	0	0	0	0	0	0	3	2	9	7	30	41	36	36	31	21	18	16	4	1	0	255
2014	0	0	0	0	0	0	0	1	0	1	3	7	21	27	42	41	43	44	31	24	2	0	0	287
2015	0	0	0	0	0	0	0	0	3	6	2	3	10	22	14	15	21	25	23	14	2	2	0	162
2016	0	0	0	0	0	0	0	0	0	8	7	13	8	18	18	14	8	11	9	5	1	1	0	121
2017	0	0	0	0	0	0	0	0	1	5	10	18	23	23	34	26	23	26	28	15	4	0	0	236
2018	0	0	0	0	0	0	0	0	9	23	22	29	40	40	30	41	34	29	22	13	4	1	0	337
2019	0	0	0	0	0	0	0	0	0	4	13	3	7	5	11	14	9	8	8	6	1	0	0	89
2020	0	0	0	0	0	0	0	0	1	1	1	2	1	4	2	0	2	2	1	0	0	0	0	17
2021	0	0	0	0	0	0	0	0	0	2	3	3	5	7	8	5	5	3	5	3	0	0	0	49
2022	0	0	0	0	0	0	0	0	3	20	11	22	31	28	38	36	31	17	11	1	1	0	0	250

Commercial Other

	Max TL Bins (4 cm)																						
Year	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	N
1992	0	0	0	0	1	1	0	7	11	9	8	4	2	5	2	1	1	0	0	0	0	0	0	52
1993	0	0	0	0	0	0	0	11	7	4	6	5	2	0	0	1	0	0	0	0	0	0	0	36
1994	0	0	0	0	0	0	0	7	14	10	15	4	2	4	1	0	1	0	0	0	0	0	0	58
1995	0	0	0	0	0	0	0	0	8	8	5	4	4	1	0	1	0	2	0	0	0	0	0	33
1996	0	0	0	0	0	0	0	2	18	34	28	19	15	6	12	6	3	2	5	0	0	0	0	150
1997	0	0	0	0	0	0	0	10	22	22	36	23	22	25	24	7	6	2	6	0	0	0	0	205
1998	0	0	0	0	0	1	3	7	36	40	22	23	26	13	13	11	1	2	1	0	0	0	0	199
1999	0	0	0	0	0	0	1	18	38	36	36	21	24	16	18	4	2	1	4	0	0	0	0	219
2000	0	0	0	0	0	3	3	23	53	36	28	15	16	10	6	4	3	2	0	0	0	0	0	202
2001	0	0	0	0	0	1	1	18	71	61	32	25	15	7	8	7	7	2	2	1	0	0	0	258
2002	0	0	0	0	0	1	0	19	56	60	40	38	42	26	15	10	7	1	1	1	0	0	0	317
2003	0	0	0	1	0	0	1	5	31	65	63	32	20	11	14	8	3	2	2	0	2	0	0	260
2004	0	0	0	0	0	0	0	0	22	34	29	17	16	9	7	11	11	5	3	2	0	0	0	166
2005	0	0	0	0	0	0	0	1	16	41	24	18	18	12	13	8	9	7	4	0	0	0	0	178
2006	0	0	0	0	0	1	0	2	26	15	8	7	7	14	10	9	9	15	7	4	0	1	0	135
2007	0	0	0	0	0	0	0	0	5	0	5	1	3	5	5	11	5	11	8	4	0	0	0	63
2008	0	0	0	0	0	0	0	5	106	80	40	27	11	16	14	16	13	25	10	1	1	0	0	365
2009	0	0	0	0	0	0	0	6	46	60	40	20	15	16	16	14	17	11	11	4	2	0	0	278
2010	0	0	0	0	0	0	0	4	50	101	100	67	54	49	29	24	12	14	6	4	1	1	0	516
2011	0	0	0	0	0	0	0	1	24	75	83	84	75	64	42	33	18	27	12	5	0	0	0	543
2012	0	0	0	0	0	0	0	0	7	16	27	27	35	35	49	54	47	14	8	6	1	0	0	326
2013	0	0	0	0	0	1	2	4	10	22	22	38	32	22	32	26	29	16	4	0	0	0	0	260
2014	0	0	0	0	1	1	0	0	31	18	26	16	16	26	32	43	26	8	3	4	0	0	1	252
2015	0	0	0	0	0	1	1	6	20	36	15	19	7	17	10	18	14	5	4	0	0	0	0	173
2016	0	0	0	0	0	0	0	1	18	19	25	25	27	10	9	6	9	8	6	2	0	0	0	165
2017	0	0	0	0	0	0	0	3	9	13	8	15	8	14	18	14	12	9	4	2	1	0	0	130
2018	0	0	0	0	0	0	0	0	7	21	20	23	24	27	23	18	18	14	11	0	0	0	0	206
2019	0	0	0	0	0	0	0	0	3	30	46	36	36	36	35	51	23	30	10	7	2	0	0	345
2020	0	0	0	0	1	0	0	0	5	23	36	61	62	54	59	66	63	53	32	4	1	0	0	520
2021	0	0	0	0	0	0	1	0	0	17	26	31	46	87	75	68	49	33	16	4	3	0	0	456
2022	0	0	0	0	0	0	0	0	2	13	24	22	58	73	87	73	46	39	17	2	0	0	0	456

Rec West

Year	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	N
1981	0	0	0	0	0	0	1	12	12	10	5	2	3	4	6	3	3	2	0	0	0	0	0	63
1982	0	0	0	0	0	0	0	4	18	18	11	11	10	8	7	10	3	2	1	1	0	0	0	104
1985	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1991	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	4
1993	0	0	0	0	0	0	0	0	3	2	6	7	7	1	2	2	1	1	0	0	0	0	0	32
1994	0	0	0	0	0	0	0	0	0	3	2	3	2	2	1	3	1	2	0	0	0	0	0	19
1995	0	0	0	0	0	0	0	1	3	9	2	1	1	4	0	1	0	0	0	0	0	0	0	22
1996	0	0	0	0	0	0	0	0	5	3	4	1	1	0	0	0	0	0	0	0	0	0	0	14
1997	0	0	0	0	0	0	0	0	5	2	3	1	0	1	0	0	0	0	0	0	0	0	0	12
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
2001	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
2002	0	0	0	0	0	0	0	6	2	8	4	3	3	3	2	0	1	2	0	0	0	0	0	34
2003	0	0	0	0	0	0	0	0	1	0	1	0	2	0	3	1	1	0	1	0	0	0	0	10
2004	0	0	0	0	0	0	0	0	5	1	1	1	2	1	2	1	0	1	0	0	0	0	0	15
2005	0	0	0	0	0	0	0	0	6	5	10	9	5	5	3	3	1	3	2	2	0	0	0	54
2006	0	0	0	0	0	0	0	0	13	10	7	6	7	6	7	8	6	5	1	1	0	0	0	77
2007	0	0	0	0	0	0	0	1	6	22	22	9	4	6	2	2	0	1	2	0	0	0	0	77
2008	0	0	0	0	0	0	1	2	20	17	49	36	21	28	33	43	21	24	15	7	0	0	0	317
2009	0	0	0	0	0	0	0	0	37	52	60	52	52	46	50	43	42	20	21	6	0	0	0	481
2010	0	0	0	0	0	0	0	3	39	55	40	24	41	35	48	32	27	22	4	1	1	0	0	372
2011	0	0	0	0	0	0	0	1	24	33	38	37	40	53	32	38	41	25	13	3	0	0	1	379
2012	0	0	0	0	0	0	1	1	13	43	47	55	64	51	53	60	34	37	26	16	3	0	0	504
2013	0	0	0	0	0	0	0	2	21	35	44	40	48	42	29	34	24	23	16	5	0	0	0	363
2014	0	0	0	0	0	0	3	3	72	56	22	28	23	23	27	34	13	5	4	1	0	0	0	314
2015	0	0	0	0	0	0	0	3	57	67	37	37	30	21	44	29	26	11	14	5	1	0	0	382
2016	0	0	0	0	0	0	0	9	82	106	86	57	65	65	68	47	39	28	11	5	0	0	0	668
2017	0	0	0	0	0	0	2	8	53	55	74	78	56	43	45	35	25	16	9	0	0	0	0	499
2018	0	0	0	0	0	0	1	1	11	81	107	81	60	48	56	52	37	16	6	2	0	0	0	559
2019	0	0	0	0	0	0	2	0	3	68	54	40	31	12	18	20	12	8	4	0	0	0	0	272
2020	0	0	0	0	0	0	0	1	0	7	9	2	3	2	2	3	2	0	0	0	0	0	0	31
2021	0	0	0	0	0	0	0	0	0	7	17	14	9	9	9	4	1	5	2	0	0	0	0	77
2022	0	0	0	0	1	0	0	0	0	25	27	23	19	16	13	17	8	4	2	0	0	0	0	155

Max TL Bins (4 cm)

Rec East

Year	Max TL Bins (4 cm)																						N
	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96
1981	0	0	0	0	0	0	1	21	26	28	6	1	1	1	0	0	1	0	0	0	0	0	0	86
1982	0	0	0	0	0	0	0	4	17	24	11	6	1	1	1	0	0	0	0	0	0	0	0	65
1983	0	0	0	0	0	0	0	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	4
1984	0	0	0	0	0	0	1	4	11	3	2	3	3	3	2	0	0	0	0	0	0	0	0	32
1985	0	0	0	0	0	0	1	3	17	21	19	7	5	8	2	1	1	1	1	0	0	0	0	87
1986	0	0	0	0	0	0	0	2	3	8	5	4	5	2	1	1	1	0	1	0	0	0	0	33
1987	0	0	0	0	0	0	1	1	3	2	0	3	2	0	2	0	0	0	0	0	0	0	0	14
1988	0	0	0	0	0	0	3	3	6	8	4	3	2	2	1	1	0	0	0	0	0	0	0	33
1990	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	0	0	0	0	0	0	0	6
1991	0	0	0	0	0	0	0	0	1	1	1	0	2	2	0	0	0	0	0	0	0	0	0	7
1992	0	0	0	0	0	0	0	1	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	5
1993	0	0	0	0	0	0	1	2	5	1	1	2	3	1	1	1	1	2	0	0	0	0	0	21
1994	0	0	0	0	0	0	0	0	0	2	2	0	2	1	0	1	1	1	0	0	0	0	0	10
1995	0	0	0	0	0	0	0	1	30	32	15	12	4	5	4	1	0	0	0	0	0	0	0	104
1996	0	0	0	0	0	0	0	0	2	3	2	1	0	1	0	0	1	0	0	0	0	0	0	10
1997	0	0	0	0	0	0	0	0	1	3	1	2	0	0	0	0	0	0	0	1	0	0	0	8
2000	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	3
2001	0	0	0	0	0	0	0	0	15	9	5	2	7	0	0	0	0	0	0	0	0	0	0	38
2002	0	0	0	0	0	0	0	1	27	15	18	9	4	6	1	1	2	0	0	0	0	0	0	84
2003	0	0	0	0	0	0	0	3	74	100	55	38	24	12	7	6	1	2	0	0	2	0	0	324
2004	0	0	0	0	0	0	0	5	67	45	51	33	12	10	7	11	3	2	1	0	0	0	0	247
2005	0	0	0	0	0	0	1	19	188	122	51	26	16	9	6	5	5	3	0	0	0	0	0	451
2006	0	0	0	0	0	0	0	14	89	65	31	14	6	6	6	2	1	0	0	0	0	0	0	234
2007	0	0	0	0	0	0	1	15	170	177	126	49	26	19	6	4	4	0	1	1	0	0	0	599
2008	0	0	0	0	0	0	0	11	217	127	57	28	13	16	7	7	2	2	0	0	0	0	0	487
2009	0	0	0	0	0	0	0	27	240	165	81	38	19	21	11	6	5	0	0	0	0	0	0	613
2010	0	0	0	0	0	0	0	14	201	200	130	59	31	16	10	2	2	2	0	0	0	0	0	667
2011	0	0	0	0	0	0	0	4	80	121	61	41	19	17	7	6	0	0	0	0	0	0	0	356
2012	0	0	0	0	0	0	0	1	15	27	30	24	17	6	5	1	1	1	0	0	1	0	0	129
2013	0	0	0	0	0	0	1	1	36	38	11	6	5	7	0	2	2	2	0	0	0	0	0	111
2014	0	0	0	0	0	0	2	6	162	64	42	13	10	2	1	0	0	1	2	1	0	0	0	306
2015	0	0	0	0	0	0	0	4	140	77	30	21	6	6	1	2	0	0	1	0	0	0	0	288
2016	0	0	0	0	0	0	0	4	121	84	52	22	17	16	5	4	3	1	2	0	0	0	0	331
2017	0	0	0	0	0	0	0	9	40	55	33	23	19	11	9	4	1	0	0	0	0	0	0	204
2018	0	0	0	0	0	0	0	2	11	61	38	22	5	15	3	3	1	0	0	0	0	0	0	161
2019	0	0	0	0	0	1	0	0	4	35	31	23	9	7	9	2	3	1	3	1	0	0	0	129
2020	0	0	0	0	0	0	0	0	1	5	4	4	1	3	1	0	0	0	0	0	0	0	0	19
2021	0	0	0	0	0	0	0	0	4	31	26	10	13	7	6	2	4	0	0	0	0	0	0	103
2022	0	0	0	0	1	0	0	0	2	62	60	14	15	14	7	7	2	4	0	0	0	0	0	188

Fishery Independent Sources

	Max TL Bins (4 cm)																							
Year	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	N
1998	2	31	20	11	3	0	2	8	21	40	24	17	6	6	6	6	0	0	1	0	0	0	0	204
1999	1	14	2	12	6	6	1	5	29	32	19	11	7	6	3	5	1	1	1	0	0	0	0	162
2000	0	13	6	3	6	6	21	48	66	29	20	7	13	9	6	5	2	3	2	0	0	0	0	265
2001	0	3	5	4	3	4	7	18	54	40	27	13	6	9	5	5	6	3	2	0	0	0	0	214
2002	0	1	0	2	0	0	8	28	19	3	13	12	4	5	6	4	3	1	0	0	0	0	0	109
2007	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	4
2008	0	0	0	0	0	0	1	0	1	0	0	0	1	2	2	0	0	0	0	0	0	0	0	7
2009	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	1	0	0	0	0	0	0	0	6
2010	0	0	0	0	0	0	0	0	0	3	0	1	0	1	0	1	0	0	0	0	0	0	0	6
2011	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	3
2012	0	0	0	0	0	1	0	0	0	0	0	1	2	1	1	1	1	0	0	1	0	0	0	9
2013	0	0	0	0	1	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	4
2014	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	3
2015	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	3
2016	0	0	0	0	1	1	0	1	0	0	1	2	0	1	2	2	0	0	0	0	0	0	0	11
2017	0	0	0	0	0	0	1	0	0	1	1	1	0	1	1	0	0	0	0	0	0	0	0	6
2018	0	0	0	0	1	0	2	3	3	3	0	0	1	1	1	1	2	0	1	0	0	0	0	19
2019	0	0	0	0	2	0	0	0	0	0	0	0	1	2	5	5	1	2	2	0	0	0	0	20
2020	0	0	0	0	0	0	0	0	0	1	2	2	0	1	1	5	1	1	1	0	0	0	0	15
2021	0	0	0	0	0	0	0	0	2	0	0	3	6	12	12	5	7	11	2	0	0	0	0	60
2022	0	0	0	0	0	0	1	1	1	1	3	5	5	9	14	12	15	9	2	1	0	0	0	79
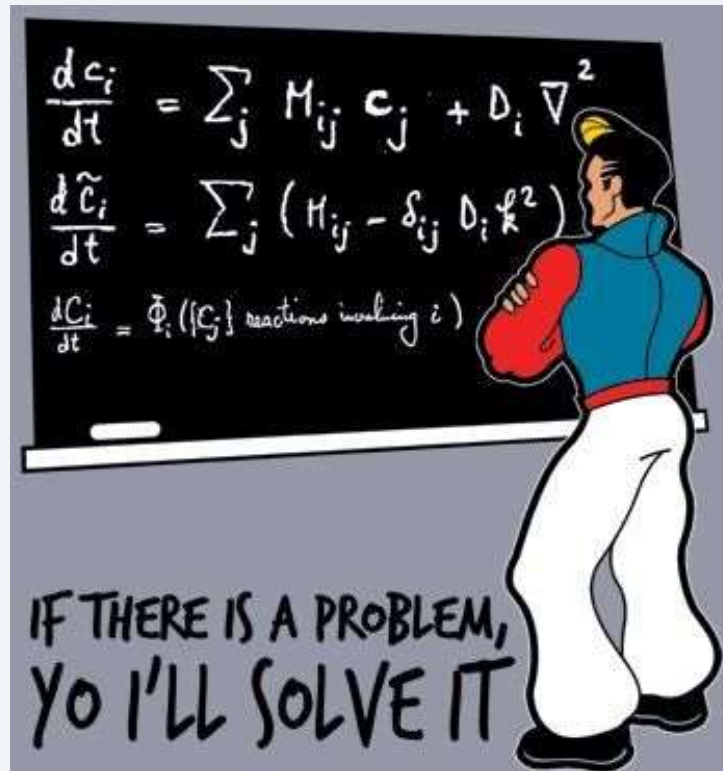
Stock Synthesis Base Model

All models are **wrong**, but some are **useful**.

- George Box
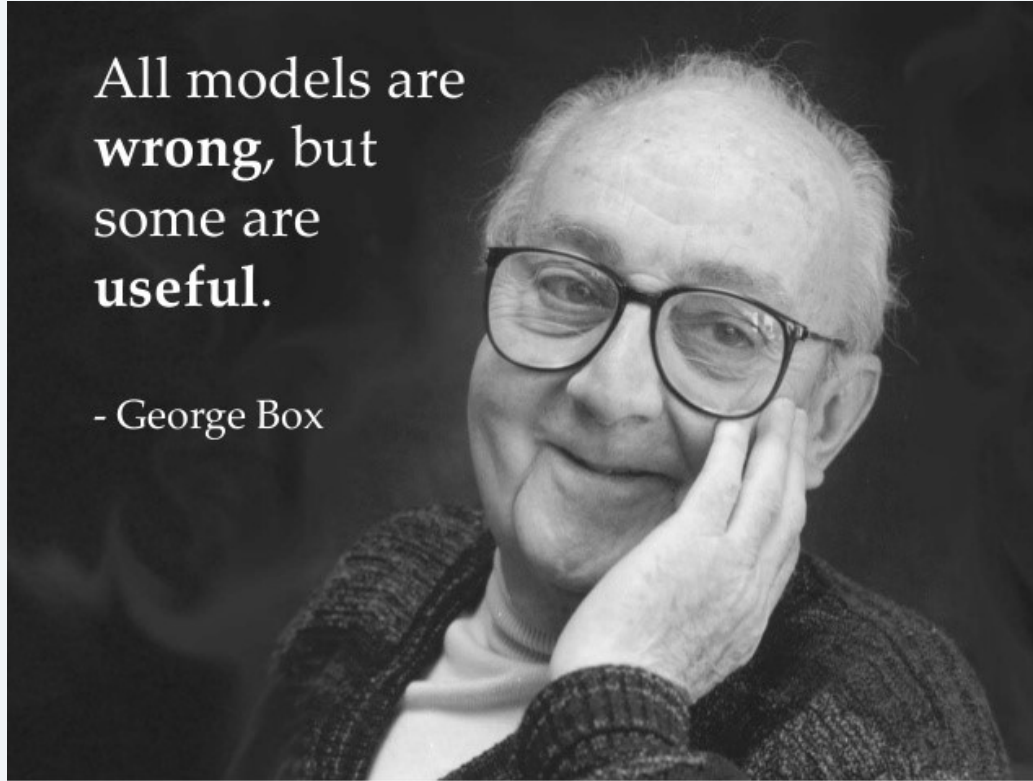
Models are approximations of reality. The real question is...

"Is this model good enough for this particular application?"
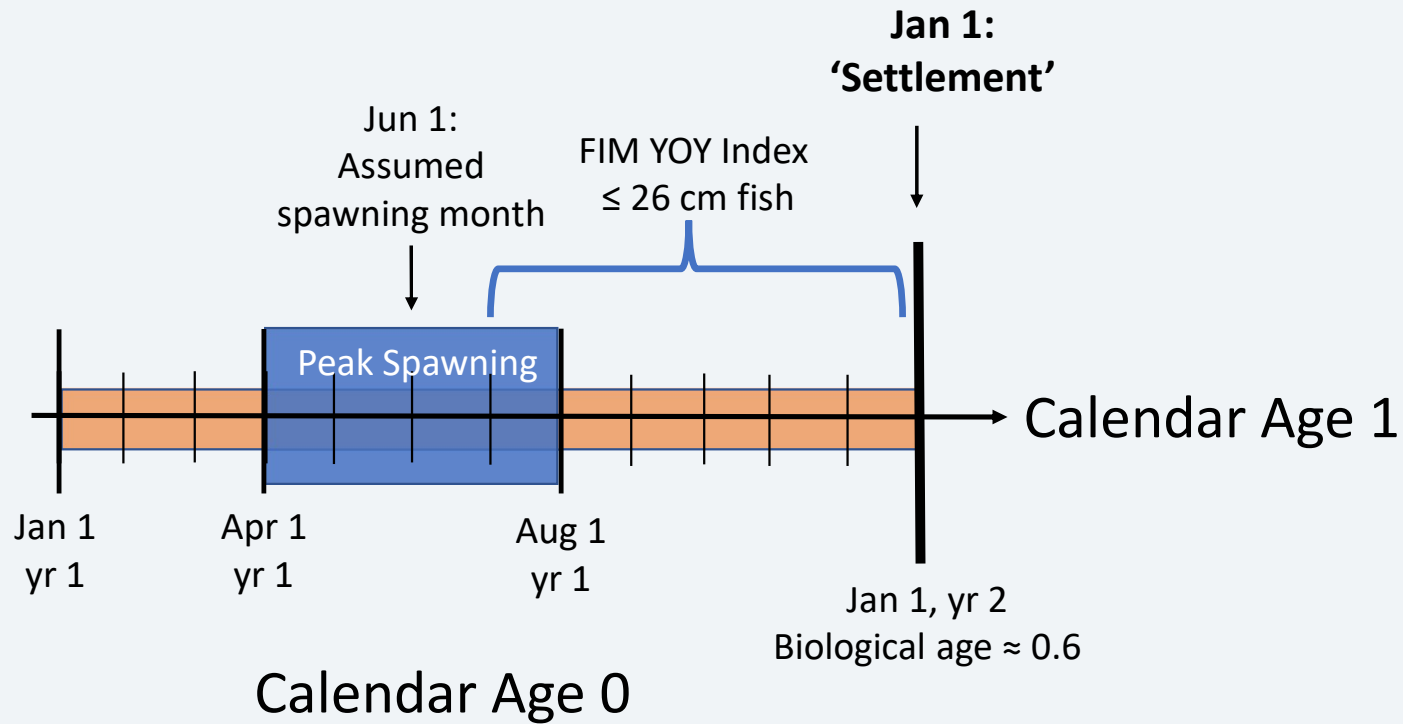
Timing Configuration

- Specifying model 'settlement' on Jan 1 at age 1 allows for the calculation of spawning stock biomass to occur at the time of peak spawning (June 1)

- There is very little data for age 0 fish.
  - The YOY index is representative of the population of age 0 fish at the end of the year. Shifting the index to be representative of age 1 fish on Jan 1 the following year should still be acceptable.

- According to Brooks (2024): avoid modeling recruitment at age 0 when survival is density dependent and at an age at which fish are already appearing in the fishery catch or are mature.
  - Very few age 1s landed or discarded by the fisheries BUT we don't have any discard lengths from shore-mode and very few shore-mode landed lengths.

Brooks, E.N., 2024. Pragmatic approaches to modeling recruitment in fisheries stock assessment: A perspective. *Fisheries Research*, *270*, p.106896.

Stock Synthesis Model Configuration

Stock Synthesis v. 3.30.22.1

- Moderate complexity: 1 season, 1 area
- Years: 1981 - 2023
- Spawning: June 1
- Settlement: January ('month = 13') at Age 1 & 8 cm but growth immediately follows VB growth curve
- Combined sex model with female SSB (Ngenders=-1, frac_female = 0.5)
- Initial numbers at age are not influenced by equilibrium catch values (lambda = 0)

Life History

- Estimated growth using external growth model inputs as initial guesses
- 40 ages in the model (1-40)
- Natural mortality: Lorenzen with Fixed Average M for ages 3-40
- Maturity: Fixed age-logistic
- Fecundity = Spawning biomass at length
- Length-Weight: Fixed

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Stock Synthesis Model Configuration

Fleets (Fmethod=4)

- Commercial LL
  - Landings (mt, fit exactly)
- Commercial Other
  - Landings (mt, fit exactly) and discards (numbers)
- Rec East (All Modes)
  - Landings and discards (numbers, not fit exactly)
- Rec West (All Modes)
  - Landings and discards (numbers, not fit exactly)

Surveys

- Commercial LL CPUE
  - Retained lbs/number of sets/number of hooks per set
- GOM Combined Video
  - Weighted Mean of Max N (numbers)
  - Changes in Catchability: 2016-2019 & 2020-2022
- RVC – Dry Tortugas, FL Keys, SE FL
  - Number of fish/diver 'cylinder'
- FIM Indian River YOY
  - Recruitment index (type 33)
  - total catch/set (numbers)
- SERFS Video
  - SumCount (numbers)

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- SERFS Video
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Stock Synthesis Model Configuration

Length Composition Data (4 cm bins)

- Commercial LL
  - Landings
- Commercial Other
  - Landings, Discards -All years combined
- Rec East
  - Landings and Discards
- Rec West
  - Landings and Discards
- GOM Combined Video
  - All years combined

General Size Composition Data (5 cm bins)

- RVC Dry Tortugas, FL Keys, SE FL

Conditional Age-at-Length Data

- Commercial LL Landings
- Commercial Other Landings
- Rec East Landings
- Rec West Landings
- Fishery-independent sources

Stock Synthesis Model Configuration

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- Commercial LL
  - Landings
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- Commercial LL Landings
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- Rec West Landings
- Fishery-independent sources

Stock Synthesis Model Configuration

Fleet Selectivity

- Commercial Longline
  - Selectivity: Simple logistic (flat-topped)
- Commercial Other
  - Selectivity: Simple logistic (flat-topped)
  - Estimated Retention (flat-topped)
    - Blocks: 1992-2017, 2018-2022
  - Discard Mortality = 30%
- Rec East & West
  - EAST Selectivity: Double normal (dome)
  - WEST Selectivity: Double normal (dome)
  - Estimated Retention (flat-topped)
    - Blocks: 1995-2017, 2018-2022
  - Discard Mortality = 30%

Index Selectivity (all constant catchability)

- Commercial LL CPUE
  - Linked to Commercial LL fleet
- GOM Combined Video Index
  - Selectivity: Simple logistic (flat-topped)
- RVC Dry Tortugas, FL Keys
  - Selectivity: Double normal (dome)
- RVC SE FL
  - Selectivity: Inverse logistic
- FIM Inshore YOY
  - Selectivity: Full selectivity for age 1 only
- SERFS Video
  - Selectivity: Assume Full selectivity for ages 3-40

Stock Synthesis Model Configuration

Fleet Selectivity

- Commercial Longline
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- FIM Inshore YOY
  - Selectivity: Full selectivity for age 1 only
- SERFS Video
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Stock Synthesis Model Configuration

Recruitment Dynamics

- Beverton-Holt stock-recruitment relationship
  - Virgin recruitment in log-space (*ln(R0)*), the standard deviation of log of recruitment (*sigmaR*), and *steepness* estimated in model
- Simple recruitment deviations
  - no sum-to-zero constraint
- Early recruitment deviations
  - 1970-1985
- Main recruitment deviations
  - 1986 – 2022
- Bias adjustments (following Methot and Taylor 2011)

Stock Synthesis Model Configuration

Parameters

- 201 out of 253 parameters estimated

'Non-Trivial' Fixed Parameters

- Commercial Other retention prior to 1992 forced to 0 (discard fraction = 0)

Priors

- Symmetric betas on initial fishing mortality rates for Commercial LL, Commercial Other, Rec East, and Rec West

Lambdas

- No emphasis on model fit (=0) for initial equilibrium catch for all fleets

Reported Fishing Mortality Rates

- Age 3

Stock Synthesis 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, indices, and discard data (except commercial discards)

Multinomial Distribution

- Length composition data of landings, discards, and indices
- Conditional age-at-length data of landings and FI sources

Data Weighting

- Length composition and conditional age-at-length data
- Initial sample sizes 0.5*number of trips (Length) or 0.5*number of fish (CAAL)
- Iterative Francis Reweighting applied separately to retained and discarded lengths

Stock Synthesis Model Configuration

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gregaragon.com

Base Model Fits

84

Log-Likelihood

Maximum gradient = 0.000095
Number of Parameters = 241
Number of Est. Parameters = 202
AIC = 3458.02

Fits to Landings

Fits to Landings
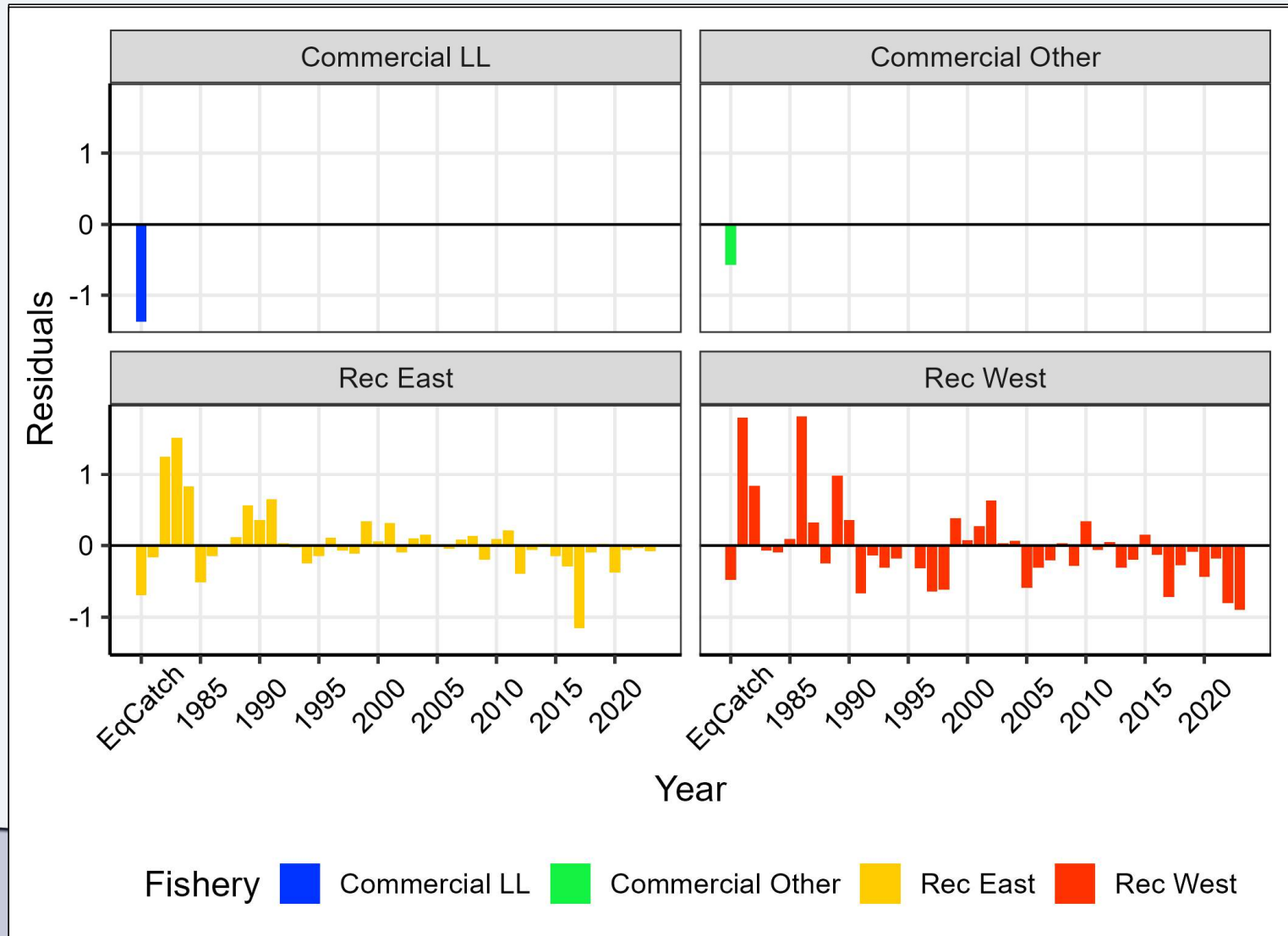
Fits to Discards
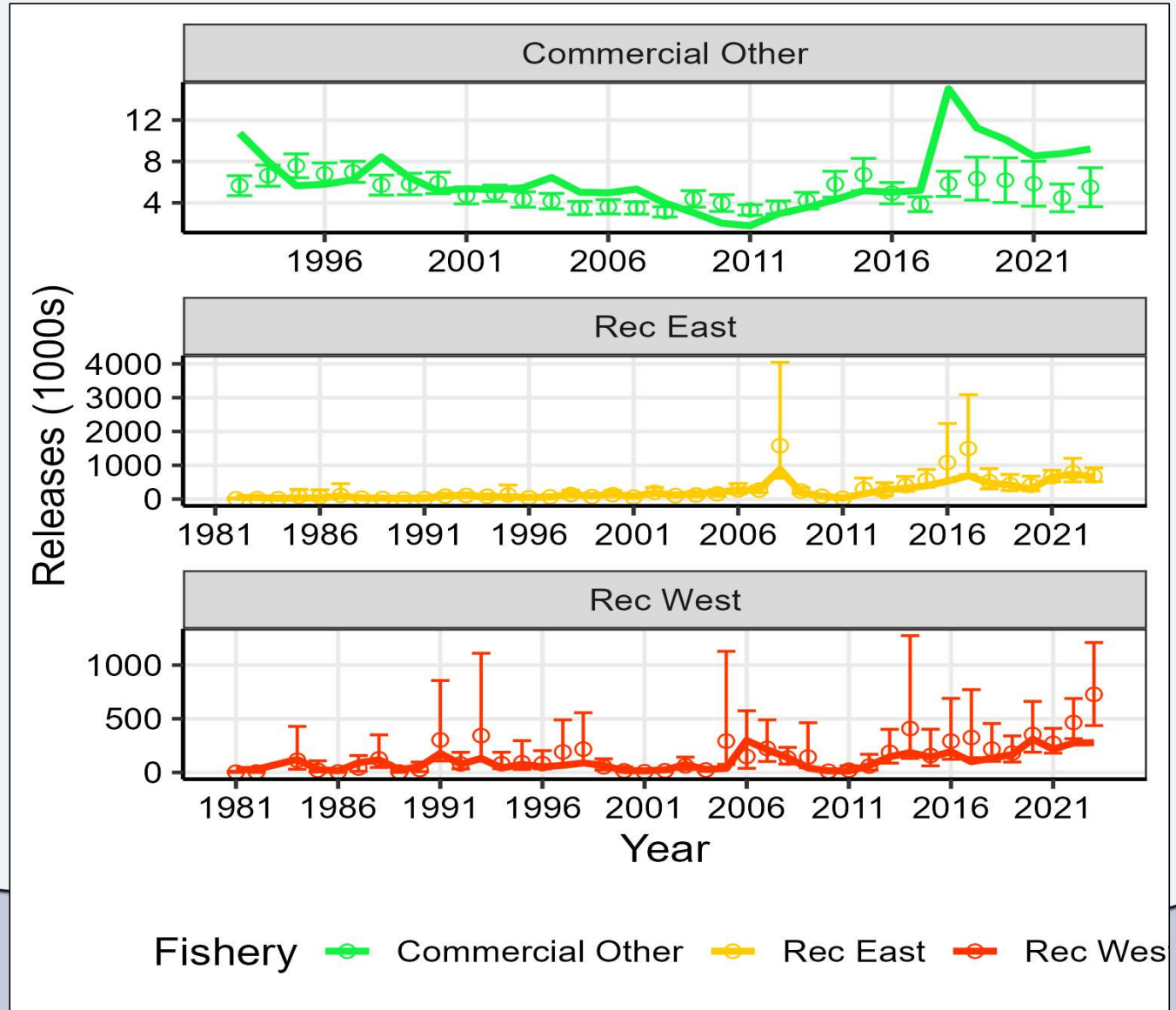
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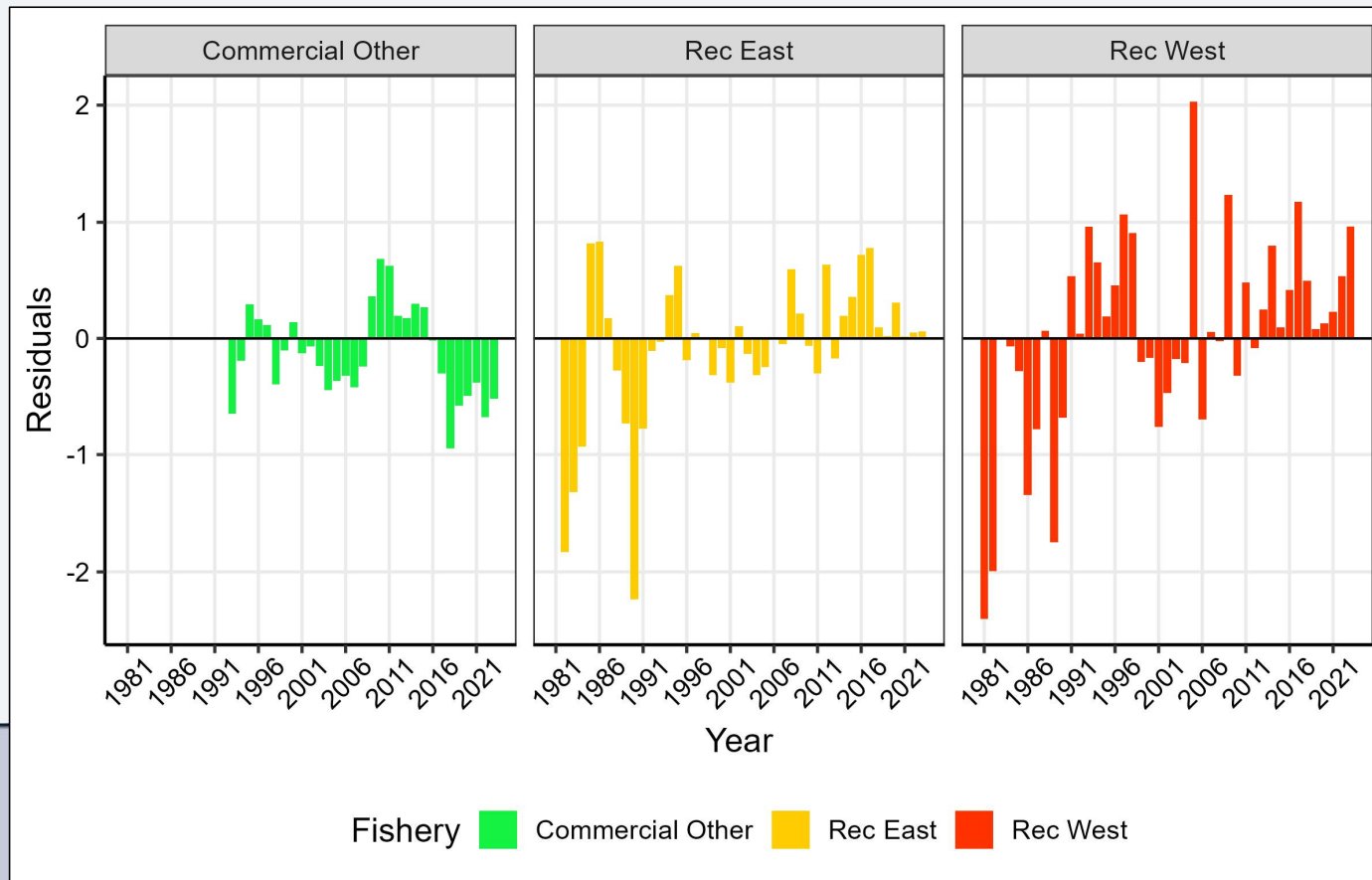
Joint Residual Plots
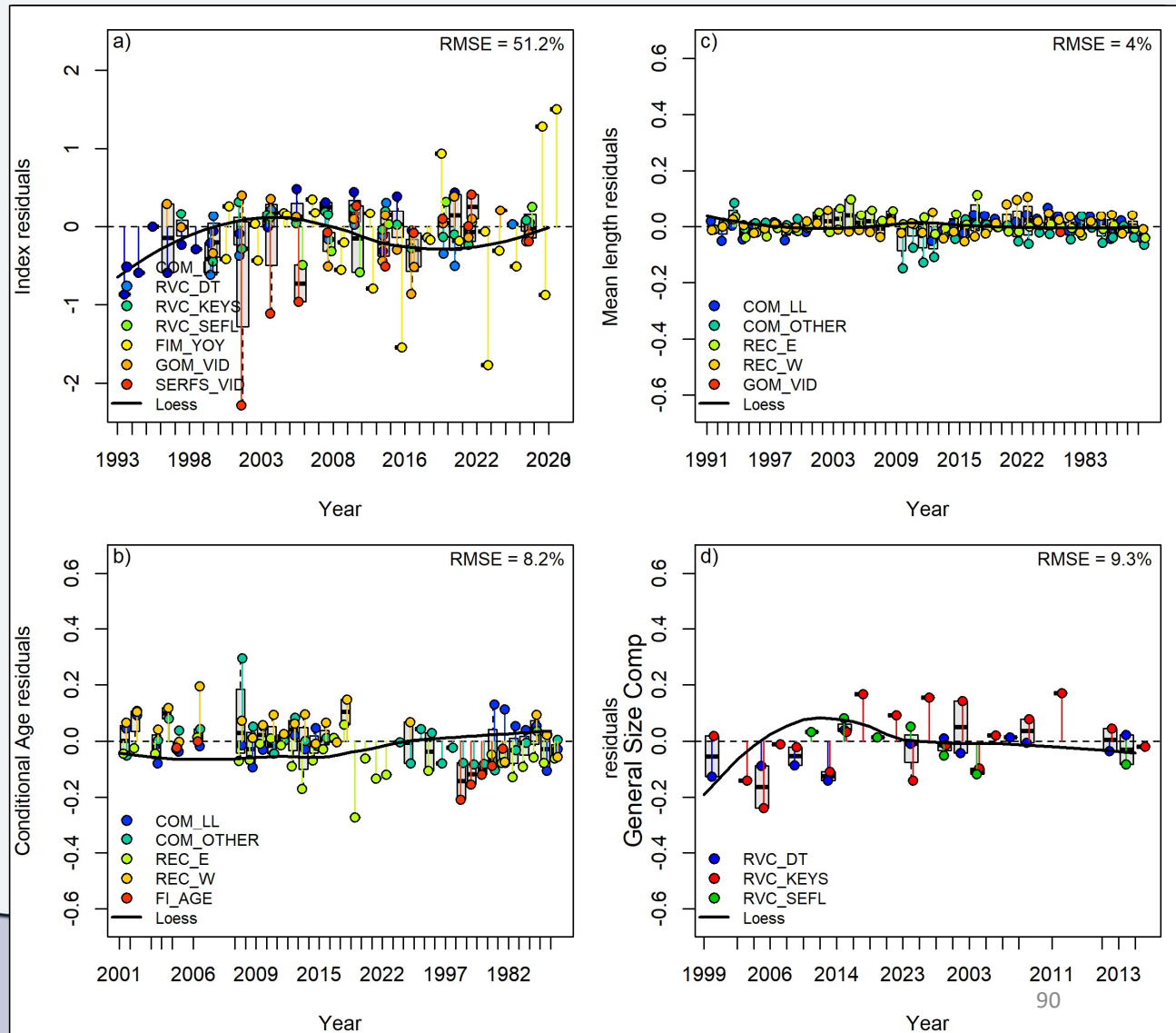
Root Mean Squared Error (RMSE)

Model Component	Data Source	RMSE (%)	N
Indices of Abundance	COM_LL	38.3	18
	FIM_YOY	74	24
	GOM_VID	34.5	20
	RVC_DT	30.4	12
	RVC_KEYS	20.8	18
	RVC_SEFL	35	7
	SERFS_VID	84.9	11
	Combined	51.2	110
Mean Length (4 cm bins)	COM_LL	3.2	31
	COM_OTHER	5.2	34
	GOM_VID	1.9	1
	REC_E	3.5	42
	REC_W	3.7	42
	Combined	4	150
Mean Length (5 cm bins)	RVC_DT	6.8	12
	RVC_KEYS	11.2	19
	RVC_SEFL	7	7
	Combined	9.3	38
Mean Conditional Age-at-Length	COM_LL	6.3	21
	COM_OTHER	7.6	31
	FI_AGE	11.3	7
	REC_E	9	28
	REC_W	8.3	22
	Combined	8.2	109

Fits to Indices
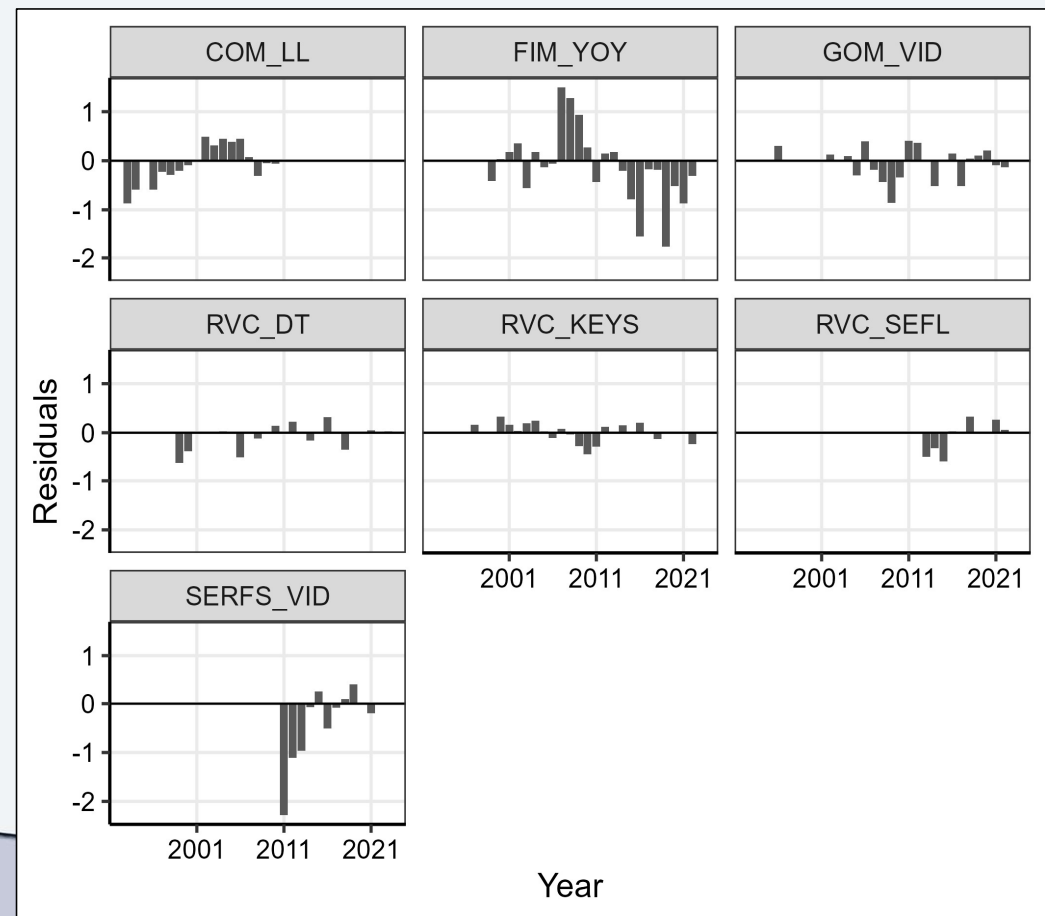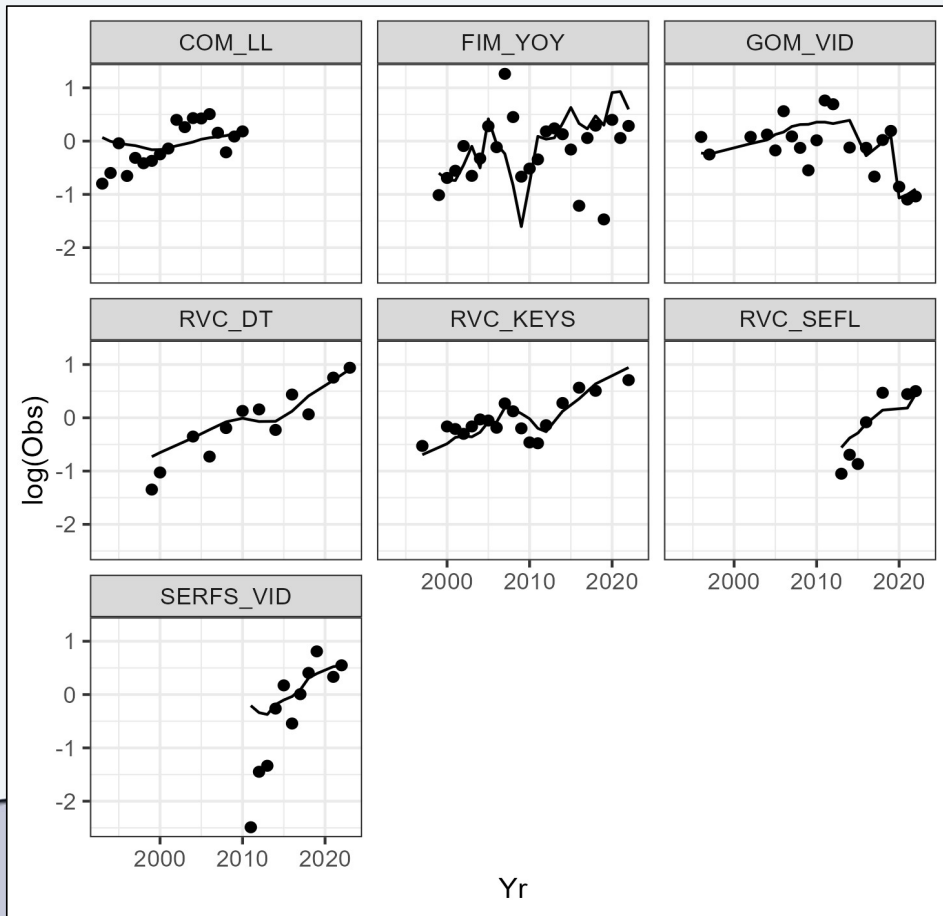
Model Fits: Overall length compositions (4 cm bins)
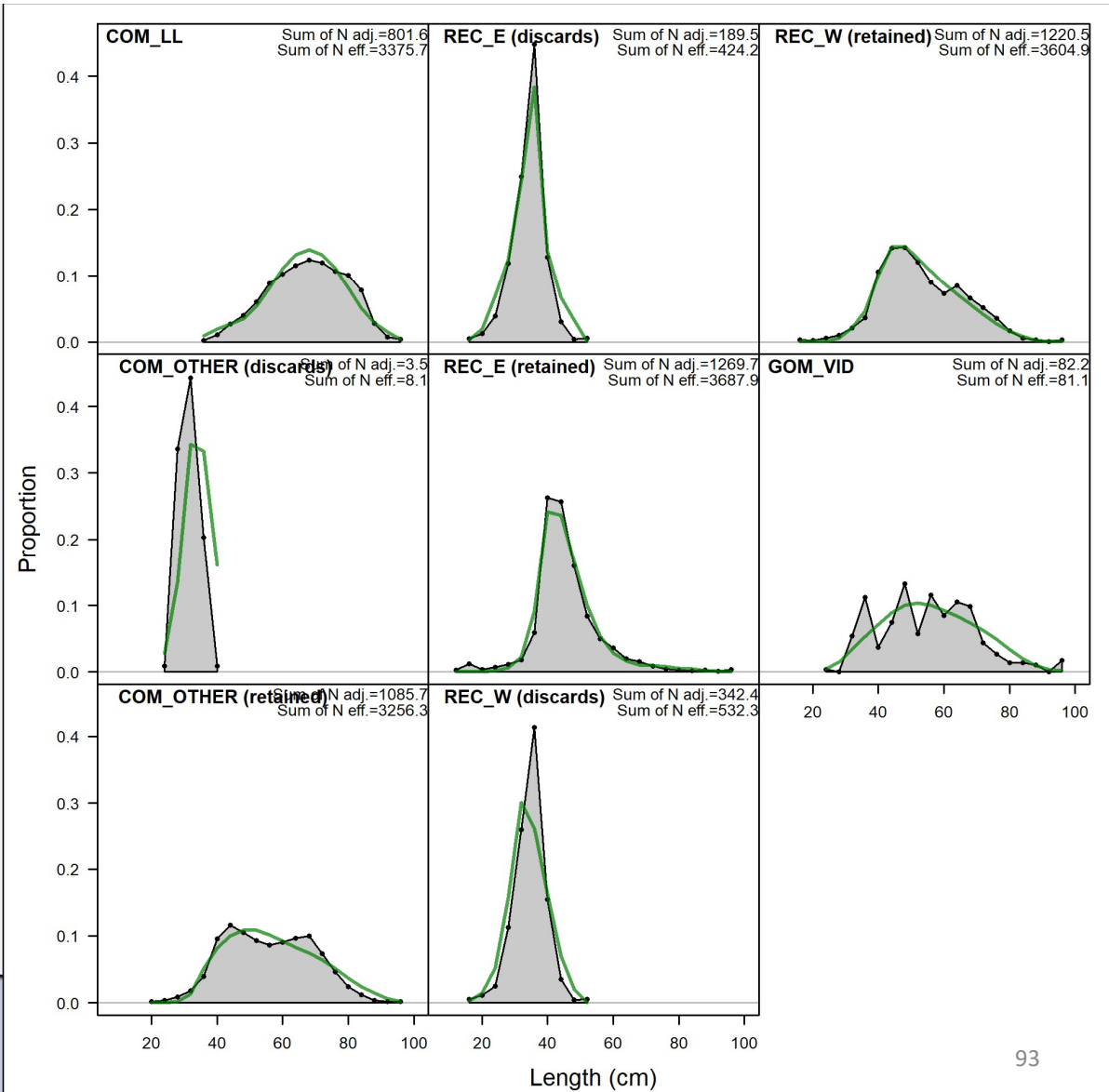
Runs Test for Length Comps (4 cm bins)
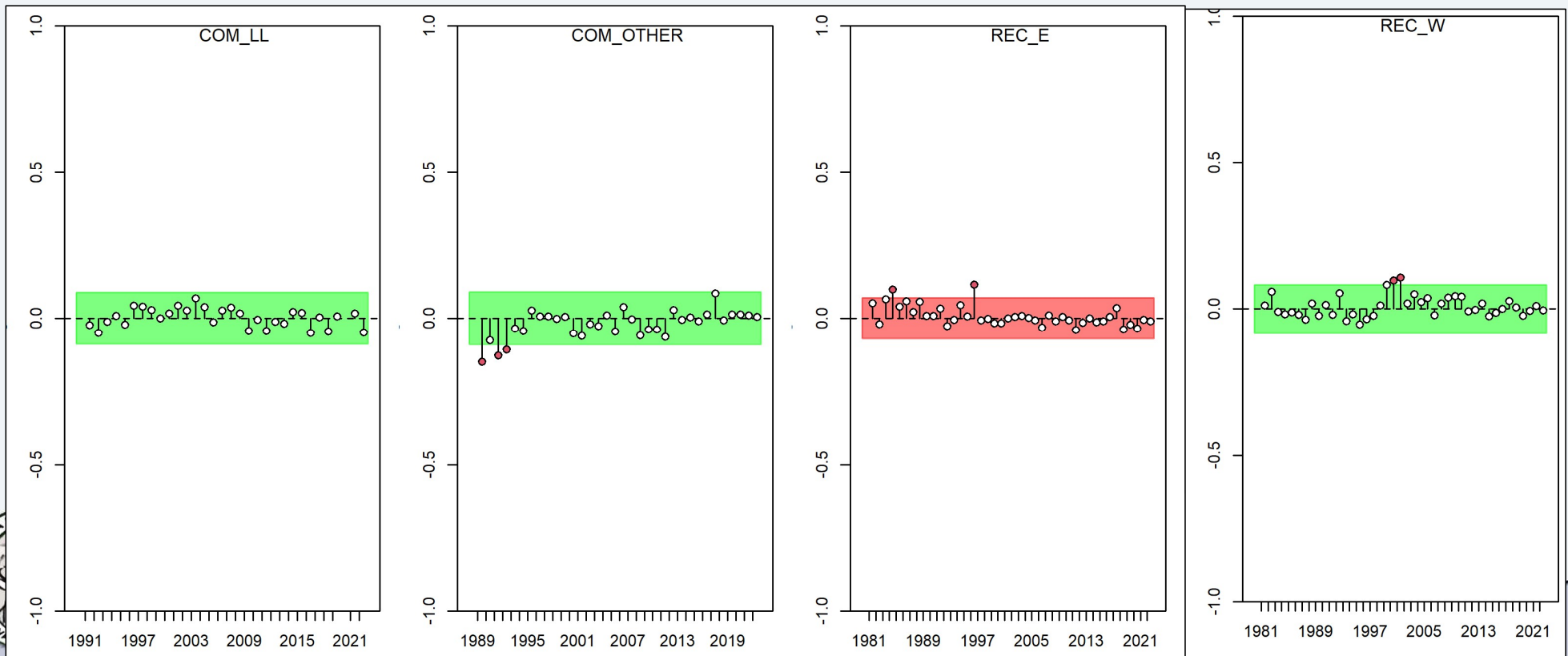
Model Fits:
Overall length compositions (5 cm bins)
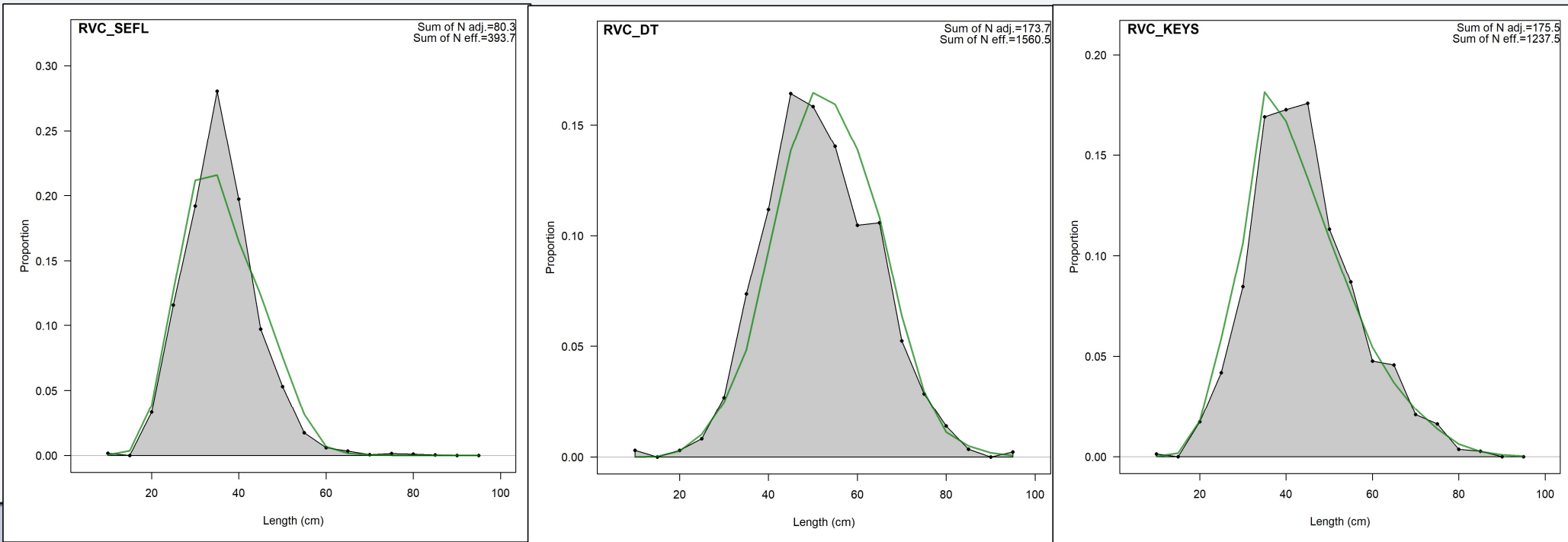
Runs Test for Length Comps (5 cm bins)
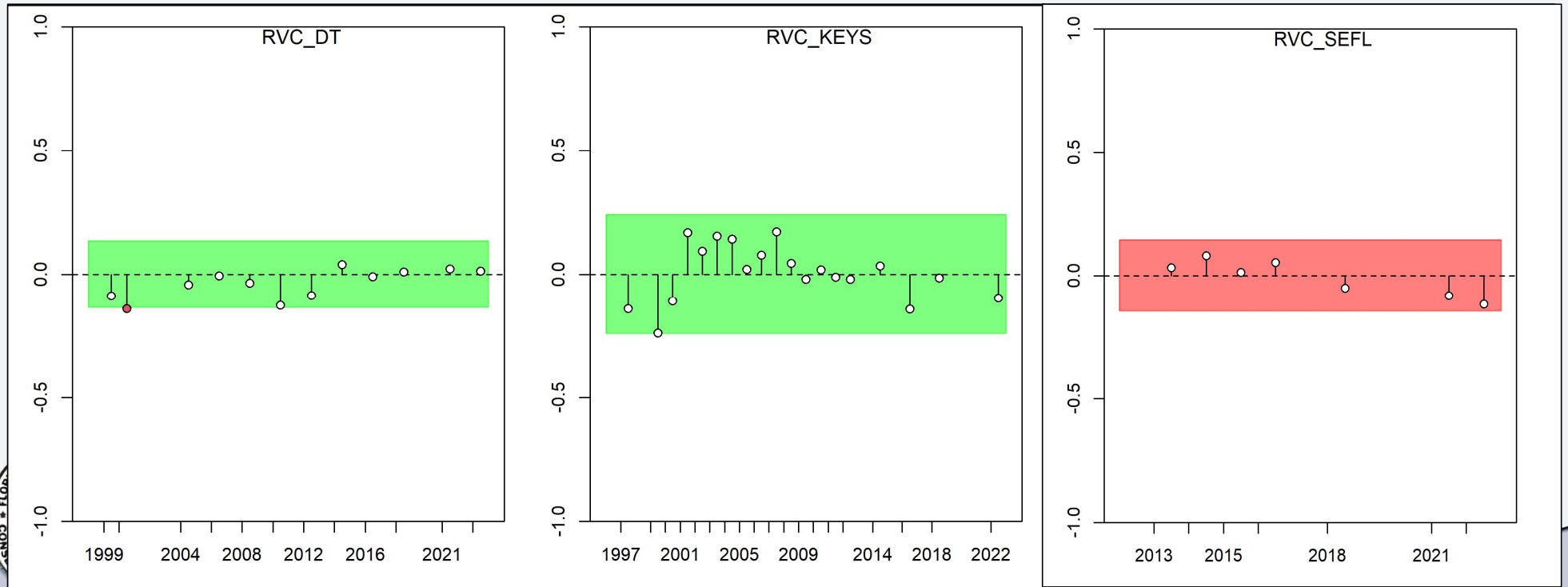
Commercial Longline CAAL
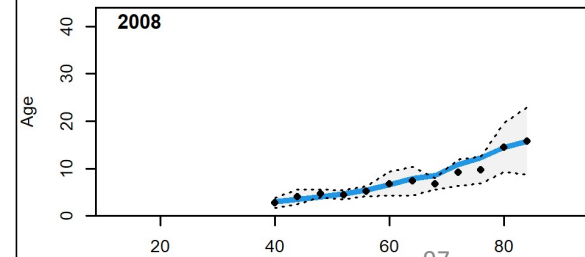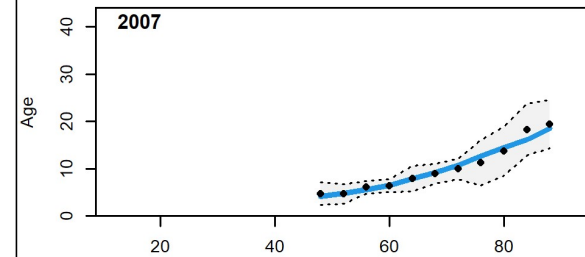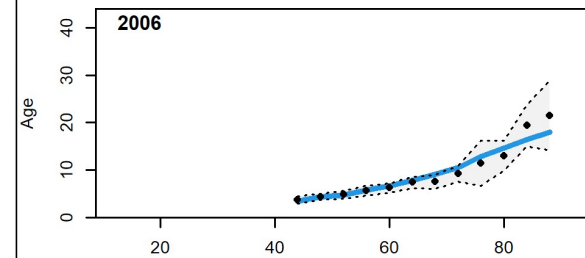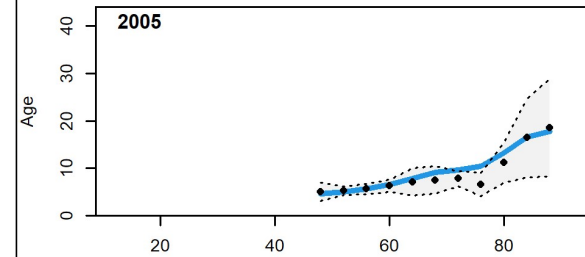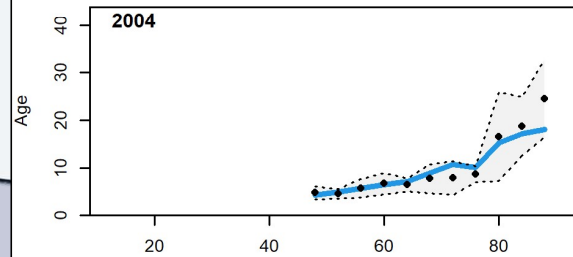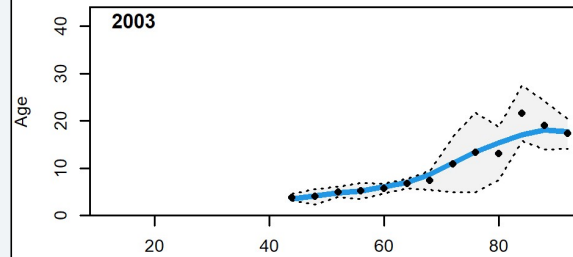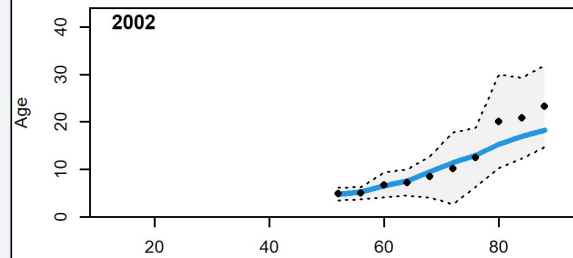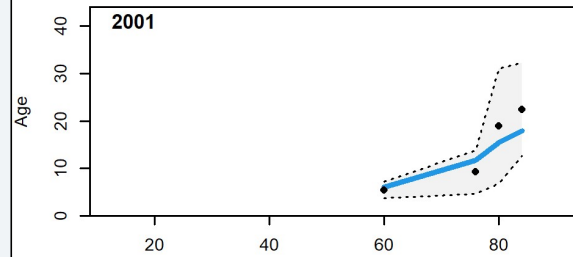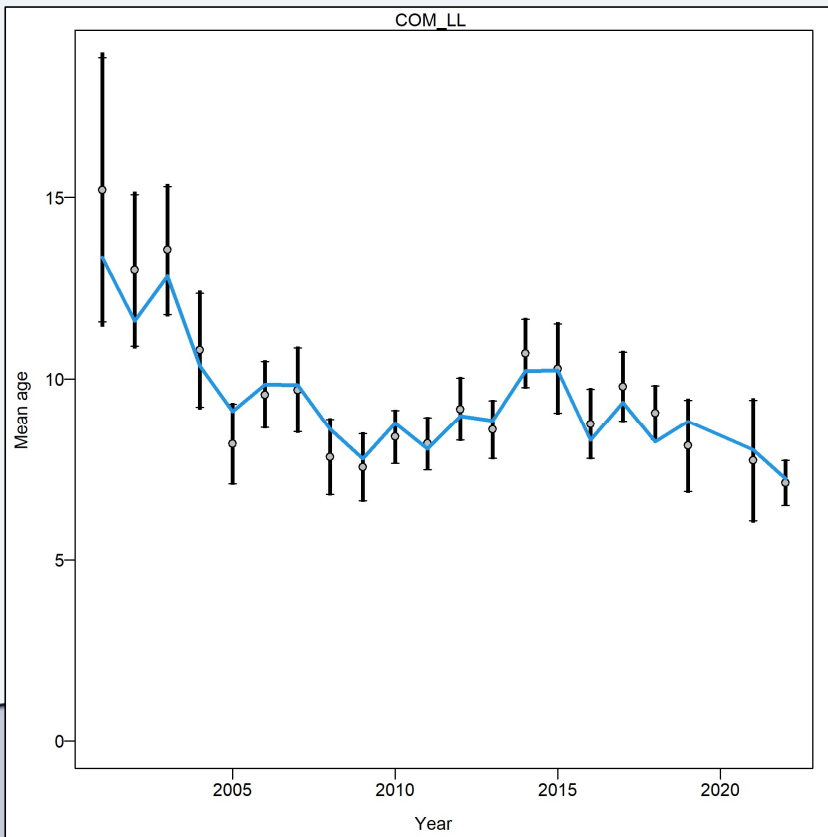
Commercial Other CAAL
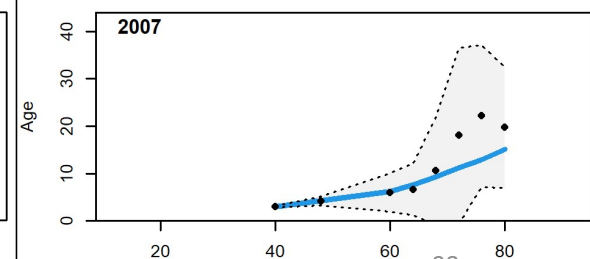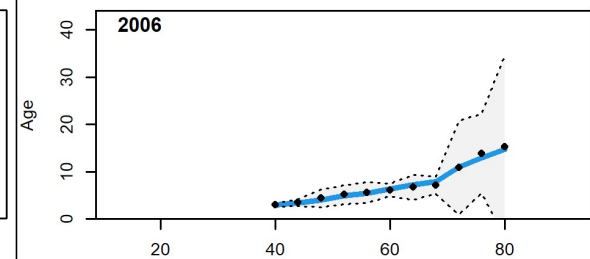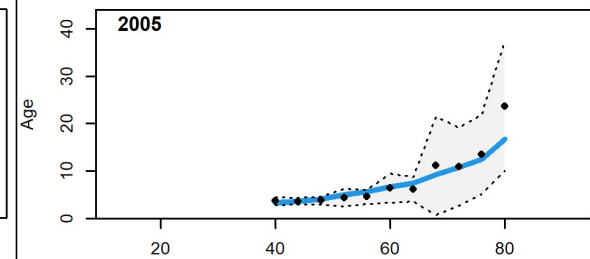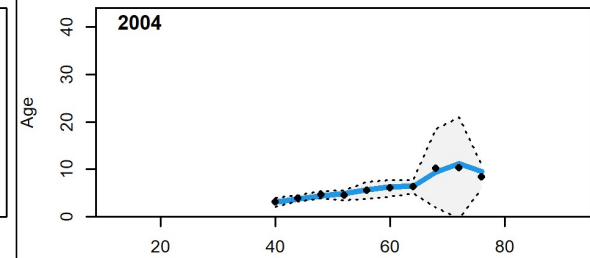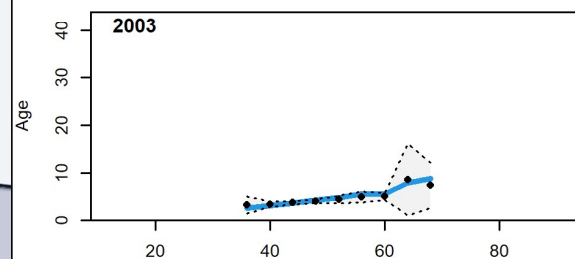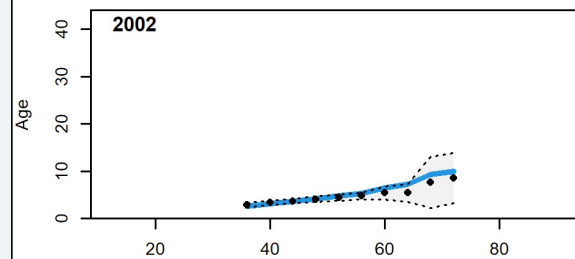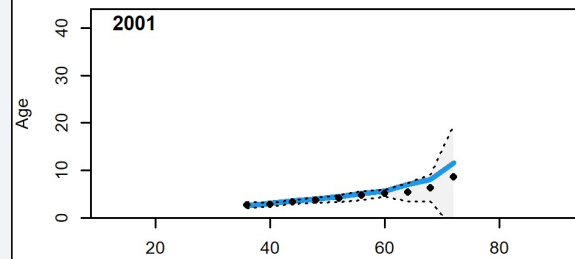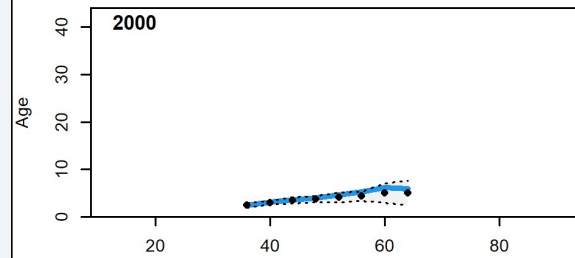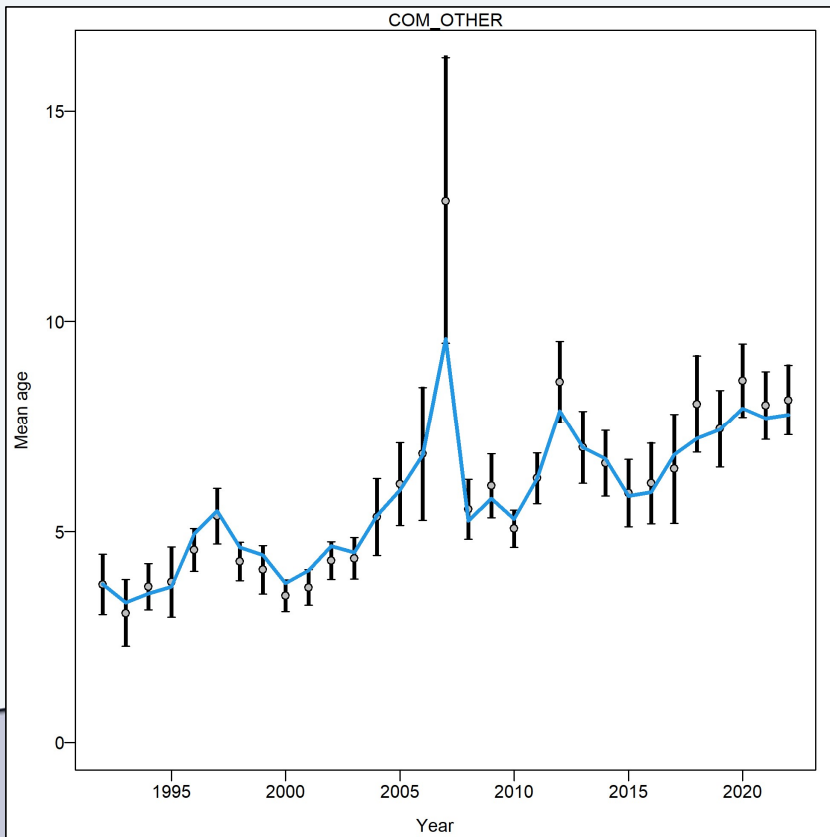
Rec East CAAL
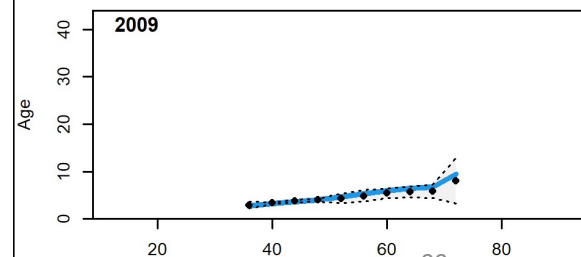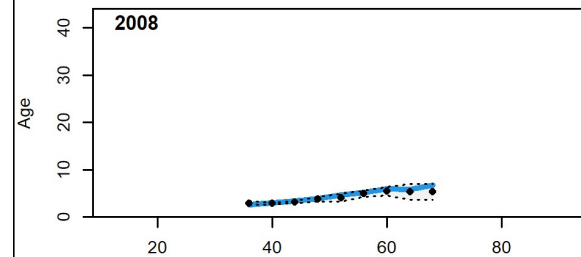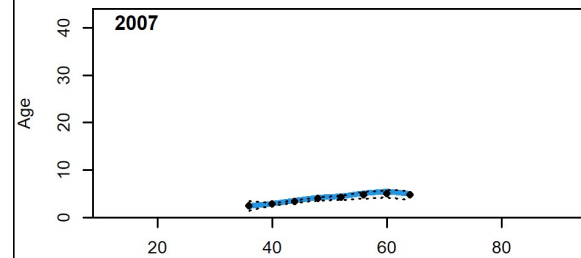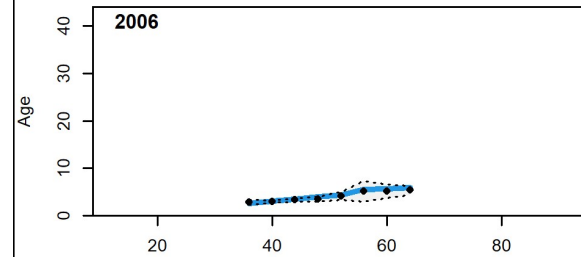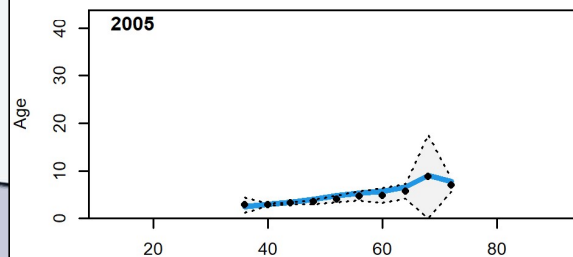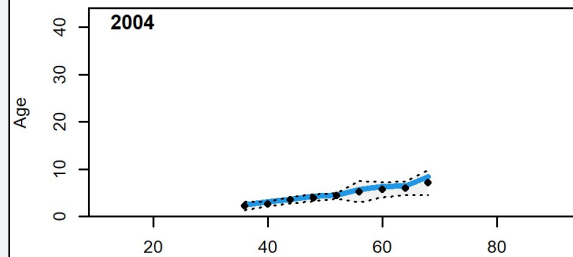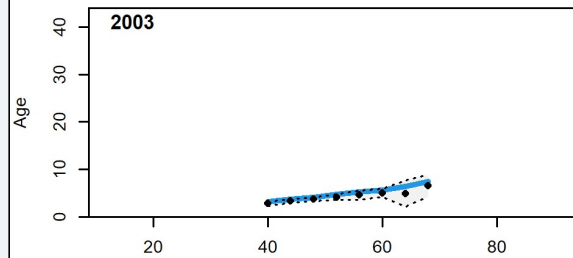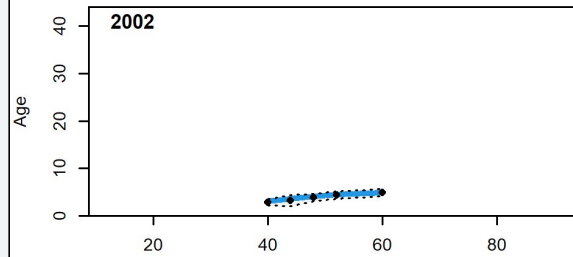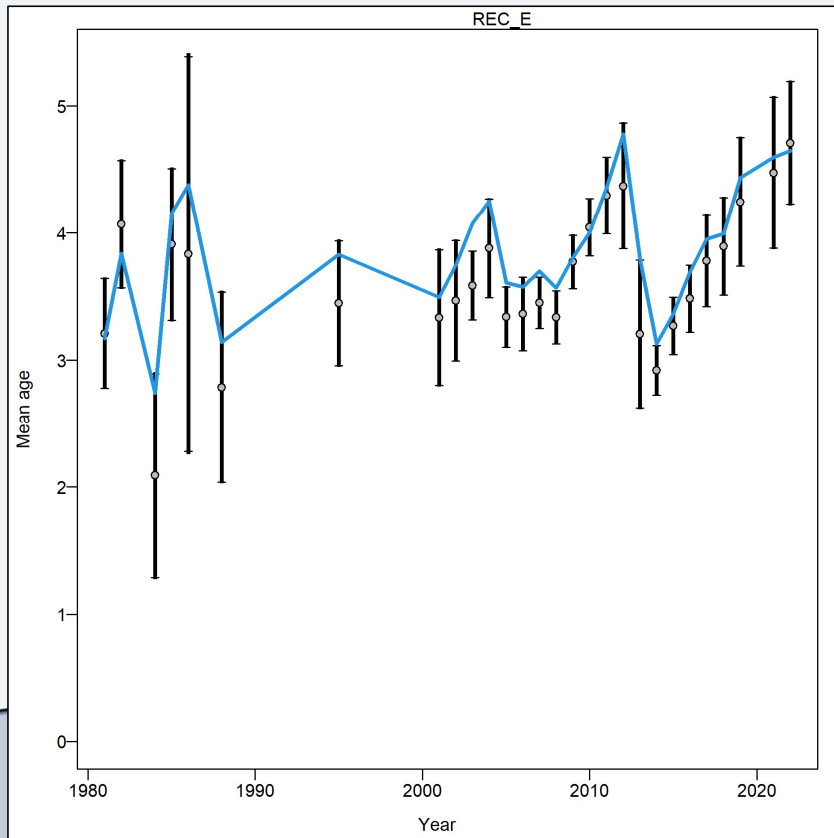
Rec West CAAL
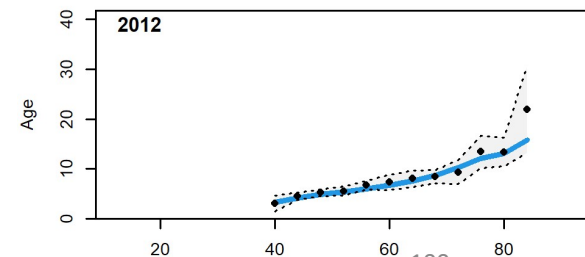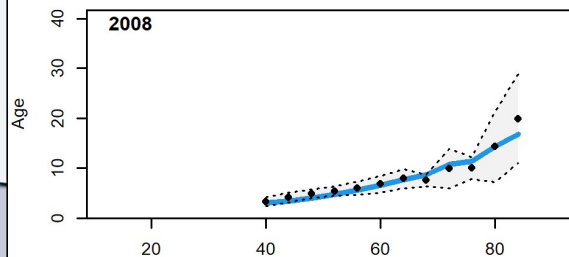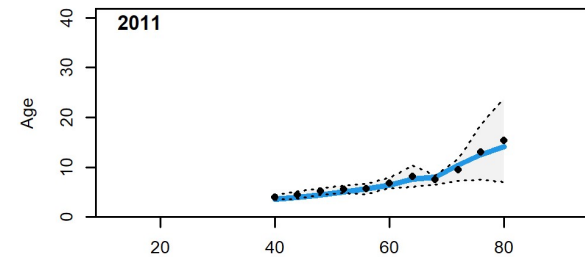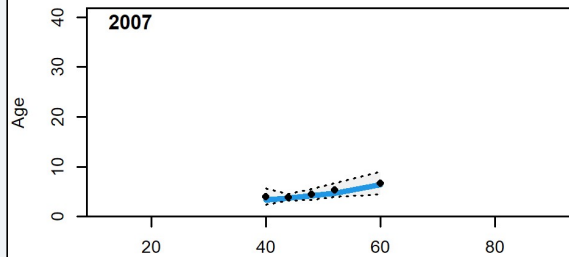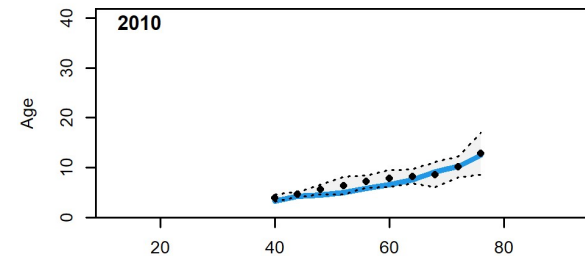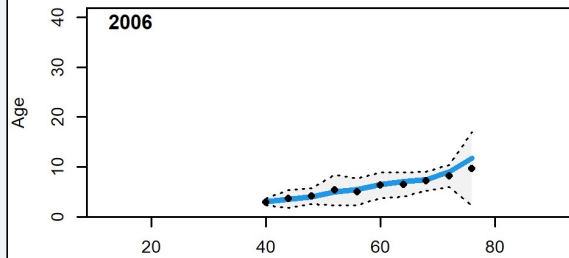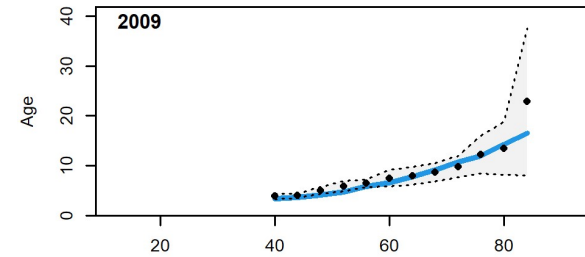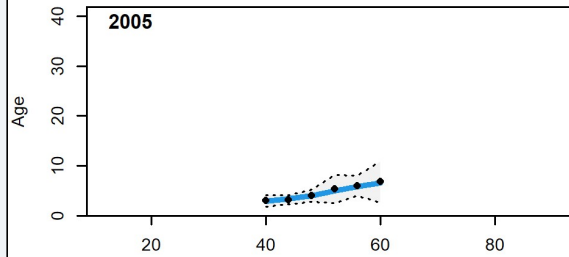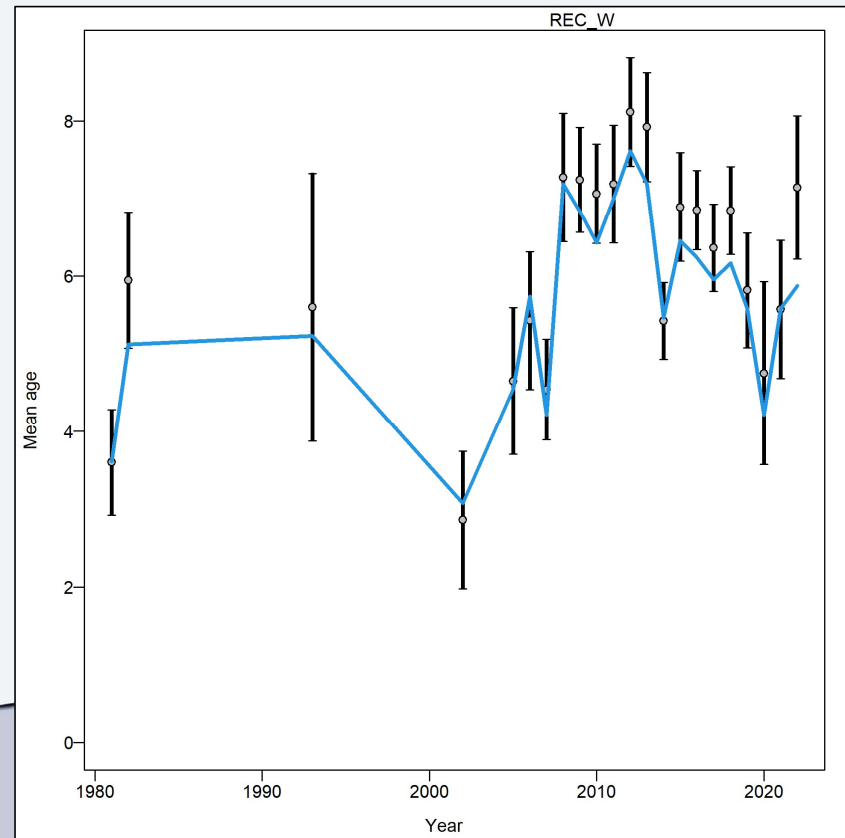
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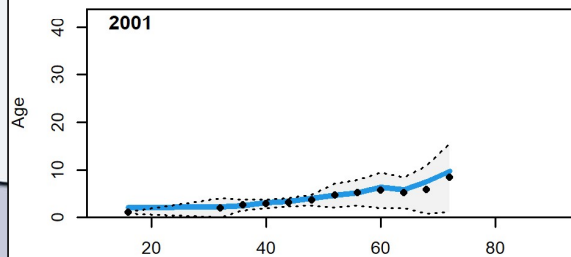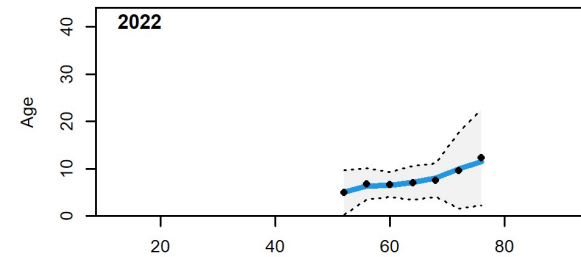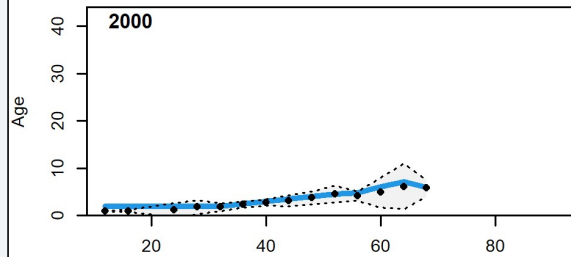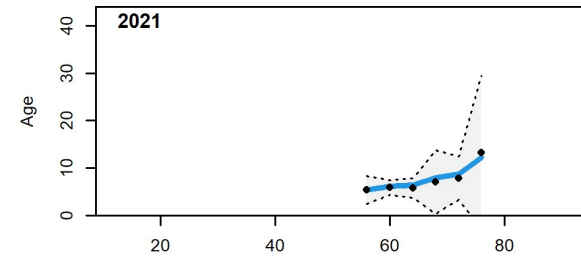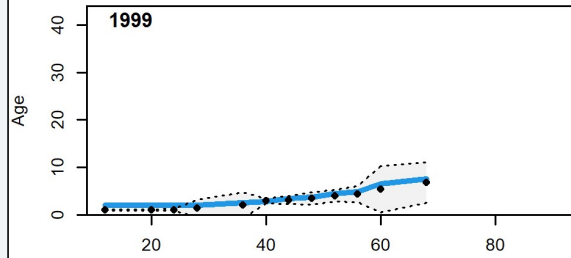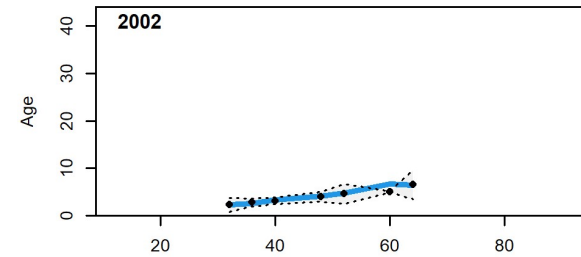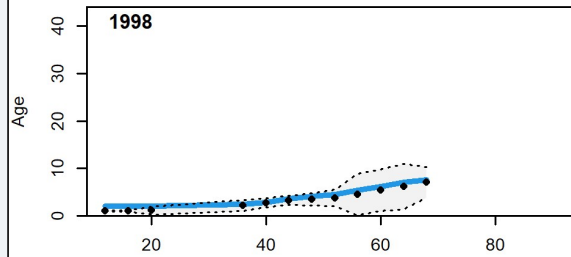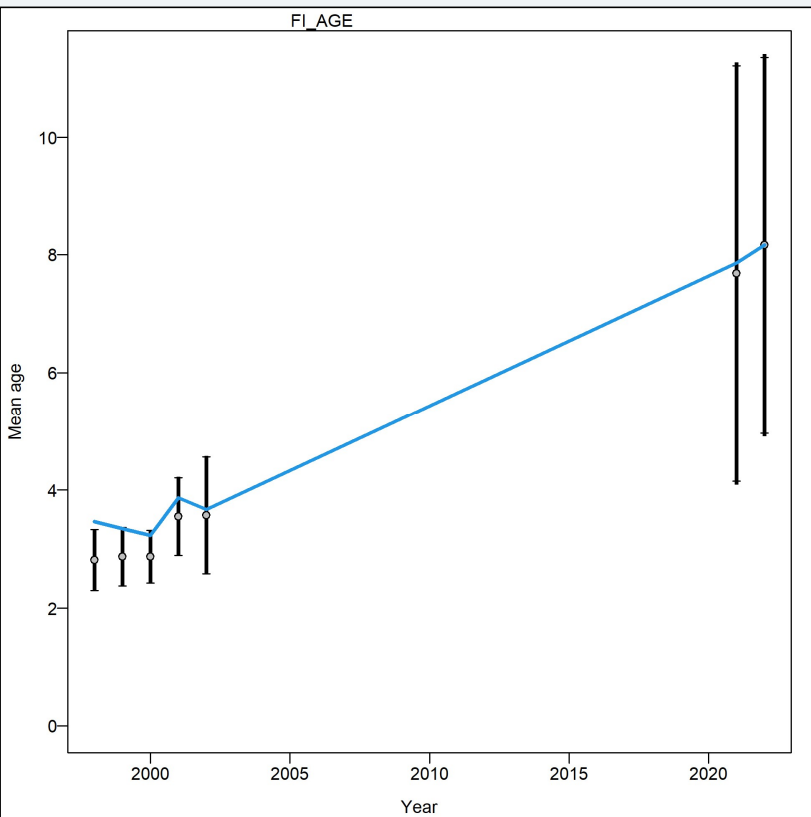
Runs Test for Conditional Age-At-Length
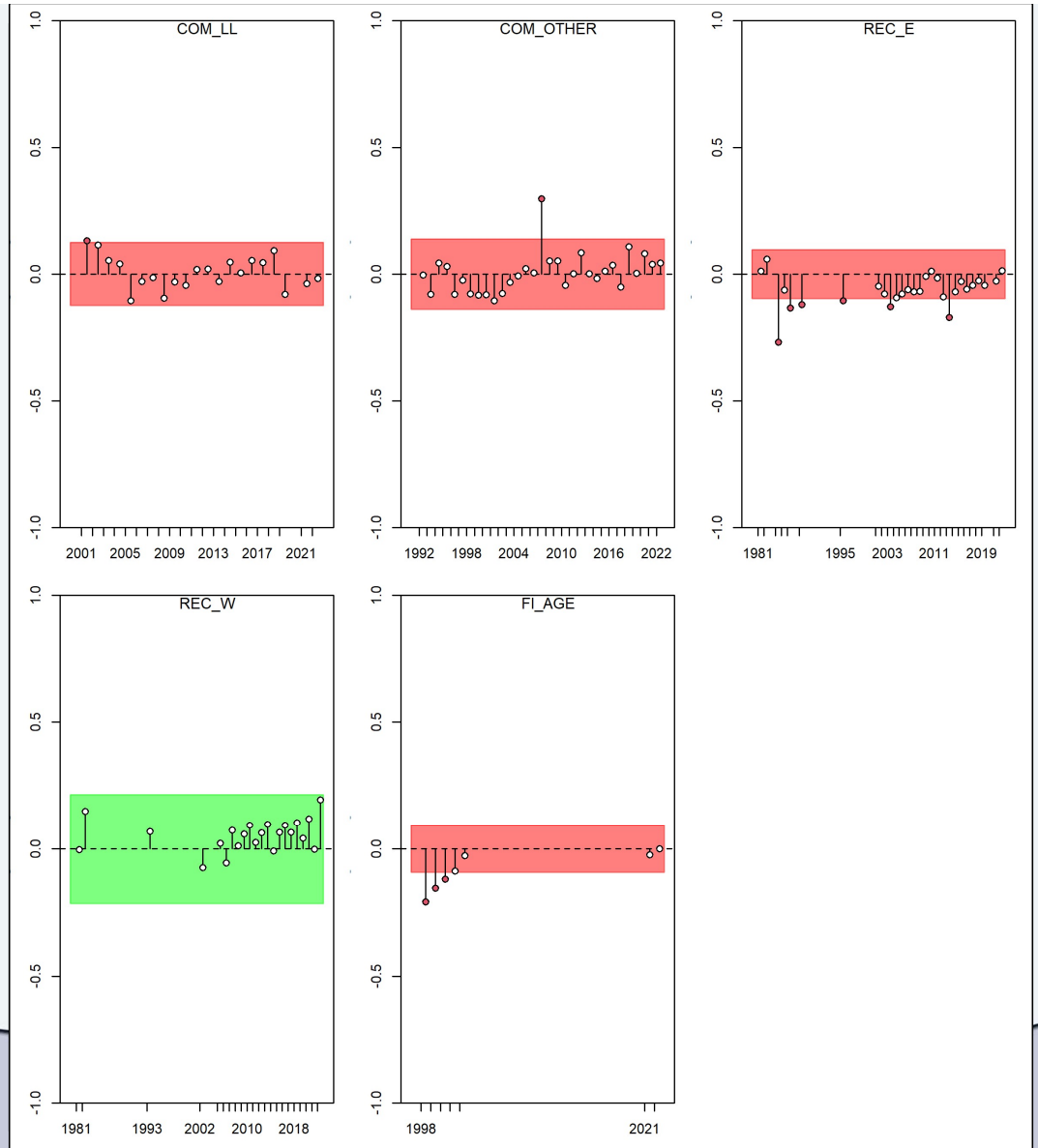
Thank you for your attention!

Questions?

Musings and Questions

- What's driving the truncated length AND age distribution in SE FL?
  - One-way migration from Dry Tortugas/Keys to northern FL and north of FL?
  - Larval transport?
  - Localized overfishing?
    - Effort shifts due to closure/limitations of the Red Snapper fishery
  - Depth-limited sampling?
  - Effect of higher SST leading to improved survival of juveniles?
  - Preferred Juvenile Habitat in SE FL?
  - ????
- Can these hypotheses be tested in an assessment model?
- What data or surveys would be needed to answer this?
  - Reproduction
  - Movement/Tagging data into and out of SE FL
  - ????

Main Data Inputs: Landings (inc MRIP-FES)
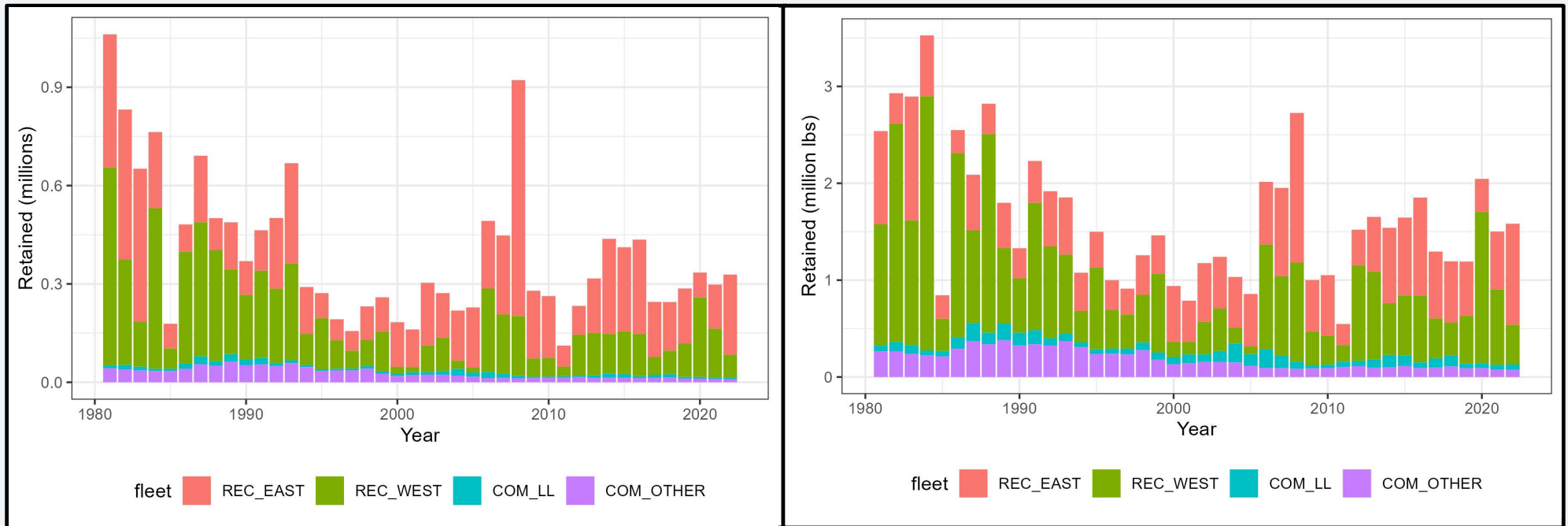
Main Data Inputs: Landings CV (inc MRIP-FES)
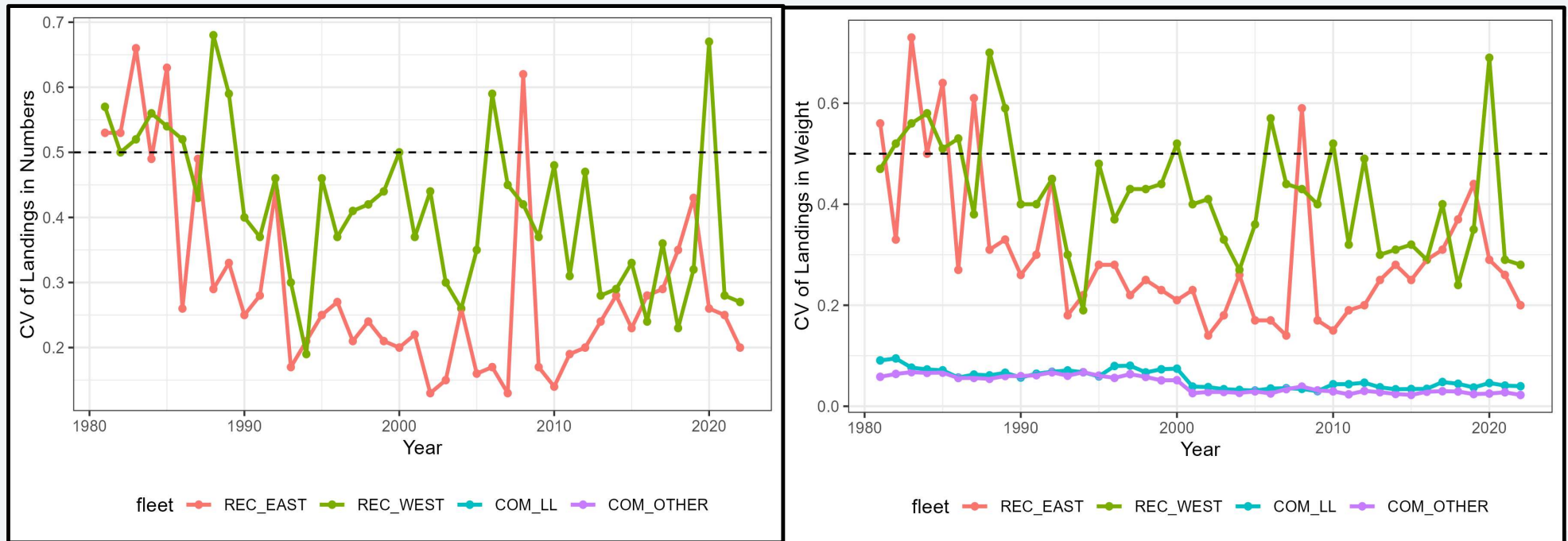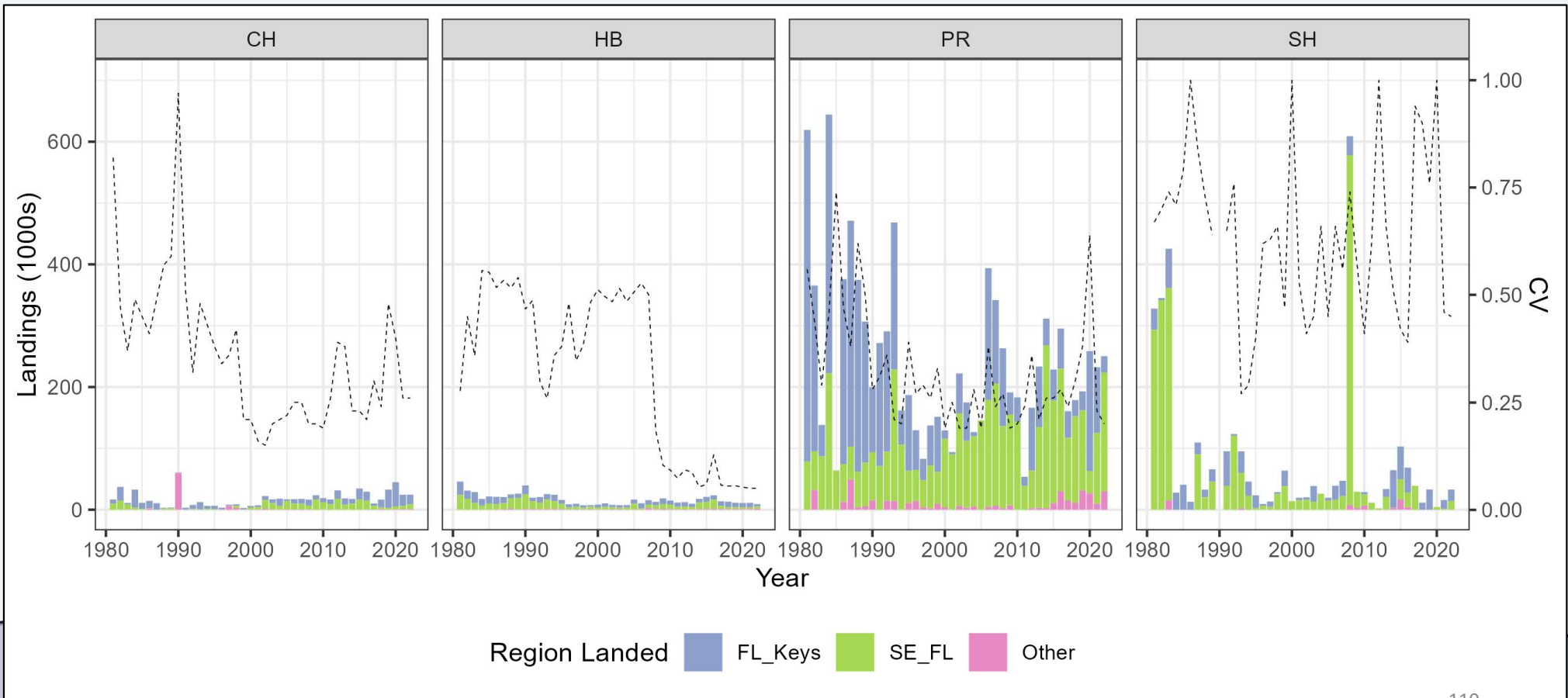
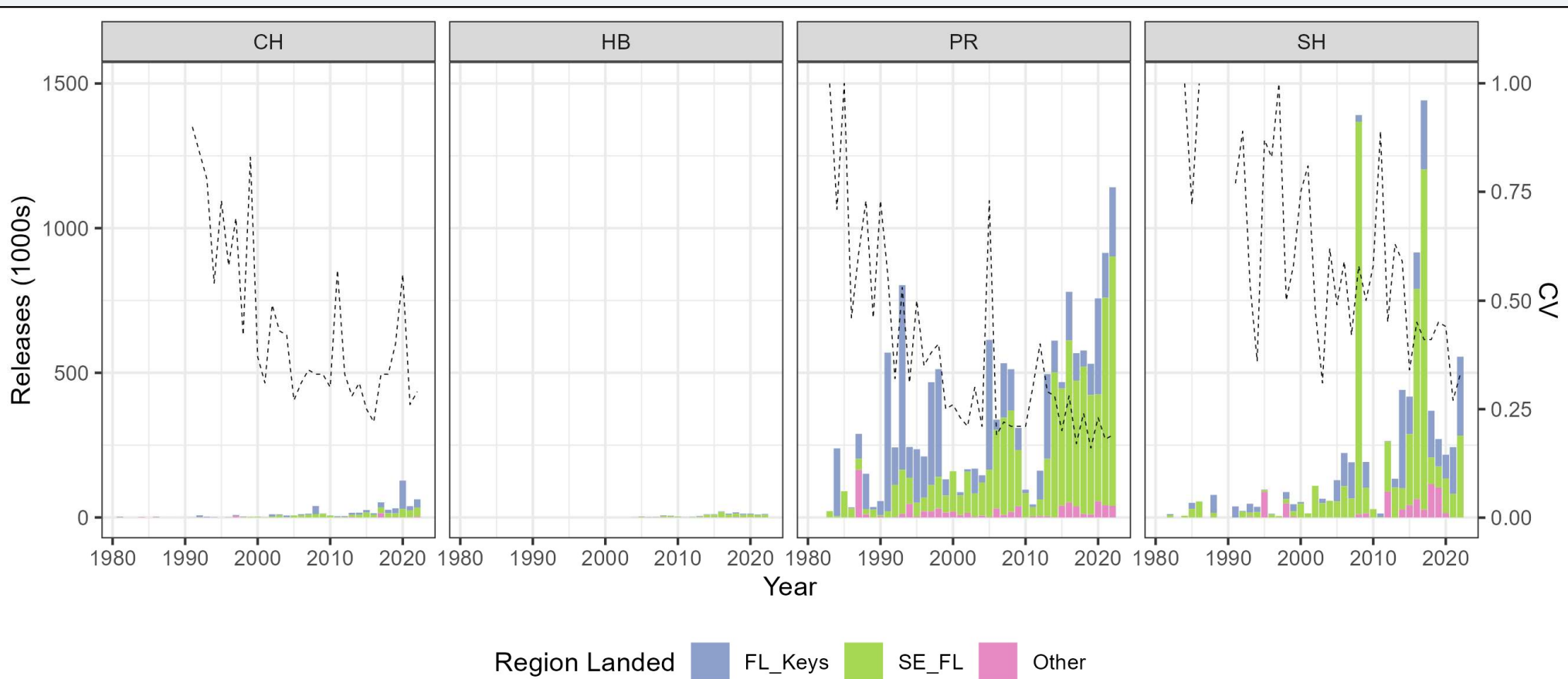# Main Data Inputs: Releases (inc MRIP-FES)
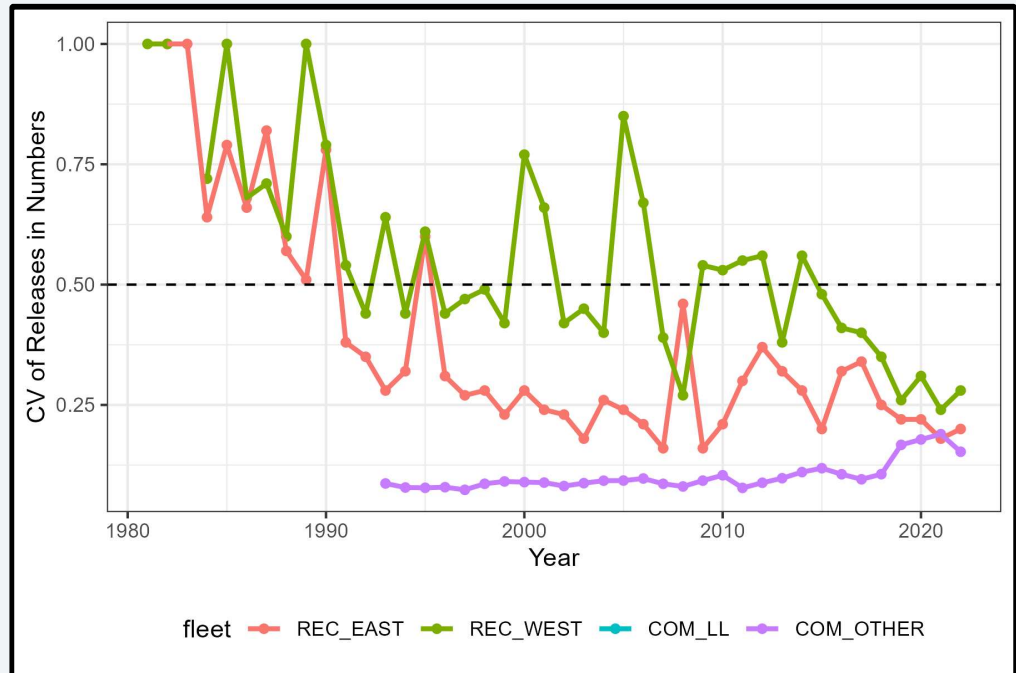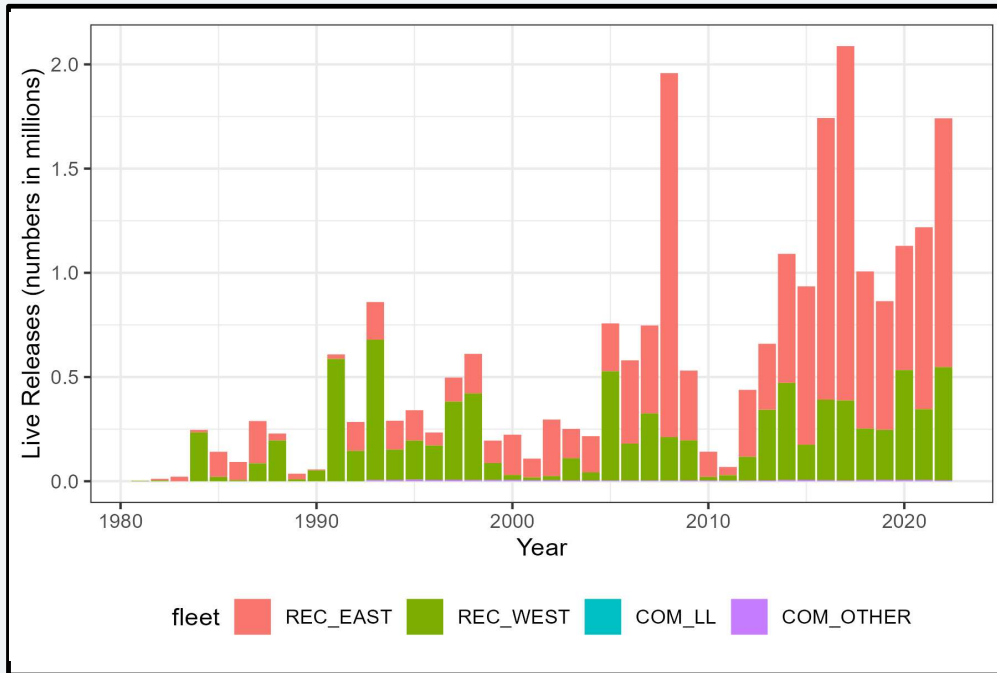
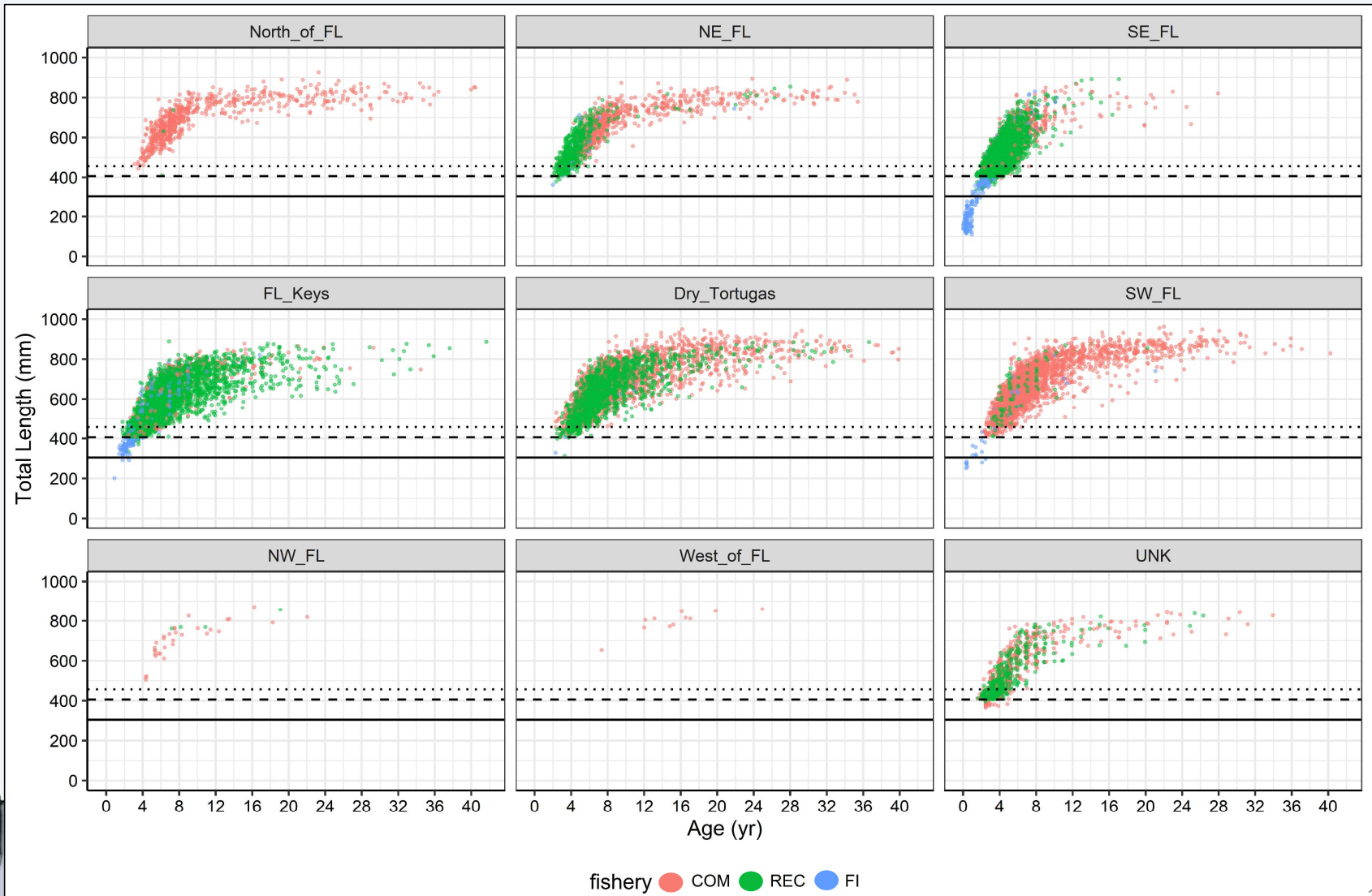# Landings (lbs) By Source
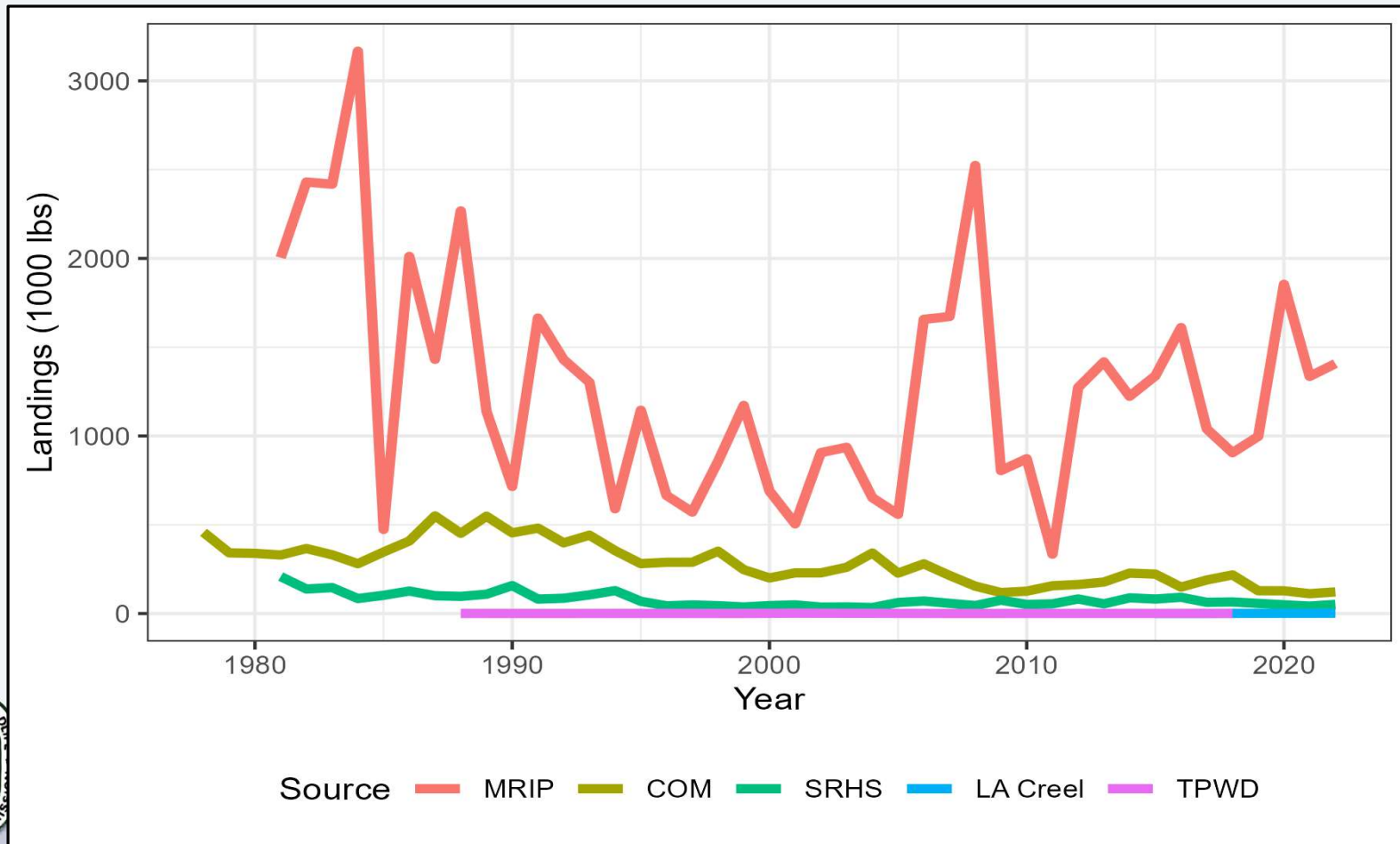
Discards (number) By Source
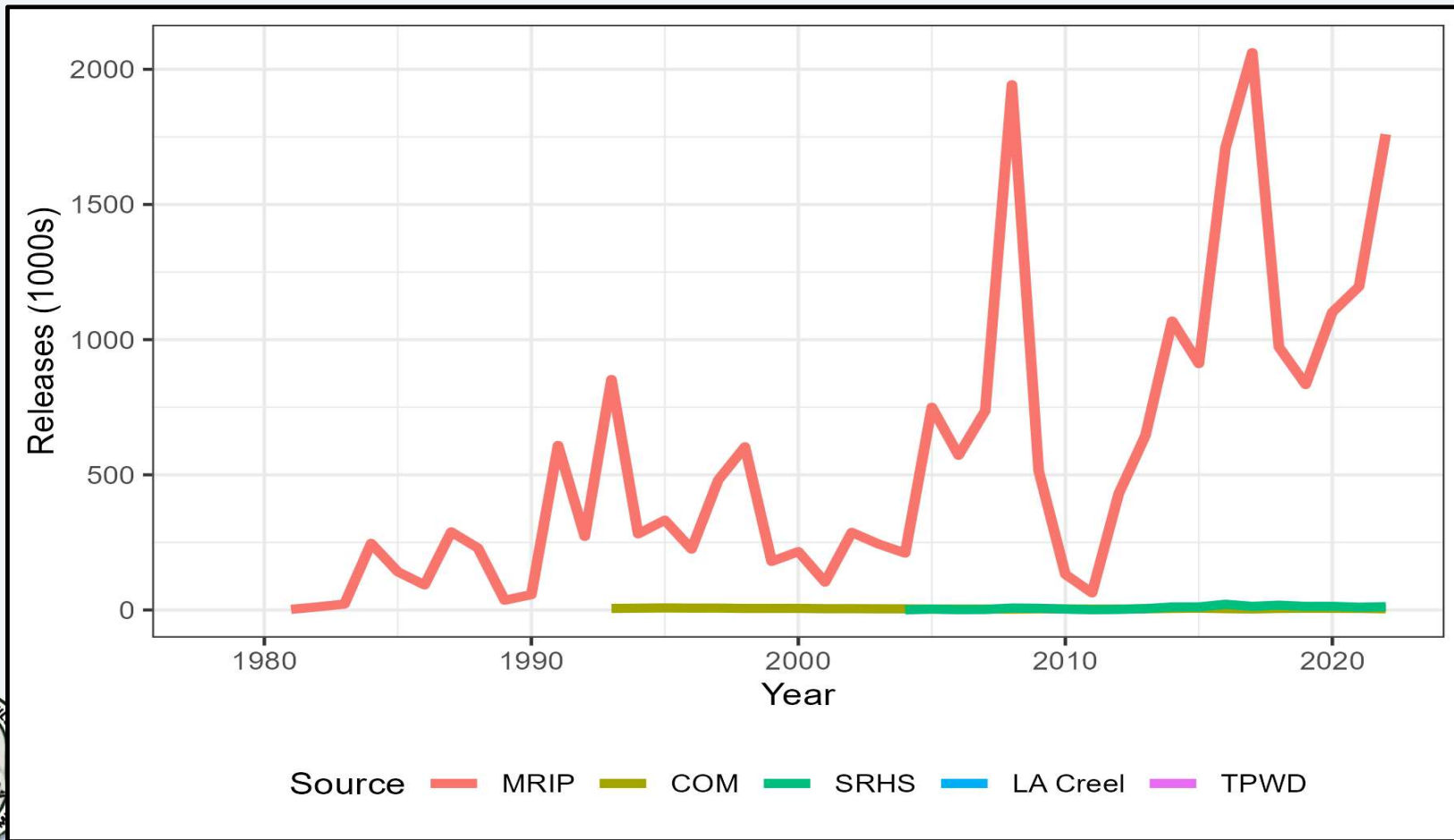
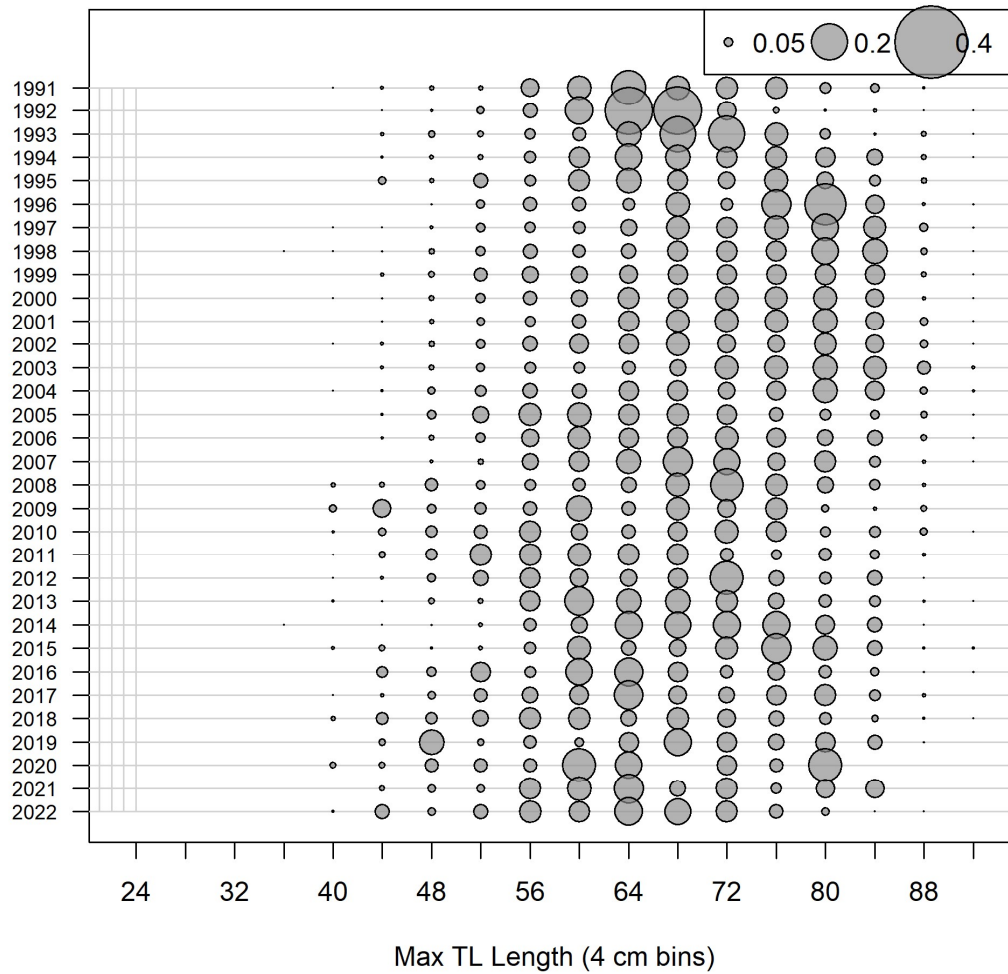# Rec MRIP Landings (num) by Region and Mode

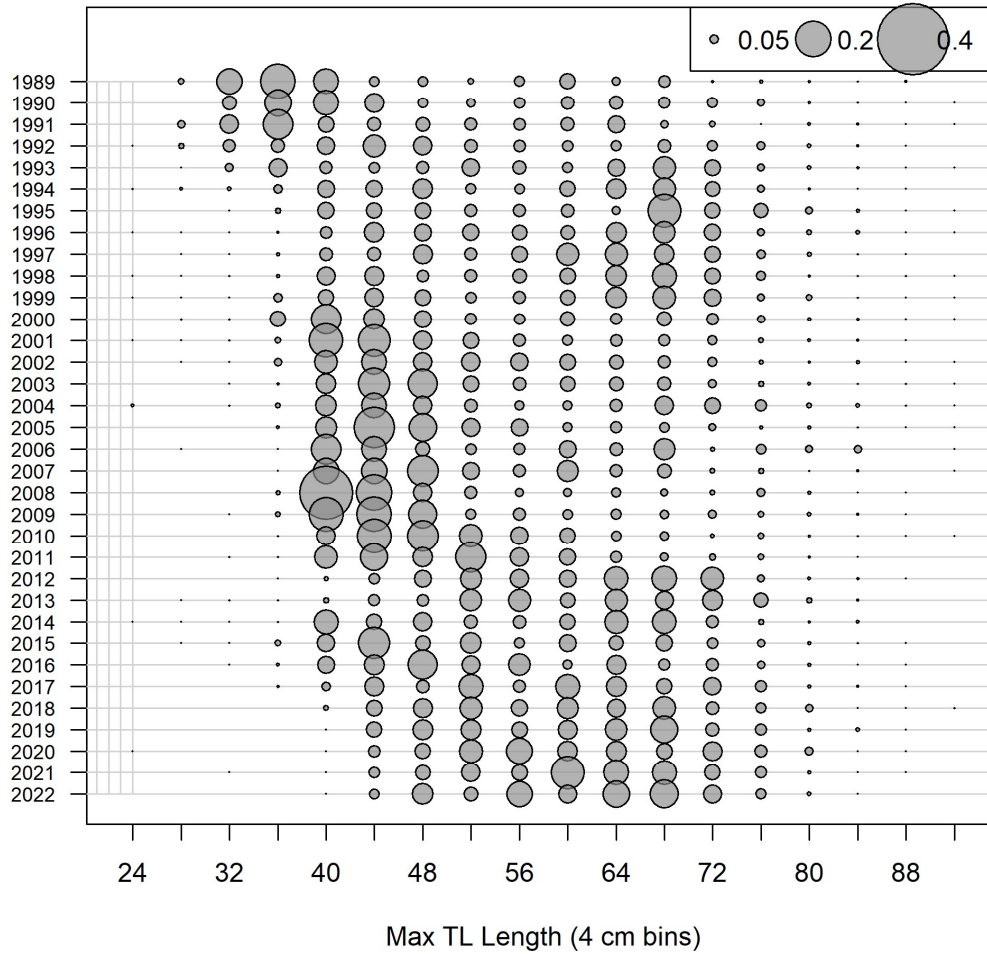# Rec MRIP Releases (num) by Region and Mode

COM LL
Updated
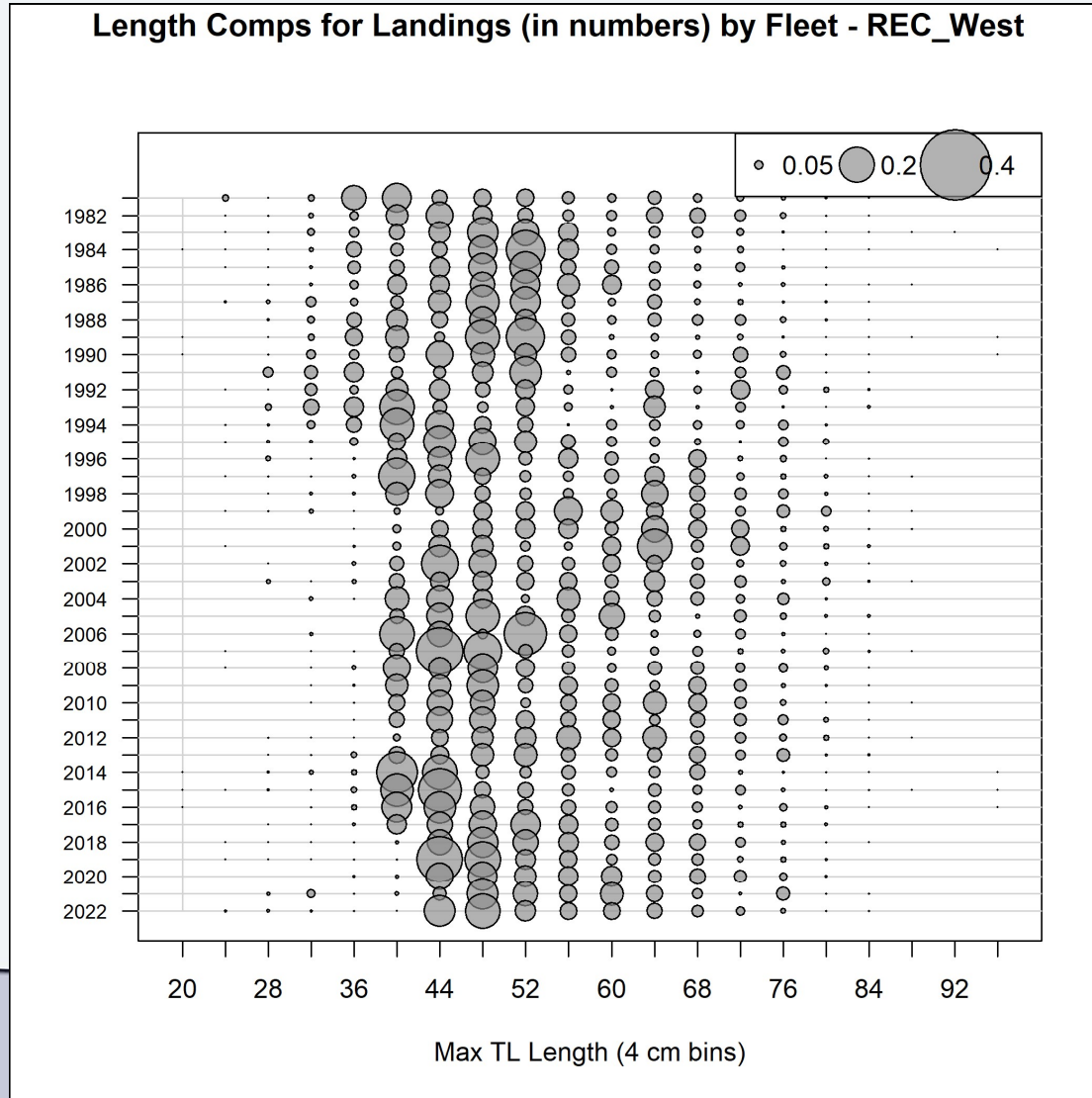## 4 cm bins

Length Comps for Landings (in numbers) by Fleet - COM_LL

COM OTHER
Updated
4 cm bins

Length Comps for Landings (in numbers) by Fleet - COM_OTHER

Rec West
Updated
4 cm bins

Length Comps for Landings (in numbers) by Fleet - REC_West

Rec East Updated 4 cm bins

Length Comps for Landings (in numbers) by Fleet - REC_East