# Monkfish CPUE SSC Review

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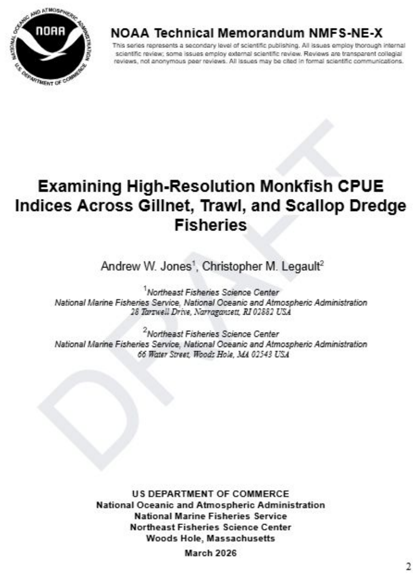

**NOAA Technical Memorandum NMFS-NE-X**

This series represents a secondary level of scientific publishing. All issues employ thorough internal scientific review; some issues employ external scientific review. Reviews are transparent collegial reviews, not anonymous peer reviews. All issues may be cited in formal scientific communications.



**Examining High-Resolution Monkfish CPUE Indices Across Gillnet, Trawl, and Scallop Dredge Fisheries**

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**US DEPARTMENT OF COMMERCE**
**National Oceanic and Atmospheric Administration**
**National Marine Fisheries Service**
**Northeast Fisheries Science Center**
**Woods Hole, Massachusetts**

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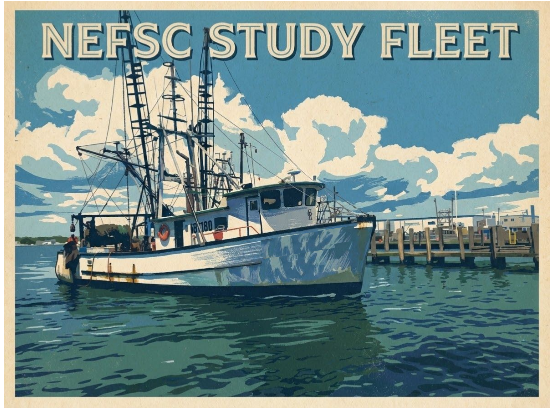
# As Mel and Steve said…

- Exploring other monkfish data sets has been identified as a high priority by both the science and fishing communities
- Two RSA projects aimed to do this
- Goal was to complement SMAST/Cornell projects as well as research track
- Different methods, but some shared data
- Value in assessing how much perception of stock trajectory changes with fairly distinct methods
- Looking at broader set of gear/region combinations

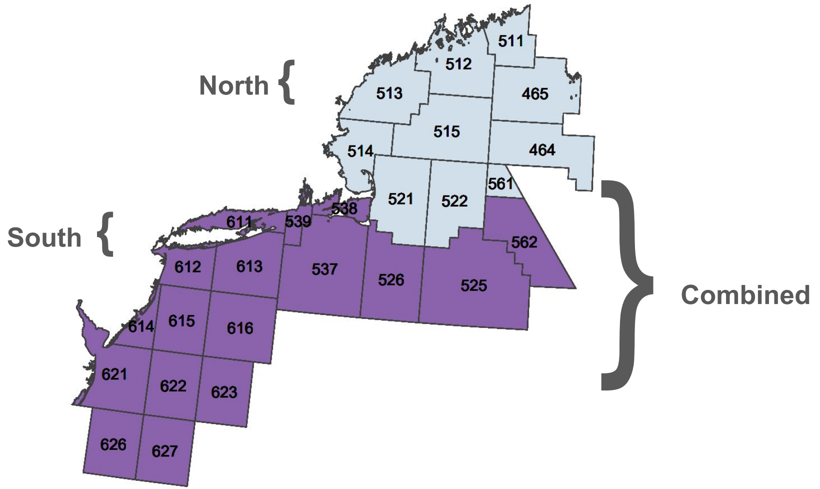
# Approach

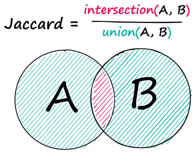
- **Many decisions**:
- **First,** leverage extensive information on catch by commercial vessels **(Study Fleet, Observer)**
  - Similar resolutions among data sets (haul-level)
  - Distinct sampling frames
    - Observer is randomly assigned
    - Study Fleet is self-selected
- **Second,** use data from **(2000 - 2024)**
  - Period of high-quality and high-resolution data
- **Third,** explore in **three gears** of interest
  - **Gillnet, bottom trawl, and scallop dredge**




# Other important choices:

- **Regions**
  - North and south divided similar to assessments
  - All regions combined
- **Catch-rate metrics (effort level)**
  - Catch (kept + discards)
  - Effort metrics
    - **Gillnet:** soak time
    - **Trawl:** tow time in hrs
    - **Dredge:** tow time in hrs
- **Jaccard index used to generate data set**
  - Includes fishing efforts with zero catch
  - Similar to Jones et al. (2025)
  - *Different than SMAST/CCCFA work*





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**Original Article**

ICES CIEM International Council for the Exploration of the Sea Conseil International pour l'Exploration de la Mer

**Combining sources of high-resolution fishery-dependent data from the northeast United States to develop a catch rate time series**

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# Methods at a high level (details to follow)

- **Sample of full data set**
  - Proportional to the statistical area size
  - Average sized stat areas ~60 record/year
  - Allows us to fit simpler models, better estimate uncertainty
- **Patterns of spatial inequality in catches (Gini index)**
  - Understanding if catches are evenly distributed in space or if they are more concentrated
- **Nominal CPUEs**
  - Simple average catch rate in each year
  - Resampling observed hauls allows us to look at variability
- **Standardized CPUE**
  - Using a model that accounts for location, time of year, and depth

# Methods at a high level (details to follow)

- **Comparison between the CPUE and traditional trawl survey indices**
  - Build understanding of monkfish stock by comparing survey and fishery data
- **Considered the potential impact of technology creep**
  - Using estimates of creep from the literature
- **Assessment relevant multiplier output**
  - Using two different terminal years

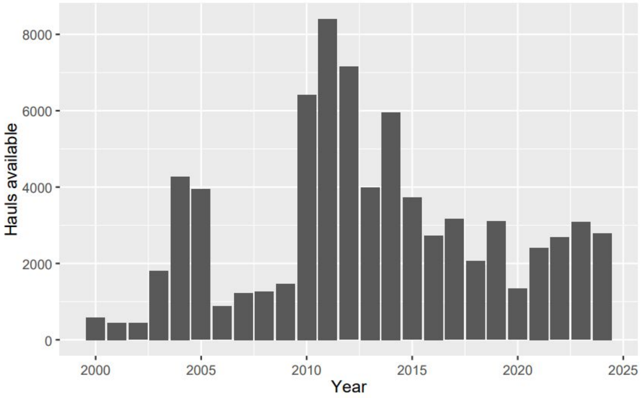
# As an example: gillnet full data set

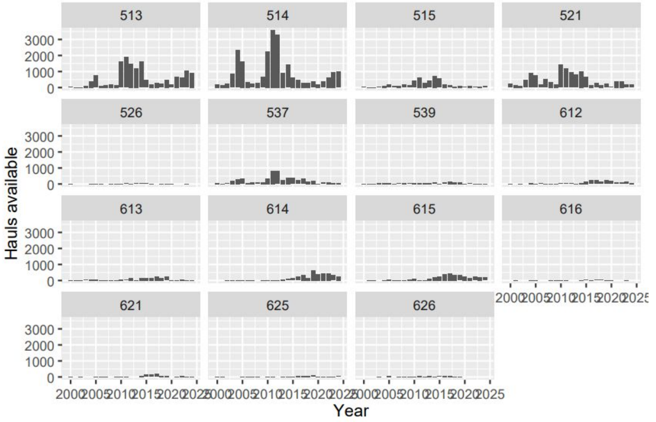
~78,000 efforts/hauls

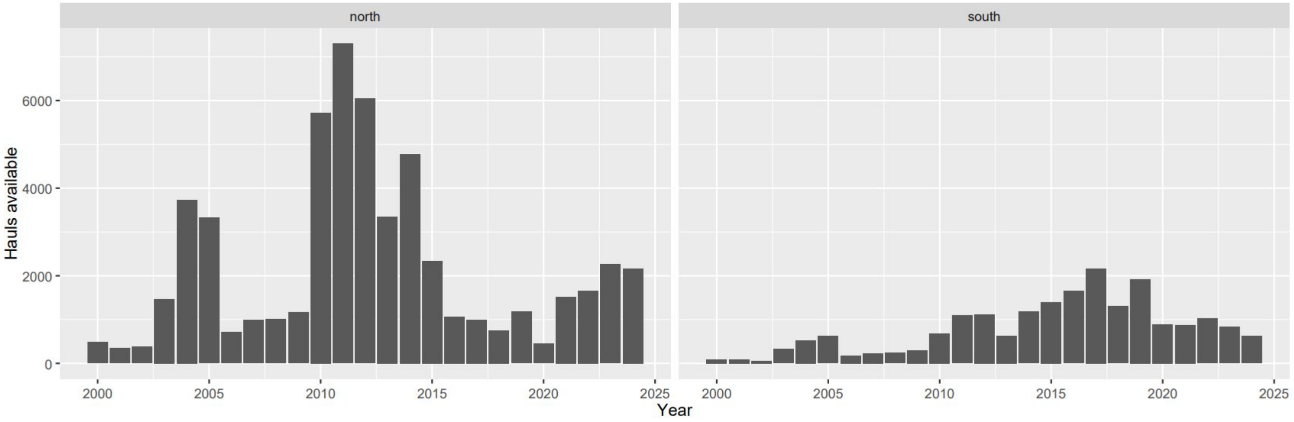
Available catch data for these programs using this gear type

Data limited from early in time series across both regions

A number of stat areas with limited info:  464, 512, 522, 525, 538, 541, 561,611, 622, 631, 632, 635, 636



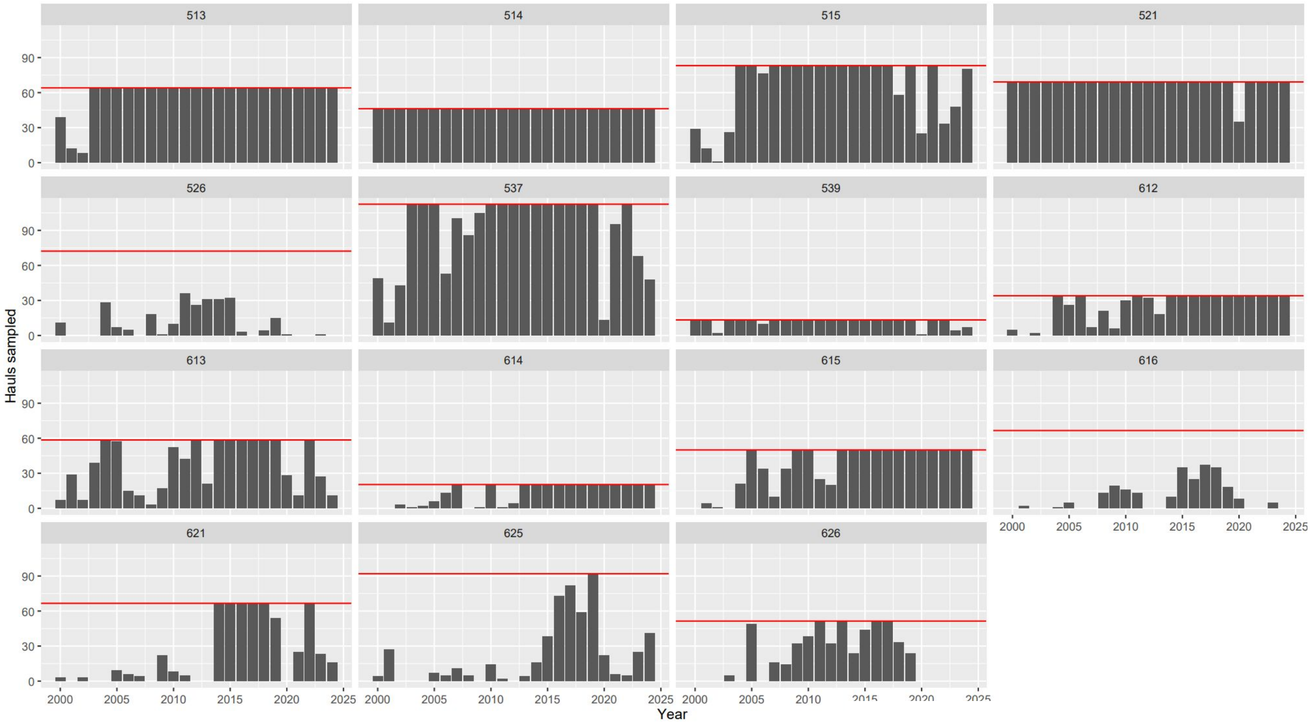



# Compared to gillnet subset sampling coverage

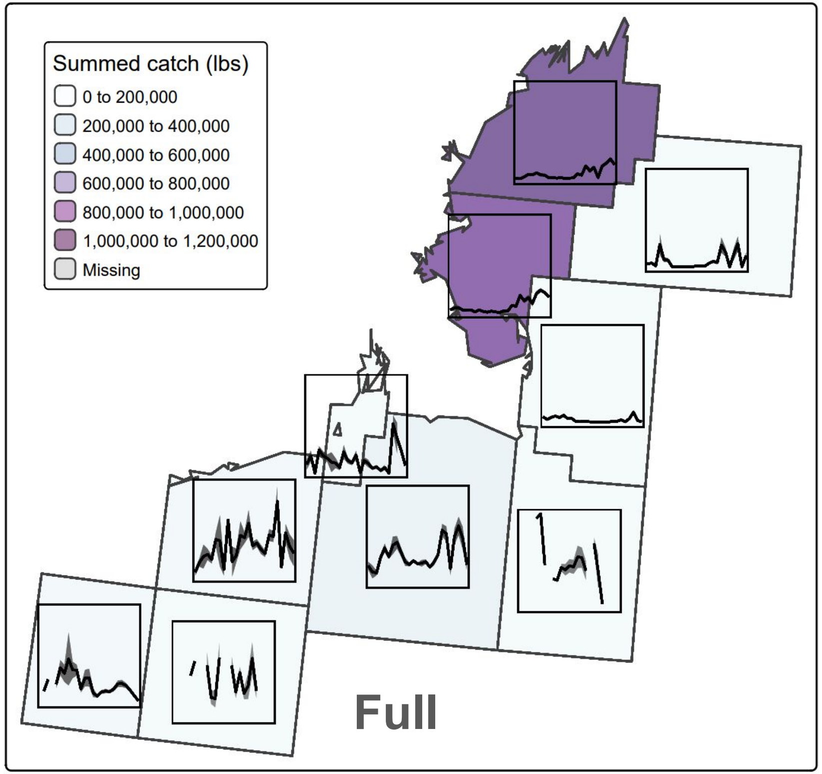
~13,300 efforts/hauls

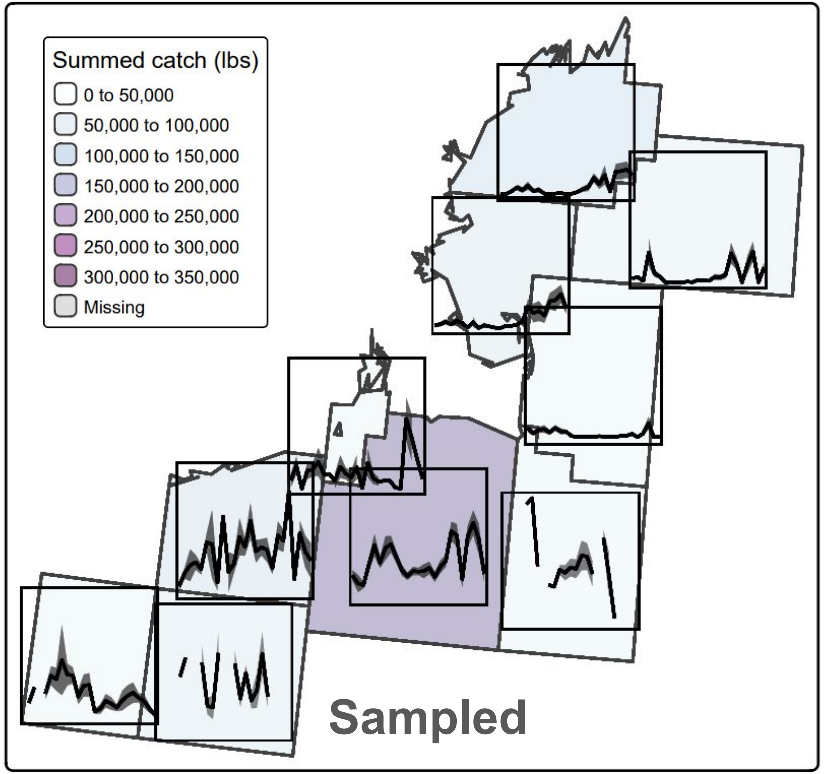
- More spatial balance in samples
- Weights sampling by stat area size
- Mean sized stat area contributed ~60 efforts per year
- Similar to survey station allocation, with some holes




Red line shows the target n based on area size

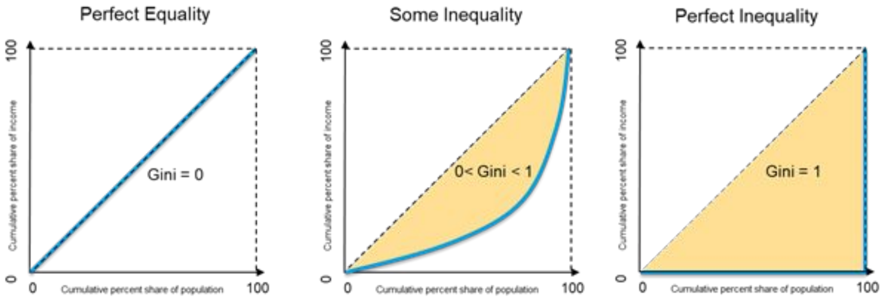
# Spatial comparison of full vs sampled for gillnet



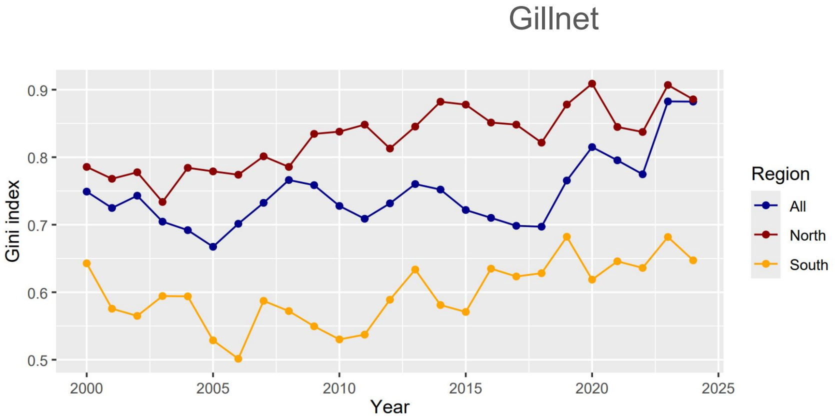



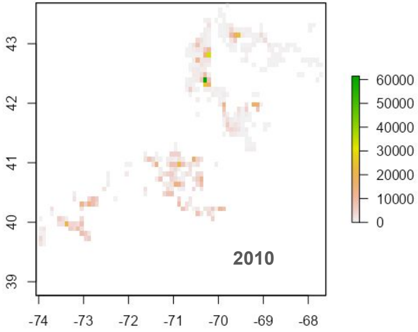
# Gini index (spatial clumping)

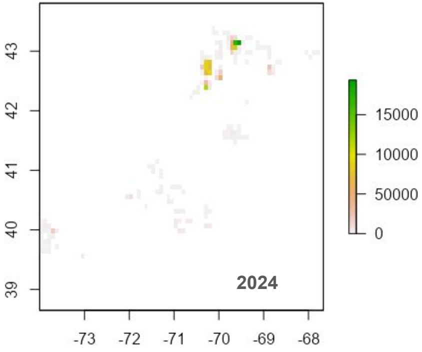
- Grid lat lon into ~65 $km^2$ cells for each year
- Calculating a gini index
- Some concentration in full data sets




## Full



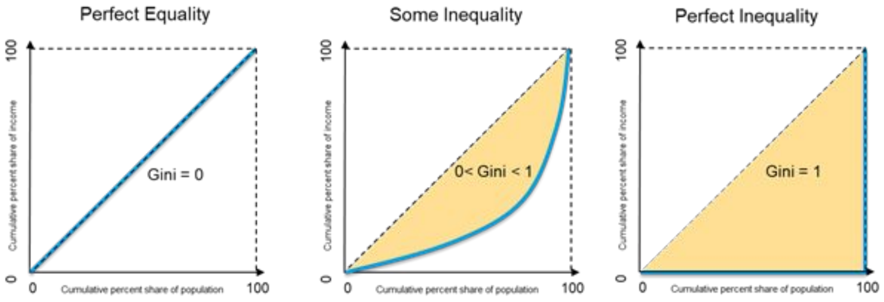



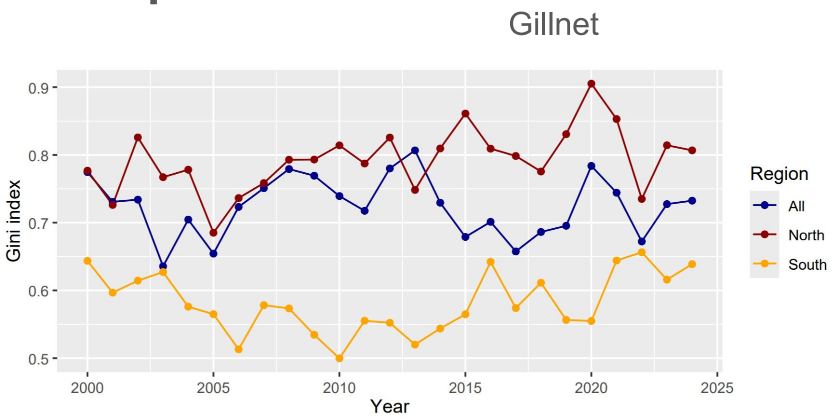

Time

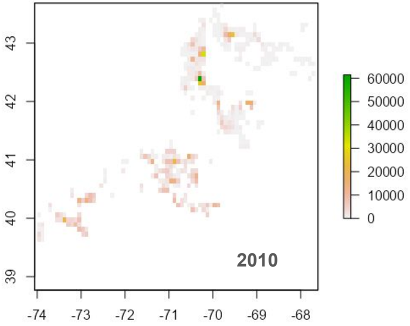
# Gini index (spatial clumping)

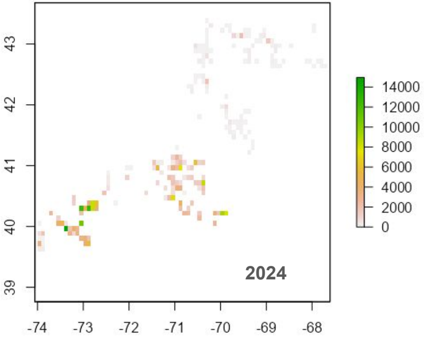
- Grid lat lon into ~65 km$^2$ cells for each year
- Patterns generally flat in sampled data sets

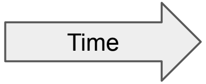



## Sampled



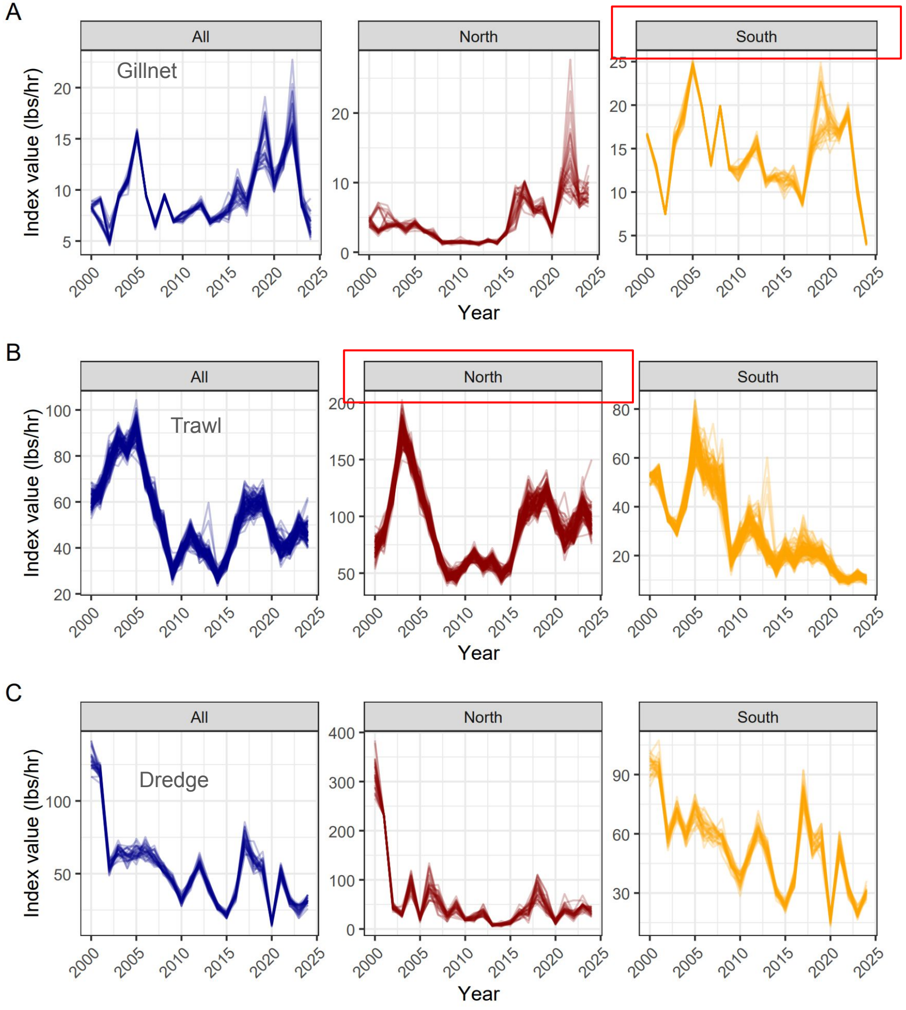



# Nominal CPUE


Gear regions also used by SMAST/CCCFA

- Explorations led us to decide to move forward with sampled data sets
- 30 data sets sampled using stat area size to determine the number of records
- Averaged CPUE per year, looking at consistency
- Generally similar patterns among samples across gears and regional configurations
- A fews outliers potentially due to large catches, small effort values, or small sample sizes



# Standardized CPUE

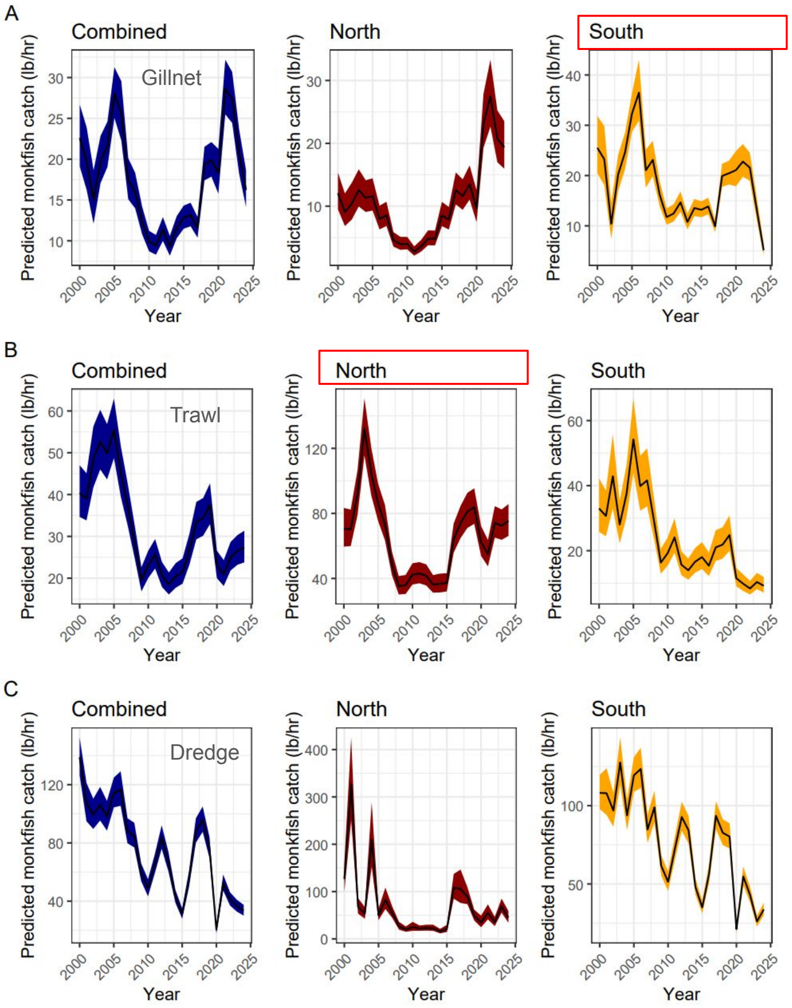
Gear regions also used by SMAST/CCCFA

- Using a single sampled data set for each gear/region we then:
- Standardized with gams and a small set of parameters and Tweedie distribution

$$Catch \sim \text{Tweedie}(\mu, \phi, p)$$

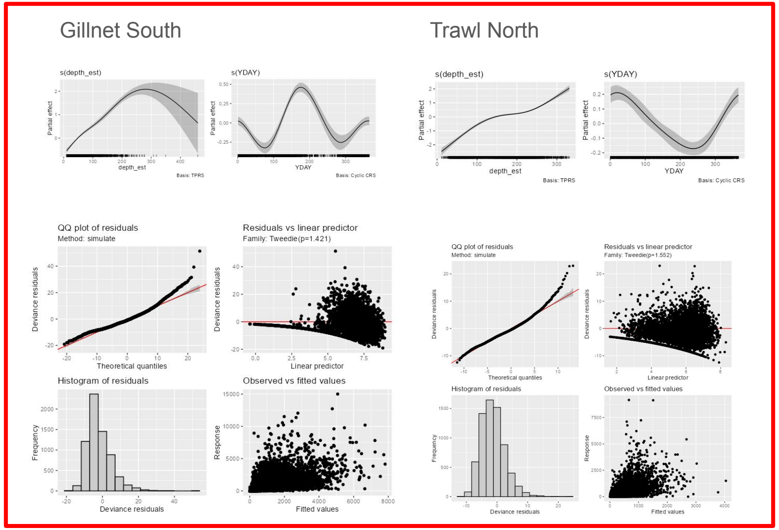
$$\ln(\mu) = \text{Offset}(\ln(\text{Effort})) + \text{Area} + \text{Year} + s(\text{Depth}) + s(\text{Day})$$

- **Offset(ln(Effort)) =** log-transformed offset for effort
- **Area =** Statistical area of the catch
- **Year =** Annual deviations
- ***s*(Depth) =** A thin-plate regression spline for the non-linear effect of bottom depth.
- ***s*(Day)** = A cyclic cubic regression spline for the day of the year that is continuous from year end to the start.
- **Interesting to note:** the 95% CI are similar in spread to the variation in the nominal CPUEs

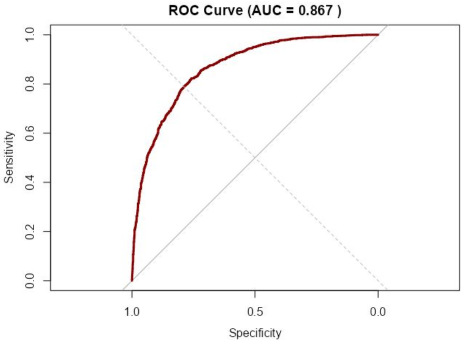


# Standardized CPUE diagnostics

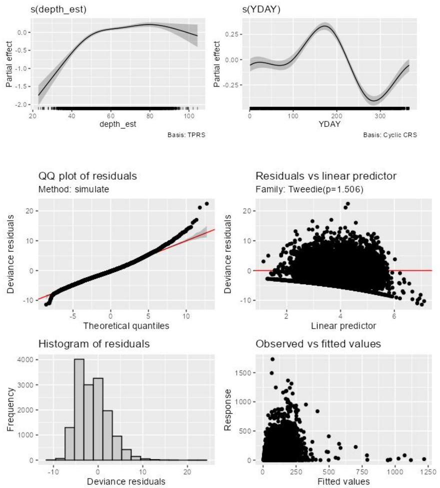
- Checked standard diagnostics
- Lots of informal explorations of modeling alternatives
- Explained deviance ~ 25% to ~ 40%
  - With only year and effort models explain ~5%
- AUC high ( > 70%) if catches treated as binary outcome
  - Models know where catches occur, but not fantastic at predicting  the size of catches
- Some patterning in residuals
  - Likely due to the inclusion of zeros




Gear regions also used by SMAST/CCCFA



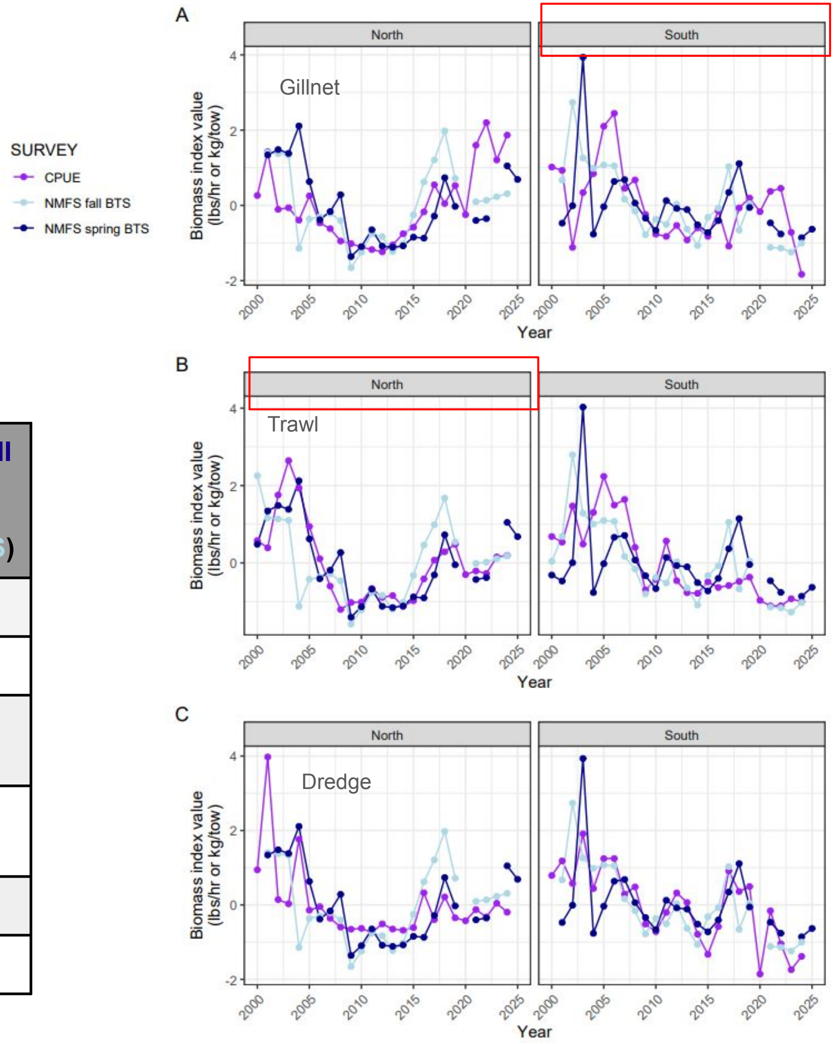

Dredge South



# Stand. CPUE and traditional trawl survey indices

- Many similarities to NEFSC surveys
- Lower correlation for gillnet could be because of selectivity (larger fish - see tech memo), need to lag

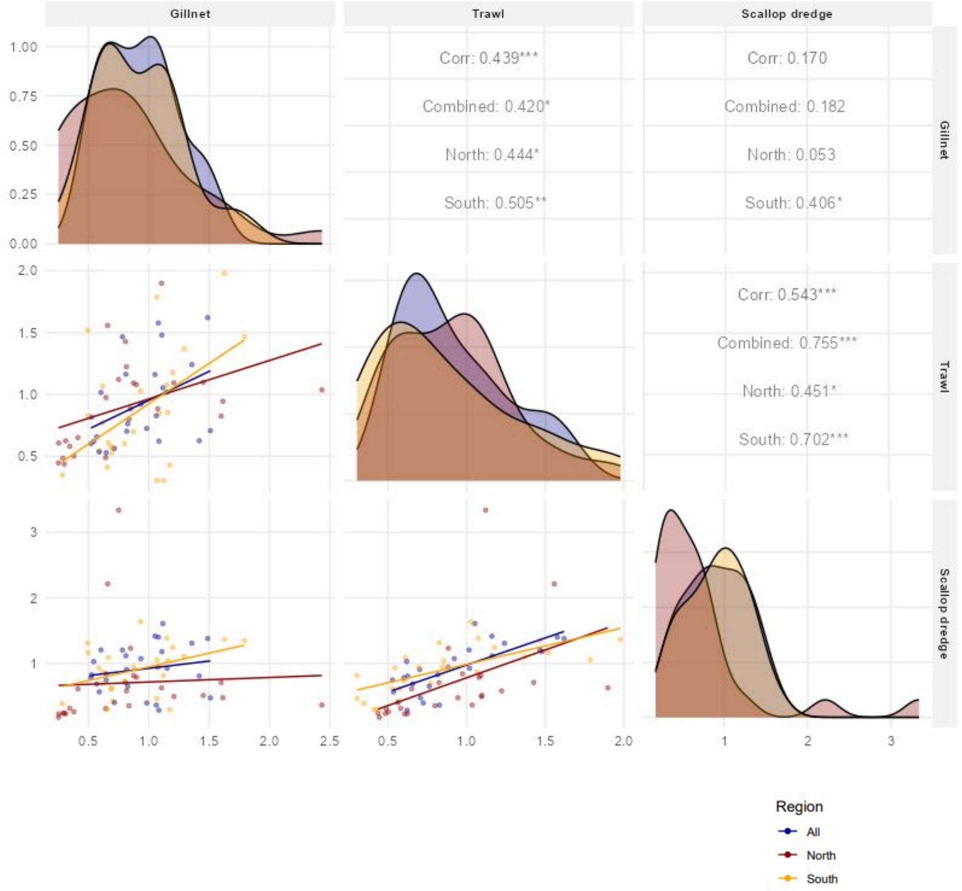
| Region | Gear | r (CPUE vs. NMFS fall BTS) | r (CPUE vs. NMFS spring BTS) | r (NMFS fall BTS vs. NMFS spring BTS) |
|---|---|---|---|---|
| **North** | *Gillnet* | 0.41 | 0.34 | 0.54 |
| **South** | *Gillnet* | 0.27 | 0.20 | 0.37 |
| **North** | *Scallop dredge* | **0.60** | **0.79** | 0.54 |
| **South** | *Scallop dredge* | **0.78** | 0.27 | 0.37 |
| **North** | *Trawl* | 0.40 | **0.58** | 0.54 |
| **South** | *Trawl* | **0.76** | **0.61** | 0.37 |



# Correlations among CPUEs

- Correlation among gears

| Region | Gear 1 | Gear 2 | *r*(CPUE vs CPUE) |
|---|---|---|---|
| **South** | *Trawl* | *Scallop dredge* | 0.70 |
| **South** | *Gillnet* | *Trawl* | 0.51 |
| **South** | *Gillnet* | *Scallop dredge* | 0.41 |
| **North** | *Trawl* | *Scallop dredge* | 0.45 |
| **North** | *Gillnet* | *Trawl* | 0.44 |
| **North** | *Gillnet* | *Scallop dredge* | 0.05 |



# Considered the potential impact of technology creep

- Tech. creep is a potential pitfall for the application of CPUE methods
- Lit. review suggests 0 - 4% per year
- CPUE standardization can help

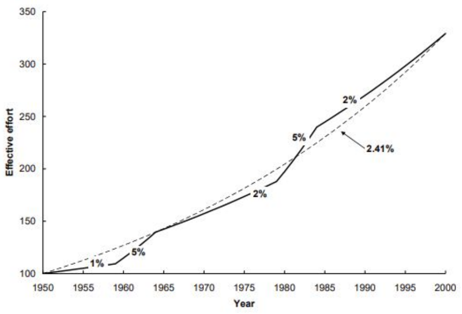
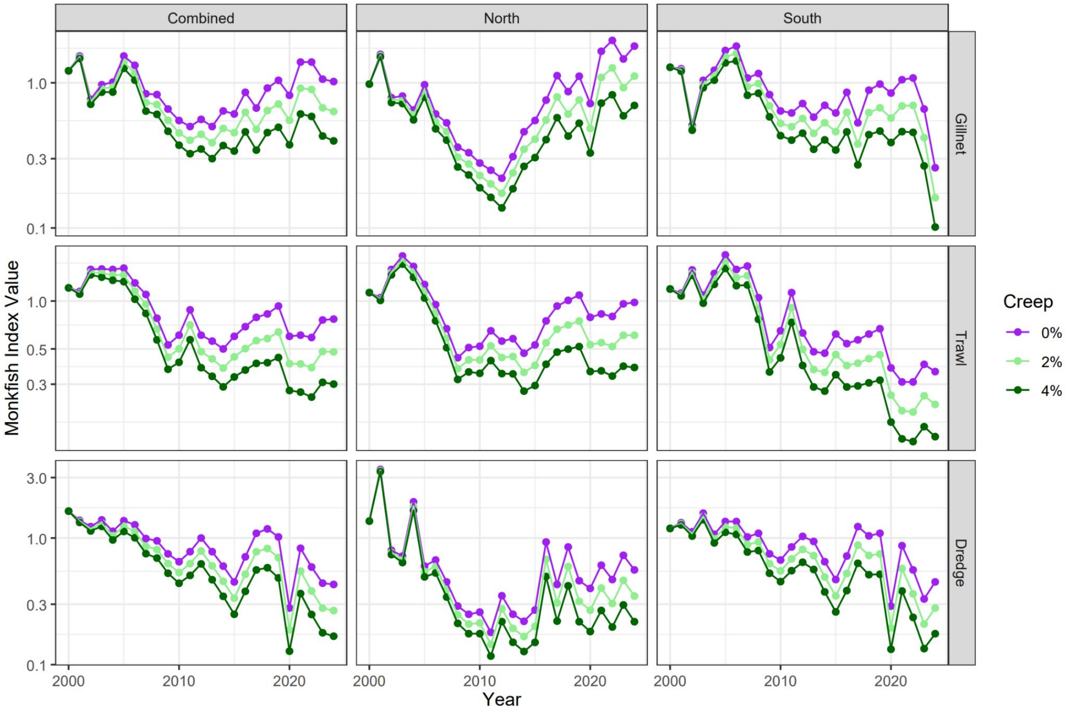



**Figure 1**. Simulation of increase in effective effort over a 50 year period consisting of a mixture of background rates (C% = 1 and 2%) and rapid increases (5%) due to technological improvements. The average rate (2.41%; dotted line) is obtained by comparison of the beginning and end estimates of effective effort, but can be approximated by an average rate of increase weighted by the number of years (2.42%).


DOI: https://doi:10.1093/icesjms/fsaa109

# Considered the potential impact of technology creep

- Applied this to the CPUE series we generated **(note log scale)**
- What would that mean for the population trend if CPUE was capturing trends, but this was occurring?
- Trend has similar peaks but distinct (lower by sig. amount)




Creep
0%
2%
4%

- Purple trends we presented earlier
- Green lines show what that could mean for the population if tech creep is occuring

# Considered the potential impact of technology creep

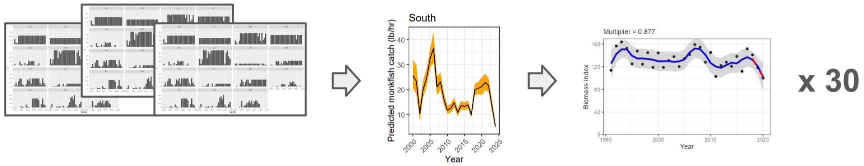
- Here without the log scale for the y axis
- **Take away: potentially impactful if occurring**

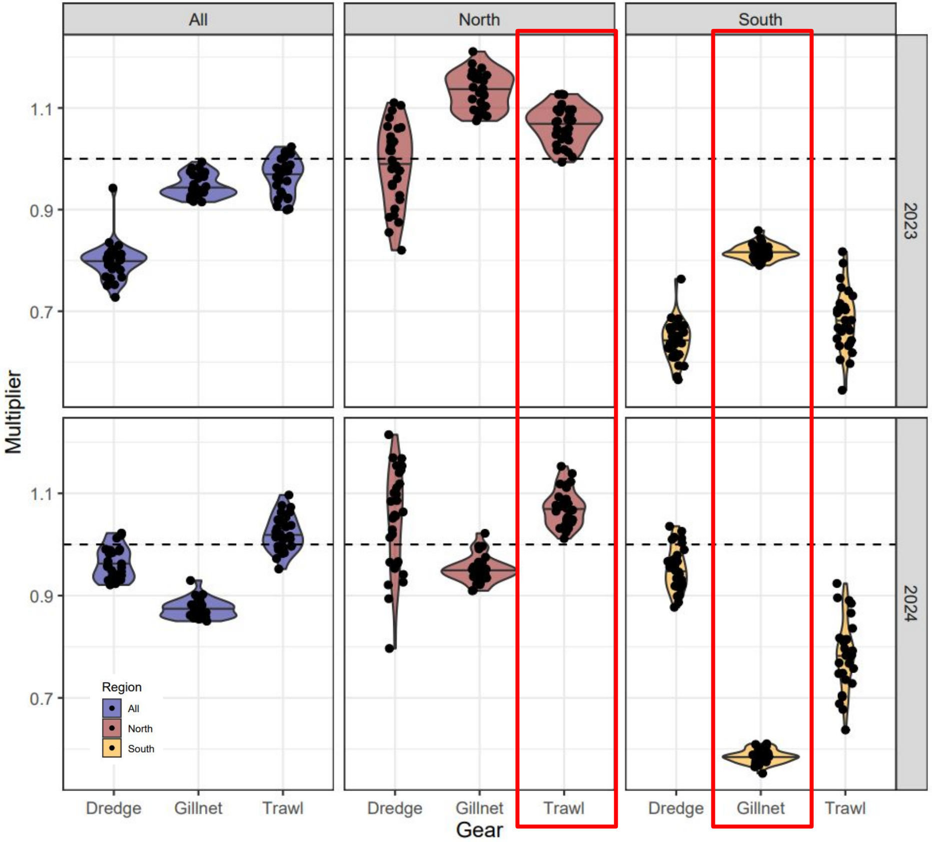


- Purple trends we presented earlier
- Green lines show what that could mean for the population if tech creep is occuring

# Looked at assessment relevant Ismooth multipliers

- Repeated standardization on 30 ‘samples’ for each gear type
- Two terminal years 2023 and 2024
- Sampling produces fairly tight groupings (with four exceptions)
- Southern gillnet lower with 2024 terminal year




• = Multiplier from standardization fit to a sampled data set

Gear regions also used by SMAST/CCCFA

# Takeaways

1. Sampling seems to be beneficial (flatter gini index, more even spread of catches)
    - As Steve showed, these CPUEs are similar to non-sampled, so it may not be essential
2. Simple standardization models fit relatively well
3. Good correspondence between standardized CPUEs and trawl survey indices
4. Good correspondence among CPUEs for different gears
5. However, with a few options it's important to appropriately select CPUE series that is most reliable when comparing gear types (not one with highest multiplier currently)
6. Consistent tech creep could be a problem
    - Might take additional investigation to rule out or quantify, characterize impact to multipliers from Ismooth
7. Multipliers based on repeated 'sampling' are fairly consistent