

National Rivers and Streams Assessment Survey Design: 2013-2014

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. from 2008-9 to 2013-14 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. from 2008-9 to 2013-14 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.
- accomplish the above while ensuring that the minimum sample size for a state will be 20.
- Revisit 10% of the sites in 2013-14 for variance component estimation and quality assurance.

The total number of sites available to satisfy these objectives is 2000.

Target population:

The target populations 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 to September and is generally characterized by low flow conditions. The target population includes the Great Rivers. Run-of-the-river ponds and pools are included while reservoirs are excluded. A complete definition of the target population is given in the field operations manual.

Sample Frame:

The sample frame was derived from the medium National Hydrography Dataset (NHD), in particular NHD-Plus. Attributes from NHD-Plus and additional attributes added to the sample frame that are used in the survey design are:

- MajorRiver: rivers identified as major rivers or additional rivers in the book: Rivers of North America
- Strahler order
- Strahler category where categories are RiversMajor (5th and higher), RiversOther (5th and higher), LargeStreams (3rd, 4th order), and SmallStreams (1st, 2nd order)

- BorderRiver: rivers and streams that occur on state and country boundaries. Each reach is identified by two-state postal codes such as MO:IL for the portion of the Mississippi river that forms the boundary between Missouri and Illinois. A border river/stream is assigned to one of the two states for the survey design.
- Ecological Reporting Region: Nine aggregated Omernik ecoregions that are used for reporting
- Omernik and North American ecoregions Levels I, II, III and IV.
- Postal code (state)
- Urban and non-urban rivers and streams
- Landownership as non-federal, Forest Service, BLM, Tribal Land, US Fish and Wildlife Service, US National Park Service, and Department of Defense.

The Urban attribute was created by intersecting a modified version of the Census Bureau national urban boundary GIS coverage with NHD-Plus. The Census Bureau's boundaries were buffered 100 meters to include a majority of stream features intersecting and coincident with urban areas. Where this buffer did not completely gather all the river features within the urban areas (rivers intersecting cities are excluded from the Census Bureau's urban areas), the NHD-Plus river area (polygon) features were clipped at a three kilometer buffer around the urban areas and combined with the buffered urban area to create the modified urban database. If a stream or river segment was within this boundary, it is designated as "Urban"; otherwise as "NonUrban".

FCODE is directly from NHD-Plus and is used to identify which segments in NHD were included in the sample frame. The attribute Frame07 identifies each segment as either "Include" or "Exclude". Frame07 was created so that segments included in the sample frame could be easily identified. FCODE values included in the GIS shapefile:

Included in sample frame:

- 33600 Canal/Ditch
- 42801 Pipeline: Pipeline Type = Aqueduct; Relationship to Surface = At or Near
- 46000 Stream/River
- 46006 Stream/River (Perennial)
- 58000 Artificial Path (removed from dataset if coded through Lake/Pond and Reservoirs)

Excluded in FW08 sample frame

- 33400 Connector
- 46003 Stream/River (Intermittent)
- 42800 Pipeline
- 42802 Pipeline: Pipeline Type = Aqueduct; Relationship to Surface = Elevated
- 42803 Pipeline: Pipeline Type = Aqueduct; Relationship to Surface = Underground
- 42804 Pipeline: Pipeline Type = Aqueduct; Relationship to Surface = Underwater
- 42806 Pipeline: Pipeline Type = General Case; Relationship to Surface = Elevated
- 4280 Pipeline: Pipeline Type = General Case; Relationship to Surface = Underground
- 42809 Pipeline: Pipeline Type = Penstock; Relationship to Surface = At or Near
- 42811 Pipeline: Pipeline Type = Penstock; Relationship to Surface = Underground
- 42813 Pipeline: Pipeline Type = Siphon
- 56600 Coastline
- 58000 Artificial Path if coded through Lake/Pond and Reservoirs

Survey Design:

The survey design consists of two major components (NRSA14 design and NRSA09 design) in order to address the dual objectives of (1) estimating current status and (2) estimating change in status for all flowing waters.

NRSA09 Design: The NRSA09 survey design is a subsample of the NRSA 2008-9 sites that were target and sampled in the NRSA 2008-9. The major objective for this design is change estimation, although all sites sampled in 2013-14 will be used when change is estimated. The expected sample sizes were based on the nine ecological reporting regions and two Strahler order categories of Rivers (5th and greater) and Streams (1st through 4th). Three ecological reporting regions (UMW, NPL, SPL) involve a smaller number of states and were allocated fewer sites than the other six regions (NAP, SAP, CPL, TPL, WMT, XER). Given these expected sample sizes, the number of sites for each state was allocated proportional to the River or Stream length in each state for each ecological reporting region.

Ecological Region	Expected Sample Size NRSA09		
	Rivers	Stream	Total
NAP	45	50	95
SAP	45	50	95
CPL	45	50	95
TPL	45	50	95
XER	45	50	95
WMT	45	50	95
UMW	40	40	80
NPL	40	40	80
SPL	40	40	80
Total	390	420	810

The overall survey design included having 10% of the sites be visited twice in 2013-14. This was accomplished by allocating 4 sites (2 Rivers and 2 Streams sites) to each of the 48 states for revisits (192 sites total). All of these revisit sites were assigned to the NRSA09 design. More over the sites selected to be revisited were also the same sites that were visited twice in 2008-9. This results in 192 sites that were visited twice in 2008-9 and will be visited twice in 2013-14.

The NRSA09 Design sites will also be resampled in NRSA 2018-19.

NRSA14 Design: The NRSA14 survey design is a new survey design that will select new sites. The expected sample sizes were based on the nine ecological reporting regions and four categories of RiversMajor (5th and greater), RiversOther (5th and greater), LargeStreams (Strahler order 3rd, 4th), and SmallStreams (Strahler order 1st, 2nd). Three ecological reporting regions (UMW, NPL, SPL) involve a smaller number of states and were allocated fewer sites than the other six regions (NAP, SAP, CPL, TPL, WMT, XER). Given these expected sample sizes, the number of sites for each state was allocated proportional to the four river and stream category length in each state for each ecological reporting region. Adjustments to the number of sites for states were made to ensure that each state had a minimum of 20 sites

from the NRSA09 and NRSA14 designs. The final number of sites was also adjusted to ensure that a total of 1808 unique sites were selected.

Ecological Region	Expected Sample Size NRSA14				Total
	RiversMajor	RiversOther	LargeStreams	SmallStreams	
NAP	29	30	33	35	127
SAP	29	30	33	35	127
CPL	29	30	33	35	127
TPL	29	30	33	35	127
XER	29	30	33	35	127
WMT	29	30	33	35	127
UMW	18	19	19	22	78
NPL	18	19	19	22	78
SPL	18	19	19	22	78
Total	228	237	255	276	996

Stratification: The survey design is explicitly stratified by state for both the NRSA09 and NRSA14 designs.

Multi-density categories: Within each state, unequal probability of selection was based on river and stream categories as well as ecological reporting regions.

NRSA09 design: The target and sampled sites from NRSA 2008-9 were placed in siteID order within a state and within the River and Stream categories. The sites required for these categories were then selected as the first set of sites within that list required to meet the sample size requirements. That is, the sites were selected with equal probability within the categories.

The original NRSA 2008-9 survey design used unequal probability categories defined separately for streams (1st to 4th order) and rivers (5th to 10th order). For the stream category, within each state unequal selection probabilities were defined for 1st, 2nd, 3rd, and 4th order streams so that an equal number of sites would occur for each order. Then these unequal selection probabilities were adjusted by the nine ecological reporting regions so that an equal number of sites would occur in each region. For the river category, unequal selection probabilities were defined for 5th, 6th, 7th, and 8th+ order rivers. Then these unequal selection probabilities were adjusted by the nine ecological reporting regions so that an equal number of sites would occur in each region.

NRSA14 design: The unequal probability of selection categories were the combination of state, ecological reporting region, and the four river and stream categories (RiversMajor, RiversOther, LargeStreams and SmallStreams).

Over Sample and Site Replacement

Both the NRSA09 and NRSA14 designs include a set of over sample sites to be used when a base site cannot be sampled for any reason. The two designs have six categories within each state that are the basis for the over sample and site replacement:

Replacement Category	Base sites	Replace by Over sample sites
NRSA09 Rivers	Base_09River & Base09River_RVT	Over_09River
NRSA09 Streams	Base_09Stream & Base09Stream_RVT	Over_09Stream
NRSA14 Rivers Major	Base_NewRiversMajor	Over_NewRiversMajor
NRSA14 Rivers Other	Base_NewRiversOther	Over_NewRiversOther
NRSA14 Large Streams	Base_NewLargeStreams	Over_NewLargeStreams
NRSA14 Small Streams	Base_NewSmallStreams	Over_NewSmallStreams

Sites within each state and above six categories are provided in siteID order and the replacement must be in siteID order. The Base09River_RVT and Base09Stream_RVT sites identify the four sites within each state that must sample visited twice in 2013-14. If one of those sites cannot be sampled, then the next site within the category then becomes a site to be visited twice.

State Designs

States may elect to implement a state-wide survey design. The above survey design describes the national survey design and sets the required number of sites that must be sampled within each state and the six design categories. If a state implements a state design, the NRSA09 design sites must be sampled as part of the state-wide design. The rest of the state design may be of two general types. The first type is one where a state may simply sample additional sites from the over sample list of sites within their state to achieve a minimum of 50 sites. The second type is where the state has state-specific survey design requirements. In this case a new survey design for the state is completed that meets both the national and state survey design requirements. The new design will include the NRSA09 design sites. This new survey design will replace the current national design sites within the state. Survey design descriptions for each state are described separately.

Sample Frame Summary

The sample frame is available as 48 state shapefiles.

State	Ecological Report Region									Total
	CPL	NAP	NPL	SAP	SPL	TPL	UMW	WMT	XER	
AL	41,404.4	0.0	0.0	28,910.9	0.0	0.0	0.0	0.0	0.0	70,315.4
AR	31,763.4	0.0	0.0	19,782.0	0.0	0.0	0.0	0.0	0.0	51,545.5
AZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3,616.5	2,770.5	6,387.0
CA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57,630.8	56,277.4	113,908.1
CO	0.0	0.0	0.0	0.0	12,388.6	0.0	0.0	37,884.9	11,627.4	61,901.0
CT	0.0	8,497.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8,497.9
DE	3,567.6	0.0	0.0	139.3	0.0	0.0	0.0	0.0	0.0	3,706.9
FL	77,346.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	77,346.0
GA	35,886.8	0.0	0.0	32,888.7	0.0	0.0	0.0	0.0	0.0	68,775.5

IA	0.0	0.0	0.0	0.0	0.0	40,991.2	2,684.9	0.0	0.0	43,676.0
ID	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66,912.5	27,364.0	94,276.5
IL	162.4	0.0	0.0	1,489.2	0.0	46,281.5	728.0	0.0	0.0	48,661.4
IN	0.0	0.0	0.0	5,663.8	0.0	27,209.5	5,051.6	0.0	0.0	37,924.9
KS	0.0	0.0	0.0	51.4	12,407.2	14,185.8	0.0	0.0	0.0	26,644.4
KY	2,849.0	0.0	0.0	43,180.3	0.0	8,354.5	0.0	0.0	0.0	54,384.0
LA	61,231.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	61,231.4
MA	156.6	10,597.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10,754.3
MD	7,322.3	0.0	0.0	8,120.8	0.0	0.0	0.0	0.0	0.0	15,443.1
ME	0.0	37,287.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37,287.5
MI	0.0	0.0	0.0	0.0	0.0	9,071.2	40,819.3	0.0	0.0	49,890.6
MN	0.0	0.0	0.0	0.0	0.0	21,753.9	41,555.8	0.0	0.0	63,309.7
MO	8,329.5	0.0	0.0	19,431.0	0.0	25,586.3	0.0	0.0	0.0	53,346.9
MS	44,524.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44,524.7
MT	0.0	0.0	33,831.5	0.0	0.0	0.0	0.0	60,121.0	232.5	94,185.1
NC	31,483.1	0.0	0.0	45,549.6	0.0	0.0	0.0	0.0	0.0	77,032.5
ND	0.0	0.0	7,640.3	0.0	0.0	6,586.7	0.0	0.0	0.0	14,226.9
NE	0.0	0.0	2,680.7	0.0	17,778.2	9,017.5	0.0	0.0	0.0	29,476.6
NH	0.0	12,622.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12,622.9
NJ	8,062.5	1,170.4	0.0	4,183.8	0.0	0.0	0.0	0.0	0.0	13,416.9
NM	0.0	0.0	0.0	0.0	3,643.0	0.0	0.0	6,598.9	7,146.0	17,387.8
NV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	396.4	19,881.9	20,278.3
NY	386.5	70,996.2	0.0	1,890.8	0.0	0.0	0.0	0.0	0.0	73,273.5
OH	0.0	9,079.5	0.0	16,390.5	0.0	21,961.0	0.0	0.0	0.0	47,431.1
OK	2,742.3	0.0	0.0	9,042.2	19,354.8	3,568.8	0.0	0.0	0.0	34,708.1
OR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	78,530.7	9,595.3	88,126.0
PA	195.5	23,282.7	0.0	38,404.0	0.0	0.0	0.0	0.0	0.0	61,882.3
RI	0.6	1,363.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,364.1
SC	24,374.6	0.0	0.0	15,085.9	0.0	0.0	0.0	0.0	0.0	39,460.4
SD	0.0	0.0	10,365.3	0.0	355.5	4,646.2	0.0	1,349.3	0.0	16,716.5
TN	22,402.4	0.0	0.0	64,593.6	0.0	0.0	0.0	0.0	0.0	86,995.9
TX	43,452.4	0.0	0.0	0.0	26,892.1	0.0	0.0	0.0	3,130.6	73,475.2
UT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12,077.6	17,684.2	29,761.8
VA	13,715.8	0.0	0.0	42,659.6	0.0	0.0	0.0	0.0	0.0	56,375.4
VT	0.0	10,946.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10,946.2
WA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	58,358.2	12,431.7	70,789.7
WI	0.0	0.0	0.0	0.0	0.0	8,602.7	40,886.6	0.0	0.0	49,489.1
WV	0.0	0.0	0.0	33,842.9	0.0	0.0	0.0	0.0	0.0	33,842.9
WY	0.0	0.0	5,833.1	0.0	2,834.3	0.0	0.0	26,189.9	23,942.0	58,799.3
Total	461,360.3	185,844.4	60,350.9	431,300.2	95,653.9	247,817.4	131,726.1	409,667.0	192,083.2	2,215,803.3

Site Selection Summary

Number of Sites

Ecological Report Region	NRSA09 Design			NRSA14 Design					Design Total
	Rivers	Streams	Total	Rivers Major	Rivers Other	Large Streams	Small Streams	Total	
CPL	52	48	100	29	33	34	42	138	238
NAP	52	41	93	30	34	39	44	147	240
NPL	43	39	82	16	17	17	25	75	157
SAP	52	60	112	29	30	31	38	128	240
SPL	41	34	75	20	21	20	20	81	156
TPL	44	49	93	28	27	30	28	113	206
UMW	39	40	79	19	20	20	18	77	156
WMT	43	61	104	29	26	32	32	119	223
XER	43	30	73	27	28	33	31	119	192
Total	409	402	811	227	236	256	278	997	1808

Description of Sample Design Output:

The dbf file for the shapefile (**NRSA14_Integrated_20120515**) has the following variable definitions:

Variable Name	Description
sitelD14	Unique identification label for each site in the design
sitelD09	SiteID from NRSA 2008-9 survey design that may be resampled in 2013-14. Blank if not a site from NRSA 2008-9 design
PSTL_CODE	State two-letter postal code
DES_NRSA14	Identifies six design categories: Rivers (NRSA09 design), Streams (NRSA09 design), RiversMajor (NRSA14 design), RiversOther (NRSA14 design), LargeStreams (NRSA14 design), SmallStreams (NRSA14 design)
panel	Base_XXXXXX identifies the 1808 stream and river sites in the base design. Over_XXXXXX identifies sites to be used as replacements as necessary within the DES_NRSA14 categories
LATDD_GRS	Latitude in decimal degrees of stream/river site
LONDD_GRS	Longitude in decimal degrees of stream/river site
xcoord	x-coordinate of stream/river site (see Albers projection information below)
ycoord	y-coordinate of stream/river site (see Albers projection information below)
mdcaty	inclusion probability used for the unequal probability selection of the sample stream/river
wgt	Weight (in km) to be used in the statistical analyses. It is the inverse of the inclusion probability
stratum	Strata used in design
DES_CAT	Six design categories used in the survey designs
STRAH_CAT	Strahler order categories
SO	NHD-Plus new Strahler order
FRAME14	Identifies whether site is part of NRSA_ST, NRSA_only, or state only
WSA_9	Nine Ecological reporting region code: NAP, SAP, CPL, UMW, TPL, NPL, SPL, XER, WMT
WSA_9_NM	Nine Ecological reporting region name
WSA_3	Three Ecological reporting region code: EHIGH, PLNLOW, WMTNS
STATE	Two-letter state code. If site is on border river then identifies both states as ST:ST
STATE_NAME	State name
URBAN	Identifies site as Urban or non-urban
GNIS_ID	GNIS feature code
GNIS_NAME	GNIS feature name

NRSA_Name	GNIS feature name unless updated/added by NRSA
MAJ_RIVER	Identifies river as major or additional river based on Rivers of North America
MAJ_RIV_NM	Name of major or additional river
US_L4CODE	Omernik ecoregion Level IV code
US_L4NAME	Omernik ecoregion Level IV name
US_L3CODE	Omernik ecoregion Level III code
US_L3NAME	Omernik ecoregion Level III name
NA_L3CODE	North American ecoregion Level III code
NA_L3NAME	North American ecoregion Level III name
NA_L2CODE	North American ecoregion Level II code
NA_L2NAME	North American ecoregion Level II name
NA_L1CODE	North American ecoregion Level I code
NA_L1NAME	North American ecoregion Level I name
FEAT_NAME	Federal land ownership type
OWNER	Federal agency and Tribal land owner
OWNER_CAT	Federal agency name for land (eg name of national forest)
OWNER_ADM	Administrative agency identifier
OWNER_CAT2	BLM district office identifier
COMID	NHD-PLUS unique segment identifier
LENGTHKM	Length is stream reach that site is one (km)
REACHCODE	NHD-Plus reach code
FCODE	NHD feature type code
FTYPE	NHD feature type name
DES_FTYPE	Design FTYPE created from FTYPE and other NHD-Plus features
HUC8	Hydrologic unit code: 8-digit
BOAT_WADE	NRSA 2008-9 site was boatable or wadeable when sampled
NFWAWgtCat	Categories used to create weights for the analysis of NRSA 2008-9 survey
WgtNRSAnew	Weights for NRSA 2008-9 sites when only the new NRSA 2008-9 sites are used to define the weights (ie excludes WSA sites)

Projection Information

PROJCS["USA_Contiguous_Albers_Equal_Area_Conic_USGS_version",
 GEOGCS["GCS_North_American_1983",
 DATUM["D_North_American_1983",
 SPHEROID["GRS_1980",6378137.0,298.257222101]],
 PRIMEM["Greenwich",0.0],
 UNIT["Degree",0.0174532925199433]],
 PROJECTION["Albers"],
 PARAMETER["False_Easting",0.0],
 PARAMETER["False_Northing",0.0],
 PARAMETER["Central_Meridian",-96.0],
 PARAMETER["Standard_Parallel_1",29.5],
 PARAMETER["Standard_Parallel_2",45.5],

PARAMETER["Latitude_Of_Origin",37.5],
UNIT["Meter",1.0]]

For further information, contact

Anthony (Tony) R. Olsen
USEPA NHEERL
Western Ecology Division
200 S.W. 35th Street
Corvallis, OR 97333
Voice: (541) 754-4790
Fax: (541) 754-4716
email: Olsen.Tony@epa.gov