R-WD-18-09

Assessing Aquatic Life and Primary Contact Recreation Designated Uses of New Hampshire's Rivers and Streams 2013-2017:

A statewide probability-based survey

Punch Brook, Franklin, NH (NHDES)

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INTRODUCTION

The purpose of this report is to summarize the results of the probability-based assessments of aquatic life use and primary contact recreation designated uses in rivers and streams for New Hampshire's 2018 Section 305(b) federal water quality report. Aquatic life use is assessed by analyzing macroinvertebrate and fish communities while primary contact recreation or swimming is assessed by analyzing bacteria concentrations. Probability-based monitoring uses randomly selected stations to sample a natural resource without bias. Statistics from the sample set can be used to make inferences about conditions on the target resource as a whole, such as the state's rivers and streams. Using this type of survey design allows data from the sampled sites to be applied to the defined target population, and assessments with known confidence bounds to be made. The advantage of this approach is that a substantial portion of the resource can be assessed at minimal cost. One disadvantage is that the probability-based design is not constructed to make waterbody specific statements. The utility of probability-based assessments are to provide insight on the overall condition of the target population, in this case, New Hampshire's rivers and streams.

METHODS

Data Source

Data for these assessments were collected from June through August, in 2013 and 2014 for the National Rivers and Streams Assessment (NRSA) and 2014 through 2016 for the State intensification, identified as the State Rivers and Streams Assessment (SRSA).

The NRSA was organized by the US Environmental Protection Agency (USEPA) to assess the condition of flowing freshwaters as part of the National Aquatic Resource Surveys (NARS), inclusive of wetlands, lakes and coastal waters. Work for the NRSA in New Hampshire (NH) was completed by New Hampshire Department of Environmental Services (NHDES) staff with assistance from the USEPA. The study involved collection of biological and bacterial data at 20 stations as described under site selection and study design. Detailed study design and sampling method documents include the National Rivers and Streams Assessment Survey Design (Olsen, 2012) and the National Rivers and Streams Assessment manuals covering the quality assurance project plan (*USEPA, 2013a)*, site evaluation guidelines (*USEPA, 2013b)*, non-wadeable rivers (*USEPA, 2013c)*, wadeable streams (*USEPA, 2013d),* and laboratory operations (*USEPA, 2013e)*.

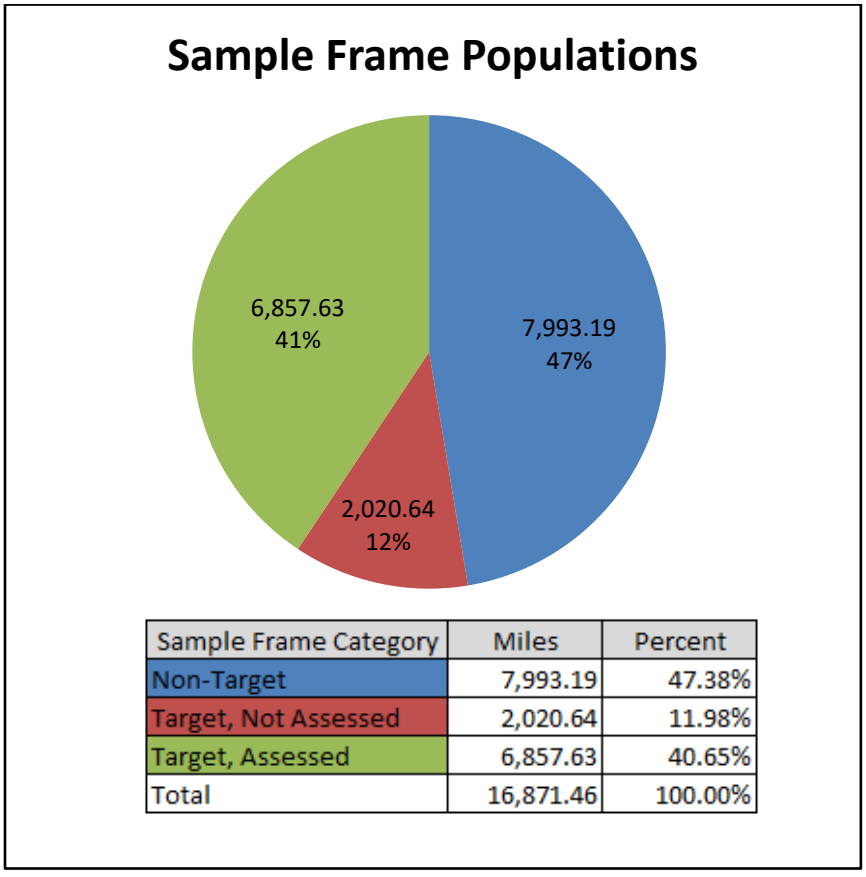
The SRSA study was a sampling intensification study that involved the collection of biological and bacterial data at an additional 30 stations to generate a 50 sample dataset. As with the NRSA, SRSA stations were proportional to the number of large and small streams sampled under the NRSA survey design. SRSA stations with a drainage area less than 2 sq. miles, those

unlikely to have a substantial fish population, or with a drainage area greater than 85 sq. miles, and therefore likely not wadeable, were eliminated from possible selection. Detailed sampling method documents include macroinvertebrate and fish sampling protocols described in the Ambient River Monitoring Quality Assurance Project Plan (NHDES, 2014).

Study Area

The New Hampshire Hydrographic Database stream layer (NHHD 2012, 1:24,000 scale) provided to USEPA for the survey design and subsequent sample station selection contained 18,561 river miles. A 1,689 mile subset was removed from the network because they were not contained within state boundaries, had mapping inconsistencies, or did not represent freshwater, flowing environments (see Table 1, NH River Sample Frame). As a result, the study area or sample frame included 16,871 river miles. Based on site visits, some of the randomly selected sites were not sampled and were categorized as non-target resulting in the removal of an additional 7,993 miles from the sample frame. The probability based assessment applies to the remaining target population of 8,878 miles of New Hampshire's rivers and streams (Figure 1 and Table 2). A portion of the target population was not assessed. See Table 2 and section, "River Classification, Site Selection and Sampling Design."

Figure 1: Sample Frame Populations



Sample Frame Category	Miles	Percent
Non-Target	7,993.19	47.38%
Target, Not Assessed	2,020.64	11.98%
Target, Assessed	6,857.63	40.65%
Total	16,871.46	100.00%

Table 1: NH River Sample Frame

Category	Step #	Step Description	Miles Removed	Miles Remaining	Sum of Miles Removed (Steps 2-8)
Original Sample Frame	1	NH2012_NHHD		18,561.14	
Rivers/ Streams not in NH	2	Removal of Source_Fea that are not in NH	56.97	18,504.18	
Mapping Inconsistencies	3	Removal of Strahler Order "-99" (these are the three areas that are more intensly mapped (1,2 order)	527.79	17,976.39	
	4	Removal of Strahler Order "0" (these the streams sections that are not part of the 24K NHD network)	13.31	17,963.08	
Not freshwater free-flowing	5	Removal of "LAK" AUIDs	1,051.16	16,911.92	
	6	Removal of "EST" AUIDs	20.31	16,891.61	
	7	Removal of "OCN" AUIDs	2.28	16,889.33	
Professional judgement of non-free flowing waters	8	Removal of the 21 AUIDs (these are all classified as NHIMP, but are really natural lakes/ponds raised by damming), defined below*	17.87	16,871.46	1,689.68
NH RIVER SAMPLE FRAME MILES = 16,871.46					
* An additional 21 AUIDs were removed from the target population either because they are coded as impoundments but are more appropriately considered natural lakes or ponds raised by a registered dam. These were historically categorized as a "natural [lake], raised by damming" by NHF&G (1970s), and carried forward in LMORPH (by Bob Estabrook, NHDES) and therefore should not be evaluated as a river/stream.					

Table 2: Estimated River Miles, Sample Frame Categories derived from statistical analysis of evaluated stations

Sample Frame Population	Category	Miles	% of Non-Target/ Target	% of Sample Frame Population
Non-Target	Canal	140.87	2%	0.83%
	Impounded	156.63	2%	0.93%
	Map Error	259.97	3%	1.54%
	Non Perennial	1,299.86	16%	7.70%
	Estuarine	69.45	1%	0.41%
	Impounded	400.84	5%	2.38%
	Other	140.87	2%	0.83%
	Pipe	259.97	3%	1.54%
	Wetland	259.97	3%	1.54%
	WS Size < 2 sq. miles	4,203.08	53%	24.91%
	Wetland	801.68	10%	4.75%
	Total (Non-Target)	7,993.19	100%	47.38%
Target	Not Assessed, Inaccessible	1,059.68	12%	6.28%
	Not Assessed, Not Wadeable	491.06	6%	2.91%
	Not Assessed, WS Size > 85 sq. miles	313.26	4%	1.86%
	Not Assessed, Other	156.63	2%	0.93%
	Total, Not Assessed	2,020.64	23%	11.98%
	Assessed	6,857.63	77%	40.65%
	Total, Assessed	6,857.63	77%	40.65%
	Total (Target)	8,878.27	100%	52.62%
Sample Frame Population (Target + Non-Target) Total		16,871.46	N/A	100.00%

River Classification, Site Selection, and Sampling Design

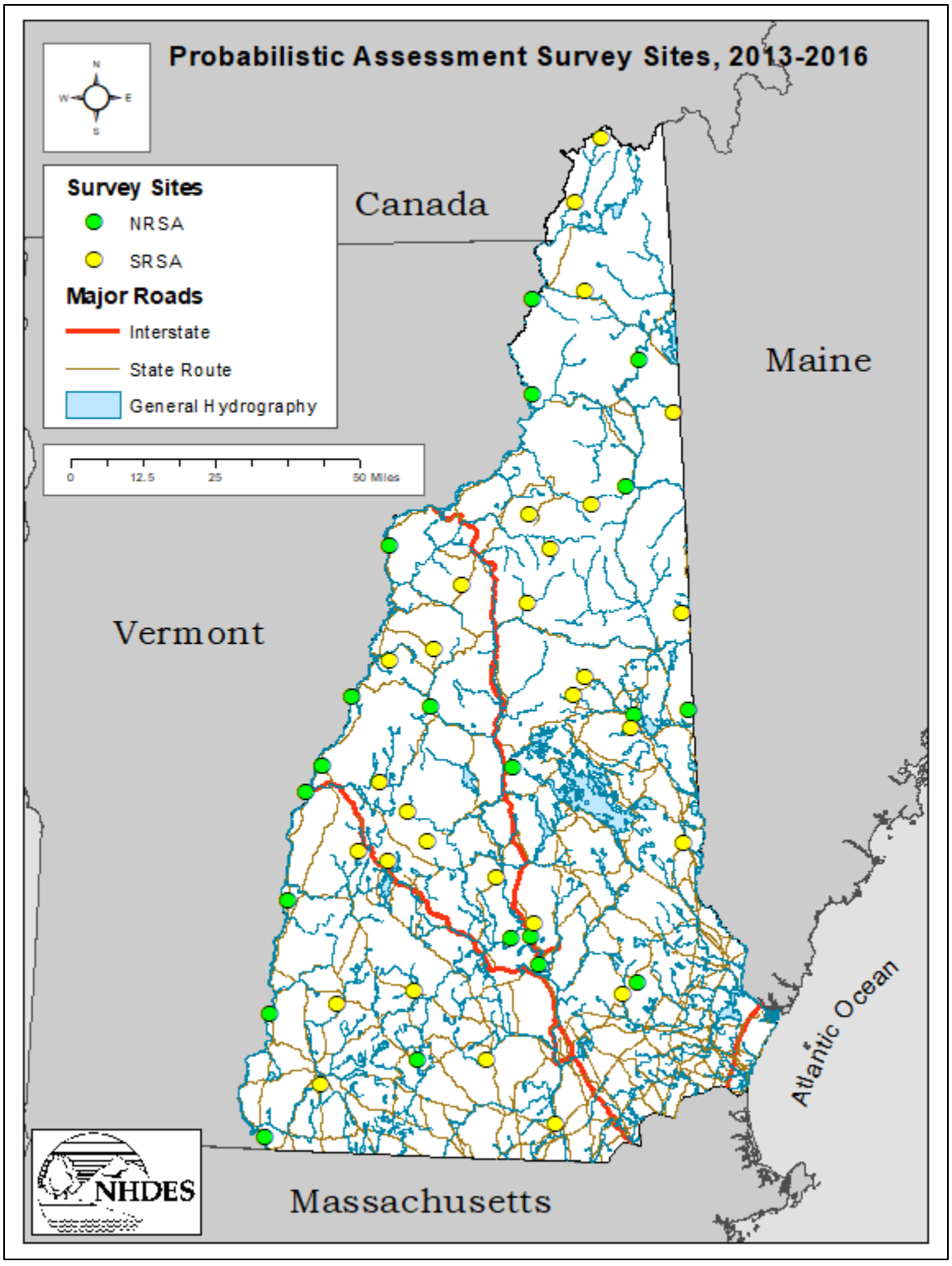
Rivers were categorized by Strahler Order as small streams (1-3 Strahler order), large streams (3-5 Strahler order), major rivers (5+ Strahler order rivers identified as major rivers or additional rivers in the book: Rivers of North America), and other rivers (5+ Strahler order not considered major rivers) (USEPA, 2013b).

A Generalized Random Tessellation Stratified (GRTS) survey design for a linear resource was used for the NRSA design (Olsen, 2012). Twenty sites for the NRSA and an additional 30 sites were selected to satisfy the SRSA intensification. Locations of the 50 sites used in the probability-based assessment of New Hampshire's rivers and streams are shown in Figure 2. The 30 SRSA sites were selected from small stream and large stream categories in the same proportion (60% large streams, 40% small streams) as done for the NRSA. Following site specific aquatic life use and primary contact recreation condition assessments, station data sets were merged and a site specific weighting factor as described by Olsen (2012) to account for the unbalanced nature of the sample scheme was applied to individual sites. This allowed a statewide assessment of river and stream condition for the target population of 8,878 river miles within the 16,871 river mile sample frame. As noted above, some sites were determined to be too large, too small, or inaccessible resulting in 2,021 of the 8,878 river miles (23%) falling within the "Target: Total, Not Assessed" category (Table2). For a complete list of sites assessed see Appendix A, NH River Probability-Based Sites Surveyed, 2013-2016.

Sample Collection and Processing Methodology

Data collection methods differed between NRSA sites and SRSA sites. Fish collection surveys for NRSA sites required a reach length equal to 40 times the river wetted width while SRSA sites required a reach length of 20 times the river wetted width. While a reach length 40 times the wetted width is more robust at capturing most habitat types, professional experience working in NH's streams has found that a reach length 20 times the river wetted width to be both adequate and efficient for documenting the fish species within a representative range of habitat types specific to each stream. On occasion, the reach is adjusted either upstream or downstream of the station, keeping the station within the reach, to best capture a variety of habitat types that are observed or known to be present in a particular stream. Fish were collected using boat or backpack electrofishing techniques and identified and enumerated in the field. Macroinvertebrate surveys for NRSA sites required kick net collection while SRSA sites were evaluated using artificial substrates (rock baskets made of wire mesh cylinders filled with natural rocks, deployed for approximately eight weeks). Both the techniques and indices to evaluate macroinvertebrate taxa composition and abundance were independently developed and tested with the goal of assessing the biological condition of the stream. Therefore, one can reason that the ultimate condition outcome (good, fair, poor) would be the same, regardless of the technique applied. Macroinvertebrate samples were sorted, identified,

Figure 2: Probabilistic Assessment Survey Sites, 2013-2016



and enumerated by a third party. Water samples for bacteria were collected using the same collection protocol and either shipped in a cooler on ice to a third party for analysis for NRSA sites or analyzed by the NH Department of Health and Human Services, Public Health Laboratory for SRSA sites.

Data Analysis

Prior to performing the probability-based assessment of the aquatic life use condition (macroinvertebrate and fish communities) and primary contact use (swimming) condition for the target population (8,878 miles) of the State's rivers and streams, the condition for each assessed site was evaluated. Biological indices for assessing the condition of the fish and macroinvertebrate communities also differed between NRSA and SRSA sites, using different metrics. For bacteria assessments, NRSA and SRSA samples were analyzed for *Enterococcus* spp. and *Escherichia coli*, respectively. Each site was assigned a weight factor, relating to the probability that a site is included in the sample and is proportional to the amount (length in miles) of the resource represented by each evaluated site. The condition rating is combined with the weight factor to assess the aquatic life use and primary contact conditions of the target population of rivers and streams. Target river miles that were not sampled were placed in the "not assessed" category. See Table 2 and Appendix B (flow chart) describing river miles of the sample frame, target, and non-target populations as well as the assessed and not assessed river miles within the target population. One NRSA site on the Connecticut River, NHR9-0903, was later removed from the data set since it is coded as a lake by NHDES' Water Quality Assessments Program.

Sites were assigned condition ratings on a three-tiered scale (good, fair, poor) for biological (aquatic life use) condition of macroinvertebrate and fish communities and a two-tiered scaled (good, poor) for primary contact recreation (Table 3). For aquatic life use a "good" or "fair" rating is achieved when the biological index score meets the water quality standard by a large (good) or small (fair) margin above the threshold and "poor" rating when the biological index score is below the threshold. For primary contact recreation a "good" rating is achieved when bacteria levels are below the threshold and "poor" ratings when levels are above the threshold. The condition assignments were completed separately for NRSA and SRSA sites.

The biological condition of NRSA sites was evaluated and assigned a condition rating according to Multi Metric Index outputs developed for macroinvertebrates and fish according to the NRSA 2008-09 Technical Report (USEPA, 2016). Biological condition for SRSA sites were evaluated using NHDES biocriteria and assessment methodologies for macroinvertebrates and fish: Development of the New Hampshire Benthic Index of Biotic Integrity (NHDES, 2004), Coldwater Fish Assemblage Index of Biotic Integrity for New Hampshire Wadeable Streams (NHDES, 2007a), Predicted Coldwater Fish Indicator Species Presence in New Hampshire Wadeable

Streams (NHDES, 2007b), Transitional Water Fish Assemblage Index of Biotic Integrity for New Hampshire Wadeable Streams (NHDES, 2011a), and Site Classification for the New Hampshire Benthic Index of Biotic Integrity (B-IBI) Using a Non-Linear Predictive Model (NHDES, 2011b). Where the biological condition rating for macroinvertebrates and fish matched, the corresponding biological condition was assigned to the final biological condition assessment (Appendix C). Where the biological condition rating did not match, biological index availability, proximity of score to threshold, and best professional judgement based upon knowledge of biological indices and site conditions was applied to determine a final biological condition assessment.

Primary contact condition for NRSA sites were evaluated and assigned a condition rating according to USEPA's Recreational Water Quality Criteria (USEPA, 2012, Table 6). Data less than or greater than a statistical threshold value (STV) of 1,280 colony cell equivalents (cce) per 100 mL for qPCR (quantitative polymerase chain reaction) were assigned a "good" or "poor" rating, respectively. Primary contact condition for SRSA sites were evaluated and assigned a condition rating according to State of New Hampshire's Surface Water Quality Standards (Chapter Env-Wq 1700), "Appendix E: Summary of Bacteria Standards from RSA 485-A:8" (NHDES, 2017). Data less than or greater than 153 Escherichia coli per 100 mL for Class A waterbodies or 406 Escherichia coli per 100 mL for Class B waterbodies were assigned a "good" or "poor" rating, respectively. All but two sites were evaluated according to the *Escherichia coli* threshold for Class B waterbodies. See Table 3 for condition rating descriptions.

Table 3: Condition Rating Descriptions, NRSA and SRSA sample sites

		SRSA Condition Ratings					NRSA Condition Ratings		
Parameter	Designated Use	Description	Category	IBI Score			Description	Category	MMI Score
				CW*	TW*	WW*			
Fish	Aquatic Life	Meets WQ standard by large margin	good	≥32	≥30	NO WW INDEX, not assessed	25th-100th percentile	good	>62.4
		Meets WQ standard by small margin	fair	≥30-32	≥28-30		5th-25th percentile	fair	52.1-62.4
		Does not meet WQ standard	poor	<30	<28		0-5th percentile	poor	<52.1
Parameter	Designated Use	Description	Category	IBI Ratio Score (IBI score/90% threshold)			Description	Category	MMI Score
Inverts	Aquatic Life	Meets WQ standard by large margin	good	B-IBI ratio ≥1.1			25th-100th percentile	good	>55.0
		Meets WQ standard by small margin	fair	B-IBI ratio ≥1.0 -1.1			5th-25th percentile	fair	40.9 - 55.0
		Does not meet WQ standard	poor	B-IBI ratio <1.0			0-5th percentile	poor	<40.9
Parameter	Designated Use	Description	Category	*E. coli* cts/ 100 mL			Description	Category	*Enterococcus* spp. cce/100 mL
E. coli	Primary Contact Recreation	Class A, meets WQ stds	good	<153 cts/100 mL			STV *Enterococcus* spp. < 1,280 cce/ 100 mL	good	<1,280 cce/100 mL
		Class A, does not meet WQ std	poor	>153 cts/100 mL					
		Class B, meets WQ stds	good	<406 cts/mL			STV Enterococcus spp. > 1,280 cce/ 100 mL	poor	>1,280 cce/100 mL
		Class B, does not meet WQ std	poor	>406 cts/100 mL					

* CW (cold water), TW (transitional water) and WW (warm water) refer to fish community assemblages defined in Transitional fish assemblage index of biotic integrity for New Hampshire wadeable streams (NHDES, 2011a).

RESULTS

The 2013-2016 probabilistic assessment covered 8,878 miles (53%) of the 16,871 river miles mapped in the state for inclusion in the sample frame. The remaining 7,993 miles (47%) were not part of the target population. The most common reasons that flowing water was not part of the target population was that it was too small (53%) with a watershed size less than 2 square miles or was non perennial (16%). NHDES does not have an established sampling methodology to assess aquatic life use for these systems. Approximately 2,021 miles of the 8,878 target population of flowing waters were not assessed. The most common reasons these sites were not assessed was due to inadequate access (12%) or a site was not wadeable (6%). Condition assessment estimates were estimated for the remaining 6,857 miles (77%) of the target population.

For aquatic life use, the bioindicator(s) (macroinvertebrates and/or fish) used for the final site condition assessment (good, fair, poor) is provided in Appendix C. For the primary contact recreation designated use, the bacteria indicator (E*nterococcus* spp. or *Escherichia coli*) applied to the final site condition assessment (good, poor) is provided in Appendix D.

Fifty percent of the sites assessed for aquatic life use condition included both fish and macroinvertebrates, 34% were assessed based on macroinvertebrates only, and 16% using only fish (Figure 3). Primary contact recreation condition was assessed using *E. coli* at 60% of sites and *Enterococcus* spp. at 40% of sites (Figure 4).

Figure 3: Percent of assessed sites that used a specific bioindicator(s) applied to the aquatic life use condition rating of NH's rivers and streams.

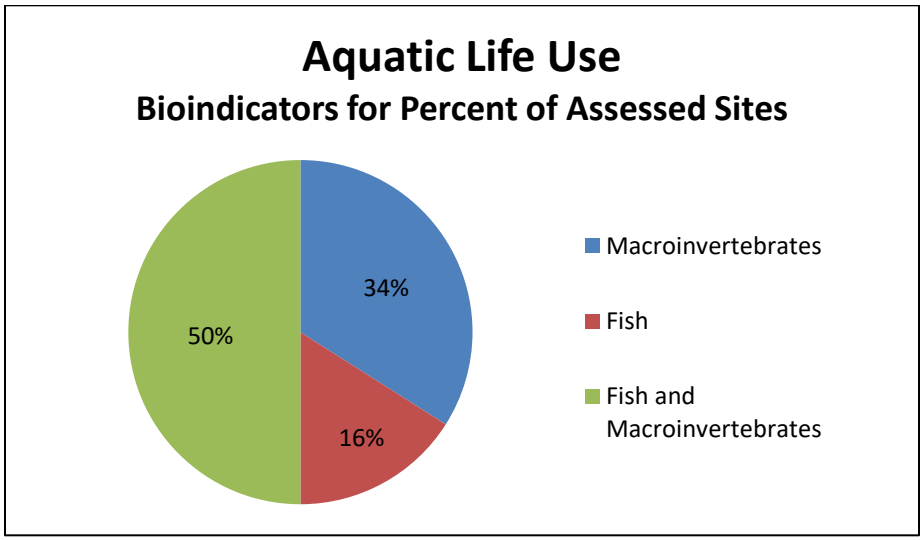
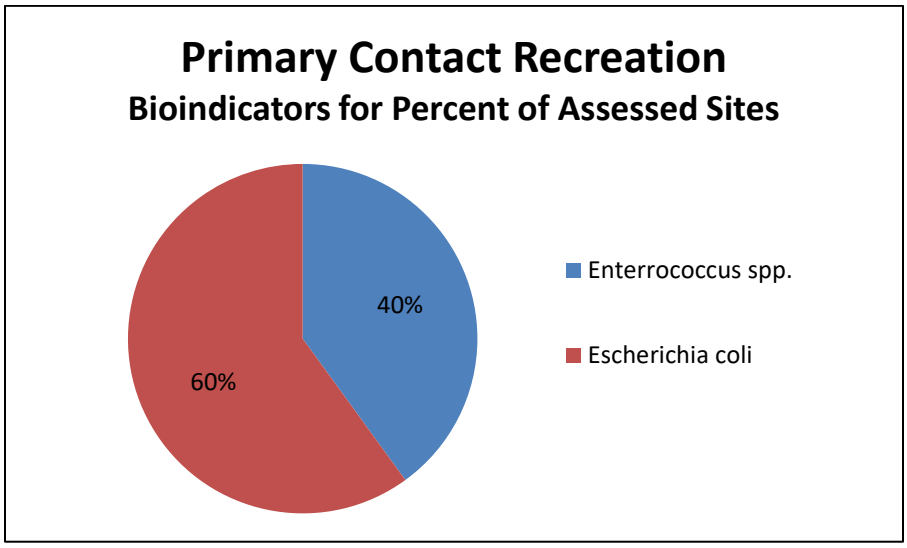


Figure 4: Percent of assessed sites that used a specific bioindicator applied to the primary contact recreation condition rating of NH's rivers and streams.



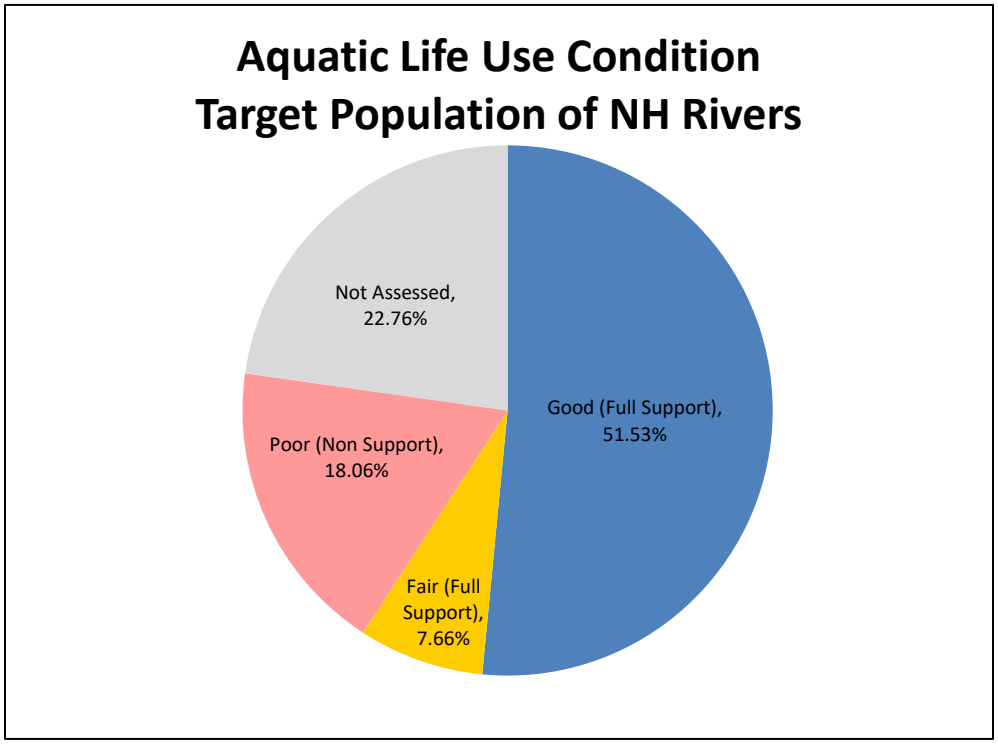
Sites with assigned weights and condition ratings for aquatic life use and primary contact recreation were then evaluated for a final statewide probability based assessment through the use of several R programming scripts developed by USEPA, Office of Research and Development (USEPA-ORD). Statewide river condition ratings for aquatic life use and primary contact recreation apply to the 6,857 assessed river miles (table 2) or 77% of the target population. The remaining 2,021 river miles (23% of the target population) is considered not assessed.

For aquatic life use support, the biological indicators (fish and macroinvertebrates) showed that 59% (5,254 miles) of rivers and streams were in good or fair condition (fully supporting), while 18% (1,603 miles) were in poor condition (non-supporting). The remaining 23% (2,021 miles) were not assessed (Table 4 and Figure 5).

Table 4: Aquatic Life Use Condition Assessment

Aquatic Life Use Condition in the Target Population of NH Rivers				
	Percent of Resource		Miles of Resource	
Category	Percent	Error (+/-)	Miles	Error (+/-)
Good (Full Support)	51.5%	11.2%	4,574.60	1113.68
Fair (Full Support)	7.7%	5.6%	679.66	482.40
Poor (Non Support)	18.1%	7.5%	1,603.37	661.44
Not Assessed	22.8%	10.1%	2,020.64	932.42

Figure 5: Aquatic Life Use Condition Assessment

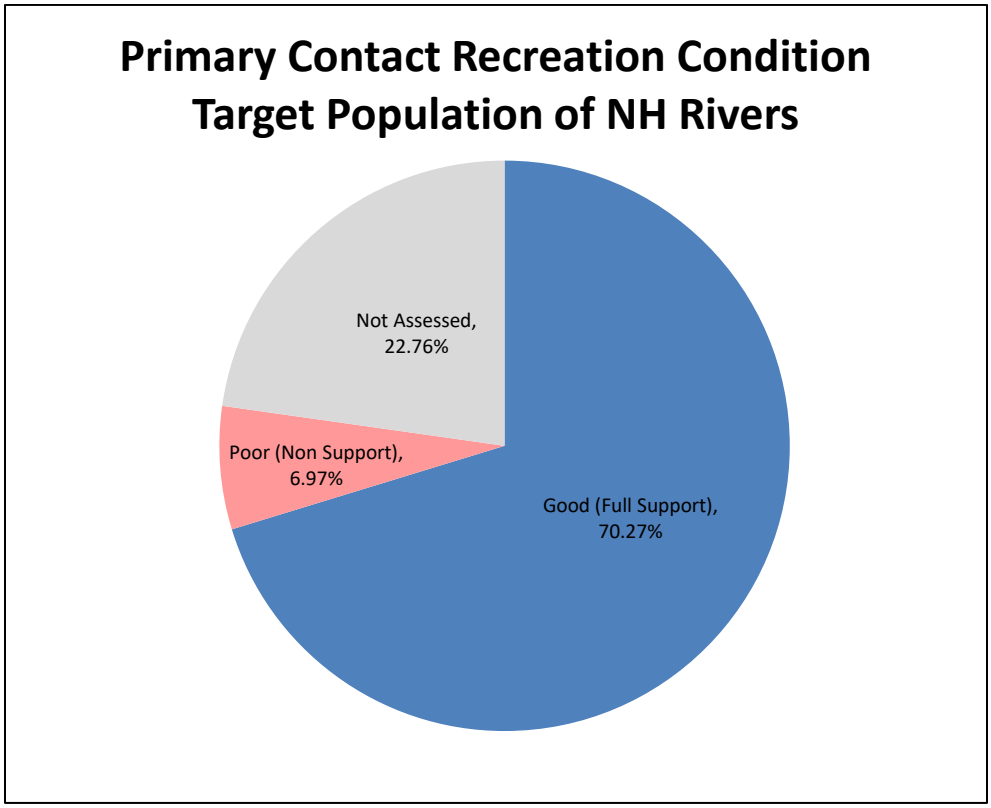


For primary contact recreation, the bacteriological indicators (*Enterococcus* spp. or *Escherichia coli*) showed that 70% (6,239 miles) of rivers and streams were in good condition (fully supporting), while 7% (618 miles) were in poor condition (non-supporting). Twenty-three percent of river miles (2,021) were not assessed (Table 5 and Figure 6).

Table 5: Primary Contact Recreation Condition Assessment

Primary Contact Recreation Condition in the Target Population of NH Rivers				
	Percent of Resource		Miles of Resource	
Category	Percent	Error (+/-)	Miles	Error (+/-)
Good (Full Support)	70.3%	10.9%	6,238.64	1042.07
Poor (Non Support)	7.0%	5.2%	618.99	464.00
Not Assessed	22.8%	10.1%	2,020.64	932.42

Figure 6: Primary Contact Recreation Condition Assessment



Overall, 6,857 river and stream miles in New Hampshire were assessed from 2013-2016 using a probability-based assessment methodology for aquatic life use (macroinvertebrate and fish communities) and primary contact recreation (swimming) designated uses for New Hampshire's 2018 Section 305(b) and 303(d) federal water quality report (pending). An additional 2,021 miles or 23% of the 8,878 target population were inaccessible or too deep to implement wadeable stream sampling protocols and were therefore within the unassessed portion of the target population. More than 59% of rivers and streams were in good or fair condition (full support) for aquatic life use while over 70% were in good condition (full support) for primary contact recreation.

Comparison of results from the current probability-based assessment (2013-2017) to previous probability-based assessments including the New England Wadeable Streams Assessment (NEWS) in 2002-2003 and the National Rivers and Streams Assessment with state intensification from 2008-2012 indicates that water quality conditions supportive of aquatic life use remains close to 60% (Figure 7) while that for primary contact recreation has decreased from near 90% (2003-04 and 2008-2012) to 70% with the most recent assessment (Figure 8). However, the percent of waterbodies in the not assessed category increased from less than 5% to greater than 20%. This is likely attributed to an increase in sites considered inaccessible compared to previous assessments. Overall the percent of waterbodies in the non-support category were

similar to previous assessments, between 5% and 10% supporting the possibility that the water quality of the state's rivers and streams have not worsened.

Figure 7: Comparison of three aquatic life use probability-based survey assessments (2003-04, 2008-2012 and 2013-2017)

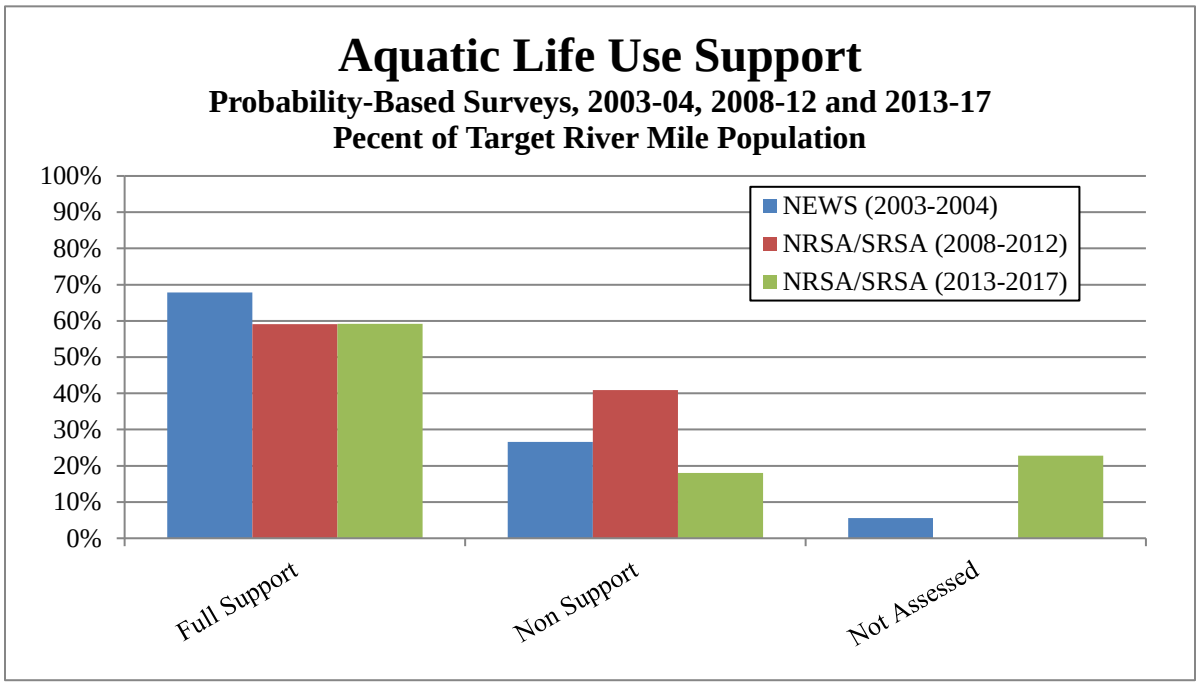
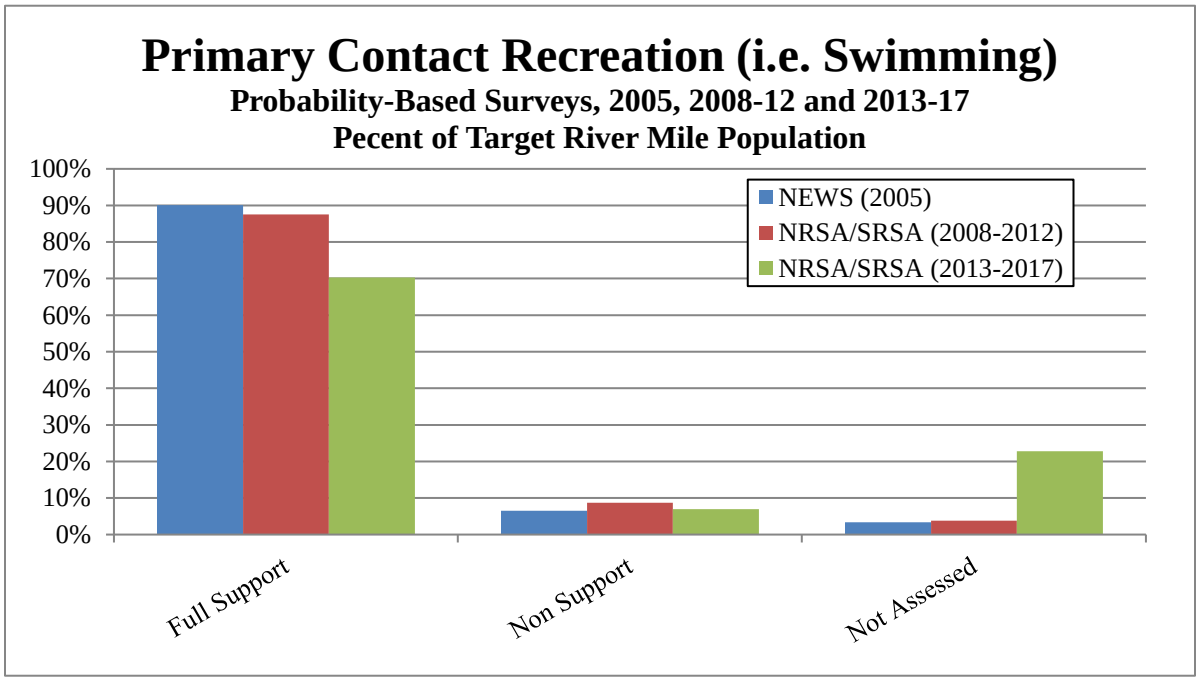


Figure 8: Comparison of three primary contact recreation probability-based survey assessments (2002-03, 2008-2012 and 2013-2017)



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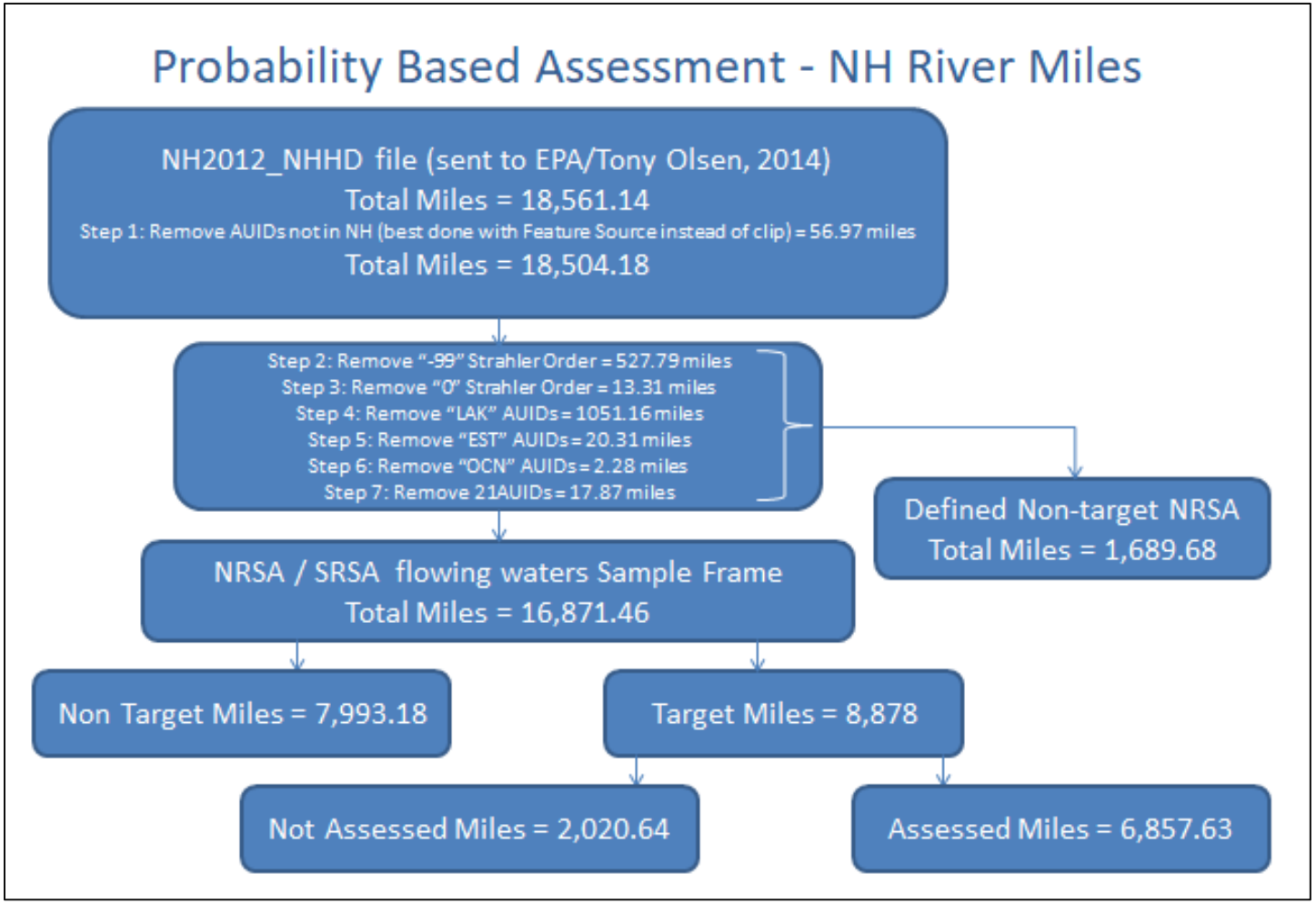
Appendix A: NH River Probability-based Sites Surveyed, 2013-2016

StationID	Town	WaterbodyName	AU_ID	Lat_ Dec	Long_ Dec	Basin	Strahler Order	Drain Area (sq. mi.)	Elevation (ft.)	NRSA/ SRSA
NHLS-1044	Wentworth	Baker River	NHRIV700010305-04	43.8395	-71.8992	Merrimack	4	85	535	NRSA
NHLS-1045	Hanover	Mink Brook	NHRIV801040401-05	43.6927	-72.2766	Connecticut	3	16	484	NRSA
NHR9-0901	Monroe	Connecticut River	NHIMP801030206-01-02	44.2431	-72.0482	Connecticut	5	2206	405	NRSA
NHR9-0902	Walpole	Connecticut River	NHRIV801070501-10-02	43.0681	-72.4487	Connecticut	6	5613	226	NRSA
NHR9-0903	Lyme	Connecticut River	NHLAK801040402-03	43.8658	-72.1782	Connecticut	5	3125	385	NRSA
NHR9-0904	Concord	Merrimack River	NHRIV700060302-24	43.1932	-71.5235	Merrimack	7	2388	213	NRSA
NHR9-0905	Claremont	Connecticut River	NHRIV801060702-12	43.3512	-72.3934	Connecticut	6	4998	278	NRSA
NHRM-1001	Columbia	Connecticut River	NHRIV801010404-02	44.8640	-71.5482	Connecticut	5	584	997	NRSA
NHRM-1002	Errol	Androscoggin River	NHRIV400010602-04	44.7130	-71.1727	Androscoggin	5	1157	1167	NRSA
NHRM-1003	Lebanon	Connecticut River	NHRIV801060302-05	43.6245	-72.3318	Connecticut	6	4292	331	NRSA
NHRM-1004	Concord	Merrimack River	NHRIV700060302-24	43.2627	-71.5564	Merrimack	7	2362	241	NRSA
NHRM-1005	Northumberland	Connecticut River	NHRIV801010603-05	44.6245	-71.5473	Connecticut	5	925	858	NRSA
NHRO-1031	Hancock	Contoocook River	NHRIV700030106-08	42.9527	-71.9421	Merrimack	5	163	683	NRSA
NHRO-1033	Concord	Contoocook River	NHIMP700030507-04	43.2568	-71.6229	Merrimack	6	758	347	NRSA
NHS9-0911	Ossipee	Chocorua River	NHRIV600020604-06	43.8188	-71.1952	Saco	3	22	420	NRSA
NHS9-0912	Deerfield	Back Creek	NHRIV600030704-02	43.1451	-71.1860	Coastal	2	2	364	NRSA
NHS9-0913	Gorham	Moose River	NHRIV400020101-04	44.3932	-71.2199	Androscoggin	3	23	962	NRSA
NHSS-1067	Hinsdale	Unnamed Stream	NHRIV802010501-01	42.7567	-72.4633	Connecticut	1	0	446	NRSA
NHSS-1068	New Hampton	Ames Brook	NHRIV700010502-05	43.6873	-71.6190	Merrimack	2	4	585	NRSA
NHSS-1070	Freedom	Bennett Brook	NHRIV600020901-05	43.8318	-71.0050	Saco	1	0	837	NRSA
NHLS-1046	Swanzey	South Branch Ashuelot River	NHRIV802010303-20	42.8732	-72.2271	Connecticut	3	37	644	SRSA
NHLS-1047	Pittsburg	Indian Stream	NHRIV801010202-03	45.1068	-71.3965	Connecticut	4	60	1301	SRSA
NHLS-1048	Franklin	Punch Brook	NHRIV700060101-05	43.4121	-71.6719	Merrimack	3	10	417	SRSA
NHLS-1049	Merrimack	Pennichuck Brook	NHRIV700061001-10	42.7936	-71.4708	Merrimack	4	27	134	SRSA
NHLS-1050	Marlow	Grassy Brook	NHRIV802010103-06	43.0907	-72.2179	Connecticut	4	10	1129	SRSA
NHLS-1051	Wakefield	Branch River	NHRIV600030402-05	43.4948	-71.0260	Coastal	3	36	482	SRSA

StationID	Town	WaterbodyName	AUID	Lat_ Dec	Long_ Dec	Basin	Strahler Order	Drain Area (sq. mi.)	Elev. (ft.)	NRSA/ SRSA
NHLS-1054	New Boston	Piscataquog River-South Branch	NHRIV700060606-03	42.9545	-71.7085	Merrimack	4	47	490	SRSA
NHLS-1055	Ossipee	Lovell River	NHRIV600020802-04	43.7867	-71.2084	Saco	3	14	640	SRSA
NHLS-1056	Lincoln	East Branch Pemigewasset River	NHRIV700010102-03	44.1030	-71.5653	Merrimack	5	48	1443	SRSA
NHLS-1057	Swanzey	South Branch Ashuelot River	NHRIV802010303-23	42.8889	-72.2761	Connecticut	5	75	504	SRSA
NHLS-1059	Canaan	Mascoma River	NHRIV801060105-05	43.6485	-72.0762	Connecticut	5	80	891	SRSA
NHLS-1062	Deerfield	Nicholls Brook	NHRIV600030701-11	43.1156	-71.2374	Coastal	3	4	272	SRSA
NHSS-1076	Randolph	Isreal River	NHRIV801010801-01	44.3466	-71.3418	Connecticut	2	3	1760	SRSA
NHSS-1079	Piermont	Bean Brook	NHRIV801040205-02-01	43.9574	-72.0458	Connecticut	2	3	1046	SRSA
NHSS-1082	Colebrook	East Branch Mohawk River	NHRIV801010401-04-02	44.8836	-71.3626	Connecticut	4	15	1431	SRSA
NHSS-1083	Grafton	Halfmoon Pond Brook	NHRIV700010701-04	43.5756	-71.9795	Merrimack	3	4	855	SRSA
NHSS-1084	Pittsburg	Middle Branch Indian Stream	NHRIV801010201-01	45.2670	-71.2985	Connecticut	1	4	1774	SRSA
NHSS-1085	Grantham	Littlefield Brook	NHRIV801060404-03	43.4763	-72.1518	Merrimack	1	3	915	SRSA
NHSS-1086	Sandwich	Cold River	NHRIV600020602-01	43.8683	-71.4059	Saco	3	8	759	SRSA
NHSS-1088	Bethlehem	Zealand River	NHRIV801030402-40	44.2387	-71.4863	Connecticut	3	9	1758	SRSA
NHSS-1090	Success	Chickwolnepy Stream	NHRIV400010603-02	44.5797	-71.0490	Androscoggin	1	4	620	SRSA
NHSS-1092	Chatham	Weeks Brook	NHRIV600020305-05	44.0764	-71.0257	Saco	3	4	475	SRSA
NHSS-1095	Concord	Hackett Brook	NHRIV700060302-06	43.2976	-71.5448	Merrimack	3	6	376	SRSA
NHSS-1096	Walpole	Great Brook	NHRIV801070501-09	43.0410	-72.4579	Connecticut	2	11	607	SRSA
NHSS-1097	Warren	Oliverian Brook	NHRIV801030701-03	43.9863	-71.8910	Connecticut	3	6	1122	SRSA
NHSS-1101	Danbury	Unnamed	NHRIV700030401-03	43.5035	-71.9101	Merrimack	2	7	993	SRSA
NHSS-1102	Easton	Ham Branch	NHRIV801030303-02	44.1473	-71.7921	Merrimack	3	11	1176	SRSA
NHSS-1105	Springfield	Unnamed	NHRIV801060402-09	43.4527	-72.0496	Connecticut	3	3	1185	SRSA
NHSS-1106	Carroll	Carrol Stream	NHRIV801030102-02	44.3241	-71.5599	Connecticut	3	7	1160	SRSA
NHSS-1108	Sandwich	Wonalancet River	NHRIV600020603-01	43.9137	-71.3652	Saco	2	4	1194	SRSA

Appendix B: Probability-Based Assessment, NH River Miles Flow Chart



Appendix C: Site Specific Aquatic Life Use Condition Ratings for NH River Probability-based Sites Surveyed, 2013-2016

Station ID	Waterbody	Town	Fish Condition Rating	Macro-invertebrate Condition Rating	Final Condition Assessment	Bioindicator F=Fish M=Macro-invertebrates
NHLS-1044	Baker River	WENTWORTH	good	good	good	F and M
NHLS-1045	Mink Brook	HANOVER	good	good	good	F and M
NHR9-0901	Connecticut River	MONROE	poor	poor	poor	F and M
NHR9-0902	Connecticut River	WALPOLE	poor	poor	poor	F and M
NHR9-0903	Connecticut River	LYME	poor	poor	poor	F and M
NHR9-0904	Merrimack River	CONCORD	poor	poor	poor	F and M
NHR9-0905	Connecticut River	CLAREMONT	fair	poor	fair	F
NHRM-1001	Connecticut River	COLUMBIA	good	fair	good	F
NHRM-1002	Androscoggin River	ERROL	good	Not Assessed	good	F
NHRM-1003	Connecticut River	LEBANON	poor	poor	poor	F and M
NHRM-1004	Merrimack River	CONCORD	poor	good	poor	F and M
NHRM-1005	Connecticut River	NORTHUMBERLAND	fair	Not Assessed	fair	F
NHRO-1031	Contoocook River	HANCOCK	poor	poor	poor	F and M
NHRO-1033	Contoocook River	CONCORD	poor	poor	poor	F and M
NHS9-0911	Chocorua River	OSSIPEE	fair	poor	poor	F and M
NHS9-0912	Back Creek	DEERFIELD	poor	poor	poor	F and M
NHS9-0913	Moose River	GORHAM	good	good	good	F and M
NHSS-1067	Unnamed Stream	HINSDALE	Not Assessed	good	good	M
NHSS-1068	Ames Brook	NEW HAMPTON	fair	fair	fair	F and M
NHSS-1070	Bennett Brook	FREEDOM	good	poor	good	F
NHLS-1046	South Branch Ashuelot River	SWANZEY	Not Assessed	good	good	M
NHLS-1047	Indian Stream	PITTSBURG	poor	good	good	M
NHLS-1048	Punch Brook	FRANKLIN	poor	good	good	M
NHLS-1049	Pennichuck Brook	MERRIMACK	Not Assessed	poor	poor	M
NHLS-1050	Grassy Brook	MARLOW	poor	good	good	M
NHLS-1051	Branch River	WAKEFIELD	Not Assessed	fair	fair	M

Appendix C, Continued

Station ID	Waterbody	Town	Fish Condition Rating	Macro-invertebrate Condition Rating	Final Condition Assessment	Bioindicator F=Fish M=Macro-invertebrates
NHLS-1054	South Branch Piscataquog River	NEW BOSTON	Not Assessed	good	good	M
NHLS-1055	Lovell River	OSSIPEE	good	good	good	F and M
NHLS-1056	East Branch Pemigewasset River	LINCOLN	Not Assessed	fair	fair	M
NHLS-1057	South Branch Ashuelot River	SWANZEY	Not Assessed	fair	fair	M
NHLS-1059	Mascoma River	CANAAN	Not Assessed	good	good	M
NHLS-1062	Nicholls Brook	DEERFIELD	Not Assessed	poor	poor	M
NHSS-1076	Isreal River	RANDOLPH	good	good	good	F and M
NHSS-1079	Bean Brook	PIERMONT	good	good	good	F and M
NHSS-1082	East Branch Mohawk River	COLEBROOK	good	good	good	F and M
NHSS-1083	Halfmoon Pond Brook	GRAFTON	poor	good	good	M
NHSS-1084	Middle Branch Indian Stream	PITTSBURG	good	fair	good	F
NHSS-1085	Littlefield Brook	GRANTHAM	fair	good	good	M
NHSS-1086	Cold River	SANDWICH	poor	good	good	M
NHSS-1088	Zealand River	BETHLEHEM	good	good	good	F and M
NHSS-1090	Chickwolnepy Stream	SUCCESS	poor	poor	poor	F and M
NHSS-1092	Weeks Brook	Chatham	good	good	good	F and M
NHSS-1095	Hackett Brook	CONCORD	poor	poor	poor	F and M
NHSS-1096	Great Brook	WALPOLE	poor	poor	poor	F and M
NHSS-1097	Oliverian Brook	WARREN	good	good	good	F and M
NHSS-1101	Unnamed	Danbury	poor	good	good	M
NHSS-1102	Ham Branch	Easton	poor	good	good	M
NHSS-1105	Unnamed	Springfield	good	good	good	F and M
NHSS-1106	Carrol Stream	CARROLL	good	poor	good	F
NHSS-1108	Wonalancet River	Sandwich	good	poor	good	F

Appendix D: Site Specific Primary Contact Recreation Condition Ratings for NH River Probability-based Sites Surveyed, 2013-2016

StationID	Waterbody	Town	Final Assessment	Bioindicator
NHLS-1044	Baker River	Wentworth	good	*Enterrococcus* spp.
NHLS-1045	Mink Brook	Hanover	good	*Enterrococcus* spp.
NHR9-0901	Connecticut River	Monroe	good	*Enterrococcus* spp.
NHR9-0902	Connecticut River	Walpole	poor	*Enterrococcus* spp.
NHR9-0903	Connecticut River	Lyme	good	*Enterrococcus* spp.
NHR9-0904	Merrimack River	Concord	good	*Enterrococcus* spp.
NHR9-0905	Connecticut River	Claremont	good	*Enterrococcus* spp.
NHRM-1001	Connecticut River	Columbia	poor	*Enterrococcus* spp.
NHRM-1002	Androscoggin River	Errol	poor	*Enterrococcus* spp.
NHRM-1003	Connecticut River	Lebanon	good	*Enterrococcus* spp.
NHRM-1004	Merrimack River	Concord	good	*Enterrococcus* spp.
NHRM-1005	Connecticut River	Northumberland	good	*Enterrococcus* spp.
NHRO-1031	Contoocook River	Hancock	good	*Enterrococcus* spp.
NHRO-1033	Contoocook River	Concord	good	*Enterrococcus* spp.
NHS9-0911	Chocorua River	Ossipee	good	*Enterrococcus* spp.
NHS9-0912	Back Creek	Deerfield	good	*Enterrococcus* spp.
NHS9-0913	Moose River	Gorham	good	*Enterrococcus* spp.
NHSS-1067	Unnamed Stream	Hinsdale	poor	*Enterrococcus* spp.
NHSS-1068	Ames Brook	New Hampton	good	*Enterrococcus* spp.
NHSS-1070	Bennett Brook	Freedom	good	*Enterrococcus* spp.
NHLS-1046	South Branch Ashuelot River	Swanzey	good	*E. coli*
NHLS-1047	Indian Stream	Pittsburg	good	*E. coli*
NHLS-1048	Punch Brook	Franklin	good	*E. coli*
NHLS-1049	Pennichuck Brook	Merrimack	good	*E. coli*
NHLS-1050	Grassy Brook	Marlow	good	*E. coli*
NHLS-1051	Branch River	Wakefield	good	*E. coli*

Appendix D, Continued

NHLS-1054	South Branch Piscataquog River	New Boston	good	*E. coli*
NHLS-1055	Lovell River	Ossipee	good	*E. coli*
NHLS-1056	East Branch Pemigewasset River	Lincoln	good	*E. coli*
NHLS-1057	South Branch Ashuelot River	Swanzey	good	*E. coli*
NHLS-1059	Mascoma River	Canaan	good	*E. coli*
NHLS-1062	Nicholls Brook	Deerfield	good	*E. coli*
NHSS-1076	Isreal River	Randolph	good	*E. coli*
NHSS-1079	Bean Brook	Piermont	good	*E. coli*
NHSS-1082	East Branch Mohawk River	Colebrook	good	*E. coli*
NHSS-1083	Halfmoon Pond Brook	Grafton	good	*E. coli*
NHSS-1084	Middle Branch Indian Stream	Pittsburg	good	*E. coli*
NHSS-1085	Littlefield Brook	Grantham	good	*E. coli*
NHSS-1086	Cold River	Sandwich	good	*E. coli*
NHSS-1088	Zealand River	Bethlehem	good	*E. coli*
NHSS-1090	Chickwolnepy Stream	Success	good	*E. coli*
NHSS-1092	Weeks Brook	Chatham	good	*E. coli*
NHSS-1095	Hackett Brook	Concord	good	*E. coli*
NHSS-1096	Great Brook	Walpole	poor	*E. coli*
NHSS-1097	Oliverian Brook	Warren	good	*E. coli*
NHSS-1101	Unnamed	Danbury	good	*E. coli*
NHSS-1102	Ham Branch	Easton	good	*E. coli*
NHSS-1105	Unnamed	Springfield	good	*E. coli*
NHSS-1106	Carrol Stream	Carroll	good	*E. coli*
NHSS-1108	Wonalancet River	Sandwich	good	*E. coli*