NOAA FISHERIES

MRIP Design and Estimation

SAFMC SSC MRIP Data Workshop
August 2019
Charleston, SC

Presentation Outline

I. Background (MRFSS to MRIP)

II. APAIS Design

III. FES Design

IV. Catch and Effort Estimation

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Background

- Marine Recreational Fishery Statistics Survey, 1979-2006, primarily consisted of two component surveys:

MRFSS Intercept Survey

(Angler interviews at public fishing access points)

CHTS: Coastal Household Telephone Survey

(Random digit dialing telephone survey)

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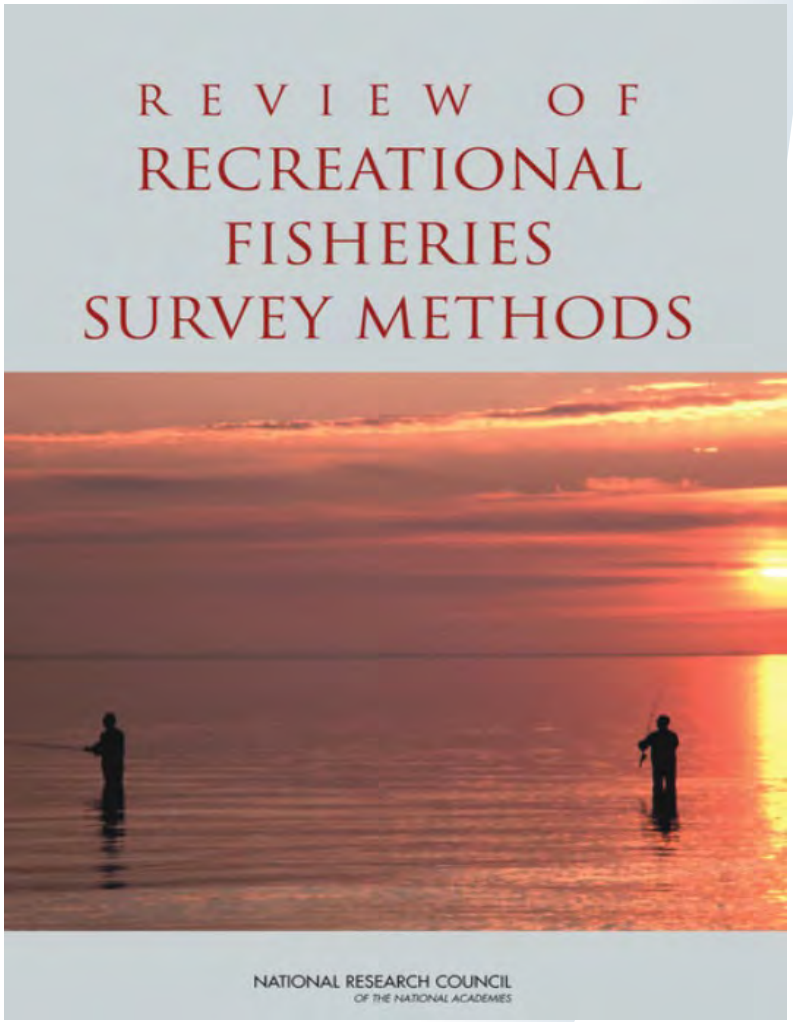
Background

- Entire redesign of program began after 2006 evaluation and reauthorization of MSA

'[The MRFSS Intercept Survey and the CHTS] suffer from weaknesses that may lead to biases in catch and effort estimation.'



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Background

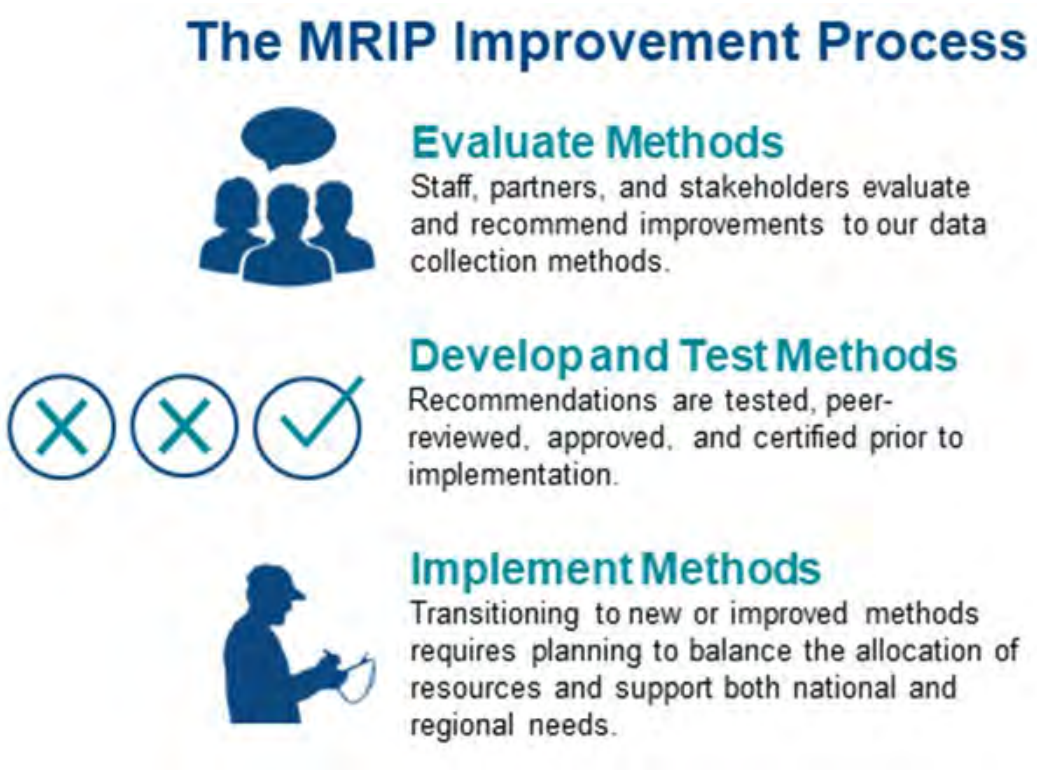
- MRFSS Intercept Survey Issues:
  - Estimation methods did not account for complex sampling design
  - Coverage limited with respect to time of day and type of access (primarily public)

Background

- CHTS Issues:
  - Inefficient (low proportion of fishing households among general population)
  - Declining coverage with increasing cell phone use (fewer households with landlines)
  - Declining response rates (<10% in final years)

Background

2006 → 2018



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Background

- 2013: Access Point Angler Intercept Survey (APAIS) replaces MRFSS Intercept Survey
- 2018: Fishing Effort Survey (FES) replaces CHTS
  - Both surveys:
    - Have greater coverage (more complete sample frames)
    - Utilize more advanced statistical methods, including appropriate weighting techniques
    - Result in design unbiased estimates

Background

- Progress Evaluation in 2017

*"[The APAIS methods are] a **vast improvement** over the previous sampling and estimation procedures and reflect **state-of-the-art** methods in survey sampling."*

*"The methodologies associated with the current FES…are **major improvements** from the original Coastal Household Telephone Survey."*

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APAIS Overview

- In-person interviews of anglers intercepted at public access fishing sites
- Sample selected monthly for continuous data collection
- Used to estimate catch rates and trip characteristics for 2-month waves

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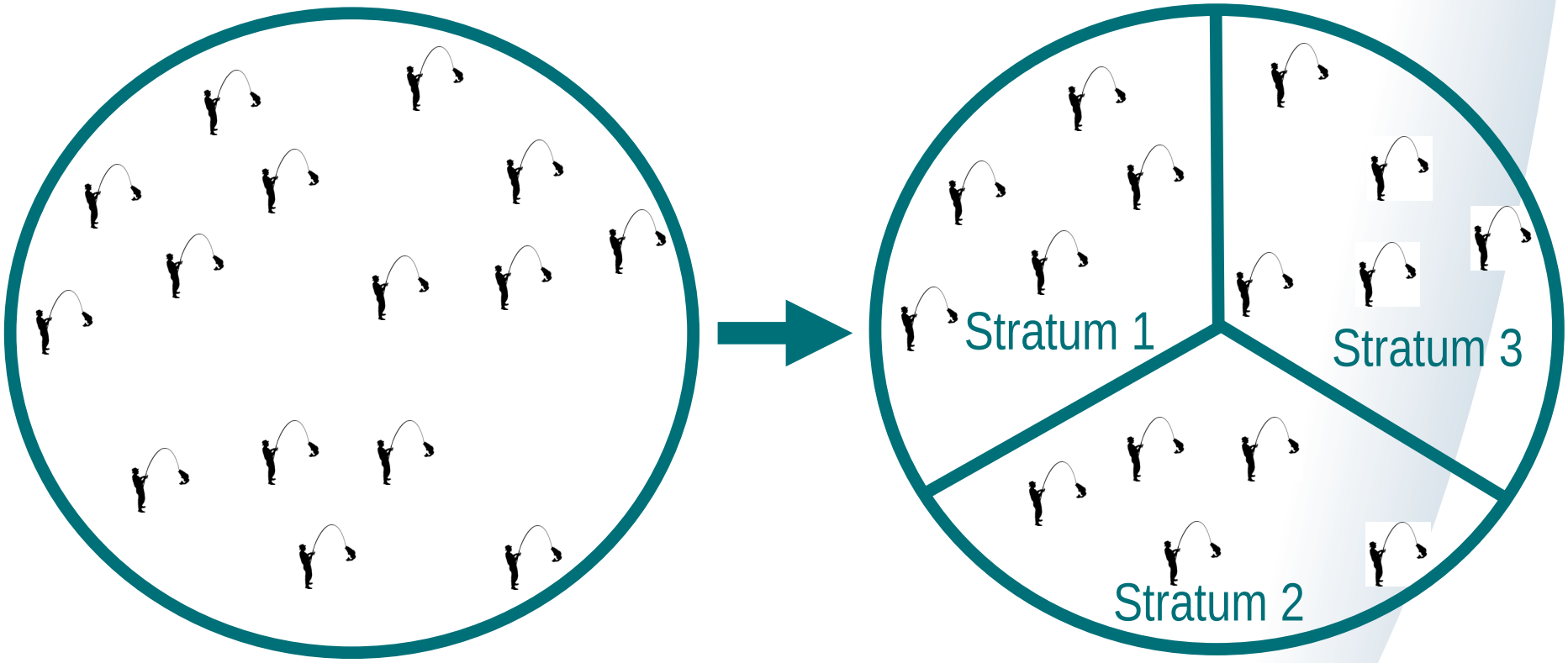
APAIS Overview

- **Stratified**, multi-stage cluster design



Target Population

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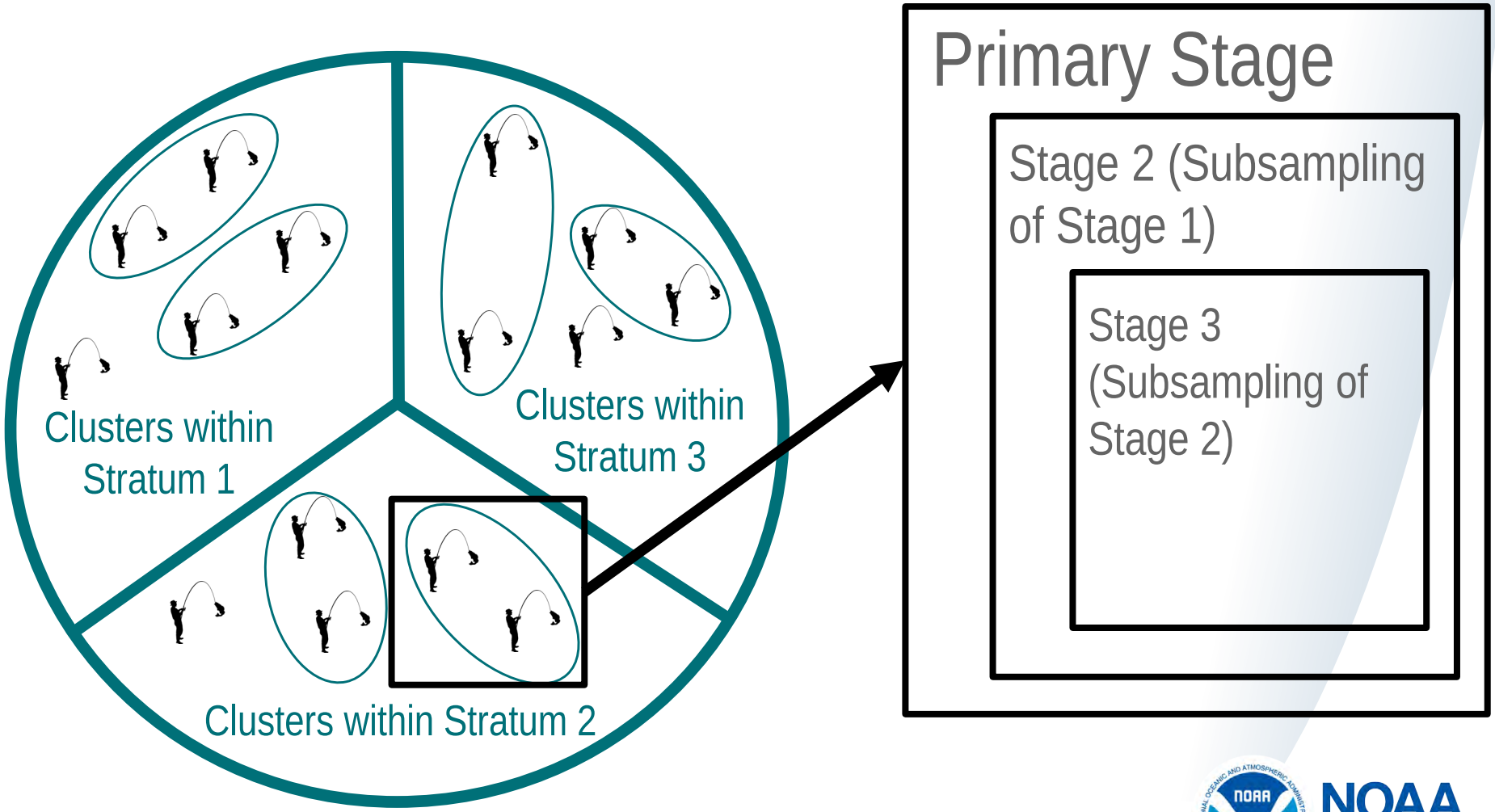
APAIS Overview

- Stratified, multi-stage cluster design



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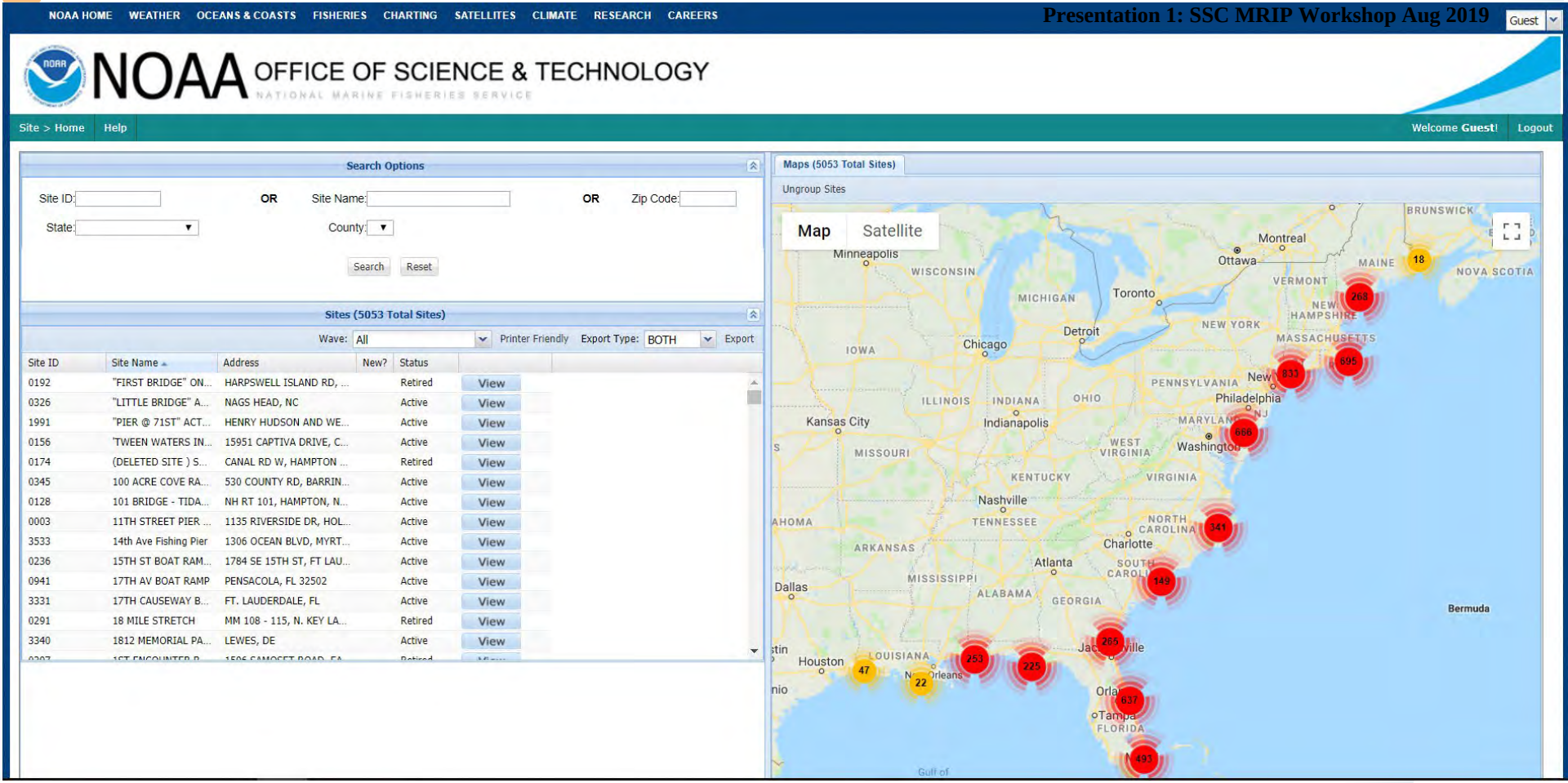

APAIS Sample Frame Creation

APAIS sample frame (i.e. list of all units in target population from which the actual sample is drawn) is derived from NOAA Fisheries Public Access Fishing Site Register – consists of over 5000 sites along the U.S. Atlantic and Gulf Coasts. For each site, the register includes estimated fishing pressure by fishing mode (e.g. shore, private boat).

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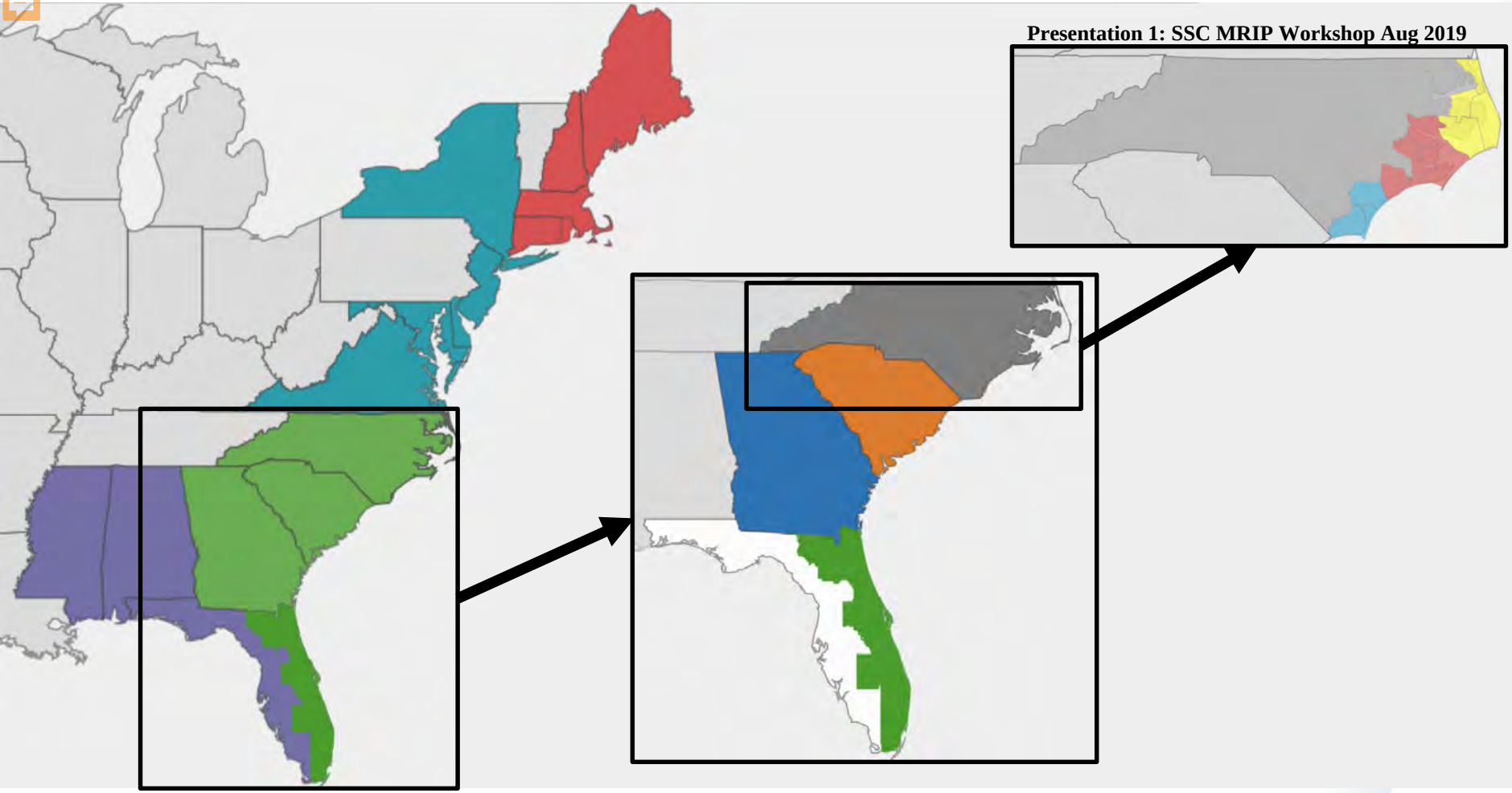

APAIS Stratification – Geographic

Stratified by Coastal Region, State, Sub-State Region

(sub-state regions are delineated by county lines and decided by each state)

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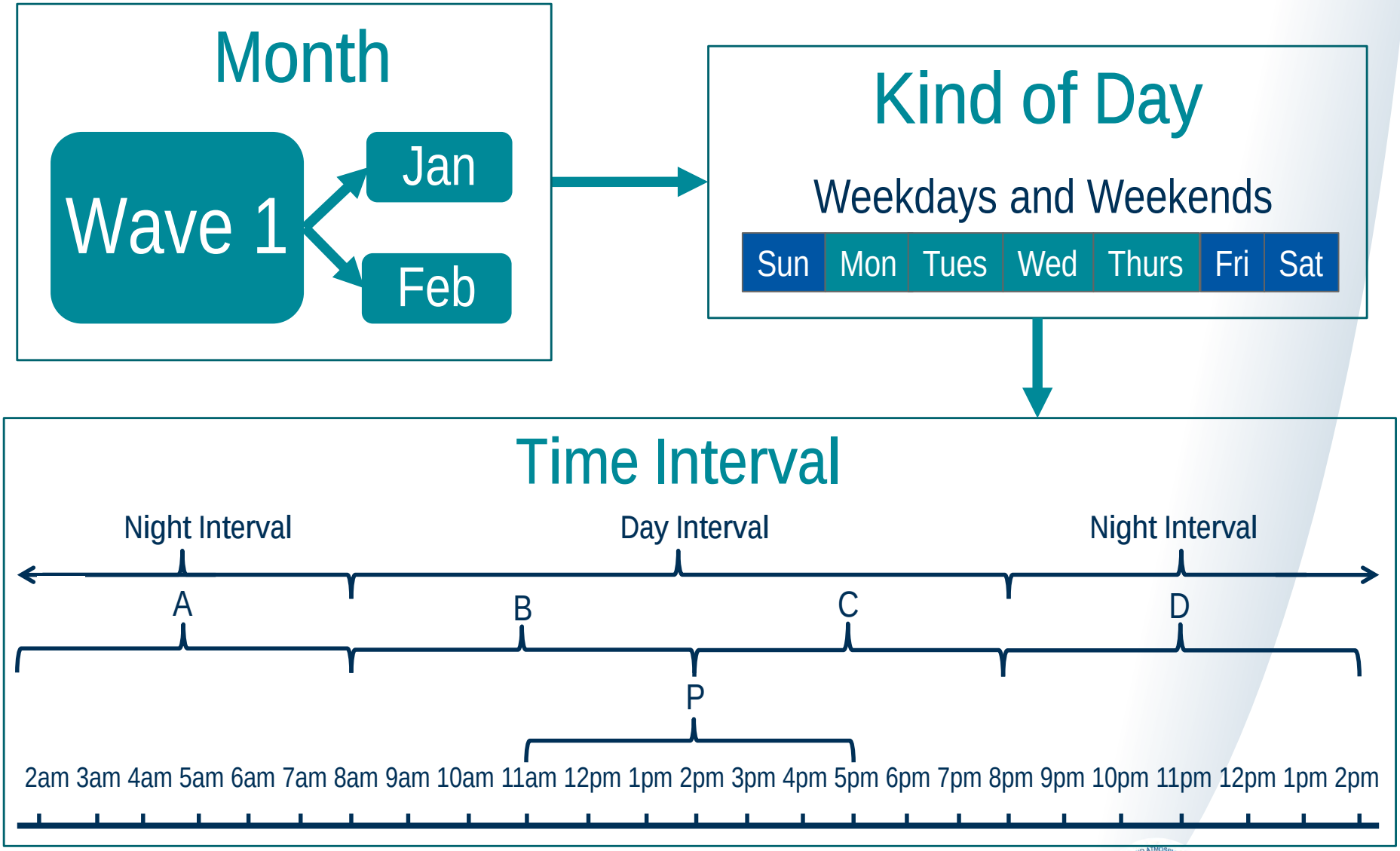
APAIS Stratification – Temporal



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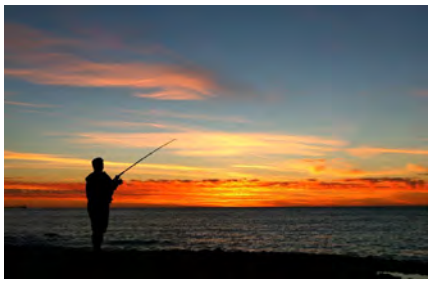
APAIS Stratification – Site Group

- Historically stratified by fishing mode – only anglers fishing in the assigned mode were eligible for interview.
- Current design replaced mode with site group strata:



Primarily shore fishing

Primarily private boat fishing

Primarily charter boat fishing

Any angler at a site eligible for interview: maintains ability to target sample to specific fishing modes but increases survey productivity

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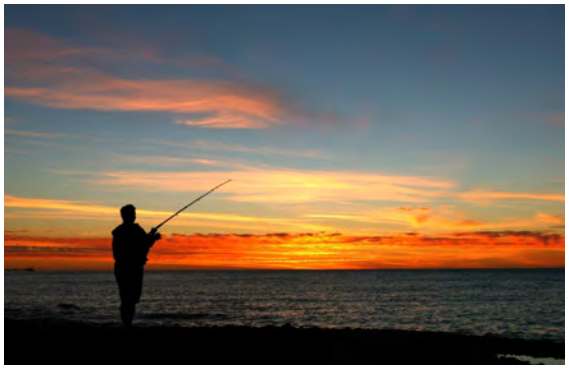
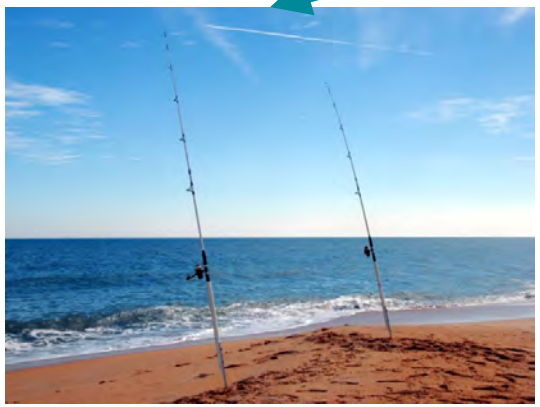
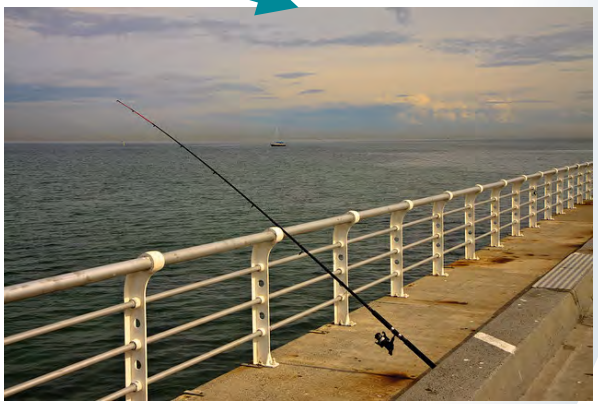
APAIS Stratification – Site Group - NC



Primarily shore fishing



Beach/Bank



Man-Made

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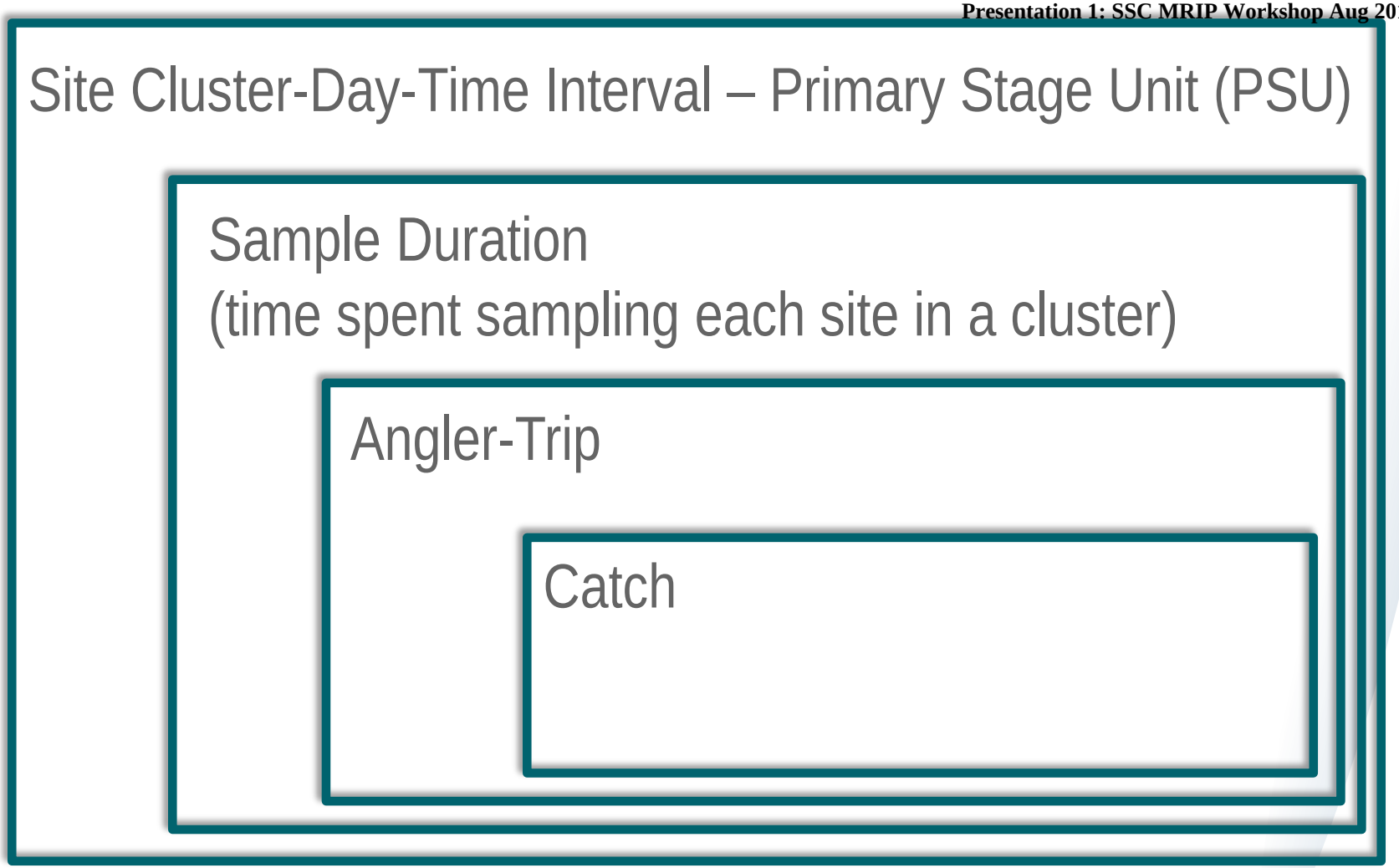

APAIS Design Stages

Sampling occurs in 4 nested stages

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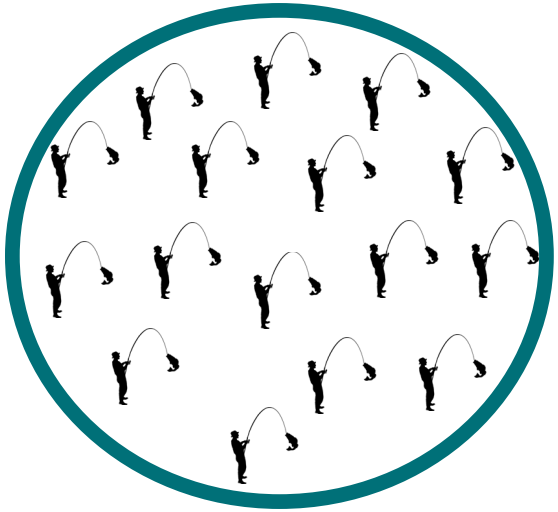
APAIS Site Clustering

- 1 or 2 sites clustered by fishing pressure

Single-Site Cluster



Clustered with another site

- Clusters created monthly – sites are clustered independently within strata
- Random process – site cluster combinations can change each month because fishing pressure is not static

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APAIS Sample Selection

- Probability of selecting PSU's based on fishing pressure
  - Higher probability of selecting high pressure sites

Expected Number of Angler-Trips	Size Measure (Weight)
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
Mode not present at site/site is inactive	0

APAIS Sample Selection (cont)

- APAIS sample selection of PSU's is based on stratified probability proportional to size without replacement (PPSWOR)
- Logistical field sample constraints (such as number of available samplers per day) are also incorporated into the process using a replication based control selection approach
- Using controlled selection ensures that sample draws can be accomplished with available field staff in a way that is statistically valid

APAIS QA/QC

Step 1
- Each state partner's manager/lead biologist checks and edits raw fish records for unusual data elements

Step 2
- Regional data collection partners (ACCSP, GulfFIN) run automated checks to identify 1) potential errors and 2) produce warnings when data elements seem unusual (e.g. high fish counts).

Step 3
- Data Delivered to NMFS

Step 4
- NMFS runs the same automated checks to identify 1) potential errors and 2) produce warnings when data elements seem unusual (e.g. high fish counts).
  - Done to double check for any raw data issues that may need to be addressed prior to using the data in estimation.

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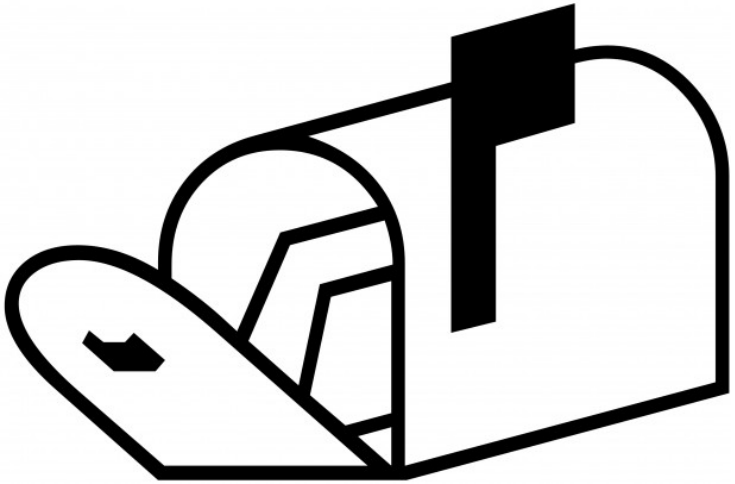
FES Overview



- Self-administered mail survey
- Conducted for six, 2-month waves annually
- Sample Frame:
  - USPS Computerized Delivery Sequence File – a comprehensive directory of residential addresses serviced by USPS
- Used to estimate private boat and shore mode effort estimates for all in-state resident anglers

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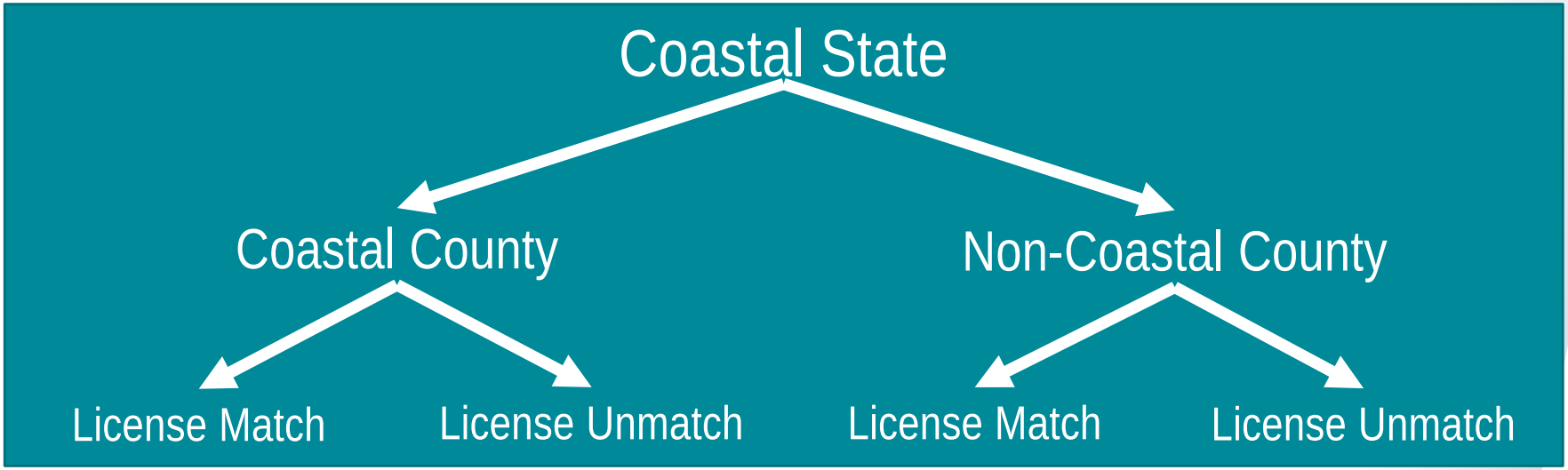
FES Stratification



- Coastal vs Non-Coastal: coastal under ~25 miles from shore, but each state customized by fishing activity across waves
- License Match vs Unmatch: Households matched to National Saltwater Angler Registry (NSAR) and not matched to NSAR

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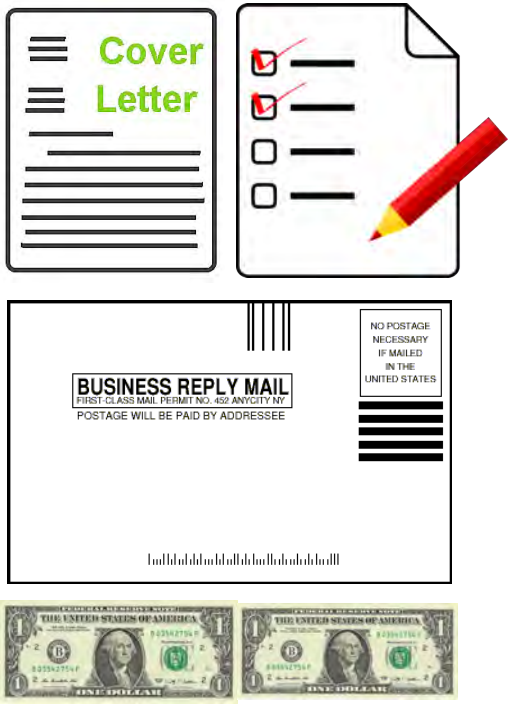
FES Sample Selection and Sample Size Allocation

- Simple random sampling to select households from each stratum
- Allocation: assessed annually based on precision goals and historical response rates
  - Neyman allocation approach (Neyman 1934)
    - long-established statistical technique used to maximize precision of estimates

FES Data Collection Design

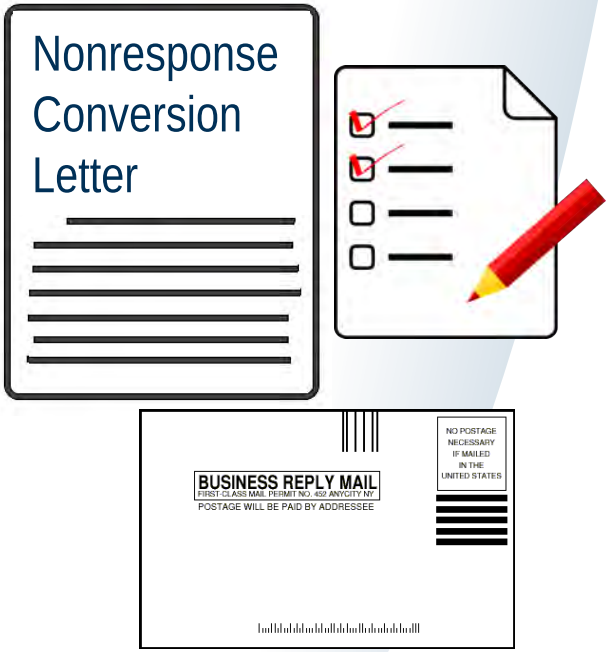
- 3 mailings to selected households

Initial



1-Week Follow-Up

3-Week Follow-Up



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FES QA/QC

Step 1
- Verify survey deliverables

Step 2
- Identify item nonresponse and illogical responses and make minor edits

Step 3
- Check for contradictory, nonsensical, and unlikely or extreme values

Step 4
- Adjust weight(s) of non-representative* values

*Non-representative values = those that contribute a disproportionate amount of effort to the total effort estimate within a domain for the current wave OR represent outliers within the time series

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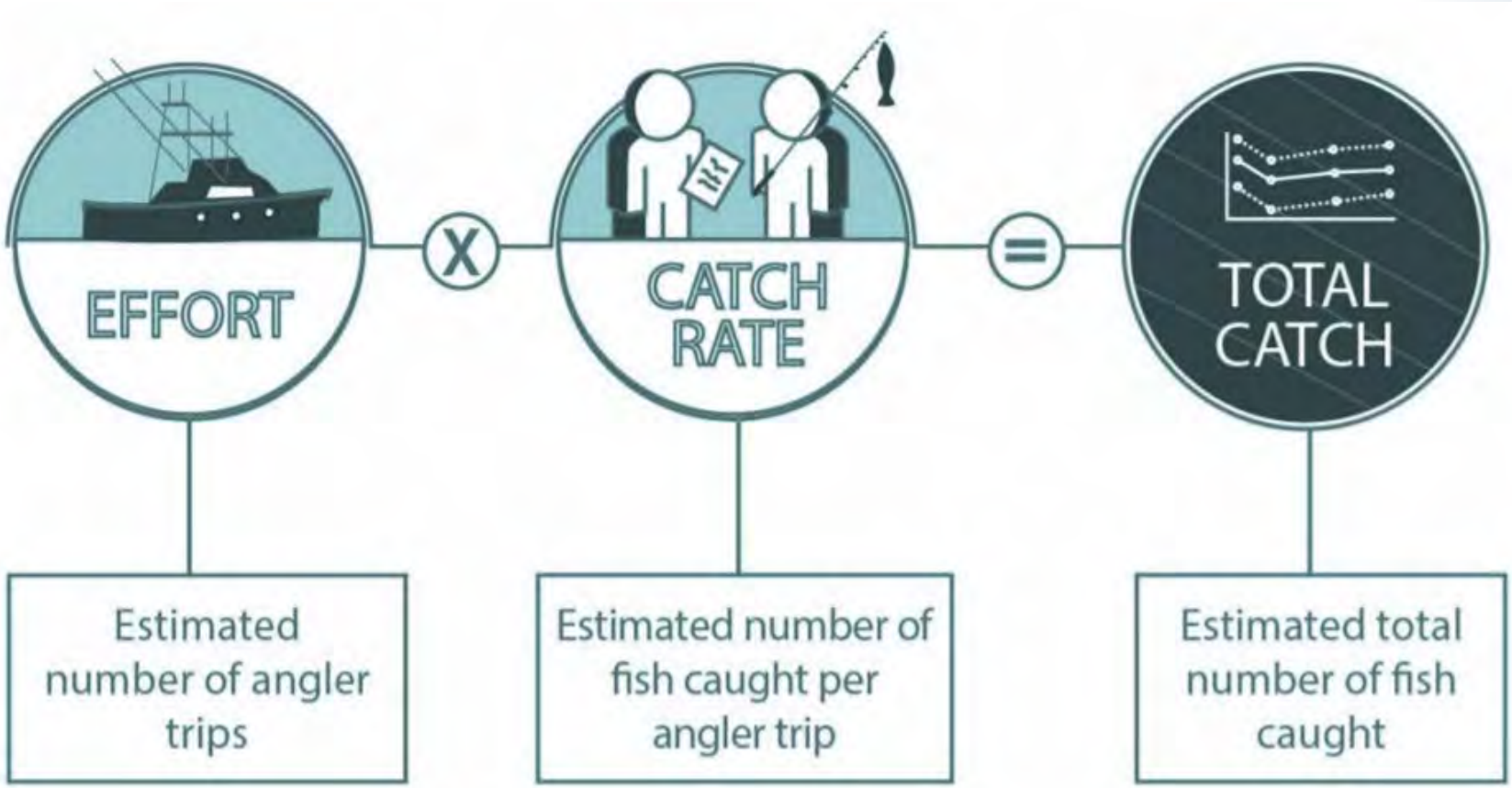
Catch Estimation – Basic



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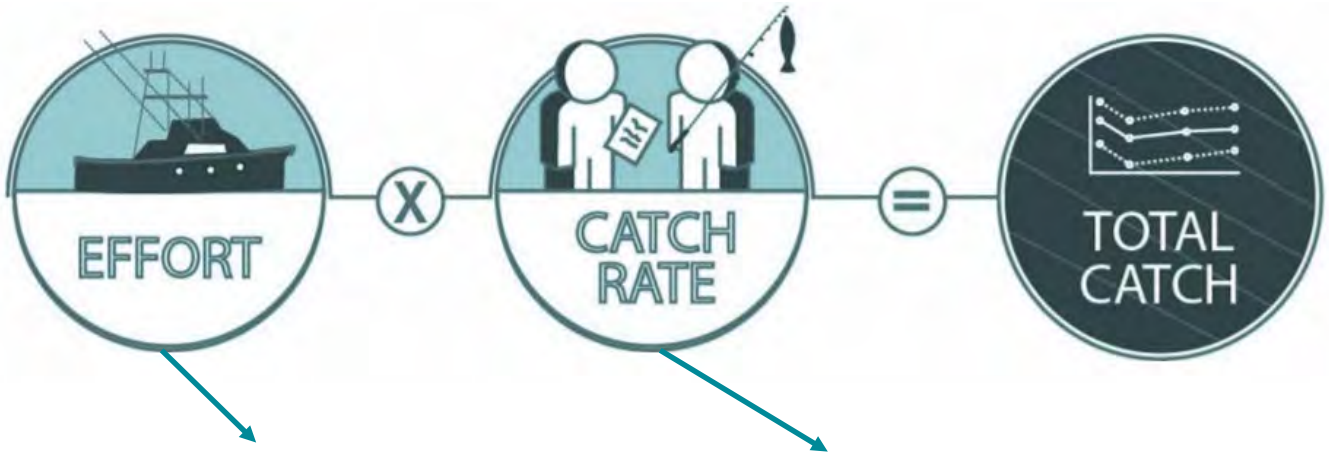
Catch Estimation – Broken Down



Weighted FES Effort

- Sample weighting components
- Calculations use standard weighted total estimator
- From APAIS: an adjustment factor to account for out-of-state angler trips
- From APAIS: partitioned by area fished (inland, nearshore, offshore)

Weighted APAIS catch rate

- Sample weighting components
- Calculations use standard weighted mean estimator

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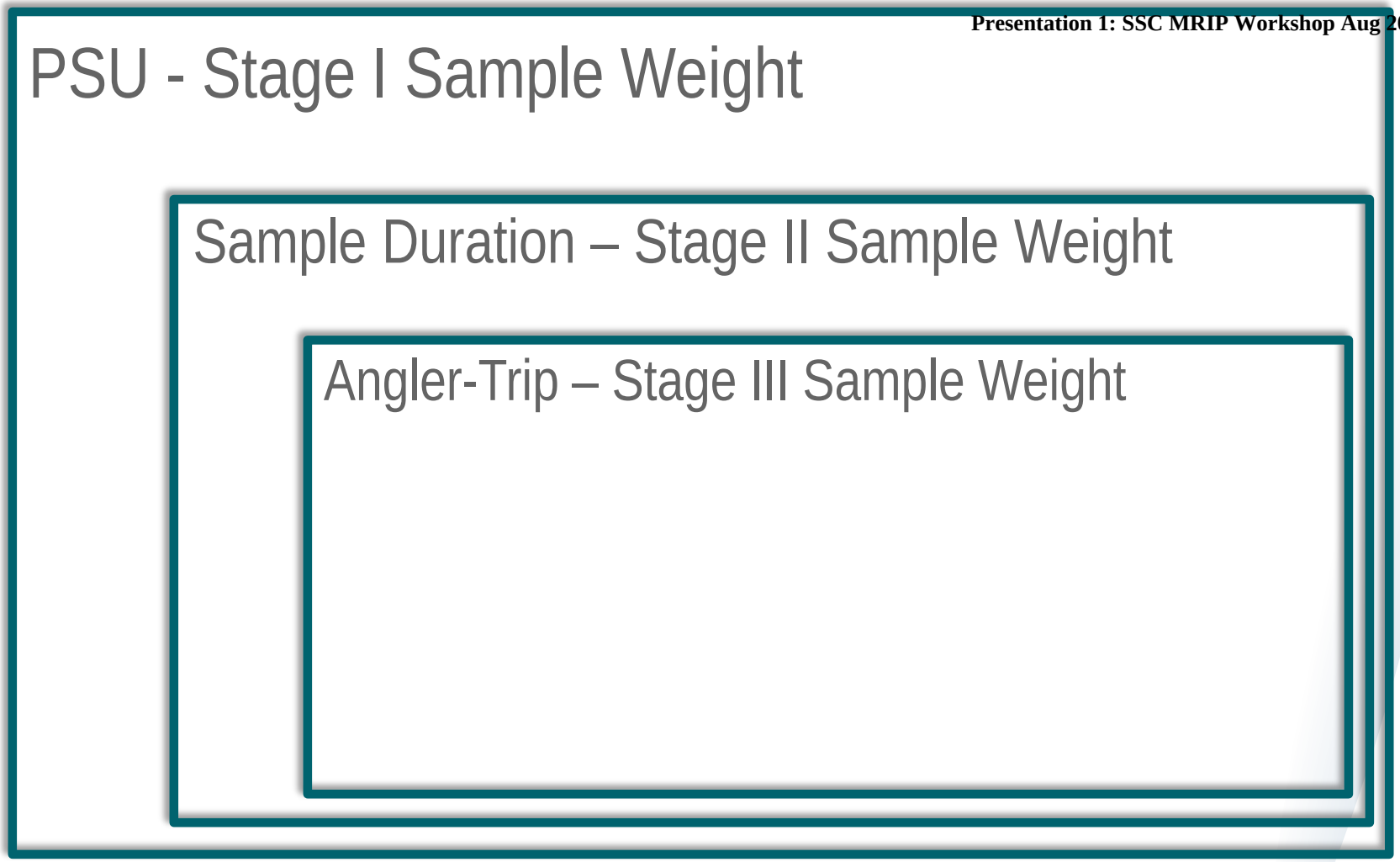

Overview of APAIS Sample Weight

Calculated as the product of the first 3 stage weights

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Stage I Sample Weight: based on PSU inclusion probability set by survey design

$$w_{hi} = \frac{1}{\pi_{hi}}$$

Weight of site cluster-day-time interval *i* in stratum *h*

Inclusion probability of unit *i* (as assigned during sample selection)

Stage II Sample Weight: within cluster temporal component

Weight of sample duration

6-hour time interval assigned to every site cluster-day i

$$w_{aki} = \frac{6}{t_{aki}}$$

Time spent sampling at site *a* within time window *k* in site cluster-day *i*

APAIS Sample Weight

Stage I and II Weights

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Stage III Sample Weight: within cluster angler-trip component

Shore Mode

$$\text{Stage III Weight} = \frac{\text{Total observed angler trips}}{\text{Total intercepted angler trips}}$$

Boat Modes

$$\text{Stage III Weight} = \left(\frac{\text{Total observed anglers in individual intercepted boat party}}{\text{Total intercepted anglers in individual party}}\right)\left(\frac{\text{Total observed angler trips}}{\text{Total observed angler trips in all intercepted boat parties}}\right)$$

$$\text{Final Sample Weight} = \text{Stage I Weight} \times \text{Stage II Weight} \times \text{Stage III Weight}$$

APAIS Sample Weight

Stage III Weight differs by fishing mode (shore vs. boat)

For NC: man-made and beach/bank weighted separately using shore weighting methods

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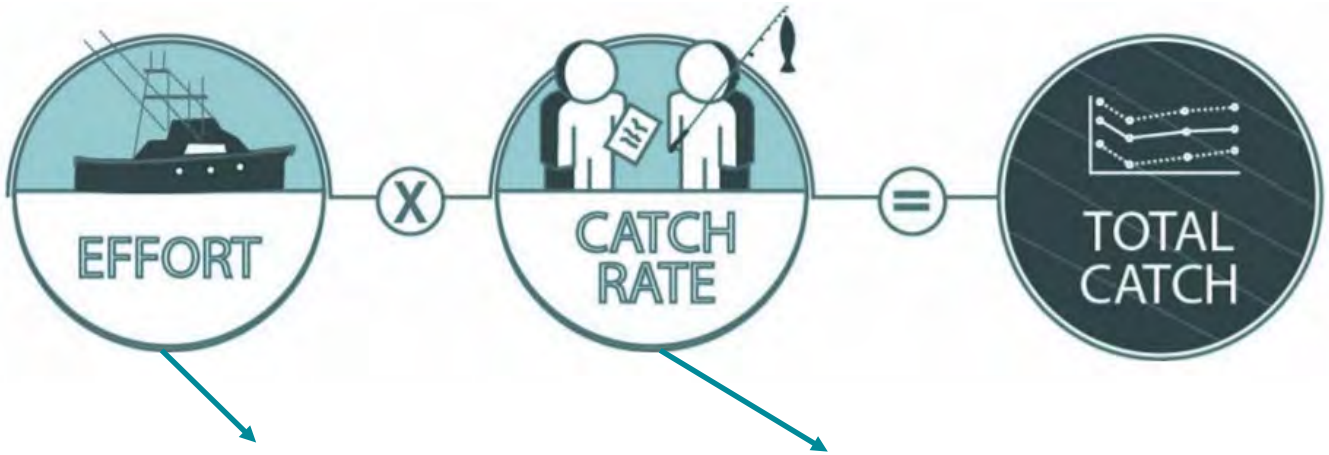
Catch Estimation – Broken Down



Weighted FES Effort

- sample weighting components
- calculated using standard weighted total estimator
- From APAIS: an adjustment factor to account for out-of-state angler trips
- From APAIS: partitioned by area fished (inland, nearshore, offshore)

Weighted APAIS catch rate

- sample weighting components
- calculated using standard weighted mean estimator

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APAIS Catch Rate Estimates

Mean catch per angler-trip calculated as a *domain* estimate, defined by year, wave, region, state, fishing mode, area fished (Inland, STS, EEZ), species* and catch type (e.g. harvested, released):

Sample weight for angler trip *j* in PSU *i* in stratum *h*

Number of fish caught on angler trip *j*, in PSU *i*, in stratum *h*.

Catch rate in domain *d* (i.e. year, region, state, etc…)

$$\hat{\bar{y}}_d = \frac{\sum w_{hij} y_{hij} I_{d(h,i,j)}}{\sum w_{hij} I_{d(h,i,j)}}$$

Indicator variable set to 1 if trip in domain *d;* set to 0 if not.

This is a **standard** weighted mean estimator calculated using proc surveymeans (SAS Institute Inc, 2016)

For NC: single shore domain used for estimation, but man-made and beach/bank samples weighted representatively within the combined domain

*Angler-trips with no catch for a given species are still included, as zeros, in catch rate estimation for that species

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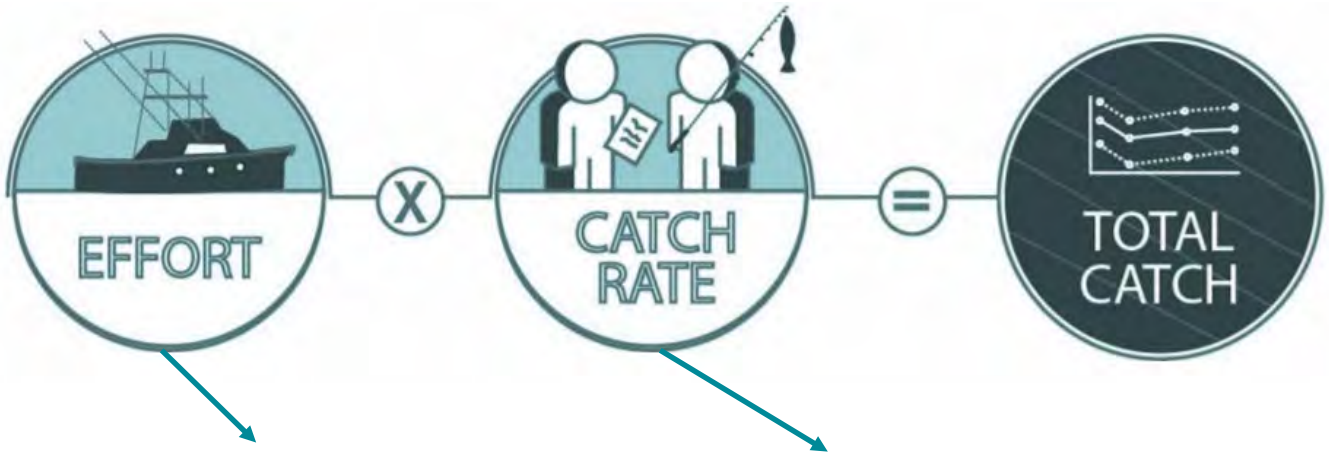
Catch Estimation – Broken Down



Weighted FES Effort

- includes 3 sample weighting components
- calculated using standard weighted total estimator
- From APAIS: an adjustment factor to account for out-of-state angler trips
- From APAIS: partitioned by area fished (inland, nearshore, offshore)

Weighted APAIS catch rate

- includes 3 sample weighting components
- calculated using standard weighted mean estimator

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FES Coverage Adjustment for Out-Of-State Trips (from APAIS)

Sample weight for angler trip *j* in PSU *i* in stratum *h*

$$\hat{p}_r = \frac{\sum w_{hij}\, I_{r(hij)}}{\sum w_{hij}}$$

Indicator variable:
$I_{r(hij)} = 1$ if angler trip *j* was completed by an in-state resident
$I_{r(hij)} = 0$ if angler trip *j* was completed by out-of-state resident

Uses standard methods for weighted proportions

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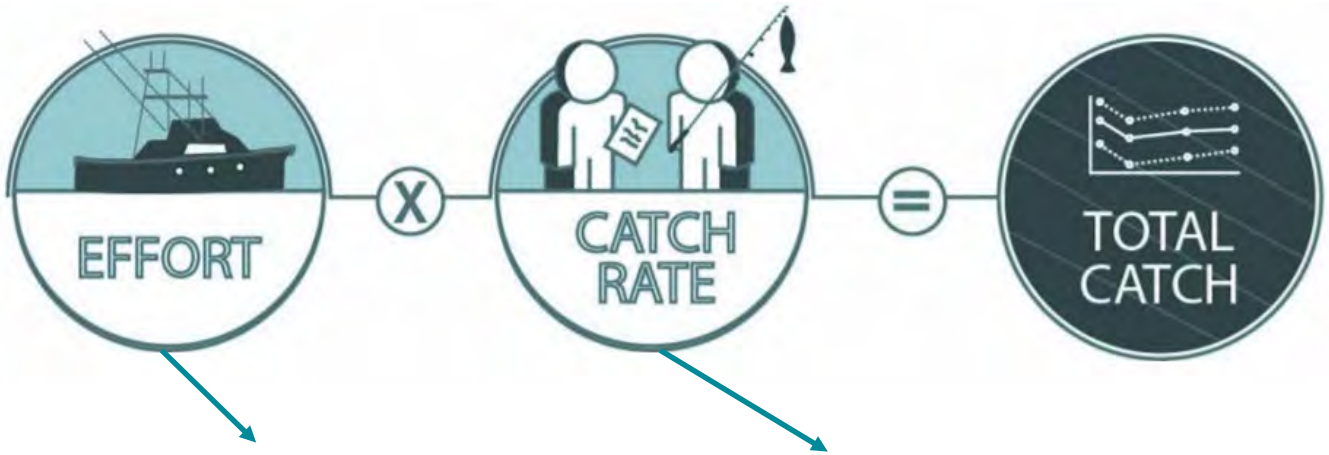
Catch Estimation – Broken Down



Weighted FES Effort

- includes 3 sample weighting components
- calculated using standard weighted total estimator
- From APAIS: an adjustment factor to account for out-of-state angler trips
- From APAIS: partitioned by area fished (inland, nearshore, offshore)

Weighted APAIS catch rate

- includes 3 sample weighting components
- calculated using standard weighted mean estimator

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Area Fished Proportions (from APAIS)

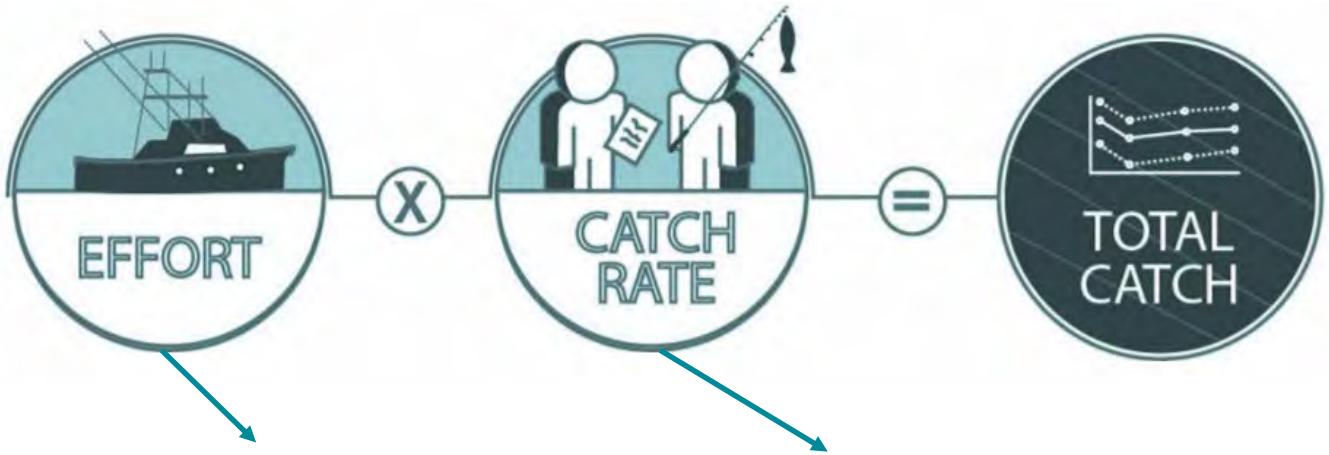
Sample weight for angler trip *j* in PSU *i* in stratum *h*

$$\hat{p}_a = \frac{\sum w_{hij}\, I_{a(hij)}}{\sum w_{hij}}$$

Indicator variable:
$I_{hij} = 1$ if angler trip *j* was in fishing area *a*
$I_{hij} = 0$ if angler trip *j* was not in fishing area *a*

Area fished proportions

Catch Estimation – Broken Down



Weighted FES Effort

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- Calculations use standard weighted total estimator
- From APAIS: an adjustment factor to account for out-of-state angler trips
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Weighted APAIS catch rate

- Sample weighting components
- Calculations use standard weighted mean estimator

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Overview of FES Sample Weights

- 3 main weight components:
  - Base design weight
  - Nonresponse adjustment
  - Post-stratification/Raking adjustments
    - To improve representativeness of responding sample by matching to demographic control totals from the US Census Bureau

FES Sample Weights

Base weight:
based on sample inclusion probability set by survey design

$$\omega_i = \frac{1}{\pi_i} = \frac{N_h}{n_h}$$

Inclusion probability of household unit *i*

FES Sample Weights

Nonresponse adjustment:
done to minimize nonresponse bias and ensure that the weighted respondent sample accurately represents the target population

Sample partitioned into nonresponse adjustment cells (i.e. weighting classes) and adjusted by response rates

Base weight for household unit *i* in adjustment cell *c*

Indicator variable:
r_{ci} = 1 for respondents
r_{ci} = 0 for nonrespondents

$$w_{ci}^{*} = \frac{\omega_{ci} r_{ci}}{\hat{\emptyset}_c}$$

Adjusted weight for household unit *i* in cell *c*

Weighted response rate: $\hat{\emptyset}_c = \sum \omega_{ci} r_{ci} \Big/ \sum \omega_{ci}$

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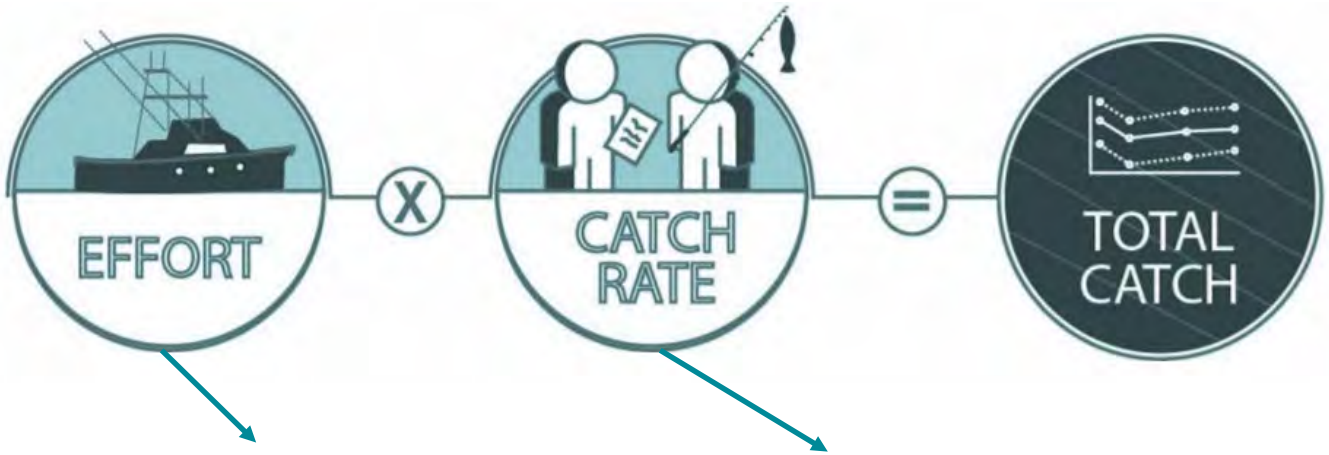
FES Sample Weights

Post-stratification/Raking adjustments:
standard technique used to conform survey estimates to control or population totals (e.g. Brick and Kalton 1996)

We use American Community Survey residential household estimates (United States Census Bureau 2018)

$$w_i = w_{ci}^{*} \frac{\theta}{\hat{\theta}}$$

Catch Estimation – Broken Down



Weighted FES Effort

- Sample weighting components
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- From APAIS: an adjustment factor to account for out-of-state angler trips
- From APAIS: partitioned by area fished (inland, nearshore, offshore)

Weighted APAIS catch rate

- Sample weighting components
- Calculations use standard weighted mean estimator

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$$\text{FES Effort} = \sum w_i t_i$$

Trips taken by household *i*

Final sample weight of household *i* (comprised of base weight, nonresponse adjustment, and post-stratification/raking adjustments)

FES Effort Estimates

This is a Horvitz-Thompson total estimator (Horvitz and Thompson 1952) a standard method for estimating the weighted total of a sample.

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Catch Estimation – Broken Down

Weighted FES Effort

- Sample weighting components
- Calculations use standard weighted total estimator
- From APAIS: an adjustment factor to account for out-of-state angler trips
- From APAIS: partitioned by area fished (inland, nearshore, offshore)

Weighted APAIS catch rate

- Sample weighting components
- Calculations use standard weighted mean estimator

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Total Private and Shore Fishing Effort (partitioned by area fished)

$$\text{Total Private and Shore Fishing Effort} = \frac{\text{FES Effort}}{\hat{p}_r}$$

$\hat{p}_r$ ← Proportion of trips by in-state residents; adjusts for trips by out-of-state residents

$$\text{Total Private and Shore Fishing Effort by area fished} = \text{Total Private and Shore Fishing Effort} \times \hat{p}_a$$

$\hat{p}_a$ ← Area fished proportions

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Catch Estimation – Putting all together

$$\left(\frac{\sum w_{hi} t_{hi}}{\hat{p}_r} X \ \hat{p}_a\right) X \quad \hat{\bar{y}}_d \quad = \quad \hat{Y}$$

FES weighted effort estimate, adjusted for coverage and partitioned by area fished

APAIS weighted catch rate estimate

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Estimate Review: Identifying Outliers

Outliers	Actions
Outlier identification	1. Automated review and flagging using application of time series methodology 2. Review by OST staff 3. Review by NMFS staff in regions
Outlier with data errors detected	Correct data errors or remove records; re-run estimation
Outlier with no error detected	Conduct and document data and estimation investigation. Leave estimate as-is.

Estimates are reviewed by NMFS OST Fisheries Statistics Division, and representatives from NOAA Regional Offices and Science Centers to identify and investigate outliers (i.e. unusual catch or effort estimates).

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SAFMC SSC MRIP Data Workshop
August 2019
Charleston, SC