Partial Observer Coverage Cost Efficiencies Integrated Analysis (i.e. the 2024 ADP)

May 2023 Update

Fisheries Monitoring Advisory Committee
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U.S. Department of Commerce | National Oceanic and Atmospheric Administration | National Marine Fisheries Service
Pacific States Marine Fisheries Commission

Introduction

Design Considerations

- Stratification
- Allocation

Evaluation

Non-design Elements

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Summary of Priorities

- Design a monitoring program that collects credible, statistically rigorous scientific data
- Collect the best and most data for a given budget
- Meets the data needs of a range of analytic needs (multi-objective program)

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Challenge is to …..

Meet data needs of wide range of data users with different analytic needs (MSA)

- Catch Accounting System (CAS)
  - Groundfish discards
  - Ecosystem species
  - Prohibited species catch (PSC)
- Stock assessors
- Stock of origin (genetics)
- Protected species (MMPA & ESA)
  - Marine mammals & seabirds

Collect data that reflects the full range of fishing activities

- Decrease the potential for gaps of information
  - Clustering of trips, isolated trips
  - Low sample size

Data Type by Monitoring Method

Data Collected - Catch	At-Sea Observers	Trawl EM + Shoreside	Fixed Gear EM
Trip Characteristics (E.g., Duration, Total Effort)	✓	✓	✓
Haul Characteristics (E.g., Location, Effort, Depth, Gear Performance)	✓	⊘	⊘
Haul Level Species Composition - Counts	✓	✗	✓
Haul Level Species Composition - Weights	✓	✗	✗
Trip Level Species Composition - Counts	✓	✓	✓
Trip Level Species Composition - Weights	✓	✓	✗
Speciation of Similar Species (e.g., large red rockfishes, king crabs)	✓	✓	✗
Haul Specific Salmon Enumeration	✓	✗	⊘
Trip Specific Salmon Enumeration	✓	✓	⊘
USCG Marine Casualty Information	✓	⊘	⊘

Data Type by Monitoring Method

Data Collected - Biologicals	At-Sea Observers	Trawl EM + Shoreside	Fixed Gear EM
Sexed Length Data (fish and crab)	✓	✓	✗
Pacific Halibut Size and Mortality Assessment	✓	✓	✗
Trip Specific Age Structures (e.g., otoliths, scales, fin rays)	✓	✓	✗
Trip Specific Tissues for Genetic Analyses	✓	✓	✗
Tagged Organism Information	✓	✓	✗
Stomach Samples (Trophic Interactions)	✓	⊘	✗
Maturity Information	✓	⊘	✗

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Data Type by Monitoring Method

Data Collected - Protected Species	At-Sea Observers	Trawl EM + Shoreside	Fixed Gear EM
Marine Mammal Injury and Mortality	✓	⊘	⊘
Marine Mammal Tissue (genetics, trophic Information, contaminants)	✓	✗	✗
Marine Mammal Interaction (non-lethal; non-injury)	✓	✗	⊘
Marine Mammal Sighting	✓	✗	✗
Verify Seabird Avoidance	✓	N.A.	✓
Seabird Mortality (catch by gear)	✓	✓	✓
Seabird Mortality (vessel interaction)	✓	⊘	⊘
ESA-Listed Seabird Carcass	✓	⊘	✗

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Current Monitoring Methods

Each monitoring method has advantages

Method	Benefit
Observers at-sea	Full suite of data (counts, lengths, weights, otoliths, other specimen data, marine mammals and seabird interactions)
EM at-sea	Counts of species from video review
EM compliance at sea w/ shore based observers	Ensure compliance of maximized retention with biological and specimen data collected at landing (lose haul specificity, decreased protected species, ecosystem species)

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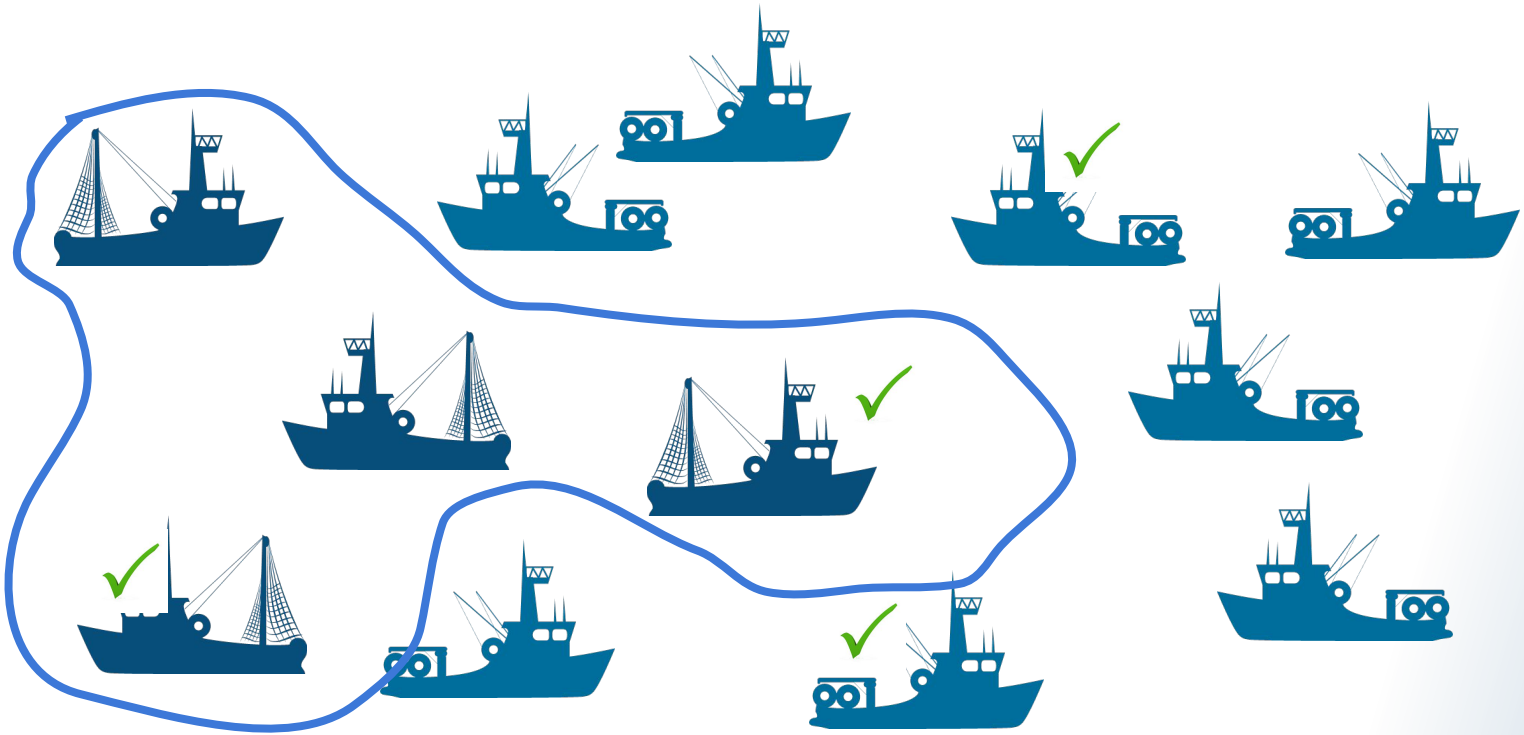
Stratification: How to divide population

Allocation: How much to sample in each stratum



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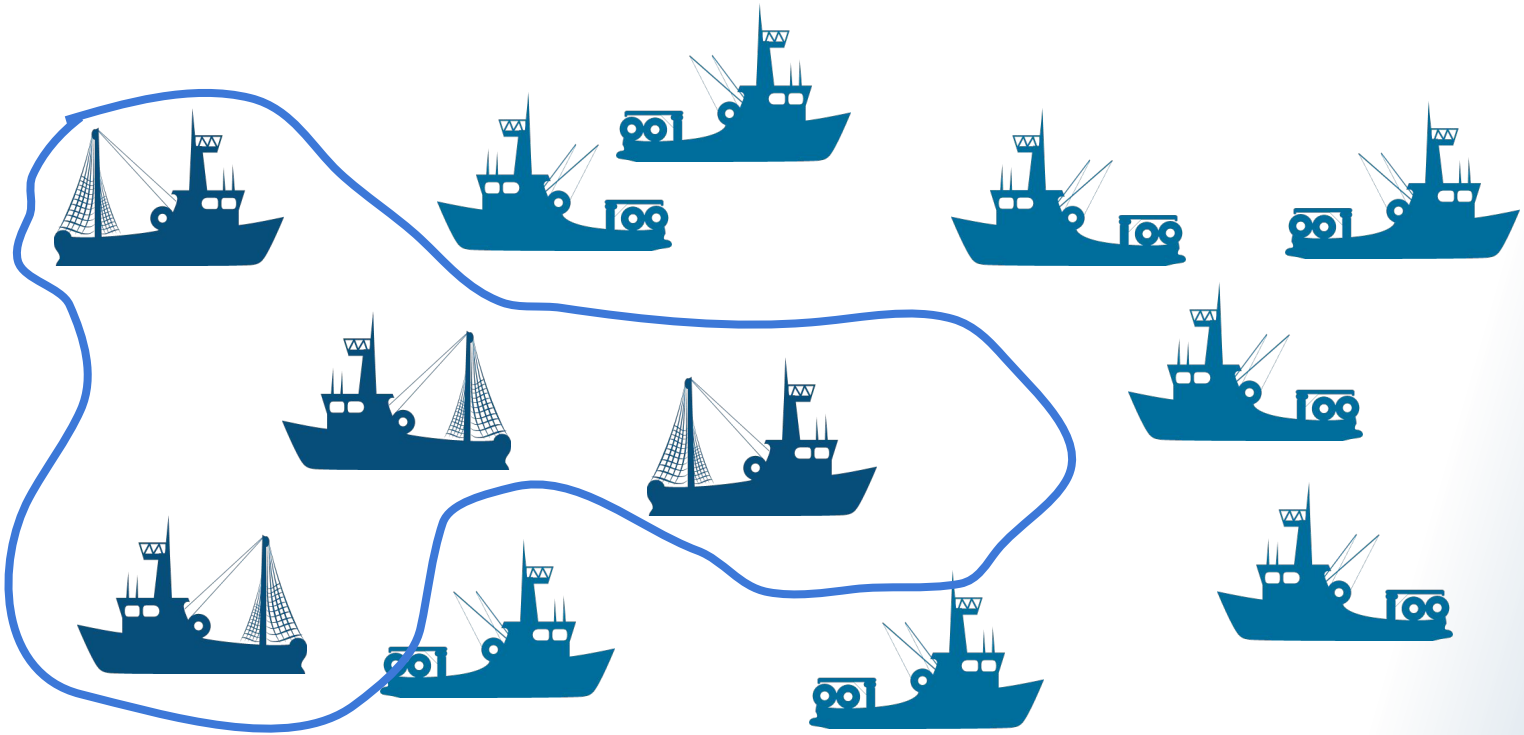
Stratification: How to divide population



Stratification

Defined by monitoring method and fishing trip characteristics known *before* random selection

Can be used to

- Set different sampling rates
  - Focus sampling on a portion of the population
- Use different sampling methods
  - Control costs

Can be defined by

- Monitoring method
- Gear
- FMP
  - Bering Sea / Aleutian Islands / Gulf of Alaska

Current Stratification

7 strata defined by monitoring method and gear type

		Monitoring Method			
		At-sea Observer	At-sea EM	EM Compliance + Shoreside OB	None (Zero)
Gear Type	HAL	1,352	722		1,601
	POT	1,086	353		
	TRW	631		620	

Under Consideration:

Split Strata by FMP

- BSAI/GOA
- BS/AI/GOA

Pool Fixed Gear Strata

- Mixed-gear Trips

Stratification - Monitoring Method

Low-discard EM POT w/ shorebased observers

- Not feasible for HAL gear
- All or a subset of trips
- Requires regulatory change
- Requires more self-reporting (i.e., logbooks)

Neither under consideration for 2024!

EM paired with at-sea observers

- EM coverage rate determined through allocation process with other strata
- Observer rate set to increase likelihood of observed trips neighboring EM trips
  - Ensure full suite of data within a neighborhood
- Initial analyses indicate minimal gain under *current fishing and size of EM pool*
  - Low sampling rates could increase observer effects
  - Under future increases in EM pool size or changes to fishing patterns, may reconsider

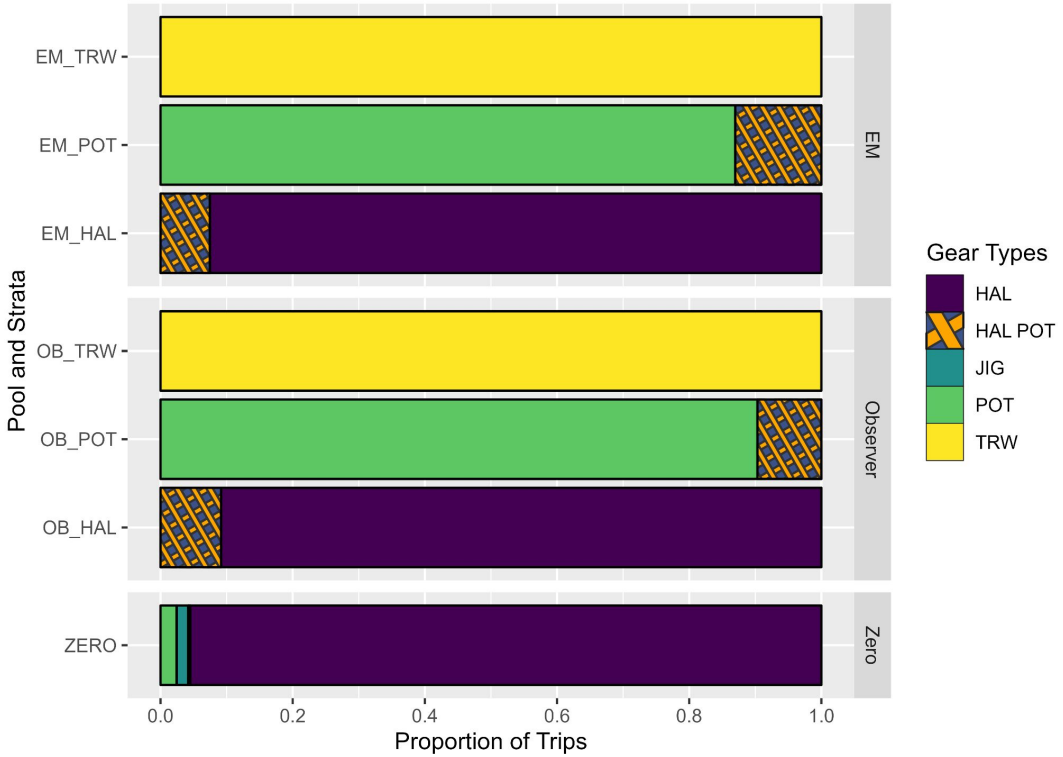
Stratify by Gear

In 2022, increased number of trips fished multiple gears

Pros: Gear type is known in advance

Separates different fishing activities

Cons: Mixed-gear trips and mis-declared trips can create biases in estimates

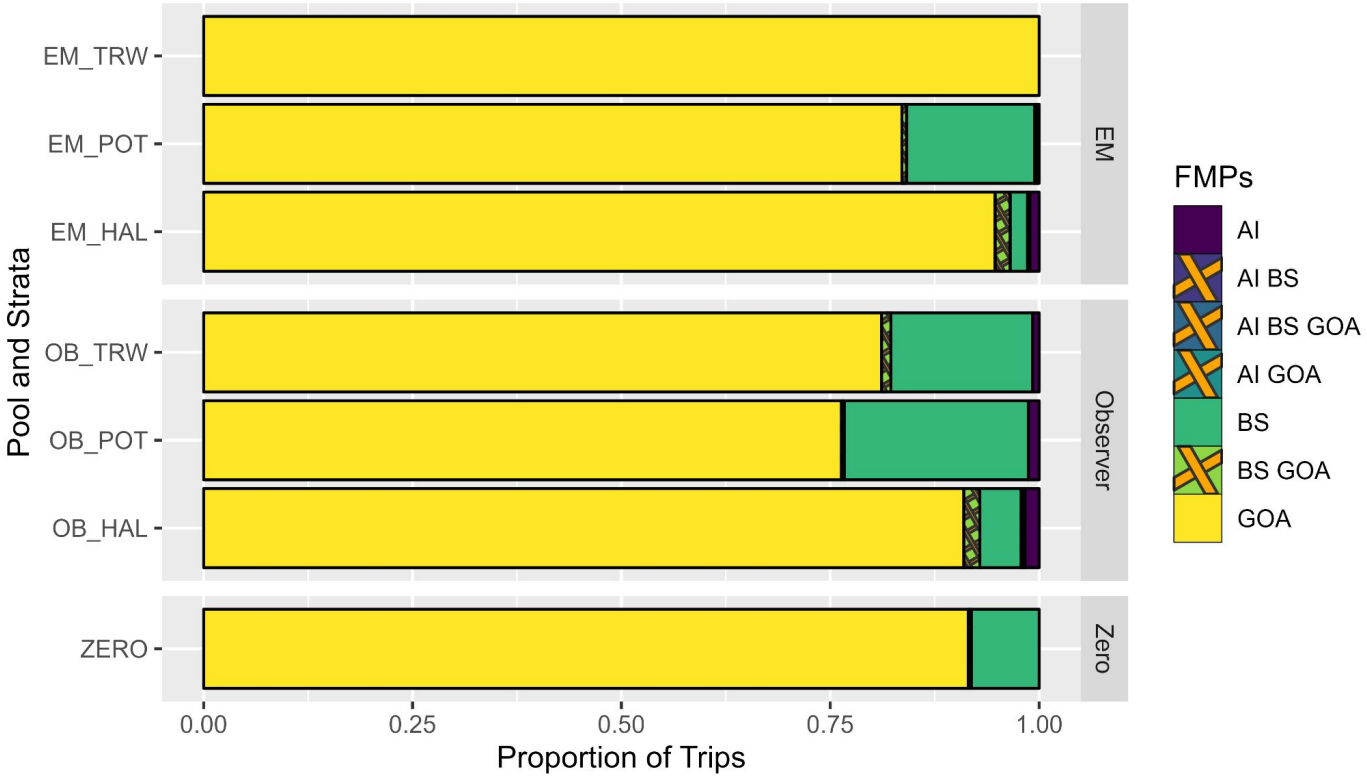


Stratify by FMP?

In 2022, most trips fished in only one FMP

Pros: Can differentially assign trip selection rates

Cons: In ODDS, trips need to declare which FMP they plan to fish



		Monitoring Method			
		At-sea Observer	At-sea EM	EM Compliance + Shoreside OB	None (Zero)
Gear Type	HAL	1,352	722		1,601
	POT	1,086	353		
	TRW	631		620	

Current stratification: Monitoring method and gear type

Example alternative stratification: EM Pot with shoreside observers and HAL gear trips split separated by BSAI and GOA

		Monitoring Method					
		At-sea Observer	At-sea EM	EM Compliance + Shoreside OB	None (Zero)		
Gear Type	HAL	106	32	722	1,601	BSAI	FMP
		1,246	690			GOA	
	POT	1,086		353		BSAI + GOA	
	TRW	631		620		BSAI + GOA	

Stratification to Be Evaluated

Three options:

- Current: 7 strata
  - Defined by monitoring method and gear type
- Current + FMP
  - Split strata by FMP: **BS** & **AI** & **GOA** (where appropriate)
- Current + 2FMP
  - Split strata by FMP: **BSAI** & **GOA** (where appropriate)

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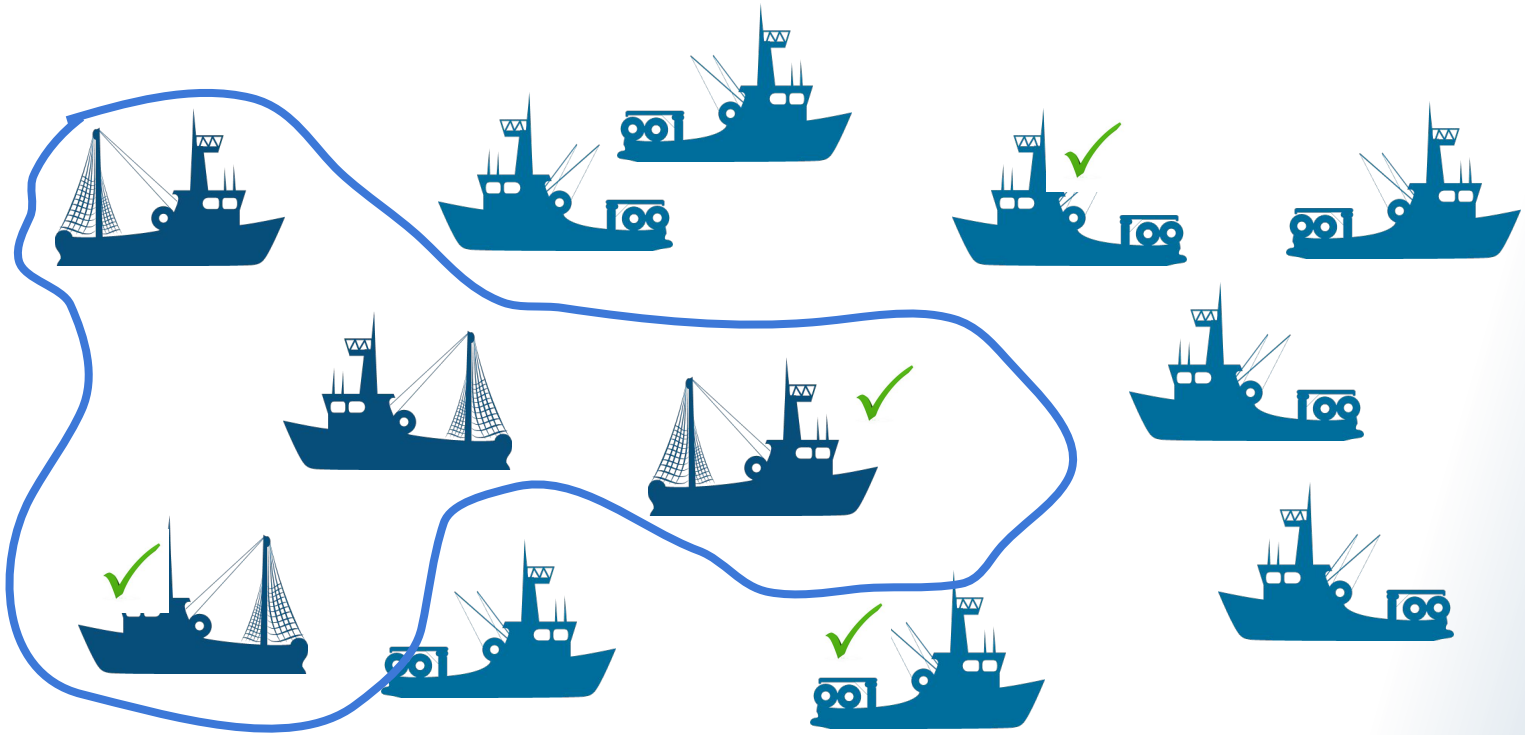
Allocation: How much to sample in each stratum



Allocation

Distributing samples to different strata

Equal Rates

Goal: Representative sample with equal burden of monitoring

- commonly used when don't know about population

Status Quo - current standard

Goal: *Equal Rates* to 15% plus variance minimization

- Add sample to decrease between-trip variance of discards
  - salmon, halibut, & total groundfish
- Observed strata only
- EM fixed gear strata 30% sample rate

Allocation

Distributing samples to different strata

Novel approaches

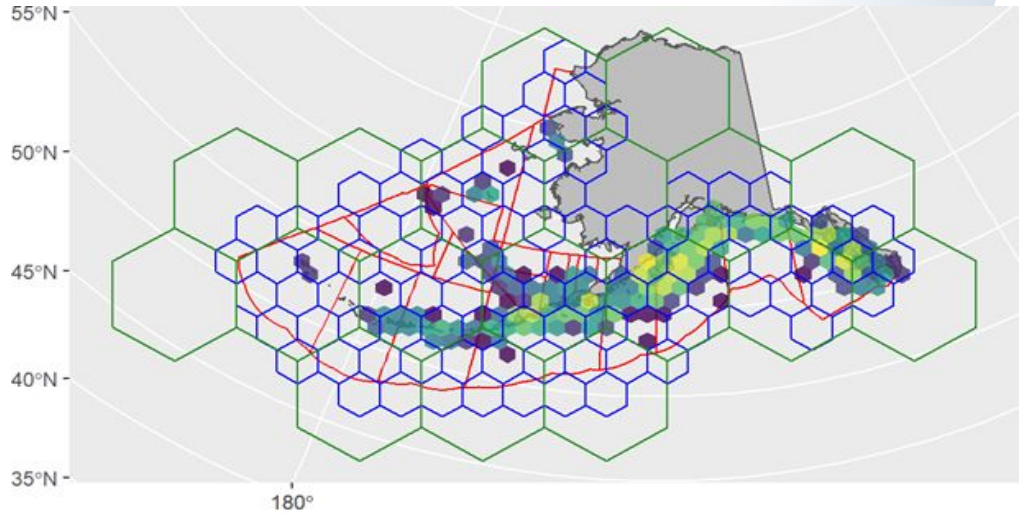
Goal: Representative sample without data gaps

- In past, evaluated extent of gaps in fishery data
  - Probability of having data
    - Gear, NMFS Areas, trip target
    - Gap index, SEA
- Avoid data gaps
  - Intermingle monitored and unmonitored trips
    - Proportion of pre-defined boxes near a monitored box
    - Proportion of trips near a monitored trip
- Relies on a reasonable box definition

Defining appropriate “box’

Boxes defined by a unit of **space** and a unit of **time**

- Pick of scale of time and space that is useful
  - Spatial cells are all equal in size (vs. NMFS areas)
- Allow boxes to rely on **neighboring** boxes
  - Provides stability
  - Reduces importance of where boxes start and end

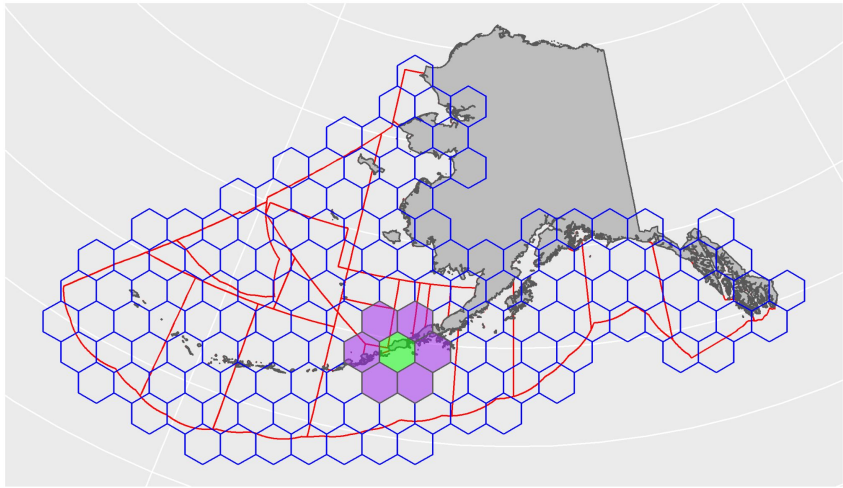


Red: NMFS Reporting Area Boundaries
Filled hexagons: 125 km across; Blue hexagons: 200 km across; Green hexagons: 750 km across

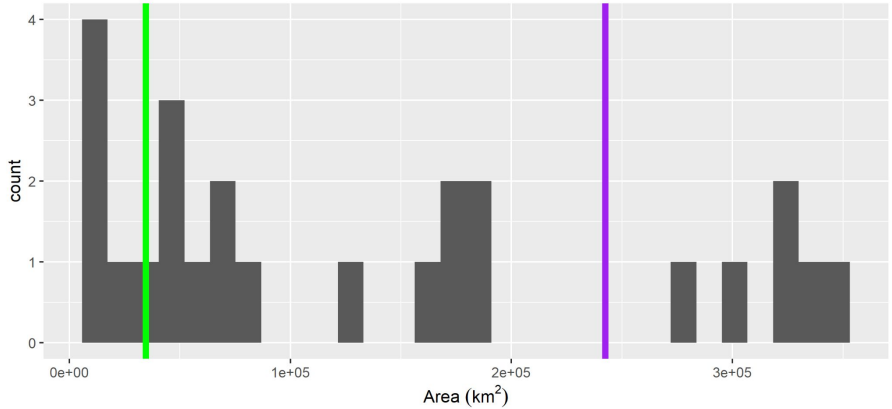
Final Definition

- Each box : **200km-wide** hexagon cell and **1-week**
- Neighboring trips : Include **adjacent cells** and **+/- 1 week**

Grid of 200km-wide hexagon cells.

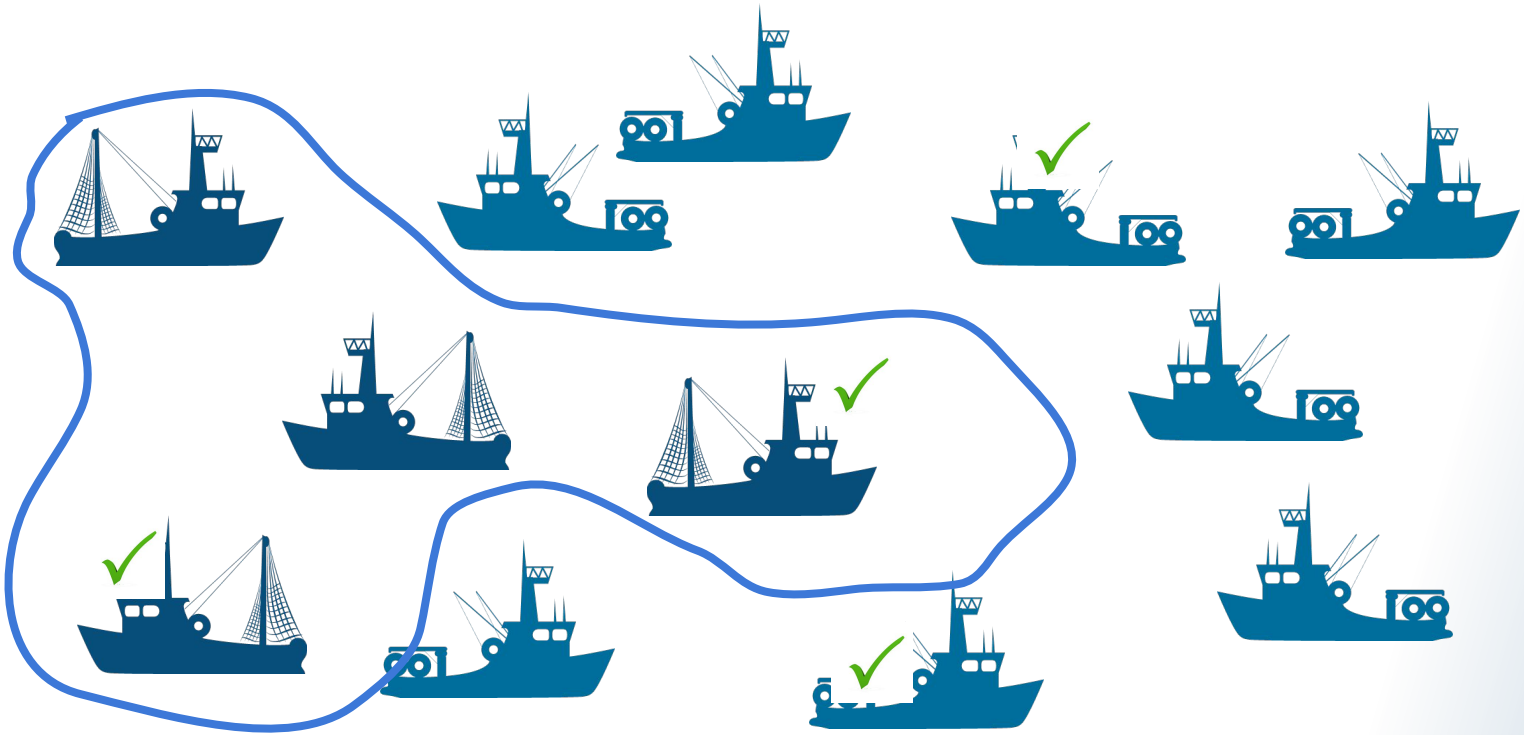


Histogram of extent of NMFS Areas. Green = box, Purple = box with 6 neighbors.



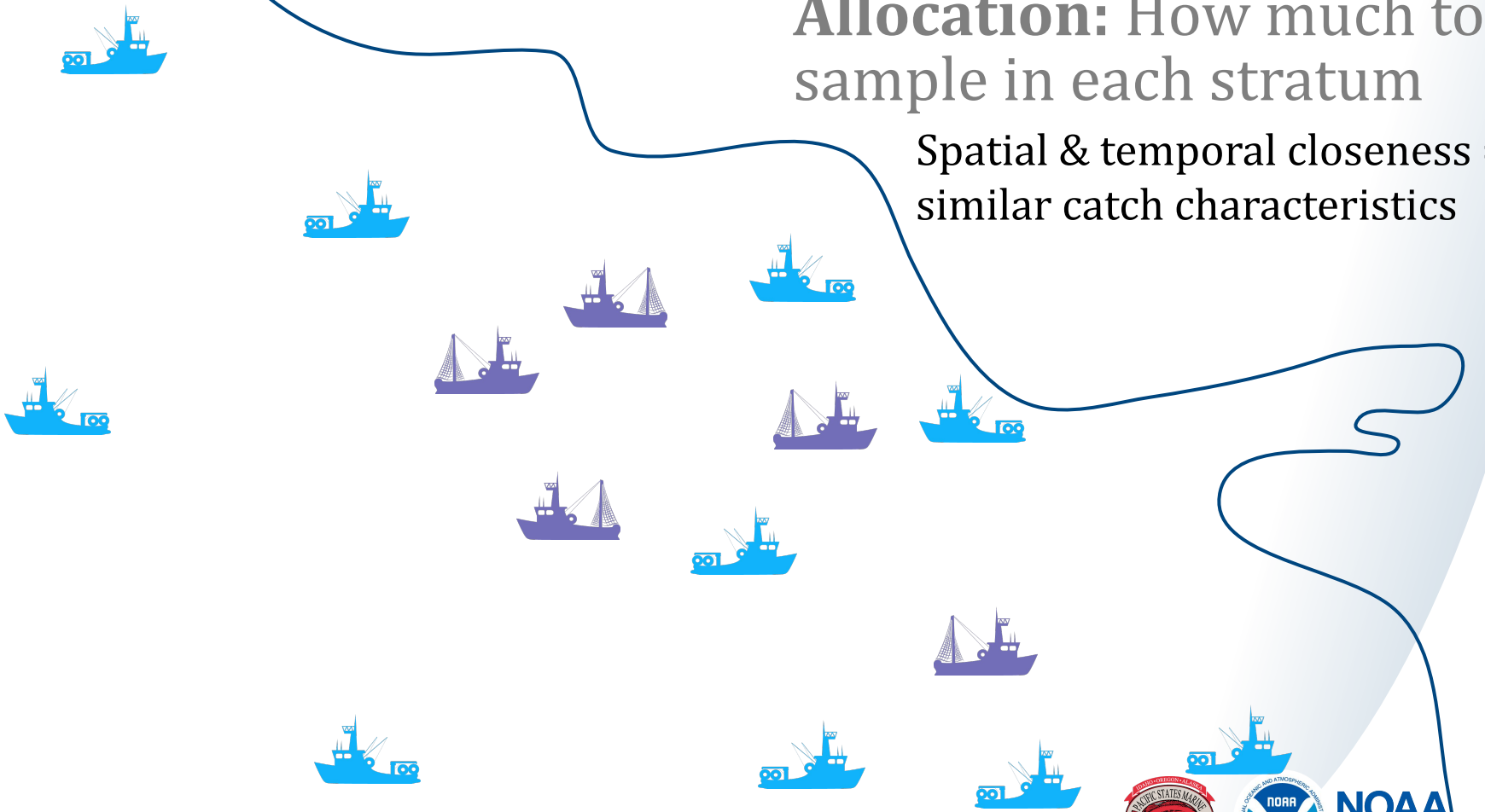
- Spatial extent of a box and its neighbors is ~ NMFS area.

Allocation: How much to sample in each stratum



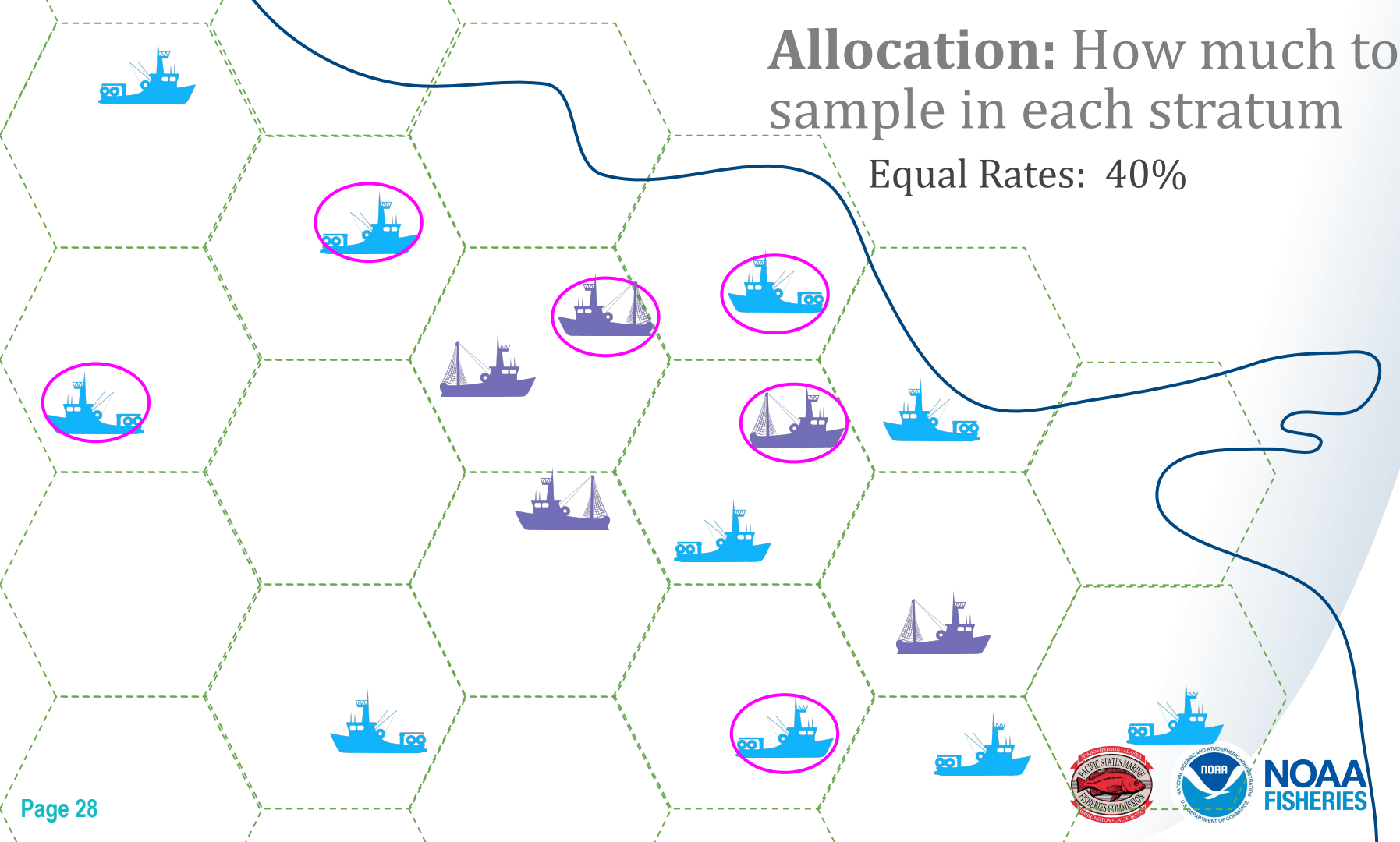
Allocation: How much to sample in each stratum

Spatial & temporal closeness = similar catch characteristics



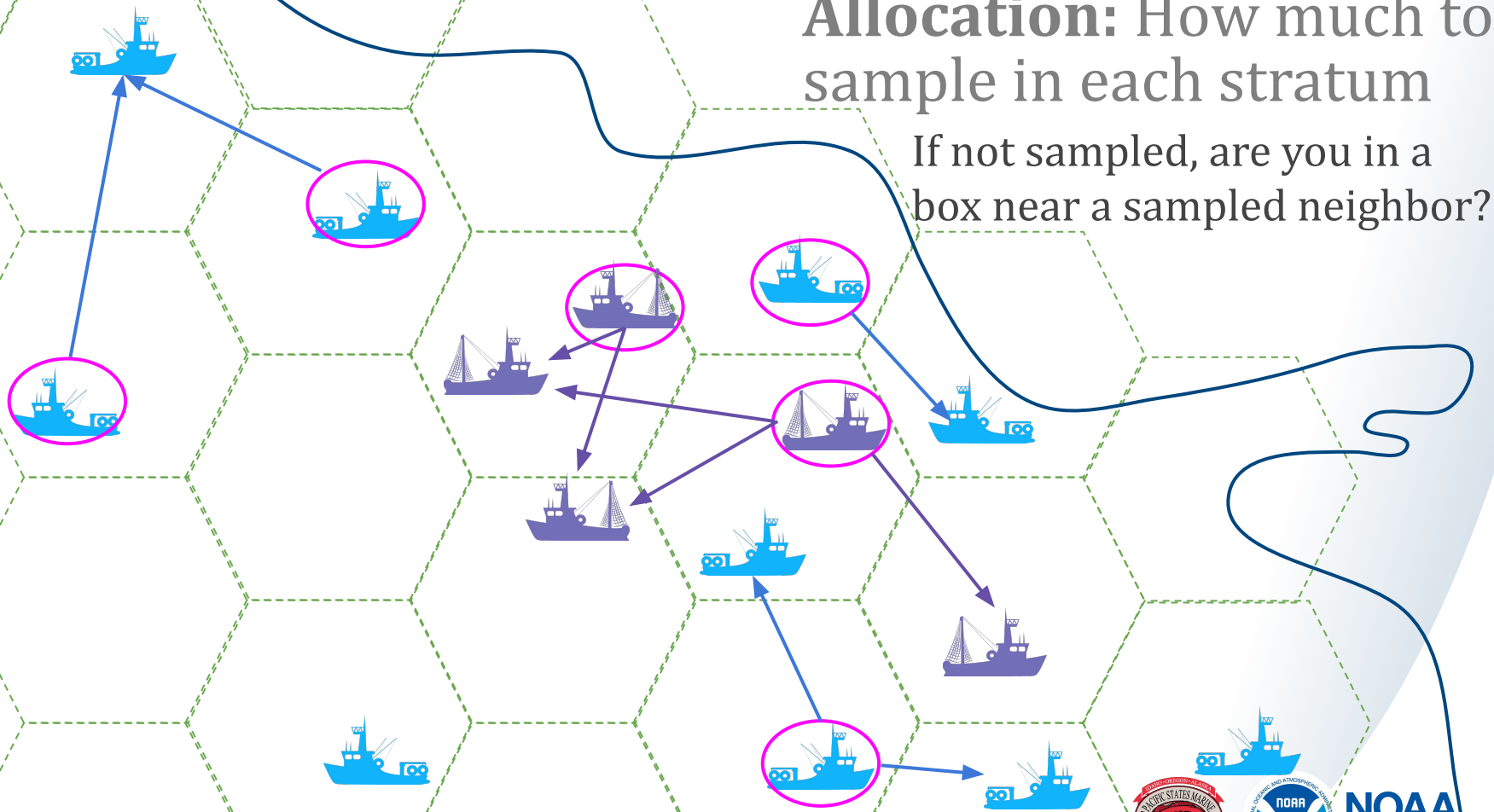
Allocation: How much to sample in each stratum

Equal Rates: 40%



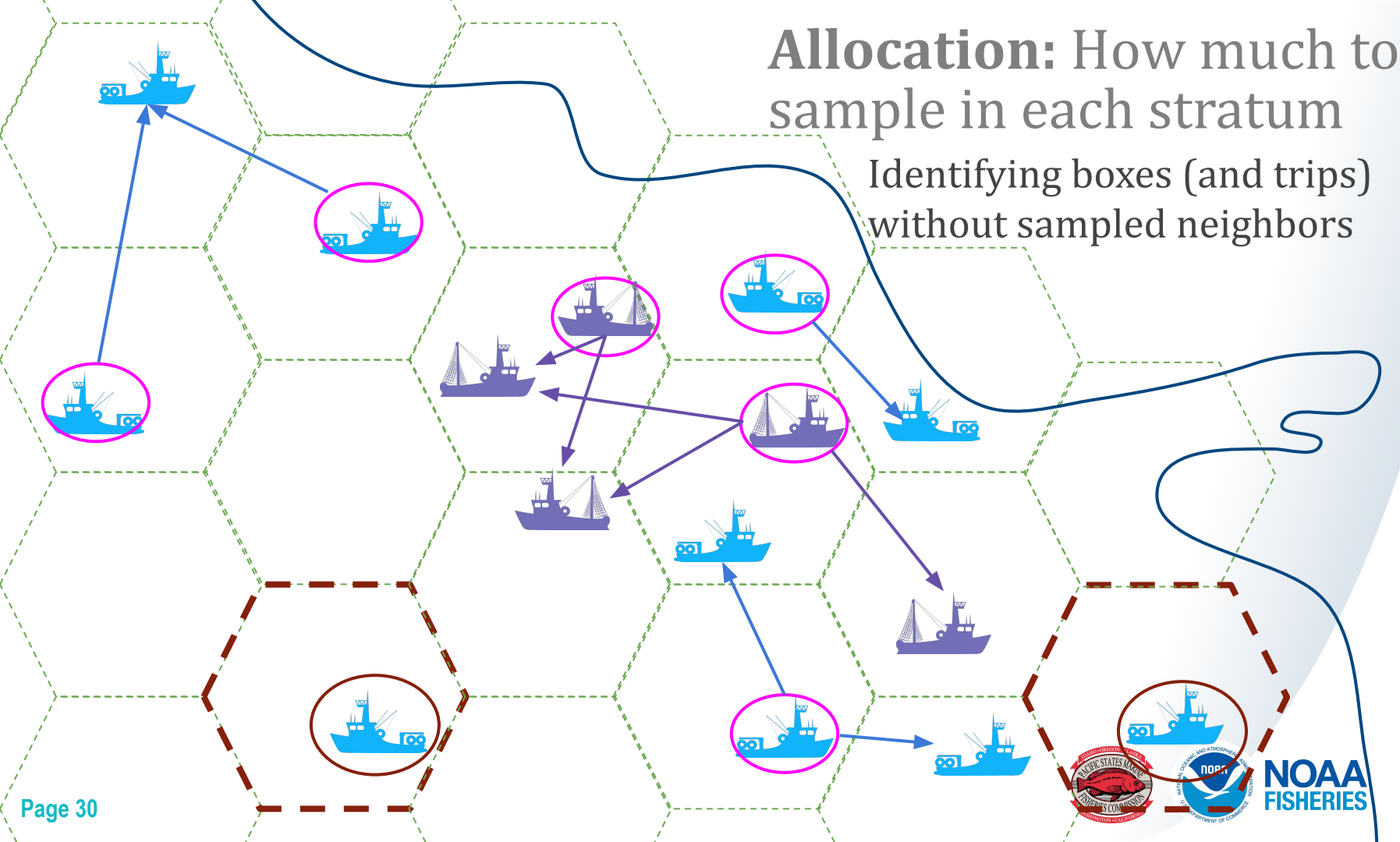
Allocation: How much to sample in each stratum

If not sampled, are you in a box near a sampled neighbor?



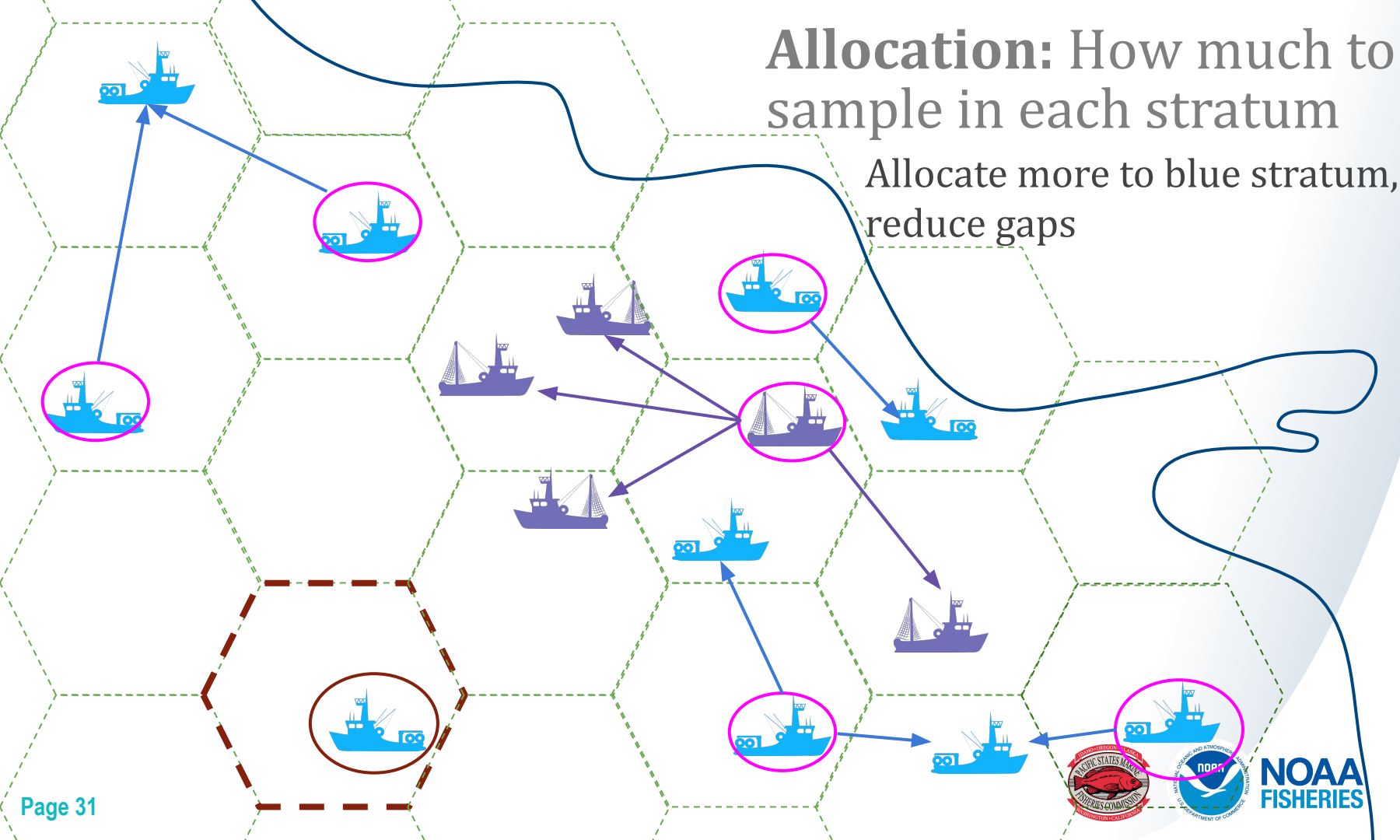
Allocation: How much to sample in each stratum

Identifying boxes (and trips) without sampled neighbors



Allocation: How much to sample in each stratum

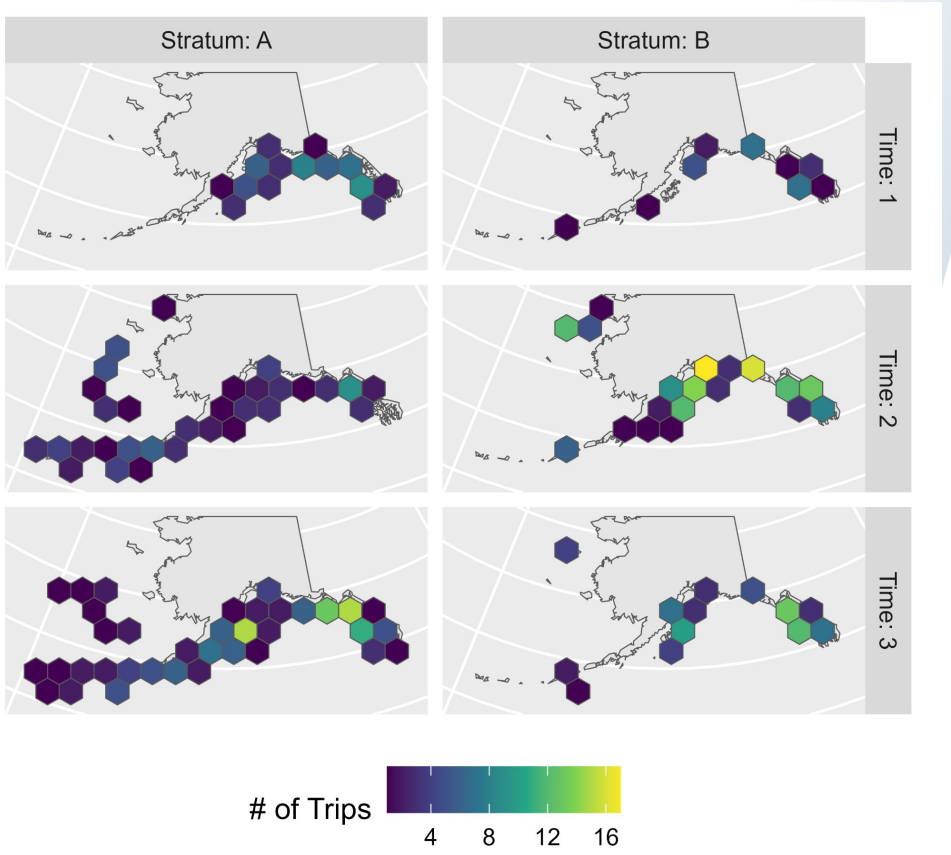
Allocate more to blue stratum, reduce gaps



How to apply towards allocation

Either:

- Allocate such that we sample more **boxes**
- Allocate such that we get more **trips** in sampled boxes



Allocation

Cost-weighted boxes

Goal: maximize the proportion of boxes monitored (or near), penalizing strata with high monitoring costs

$$\text{stratum weight} = \frac{[\#\ trips\ in\ stratum] \times \begin{pmatrix} proportion\ of\ boxes \\ near\ sampled\ trip \end{pmatrix}}{[monitoring\ cost]}$$

Allocate:

- Apply weighting factor for each strata to total sample size
- Remain within funding cap

Allocation

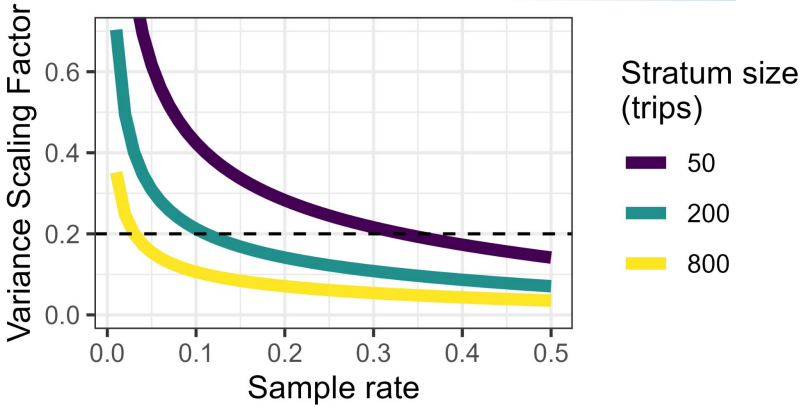
Proximity

Goals: maximize proportion of trips near monitored trips while guarding against low sample sizes

$$\text{Index} = \frac{[\textit{proportion of trips near sampled neighbor}]}{[\textit{variance scaling factor}]}$$

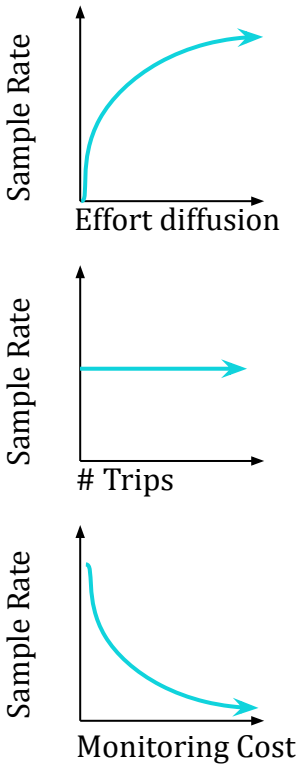
Allocate:

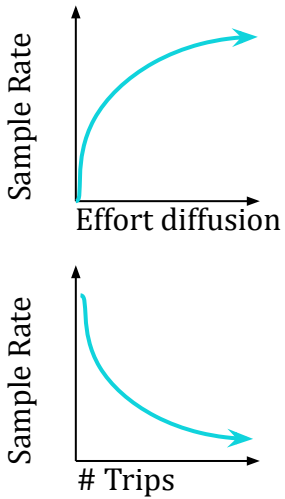
- Index constant index for all strata
- distribute sample to strata until funding cap



Allocation

Cost-Weighted Boxes





Proximity

Allocation Schemes to be Evaluated

Status Quo - current standard

Equal Rates - equally distributed monitoring burden

Cost-weighted boxes - control both the probability of monitoring in a pre-specified 'box' and costs

Proximity - intersperse monitored and unmonitored trips, guard against low sample sizes

Summary of Designs

Considering 12 designs

3 stratification schemes X **4** allocation methods

Gear & monitoring method

Status Quo, Equal Rates, Cost-weighted boxes, Proximity

*Gear & monitoring method by FMP (**BS**, **AI**, & **GOA**)*

Status Quo, Equal Rates, Cost-weighted boxes, Proximity

*Gear, monitoring method by FMP (**BSAI** & **GOA**)*

Status Quo, Equal Rates, Cost-weighted boxes, Proximity

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Which is “best”?

Not one value, but suite of values

Balance between over-summarizing and too much information

People will differ in how much they value each metric

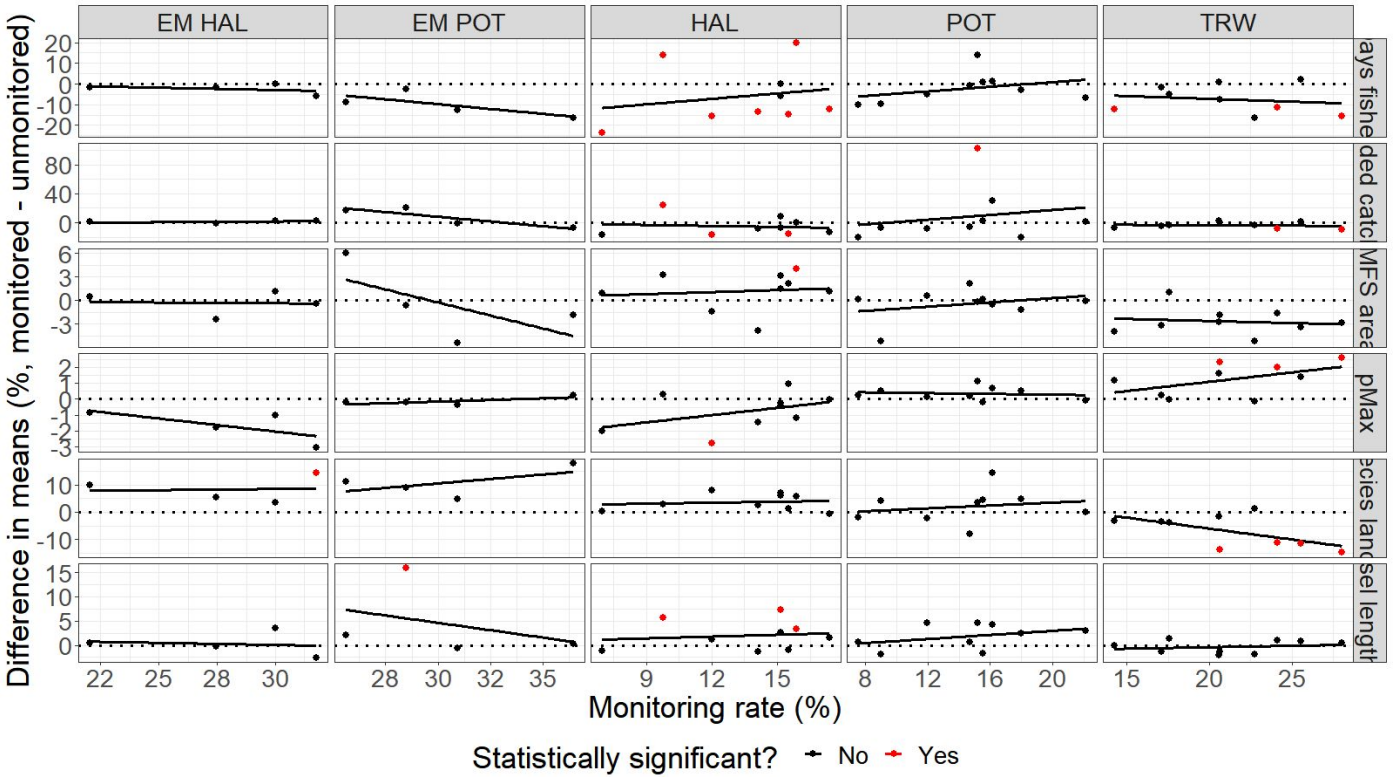
Evaluation Metrics

- Data collection opportunities
  - Trips sampled (observers)
  - Trips monitored (observers or EM)
- Variance in *expenses*
- Burden share
- Power to detect
  - Rare events (Short-tailed albatross, Steller sea lion)
  - Observer effects
- Data timeliness
- Variance between trips
  - Salmon PSC
  - Halibut PSC
  - Groundfish discards
  - Crab PSC
- Interspersion

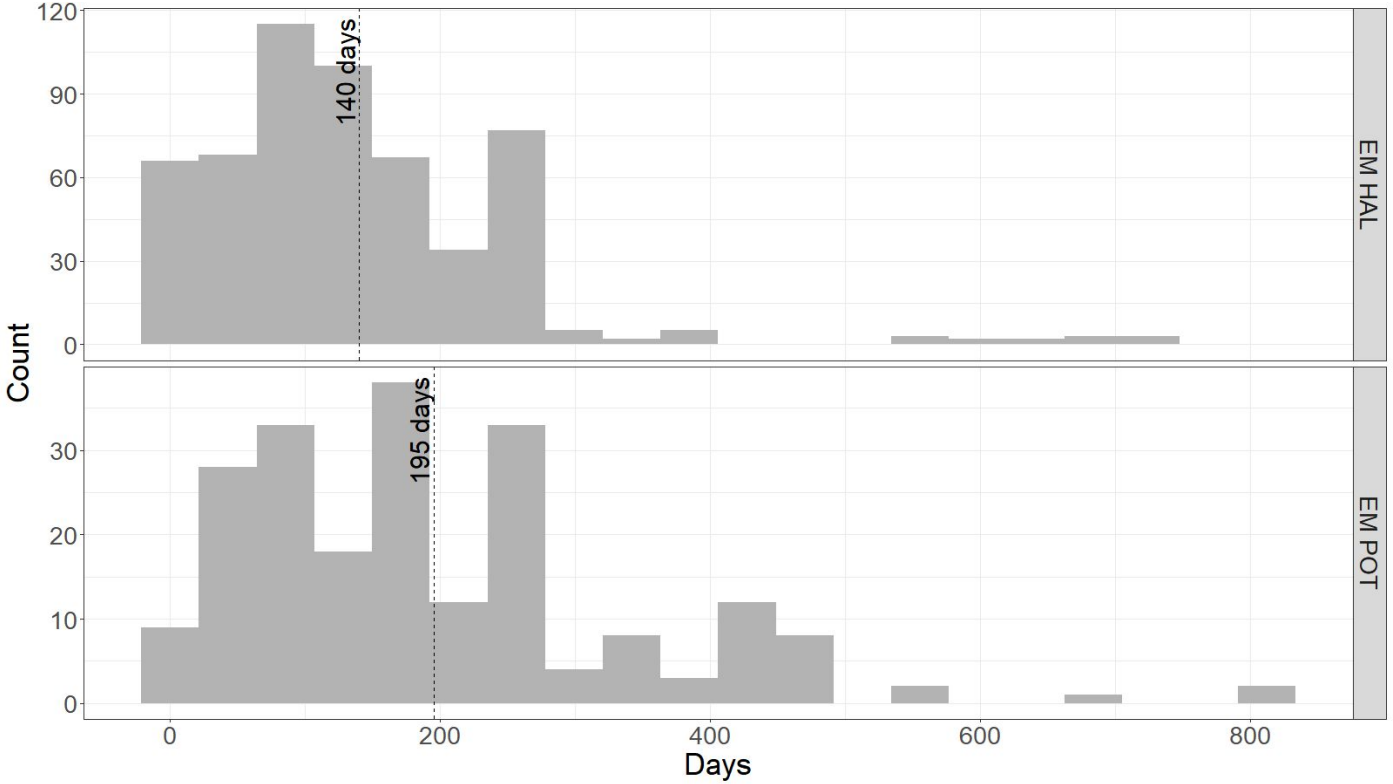
Evaluation Metrics

- Data collection opportunities
  - Trips sampled (observers, all data)
  - Trips monitored (observers or EM)
- Variance in *expenses*
- Burden share
- Power to detect
  - Rare events (Short-tailed albatross, Steller sea lion)
  - **Observer effects**
- **Data timeliness**
- **Variance**
  - **Salmon PSC**
  - **Halibut PSC**
  - **Groundfish discards**
  - Crab PSC
- **Interspersion**

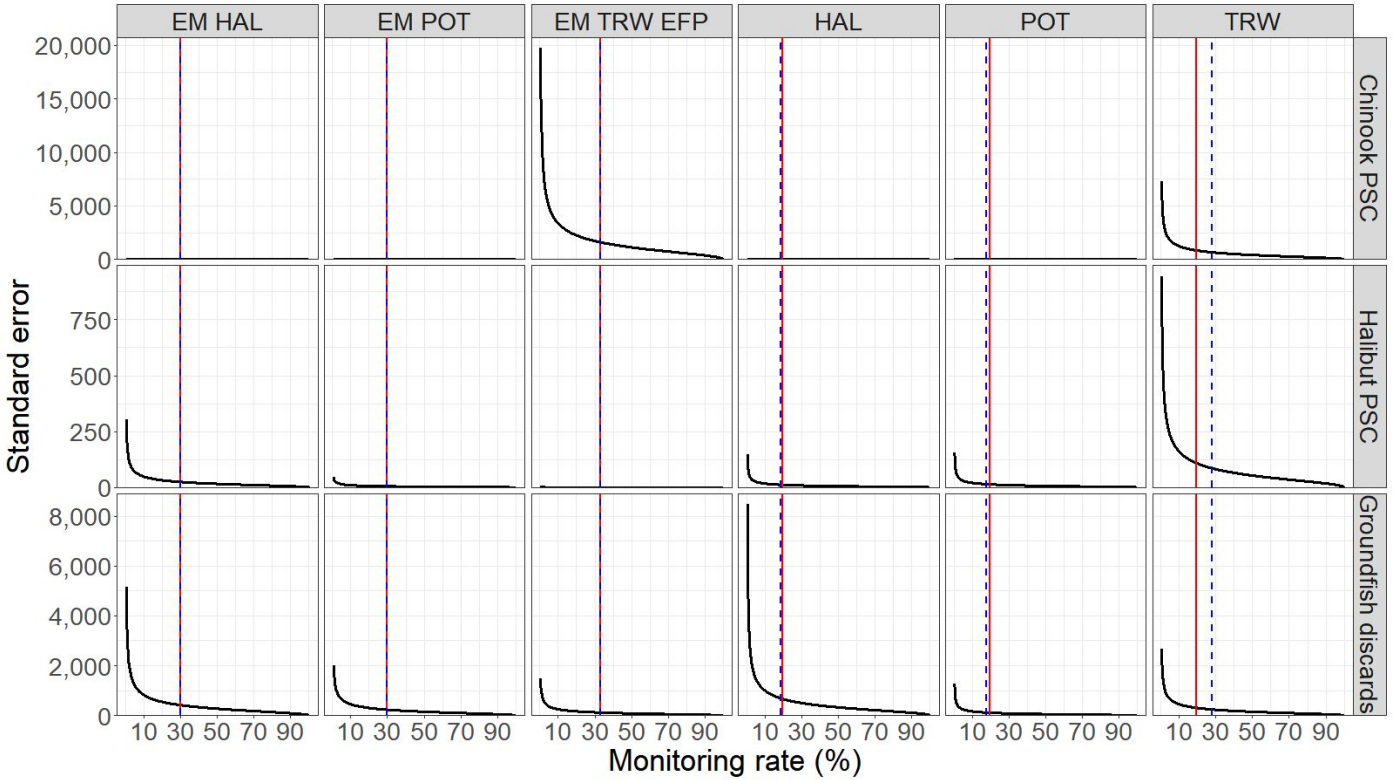
Evaluation - Observer Effects



Evaluation - Data timeliness



Evaluation - Variance



Evaluation - Interspersion by gear type and FMP

How well are trips with biological samples interspersed among trips fishing with similar gear types?

Remember the full suite of data!

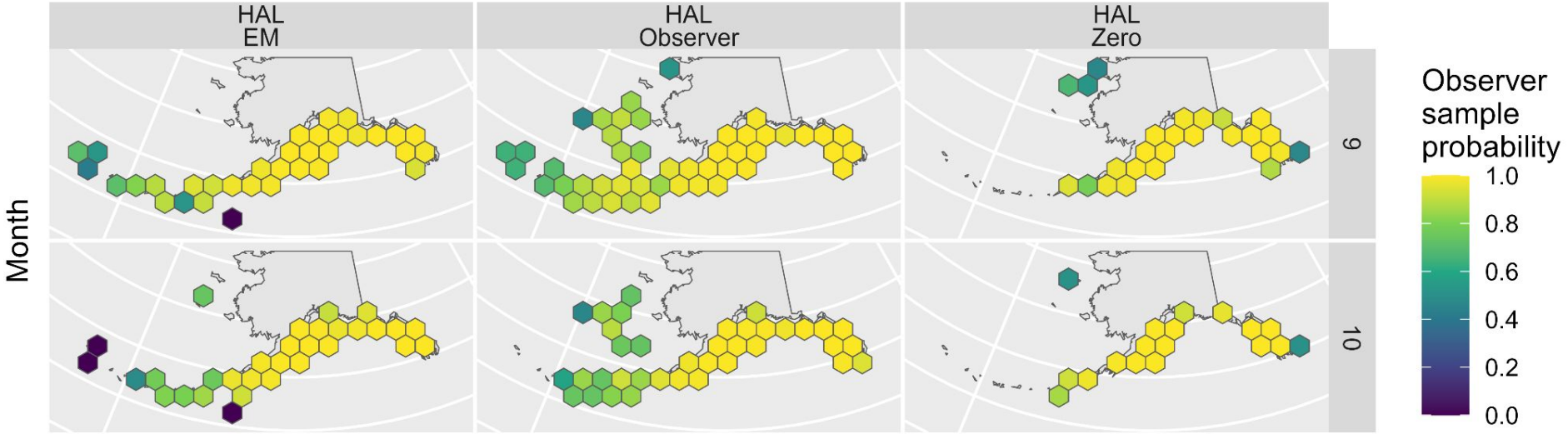
Evaluation - Interspersion

How well observed trips are distributed in space and time relative to similar trips without an observer

Evaluated for EM, Observer, and Zero pools by gear type

The expected proportion of trips neighboring an observed trip

EM at-sea and zero coverage rely on data from observers



Evaluations of Designs

Super fake data!

Metric	Design			
	A	B	C	D
Trips sampled (observers, all data)	**291**	126	221	237
Trips monitored (observers or EM)	**20**	37	60	43
Variance in expenses	**3115**	3028	3017	2979
Short-tailed albatross	**0.03**	0.07	0.25	0.15
Steller sea lion	**0.01**	0.04	0.04	0.01
Observer effects …	**0.45**	0.47	0.39	0.56
Burden share	**0.42**	0.85	1	0.49
Data timeliness	**164**	164	200	159
Salmon PSC (#)	**3940**	4444	3892	4602
Halibut PSC (t)	**60**	180	98	181
Crab PSC	**51**	111	70	38
Groundfish discards (t)	**651**	735	1198	338
Interspersion …	**0.16**	0.11	0.54	0.5

Evaluations of Designs

It is unlikely that one design will be the best across all metrics

Scores and rankings will change with different budgets

We want the best design that will work on small and large budgets.

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Other Cost Efficiency Ideas - outside deployment design

- Program elements that provide flexibility to fishery participants but increase cost
- EM Improvements - might also bring some cost efficiency
- Modify biological data collection
- Observer procurement & duties
- Change definition of zero coverage

Flexibility for fishery participants

No further evaluation planned

Description	Potential cost efficiency	Requires regulations change?	Status
Require vessels to pick up observers in particular ports	Potential cost savings by reducing the number of ports from which observers can deploy.	Yes - would need to be a regulation requiring vessels to pick up observers in, and return them to, one of the ports listed in the ADP.	In March 2022 -- PCFMAC did not support continued evaluation. NMFS not planning to evaluate further.
Instead of selecting one trip at a time for coverage, select multiple trips.	Potentially reduce travel costs for partial coverage observers.	No changes to regulations needed.	In March 2022 -- PCFMAC raised concerns about negative impacts for industry and the potential to introduce bias. NMFS not planning to evaluate further.
Extending the length of the notice for deploying at-sea observers	Potential cost savings by requiring vessels to log fishing trips in ODDS further in advance from their departure date. The 72 hour window is expensive, as it gives both the agency and the observer provider a relatively short advance warning.	Yes - regulations specify the requirement for vessels to register an anticipated trip in ODDS a minimum of 72 hours prior to embarking on each fishing trip.	In Sept 2021, PCMFAC noted the logistical challenges of this idea and did not support it. NMFS not planning to evaluate further.

EM Improvement Projects

Ongoing work

Description	Potential cost efficiency	Requires regulations change?	Status
EM monitoring in plants	Evaluate the potential cost savings of monitoring fisheries offloads using machine vision and artificial intelligence	Maybe. Might be able to include this as part of CMCPs	Several projects in progress.
Utilize trawl EM equipment on vessels that also fish fixed gear	Vessels in the trawl EM program that already have EM equipment could also use that EM equipment to collect data in fixed-gear fisheries.	No changes to regulations needed. This could be implemented through changes to VMPs and definitions of EM selection pools in the ADP.	Ongoing project: Aleutians East Borough funded through NFWF. Will test EM configurations on vessels that fish using multiple gear types and evaluate catch handling and EM data review protocols for pot vessels
Change catch handling on pot boats to focus data collection on discards only	Reduce video review time and reduce catch handling burden for boats	No changes to regulations needed. This could be implemented through changes to VMP	
Evaluating more cost-effective and mobile EM systems	Development and testing of lower cost EM hardware that could be moved between vessels, which could increase the cost effectiveness of the fixed-gear EM program	No changes to regulations needed.	Project conducted by NPFA and ALFA. Funded through NFWF

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EM Improvement Projects

Ongoing work or no further evaluation planned

Description	Potential cost efficiency	Requires regulations change?	Status
Reduce time delay for EM data	Evaluate cost to get fixed-gear EM data in a timely fashion that is useful for inseason management. Could better leverage EM & reduce data gaps	No changes to regulations needed.	**Information available for FMAC**
Eligibility to be in the EM pool	Evaluate ways to optimize the fixed gear EM program for cost efficiencies by modifying ongoing eligibility for the fixed-gear EM program to ensure EM equipment is used cost effectively (for example, not installed on vessels not fishing or taking very few trips). Currently once NMFS approves vessel in the EM pool there isn't a mechanism to remove them.	Yes - would require change in regulations. While vessels can be removed for not following their VMP, they can't be removed for being cost inefficient	NMFS could consider as a longer term improvement which is more consistent with Trawl EM.
Require fixed gear EM vessels to run EM system on all trips & post-select trips to be submitted to NMFS	Could better enable space-based strata by determining which strata the boat was in based on what they did on the trip, rather than what they think they are going to do. This approach would eliminate any monitoring effect.	No changes to regulations needed. Vessels could be told in ODDS in advance to run their cameras on all trips, and then be told to mail hard drives only for trips that were selected.	Proposed by NMFS but not supported by PCFMAC nor Council. NMFS would consider if annual report analysis shows evidence of monitoring effect and after evaluating catch handling protocols on pot vessels.

EM Review Timeliness

- Pacific States Currently has 4 video reviewers working on fixed-gear data from Alaska
- Pacific States estimates that 3 additional reviewers would be needed in order to review hard drives within 1 week of receiving them.
- The estimated cost of 3 additional reviewers annually is 3 x $95,000 = $285,000, a 28.5% increase in the current EM budget of ~$1,000,000.

Modify biological data collection

Some further evaluation

Description	Potential cost efficiency	Requires regulations change?	Status
Using survey data for average weights and biological data	Potential method to reduce impact from loss of biological data from EM.	No	**Information available for FMAC**
Opportunistically deploy idle observers for focused collection of biological data	No cost efficiencies, but may provide more data for stock assessments.	No	NMFS not planning to evaluate. Opportunistic deployments do not result in the best data. Predicting where and when observers will be 'idle' is challenging and cost of at-sea observer data are more expensive than “idle” days.
Specify differing observer sampling protocols regionally or temporally based on data needs	No cost efficiencies, but may provide more data for stock assessments.	No	NMFS not planning to evaluate. We achieve the highest quality data from standardized sampling protocols and it is most efficient to have observers that with skills that interchangeable. It is inefficient to have specialized observers and this could result in extra costs to get the “right” type of observer to a port.

Replace with Fishery-Independent Data?

Use fishery-independent longline survey data for weights to inform EM?

- Problematic for the growing EM sablefish pot fishery because of gear selectivity differences
- Current commercial pots are not standardized (e.g., escape rings will further change selectivity)
- Average weights in fishery may be higher than survey because the fishery is targeting larger fish at ideal depths, rather than mirroring the survey

Weight data is only one component of observer data used in assessments

- Loss of catch-at-age data will add more uncertainty to the assessment, especially for fisheries which are rapidly changing (e.g., sablefish)
- Observer data is highly influential data source in the assessment to inform age class strength
- Assessment is attempting to estimate contemporary selectivity differently from the historic, single gear (H&L) fishery

If full retention requirements were to be removed, the assessment would have no data to understand discard information

NOAA FISHERIES

Observer procurement & duties

Some further evaluation planned

Description	Potential cost efficiency	Requires regulations change?	Status
Voucher Program to procure observers	Allow vessels in partial coverage, once selected in ODDS, to procure observer through current observer companies and then to be reimbursed by NMFS at the end of the season from the observer fees collected.	Yes	In 2017, the OAC reviewed a discussion paper (see section 3.5). No further work planned at this time.
Hire observers (as federal employees and/or contractors) that would live in Alaska ports	Could reduce travel expenses if observers live in communities where fishing occurs	Maybe - needs to be evaluated.	**Information available for FMAC**
Have observers review EM video	Partial coverage observers could potentially review EM video during "down time" when they are in port.	No	NMFS not planning to evaluate due to the logistical complexity of having observers in the field review video and the associated low potential of substantial cost savings.

Federally hire observers

At-Sea

- Assumptions
  - 2 supervisors for up to 30 at-sea observers
- Cost estimates compared to current PC contract
  - Federal observers (estimate): ~$1,130 per day for 3,000 days
  - Current contract: ~$1,492 per day for 2,938 days

Shoreside

- Assumptions
  - 6 observers + 1 supervisor
  - Kodiak only
- Costs estimates compared to future PC contract
  - Federal observers (estimate): ~$700 per day for 1,306 days
  - Future contract (estimate): $500-$1,600 per day

Zero Coverage

- Current definition based on vessel length (<40ft LOA) and gear (jig)
- Continue evaluation using criteria that are predictable from year to year
  - Look at fixed-gear EM vessels that have not fished for groundfish in multiple years

Discussion