NOAA FISHERIES

Office of Science and Technology

Marine Recreational Information Program

MRIP Data User Seminar:
Statistical Methods and Procedures

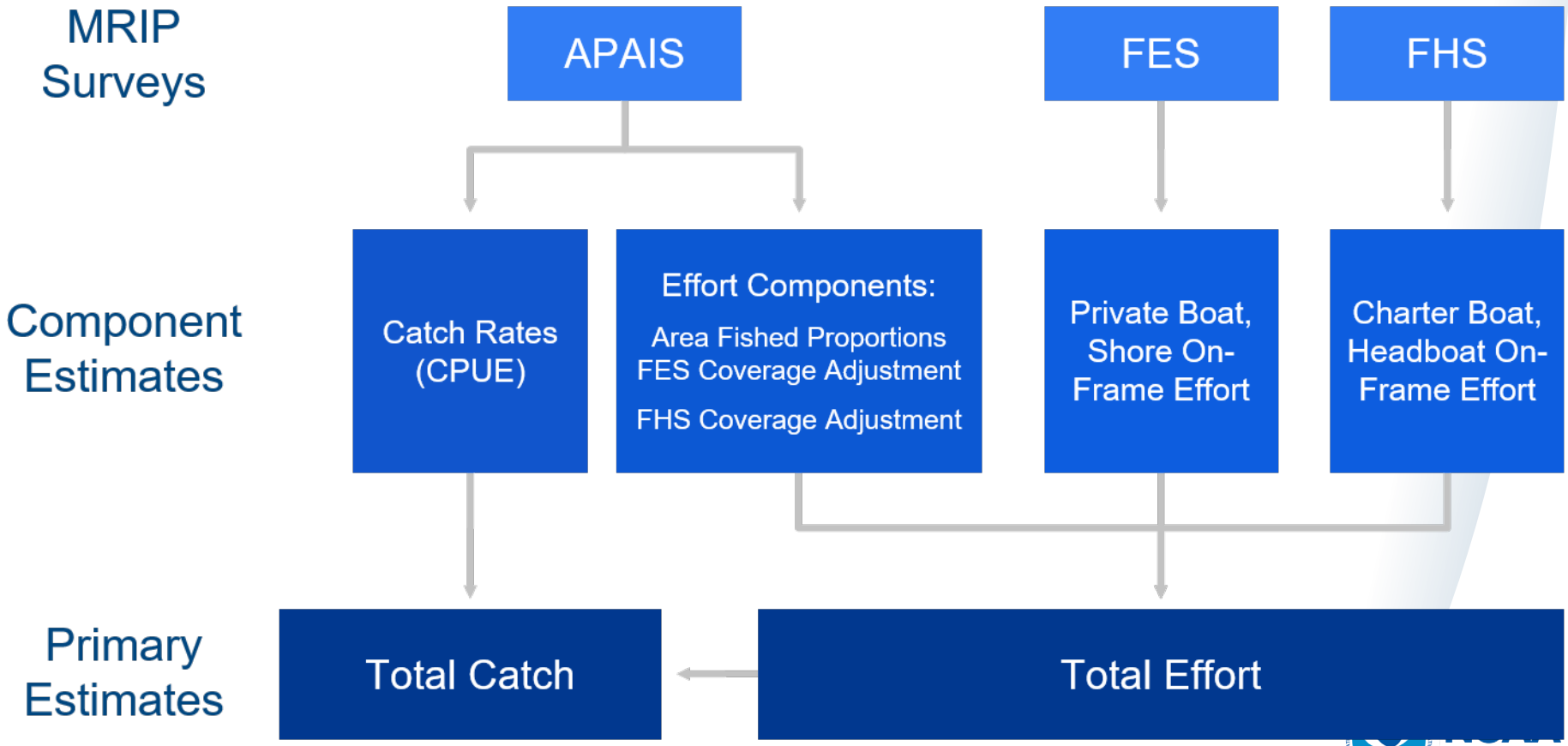
November 30, 2021

John Foster

Overview

Survey Design and Statistical Methods

- Surveys and Estimates Schematic
- Access Point Angler Intercept Survey (APAIS)
- Fishing Effort Survey (FES)
- For-Hire Survey (FHS)
- Catch and Effort Estimation


MRIP Surveys
APAIS
FES
FHS
Component Estimates
Catch Rates (CPUE)
Effort Components:
Area Fished Proportions
FES Coverage Adjustment
FHS Coverage Adjustment
Private Boat, Shore On-Frame Effort
Charter Boat, Headboat On-Frame Effort
Primary Estimates
Total Catch
Total Effort

Access Point Angler Intercept Survey (APAIS)

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APAIS Overview


Image: North Carolina DEQ


Image: NOAA Fisheries

- In-person **interviews of anglers** intercepted at **public fishing access sites**
- Anglers interviewed at the end of their fishing trips
- Samplers record detailed trip characteristic and catch information including individual fish length and weight measurements

APAIS

- Resource Links
- Design
- Sample Weighting
- Weighted Estimation Components

Image: NOAA Fisheries

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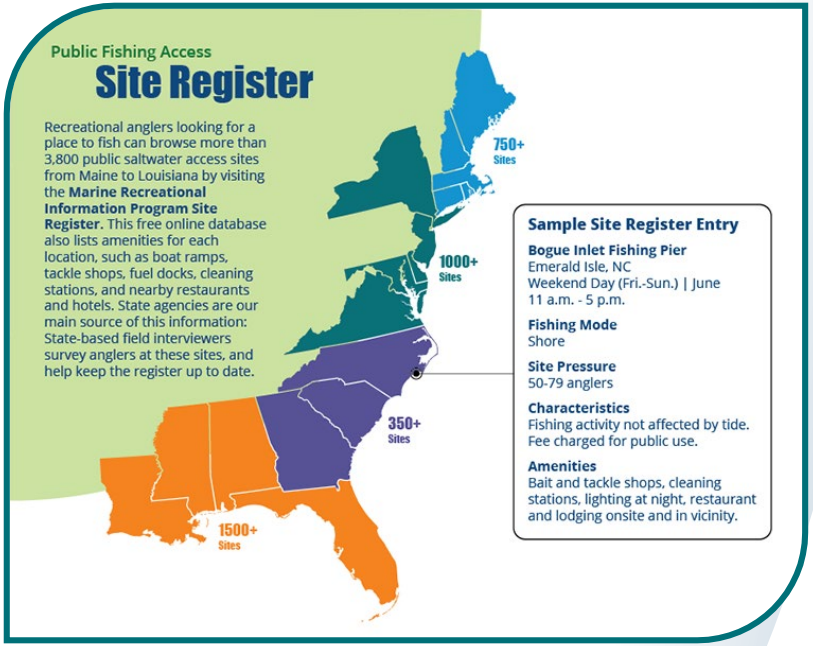
APAIS Resource Links

- Survey Design and Statistical Methods

  APAIS Section 2

- Site Register
- APAIS At-a-Glance
- Outreach Information



APAIS Design

- Complex Probability-Based Design
- Sample Frame
- Stratification
- Multi-stage Clustering
- Sample Selection using Probability Proportional to Size

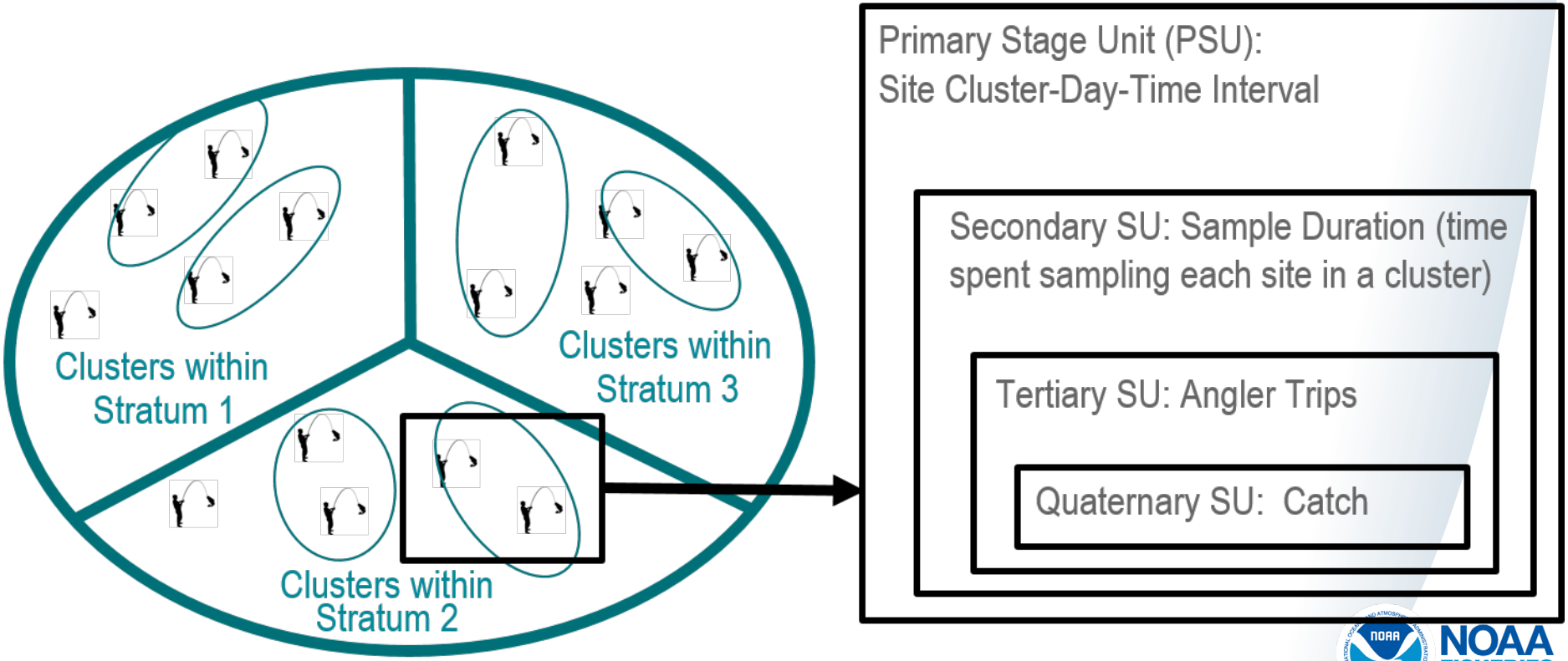
APAIS Design: Sample Frame

- List Fishing Access Sites
- Calendar
- 6-hour Time Intervals
- Primary Stage Unit
  - 1 or 2 Sites (Site-Cluster)
  - Date
  - Time Interval

APAIS Design: Stratification

- Space
  - State, Sub-state regions
- Time
  - Month
  - Kind-of-Day (weekday, weekend)
  - Interval (day, night)
- Fishing Access Site Group
  - Grouping sites by predominant mode or other trip characteristics
  - Shore, Private Boat, Charter Boat, Offshore

APAIS Design: Multi-stage Clustering



APAIS Design: Sample Selection

- Primary Stage Units (PSU): Site cluster-day-time interval
- PSUs selected using a probability proportional to size (PPS) approach
- Chance of being selected is related to the expected amount of fishing activity or **fishing pressure**

Expected Number of Angler Trips	Size Measure
1-4 Angler Trips	0.5
5-8	2.5
9-12	9
13-19	13
20-29	20
30-49	30
50-79	50
80+	80

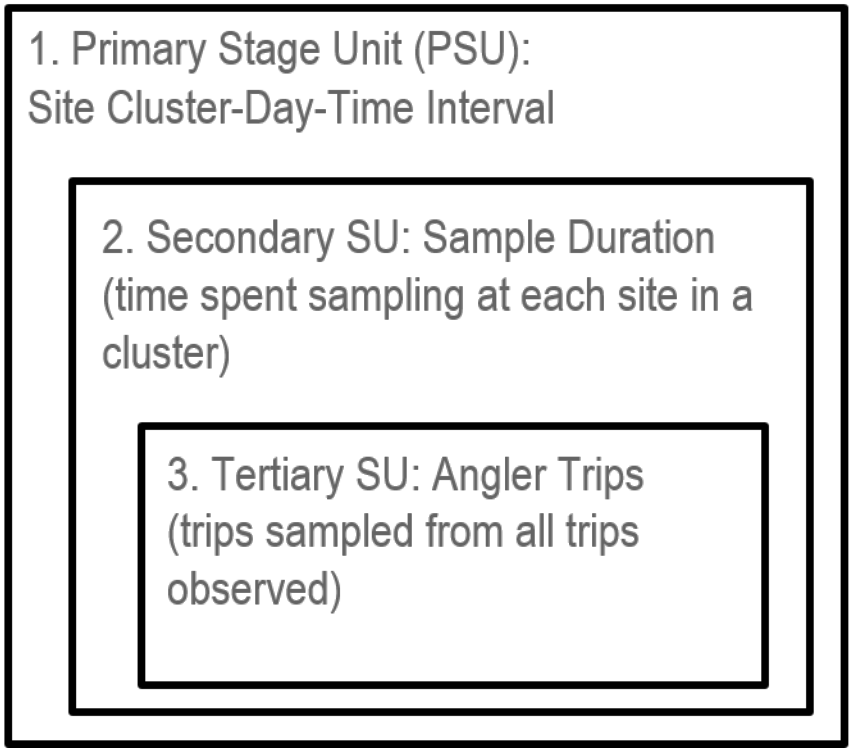
APAIS Design: Sample Selection

- Estimates of expected fishing pressure continually updated by regional and state agency partners that conduct APAIS field sampling
- For every site, pressures provided separately for each combination of month, kind-of-day, 6-hour time interval, mode of fishing
- All fishing pressures and other site characteristics available in Public Fishing Access Site Register

APAIS Sample Weighting

- Design aspects that impact the probability or chance of including an angler-trip in the APAIS sample must be accounted for in the sample weights and sample weights must be used in estimation
- Sample weight is the inverse (reciprocal) of the probability that a trip is included in the sample (e.g., a trip has a 10% chance of being interviewed, sample weight is 1 / 10% = 1 / 0.10 = 10)
- APAIS has multiple stages of sampling, each stage has a separate inclusion probability and corresponding sample weight
- Final APAIS sample weight for each interviewed trip is the product of the individual weights associated with each separate stage

APAIS Sample Weighting



$$w_1 = 1 / \pi_{psu}$$

$$w_2 = \frac{\text{6 hours (total time of sample interval)}}{\text{sample duration (time spent sampling)}}$$

$$w_3 = \frac{\text{all trips observed (sampled + only counted)}}{\text{trips sampled}}$$

$$w_F = w_1 * w_2 * w_3$$

APAIS Weighted Estimation Components

- Catch rate, CPUE, mean catch per trip
- Area fished proportions (Ocean >3mi - EEZ, Ocean <=3mi - STS, Inland)
- FES coverage adjustment - instate resident trip proportion
- FHS coverage adjustment - on-frame vessel trip proportion

$$\hat{\bar{y}} = \frac{\Sigma w_{Fi}\, y_i}{\Sigma w_{Fi}} \qquad \hat{P}_a = \frac{\Sigma w_{Fi}\, I_{ai}}{\Sigma w_{Fi}} \qquad \hat{P}_s = \frac{\Sigma w_{Fi}\, I_{si}}{\Sigma w_{Fi}} \qquad \hat{P}_f = \frac{\Sigma w_{Fi}\, I_{fi}}{\Sigma w_{Fi}}$$

APAIS Weighted Estimation Components

- Estimation Domains
  - Catch Rates by Species and Catch Type (e.g., landed catch, released catch)
    - Sub-region, State, Year, 2-month Wave, Fishing Mode, Area Fished
  - Area fished proportions
    - Sub-region, State, Year, 2-month Wave, Fishing Mode **(Private boat, Shore)**
  - FES coverage adjustment
    - Sub-region, State, Year, 2-month Wave, Fishing Mode **(Private boat, Shore)**
  - FHS coverage adjustment - on-frame vessel trip proportion
    - Sub-region, State, Year, 2-month Wave, Fishing Mode **(Charter boat, Headboat)**

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Fishing Effort Survey (FES)

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FES Overview

- **Self-administered household mail survey** that includes household and individual person-level questions
- Sample frame: a comprehensive directory of **residential addresses from the USPS**
- Used to estimate in-state **private boat and shore mode effort estimates** for resident anglers

FES

- Resource Links
- Design
- Sample Weighting
- Estimation

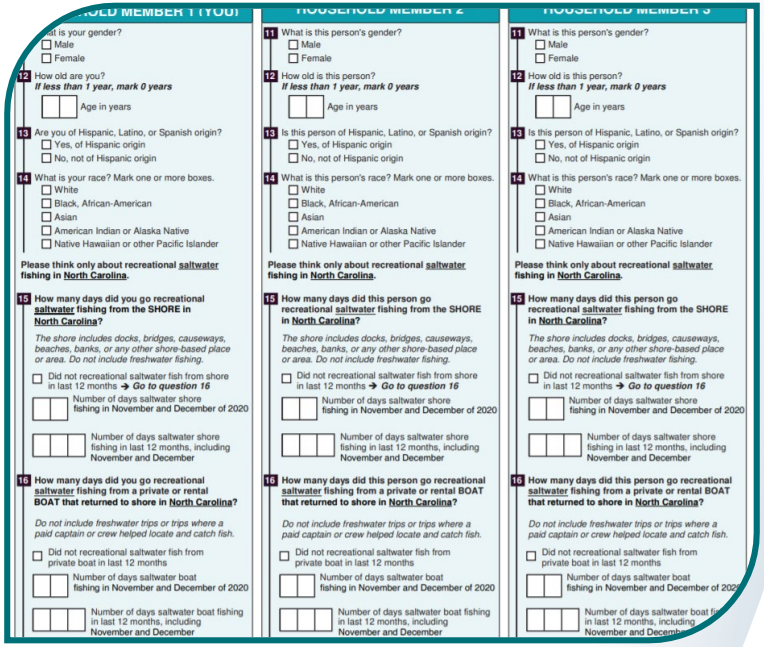

Image: Chesapeake Bay Program

FES Resource Links

- Survey Design and Statistical Methods

  FES Section 2

- Annual Reports
- FES At-a-Glance
- Outreach Information



HOUSEHOLD MEMBER 1 (YOU)

What is your gender?
- Male
- Female

12 How old are you?
If less than 1 year, mark 0 years
Age in years

13 Are you of Hispanic, Latino, or Spanish origin?
- Yes, of Hispanic origin
- No, not of Hispanic origin

14 What is your race? Mark one or more boxes.
- White
- Black, African-American
- Asian
- American Indian or Alaska Native
- Native Hawaiian or other Pacific Islander

Please think only about recreational saltwater fishing in North Carolina.

15 How many days did you go recreational saltwater fishing from the SHORE in North Carolina?

The shore includes docks, bridges, causeways, beaches, banks, or any other shore-based place or area. Do not include freshwater fishing.

- Did not recreational saltwater fish from shore in last 12 months → *Go to question 16*

Number of days saltwater shore fishing in November and December of 2020

Number of days saltwater shore fishing in last 12 months, including November and December

16 How many days did you go recreational saltwater fishing from a private or rental BOAT that returned to shore in North Carolina?

Do not include freshwater trips or trips where a paid captain or crew helped locate and catch fish.

- Did not recreational saltwater fish from private boat in last 12 months

Number of days saltwater boat fishing in November and December of 2020

Number of days saltwater boat fishing in last 12 months, including November and December

HOUSEHOLD MEMBER 2

11 What is this person's gender?
- Male
- Female

12 How old is this person?
If less than 1 year, mark 0 years
Age in years

13 Is this person of Hispanic, Latino, or Spanish origin?
- Yes, of Hispanic origin
- No, not of Hispanic origin

14 What is this person's race? Mark one or more boxes.
- White
- Black, African-American
- Asian
- American Indian or Alaska Native
- Native Hawaiian or other Pacific Islander

Please think only about recreational saltwater fishing in North Carolina.

15 How many days did this person go recreational saltwater fishing from the SHORE in North Carolina?

The shore includes docks, bridges, causeways, beaches, banks, or any other shore-based place or area. Do not include freshwater fishing.

- Did not recreational saltwater fish from shore in last 12 months → *Go to question 16*

Number of days saltwater shore fishing in November and December of 2020

Number of days saltwater shore fishing in last 12 months, including November and December

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Do not include freshwater trips or trips where a paid captain or crew helped locate and catch fish.

- Did not recreational saltwater fish from private boat in last 12 months

Number of days saltwater boat fishing in November and December of 2020

Number of days saltwater boat fishing in last 12 months, including November and December

HOUSEHOLD MEMBER 3

11 What is this person's gender?
- Male
- Female

12 How old is this person?
If less than 1 year, mark 0 years
Age in years

13 Is this person of Hispanic, Latino, or Spanish origin?
- Yes, of Hispanic origin
- No, not of Hispanic origin

14 What is this person's race? Mark one or more boxes.
- White
- Black, African-American
- Asian
- American Indian or Alaska Native
- Native Hawaiian or other Pacific Islander

Please think only about recreational saltwater fishing in North Carolina.

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The shore includes docks, bridges, causeways, beaches, banks, or any other shore-based place or area. Do not include freshwater fishing.

- Did not recreational saltwater fish from shore in last 12 months → *Go to question 16*

Number of days saltwater shore fishing in November and December of 2020

Number of days saltwater shore fishing in last 12 months, including November and December

16 How many days did this person go recreational saltwater fishing from a private or rental BOAT that returned to shore in North Carolina?

Do not include freshwater trips or trips where a paid captain or crew helped locate and catch fish.

- Did not recreational saltwater fish from private boat in last 12 months

Number of days saltwater boat fishing in November and December of 202

Number of days saltwater boat fi in last 12 months, including November and Decembe

FES Design

- Probability-Based Design
- Sample Frame
- Stratification & Sample Selection
- Data Collection

FES Design: Sample Frame

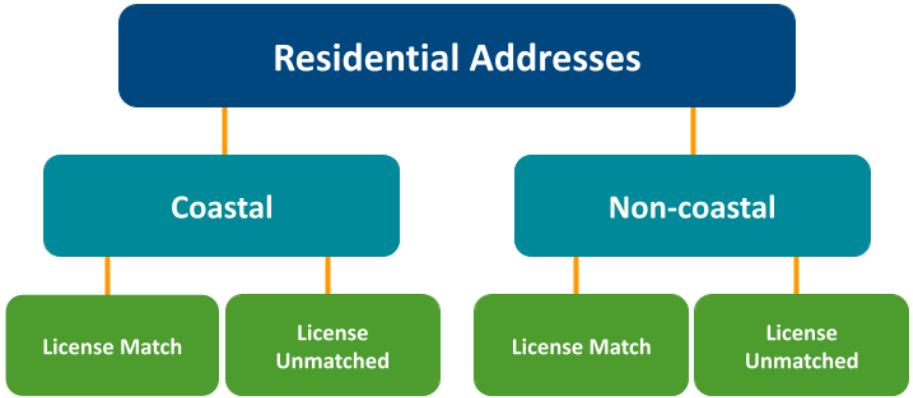
- United States Postal Service Delivery Sequence File
- >95% of Residential Households
- State Saltwater Fishing License Databases
- Primary Stage Unit:
  - Residential Household

FES Design: Stratification and Sample Selection

- Space
  - State
  - Sub-state regions

    (Coastal, Non-Coastal)
- State Saltwater Fishing License

  Match Status
- Time
  - Year
  - 6 2-Month Waves
- Samples selected using equal selection probabilities within strata



FES Design: Data Collection

- Generally follows Dillman Approach for Mail Surveys
- Mailings administered near the end of each 2-month wave

FES Sample Weighting

- Household Sample Base Weight

$$w_B = 1 / \pi_{psu} = N_h / n_h$$

- Non-response adjustment

$$w_{BR} = w_B / response\ rate_R$$

- Ratio adjustments
  - Demographic ***C***ontrol Totals from U.S. Census Bureau
  - Raking Ratio, Post-stratification

$$w_{BRP} = w_{BR} * \frac{C}{\hat{C}}$$

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FES Effort Estimation

- Estimate effort as weighted sum of trips reported by sampled households
- Estimation Domains
  - State
  - Year, 2-month Wave (Jan/Feb, Mar/Apr,...)
  - Fishing Mode
    - Private Boat
    - Shore
- State resident in-state fishing effort

$$\hat{T} = \Sigma\, w_{BRP}\, t_i$$

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For-Hire Survey (FHS)

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FHS Overview


Image: Chesapeake Bay Program

Image: Cayobo/Flickr

- **List-frame telephone survey** of captains and operators of for-hire vessels
- Vessels selected for **weekly reporting** of for-hire trips
- Used to estimate **charter boat and headboat effort estimates** by state, year, 2-month wave, and area fished

FHS Resource Links

- Survey Design and Statistical Methods

  FHS Section 2

- FHS At-a-Glance
- Outreach Information

Catch and Effort Estimation

Catch and Effort Estimation

- Resource Links
- Catch and Effort Estimation Example
- Variance Estimation and Percent Standard Error (PSE)

Estimation Resource Links

- Survey Design and Statistical Methods

  Total Catch and Effort Estimation Section 6

$$\hat{Y}_d = \hat{\bar{y}}_d \times \hat{T}_{T\ldots}$$

- Estimation Methods Overview
- Survey Statistics Overview

$$V(\hat{Y}_d) = \hat{\bar{y}}_d^{\,2} V(\hat{T}_{T\ldots}) + (\hat{T}_{T\ldots})^2 V(\hat{\bar{y}}_d) - V(\hat{T}_{T\ldots}) V(\hat{\bar{y}}_d)$$

$$\hat{Y}_D = \sum_{w=1} \hat{Y}_{dl}$$

- Applied Survey Data Analysis (Textbook)
- SAS® PROC Surveymeans

$$V(\hat{Y}_D) = \sum_{w=1} V(\hat{Y}_{dl})$$

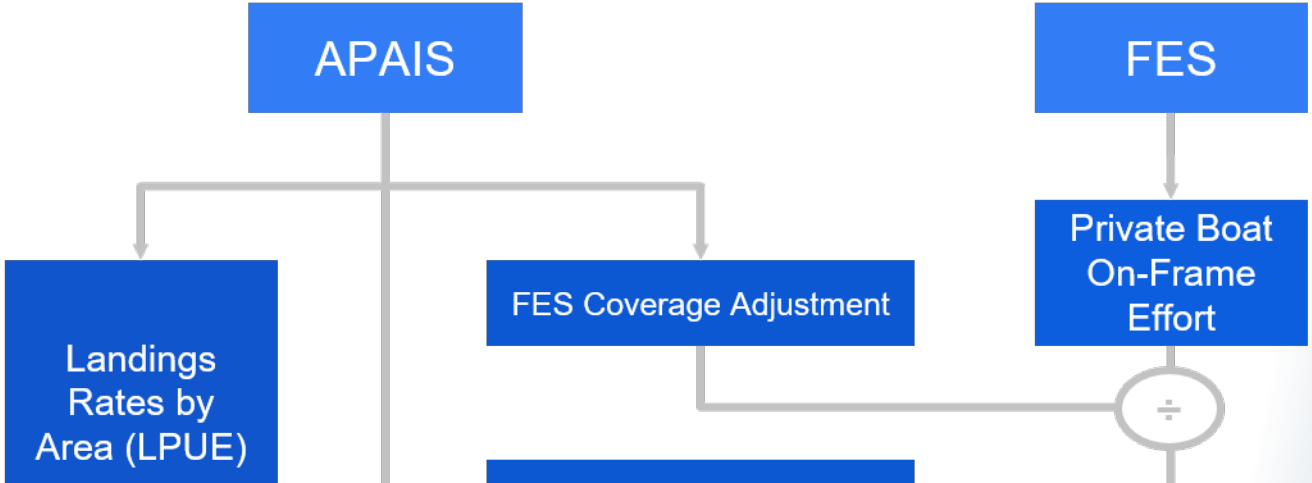
Catch and Effort Estimation Example

- New Jersey Wave 4 (Jul/Aug) 2019
- Private Boat (PR)
- PR Summer Flounder Landings (No.)
- n=857 APAIS PR Intercepts

Area Fished	PR Effort (No. Angler Trips)	PR Summer Flounder Landings (No. Fish)
All	**1,590,161**	**609,019**
Ocean – STS	287,957	129,534
Ocean – EEZ	562,778	273,132
Inland	739,426	206,354

NJ PR 2019 W4 Summer Flounder Landings

Component Estimates

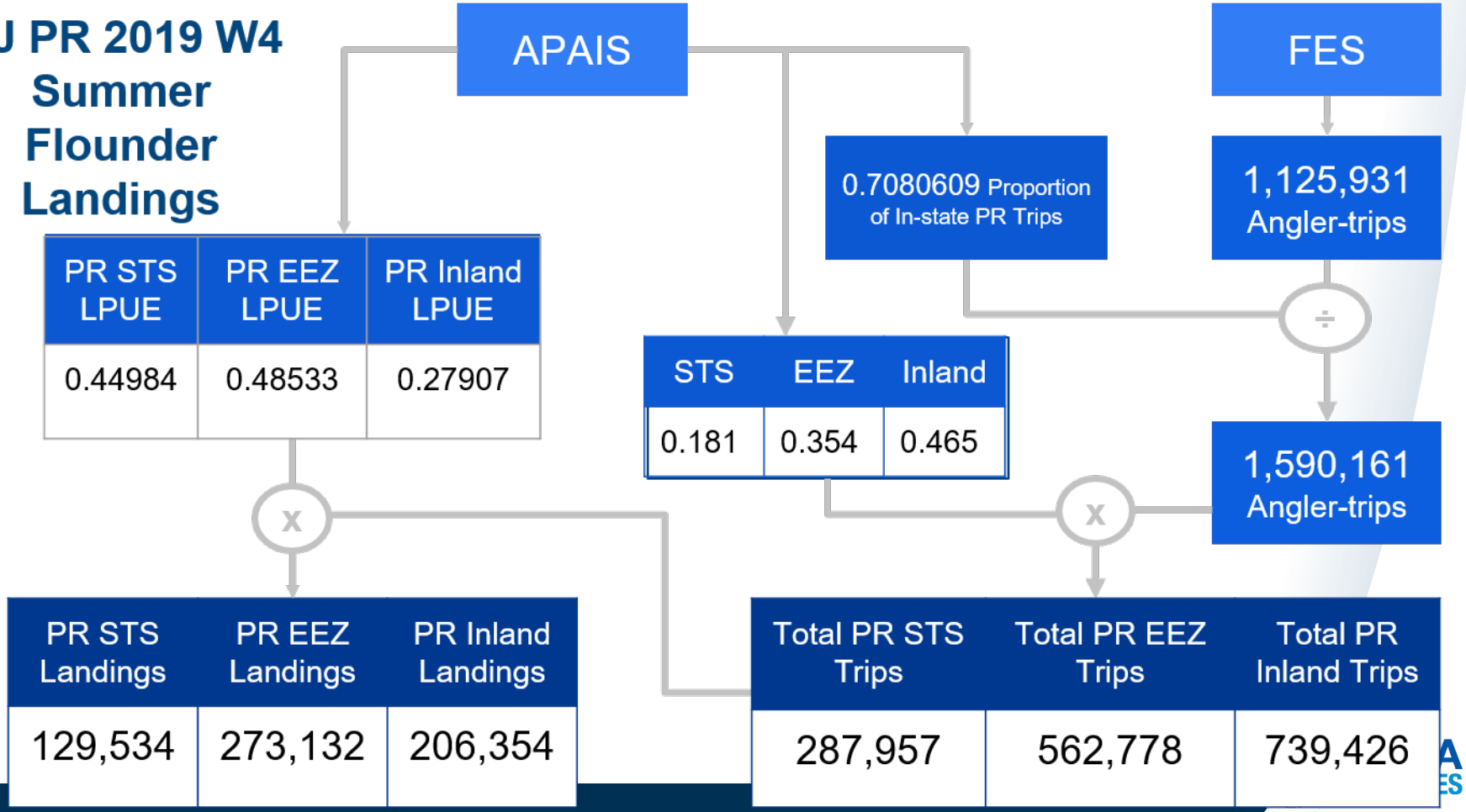


Primary Estimates

Total PR Landings by Area

Total PR Effort by Area

NJ PR 2019 W4 Summer Flounder Landings



APAIS Components

- New Jersey Wave 4 (Jul/Aug), 2019, Private Boat Mode
- n=857 APAIS PR Intercepts

Component	Value	Raw Count	Raw Proportion	Weighted Count	Weighted Proportion
FES Coverage Adjustment	NJ Resident Angler	660	0.770128	54,338	**0.708061**
	Out-of-State Angler	197	0.229872	22,404	0.291939
Area Fished Proportions	Ocean STS (<=3mi)	189	0.220537	13,897	**0.181087**
	Ocean EEZ (>3mi)	320	0.373396	27,160	**0.353912**
	Inland	348	0.406068	35,685	**0.465001**

APAIS Components

- New Jersey Wave 4 (Jul/Aug), 2019, Private Boat Mode
- n=857 APAIS PR Intercepts

Component	Area	Raw Landings Count	Raw Trip Count	Raw LPUE	Weighted Landings Count	Weighted Trip Count	Weighted LPUE
LPUE by Area	O-STS (<=3mi)	86	189	0.455	6251.4242	13,897	**0.44984**
	O-EEZ (>3mi)	123	320	0.384	13182	27,160	**0.4853**
	Inland	77	348	0.221	9958.8215	35,685	**0.27907**

Variance Estimation

- Sampling error - measure of uncertainty about a point estimate related to variability in the population characteristic being estimated, sample size and other design factors

- Variances for MRIP estimation components estimated using Linearization (Taylor Series approximation) - a standard approach for complex survey designs

- Variances for MRIP catch and effort estimates generally estimated using Goodman's Formula for the Variance of Products

Percent Standard Error (PSE)

- Coefficient of Variation on the percent scale
- $PSE = 100 * \frac{\text{Square Root of Variance (aka Standard Error)}}{\text{Point Estimate}}$
- Relative measure of uncertainty, useful for comparing precision of estimates with very different magnitudes
- 30%, 50%
- MRIP Survey and Data Standards (Standard 7)

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MRIP Data User Seminar:
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