Blending Administrative Data with a Probability Sample of Nonparticipants to Produce National Estimates: The NCS-X NIBRS Estimation Project

# 2020 Federal Committee on Statistical Methodology

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INTERNATIONAL

Background

- The Uniform Crime Reporting (UCR) Program – aggregated by the FBI – has been the repository of crimes reported to the police for the last 100 years

- Traditionally, police agencies have reported crime in "summary" form – aggregate monthly counts

- The FBI is sunsetting "summary reporting system" (SRS) UCR transitioning agencies to the National Incident Based Reporting System (NIBRS)

- NIBRS provides incident-level level information for each reported crime

- But, law enforcement agencies need to upgrade their record management systems in order to submit NIBRS compliant data to the FBI

Understanding the Problem: Transitioning to NIBRS
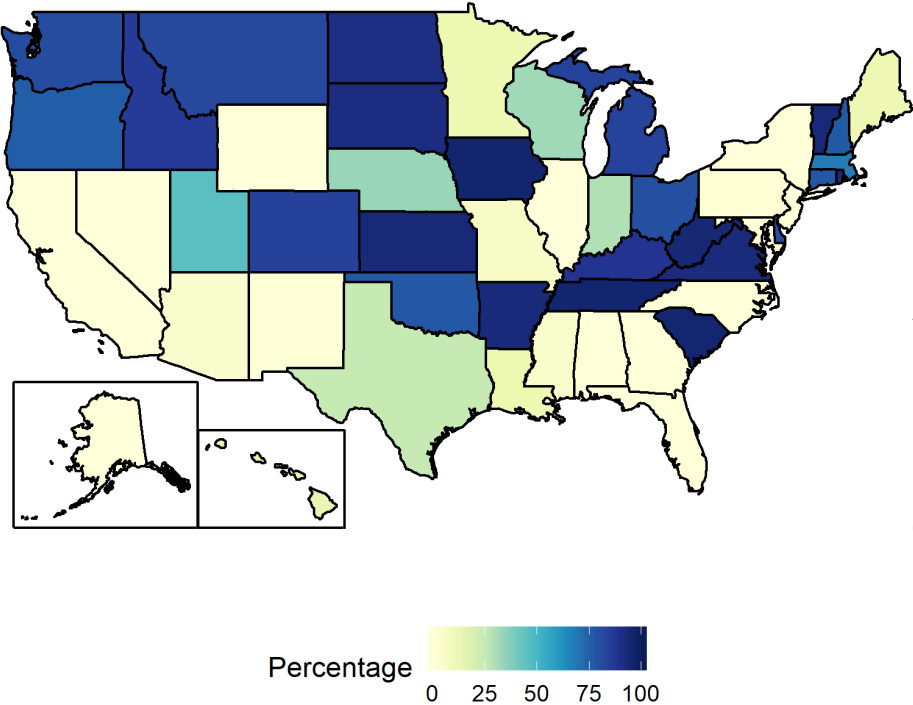
By 2018, **approximately 8,000 out of 18,000** Law Enforcement Agencies (LEAs) have transitioned to NIBRS.
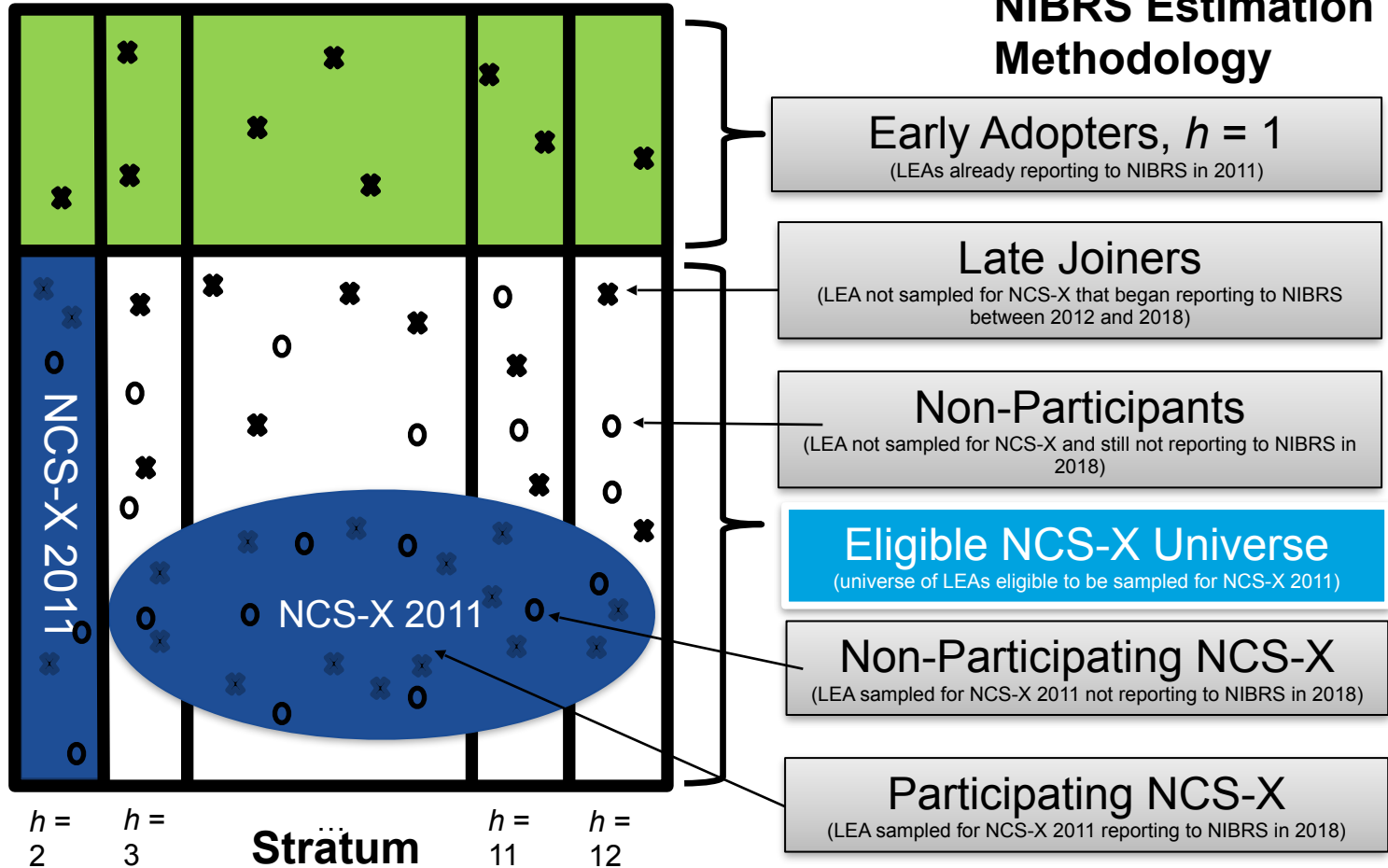
Reporting agencies are **not randomly distributed** and **skewed towards less populated states**

Percentage

0   25   50   75   100
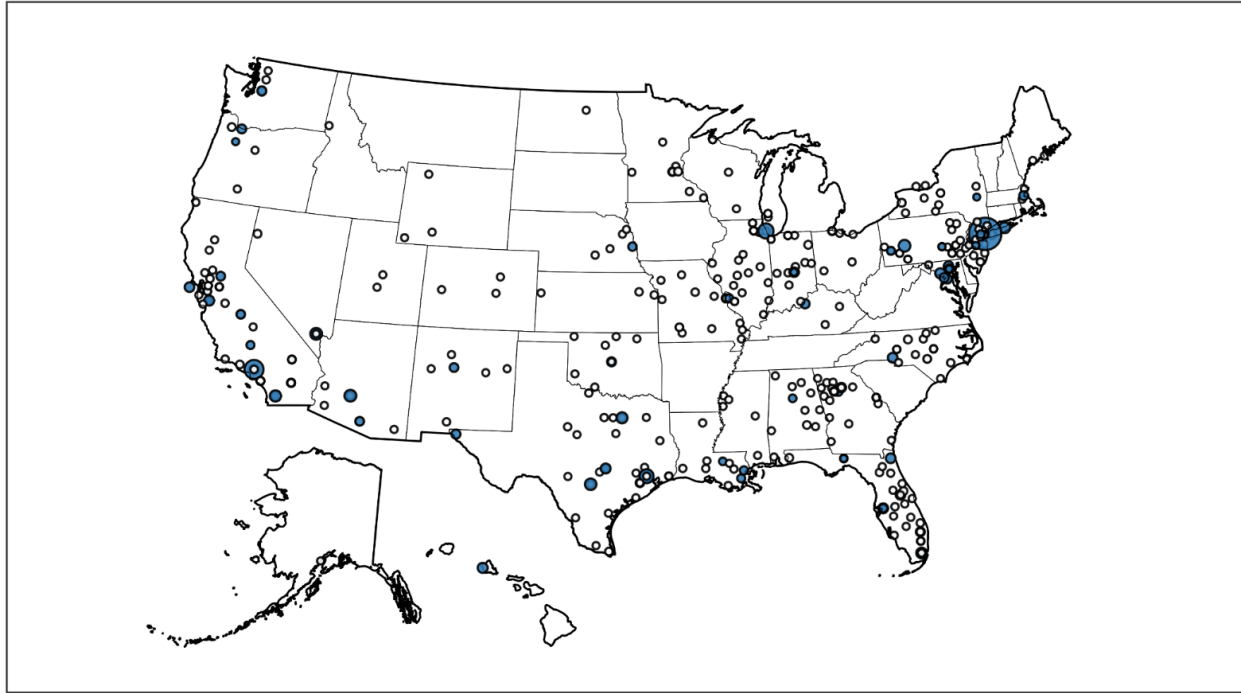
NCS X

NATIONAL CRIME STATISTICS EXCHANGE

Powering the Transition to NIBRS

○Recruiting a probability sample of 400 law enforcement agencies (LEAs) who were nonreporting agencies in 2011 to supplement the existing NIBRS data

○All nonreporting agencies with 750+ police officers were included in these 400 LEAs

○Combine data from these 400 agencies with data from the 8,000+ existing reporting agencies to produce national estimates

NIBRS Estimation Methodology

Early Adopters, $h = 1$
(LEAs already reporting to NIBRS in 2011)

Late Joiners
(LEA not sampled for NCS-X that began reporting to NIBRS between 2012 and 2018)

Non-Participants
(LEA not sampled for NCS-X and still not reporting to NIBRS in 2018)

Eligible NCS-X Universe
(universe of LEAs eligible to be sampled for NCS-X 2011)

Non-Participating NCS-X
(LEA sampled for NCS-X 2011 not reporting to NIBRS in 2018)

Participating NCS-X
(LEA sampled for NCS-X 2011 reporting to NIBRS in 2018)

NCS-X 2011

$h = 2$ $h = 3$ ... $h = 11$ $h = 12$

Stratum

5

NCS-X Sample Agencies (n=400)

Population Served: ∘ 0 ○ 2,000,000 ◯ 4,000,000 ◯ 6,000,000 ◯ 8,000,000

Agency Type: ● 750+ Officer LEAs ∘ Other LEAs

NIBRS Estimation Project: Objectives

○ Determine the optimal method to weight and blend the NCS-X sample with "early adopters" and "late joiners" to produce representative national and state-level estimates

○ Validate the estimation methodology
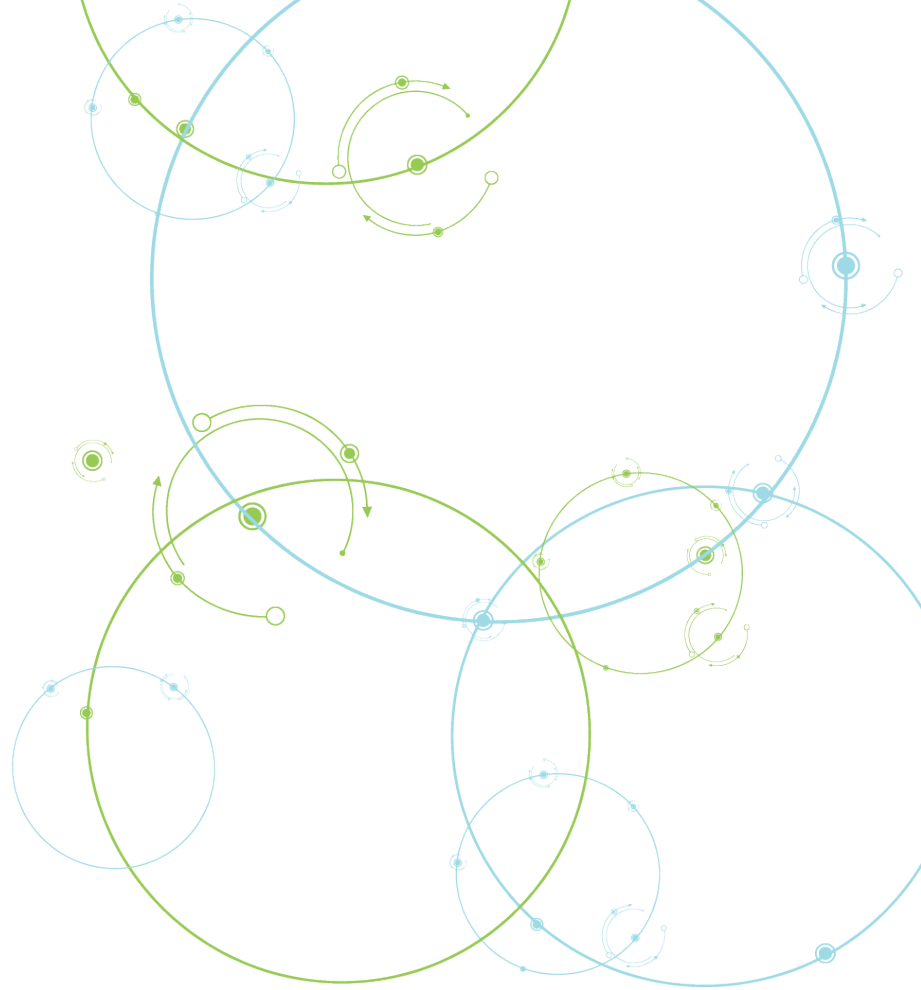
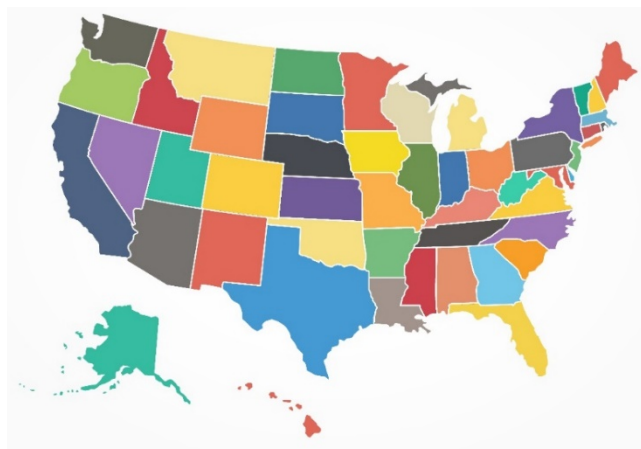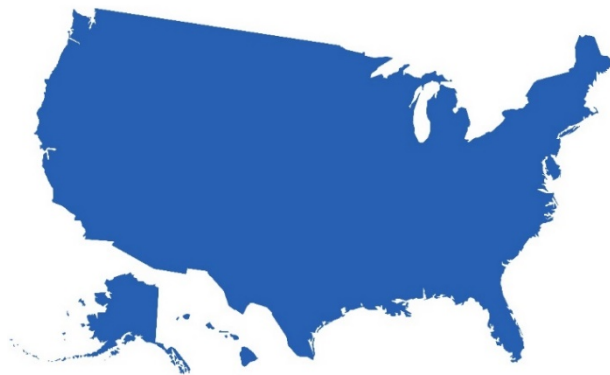# Estimation Approach #1: Top-Down Approach

TOP-DOWN APPROACH

- Develops national weights first

- Uses national weights to develop subnational estimates
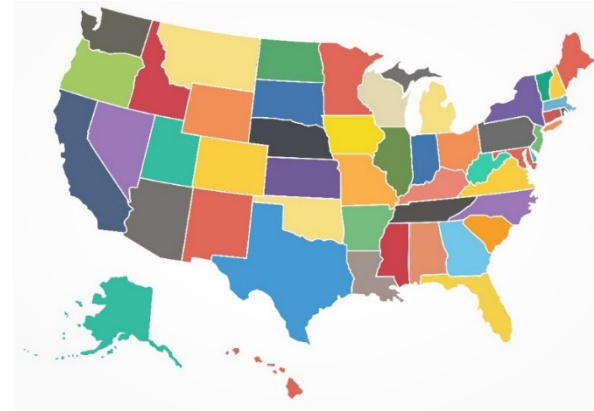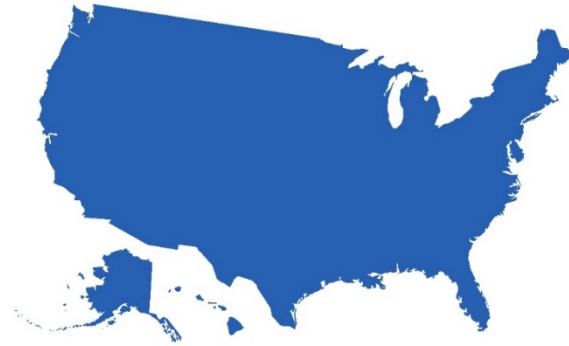
Estimation Approach #1: Top-Down Approach (cont.)

- Advantages
  - The intended approach for the NCS-X sample
  - Most efficient (in terms of precision) approach for national estimates
- Disadvantages
  - Agency weights may represent agencies in different states making state estimates difficult to produce
  - Long term, does not lend itself to subnational estimation

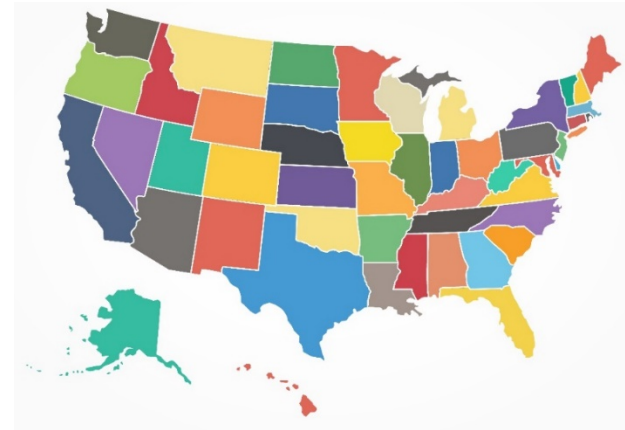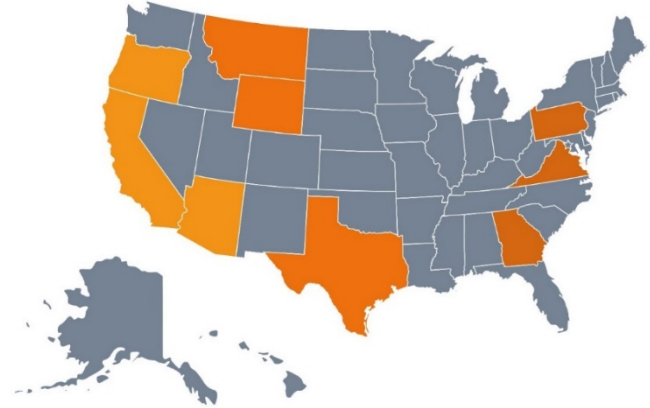# Top-Down Approach Weighting/Estimation Strategy
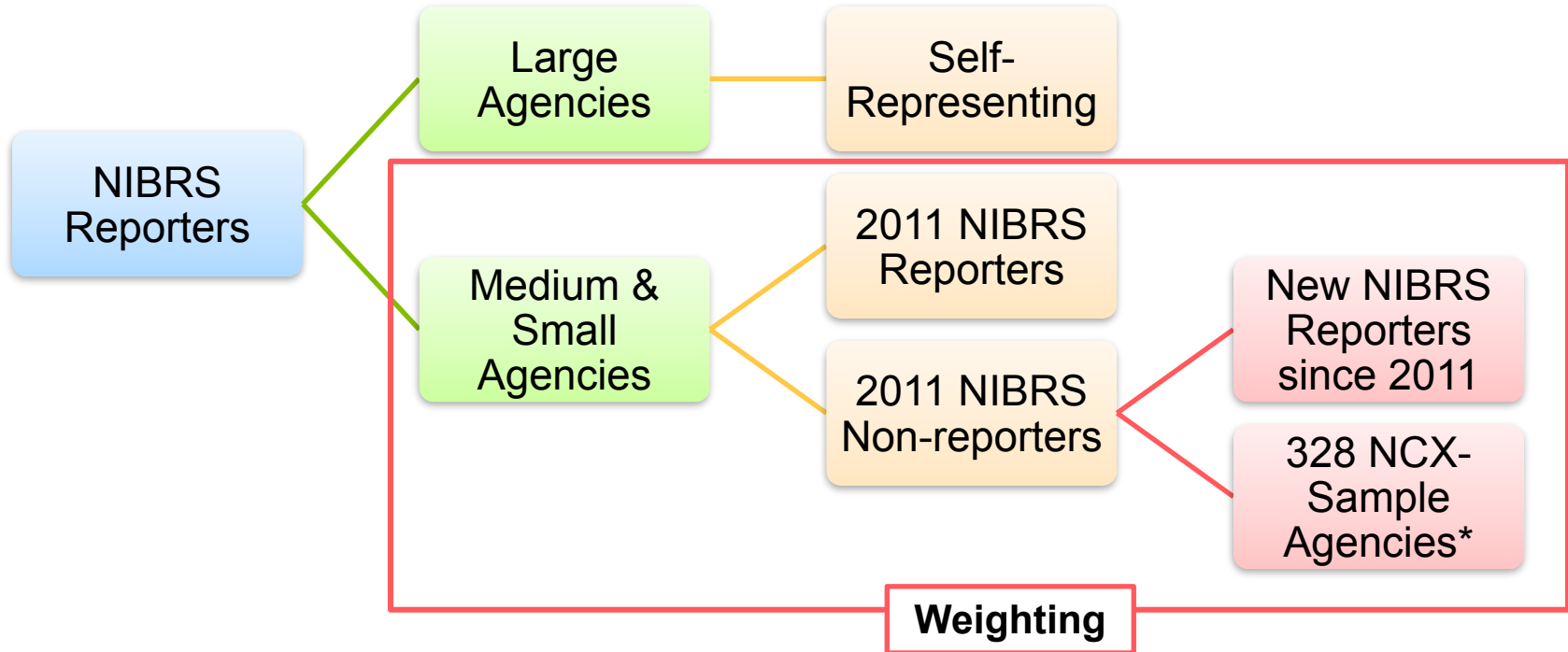
*72 out of the 400 NCS-X sample agencies are large agencies (750+ officers).

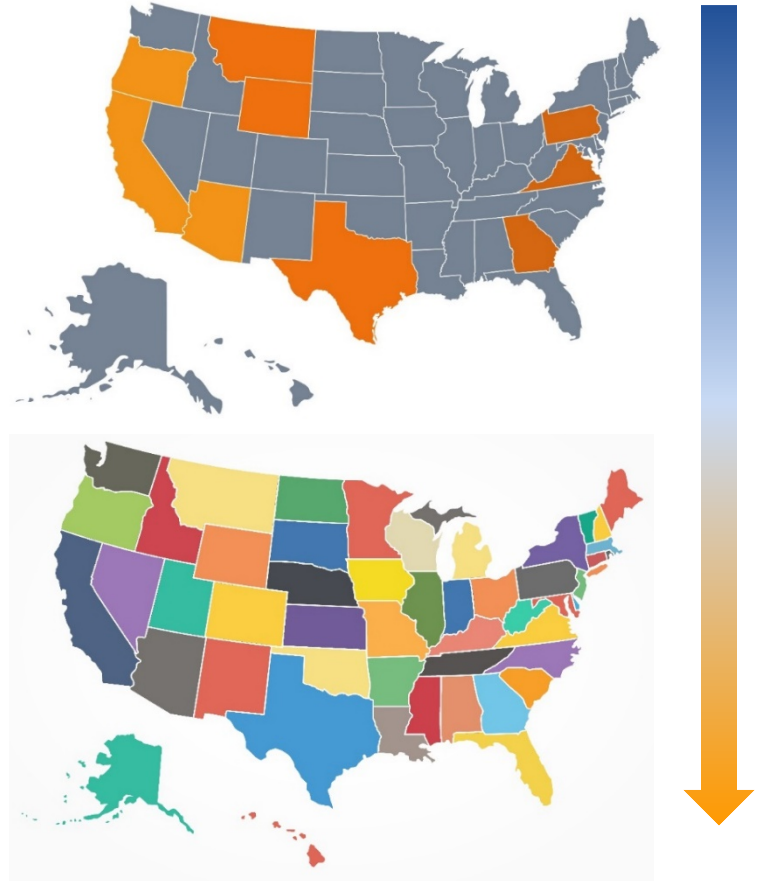# Estimation Options: Intermediate Approach

INTERMEDIATE APPROACH

- Begins with a mix of weights designed for estimation at different levels of geography

- State-level estimates created where able; regional estimates created when needed

- Together state and regional weights can produce national estimates
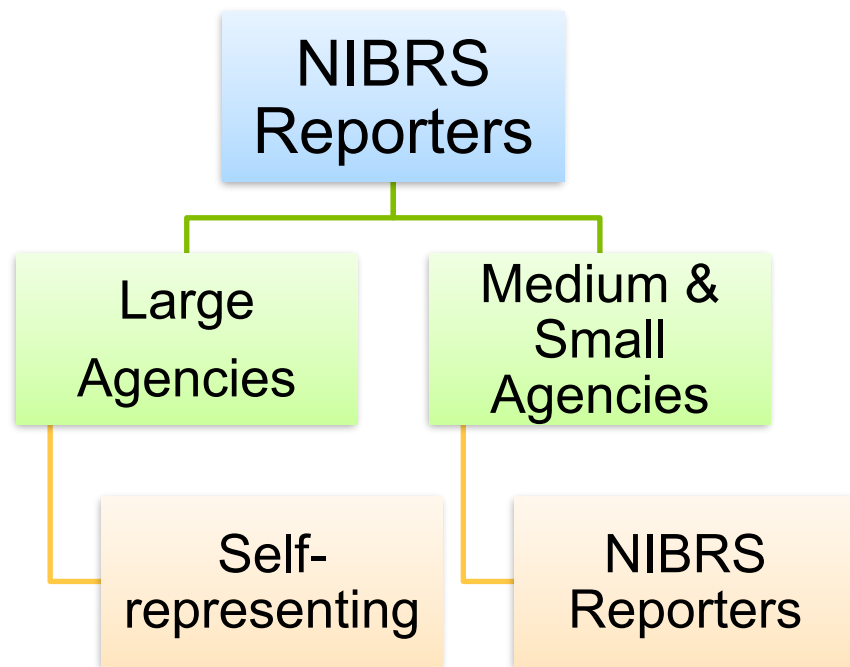
Estimation Options: Intermediate Approach (cont.)

- Advantages
  - Provides for state-level estimates sooner than top-down approach
  - Allows most flexibility with the type of subnational areas available for estimation
- Disadvantages
  - Weights are not as efficient as top-down approach, but more efficient than bottom-up approach
  - Subnational estimates will be available on a flow basis

Intermediate Approach Weighting/Estimation Strategy

Weighting by State

```
                NIBRS
              Reporters
          ┌───────────────┐
    Large            Medium &
   Agencies         Small
                    Agencies
   │                    │
   Self-              NIBRS
   representing       Reporters
```

- Weighting by state if coverage ratio exceeds 80%

- For remaining states, produce top-down weights

- Over time, will achieve a 50-state design which will allow for simultaneous estimates at the national and state levels

Weighting Strategy: Naïve Design-Based

Early Adopters → Self-Representing

Late Joiners → Self-Representing

NCS-X Sample → Representing All Non-joiners
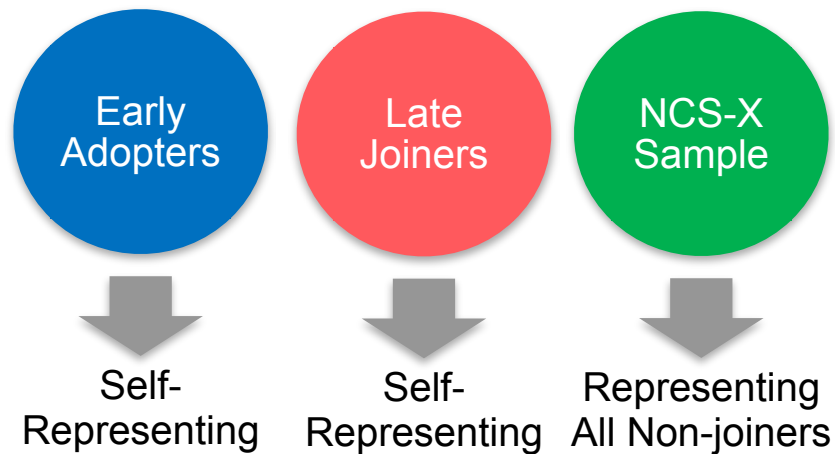
○ Advantages
  - Closest strategy to the original sample design
  - Theoretically should have the smallest amount of bias
○ Disadvantages
  - Unclear if original sample design still applicable given level of late joiners since 2011 NCS-X sample drawn
  - Will result in estimates with larger variances than other strategies

Weighting Strategy: Blending New Joiners

NCS-X Sample

Late Joiners

Early Adopters

Representing All Non-joiners

Self-Representing
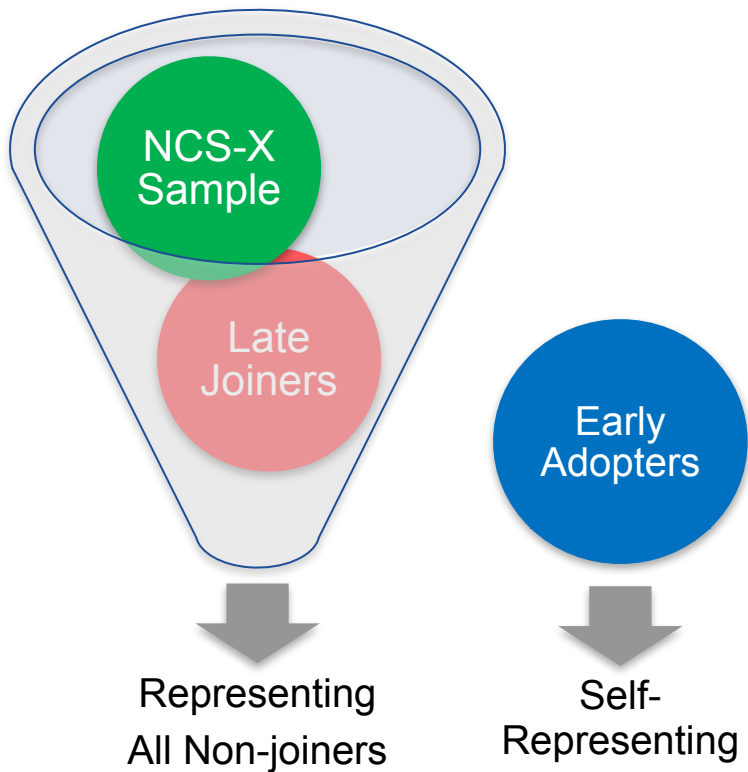
○ Advantages
  - Helps smooth the weights compared to the naïve design-based method
  - Since late joiners come from the same pool of agencies the NCS-X sample was drawn they are more likely to be similar to the NCS-X sample agencies than the early adopters
○ Disadvantages
  - Deviates from the original sample design
  - Allowing late joiners to represent non-joiners may introduce bias in the estimates

Weighting Strategy: Blending All Reporters

Late-Joiners

NCS-X Sample

Early Adopters

Representing
All Non-joiners
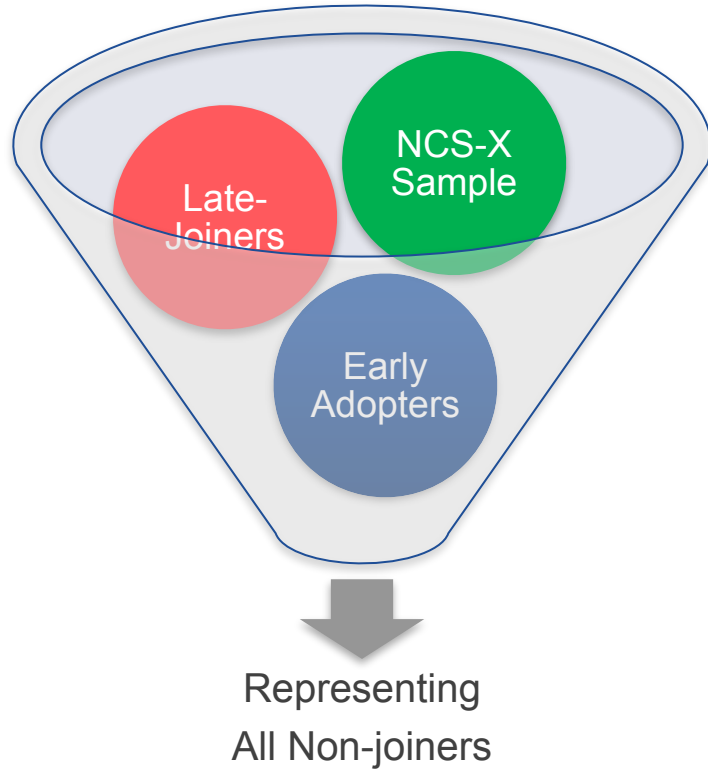
- ○ Advantages
  - Minimizes the variance in estimates
- ○ Disadvantages
  - Deviates from the original sample design
 - Strategy that is most likely to introduce bias into the estimates

Crime Statistics Validation

- For each blending, weighting, and estimation strategy, we tabulated estimated crime totals and compared against external benchmarks
- Validation Sources:
  - SRS for crime count estimates
  - UCR arrest data for arrest count estimates

| Offense Type	Weighted Total among NIBRS Reporters			SRS Total among all LEAs	Relative Bias(%)
	Estimate	SE	RSE	Estimate	
All Crime					
All Violent Crime					
Murder					
Manslaughter					
Rape					
Robbery					
Assault					
Aggravated Assault					
Simple Assault					
All Property Crime					
Burglary					
Larceny					
Vehicle Theft					

Median Relative Bias of Crimes

○ Plot shows the median relative bias across all crime types

○ In some cases, poststratification leads to bias reduction, but not for the Intermediate Blending New Joiners strategy
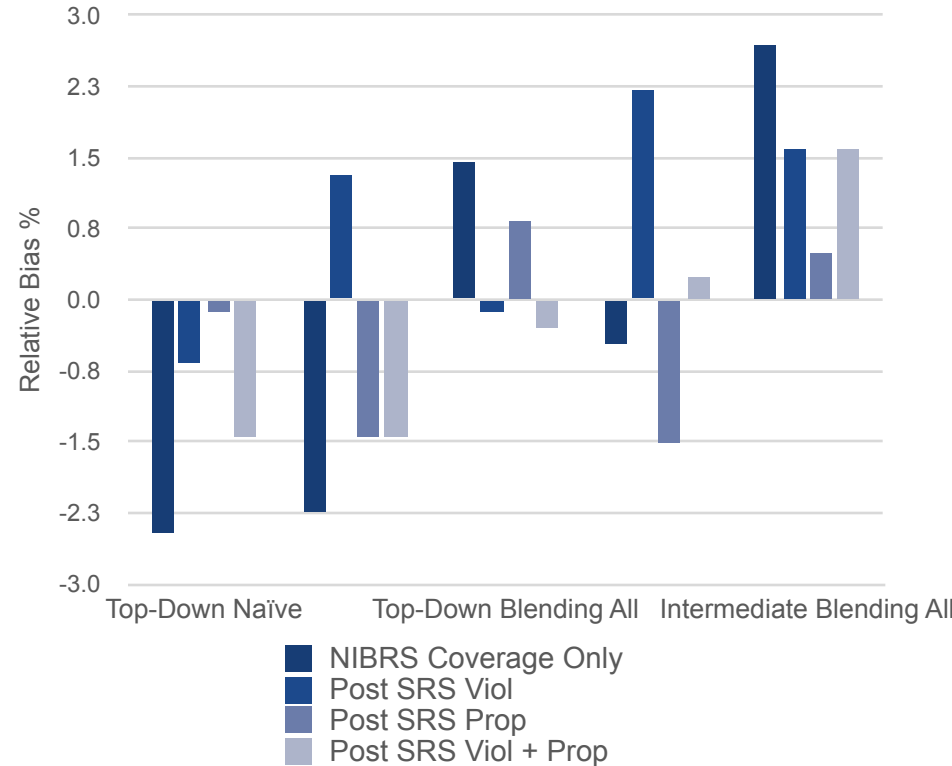
Median Relative Bias of Arrests

- Plot shows the median relative bias across all arrest types
- In all cases, estimated arrest totals are negatively biased (i.e., underestimates), and the benefits of poststratification are less clear
- Although the Blending All Reporters strategy appears to have less bias, it is not the most precise…
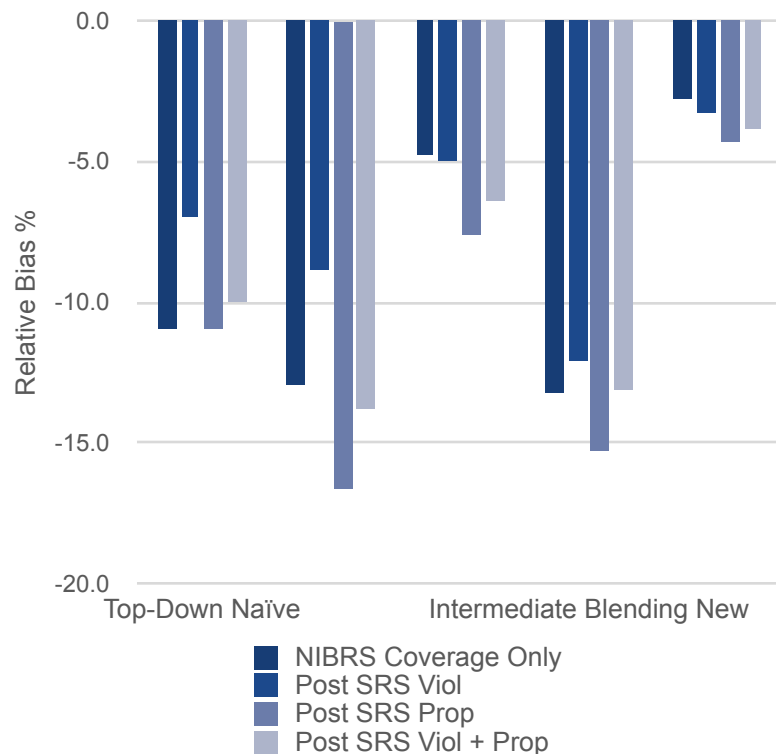
Median Relative Bias and RSE of Crimes and Arrests

Strategy	Crimes			Arrests	
	Relative Bias	RSE		Relative Bias	RSE
Top-Down Naïve Design-Based	-2.5	4.1		-10.2	4.7
Top-Down Blending New Joiners	-2.2	2.8		-12.0	3.7
Top-Down Blending All Reporters	-2.2	3.6		-4.8	4.6
Intermediate Blending New Joiners	**-0.5**	**2.7**		**-12.7**	**2.9**
Intermediate Blending All Reporters	2.7	3.9		-2.8	4.5

○ Although not necessarily most accurate with respect to arrests, Intermediate Blending New Joiners has lowest median RSE with respect to both crimes and arrests

Thank you
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