# National Rivers and Streams Assessment Survey Design: 2023-2024

## Target Population

The target population consists of all streams and rivers within the 48 contiguous states that have flowing water during the study index period excluding portions of tidal rivers up to head of salt. The study index period extends from April/May through September and is generally characterized by low flow conditions. The target population includes the Great Rivers and run-of-the-river ponds, and pools are included while non-run-of-the-river reservoirs are excluded. A complete definition of the target population is given in the field operations manual.

## Data Quality Objectives

The data quality objectives, or design requirements, for the National Rivers and Streams Assessment are

- to estimate the proportion of rivers and streams with a margin of error of $\pm$ 5% in the conterminous U.S. that fall below the designated threshold for good conditions for selected indicators with 95% confidence
- to estimate the proportion of rivers and streams with a margin of error of $\pm$ 15% in each of nine ecological reporting regions that fall below the designated threshold for good conditions for selected indicators with 95% confidence.
- to estimate the change in proportion of river and streams in the conterminous U.S. between 2018-19 and 2023-24 that fall below the designated threshold for good (or poor) condition for selected indicators. Change estimates should have a margin of error of $\pm$ 15% at 95% confidence.
- to estimate the change in proportion of river and streams in the conterminous U.S. between 2018-19 and 2023-24 in each of nine ecological reporting regions that fall below the designated threshold for good (or poor) condition for selected indicators. Change estimates should have a margin of error of $\pm$ 15% at 95% confidence.
- To revisit 10% of the sites in 2023-24 for variance component estimation and quality assurance.

## Sampling Frame

Site selection using a survey design requires a sampling frame that includes the target population. Preferably the sampling frame includes all possible sites that are in the target population; since if they are not included, they have no opportunity to be selected. This is called undercoverage. Also, preferably the sampling frame excludes stream and river channels that are not in the target population, e.g., streams that are dry or canals/ditches. This is called overcoverage. The impact of undercoverage is that a portion of the target population is excluded. If this portion is small, then the impact on the estimates of stream condition will be small. The impact of overcoverage is that it increases the cost associated with completing the site evaluation. That is, more time and expense is involved in determining that a site selected by the survey design is in the target population. It also implies that the total stream length in the target population must be estimated from the site evaluation information. Consequently, the selection

of the sampling frame must minimize any undercoverage while also minimizing the amount of overcoverage.

The sampling frame was derived from and is a subset of the National Hydrography Dataset (NHD) product NHDPlusHR. The NHDPlus HR (https://doi.org/10.3133/fs20203033) is a geospatial dataset depicting the flow of water across the Nation's landscapes and through the stream network. The NHDPlus HR is built using the National Hydrography Dataset High Resolution data at 1:24,000 scale or more detailed, the 10-meter 3D Elevation Program data, and the nationally complete Watershed Boundary Dataset (Moore et.al. 2019). Since this is a better representation of streams and rivers in the contiguous United States, NRSA 2023-24 will use it as the source for its sampling frame with the intent to use it for at least the next 10-15 years. Note that NHDPlusHR is not restricted to a single map scale, e.g., 1:24K. While NHDPlusHR also includes attributes for Strahler order and Strahler Calculator, they are based on the available map scale, which means their definition depends on the map scale. NHDPlusHR also includes an attribute for mean annual flow for each reach. Mean annual flow estimates are based on a model described in the NHDPlusHR Users Guide. Details on the construction of the sampling frame are given in Appendix A.

The survey design depends on several key variables in the sampling frame. First, FRAME23 identifies which reaches are included in the sampling frame. Second, all reaches are assigned to a state and to an aggregated ecoregion. Third, all reaches have an estimated mean annual flow. The latter is used to define three stream size categories: small streams (SS) with flow between 1 to 5 cfs, large streams (LS) with flow between 5 to 100 cfs, and rivers (RV) with flow greater than 100 cfs. Note that reaches with mean annual flow below 1 cfs but are 5th or greater Strahler order are included. These mean annual flow categories were selected to be similar to the same categories based on Strahler order used in prior NRSA surveys.

Moore, R.B., McKay, L.D., Rea, A.H., Bondelid, T.R., Price, C.V., Dewald, T.G., and Johnston, C.M., 2019, User's guide for the national hydrography dataset plus (NHDPlus) high resolution: U.S. Geological Survey Open-File Report 2019–1096, 66 p., https://doi.org/10.3133/ofr20191096

# Survey Design

The survey design is a spatially balanced design that is stratified by state with unequal probability selection by stream/river size based on mean annual flow. The survey design consists of two parts:
- Sites from NRSA 2018-19 that will be resampled in 2023-24 (note there are 3,197 evaluated sites available)
- New sites selected for NRSA 2023-24.

This design enables NRSA to address the dual objectives of (1) estimating status in 2023-24 and (2) estimating change in status compared to 2018-19 for all flowing waters. The total number of site visits available to satisfy the survey objectives is 2000. Since four sites (1 small stream, 1 large stream and 2 rivers) will be visited twice in each of the 48 states, this results in 1808 unique sites. NRSA 2018-19 sites will comprise approximately 904 unique sites and will contain all the

192 sites that will be sampled twice in 2023-24, if available otherwise they are new sites. New sites will be selected for the other approximately 904 unique sites.

Sample size requirements are given in terms of aggregated ecoregions and reach length. The survey design will be implemented by state so the sample size requirements must be given by state and reach length. Additionally, administrative restrictions specify that for each state the minimum number of unique sites must be greater than or equal to 20, less than or equal to 72, and be an even number of sites. The allocation of sites to states is approximately proportional to the reach length in each aggregated ecoregion that occurs in each state for small streams, large streams, and rivers, individually.

There are 498 site visits at small streams. Of these 498 site visits, 450 will be at unique sites and 48 will be revisits (1 revisit per state). Each state will sample a minimum of 5 unique small streams and a maximum of 18 unique large streams. For the 450 unique sites, 50 unique sites were allocated to each ecoregion and then sample sizes were assigned among the states approximately proportional to the total small stream length for that state and ecoregion combination. There will be 502 site visits at large streams. Of these 502 site visits, 454 will be at unique sites and 48 will be revisits (1 revisit per state). Each state will sample a minimum of 5 unique large streams and a maximum of 18 unique large streams. For the 454 unique sites, approximately 50 unique sites were allocated to each ecoregion and then sample sizes were assigned among the states approximately proportional to the total small stream length for that state and ecoregion combination. Of these 1000 site visits, 904 will be revisits (2 revisits per state). Each state will sample a minimum of 10 unique rivers and a maximum of 36 unique rivers. For the 904 unique sites, approximately 100 unique sites were allocated to each ecoregion and then sample sizes were assigned among the states approximately proportional to the total small stream length for that state and ecoregion combination.

Together, this all implies that there will be 2000 site visits. Of these 2000 site visits, 1808 will be at unique sites and 192 will be revisits (4 revisits per state). Each state will sample a minimum of 5 unique small streams, 5 unique large streams, and 10 unique rivers – totaling a minimum of 20 unique site visits. Combined with the 4 revisits, each state will have 24 site visits at a minimum. Each state will sample a maximum of 18 unique small streams, 18 unique large streams, and 36 unique rivers – totaling a minimum of 72 unique site visits. Combined with the 4 revisits, each state will have 76 site visits at a maximum.

# Fish Tissue Study

A special study for fish tissue contaminants is planned to be conducted on rivers only. While the exact sample size is not currently known, the expectation is that they will be able to evaluate approximately 70% of the River sites with some of those sites not being able to provide an appropriate fish tissue sample. All river sites for NRSA 2023-24 were identified and 70% of them were designated for the study. The sites are assigned to NRS23_18RVT2 panels first, then NRS23_18Base, and then NRS23_23Base if necessary (more details about panel definitions are provided in the next section). Each of these sites are designated as a new panel with the addition of "_FT" at the end of the panel name. The number sites by state and panel are given below. Approximately 50% of sites are sites from 2018-19 and 50% are new sites.

| State | NRS23_18RVT2RV_FT | NRS23_18BaseRV_FT | NRS23_23BaseRV_FT | Total |
|-------|-------------------|-------------------|-------------------|-------|
| AL | 2 | 2 | 8 | 12 |
| AR | 2 | 2 | 10 | 14 |
| AZ | 2 | 3 | 4 | 9 |
| CA | 2 | 9 | 14 | 25 |
| CO | 2 | 3 | 5 | 10 |
| CT | 2 | 0 | 4 | 6 |
| DE | 2 | 0 | 4 | 6 |
| FL | 2 | 2 | 3 | 7 |
| GA | 2 | 4 | 5 | 11 |
| IA | 2 | 5 | 7 | 14 |
| ID | 2 | 6 | 7 | 15 |
| IL | 2 | 4 | 6 | 12 |
| IN | 2 | 2 | 4 | 8 |
| KY | 2 | 3 | 4 | 9 |
| LA | 2 | 2 | 6 | 10 |
| MA | 2 | 2 | 3 | 7 |
| MD | 2 | 2 | 3 | 7 |
| ME | 2 | 1 | 12 | 15 |
| MI | 2 | 10 | 12 | 24 |
| MN | 2 | 7 | 12 | 21 |
| MO | 2 | 5 | 11 | 18 |
| MS | 1 | 0 | 8 | 9 |
| MT | 2 | 9 | 14 | 25 |
| NC | 2 | 2 | 4 | 8 |
| ND | 2 | 4 | 9 | 15 |
| NE | 2 | 4 | 6 | 12 |
| NH | 1 | 0 | 6 | 7 |
| NJ | 2 | 2 | 3 | 7 |
| NM | 2 | 2 | 3 | 7 |
| NV | 2 | 2 | 4 | 8 |
| NY | 2 | 5 | 16 | 23 |
| OH | 2 | 4 | 8 | 14 |
| OK | 2 | 10 | 12 | 24 |
| OR | 2 | 8 | 11 | 21 |
| PA | 2 | 3 | 7 | 12 |
| RI | 1 | 0 | 6 | 7 |
| SC | 2 | 2 | 3 | 7 |
| SD | 2 | 7 | 9 | 18 |
| TN | 2 | 3 | 5 | 10 |
| TX | 2 | 11 | 12 | 25 |
| UT | 2 | 4 | 5 | 11 |
| VA | 2 | 0 | 6 | 8 |
| VT | 2 | 2 | 3 | 7 |
| WA | 2 | 6 | 12 | 20 |

| | | | | |
|---|---|---|---|---|
| WI | 2 | 9 | 11 | 22 |
| WV | 2 | 0 | 4 | 6 |
| WY | 2 | 4 | 6 | 12 |
| Total | 91 | 177 | 337 | 605 |

# Panels and Site Replacement

This is a critical variable for implementing the survey design. The possible values are given below and within each state the sites are ordered by these panels. While the names appear to be redundant, they ensure that the panels are uniquely named across all design cycles. The first part "NRS23" identifies the panel as one from the NRSA 2023-24 design cycle. The next values of "18" or "23" identifies the panel sites as being sites from the 2018-19 design cycle or new sites from the 2023-24 design cycle. "RVT2" identifies sites that will be visited twice in 2023-24 and they are all from previously sampled sites in 2018-19. "Base" identifies sites that are part of the base sites for 2023-24 in addition to the RVT2 sites which are also base sites. "Over" designates over sample sites. Finally, "SS", "LS" and "RV" designates sites from the three reach categories. Note that sites will be replaced by sites from the same reach category.

- NRS23_18RVT2SS – only one of these for each state and it is the first resample site in this reach category in siteID order. Note that it is very possible that this site may have not been sampled in 2018-19. It will be evaluated again in 2023-24 to determine if it can be sampled, and if not, it is then replaced by the first NRS23_18BaseSS sample.
- NRS23_18BaseSS – all the remaining sites required for each state in this reach category from 2018-19. If it cannot be sampled in 2023-24, then it will be replaced by the next available NRS23_18OverSS site.
- NRS23_18RVT2LS – only one of these for each state and it is the first resample site in this reach category in siteID order. Note that it is very possible that this site may have not been sampled in 2018-19. It will be evaluated again in 2023-24 to determine if it can be sampled, and if not, it is then replaced by the first NRS23_18BaseLS sample.
- NRS23_18BaseLS– all the remaining sites required for each state in this reach category from 2018-19. If it cannot be sampled in 2023-24, then it will be replaced by the next available NRS23_18OverLS site.
- NRS23_18RVT2RV_FT – There are two of these for each state and it is the first two resample sites in this reach category in siteID order. Note that it is very possible that these sites may have not been sampled in 2018-19. It will be evaluated again in 2023-24 to determine if it can be sampled and if not then replaced by the first NRS23_18BaseRV sample. The first visit will also include sampling for fish tissue contaminants.
- NRS23_18BaseRV_FT– Site that must be sampled for fish tissue contaminants from 2018-19. If it cannot be sampled in 2023-24, then it will be replaced by the next available NRS23_18BaseRV or NRS23_18OverRV site if no NRS23_18BaseRV site is available.
- NRS23_18BaseRV– all the remaining sites required for each state in this reach category from 2018-19. If it cannot be sampled in 2023-24, then it will be replaced by the next available NRS23_18OverRV site.
- NRS23_23BaseSS – These are the SS new sites selected for 2023-24 listed in their siteID order.

- NRS23_23BaseLS – These are the LS new sites selected for 2023-24 listed in their siteID order.
- NRS23_23BaseRV_FT– These are the RV new sites selected for 2023-24 listed in their siteID order that will be sampled for fish tissue contaminants. If it cannot be sampled then it will be replaced by the next available NRS23_23BaseRV or NRS23_18OverRV site if no NRS23_23BaseRV site is available.
- NRS23_23BaseRV– These are the RV new sites selected for 2023-24 listed in their siteID order.
- NRS23_18OverSS – These are the remaining SS sample sites evaluated in 2018-19 listed in their siteID order.
- NRS23_18OverLS – These are the remaining LS sample sites evaluated in 2018-19 listed in their siteID order.
- NRS23_18OverRV – These are the remaining RV sample sites evaluated in 2018-19 listed in their siteID order.
- NRS23_23OverSS – These are the SS new over sample sites selected for 2023-24 listed in their siteID order.
- NRS23_23OverLS – These are the LS new over sample sites selected for 2023-24 listed in their siteID order.
- NRS23_23OverRV – These are the RV new over sample sites selected for 2023-24 listed in their siteID order.

The survey design is explicitly stratified by state for both designs. The unequal probability categories are specific to survey design used for NRSA 2018-19 and NRSA 2020-24.  In all cases, the categories are SS, LS, and RV.

# Expected Sample Size

While the overall sample size is 1808 unique sites, these sites must be allocated to the NARS nine aggregate ecoregion. Each region is expected to have the same number of sites as well as half the sites be streams and the other half be rivers. Based on this the following allocation was made to add up to 1,808 sites.

**Table 1 Expected number of sites by ecoregion and stream size**

| Aggregated Ecoregion | SS | LS | RV | Total |
|---|---|---|---|---|
| Coastal Plains | 50 | 51 | 101 | 202 |
| Northern Appalachians | 50 | 50 | 100 | 200 |
| Northern Plains | 50 | 50 | 100 | 200 |
| Southern Appalachians | 50 | 51 | 101 | 202 |
| Southern Plains | 50 | 50 | 100 | 200 |
| Temperate Plains | 50 | 51 | 101 | 202 |
| Upper Midwest | 50 | 50 | 100 | 200 |
| Western Mountains | 50 | 51 | 101 | 202 |
| Xeric | 50 | 50 | 100 | 200 |
| Total | 450 | 454 | 904 | 1808 |

**Table 2 Total length (miles) by Aggregated Ecoregion and Stream Size**

| Aggregated Ecoregion | SS | LS | RV | Total |
|---|---|---|---|---|
| Coastal Plains | 159,836 | 117,351 | 38,642 | 315,829 |
| Northern Appalachians | 76,687 | 46,658 | 11,894 | 135,239 |
| Northern Plains | 54,864 | 31,908 | 6,353 | 93,125 |
| Southern Appalachians | 183,091 | 103,567 | 30,742 | 317,400 |
| Southern Plains | 70,753 | 56,464 | 13,584 | 140,801 |
| Temperate Plains | 143,977 | 88,262 | 24,758 | 256,997 |
| Upper Midwest | 41,879 | 39,013 | 14,015 | 94,906 |
| Western Mountains | 163,465 | 107,207 | 26,634 | 297,306 |
| Xeric | 65,126 | 44,480 | 17,858 | 127,465 |
| Total | 959,676 | 634,911 | 184,480 | 1,779,067 |

The allocation of sites to states is approximately proportional to the reach length in each aggregated ecoregion that occurs in each state for small streams, large streams, and rivers. Additionally, administrative requirements specify that for each state the minimum sample size must be 20 and maximum must be 72 (or 24 and 76 with 4 revisits). The minimum for each state is allocated so that the minimum must be 5 for small streams, 5 for large streams, and 10 for rivers. Similarly, the maximum for each state must be 18 for small streams, 18 for large streams, and 36 for rivers.

# Final Survey Design Summary

| State | SS | LS | RV | Unique Sites | SS Revisits | LS Revisits | RV Revisits | Total Visits |
|---|---|---|---|---|---|---|---|---|
| AL | 10 | 9 | 17 | 36 | 1 | 1 | 2 | 40 |
| AR | 8 | 8 | 20 | 36 | 1 | 1 | 2 | 40 |
| AZ | 8 | 8 | 14 | 30 | 1 | 1 | 2 | 34 |
| CA | 18 | 18 | 36 | 72 | 1 | 1 | 2 | 76 |
| CO | 11 | 12 | 15 | 38 | 1 | 1 | 2 | 42 |
| CT | 5 | 5 | 10 | 20 | 1 | 1 | 2 | 24 |
| DE | 5 | 5 | 10 | 20 | 1 | 1 | 2 | 24 |
| FL | 5 | 5 | 10 | 20 | 1 | 1 | 2 | 24 |
| GA | 8 | 8 | 16 | 32 | 1 | 1 | 2 | 36 |
| IA | 9 | 9 | 20 | 38 | 1 | 1 | 2 | 42 |
| ID | 10 | 10 | 22 | 42 | 1 | 1 | 2 | 46 |
| IL | 9 | 10 | 17 | 36 | 1 | 1 | 2 | 40 |
| IN | 5 | 5 | 12 | 22 | 1 | 1 | 2 | 26 |
| KS | 17 | 14 | 21 | 52 | 1 | 1 | 2 | 56 |
| KY | 6 | 6 | 14 | 26 | 1 | 1 | 2 | 30 |
| LA | 7 | 7 | 14 | 28 | 1 | 1 | 2 | 32 |
| MA | 5 | 5 | 10 | 20 | 1 | 1 | 2 | 24 |

| | | | | | | | | |
|-----|-----|-----|-----|------|----|----|----|------|
| MD | 5 | 5 | 10 | 20 | 1 | 1 | 2 | 24 |
| ME | 9 | 11 | 22 | 42 | 1 | 1 | 2 | 46 |
| MI | 15 | 18 | 35 | 68 | 1 | 1 | 2 | 72 |
| MN | 13 | 16 | 31 | 60 | 1 | 1 | 2 | 64 |
| MO | 14 | 12 | 26 | 52 | 1 | 1 | 2 | 56 |
| MS | 9 | 8 | 13 | 30 | 1 | 1 | 2 | 34 |
| MT | 18 | 18 | 36 | 72 | 1 | 1 | 2 | 76 |
| NC | 6 | 7 | 13 | 26 | 1 | 1 | 2 | 30 |
| ND | 9 | 8 | 21 | 38 | 1 | 1 | 2 | 42 |
| NE | 12 | 11 | 17 | 40 | 1 | 1 | 2 | 44 |
| NH | 5 | 5 | 10 | 20 | 1 | 1 | 2 | 24 |
| NJ | 5 | 5 | 10 | 20 | 1 | 1 | 2 | 24 |
| NM | 6 | 6 | 10 | 22 | 1 | 1 | 2 | 26 |
| NV | 8 | 7 | 11 | 26 | 1 | 1 | 2 | 30 |
| NY | 18 | 18 | 34 | 70 | 1 | 1 | 2 | 74 |
| OH | 8 | 8 | 20 | 36 | 1 | 1 | 2 | 40 |
| OK | 13 | 10 | 35 | 58 | 1 | 1 | 2 | 62 |
| OR | 10 | 11 | 31 | 52 | 1 | 1 | 2 | 56 |
| PA | 10 | 10 | 18 | 38 | 1 | 1 | 2 | 42 |
| RI | 5 | 5 | 10 | 20 | 1 | 1 | 2 | 24 |
| SC | 5 | 5 | 10 | 20 | 1 | 1 | 2 | 24 |
| SD | 16 | 16 | 26 | 58 | 1 | 1 | 2 | 62 |
| TN | 7 | 6 | 15 | 28 | 1 | 1 | 2 | 32 |
| TX | 16 | 18 | 36 | 70 | 1 | 1 | 2 | 74 |
| UT | 7 | 7 | 16 | 30 | 1 | 1 | 2 | 34 |
| VA | 5 | 6 | 11 | 22 | 1 | 1 | 2 | 26 |
| VT | 5 | 5 | 10 | 20 | 1 | 1 | 2 | 24 |
| WA | 9 | 10 | 29 | 48 | 1 | 1 | 2 | 52 |
| WI | 18 | 18 | 32 | 68 | 1 | 1 | 2 | 72 |
| WV | 5 | 5 | 10 | 20 | 1 | 1 | 2 | 24 |
| WY | 13 | 15 | 18 | 46 | 1 | 1 | 2 | 50 |
| Total | 450 | 454 | 904 | 1808 | 48 | 48 | 96 | 2000 |

# Appendix A: Sample Frame

NHDPlusHR was downloaded from the USGS NHD website in September 2021 by hydrologic region. It contains approximately 24,719,751 reaches and is 26GB in size. The reaches were intersected with state boundaries (see below for details) and a single geopackage data base was created with reaches allocated to states. For streams and rivers on the boundary between two states, the reaches are included in both states and are identified as a border stream and river (see below). Additional attributes are added (see below for description of each) which may also result in reaches being split. NHDPlusHR Reach length by state in miles is:

| PSTL_CODE | LENGTH_MI | PSTL_CODE | LENGTH_MI |
|-----------|-----------|-----------|-----------|
| AL | 132909.1376 | NC | 143953.9832 |
| AR | 137592.4741 | ND | 92843.92524 |
| AZ | 296545.6658 | NE | 128135.3446 |
| CA | 520129.1329 | NH | 18659.377 |
| CO | 279584.3583 | NJ | 25568.88806 |
| CT | 13880.76264 | NM | 241910.7378 |
| DE | 5968.506539 | NV | 315349.1841 |
| FL | 106259.2024 | NY | 101715.6812 |
| GA | 119677.4003 | OH | 92099.41976 |
| IA | 115399.4602 | OK | 168921.0201 |
| ID | 181427.888 | OR | 318148.6298 |
| IL | 121624.4618 | PA | 86507.30841 |
| IN | 274222.1655 | RI | 2398.599804 |
| KS | 184292.9011 | SC | 79842.98214 |
| KY | 102063.5363 | SD | 165250.777 |
| LA | 138742.2117 | TN | 113588.2242 |
| MA | 18693.81835 | TX | 537849.2994 |
| MD | 28163.49805 | UT | 187347.2569 |
| ME | 55800.10056 | VA | 110930.4345 |
| MI | 87085.95572 | VT | 26509.93282 |
| MN | 106029.4588 | WA | 245880.6961 |
| MO | 184692.6077 | WI | 89541.57907 |
| MS | 166290.6754 | WV | 55392.41855 |
| MT | 390617.0623 | WY | 289208.0737 |
| Total | | | 7405246.2154 |

## FRAME23 Variable

The sampling frame is identified in NHDPlusHR by adding an attribute, FRAME23, that identifies if the reach is included in the sampling frame or excluded and for what reason. The sampling frame is identified using the criteria: FCODE, NHD lake polygon intersection, side channels, connectors within double-lined rivers, and mean annual flow (QEMA). In addition, border reaches are identified as being included for only one of the states. The following sections

describe the exclusion process, and it is assumed that they are done in order presented. Note that all reaches initially have a value for FRAME23 that is "Include", i.e., the reach is included in the sampling frame. Possible values are **Include, Exclude_FCODE, Exclude_Lake, Exclude_SideChannel**, **Exclude_Connector**, and **Exclude_NoFlow**.

## FCODE Exclusions of Sample Frame Reaches

Reaches will be excluded and assigned value "Exclude_FCODE" when the FCODES are associated with
- Pipelines (FCODE 42800 - 42824)
- Coastline (FCODE 56600)
- Canal/ditch (FCODE 33600, 33601, 33603)
- Underground Connector (42000 – 42003)

Note that a reach coded as **Exclude_FCODE** is the initial reason a reach is excluded.

## Identification of Lakes and Reservoirs

The linear network of reaches includes centerlines through lakes and reservoirs. Since impounded waters with a residence time greater than one week are not part of the NRSA target population, reaches within lakes and reservoirs are removed from the sampling frame. This will be done using the polygon layer of NHDPlusHR associated with lakes and reservoirs. The value for **FRAME23** will be **Exclude_Lake** if the reach is within an NHDPlusHR Waterbody feature (denoted by sharing a NHDWaterbody). The assumption is that only reaches that already are coded **Include** will be changed to **Exclude_Lake**. This must be verified. But if reach is already coded **Exclude_FCODE**, it is retained.

## Identification of Side Channels

Rivers and streams occasionally are braided, i.e., have side channels. These side channels can be identified using Strahler calculator and Strahler order. If a reach is identified as a side channel, then **FRAME23** will be coded as **Exclude_SideChannel**, unless it is already excluded for other reasons.

## Identification of Connectors within Double-lined Rivers

NHDPlusHR includes reaches that are connectors to the centerline of double-lined rivers (i.e., rivers that are polygons). Experience in field operations, has identified that occasionally selecting a site on one of these connectors leads to a site being located within the double-lined river and the river is sampled instead of the stream tributary. To minimize this issue, the reaches in the NHDPlusHR linear network will identify those that are within the river polygon and change the **FRAME23** value to **Exclude_Connector**, unless the **FRAME23** value is already an exclude code.

## Identification of Flowing Water Reaches

In the past, NRSA has used perennial/intermittent FCODEs to identify reaches that are likely to have flowing waters during the summer index period. It is well-known that this coding is not reliable. NHDPlusHR includes a mean annual flow estimate (QEMA) for every reach. Mean annual flow will be used to identify reaches expected to have flowing waters during the May

through September field season. Given a flow criterion, **FRAME23** will be set to **Exclude_NoFlow** if a reach does not meet the criteria; unless the **FRAME23** value is already an exclude code.

## PSTL_CODE

Each reach is assigned to a state using the Census Bureau state boundary file.  State two letter postal code for site sampled. 50 state postal codes plus AS, MP, GU, PR, VI for American Samoa, Commonwealth of Northern Marianas, Guam, Puerto Rico and Virgin Islands.  No missing or "blank" values allowed. Reaches in the District of Columbia are assigned to Maryland. For reaches that intersect the border between two states the reach is split and assigned to the appropriate state. For reaches that are on the border of two states, a Canadian province, or Mexico, the reach is assigned to both states or to the state if share with Canadian province or Mexico. See **BORD_RIV**.

## BORD_RIV: Border River

Each reach must be assigned to a state or may be a river between two states. The NHDPlusHR flowline represented by reaches represents the centerline of the stream or river. This centerline may cross back-and-forth across the US. Census Bureau state boundary line.  Rather than have this occur, a decision was made to assign the entire reach, or collection of reaches, for the border reaches to one state of the two states.  An attribute, **BORD_RIV**, designates whether a reach is a border reach or is internal to a state.  **BORD_RIV** has a two-letter state postal code if within a state and combination of postcodes if on border between two states: MM:NN format. Note that this does not identify which state the reach will be assigned to for the survey design. It only identifies the border rivers. For NRSA, the assignment to a state is completed as the last assignment for **FRAME23**.

## EPA_REG: EPA Region

The attribute **EPA_REG** provides the US EPA region associated with the reach (https://www.epa.gov/aboutepa/regional-and-geographic-offices). The assignment is based on the **PSTL_CODE**. The values are Region_01, Region_02, Region_03, Region_04, Region_05, Region_06, Region_07, Region_08, Region_09, and Region_10.

| US EPA Region | States |
|---|---|
| Region_01 | Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont |
| Region_02 | New Jersey, New York |
| Region_03 | Delaware, Maryland, Pennsylvania, Virginia, West Virginia |
| Region_04 | Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee |
| Region_05 | Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin |
| Region_06 | Arkansas, Louisiana, New Mexico, Oklahoma, Texas |
| Region_07 | Iowa, Kansas, Missouri, Nebraska |
| Region_08 | Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming |
| Region_09 | Arizona, California, Nevada |

| Region_10 | Idaho, Oregon, Washington |
|---|---|

# STATECTY: State County FIPS Code

Federal Information Processing System (FIPS) Codes for States and Counties is assigned based on the above assignment of a reach to a county. The FIPS value is preceded by the letter "F" to preserve leading zeros.

# STATE_NM: State Name

The full state name is assigned based on **PSTL_CODE**.

# CNTYNAME: County Name

The full county name within a state is assigned based on **FIPS_CODE**. The source for the name is ESRI counties based on census 2010. Note that reaches that cross-county borders are split. The assignment of county name is made to be consistent with the assignment to a state. That is, a border reach is assigned to the county associated with the state layer for the geopackage.

# Ecoregion based Attributes

Attributes are included based on Omernik Level III and Level IV ecoregions and North American Level 1 and Level 2 ecoregions. Based on combinations of Omernik Level III ecoregions, NARS defines three and nine aggregated ecoregions. The attributes and definitions are given below.

| Ecoregion Type | Attribute Name | Description |
|---|---|---|
| NARS Aggregated Ecoregion | **AG_ECO3** | NARS 3-level reporting region based on aggregating AG_ECO9 reporting regions. Values: EHIGH, PLNLOW, WMTNS.  No missing or "blank" values allowed. |
| NARS Aggregated Ecoregion | **AG_ECO3_NM** | NARS 3-level reporting region name. Values: Eastern Highlands, Plains and Lowlands, West. No missing or "blank" values allowed. |
| NARS Aggregated Ecoregion | **AG_ECO9** | NARS 9-level reporting region based on aggregated Omernik Level III ecoregions. Values: CPL, NAP, NPL, SAP, SPL, TPL, UMW, WMT, XER.  No missing or "blank" values allowed. |
| NARS Aggregated Ecoregion | **AG_ECO9_NM** | NARS 9-level reporting region name. Values: Coastal Plains, Northern Appalachians, Northern Plains, Southern Appalachians, Southern Plains, Temperate Plains, Upper Midwest, Western Mountains, Xeric.  No missing or "blank" values allowed. |
| CEC North American Ecoregion | **NA_L1CODE** | CEC North American Level I ecoregion code.  Values of 5 to 15 excluding 14. No missing or "blank" values allowed. |

| | | |
|---|---|---|
| CEC North American Ecoregion | **NA_L1NAME** | CEC North American Level I ecoregion name. Values: EASTERN TEMPERATE FORESTS, GREAT PLAINS, MARINE WEST COAST FOREST, MEDITERRANEAN CALIFORNIA, NORTH AMERICAN DESERTS, NORTHERN FORESTS, NORTHWESTERN FORESTED MOUNTAINS, SOUTHERN SEMI-ARID HIGHLANDS, TEMPERATE SIERRAS, TROPICAL WET FORESTS.  No missing or "blank" values allowed. |
| CEC North American Ecoregion | **NA_L2CODE** | CEC North American Level II ecoregion code.  Form is n.n where leading "n" is L1 and following "n" is level 2. No missing or "blank" values allowed. |
| CEC North American Ecoregion | **NA_L2NAME** | CEC North American Level II ecoregion name.  No missing or "blank" values allowed. |
| Omernik Ecoregion | **US_L3CODE** | Omernik Level III ecoregion code. Coded as "0" if ecoregions have not been defined for state or territory. No missing or "blank" values allowed. |
| Omernik Ecoregion | **US_L3NAME** | Omernik Level III ecoregion name. "None" if no ecoregion defined for state or territory.  No missing or "blank" values allowed. |
| Omernik Ecoregion | **US_L4CODE** | Omernik Level IV ecoregion code.  Level three codes plus aphabetic ending identifying level 4 subregion. "None" if no ecoregion defined for state or territory.  No missing or "blank" values allowed. |
| Omernik Ecoregion | **US_L4NAME** | Omernik Level IV ecoregion name.  "None" if no ecoregion defined for state or territory.   No missing or "blank" values allowed. |
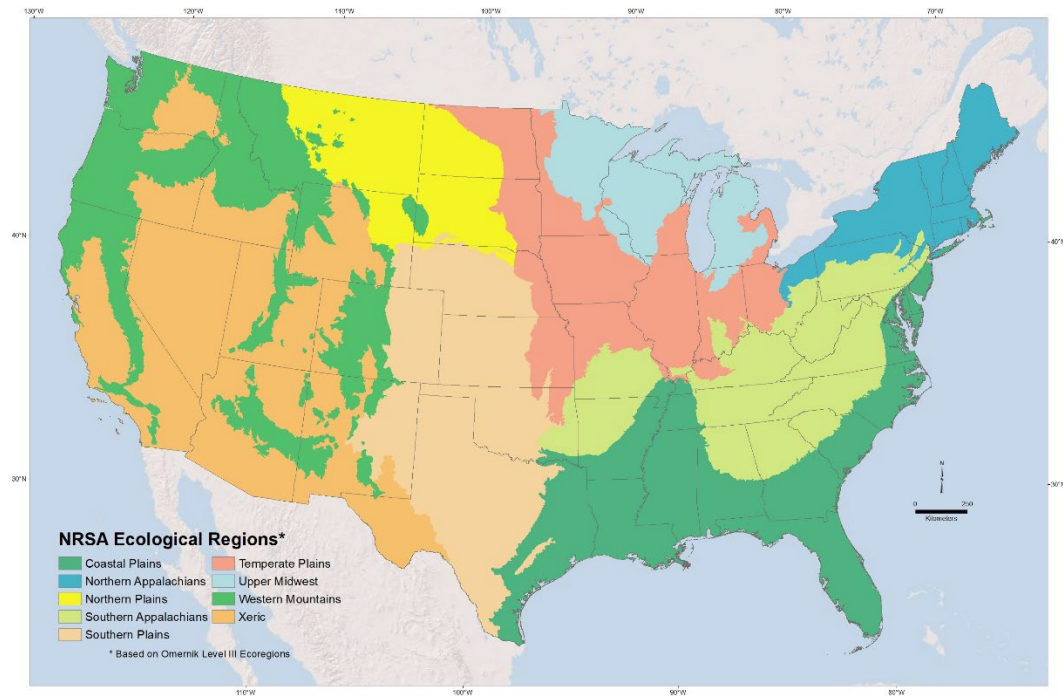
## Urban Attributes

### URBN_NRS08: Urban reach defined for NRSA 2008-9

Stream identified as an urban stream based on urban definition used in NRSA 2008-9 design. Urban based on 2000 Census polygons of urban areas and 3km buffer to ensure census waters included.  No missing or "blank" values allowed.

### URBN_NRS18: Urban reach defined for NRSA 2018-19

Reach identified as an urban reach based on urban definition used in NRSA 2018-19 design. Urban based on 2010 Census polygons of urban areas. No 3km buffer to ensure census waters included since census polygons now include census waters.  No missing or "blank" values allowed.

### URBN_NRS23: Urban reach defined for NRSA 2023-24

Reach identified as an urban reach based on urban definition used in NRSA 2018-19 design. Urban based on 2021 Census polygons of urban areas. No 3km buffer to ensure census waters included since census polygons now include census waters.  No missing or "blank" values allowed.

## STRM_SIZE: Stream Size

NRSA has used Strahler order categories to assign stream/river size to each reach. Given that NHDPlusHR uses multiple resolutions for the stream network, Strahler order is likely not a good surrogate for stream size. More likely a variable can be created based on mean annual stream

flow. The categories found to be useful in the past are small streams, large streams, and rivers. Reason for these categories is that the ability to obtain landowner permission differs for the categories and that whether the stream is found to be in the target population differs. Three mean annual flow categories are 1 to 5 cfs, 5 to 100 cfs and greater than 100 cfs.

# NHDPlusHR Attributes

Several attributes are included with NHDPlusHR.

## FCODE: NHD Feature Code

NHD 5-digit code for feature type.  Generally, no missing values allowed but it is possible that a few lakes may not be in sample frame if from a state study or are hand-picked lakes.  In this case value is "0". No missing or "blank" values allowed.

## FTYPE: NHD Feature Type

Generally, no missing values allowed but it is possible that a few lakes may not be in sample frame if from a state study or are hand-picked lakes.  In this case value is "None". No missing or "blank" values allowed.

## STRAH_CAL: Strahler Calculator

This is a modified Strahler order for each reach that accounts for side channels. Used to identify braided reaches. Values of 0 to 10. No missing or "blank" values allowed.

## STRAH_ORD: Strahler Order

Strahler order for reach from NHDPlusHR. Values from 0 to 10. No missing or "blank" values allowed.

## GNIS_ID:

Geographic Names Information System ID (from NHD). If value is "0", then no GNIS_ID available. No missing or "blank" values allowed.

## GNIS_NAME:

USGS Geographic Names Information System name (from NHD).   Value of "None" if no GNIS_NAME available. No missing or "blank" values allowed.

## LENGTH_KM:

Reach length in km.

## MEAN_FLOW: Mean Annual Flow

The reach estimated mean annual flow (cfs).

## REACHCODE:

NHD Reach code assigned. Value of 'None' if site is on reach that is not in NHD. No missing values or "blanks" allowed.

**NHDPLUSID:**

NHDPlusHR identifier for a flowline feature.

# Hydrologic Basin Attributes

| Attribute | Description | Values |
|---|---|---|
| HUC2 | USGS Level 2 Hydrologic Unit Code where stream reach is located (based on NHDPlusV2 use of HUCs). No missing or "blank" values allowed. | H01, H02, H03N, H03S, H03W, H04, H05, H06, H07, H08, H09, H10L, H10U, H11, H12, H13, H14, H15, H16, H17, H18, H19, H20 |
| HUC2_NM | USGS Level 2 Hydrologic Unit Region Name where stream reach is located (based on NHDPlusV2 use of HUCs). No missing or "blank" values allowed. | Arkansas-Red-White Region, California Region, Great Basin Region, Great Lakes Region, Lower Colorado Region, Lower Mississippi Region, Lower Missouri Region, Mid-Atlantic Region, New England Region, Ohio Region, Pacific Northwest Region, Rio Grande Region, Souris-Red-Rainy Region, South Atlantic-North Region, South Atlantic-South Region, South Atlantic-West Region, Tennessee Region, Texas Region, Upper Colorado Region, Upper Mississippi Region, Upper Missouri Region |
| HUC8 | USGS Level 8 Hydrologic Unit Code where stream reach is located (based on NHDPlusV2 use of HUCs). | Eight-digits preceded by letter H. No missing or "blank" values allowed. |
| HUC8_NM | USGS Level 8 Hydrologic Cataloging Unit Name where stream reach is located. | Character name for unit. No missing or "blank" values allowed. |
| MAJ_BASIN | Major USGS Hydrologic Basins code derived from NHDPlus codes. Has leading "H" to preserve leading zeros. No missing or "blank" values allowed. | H01, H02, H03, H04, H05_06, H07, H08, H09, H10, H11, H12_13, H14, H15, H16, H17, H18 |
| MAJ_BAS_NM | Name of major USGS Hydrologic Basins derived from NHDPlus names. No missing or "blank" values allowed. | Arkansas-White-Red Region, California Region, Great Basin Region, Great Lakes Region, Lower Colorado Region, Lower Mississippi Region, Mid-Atlantic Region, Missouri Region, New England Region, Ohio-Tennessee Region, Pacific Northwest Region, Rio Grande-Texas-Gulf Region, Souris-Red-Rainy Region, South Atlantic Gulf Region, Upper Colorado Region, Upper Mississippi Region, |

| MIS_BASIN | The hydrologic basin code for streams in the Mississippi Basin derived from NHDPlus codes. For streams not in the Mississippi Basin value equal to "NMRB". No missing values allowed. | H05, H06, H07, H08, H10L, H10U, H11, NMRB |
|---|---|---|
| MIS_BAS_NM | The hydrologic basin name for streams in the Mississippi Basin derived from NHDPlus names. "Not Miss River Basin" for streams not in the Mississippi Basin. No missing values allowed. | Ohio-Tennessee Region \| Upper Mississippi Region \|Lower Mississippi Region \| Lower Missouri Region \| Upper Missouri Region \| Arkansas-Red-White Region \| Not Mississippi River Basin |

## OWN_NARS: Land ownership

Each reach is assigned a land ownership category. Land ownership code derived from USGS PADUS (http://gapanalysis.usgs.gov/padus/data/) - pulled May 2016 version of database. Aggregated to categories used by NARS. Text of 13 land ownership category names. Similar to OWN_TYPE in USGS PADUS dataset except that Federal_Land is separated into major federal agencies. No missing or "blank" values allowed. Valid values are BLM, DOD, DOE, USFS, FWS, NOAA, Non Federal, NPS, Tribal Land, USACE, USBR, NRCS, Other Fed.

## FEOW_ID: Freshwater Ecoregions Code

Freshwater Ecoregions of the World (2015) code (https://www.feow.org/). Numeric value with no missing or "blank" values allowed.

## FS_EW: Forest Service Eastern/Western United States

Eastern or western US Forest Service land. Not_USFS if not US Forest Service land. Values are East, West, or Not_USFS. No missing or "blank" values allowed.

# Appendix B: Arizona

Arizona requested additional sites to conduct a state-level assessment and a determination whether the Arizona GIS stream network could be used to replace the national NRSA 2023-24 sample frame for Arizona. The Arizona GIS network and the NRSA 2023-24 GIS network are both based on NHD high resolution stream networks. Arizona has restricted the network based on their knowledge of streams in the state as well as flow modeling. NRSA has restricted the network based on mean annual flow as well as other criteria to eliminate none flowing waters of interest. Based on a comparison of the two networks, while difference in reaches do occur, a decision was made to use the Arizona GIS network as the basis for the sampling frame. An attribute was added to the reaches which designates whether the reach is below or above 5,000 ft elevation to designate warm (<5,000 ft) and cold (>5,000 ft) streams.

**The current sites in the design for Arizona will have to be replaced after the new sites are selected.**

ADEQ intensification study needs:

- 30+ warmwater sites
- 20+ coldwater sites
- Perennial, wadeable streams (ADEQ flow regime map or "small" and "large" streams).  We might want to see what shows up in the River category...might be some that meet our needs.
- Non-tribal land
- Two year sample period 2023-2024 to coordinate with National survey period
- Index period-April-June.  Same as national survey.

Remaining questions

- Will ADEQ sample for all NRSA parameters during our state scale survey?  Very likely not.  Mostly an issue of lab cost
- We will use our own contractors for sampling; need to make sure they get included in training.  The contractor will be crew lead and we will supply 2 ADEQ staff members to the Team.
- Will we use our own labs or EPA labs?  Once we see what the EPA national lab costs are, we'll be able to decide.
- ADEQ will likely sample in 3 other seasons for assessment purposes
- How soon will national data be made available to ADEQ? We will want to utilize the dataset for our statewide and warmwater comparison studies.
- Can the ADEQ Flow Regime map & linework be used for site selection? ADEQ's Flow regime map was created in the medium res NHD, however has been mapped to the hi-Res NHD, so the linework should align. Can you try it out? We've worked hard to update our Flow regimes and it will result in less errors for us if we just use the WBIDs with perennial status.

# Appendix C: Indiana

Indiana conducts a state monitoring program for streams that integrates NRSA 2023-24 sites that occur in three basins with their state sites. The fifth round of their statewide probabilistic sampling is conducted by the Indiana Department of Environmental Management (IDEM) in 2020-2028. The basins that overlap the NRSA are in the Great Miami River Basin (2023), Upper Wabash River Basin (2024) and Lower Wabash River Basin (2025).  For NRSA, Indiana was completed as all other states with the selection of sites by small streams, large streams, and rivers.

The additional sites for the state monitoring program are not included in the NRSA 2023-24 selection but they are provided directly to Indiana where the NRSA sites and additional sites for the state basins are combined. This was done since the state design requires additional stratification and unequal probability categories that are not in the national design.

Note that at the additional sites, Indiana will not be providing that data to NRSA.

# Appendix D: Kansas

The Kansas state-specific design is based on the Kansas Surface Water Register (KSWR) GIS layer of officially recognized streams and rivers within the state. It is based on the 1:24000 NHD. The current version was provided by Kansas during the summer 2016. For 2023-24, Kansas provided a few updates to the KSWR. The NRSA design team used this updated sample frame and added variables to match those used for all NRSA states. In prior studies, it was determined that the KSWR includes streams and rivers that meet the definition of the NRSA target population. The survey design consists of the Resample Design for Kansas as described above and an equal probability survey design for new sites. Note that the sites from 2018-19 were also based on the KSWR sample frame. The new site design is an equal probability survey design. The total number of sites selected is sufficient to provide Kansas with sites for the next 5-years. Otherwise, the survey design is the same as for NRSA 2023-24 in other states.

Note that at the additional sites, Kansas will not be providing that data to NRSA.

# Appendix E: New Hampshire

New Hampshire has a target population of wadeable streams with watersheds between 2 to 85 square miles. In addition, New Hampshire has a state sample frame based on NHD 1:24000. The NRSA 2023-24 sample frame is based on NHDPlusHR which is at least 1:24000. Given this, NHDPlusHR-based sample frame will be used for the additional sites required for New Hampshire. This was completed by selecting additional over sample sites for SS and LS (45 times more) compared to the standard 5 times more for each state. No other change was implemented.

Note that at the additional sites, New Hampshire will not be providing that data to NRSA.

# Appendix F: Oklahoma

Note that at the additional sites, Oklahoma will not be providing that data to NRSA.

## Objectives: (from Josh Bailey)

The following objectives are to satisfy the 2023-2027 Oklahoma Statistical Survey design with the 2023-2024 NRSA component built into the overall study.  The survey design must be able to satisfy the required elements of Oklahoma's statewide 5-year assessment, which are described in detail below.   The primary reporting goal of the upcoming survey is to provide an overall statewide condition assessment.  Additionally, Oklahoma will report on the condition of several subpopulations, including aggregated ecoregions, large and small waterbodies, and interim reports to meet integrated 305(b) reporting requirements. Finally, the study should be connected across Oklahoma's previous surveys to allow for a substantive trend analysis.  To meet these study and reporting needs, the design should meet the following requirements.

1.  The target sample size will be 120 sites.  The first two years will focus on completing the NRSA study with continued sampling through 2027 to satisfy n=120.   The survey design will be sampled to facilitate not only an eventual statewide condition assessment using all 120 sites, but several interim statewide condition assessments to meet Oklahoma's integrated reporting requirements for section 305(b) of the CWA.

2.  The survey design must be ecoregionally representative and will include an aggregated ecoregion component.  In the 2005-2007 (Oklahoma R-EMAP) and the 2013-2017 survey (NRSA 2), and the 2018-19 survey (NRSA 3), Oklahoma was divided into 3 aggregate ecoregional subpopulations: Western Plains/Tablelands, Temperate Forests, and Forested Plains/Flint Hills.  To facilitate a statistically meaningful condition assessment of each aggregated ecoregion, each aggregated ecoregion will have 40 target sites.

3.  The survey design will be representative of all waterbody sizes. As in the most recent survey design, waterbodies will be divided into Strahler size classes. The Oklahoma component will mirror the NRSA classification sizes creating the following subpopulations: Rivers, LargeStreams, and SmallStreams. Each subpopulation will have an associated oversample panel.   The reporting goal is to provide a statistically meaningful condition assessment of each Strahler subpopulation.

4.  The Survey design will have a trend component referenced to Oklahoma's 4 previous surveys:  2005-2007 (Oklahoma R-EMAP), 2008-2012 (NRSA 1),  2013-2017 (NRSA 2), and 2018-2022 survey (NRSA 3),.  Resample sites from each study should be included to allow for analysis of trends through each study period.

In summary, the OWRB wants a draw consistent with the outlined objectives and specifications for Oklahoma that includes the specifications of the 2023-2024 NRSA study. This design will make it possible to complete and report the following:

-  Provision of data for the 2023-2024 NRSA;

- A statewide condition assessment (n=120);
- Interim 2-year statewide condition assessments (n=~40-60 sites) to satisfy integrated reporting requirements for CWA 305(b);
- Condition assessments of the three aggregate ecoregions combined (n=40); and
- Condition assessments of 3 size classes of waterbodies (n=40), as well as small and large waterbodies (n=~60).

## Target population:

The target population consists of all streams and rivers within Oklahoma that have flowing water during the study index period. The study index period extends from April/May through September and is generally characterized by low flow conditions. Run-of-the-river ponds and pools are included while reservoirs are excluded. A complete definition of the target population is given in the NRSA field operations manual.

## Sampling Frame

## Survey Design

The survey design consists of two separate designs to address the dual objectives of (1) estimating current status and (2) estimating change in status for all flowing waters:

- Resample design applied to NRSA 2008-9 and NRSA 2013-14 sites
- Resample design for Oklahoma consisting of sites from OK 2015-16 and OK REMAP sites.
- New site design for NRSA 2018-19.
- New site design for Oklahoma state-level surveys in 2018-19 and 2020-21.

## Sample Size Requirements

## Sample Size Summary

The number of sites by Oklahoma three aggregated ecoregions and four Strahler order categories

# Sample Frame Summary

A summary of the sample frame for Oklahoma by Aggregated Oklahoma ecoregions and Strahler Category (km).

Note that all Oklahoma sites are NOT provided in the NRSA 2023-24 design file. The expectation is that the additional sites sampled by Oklahoma will NOT be submitted to NRSA.

# Appendix G: Texas

## Objectives:

The Texas primary goal is to have enough sites within each of their biological ecoregions as well as enough sites by stream size within each of those regions for a valid state statistical design.

The Texas Biological Aggregated Ecoregions are defined by combining Omernik Level 3 Ecoregions as follows:

| Biological Aggregated Ecoregions | Level 3 Ecoregions (Omernik) |
|---|---|
| **CTP: Central Texas Plateau** | 30 |
| **HPT: High Plains and Tablelands** | 25 & 26 |
| **CSH: South Central and Southern Humid** | 33 & 35 |
| **SOD: Southern Deserts** | 24 & 23 |
| **STP: Southern Texas Plains** | 31 |
| **HAP: Subhumid Agricultural Plains** | 27, 29 & 32 |
| **GCP: Western Gulf Coast Plains** | 34 |

## Survey Design

The survey design for Texas consists of two separate designs. First, the NRSA 2023-24 design for Texas is completed to meet the requirements for NRSA. Next, based on that design additional sites are selected in specific Biological Aggregated Ecoregions and stream size categories to meet the requirements for Texas.

## Sample Size Requirements

Texas would like to have approximately and equal number of sites for the seven (7) Texas Biological Regions and approximately equal number of sites by stream size categories: small streams (SS), large streams (LS), and rivers (RV) within those regions. NRSA 2023-24 requires 70 sites for Texas. The number of sites selected for NRSA for base sites are

```
                     TX_ECO LS RV SS Total
          Central Texas Plateau  1  6  2     9
                   High Plains  3  4  0     7
South Central and Southern Humid  4 11  6    21
               Southern Deserts  2  2  0     4
          Southern Texas Plains  1  4  0     5
    Subhumid Agricultural Plains  4  5  4    13
       Western Gulf Coast Plains  3  4  4    11
                         Total 18 36 16    70
```

While the actual number of sites in each of these categories will not be known until site evaluations are completed, three aggregated ecoregions have fewer sites than expected and generally they are also stream sites. Texas plans to add 10 sites to achieve 80 sites. Based on the above, additional sites are selected for the three ecoregion and stream size categories to balance the sampling.

## Panels and Site Replacement

The panels are the same as for NRSA 2023-24 with the exception that the additional 10 sites and their over samples are in NRS23_23Base_TX and NRS23_23Over_TX. Sites should be used and replaced as described for the national design with the exception that over sample sites can be replaced by the next site within a Texas biological aggregated ecoregion instead of anywhere within the state. The latter is intended to meet the requirements of approximately an equal number of sites within those regions and within stream size categories.

Note that all Texas sites are provided in the NRSA 2023-24 design file. The expectation is that the additional sites sampled by Texas will be submitted to NRSA.

# Appendix H: Virginia

Virginia conducts state-level probability surveys.  Given that the design is compatible with NRSA 2023-24, the NRSA design will consist of the panels from the Resample Design and the sites from the Virginia state-level survey.  No New Site Design is required for Virginia.  Virginia samples by year and that process must be followed for NRSA 2023-24.

# Appendix I: Wisconsin

The NRSA 2023-24 sample frame is based on NHDPlusHR which is at least 1:24000. Given this, NHDPlusHR-based sample frame will be used for the additional sites required for New Hampshire. This was completed by selecting additional over sample sites for SS, LS, and RV (10 times more), compared to the standard 5 times more for each state. No other change was implemented.

Note that at the additional sites, Wisconsin will not be providing that data to NRSA.

# Appendix J: Additional Tables

## Base Sites

### Unique Sites by State

| STRATUM | SS | LS | RV | None | Total |
|---|---|---|---|---|---|
| AL | 10 | 9 | 17 | 0 | 36 |
| AR | 8 | 8 | 20 | 0 | 36 |
| AZ | 8 | 8 | 14 | 0 | 30 |
| CA | 18 | 18 | 36 | 0 | 72 |
| CO | 11 | 12 | 15 | 0 | 38 |
| CT | 5 | 5 | 10 | 0 | 20 |
| DE | 5 | 5 | 10 | 0 | 20 |
| FL | 5 | 5 | 10 | 0 | 20 |
| GA | 8 | 8 | 16 | 0 | 32 |
| IA | 9 | 9 | 20 | 0 | 38 |
| ID | 10 | 10 | 22 | 0 | 42 |
| IL | 9 | 10 | 17 | 0 | 36 |
| IN | 5 | 5 | 12 | 0 | 22 |
| KS | 0 | 0 | 0 | 52 | 52 |
| KY | 6 | 6 | 14 | 0 | 26 |
| LA | 7 | 7 | 14 | 0 | 28 |
| MA | 5 | 5 | 10 | 0 | 20 |
| MD | 5 | 5 | 10 | 0 | 20 |
| ME | 9 | 11 | 22 | 0 | 42 |
| MI | 15 | 18 | 35 | 0 | 68 |
| MN | 13 | 16 | 31 | 0 | 60 |
| MO | 14 | 12 | 26 | 0 | 52 |
| MS | 9 | 8 | 13 | 0 | 30 |
| MT | 18 | 18 | 36 | 0 | 72 |
| NC | 6 | 7 | 13 | 0 | 26 |
| ND | 9 | 8 | 21 | 0 | 38 |
| NE | 12 | 11 | 17 | 0 | 40 |
| NH | 5 | 5 | 10 | 0 | 20 |
| NJ | 5 | 5 | 10 | 0 | 20 |
| NM | 6 | 6 | 10 | 0 | 22 |

| | | | | | |
|---|---|---|---|---|---|
| NV | 8 | 7 | 11 | 0 | 26 |
| NY | 18 | 18 | 34 | 0 | 70 |
| OH | 8 | 8 | 20 | 0 | 36 |
| OK | 13 | 10 | 35 | 0 | 58 |
| OR | 10 | 11 | 31 | 0 | 52 |
| PA | 10 | 10 | 18 | 0 | 38 |
| RI | 5 | 5 | 10 | 0 | 20 |
| SC | 5 | 5 | 10 | 0 | 20 |
| SD | 16 | 16 | 26 | 0 | 58 |
| TN | 7 | 6 | 15 | 0 | 28 |
| TX | 16 | 18 | 36 | 0 | 70 |
| UT | 7 | 7 | 16 | 0 | 30 |
| VA | 5 | 6 | 11 | 0 | 22 |
| VT | 5 | 5 | 10 | 0 | 20 |
| WA | 9 | 10 | 29 | 0 | 48 |
| WI | 18 | 18 | 32 | 0 | 68 |
| WV | 5 | 5 | 10 | 0 | 20 |
| WY | 13 | 15 | 18 | 0 | 46 |
| Total | 433 | 440 | 883 | 52 | 1808 |

## Revisit Sites by State

| STRATUM | SS | LS | RV | None | Total |
|---|---|---|---|---|---|
| AL | 1 | 1 | 2 | 0 | 4 |
| AR | 1 | 1 | 2 | 0 | 4 |
| AZ | 1 | 1 | 2 | 0 | 4 |
| CA | 1 | 1 | 2 | 0 | 4 |
| CO | 1 | 1 | 2 | 0 | 4 |
| CT | 1 | 1 | 2 | 0 | 4 |
| DE | 1 | 1 | 2 | 0 | 4 |
| FL | 1 | 1 | 2 | 0 | 4 |
| GA | 1 | 1 | 2 | 0 | 4 |
| IA | 1 | 1 | 2 | 0 | 4 |
| ID | 1 | 1 | 2 | 0 | 4 |
| IL | 1 | 1 | 2 | 0 | 4 |
| IN | 1 | 1 | 2 | 0 | 4 |

| KS | 0 | 0 | 0 | 4 | 4 |
|----|---|---|---|---|---|
| KY | 1 | 1 | 2 | 0 | 4 |
| LA | 1 | 1 | 2 | 0 | 4 |
| MA | 1 | 1 | 2 | 0 | 4 |
| MD | 1 | 1 | 2 | 0 | 4 |
| ME | 1 | 1 | 2 | 0 | 4 |
| MI | 1 | 1 | 2 | 0 | 4 |
| MN | 1 | 1 | 2 | 0 | 4 |
| MO | 1 | 1 | 2 | 0 | 4 |
| MS | 1 | 1 | 2 | 0 | 4 |
| MT | 1 | 1 | 2 | 0 | 4 |
| NC | 1 | 1 | 2 | 0 | 4 |
| ND | 1 | 1 | 2 | 0 | 4 |
| NE | 1 | 1 | 2 | 0 | 4 |
| NH | 1 | 1 | 2 | 0 | 4 |
| NJ | 1 | 1 | 2 | 0 | 4 |
| NM | 1 | 1 | 2 | 0 | 4 |
| NV | 1 | 1 | 2 | 0 | 4 |
| NY | 1 | 1 | 2 | 0 | 4 |
| OH | 1 | 1 | 2 | 0 | 4 |
| OK | 1 | 1 | 2 | 0 | 4 |
| OR | 1 | 1 | 2 | 0 | 4 |
| PA | 1 | 1 | 2 | 0 | 4 |
| RI | 1 | 1 | 2 | 0 | 4 |
| SC | 1 | 1 | 2 | 0 | 4 |
| SD | 1 | 1 | 2 | 0 | 4 |
| TN | 1 | 1 | 2 | 0 | 4 |
| TX | 1 | 1 | 2 | 0 | 4 |
| UT | 1 | 1 | 2 | 0 | 4 |
| VA | 1 | 1 | 2 | 0 | 4 |
| VT | 1 | 1 | 2 | 0 | 4 |
| WA | 1 | 1 | 2 | 0 | 4 |
| WI | 1 | 1 | 2 | 0 | 4 |
| WV | 1 | 1 | 2 | 0 | 4 |
| WY | 1 | 1 | 2 | 0 | 4 |

| Total | 47 | 47 | 94 | 4 | 192 |
|---|---|---|---|---|---|

## 18-19 vs 23-24 by State

| STRATUM | 1819 | 2324 | Total |
|---|---|---|---|
| AL | 14 | 22 | 36 |
| AR | 13 | 23 | 36 |
| AZ | 15 | 15 | 30 |
| CA | 33 | 39 | 72 |
| CO | 18 | 20 | 38 |
| CT | 7 | 13 | 20 |
| DE | 7 | 13 | 20 |
| FL | 9 | 11 | 20 |
| GA | 16 | 16 | 32 |
| IA | 16 | 22 | 38 |
| ID | 21 | 21 | 42 |
| IL | 17 | 19 | 36 |
| IN | 10 | 12 | 22 |
| KS | 25 | 27 | 52 |
| KY | 13 | 13 | 26 |
| LA | 7 | 21 | 28 |
| MA | 9 | 11 | 20 |
| MD | 9 | 11 | 20 |
| ME | 12 | 30 | 42 |
| MI | 33 | 35 | 68 |
| MN | 27 | 33 | 60 |
| MO | 17 | 35 | 52 |
| MS | 6 | 24 | 30 |
| MT | 34 | 38 | 72 |
| NC | 12 | 14 | 26 |
| ND | 16 | 22 | 38 |
| NE | 19 | 21 | 40 |
| NH | 6 | 14 | 20 |
| NJ | 9 | 11 | 20 |
| NM | 11 | 11 | 22 |
| NV | 12 | 14 | 26 |

| | | | |
|------|------|------|------|
| NY | 28 | 42 | 70 |
| OH | 15 | 21 | 36 |
| OK | 28 | 30 | 58 |
| OR | 24 | 28 | 52 |
| PA | 17 | 21 | 38 |
| RI | 6 | 14 | 20 |
| SC | 9 | 11 | 20 |
| SD | 29 | 29 | 58 |
| TN | 13 | 15 | 28 |
| TX | 35 | 35 | 70 |
| UT | 14 | 16 | 30 |
| VA | 7 | 15 | 22 |
| VT | 9 | 11 | 20 |
| WA | 20 | 28 | 48 |
| WI | 34 | 34 | 68 |
| WV | 7 | 13 | 20 |
| WY | 22 | 24 | 46 |
| Total | 790 | 1018 | 1808 |

## Fish Tissue by State for Eligible Sites (Rivers)

| STRATUM | FT | NoFT | RV_Total |
|---------|-----|------|----------|
| AL | 12 | 5 | 17 |
| AR | 14 | 6 | 20 |
| AZ | 9 | 5 | 14 |
| CA | 25 | 11 | 36 |
| CO | 10 | 5 | 15 |
| CT | 6 | 4 | 10 |
| DE | 6 | 4 | 10 |
| FL | 7 | 3 | 10 |
| GA | 11 | 5 | 16 |
| IA | 14 | 6 | 20 |
| ID | 15 | 7 | 22 |
| IL | 12 | 5 | 17 |
| IN | 8 | 4 | 12 |
| KS | 7 | 3 | 10 |

| | | | |
|-----|-----|-----|-----|
| KY | 9 | 5 | 14 |
| LA | 10 | 4 | 14 |
| MA | 7 | 3 | 10 |
| MD | 7 | 3 | 10 |
| ME | 15 | 7 | 22 |
| MI | 24 | 11 | 35 |
| MN | 21 | 10 | 31 |
| MO | 18 | 8 | 26 |
| MS | 10 | 3 | 13 |
| MT | 25 | 11 | 36 |
| NC | 8 | 5 | 13 |
| ND | 15 | 6 | 21 |
| NE | 12 | 5 | 17 |
| NH | 8 | 2 | 10 |
| NJ | 7 | 3 | 10 |
| NM | 7 | 3 | 10 |
| NV | 8 | 3 | 11 |
| NY | 23 | 11 | 34 |
| OH | 14 | 6 | 20 |
| OK | 24 | 11 | 35 |
| OR | 21 | 10 | 31 |
| PA | 12 | 6 | 18 |
| RI | 8 | 2 | 10 |
| SC | 7 | 3 | 10 |
| SD | 18 | 8 | 26 |
| TN | 10 | 5 | 15 |
| TX | 25 | 11 | 36 |
| UT | 11 | 5 | 16 |
| VA | 8 | 3 | 11 |
| VT | 7 | 3 | 10 |
| WA | 20 | 9 | 29 |
| WI | 22 | 10 | 32 |
| WV | 6 | 4 | 10 |
| WY | 12 | 6 | 18 |
| Total | 615 | 278 | 893 |

# Over Sites

## Unique Sites by State

| STRATUM | SS | LS | RV | None | Total |
|---|---|---|---|---|---|
| AL | 26 | 28 | 60 | 0 | 114 |
| AR | 23 | 26 | 75 | 0 | 124 |
| AZ | 44 | 26 | 41 | 0 | 111 |
| CA | 168 | 68 | 105 | 0 | 341 |
| CO | 117 | 46 | 55 | 0 | 218 |
| CT | 23 | 17 | 35 | 0 | 75 |
| DE | 25 | 20 | 35 | 0 | 80 |
| FL | 28 | 18 | 27 | 0 | 73 |
| GA | 28 | 24 | 44 | 0 | 96 |
| IA | 35 | 32 | 53 | 0 | 120 |
| ID | 97 | 39 | 56 | 0 | 192 |
| IL | 27 | 39 | 53 | 0 | 119 |
| IN | 22 | 25 | 35 | 0 | 82 |
| KS | 0 | 0 | 0 | 1754 | 1754 |
| KY | 18 | 18 | 38 | 0 | 74 |
| LA | 30 | 30 | 45 | 0 | 105 |
| MA | 19 | 18 | 25 | 0 | 62 |
| MD | 23 | 18 | 28 | 0 | 69 |
| ME | 30 | 35 | 90 | 0 | 155 |
| MI | 48 | 48 | 93 | 0 | 189 |
| MN | 50 | 56 | 90 | 0 | 196 |
| MO | 65 | 43 | 80 | 0 | 188 |
| MS | 30 | 35 | 60 | 0 | 125 |
| MT | 56 | 70 | 100 | 0 | 226 |
| NC | 117 | 95 | 159 | 0 | 371 |
| ND | 27 | 41 | 65 | 0 | 133 |
| NE | 36 | 84 | 72 | 0 | 192 |
| NH | 143 | 137 | 45 | 0 | 325 |
| NJ | 22 | 19 | 26 | 0 | 67 |
| NM | 97 | 101 | 80 | 0 | 278 |
| NV | 39 | 98 | 32 | 0 | 169 |
| NY | 82 | 62 | 120 | 0 | 264 |

| | | | | | |
|-----|-----|-----|-----|-----|-----|
| OH | 25 | 24 | 60 | 0 | 109 |
| OK | 52 | 43 | 94 | 0 | 189 |
| OR | 66 | 35 | 85 | 0 | 186 |
| PA | 30 | 29 | 55 | 0 | 114 |
| RI | 29 | 20 | 45 | 0 | 94 |
| SC | 18 | 23 | 29 | 0 | 70 |
| SD | 48 | 313 | 83 | 0 | 444 |
| TN | 21 | 18 | 40 | 0 | 79 |
| TX | 155 | 91 | 115 | 0 | 361 |
| UT | 25 | 24 | 47 | 0 | 96 |
| VA | 16 | 19 | 45 | 0 | 80 |
| VT | 16 | 21 | 26 | 0 | 63 |
| WA | 39 | 30 | 90 | 0 | 159 |
| WI | 93 | 112 | 187 | 0 | 392 |
| WV | 18 | 18 | 35 | 0 | 71 |
| WY | 77 | 102 | 117 | 0 | 296 |
| Total | 2323 | 2338 | 3075 | 1754 | 9490 |

## 18-19 vs 23-24 by State

| STRATUM | 1819 | 2324 | Total |
|---------|------|------|-------|
| AL | 4 | 110 | 114 |
| AR | 9 | 115 | 124 |
| AZ | 36 | 75 | 111 |
| CA | 146 | 195 | 341 |
| CO | 118 | 100 | 218 |
| CT | 10 | 65 | 75 |
| DE | 15 | 65 | 80 |
| FL | 18 | 55 | 73 |
| GA | 16 | 80 | 96 |
| IA | 10 | 110 | 120 |
| ID | 87 | 105 | 192 |
| IL | 24 | 95 | 119 |
| IN | 22 | 60 | 82 |
| KS | 104 | 1650 | 1754 |
| KY | 9 | 65 | 74 |

| | | | |
|---|---|---|---|
| LA | 0 | 105 | 105 |
| MA | 7 | 55 | 62 |
| MD | 14 | 55 | 69 |
| ME | 5 | 150 | 155 |
| MI | 14 | 175 | 189 |
| MN | 31 | 165 | 196 |
| MO | 13 | 175 | 188 |
| MS | 0 | 125 | 125 |
| MT | 36 | 190 | 226 |
| NC | 301 | 70 | 371 |
| ND | 23 | 110 | 133 |
| NE | 87 | 105 | 192 |
| NH | 10 | 315 | 325 |
| NJ | 12 | 55 | 67 |
| NM | 223 | 55 | 278 |
| NV | 99 | 70 | 169 |
| NY | 54 | 210 | 264 |
| OH | 4 | 105 | 109 |
| OK | 39 | 150 | 189 |
| OR | 46 | 140 | 186 |
| PA | 9 | 105 | 114 |
| RI | 19 | 75 | 94 |
| SC | 15 | 55 | 70 |
| SD | 299 | 145 | 444 |
| TN | 4 | 75 | 79 |
| TX | 136 | 225 | 361 |
| UT | 16 | 80 | 96 |
| VA | 5 | 75 | 80 |
| VT | 8 | 55 | 63 |
| WA | 19 | 140 | 159 |
| WI | 52 | 340 | 392 |
| WV | 6 | 65 | 71 |
| WY | 176 | 120 | 296 |
| Total | 2410 | 7080 | 9490 |