Overview of the *Illex illecebrosus* Research Track Assessment (RTA) Results

July 25, 2022 SSC Meeting

Timeline

Date	Task Conducted
March 7-11	CIE Panel RTA review
March 15	1. Panel Summary Report received, but returned for accept/reject clarity questions 2. SSC set 2022 ABC (used RTA version of Rago Indirect Estimation Method with 2021 U.S. catch and survey data)
April 11	AOP review of MTA plans (indiv. CIE reviews unavailable). Decision: data update for 2020-2021
May 18	Indiv. CIE review reports received

Overview

Summary of RTA results by ToR

Results already presented (May 10 SSC meeting):

- ToR 3 (intra-annual cohort ID and biol. analyses)
- ToR 4 (oceanog. Indicators section)
- ToR 5 (Generalized Depletion Model section)

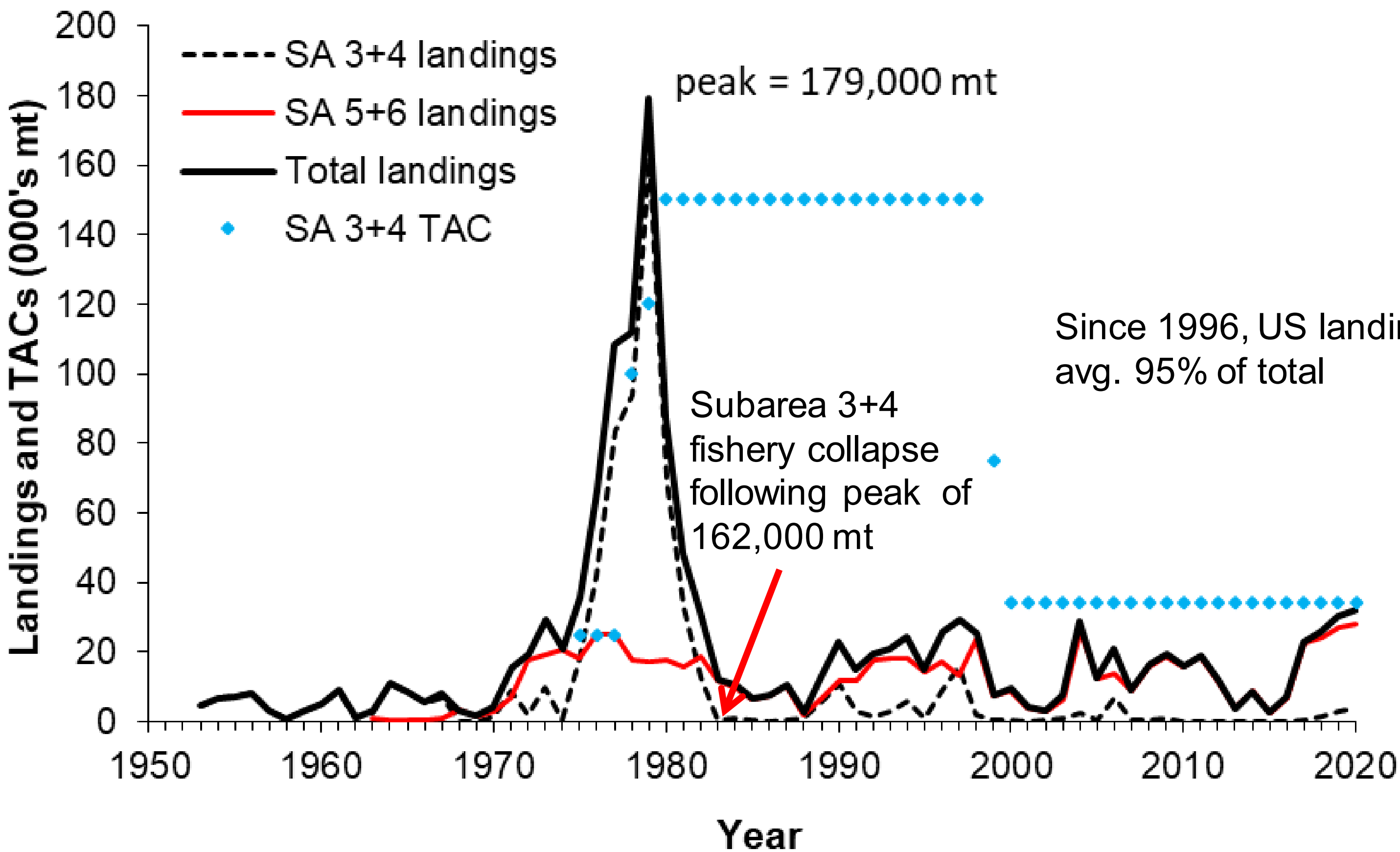
NOTE: This assessment involved a new process and was conducted by the RTA WG, not the Assessment Lead

ToR 1: Estimate catches and their precision

Catches estimated for 1997-2019

- U.S landings dominate catches and are most accurate from 1997 onward due to mandatory reporting
- 2019 RTA terminal yr because no 2020 NEFSC survey indices and observer data also impacted by pandemic
- 1997-2019 used as assessment time series

Landings by stock component & SA 3+4 TACs



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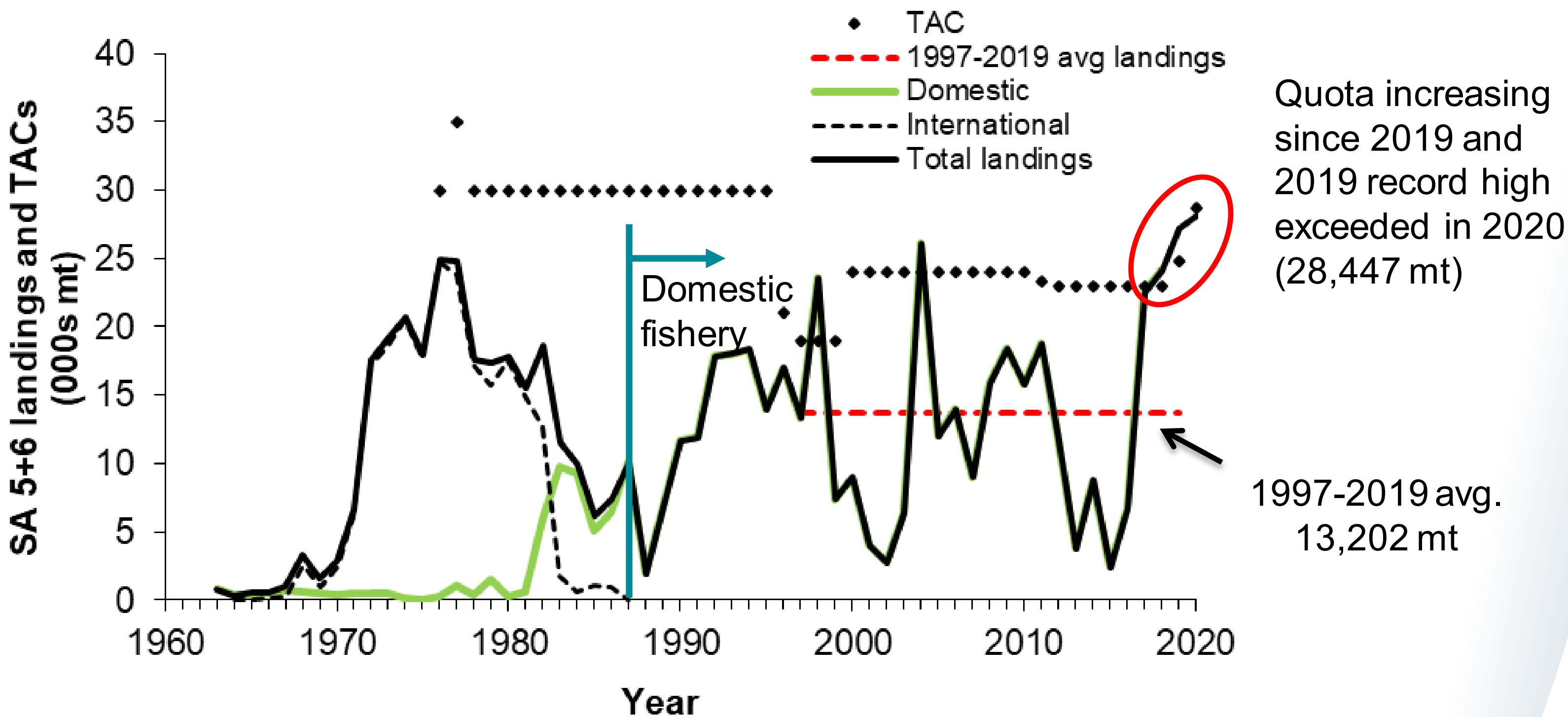
U.S. Landings and TACs



Estimation of U.S. Discards

Standardized bycatch reporting methodology (Wigley et al. 2007); fleet-based, ratio estimator:

$$\hat{R}_{jh} = \frac{\sum_{i=1}^{n_h} d_{ijh}}{\sum_{i=1}^{n_h} k_{ih}}$$

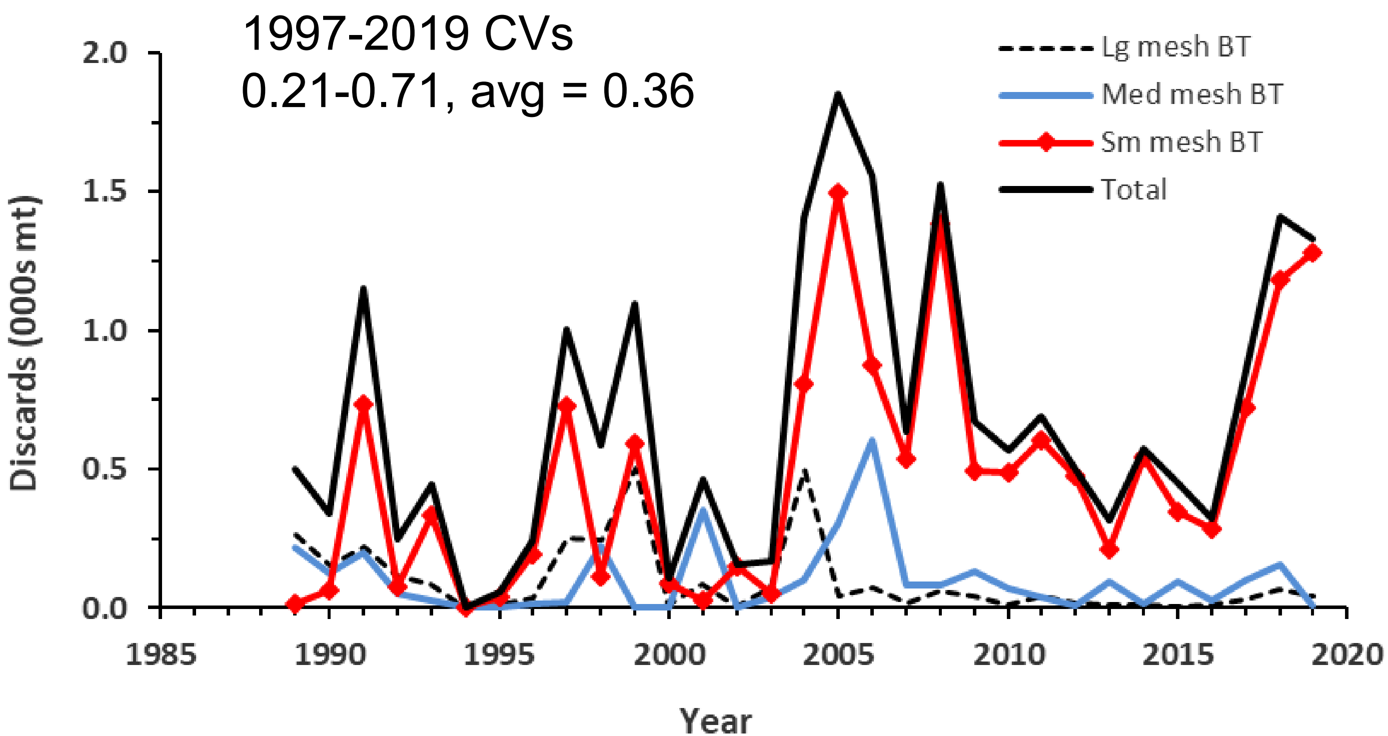
where $\hat{R}_{jh}$ is the bycatch rate of *species* ***j*** in stratum ***h***; d_{ijh} is the discard weight for *species* ***j*** within trip ***i*** in stratum ***h***; and k_{ih} is the kept weight of all species within trip ***i*** in stratum ***h***.

Estimation of U.S. Discards

Fleets: Lg-mesh BT (≥ 5.5 in.)
Med-mesh BT (2.50 – 5.49 in.)
Sm-mesh BT (< 2.49 in.)

by geogr. region (Mid-Atl. & SNE) and quarter

U.S. Discards, 1989-2019



Since 2004, highest N obs. trips, Mid-Atlantic small-mesh BT discards (mainly *Illex* and longfin squid fisheries) averaged 81% of the total discards

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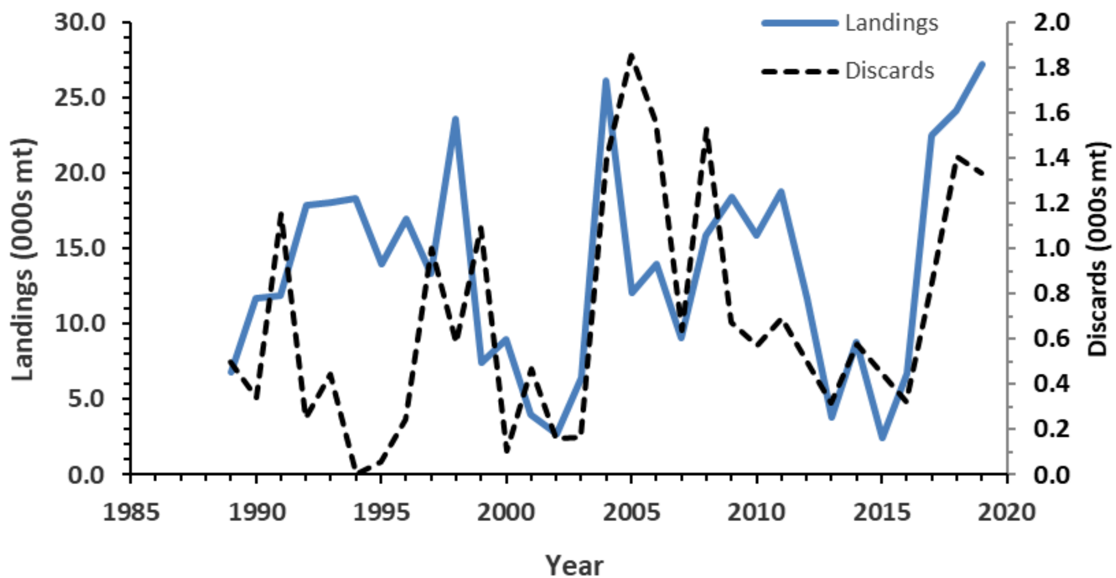
U.S. landings and discards 1989-2019



Since 2004 increase in N small-mesh observer trips, discards have generally fluctuated with landings

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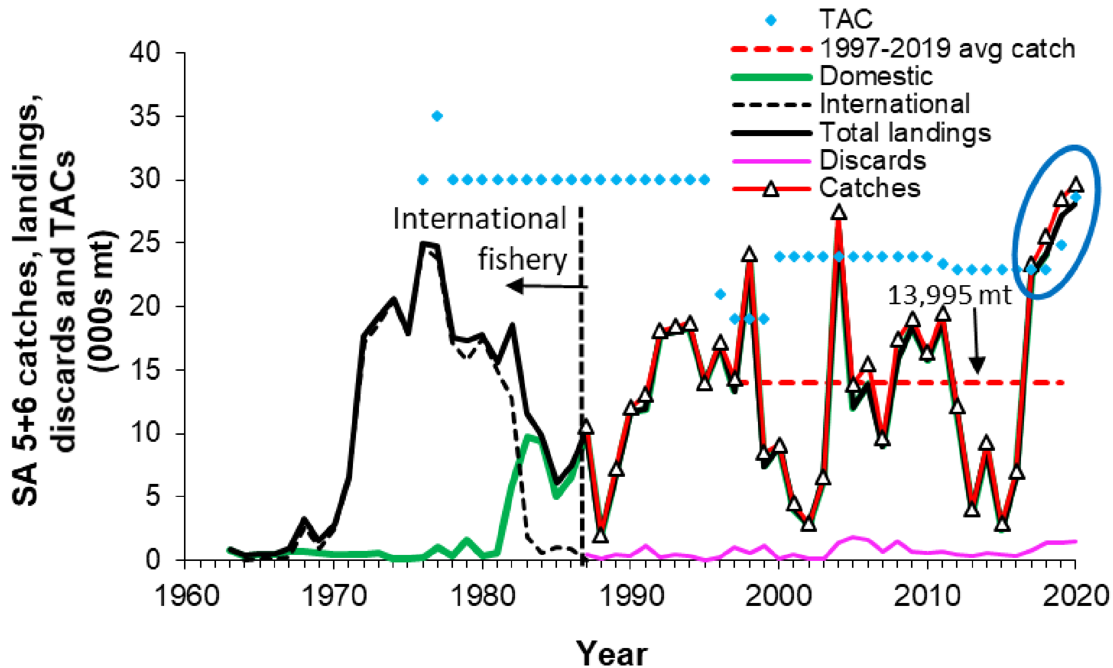
U.S. landings, discards and catches



1997-2019 U.S. discards small % of catch (avg. = 6.4%) and catches averaged 13,995 mt

Peak catch = 29,654 mt in 2020

ToR 2: Evaluate indices included in the assessment and characterize their uncertainty, including:

1. Survey relative biomass and abundance indices
2. Standardized fishery CPUE indices
3. Explore relationship between effort & economic factors (e.g., global market price) to determine if an economic factor improves fit of CPUE standardization model

ToR 2: Survey Abundance & Biomass Indices

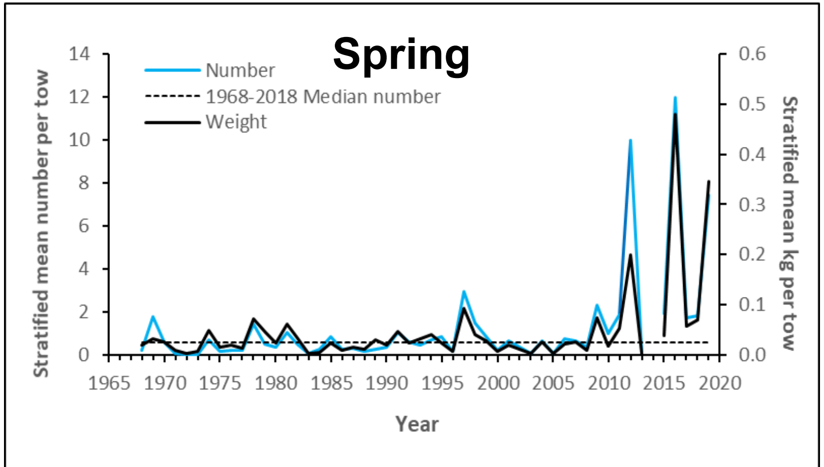
1. **NEFSC** spring & fall are longest time series & cover largest habitat area (winter - only 10 yrs and a subset of strata)

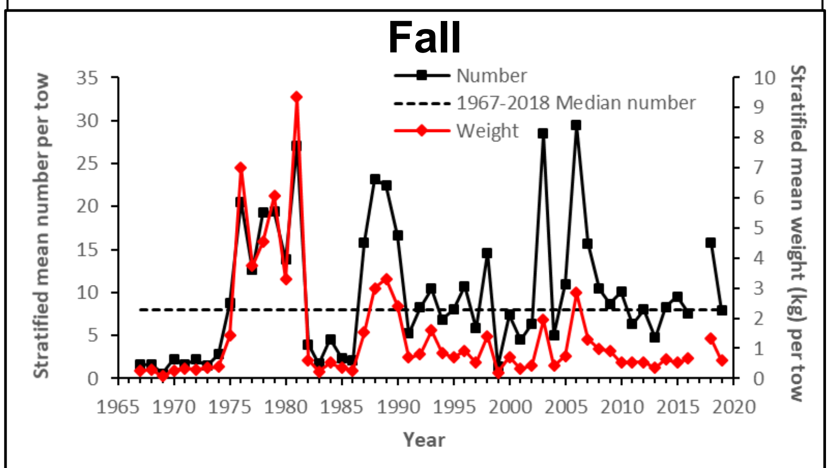
An offshore species, but also examined inshore survey indices

Inshore surveys (S. to N.) shorter TS, smaller habitat areas

2. VIMS NEAMAP (NC-RI, spring and fall)
3. NJ DEP (summer)
4. MA DMF (spring and fall)
5. ME-NH DMR (spring and fall)
6. ASMFC Gulf of Maine shrimp (summer, offshore survey)

NEFSC Survey Indices





Pre-fishery survey

14% positive tows

Avg. CVs

Num/tow	Kg/tow
0.39	0.34

Much lower catches fewer pos. tows and indices more uncertain (availability issue)

Post-fishery survey

57% positive tows

Avg. CVs

Num/tow	Kg/tow
0.23	0.23

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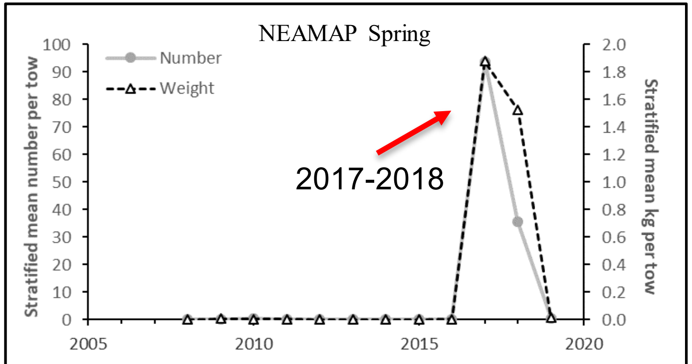
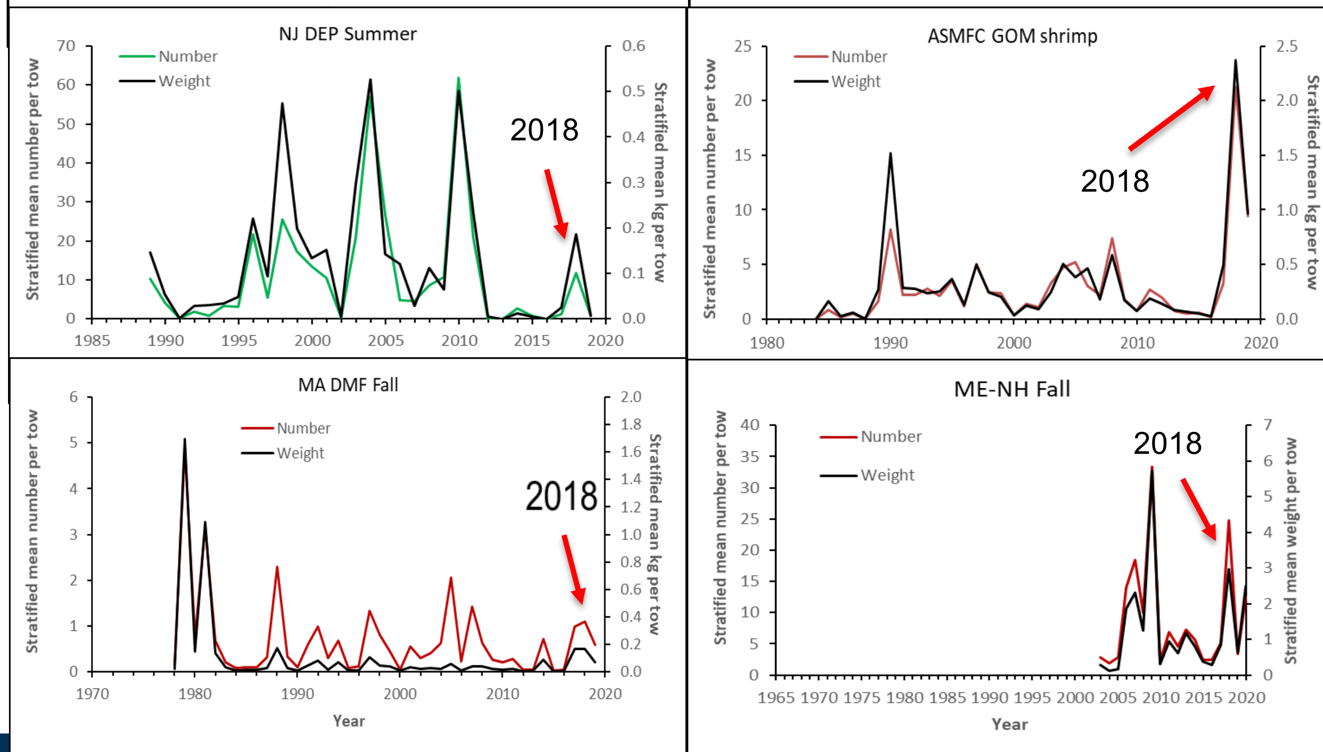
Inshore Survey Indices



Highly variable, localized trends. Few caught in spring, high abund. yrs not detected in all surveys (e.g. 2017-2018)



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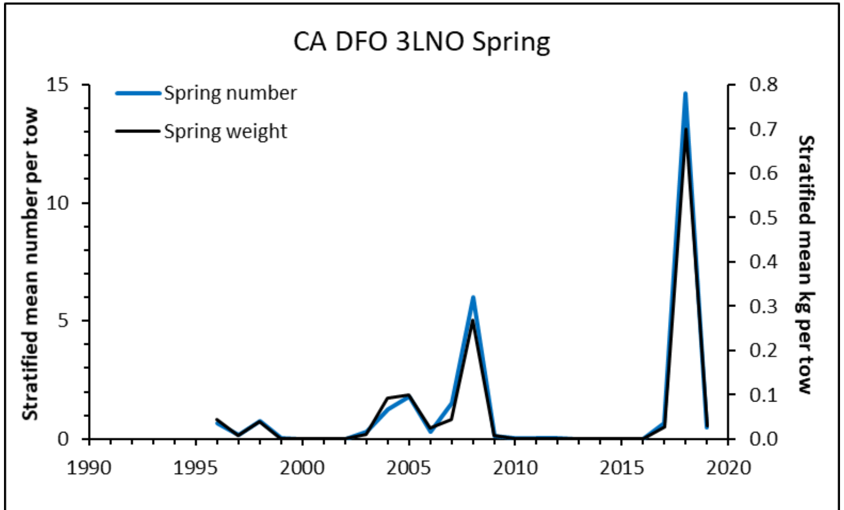

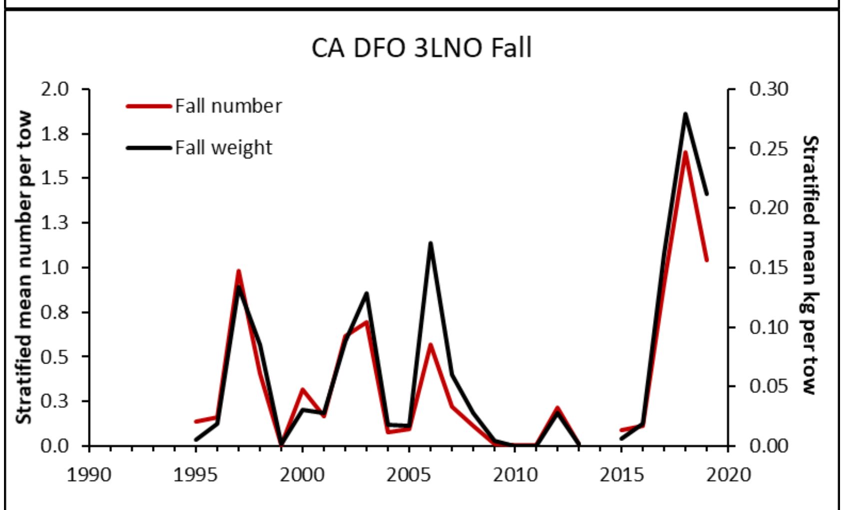

Canadian Surveys

Northernmost

Grand Banks such a large area that spring and fall surveys require 4 and 3 months, respectively, to complete

2018 abundance indices highest on record for both surveys, but their trends differed

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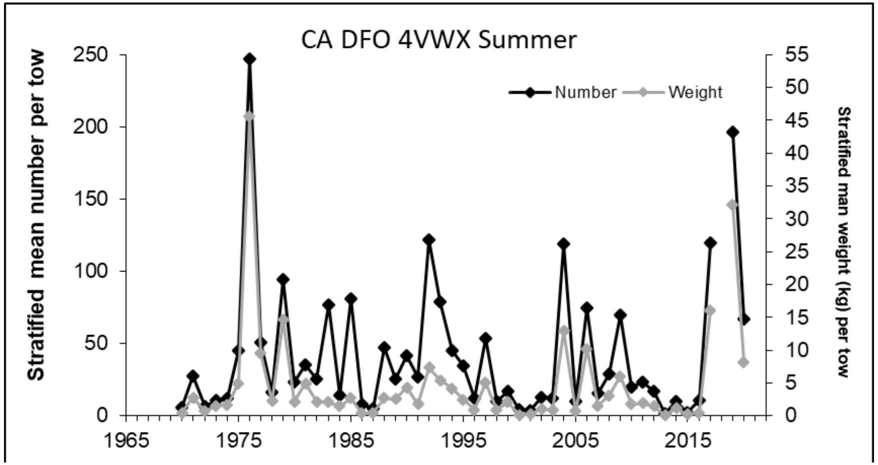
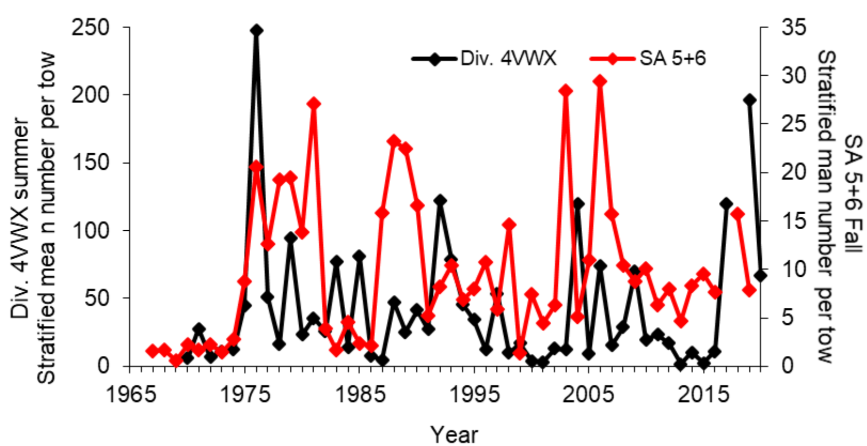
Scotian Shelf vs US NEFSC Fall Surveys





July 4VWX survey

Best availability and largest habitat area of all SA 3+4 surveys

July 4VWX vs NEFSC Fall

4VWX svy is pre-fishery for SA 3+4; NEFSC fall svy is post-fishery; B indices correlated, higher catchability for 4VWX svy

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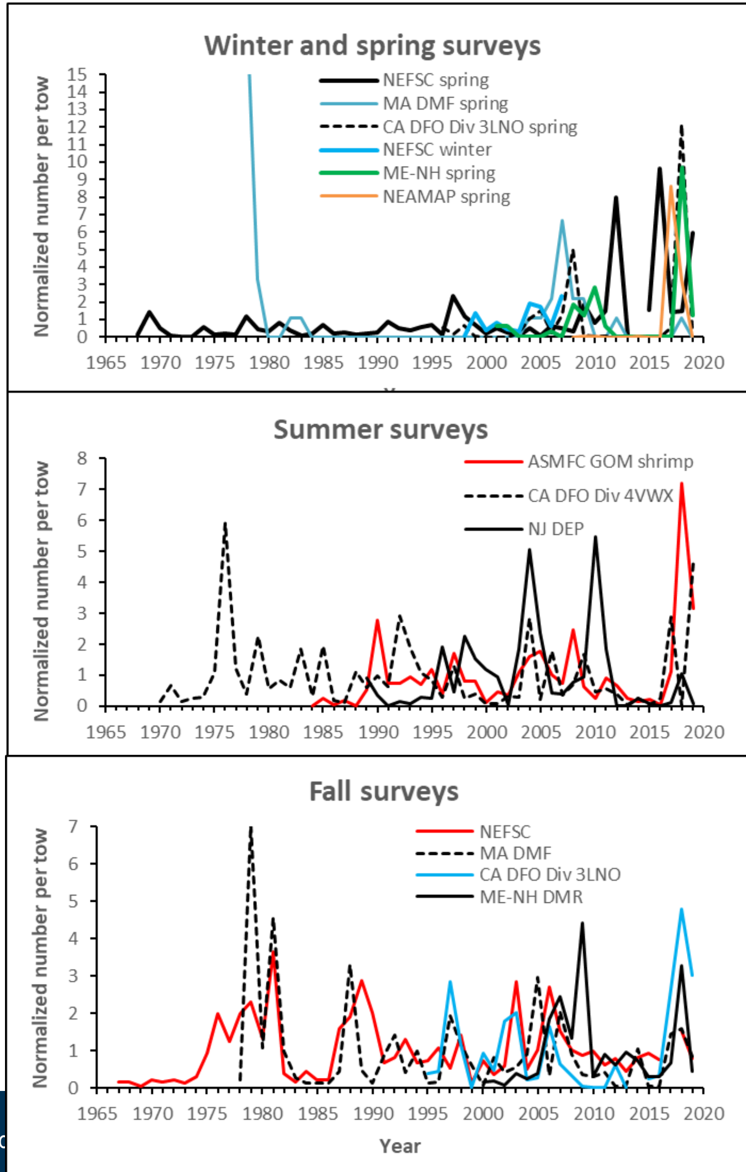


All Survey Indices by Season (normalized)

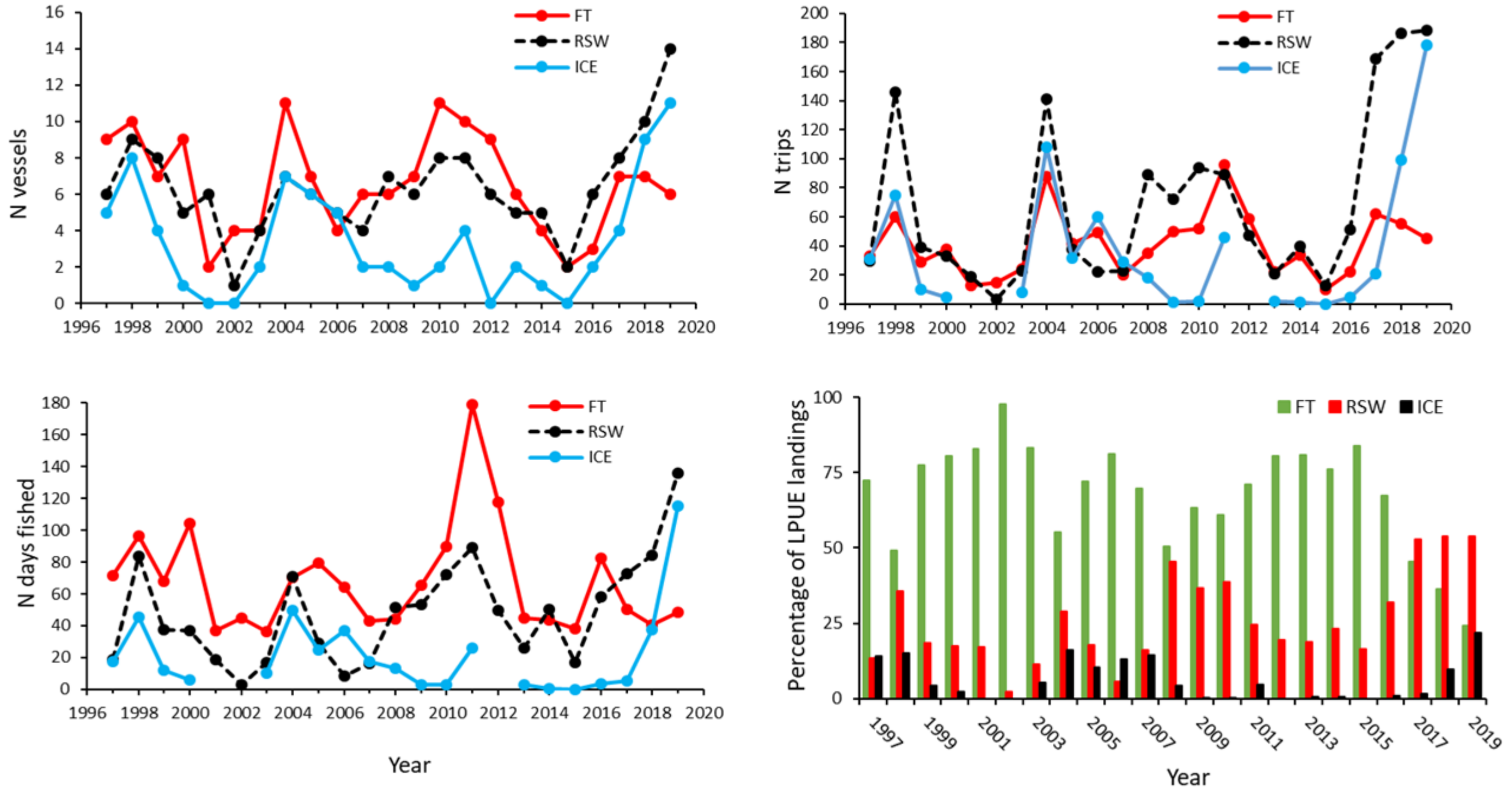
Rel. abundance lowest and most variable in spring (on-shelf migration pd)

<u>Correlations</u>: Abundance indices for CA summer and fall, NEFSC and MA fall and biomass indices for NEFSC fall and CA summer (Hendrickson and Showell 2019)

ToR 2: Standardized CPUE Indices

Given that discards low % of directed fishery catch, 0.5-6% (NEFSC 2006), LPUE was assumed representative of CPUE

Fishing Effort and % Landings by Vessel Type



FT highest % of annual landings until 2017-2019 when fleet composition dominated by wet boats, due to FT to RSW conversions & incr. N Ice boats

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Standardized LPUE Estimation

Traditional LPUE standardization method used for NEFSC stock assessments

1. Landings, fishing effort and Statistical Area fished a from "AA" Oracle tables (Wigley 2008) for directed trips (*Illex* landings > 10,000 lbs and > 50% of total trip weight) during weeks 17-45 with 1:1 matches between the Dealer and VTR databases.

2. **Type 3 GLM** with lognormal, gamma & neg. binomial error structures
- **Response variable:** log-transformed LPUE (mt landed/df)
- **Main effects:** All combinations of **Year, Week of Year, Vessel type** (RSW, ice or freezer), **Permit Number** and **Stat. Area**

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Model Fit Summary

Best fits (highlighted for each model type) based on model deviance/df

Best fit of all 3 model types was **neg. binom**. and based on AIC, incl. factors **yr, wk, permit, area**

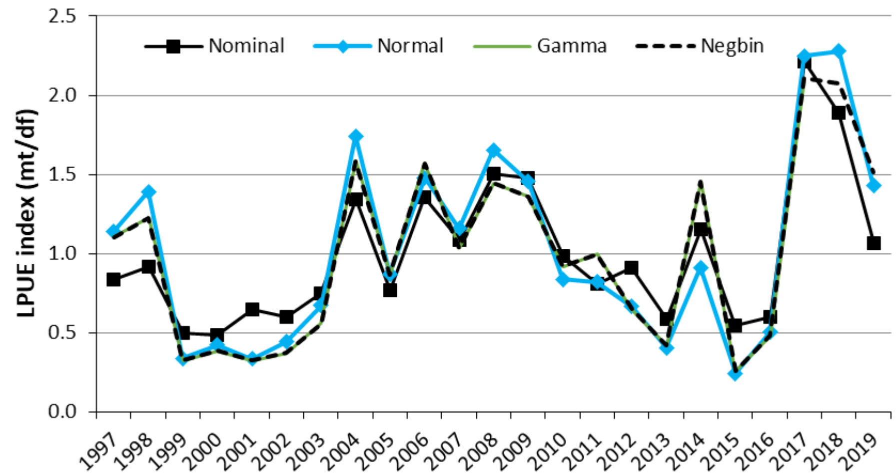
Lognormal Model	Deviance/DF	Log-Likelihood	AIC	Converge (Neg Hess PD)	All Effects Sig 5%
Year	0.8880	-4843	9735	Y	Y
Year-Week	0.8786	-4810	9725	Y	Y
Year-VessT	0.8067	-4671	9394	Y	Y
Year-Permit	0.6179	-4163	8503	Y	Y
Year-Week-VessT	0.7897	-4619	9346	Y	Y
Year-Week-Permit	0.5886	-4062	8356	Y	Y
Year-VessT-Permit	0.6169	-4160	8498	Y	Y
Year-Week-Permit-Area	***0.5831***	***-4036***	***8341***	***Y***	***Y***
Year-Week-VessT-Permit	0.5879	-4060	8353	Y	Y

Gamma Model	Deviance/DF	Log-Likelihood	AIC	Converge (Neg Hess PD)	All Effects Sig 5%
Year	0.8675	-47521	95091	Y	Y
Year-Week	0.8562	-47479	95063	Y	Y
Year-VessT	0.7664	-47273	94599	Y	Y
Year-Permit	0.5870	-46716	93609	Y	Y
Year-Week-VessT	0.7528	-47222	94553	Y	Y
Year-Week-Permit	0.5666	-46632	93497	Y	Y
Year-VessT-Permit	0.5854	-46711	93600	Y	Y
Year-Week-Permit-Area	***0.5609***	***-46603***	***93473***	***Y***	***Y***
Year-Week-VessT-Permit	0.5653	-46627	93489	Y	Y

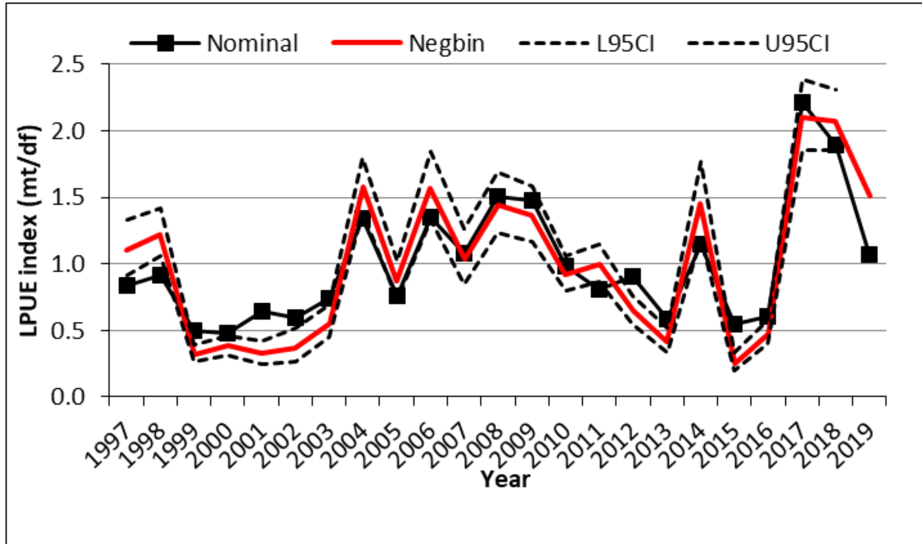
Negative Binomial Model	Deviance/DF	Log-Likelihood	AIC	Converge (Neg Hess PD)	All Effects Sig 5%
Year	1.1292	10564042180	95091	Y	Y
Year-Week	1.1360	10564042222	95063	Y	Y
Year-VessT	1.1177	10564042428	94599	Y	Y
Year-Permit	1.1129	10564042985	93609	Y	Y
Year-Week-VessT	1.1242	10564042479	94553	Y	Y
Year-Week-Permit	1.1186	10564043069	93497	Y	Y
Year-VessT-Permit	1.1130	10564042991	93600	Y	Y
Year-Week-Permit-Area	***1.1230***	***10564043099***	***93473***	***Y***	***Y***
Year-Week-VessT-Permit	1.1187	10564043075	93489	Y	Y

Standardized LPUE Indices

Similar trends for all 3 model types



LPUE indices for the Neg. Binomial model were fairly precise



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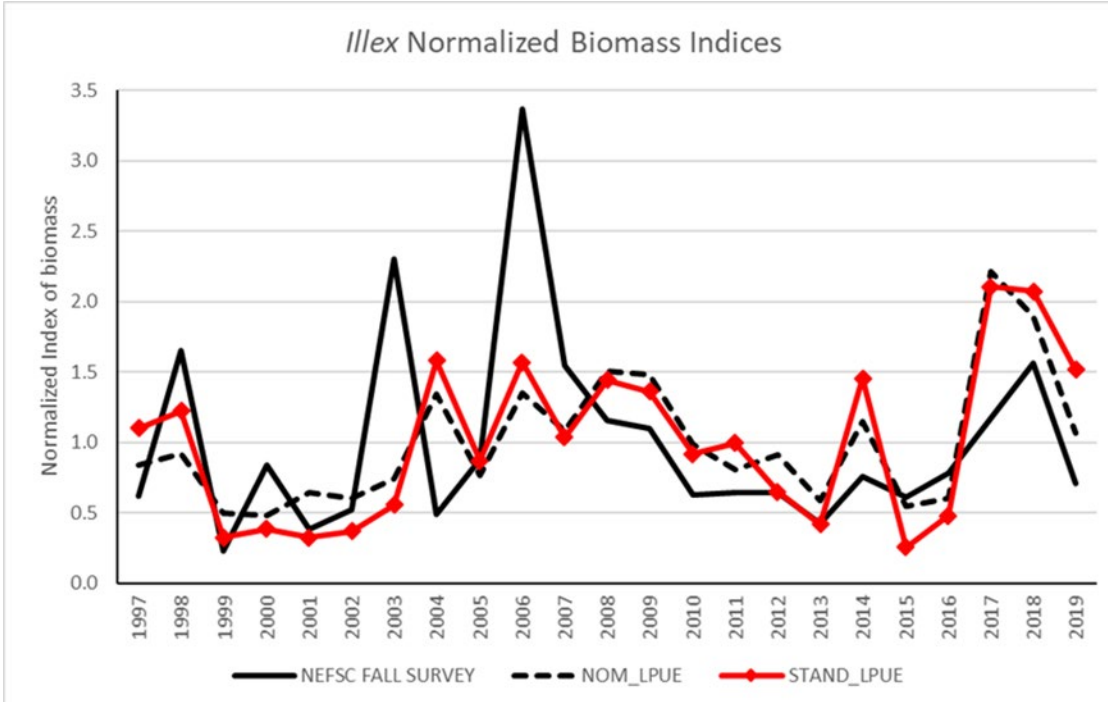
Normalized Biomass Indices



Trends in standardized LPUE indices were similar to NEFSC fall survey biomass indices during 2008-2019, due to increased N of 1:1 trip matches, and significantly correlated (r = 0.469, p < 0.05).

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ToR 2: Explore relationship between effort & economic factors (e.g., global market price) to determine if an economic factor improves fit of CPUE standardization model

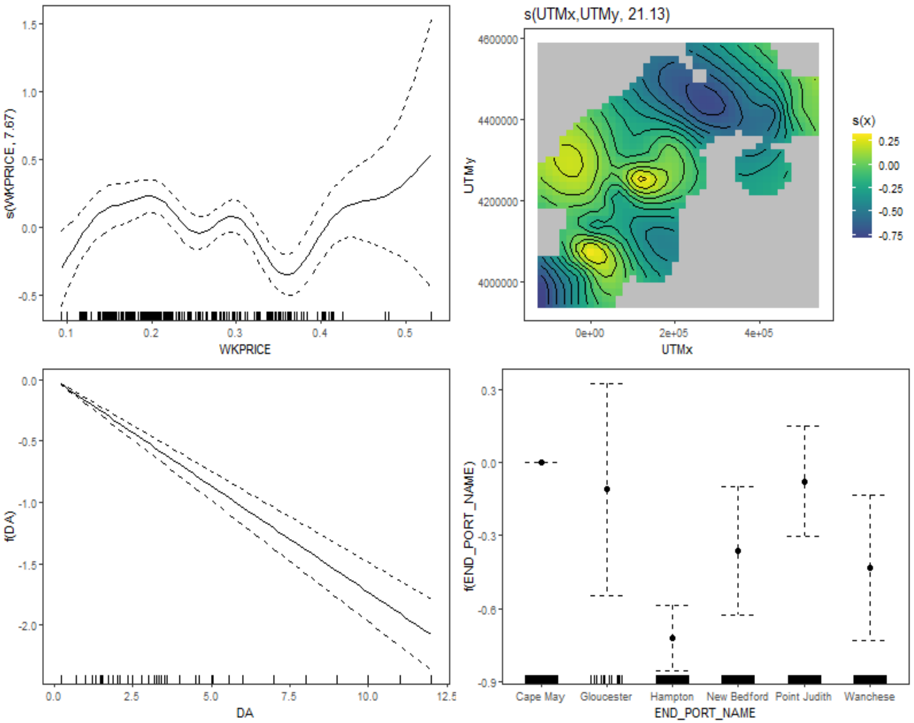
GAM, run separately for each fleet ("wet" vs freezer boats)

1. Separate models run using: study fleet data, observer data and the "AA" dataset used for the "traditional" GLM standardization method

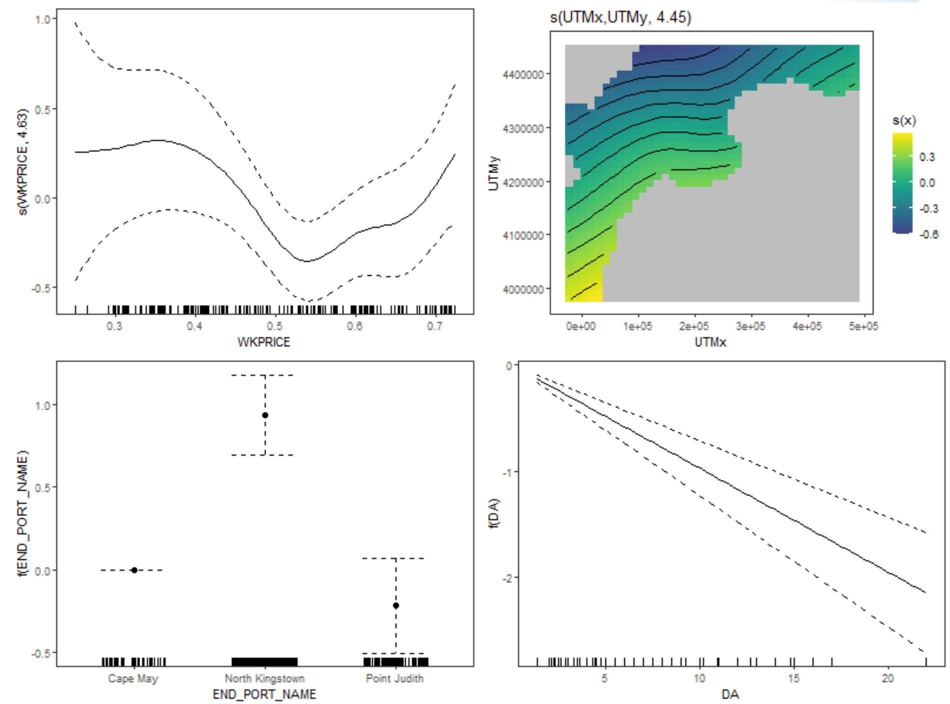
2. **Type 3 GLM** with lognormal, gamma & neg. binomial error structures
- **Response variable:** log-transformed CPUE (mt landed/df)
- **Main effects: Days Absent, Vessel type** (Wet vs freezer boats), **End Port Name, Domestic Weekly Price** and **Fishing location**

GAM smooths and effects plots for the Dealer/Logbook Dataset

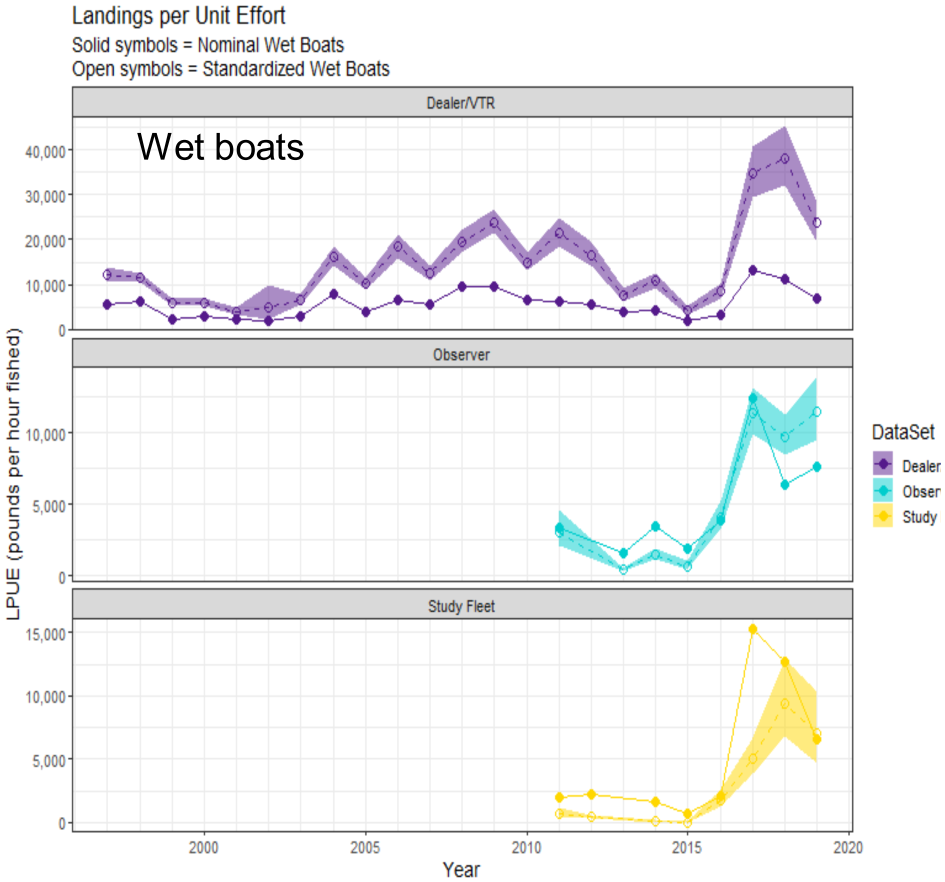
Wet boats

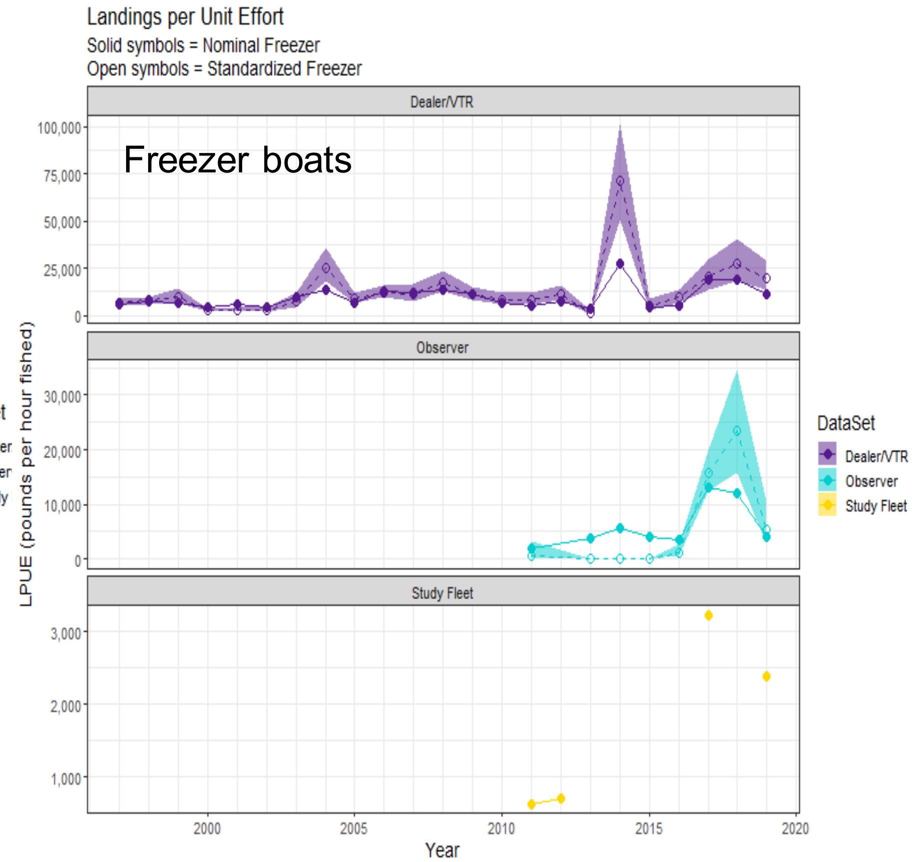


Freezer boats

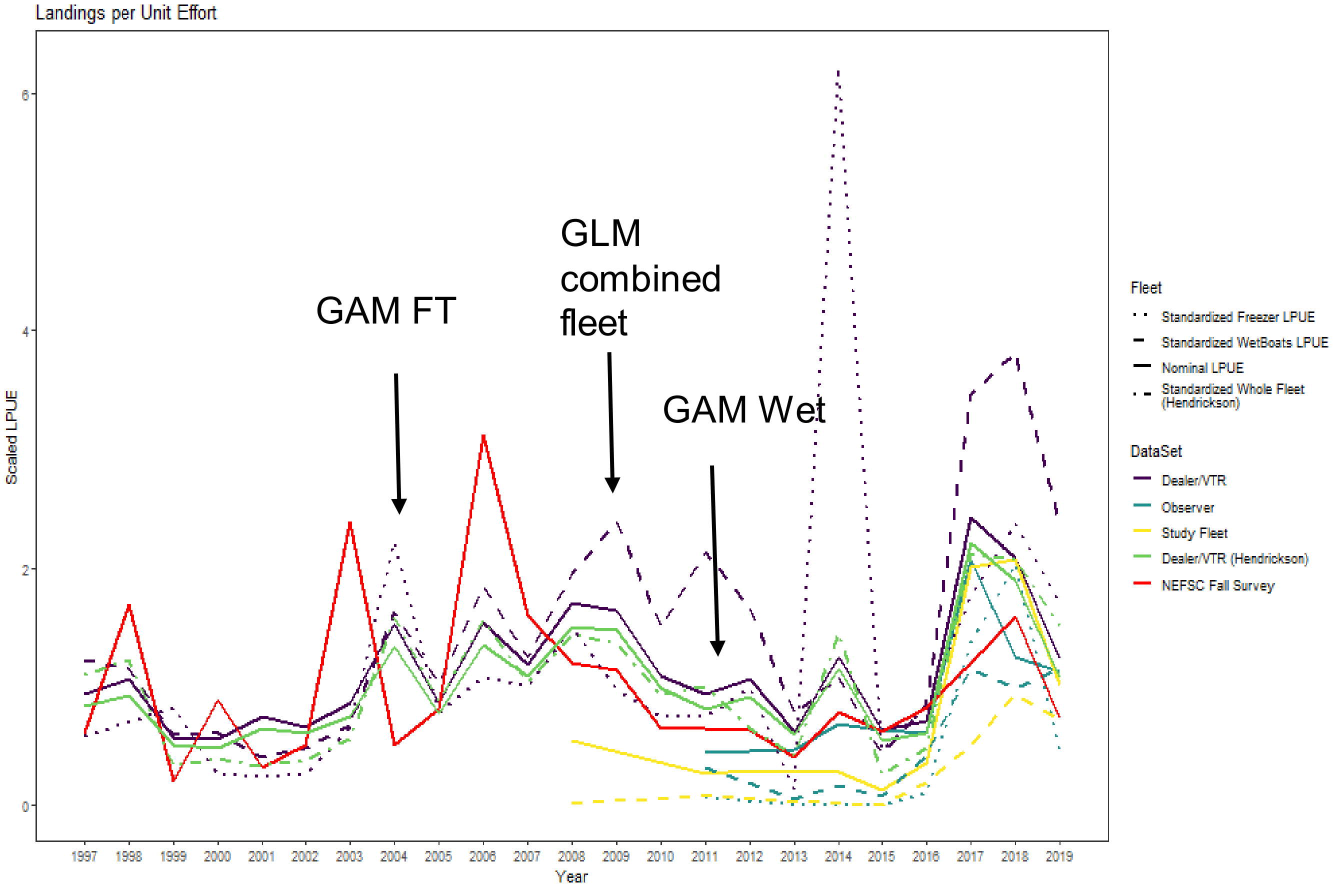


ToR 2: Nominal vs standardized CPUE results from GAMs





Comparison of all standardized LPUE indices from GAMS



ToR 4 – Characterize annual and weekly in-season spatio-temporal trends in body size based on data collected by port samplers and provided by *Illex* processors.

Consider environmental factors that may influence trends in body size and recruitment, and if possible, integrate these results in the stock assessment.

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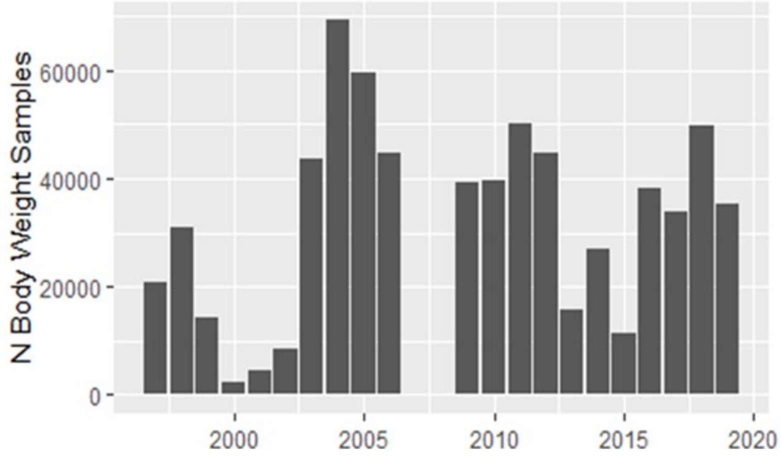
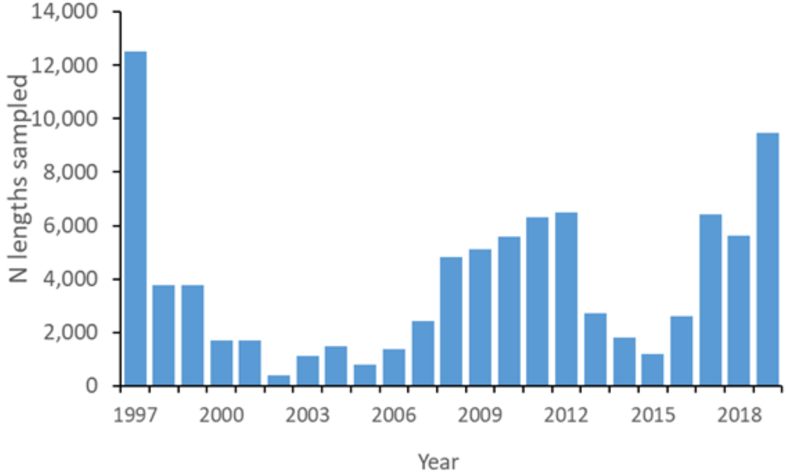
Landings length and body weight samples





<u>N body weight samples</u>

RTM Study-*Illex* processor dataset has much larger sample sizes than port samples

<u>N length samples</u>

Collected by port agents; subsampled weights of squid were divided by N length samples to compute mean body weight

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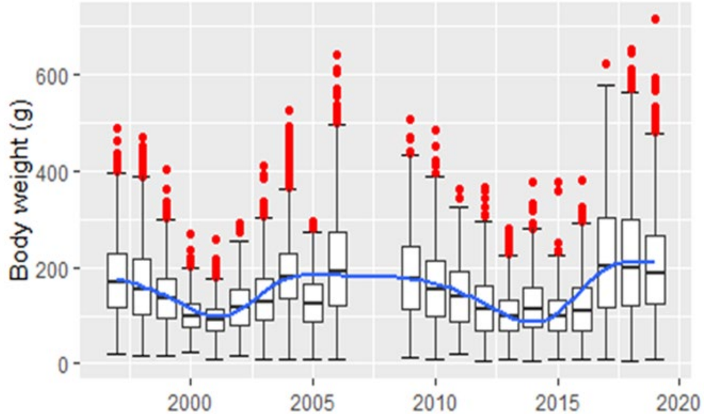
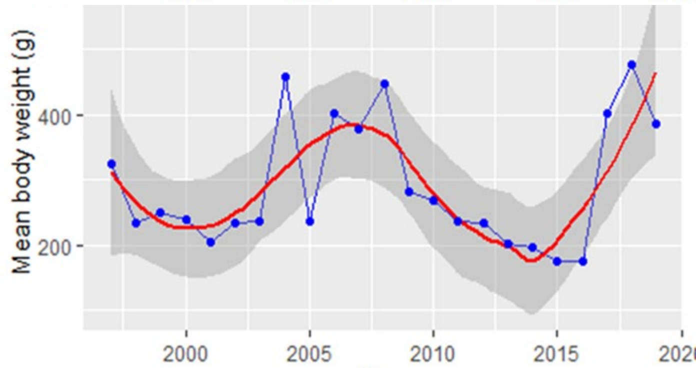
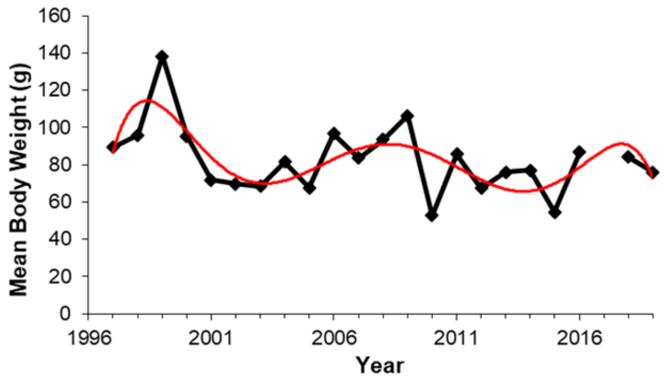
Annual Mean Body Weight Trends, 1997-2019



RTM-processor body weight data with loess smooth

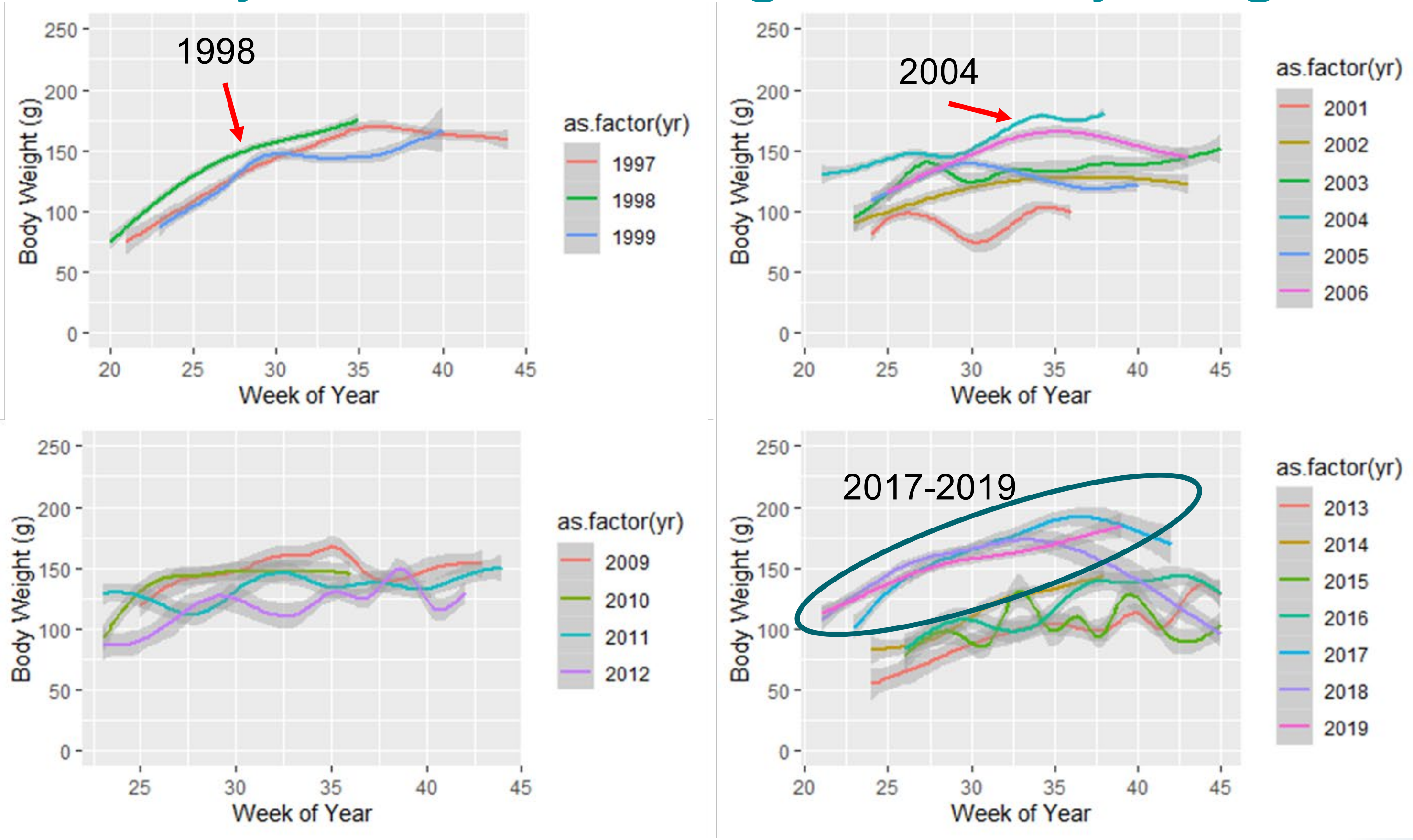


Port sampler mean body weight data with loess smooth and 95% CIs; Despite smaller N, trend similar to processor data, but port sampled body weights are larger



NEFSC fall svy mean body wts show different trend (decreasing) than the landings data

Weekly Trends in Landings Mean Body Weights



RTM-processor time series updates from 2005 assessment NEFSC (2006)

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ToR 5: Develop a model that can be used for the estimation of F and B, for each dominant cohort that supports the fishery, and estimate the uncertainty of these estimates. Compare the results from model runs for years with low, medium and high biomass estimates.

1. Generalized Depletion Model results were previously presented to SSC
2. Rago Indirect Estimation Method
   - Used by SSC for ABC estimation, but with "new twists"

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ToR 6: Describe the data that would be needed to conduct in-season stock assessments for adaptive management and identify whether the data already exist or if new data would need to be collected and at what frequency.

1. This ToR resulted in the production of a very detailed table which would be too time consuming to present at this overview meeting; please refer to the RTA WG Report

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ToR 7: For each cohort that supports the fishery, update or redefine F_{MSY} and B_{MSY} BRPs, or proxies thereof, and estimate uncertainty. If analytical model-based estimates are unavailable, recommend alternative, measurable proxies. Comment on scientific adequacy of existing and recommended BRPs or their proxies.

1. There are no existing BRPs that are appropriate for application to this semelparous species (%MSP-based BRP proxies are recommended for squid stocks)

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ToR 7 (continued)

2. The maturation-natural mortality model and weekly Per-recruit model developed by Hendrickson and Hart (2006) could not be run due to an inadequate number of aged mature females in the 2019 and 2020 age datasets developed for the RTA (only 3% and 6% of the 2019 and 2020 data, respectively, as opposed to the 37% used in the 2005 model run). Therefore, new, acceptable BRPs could not be estimated.

3. An extension of the Hendrickson and Hart (2006) model was considered by the WG but it was not sufficient to redefine an alternative basis for BRPs or MSY proxies.

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ToR 8: Recommend a stock status determination (i.e., overfishing and overfished), for each dominant cohort supporting the fishery, based on new modeling approaches developed for this peer review.

1. **Stock status is unknown with respect to reference points-based definitions of overfishing and overfished.** However, the scientific evidence examined in the current assessment is sufficient to conclude that **the *Illex* stock was lightly fished in 2019.**

2. This conclusion was based on a suite of Indirect Estimation Methods that provided bounds on biomass and fishing mortality for the US-managed component of the *Illex illecebrosus* stock.

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ToR 9: Define the methodology for performing short-term projections of catch and biomass under alternative harvest scenarios, including the assumptions of fishery selectivity, weights at age, and maturity.

- Used previously accepted PlanBSmooth method, with input data for 2021, to project the 2023 catch.
- Input data: relative biomass indices from 2011-2021 NEFSC fall bottom trawl surveys (rapid warming period); CPUE indices were also utilized
- Back-transformed LOESS-smoothed (span=0.3) values of estimated slope for 2019-2021 (no 2020 survey data, COVID) were used as the catch multiplier to estimate the 2023 catch

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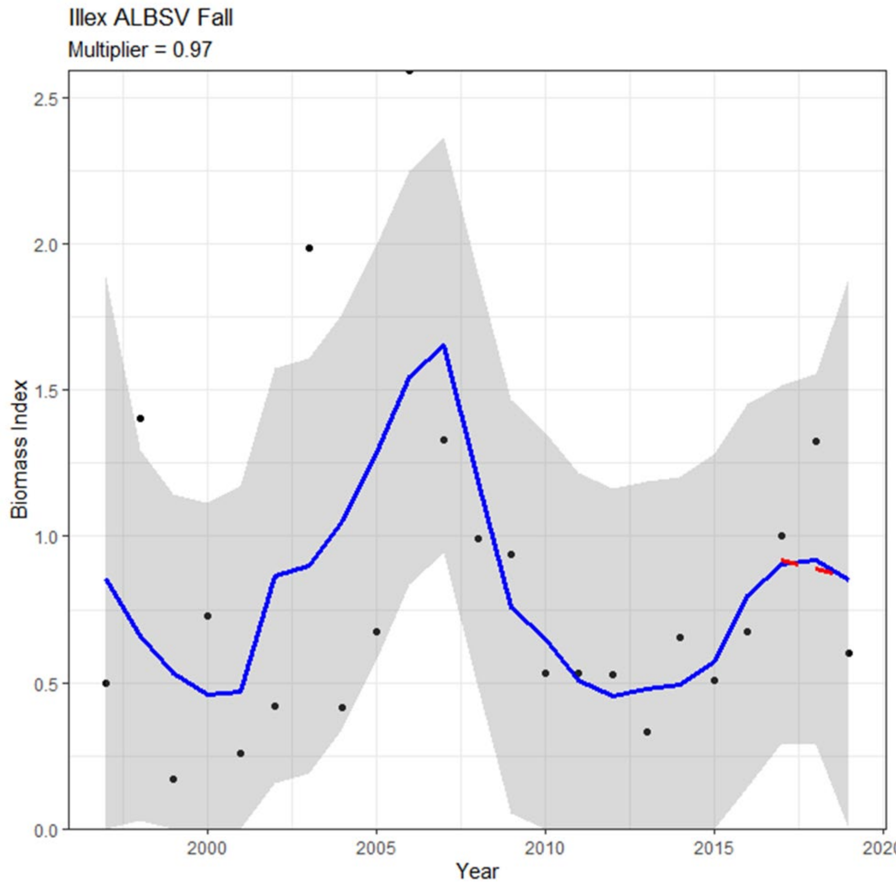
Examples of “PlanBsmooth”

1. NEFSC fall svy B indices
2. Nominal LPUE
3. Standardized LPUE
4. Combo of NEFSC fall svy B and standardized LPUE

ToR 9: Short-term Projection Methodology

NEFSC fall survey example of "PlanBsmooth"



The multipliers (from different indices) were all close to one which implies that the best estimate of next year's catch is the previous year's catch.

ToR 10: Review, evaluate and report on the status of the Stock Assessment Review Committee (SARC) and Working Group research recommendations listed in the most recent SARC-reviewed assessment and review panel reports. Identify new research recommendations.

1. The WG reviewed previous research recommendations in great detail and there is not enough time during this overview presentation to review these results

2. The WG considered a list of research recommendations and ranked them based on a poll of WG members because consensus could not be reached regarding their prioritization.

3. For the results from this ToR, please refer to the RTA WG Report

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ToR 11: Develop a "Plan B" alternate assessment approach to providing scientific advice to managers if the analytical assessment does not pass review.

1. In the event that that an analytical assessment does not pass review, the WG decided that the fallback plan for providing catch advice to managers should be to continue to use the SSC's Indirect Estimation Approach to estimating the 2023 ABC.

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