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FISHERIES

MRIP Design and Estimation

Overview of APAIS and FES Designs
and Weighted Estimation Methods

Presentation Outline

- I. Background (MRFSS to MRIP)
- II. APAIS Design
- III. FES Design
- IV. Catch and Effort Estimation



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- I. **Background (MRFSS to MRIP)**
- II. APAIS Design
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Background

- Marine recreational fisheries statistical program from 1981-2006 consisted of two component surveys:

MRFSS Intercept Survey

(Angler interviews at public fishing access points)



CHTS: Coastal Household Telephone Survey

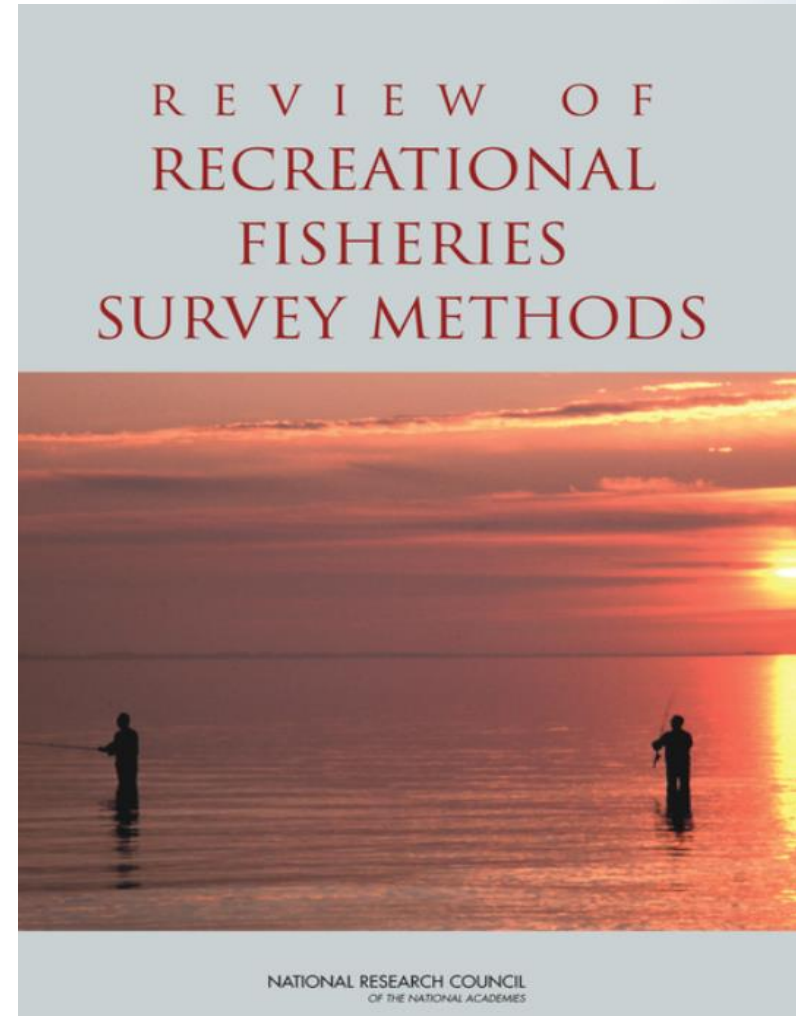
(Random digit dialing telephone survey)



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)



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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

The MRIP Improvement Process



Evaluate Methods

Staff, partners, and stakeholders evaluate and recommend improvements to our data collection methods.



Develop and Test Methods

Recommendations are tested, peer-reviewed, approved, and certified prior to implementation.



Implement Methods

Transitioning to new or improved methods requires planning to balance the allocation of resources and support both national and regional needs.



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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



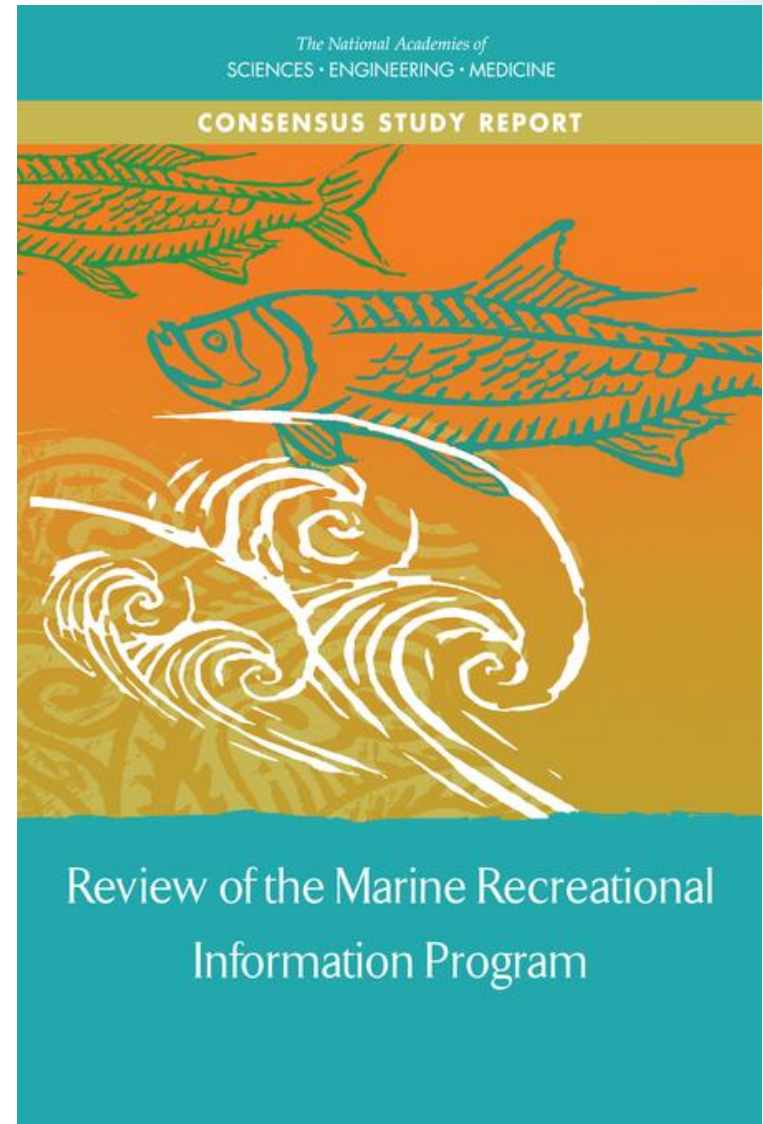
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Background

- 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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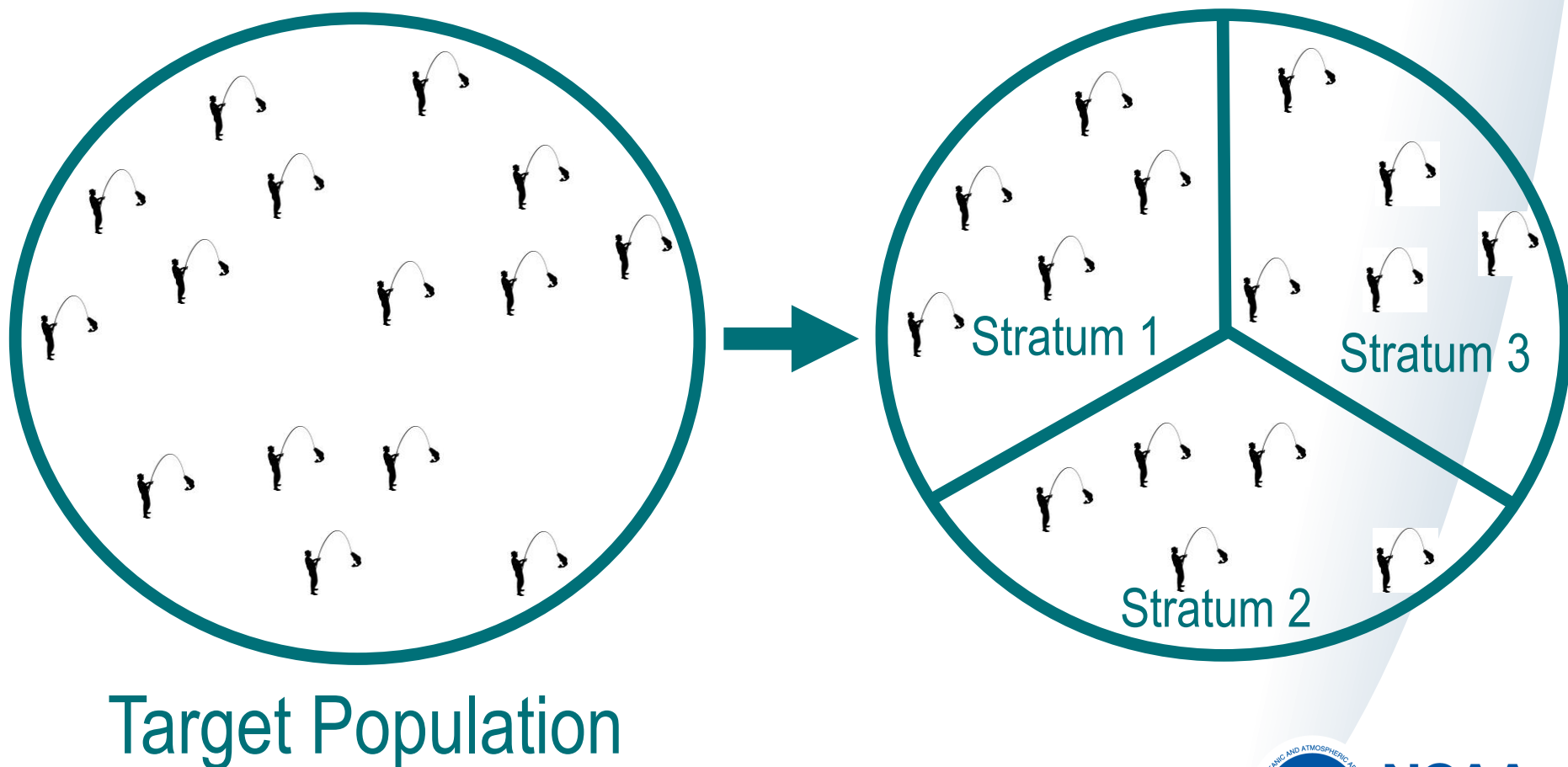
APAIS Overview

- 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



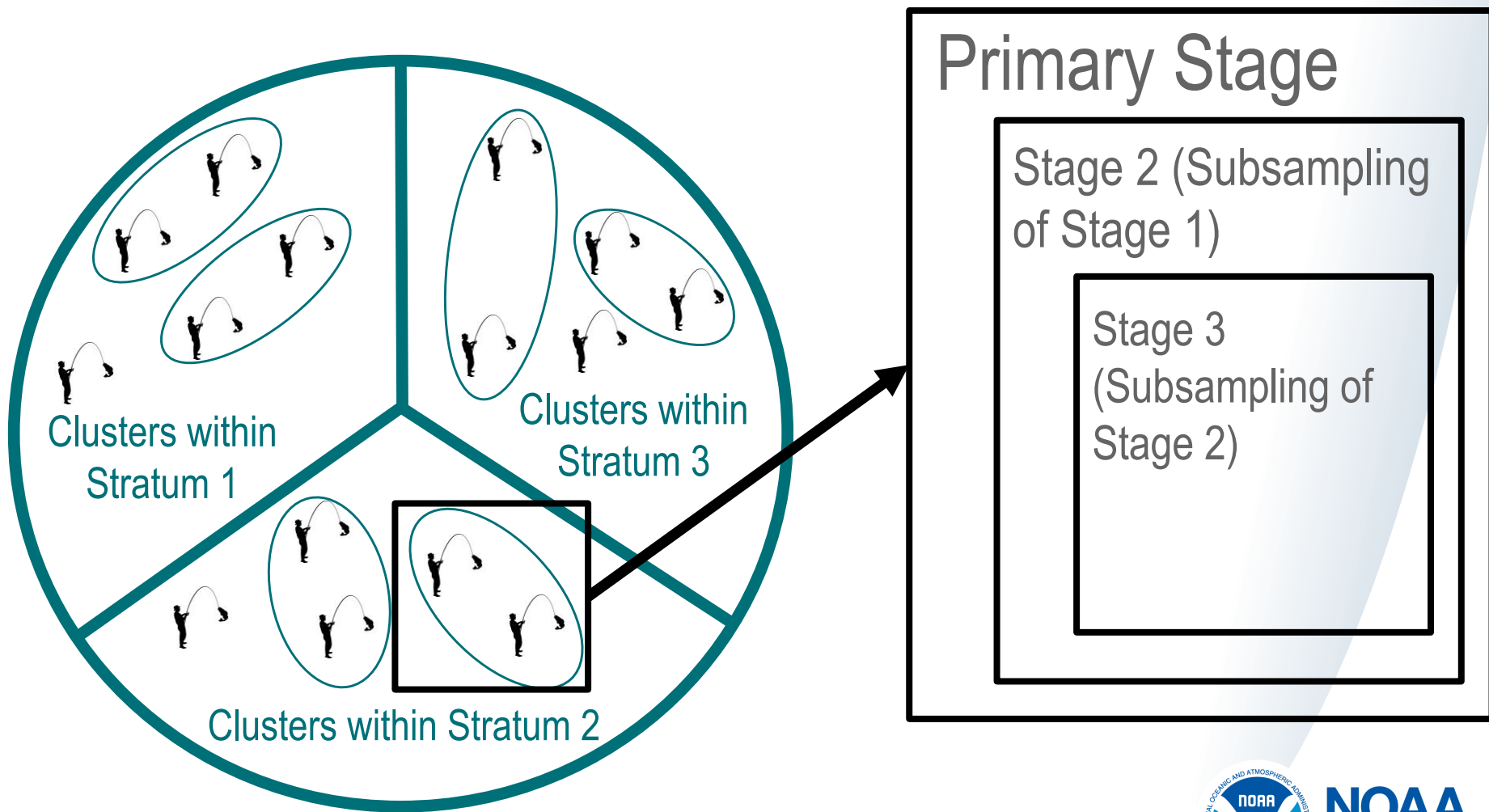
APAIS Overview

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



APAIS Overview

- Stratified, multi-stage cluster design





Search Options

Site ID: OR Site Name: OR Zip Code:

State: County:

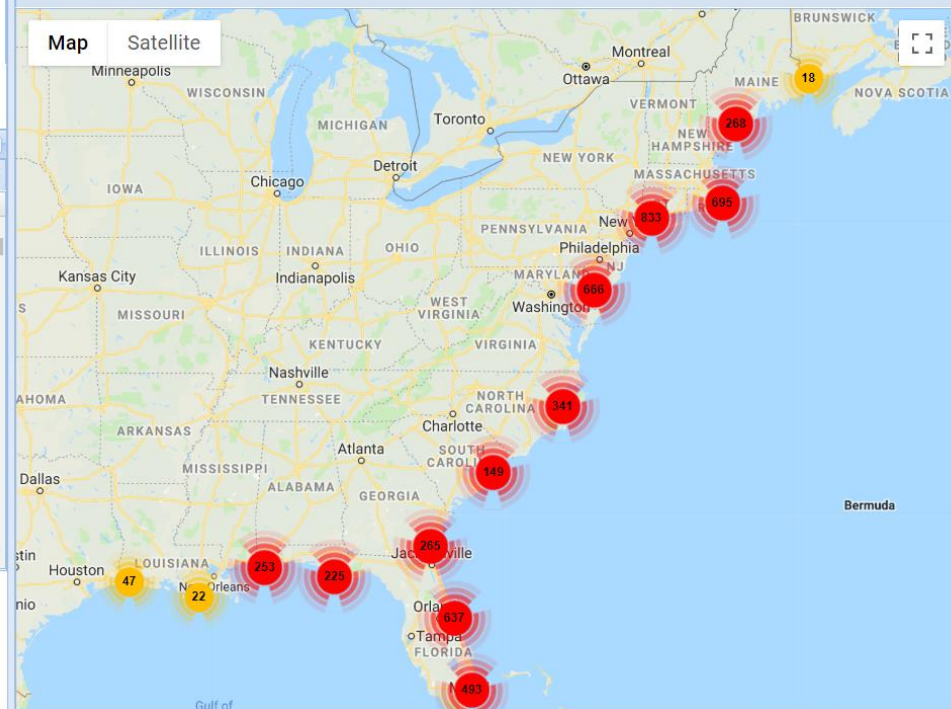
Sites (5053 Total Sites)

Wave: All Export Type: BOTH

| Site ID | Site Name | Address | New? | Status | |
|---------|-----------------------|----------------------------|------|---------|----------------------|
| 0192 | "FIRST BRIDGE" ON... | HARPSWELL ISLAND RD, ... | | Retired | View |
| 0326 | "LITTLE BRIDGE" A... | NAGS HEAD, NC | | Active | View |
| 1991 | "PIER @ 71ST" ACT... | HENRY HUDSON AND WE... | | Active | View |
| 0156 | "TWEEN WATERS IN... | 15951 CAPTIVA DRIVE, C... | | Active | View |
| 0174 | (DELETED SITE) S... | CANAL RD W, HAMPTON ... | | Retired | View |
| 0345 | 100 ACRE COVE RA... | 530 COUNTY RD, BARRIN... | | Active | View |
| 0128 | 101 BRIDGE - TIDA... | NH RT 101, HAMPTON, N... | | Active | View |
| 0003 | 11TH STREET PIER ... | 1135 RIVERSIDE DR, HOL... | | Active | View |
| 3533 | 14th Ave Fishing Pier | 1306 OCEAN BLVD, MYRT... | | Active | View |
| 0236 | 15TH ST BOAT RAM... | 1784 SE 15TH ST, FT LAU... | | Active | View |
| 0941 | 17TH AV BOAT RAMP | PENSACOLA, FL 32502 | | Active | View |
| 3331 | 17TH CAUSEWAY B... | FT. LAUDERDALE, FL | | Active | View |
| 0291 | 18 MILE STRETCH | MM 108 - 115, N. KEY LA... | | Retired | View |
| 3340 | 1812 MEMORIAL PA... | LEWES, DE | | Active | View |
| 0307 | 1ST ENCOUNTER B... | 1506 CAMOSET ROAD, FA... | | Retired | View |

Maps (5053 Total Sites)

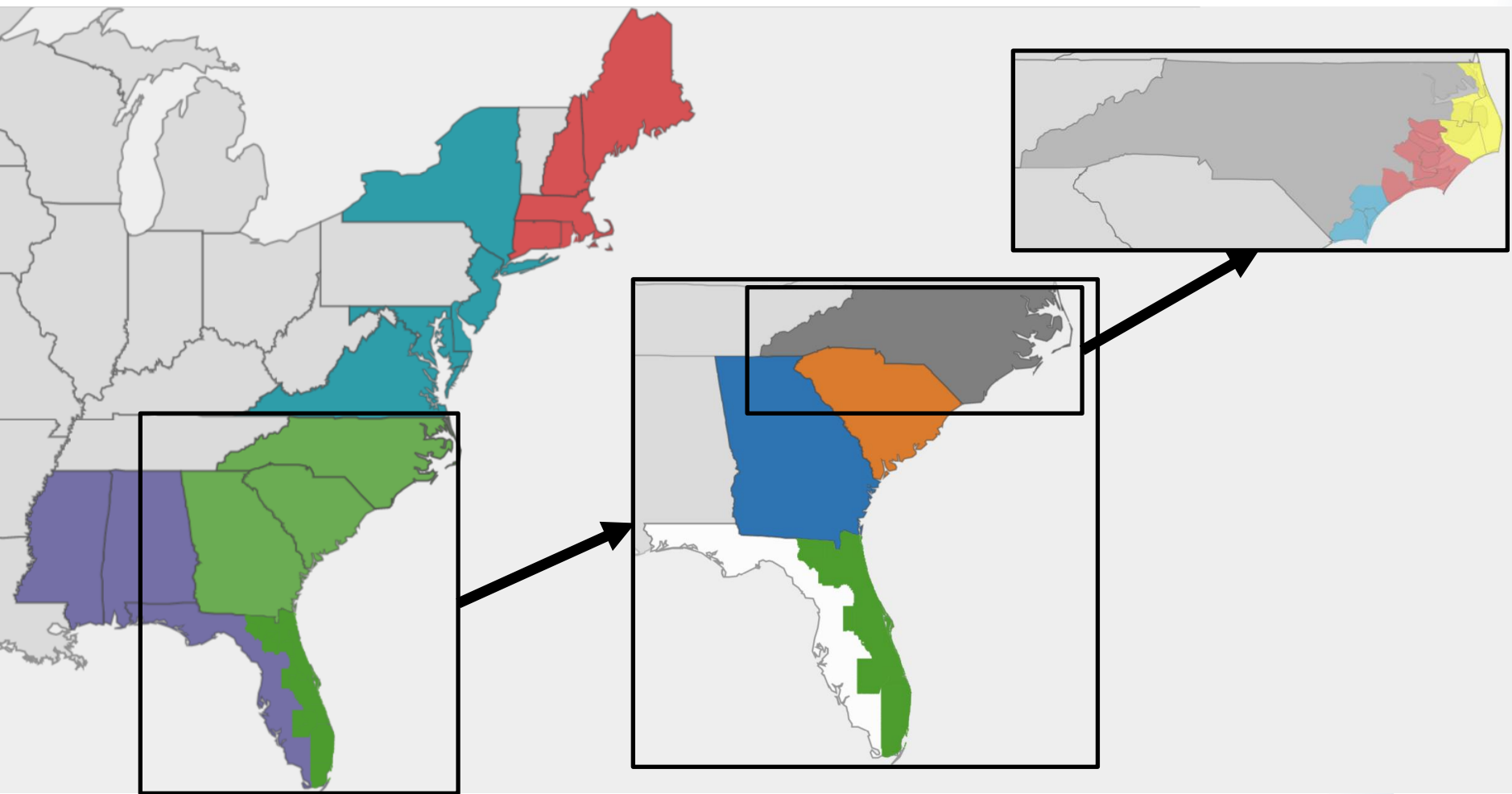
Ungroup Sites

Map 

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).



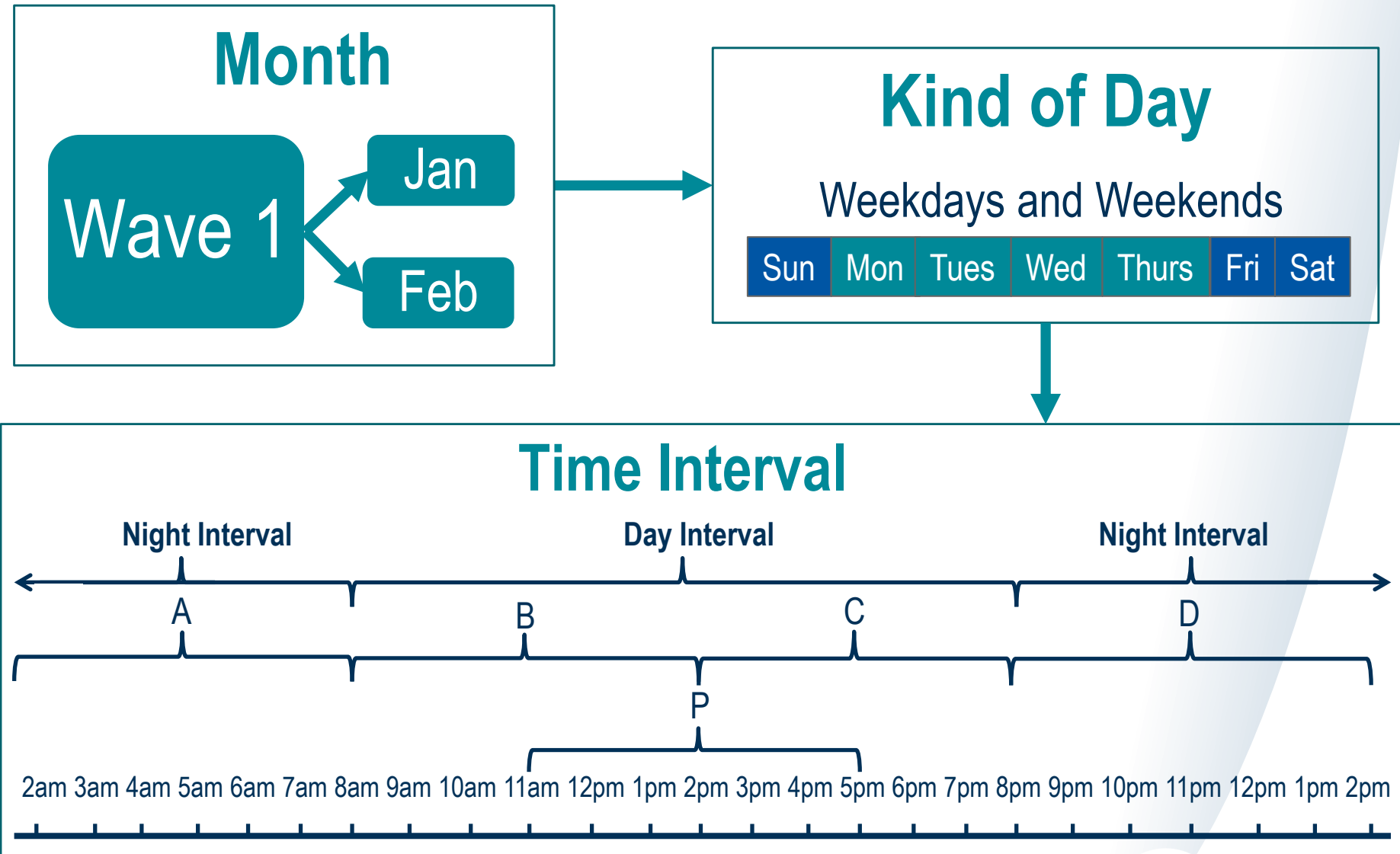


APAIS Stratification – Geographic

Stratified by Coastal Region, State, Sub-State Region

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

APAIS Stratification – Temporal



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

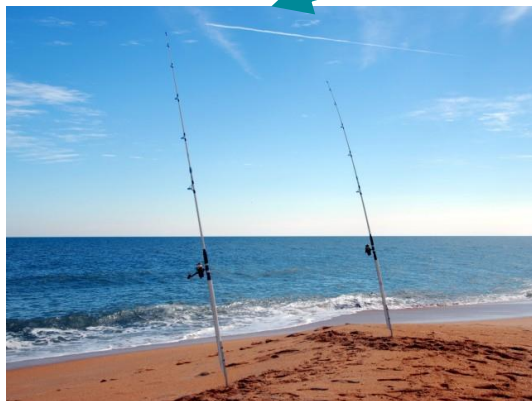


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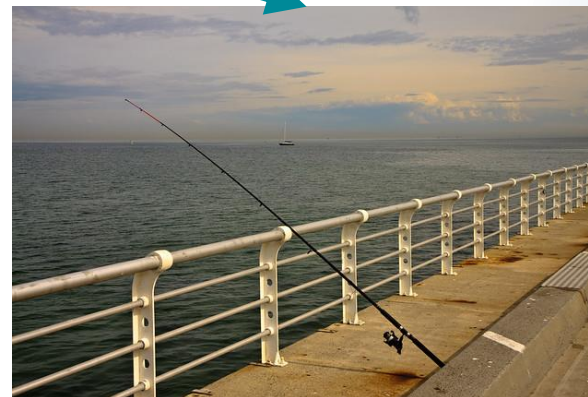
APAIS Stratification – Site Group - NC



Primarily shore fishing



Beach/Bank



Man-Made

Site Cluster-Day-Time Interval – Primary Stage Unit (PSU)

Sample Duration
(time spent sampling each site in a cluster)

Angler-Trip

Catch

APAIS Design Stages

Sampling occurs in 4 nested stages

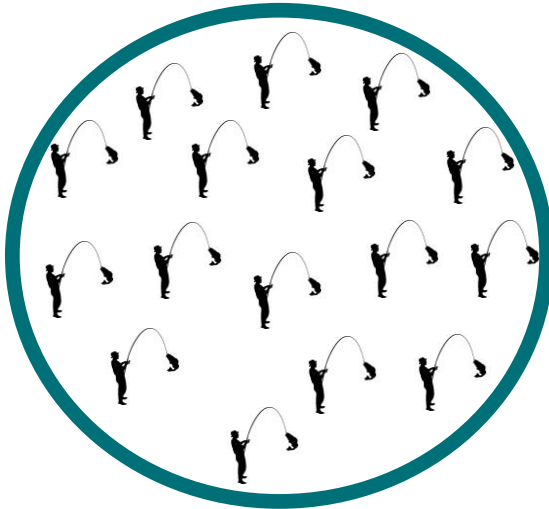


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APAIS Site Clustering

- 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 |



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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



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APAIS QA/QC

Step 1

- Each state's lead biologist checks and edits raw fish records for unusual data elements

Step 2

- States runs 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.



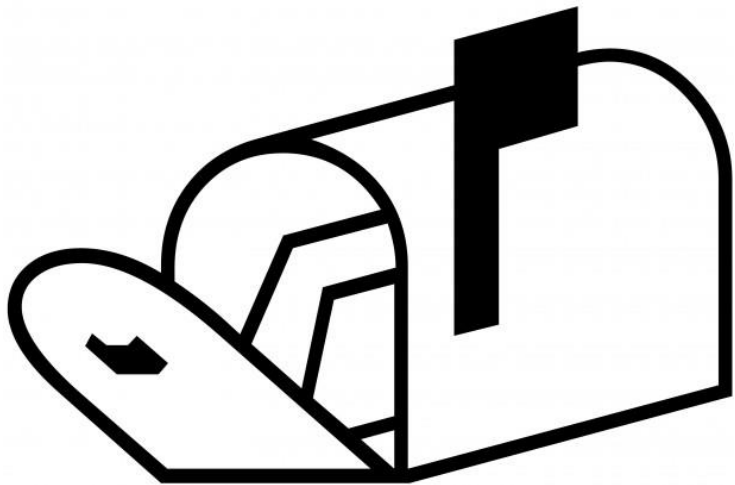
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FES Overview

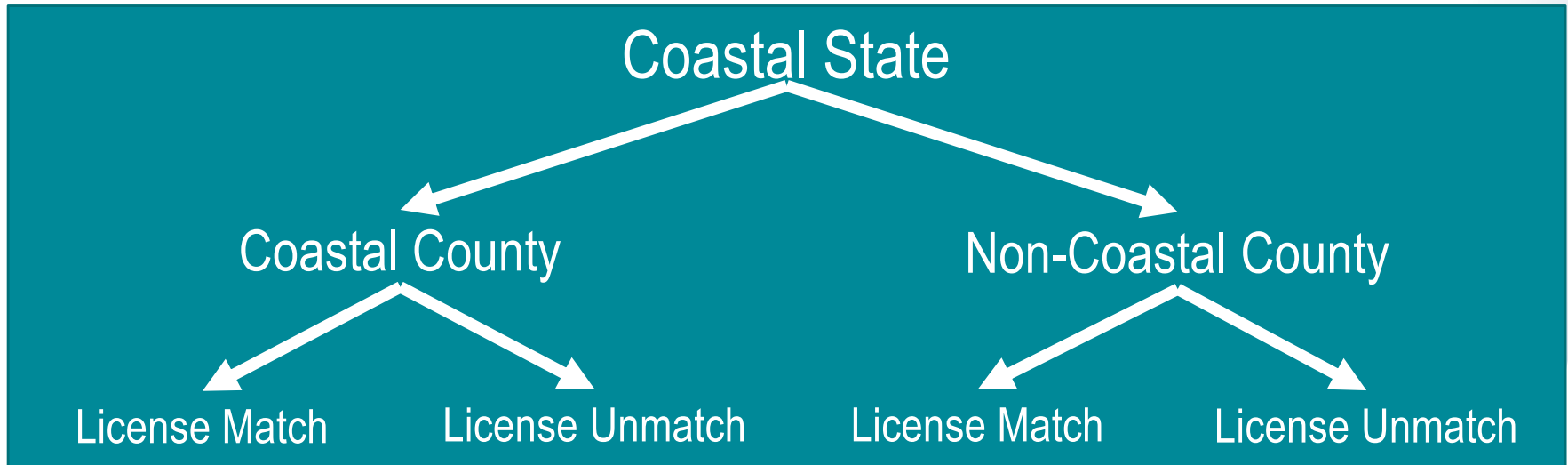


- Self-administered mail survey
- Conducted for six, 2-month waves annually
- Sample Frame:
 - USPS Computerized Delivery Sequence File – a comprehensive directory of residential addresses serviced by USPS
- Used to estimate private boat and shore mode effort estimates for all in-state resident anglers



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FES Stratification



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

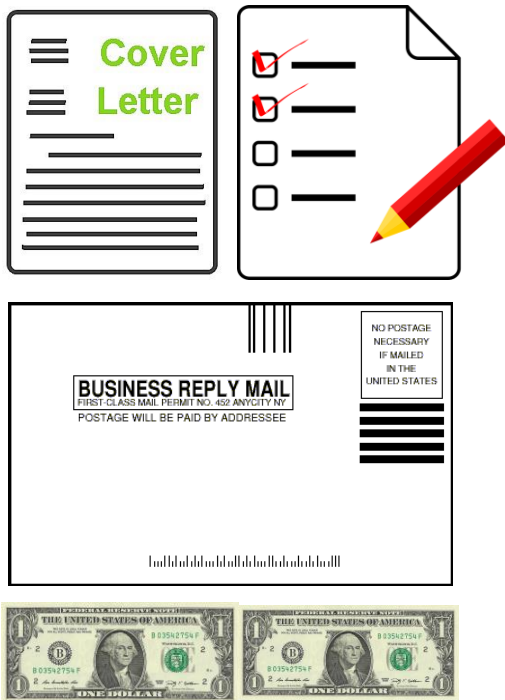
FES Sample Selection and Sample Size Allocation

- 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

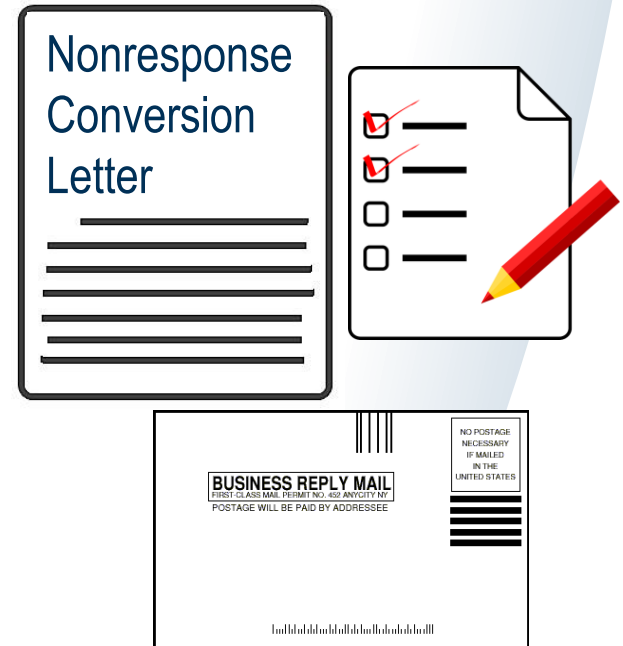
Initial



1-Week Follow-Up



3-Week Follow-Up



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



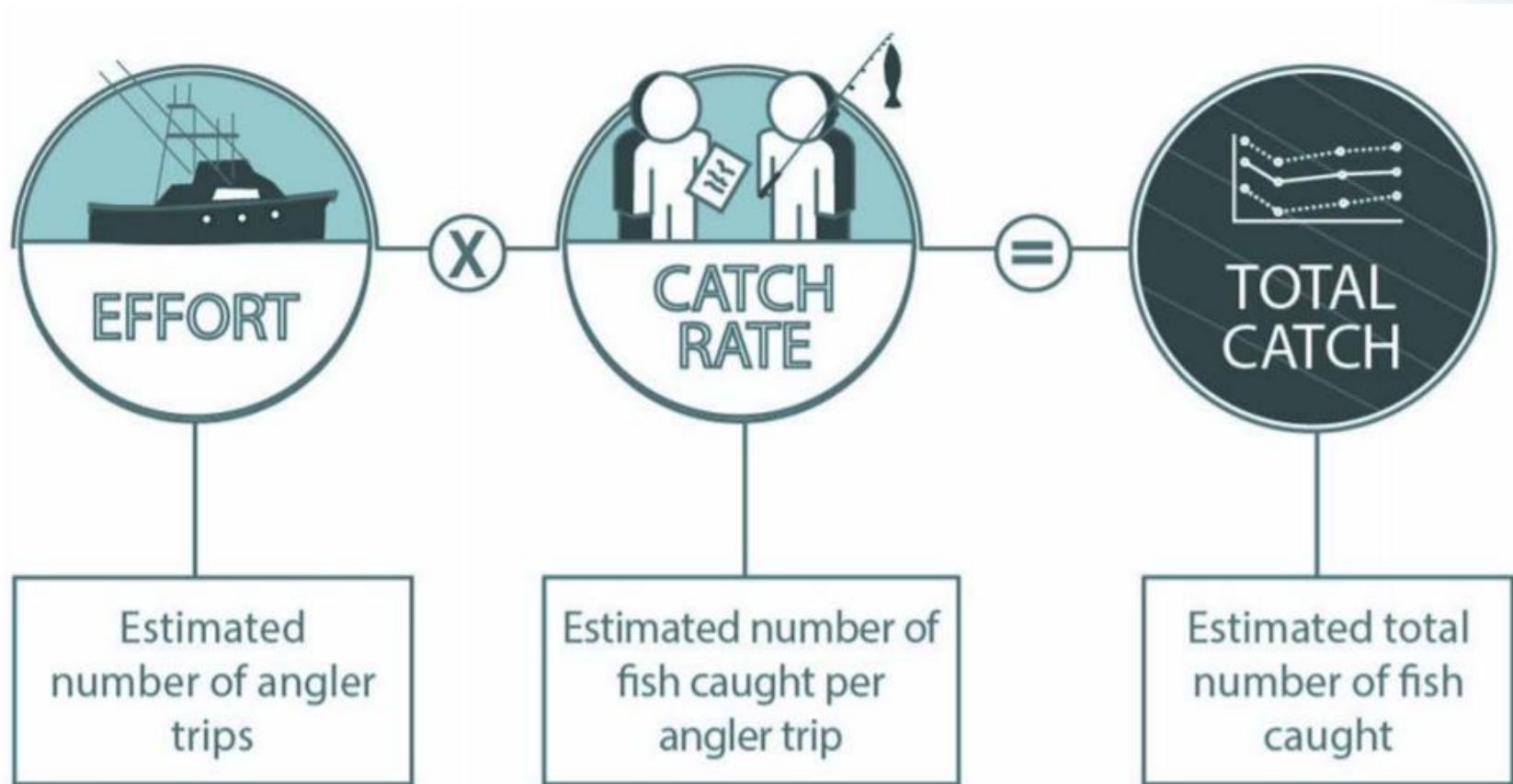
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Catch Estimation – Basic



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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Catch Estimation – Broken Down



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Weighted APAIS catch rate

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PSU - Stage I Sample Weight

Sample Duration – Stage II Sample Weight

Angler-Trip – Stage III Sample Weight

Overview of APAIS Sample Weight

Calculated as the product of the first 3 stage weights



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

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

Weight of sample duration

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

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

APAIS Sample Weight

Stage I and II Weights

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

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

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

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

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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AP AIS Catch Rate Estimates

Mean catch per angler-trip calculated as a *domain* estimate, defined by year, wave, region, state, fishing mode, area fished (inland, nearshore, offshore), 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 used in survey statistics (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



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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

Indicator variable:

$I_{hij} = 1$ if angler trip j was
completed by an in-state
resident

$I_{hij} = 0$ if angler trip j was
completed by out-of-state
resident

Adjustment for
out-of-state trips

$$\hat{p} = \frac{\sum w_{hij} I_{hij}}{\sum w_{hij}}$$

Uses standard methods for weighted proportions

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

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

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



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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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Overview of FES Sample Weights

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



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FES Sample Weights

Base weight:

based on sample inclusion probability set by survey design

$$w_i = \frac{1}{\pi_i} \longrightarrow \text{Inclusion probability of household unit } i$$

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

Adjusted weight for household unit i in cell c

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

Weighted response rate: $\hat{\phi}_c = \sum w_{ci} r_{ci} / \sum w_{ci}$



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FES Sample Weights

Post-stratification adjustment:
common technique used to conform population totals to an independent survey (e.g. Brick and Kalton 1996)

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

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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$$\text{FES Effort} = \sum w_{hi} t_{hi}$$

Final sample weight of household i in stratum h
(comprised of base weight, nonresponse weight
and post-stratification adjustment)

Trips taken by
household i in
stratum h

FES Effort Estimates

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



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



$$\text{Total Private and Shore Fishing Effort} = \frac{\text{FES Effort}}{\hat{p}} \quad \leftarrow \text{Adjustment for out-of-state trips}$$

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



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Catch Estimation – Putting all together



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

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

↓
APAIS weighted catch
rate estimate

Estimate Review: Identifying Outliers

| Example Sources of Outliers | Possible Action(s) |
|--|--|
| Extreme outlier with no error detected | Usually leave as-is, particularly if caused by a natural event or new fishing regulation. If estimate will have significant effect on fishing community, it may be reweighted if deemed appropriate by MRIP statisticians. |
| Sample weight unusually high or low | Readjust the weight and rerun estimate, or leave the weight as-is if deemed appropriate by MRIP statisticians. |

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

Questions?



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