Idaho Wadeable Stream Survey

2005–2010

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January 2013

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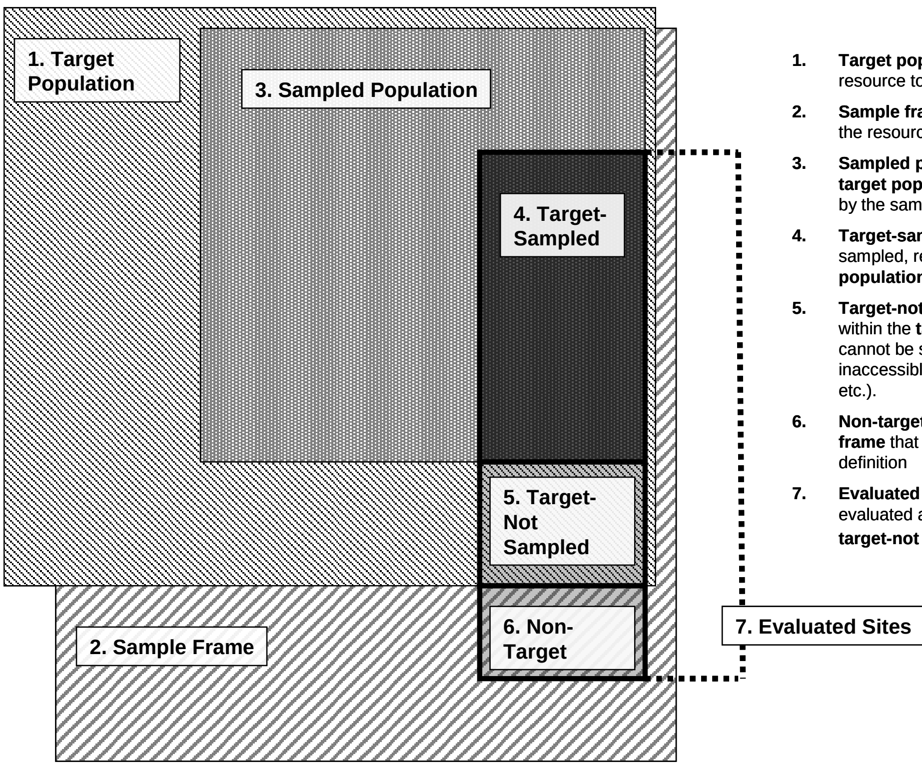
Executive Summary

What is the condition of Idaho's streams?

To answer this question, the Idaho Department of Environmental Quality (DEQ) initiated the Idaho Wadeable Stream Survey—a probability based survey designed to provide statistically valid estimates of condition for all Idaho streams.

A probabilistic sampling survey is made up of several elements: the target population, sample frame, sampled population, and evaluated sites. The conceptual relationship between these elements is presented in Figure A.



1. **Target population**: component of the resource to be assessed
2. **Sample frame**: GIS representation of the resource
3. **Sampled population**: portion of the **target population** that is represented by the sampled sites
4. **Target-sampled**: the actual sites sampled, represent the **sampled population**
5. **Target-not sampled**: sites that are within the **target population** but cannot be sampled (physically inaccessible, landowner denies access, etc.).
6. **Non-target**: the portion of the **sample frame** that doesn't fit the target definition
7. **Evaluated sites**: all sites that are evaluated are either **target-sampled, target-not sampled, or non-target**.

Figure A. Conceptual representation of elements of a probabilistic sampling survey (modified from Olsen and Peck 2008).

The sample frame is a geographical representation of the target population from which sites are selected (Figure A). In most cases, the sample frame is a map or geographic information system (GIS) layer. The sample frame commonly includes some elements that are not part of the target population or excludes some elements of the target population. Elements of the sample frame that are not part of the target population are classified as non-target (e.g., reservoirs, lakes, or dry channels in this study). Elements of the sample frame that are part of the target population and sampleable make up the sampled population. The sampled population is the portion of the resource about which we can make statistically valid estimates of condition based on survey results from the target-sampled sites.

The target population was wadeable streams in Idaho. The sample frame, or stream map, was all 1st- through 5th-order streams as defined by the National Hydrography Dataset Plus Version 2, or NHDPlusV2, for Idaho (*http://www.horizon-systems.com/nhdplus/*). The sample frame size was 148,924 kilometers (km).

Overall, 1,793 sites, representing the 148,924 km of stream map, or sample frame, were evaluated for target status. Of this total, 45.3% (standard error [SE] = 1.09), or 67,342 km, were within the target population, and 54.7% (SE = 1.09), or 81,582 km, were non-target. Target stream length was further subdivided as being either sampled (target-sampled) or not sampled due to accessibility issues or logistical issues. Similarly, the non-target stream length was subdivided based on why it was excluded from the target population, with the majority of non-target stream length being dry (Table A).

In all, DEQ field crews sampled at 252 wadeable stream target sites throughout Idaho in 2005–2008 and 2010. These sites represent a sampled population of 14,544 km, or 9.8% (SE = 0.68) of the mapped stream length. This 14,544 km of stream length is the portion of Idaho's wadeable streams for which condition can be estimated based on actual sampling results. Condition estimates for the Idaho Wadeable Stream Survey apply to the sampled population only.

Table A. Sample frame (mapped stream length) and estimates of stream length for non-target and target categories for the Idaho Wadeable Stream Survey, by DEQ region and statewide.

		Non-Target Categories (%)			Target Categories (%)		
DEQ Region	**Sample Frame (km)**	**Dry**	**Other**		**Denied Access**	**Inaccessible**	**Target-Sampled**
Coeur d'Alene	13,744	41.7	9.9		7.0	21.4	19.9
Lewiston	26,924	27.9	8.1		15.1	37.2	11.7
Boise	41,197	59.7	5.5		7.6	18.1	9.0
Twin Falls	17,006	67.9	6.2		11.3	7.5	7.0
Pocatello	16,022	54.3	9.4		24.4	2.9	9.0
Idaho Falls	34,030	35.7	8.7		3.1	45.8	6.7
Statewide	**148,924**	**47.2**	**7.6**		**10.1**	**25.3**	**9.8**

DEQ determines ecological condition of wadeable streams based on macroinvertebrate and fish communities and habitat. The highest proportion of stream length classified as good is found in DEQ's Boise Region, while the lowest was found in the Pocatello Region (Figure B).

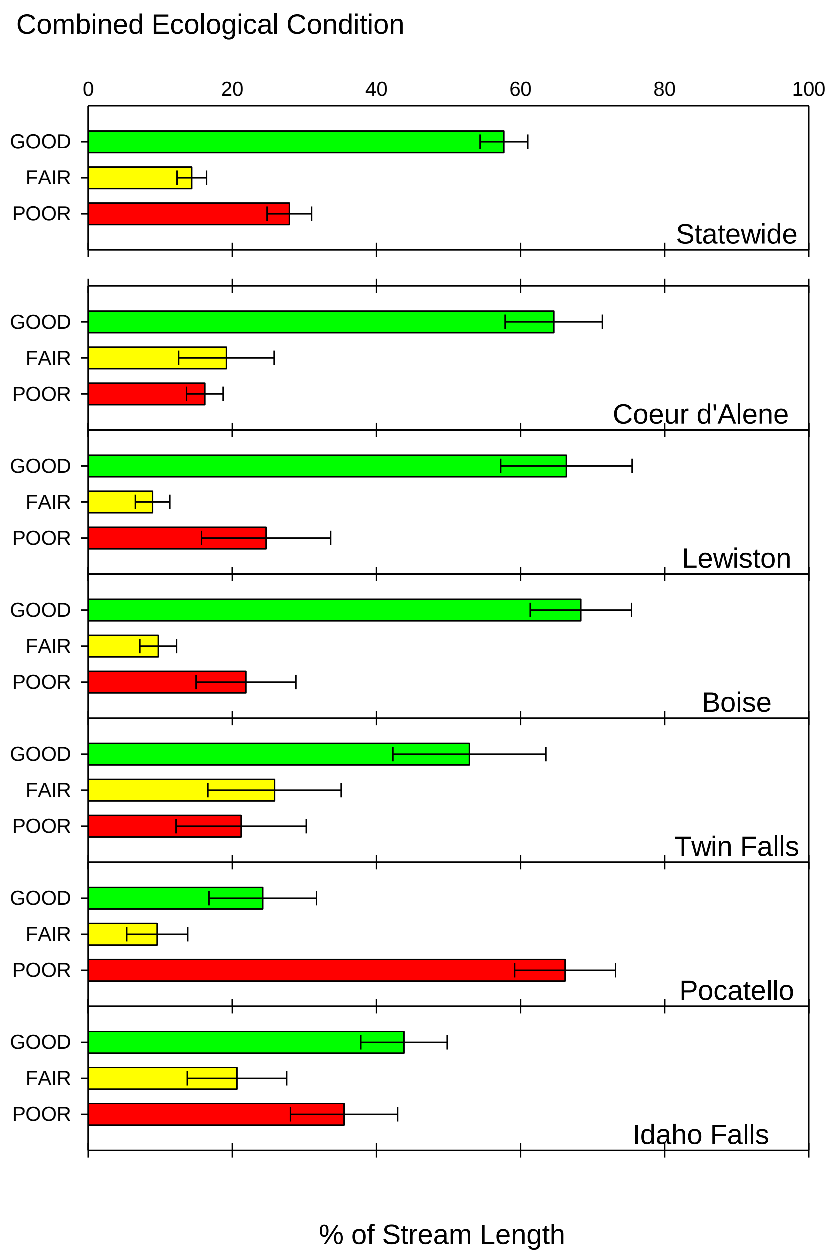


Figure B. Ecological condition estimates statewide and by DEQ region. Error bars represent standard error.

Stream length classified as good or fair was considered to be fully supporting the cold water aquatic life beneficial use, while stream length classified as poor was considered to be not fully supporting cold water aquatic life (Figure B).

Statewide, 72.1% (SE = 3.09) of the sampled population, or 10,482 km, was considered fully supporting cold water aquatic life according to ecological condition, while 27.9% (SE = 3.09), or 4,061 km, was considered not fully supporting.

Continued probabilistic surveys will enable DEQ to continue monitoring overall statewide condition and any trends in overall water quality throughout the state. However, improvements to survey design should be pursued to improve the efficiency and quality of survey results. Future efforts should focus on (1) improving the representativeness of the sample frame, (2) better defining the target population, and (3) standardizing efforts for accessing sites and obtaining permission to access private property.

The Idaho Wadeable Stream Survey indicates that the majority of Idaho's wadeable stream length is in good ecological condition and supports cold water aquatic life. When taken in context with other lake, stream, and river assessments, the Idaho Wadeable Stream Survey confirms the high quality of Idaho waters.

1 Introduction

What is the condition of Idaho's streams?

To answer this question, the Idaho Department of Environmental Quality (DEQ) initiated the Idaho Wadeable Stream Survey—a probability based survey designed to provide statistically valid estimates of condition for all streams within Idaho.

DEQ is the state agency responsible for administering the Clean Water Act in Idaho. Administration of the Clean Water Act includes monitoring and assessment of the state's surface waters to determine compliance with water quality standards. In Idaho, ambient water quality is monitored through the Beneficial Use Reconnaissance Program (BURP), which integrates biological, chemical, and physical habitat monitoring.

The federal Clean Water Act establishes a process for states to report on the quality of their surface waters. Section 305(b) of the act requires biennial reporting on the state's water quality. In an effort to fulfill this requirement, DEQ initiated the Idaho Wadeable Stream Survey; monitoring began in 2005 and concluded in 2010. This report details the results of those monitoring efforts.

1.1 Probabilistic Surveys

The Idaho Wadeable Stream Survey was a probability based survey designed to provide estimates of the condition of wadeable streams in Idaho. Probability based monitoring allows statistically valid estimates of condition for the entire population being studied while sampling only a fraction of that population. In this study, DEQ was able to estimate condition for the length of all wadeable streams in Idaho based on sampling a relatively small proportion of that entire stream length.

A probabilistic sampling survey is made up of several elements: the target population, sample frame, sampled population, and evaluated sites. Figure 1 outlines the conceptual relationship among these elements.

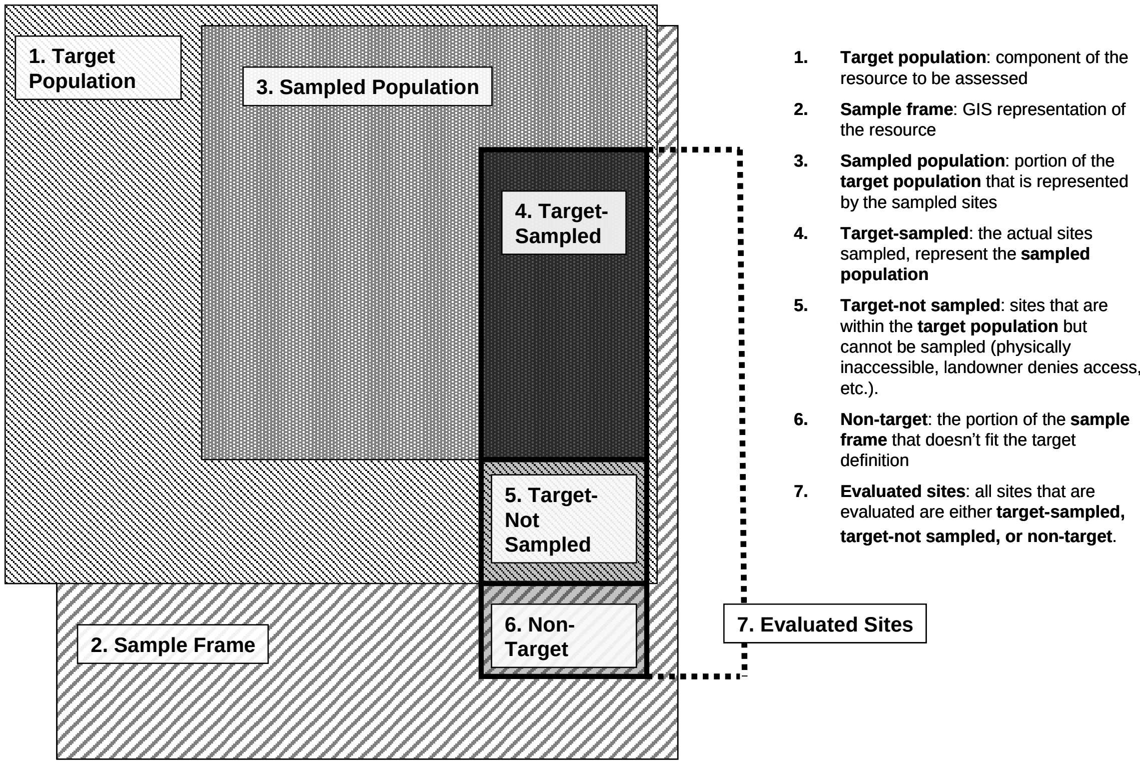


Figure 1. Conceptual representation of elements of a probabilistic sampling survey (modified from Olsen and Peck 2008).

The sample frame is a geographical representation of the target population from which sites are selected (Figure 1). The sample frame commonly includes some elements that are not part of the target population or excludes some elements of the target population. Elements of the sample frame that are not part of the target population are classified as non-target. In this survey, reservoirs, lakes, beaver ponds, non-wadeable rivers, and dry channels that were mapped as streams were classified as non-target.

Elements of the sample frame that are part of the target population and sampleable make up the sampled population. The sampled population is the portion of the resource about which we can make statistically valid estimates of condition based on survey results (Olsen and Peck 2008). Ideally, the sampled population, target population, and sample frame for a survey would be exactly the same (i.e., the squares in Figure 1 would perfectly overlap). However, because of mapping inconsistencies and accessibility, this is not realistic.

1.2 Idaho's Beneficial Use Reconnaissance Program

The goals and priorities for Idaho's Ambient Monitoring Program are described in the *Surface Water Ambient Monitoring Plan* (DEQ 2012). This plan addresses federal requirements found in Sections 303 and 305 of the Clean Water Act. Under Sections 303 and 305, DEQ prepares an Integrated Report to describe the condition of all Idaho waters (§305(b)) and identify water bodies not meeting water quality standards, or impaired waters (§303(d)).

DEQ has found that one of the most efficient monitoring strategies to evaluate water quality is directly measuring the biological condition of the water body, a strategy known as bioassessment. Thus, DEQ has focused ambient monitoring efforts on bioassessment since 1993.

DEQ implemented BURP in 1993. BURP is an ambient monitoring program aimed at integrating biological and chemical monitoring with physical habitat assessment as a way of characterizing water quality (McIntyre 1993). BURP mainly focuses on small streams and large rivers, and the program closely follows concepts and methods described in the US Environmental Protection Agency's (EPA's) *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers* (Barbour et al. 1999).

1.3 The Idaho Wadeable Stream Survey

The Idaho Wadeable Stream Survey answers two related questions: (1) what is the extent of wadeable streams in Idaho, and (2) what is the ecological condition of those streams. Conditions ratings are then used to determine if streams are supporting the cold water aquatic life beneficial use.

1.3.1 Extent Determination

What is the extent of wadeable streams in Idaho? For the Idaho Wadeable Stream Survey, the extent refers to the total length, in kilometers, of wadeable streams that met the target definition. Estimating extent can be thought of as an evaluation of the map, or sample frame, used to select sites: does the map accurately represent the target population? For those streams not meeting the target criteria, why are they rejected? What proportion of the target population can be sampled? All sites that are reviewed to determine if they meet the target criteria are considered evaluated sites, regardless of whether or not the site was sampleable.

1.3.2 Ecological Condition Estimate

What is the ecological condition of wadeable streams in Idaho? This question is answered by analyzing and interpreting data from the sampled sites. DEQ uses ecological indicators to determine the ecological condition of streams. The three indicators used are macroinvertebrate community, fish community, and habitat. These results are then applied to the sampled population (Figure 1), resulting in an estimate of condition for stream length for the entire state.

1.3.3 Support Status Determination

Estimates of ecological condition are used to determine whether streams are fully supporting or not fully supporting the cold water aquatic life beneficial uses as defined in Idaho's Water Quality Standards. These determinations provide the basis for Idaho's Integrated Report.

2 Methods

2.1 Site Selection and Target Evaluation

DEQ used a probability based survey design to make statistically valid estimates of condition for the entire population of streams being monitored. Design documentation is included as Appendix A.

The sample frame was all 1st- through 5th-order streams as defined by the National Hydrography Dataset Plus Version 2, or NHDPlusV2, for Idaho (*http://www.horizon-systems.com/nhdplus/*). The sample frame size, or mapped stream length, was 148,924 kilometers (km).

The target population for the Idaho Wadeable Stream Survey was all Idaho streams 1st through 5th order that had an active stream channel and were wadeable and sampleable as defined by DEQ’s BURP protocol. DEQ classifies flowing waters as wadeable streams if they meet at least two of the following three criteria: (1) stream order is 4th or lower, (2) average wetted width at the reach is less than 15 meters (m), and (3) average depth for the reach is less than 0.4 m. Conversely, if the water body exceeds any two of these three criteria it is classified as a non-wadeable river (Grafe 2002) and was rejected as non-target/non-wadeable and not considered to be part of this survey.

The Idaho Wadeable Stream Survey consisted of 5 separate panels, or site lists, to be completed in each of 5 years. The expected sample size was 50 sites monitored per panel, or a total of 250 sites for the study period. These sites were considered base sites. In addition to the 250 base sites, the sample design included 2,000 oversample sites. If a site was rejected as non-target or inaccessible, the site was replaced with an oversample site. Sites were further categorized by which of six DEQ regions they occurred in, with each DEQ regional office maintaining its own list of base and oversample sites throughout the study period. Site replacement occurred in numerical order within each regional list. Sites were also categorized by stream order as a way of describing stream condition relative to stream size.

Sites were evaluated for target status and accessibility using topographical maps, aerial imagery, field visits, and local experts. Sites were rejected if they did not meet the target criteria, the site was impractical to access, or a landowner denied access to the site. Sites occurring within Indian reservation boundaries were considered to be non-target. Categories of rejected sites are described in Table 1.

Table 1. Non-sampleable categories for sites determined to be non-target or target but inaccessible.

Category	Target Status	Description
Dry channel	Non-target	Channel present, but no flowing water
Marshland/wetland	Non-target	Standing water present, but no definable channel present
Map error	Non-target	No evidence of water body or stream channel
Beaver complex	Non-target	Channel impounded or altered by beaver complex
Non-wadeable	Non-target	Not wadeable according to BURP definition of wadeable
No flow	Non-target	Standing water is present but no flow
High flow	Non-target/target	Temporary category to identify unsafe conditions for sampling
Access permission denied	Target	Private landowner has denied permission to access stream
Inaccessible	Target	Cannot be safely or practically sampled in a single field day

The sampled site locations and the sample frame, or stream map, used for the survey are presented in Figure 2.

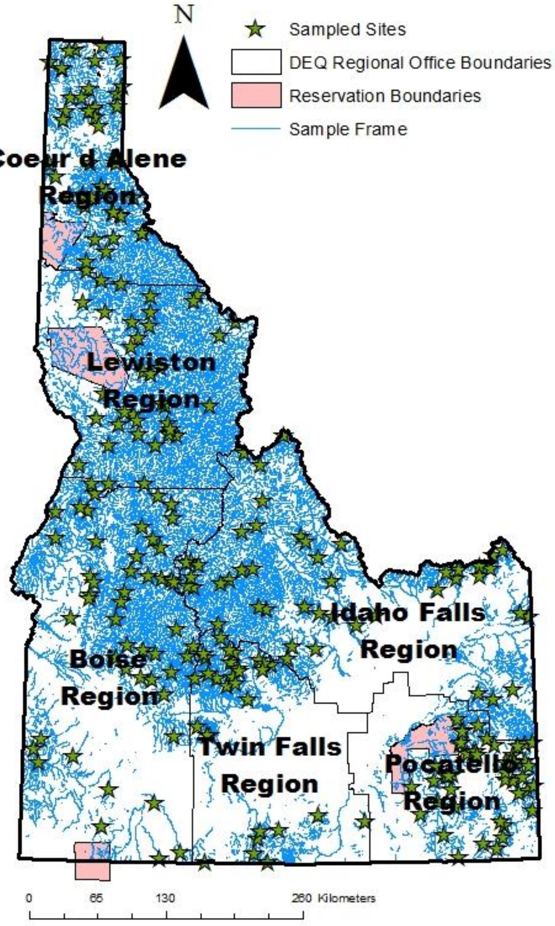


Figure 2. Location of sampled sites, along with the sample frame, or stream map, from the Idaho Wadeable Stream Survey.

2.2 Field Procedures

Sites were sampled between July 1 and September 30, 2005–2008 and 2010, following DEQ's BURP protocols (DEQ 2007). DEQ sampled 252 target sites during the Idaho Wadeable Stream Survey. Field crews delineated a representative sample reach that was 30 times the general bank-full width of the stream, or a minimum of 100 m. Crews demarcated three transects at three separate, relatively evenly spaced riffle habitats within the sample reach.

Macroinvertebrates—A single macroinvertebrate sample was collected at each transect using a Hess sampler. The three macroinvertebrate samples were either composited in the field or by the contract laboratory providing the taxonomic identification (DEQ 2007). All macroinvertebrate identification was provided by EcoAnalysts, Inc. (Moscow, Idaho).

Fish—The entire reach was electrofished following the protocols outlined in the BURP field manual (DEQ 2007). Fish were identified to the lowest taxonomic level possible in the field, and representative fish were vouchered to confirm or refine field identification. Due to collection permit and logistical limitations, only 157 of the 252 sampled target sites were electrofished.

Habitat—Crews conducted a modified Wolman pebble count at each of the three transects and measured canopy closure with a concave densiometer at each of the three transects and again 10 m upstream from each transect. Crews counted all large organic debris (>10 centimeters diameter and >1 m long) within the bank-full width. Bank stability and bank vegetative cover were measured for the entire sample reach; instream cover, particle embeddedness, channel shape, disruptive pressure, and zone of influence were visually estimated for the entire sample reach (DEQ 2007).

2.3 Data Analysis and Condition Ratings

BURP data were submitted to the DEQ State Office and entered into the BURP central database. Extent estimates were calculated using R statistical software, version 2.15.1 (R Core Team 2012). Multimetric indices of macroinvertebrate community, fish community, and habitat were calculated following DEQ's assessment framework (Grafe 2002) and assigned condition scores and support status according to DEQ's assessment guidance (Grafe et al. 2002). Condition ratings were then estimated for the sampled population (Figure 1) using the sp package (Kincaid and Olsen 2012) for R statistical software (R Core Team 2012).

The script for all R analyses is available as Appendix B.

2.3.1 Target Status and Extent Determination

Site evaluation results were used to determine the extent of wadeable streams that were sampleable in Idaho. Extents were estimated by assigning a weight to each site (i.e., the stream length that each site represented compared with the total stream length). Original weights were different depending on DEQ region and stream order (Appendix A). Weights were adjusted from the original design file to account for the use of oversample sites and to account for the difference in number of sites that were electrofished. Extent estimates were calculated independently for each DEQ region.

2.3.2 Ecological Condition Estimate

To estimate the overall ecological condition of streams in Idaho, we had to first assign condition ratings to each sampled site. DEQ uses multimetric indices of macroinvertebrates, fish, and habitat, adapted from EPA's Rapid Bioassessment Protocol (Barbour et al. 1999), to determine ecological condition in streams (Grafe 2002). Stream reaches are compared to a regionally calculated reference condition, which is assumed to exhibit the "least disturbed" condition for the region.

2.3.2.1 Stream Macroinvertebrate Index

The Stream Macroinvertebrate Index (SMI) is a multimetric index of macroinvertebrate condition. The SMI is composed of nine individual metrics (Table 2).

Table 2. Individual metrics for the Stream Macroinvertebrate Index (SMI), Stream Fish Index (SFI), and Stream Habitat Index (SHI).

SMI Metrics	SFI Metrics		SHI Metrics
	Forest	Rangeland	
Total taxa richness	Number cold water individuals captured per minute electrofishing	Number cold water individuals captured per minute electrofishing	Instream cover score
Number Ephemeroptera taxa	Percent individuals, cold water taxa	Percent individuals, cold water taxa	Number large organic debris
Number Plecoptera taxa	Number cold water taxa	Percent individuals, omnivore or herbivore	Percent fines within wetted
Number Trichoptera taxa	Percent individuals, sensitive native species	Percent Cyprinids as longnose dace	Substrate embeddedness score
Percent individuals in order Plecoptera	Number sculpin age classes	Percent individuals demonstrating Deformation, Erosion, Lesion, or Tumor DELT anomalies	Number of Wolman size classes
Hilsenhoff Biotic Index	Number salmonid age classes	Jaccard similarity to reference community	Channel shape score
Percent individuals in top 5 dominant taxa			Percent bank covered
Number scraper taxa			Percent canopy cover
Number clinger taxa			Disruptive pressure score
			Zone of influence score

The SMI score is then calculated following the formulae described in DEQ's stream assessment framework (Grafe 2002). The SMI score is assigned a condition rating following DEQ's assessment guidance (Grafe et al. 2002). For the SMI, condition ratings are based on the percentiles of SMI scores at reference sites (Table 3). Sites with a lower SMI score than the lowest SMI score among reference sites are considered to be below the minimum threshold. An SMI score and condition rating were calculated for all 252 target sites sampled as part of the Idaho Wadeable Stream Survey.

Table 3. Thresholds for Stream Macroinvertebrate Index (SMI), Stream Fish Index (SFI), and Stream Habitat Index (SHI) condition ratings.

Index	Threshold	Condition Rating
SMI	>25th percentile of reference	3
	10th–25th percentile of reference	2
	Minimum–10th percentile	1
	< minimum of reference	n/a—below threshold
SFI	>50th percentile of reference	3
	25th–50th percentile of reference	2
	5th–25th percentile	1
	< 5th percentile of reference	n/a—below threshold
SHI	>25th percentile of reference	3
	10th–25th percentile of reference	2
	< 10th percentile	1

2.3.2.2 Stream Fish Index

The Stream Fish Index (SFI) is a multimetric index of fish condition. The component metrics for the SFI differ depending on whether a site is classified as rangeland or forest according to its location and elevation. The SFI is composed of six individual metrics (Table 2).

The SFI score is calculated following the formulae described in DEQ's stream assessment framework (Grafe 2002). The SFI score is assigned a condition rating following DEQ's assessment guidance (Grafe et al. 2002). For the SFI, condition ratings are based on the percentiles of SFI scores at reference sites (Table 3). Sites with an SFI score below the 5th percentile of SFI scores among reference sites are considered to be below the minimum threshold. An SFI score and condition rating were calculated for all 157 of the 252 target sites electrofished as part of the Idaho Wadeable Stream Survey.

2.3.2.3 Stream Habitat Index

The Stream Habitat Index (SHI) is a multimetric index of habitat condition. The SHI is composed of 10 individual metrics (Table 2).

The SHI score is calculated following the formulae described in DEQ's stream assessment framework (Grafe 2002). The SHI score is assigned a condition rating following DEQ's assessment guidance (Grafe et al. 2002). For the SHI, conditions are based on the percentiles of SHI scores at reference sites (Table 3). There is no minimum threshold for SHI scores. An SHI score and condition rating were calculated for all 252 target sites sampled as part of the Idaho Wadeable Stream Survey.

2.3.3 Support Status Determination

To determine if a site is meeting its cold water aquatic life beneficial use, a site must have results from at least two of the three indices (SMI, SFI, and SHI). These indices are integrated into a single support status designation.

If either the SMI or SFI condition ratings are below the minimum threshold, the site is considered to be not fully supporting (NFS) the cold water aquatic life beneficial use. If both SMI and SFI have condition ratings above the minimum threshold, then the average of the available indices is calculated. If the average of the condition ratings is <2, then the site is considered to be NFS cold water aquatic life use. If the average is ≥2, then the site is considered to be fully supporting (FS) cold water aquatic life use.

A support status was assigned for all 252 target sites sampled as part of the Idaho Wadeable Stream Survey.

3 Results

DEQ evaluated the target status of 1,793 sites and sampled at 252 wadeable stream target sites during the Idaho Wadeable Stream Survey (Figure 2). Each DEQ regional office sampled between 30 and 47 sites during the survey (Table 4).

3.1 Extent Determination

Overall, 1,793 sites, representing the 148,924 km mapped stream length (sample frame), were evaluated for target status; 45.3 % (standard error [SE] = 1.09), or 67,342 km, were within the target population, and 54.7% (SE = 1.09), or 81,582 km, were non-target.

Table 4. Number of sites evaluated for target status and sampled by each DEQ regional office for the Idaho Wadeable Stream Survey.

	Number of Sites	
Regional Office	**Evaluated for Target**	**Sampled**
Coeur d'Alene	149	44
Lewiston	221	38
Boise	335	47
Twin Falls	352	30
Pocatello	360	47
Idaho Falls	376	46

Target stream length was further subdivided as being either sampled (target-sampled) or not sampled due to accessibility or logistical issues. Of the 148,924 km mapped stream length (sample frame), 25.3% (SE = 1.01), or 37,737 km were estimated to be inaccessible, and 10.1% (SE = 0.61), or 15,061 km, were presumed not accessible due to landowner denial (based on extrapolation from evaluated sites).

Similarly, the non-target stream length was subdivided based on why it was excluded from the target population, with 47.2% (SE = 1.11) of the sample frame's stream length estimated to be dry.

DEQ field crews sampled at 252 wadeable stream target sites throughout Idaho. These sites represent a sampled population of 14,544 km, or 9.8% (SE = 0.68), of the mapped stream length (sample frame) (Figure 3; Table 5). This 14,544 km of stream length is the portion of Idaho's wadeable streams for which condition can be estimated based on actual sampling results.

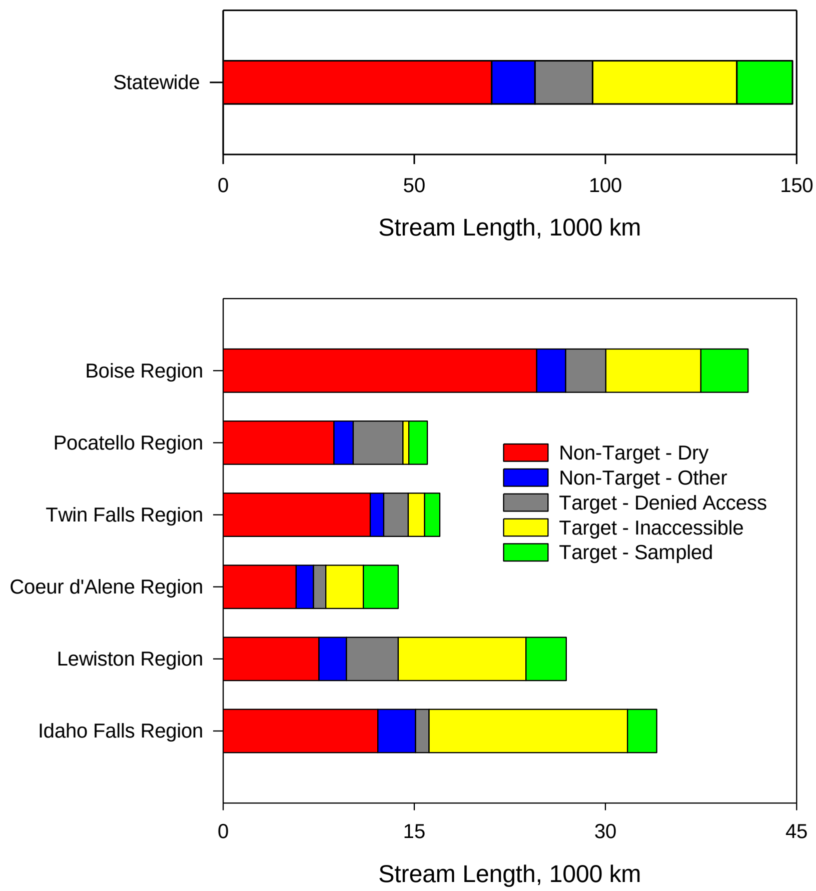


Figure 3. Length of stream, in kilometers, estimated to be non-target (dry and other non-target) and target (denied access, inaccessible, and sampled) statewide and by DEQ region.

Sites were also categorized by Strahler stream order, with the sample frame including all 1st- through 5th-order streams from the NHDPlusV2. Results of extent estimates by stream order are presented in Table 6. The 1st- and 5th-order reaches had the lowest proportion of the sample frame monitored at 4.8% and 5.2%, respectively (Table 6).

Table 5. Sample frame, or mapped stream length, and extent estimates for non-target and target categories for the Idaho Wadeable Stream Survey by DEQ region and statewide. Target and non-target lengths are extrapolations from the corresponding evaluated sites.

DEQ Region	Sample Frame		Non-Target Categories						Target Categories									
			Dry			Other			Denied Access			Inaccessible			Target-Sampled		
	Number Evaluated	Mapped Length (km)	No.	% (SE)	Length (km) (SE)	No.	% (SE)	Length (km) (SE)	No.	% (SE)	Length (km) (SE)	No.	% (SE)	Length (km) (SE)	No.	% (SE)	Length (km) (SE)
Coeur d'Alene	149	13,744	38	41.7 (4.11)	5,737 (565.3)	31	9.9 (1.87)	1,355 (257.3)	10	7.0 (2.11)	969 (290.2)	26	21.4 (3.61)	2,942 (495.6)	44	19.9 (3.13)	2,741 (430.6)
Lewiston	221	26,924	43	27.9 (2.96)	7,515 (798.3)	26	8.1 (1.69)	2,168 (455.7)	34	15.1 (1.90)	4,060 (512.1)	80	37.2 (2.73)	10,020 (735.6)	38	11.7 (2.03)	3,161 (545.9)
Boise	335	41,197	163	59.7 (1.99)	24,605 (819.4)	31	5.5 (1.10)	2,280 (454.9)	41	7.6 (1.17)	3,148 (482.5)	53	18.1 (1.80)	7,459 (741.3)	47	9.0 (1.27)	3,705 (523.9)
Twin Falls	352	17,006	190	67.9 (2.36)	11,552 (401.9)	42	6.2 (1.12)	1,054 (190.5)	64	11.3 (1.58)	1,922 (268.5)	26	7.5 (1.49)	1,282 (253.0)	30	7.0 (1.33)	1,195 (226.1)
Pocatello	360	16,022	145	54.3 (2.36)	8,702 (378.9)	54	9.4 (1.32)	1,504 (211.4)	97	24.4 (1.96)	3,909 (313.9)	17	2.9 (0.76)	462 (122.4)	47	9.0 (1.40)	1,445 (224.6)
Idaho Falls	376	34,030	108	35.7 (2.59)	12,148 (881.3)	56	8.7 (1.34)	2,961 (455.5)	18	3.1 (0.84)	1,053 (286.0)	148	45.8 (2.72)	15,573 (925.3)	46	6.7 (1.20)	2,296 (406.9)
Statewide	**1,793**	**148,924**	**687**	**47.2 (1.11)**	**70,259 (1646.2)**	**240**	**7.6 (0.59)**	**11,322 (877.1)**	**264**	**10.1 (0.61)**	**15,061 (911.9)**	**350**	**25.3 (1.01)**	**37,738 (1,507.1)**	**252**	**9.8 (0.68)**	**14,544 (1,012.5)**

Note: kilometer (km); standard error (SE)

Table 6. Sample frame, or mapped stream length, and extent estimates for non-target and target categories for the Idaho Wadeable Stream Survey by Strahler stream order. Target and non-target lengths are extrapolations from the corresponding evaluated sites.

Stream Order	Sample Frame		Non-Target Categories						Target Categories								
			Dry			Other			Denied Access			Inaccessible			Target-Sampled		
	Number Evaluated	Mapped Length (km)	No.	% (SE)	Length (km) (SE)	No.	% (SE)	Length (km) (SE)	No.	% (SE)	Length (km) (SE)	No.	% (SE)	Length (km) (SE)	No.	% (SE)	Length (km) (SE)
1	698	98,230	409	55.3 (1.52)	54,365 (1,490.9)	32	4.4 (0.70)	4,354 (690.7)	73	8.6 (0.82)	8,404 (808.4)	152	26.8 (1.34)	26,355 (1315.7)	32	4.8 (0.74)	4,753 (728.3)
2	187	27,216	81	40.6 (2.64)	11,050 (719.6)	13	7.0 (1.67)	1,894 (455.7)	21	10.0 (1.52)	2,735 (413.7)	38	24.7 (2.81)	6,725 (764.5)	34	17.7 (2.39)	4,811 (651.0)
3	547	13,366	149	27.1 (1.31)	3,618 (175.2)	68	11.6 (1.17)	1,555 (155.7)	94	15.6 (1.26)	2,082 (168.2)	91	17.9 (1.34)	2,393 (178.5)	145	27.8 (1.62)	3,719 (216.6)
4	216	6,182	31	12.7 (1.61)	783 (99.7)	61	29.2 (2.66)	1,807 (164.7)	46	18.3 (1.66)	1,129 (102.7)	42	22.8 (2.34)	1,408 (145.0)	36	17.1 (2.40)	1,056 (148.5)
5	145	3,929	17	11.3 (2.13)	44 (83.6)	66	43.6 (3.11)	1,713 (122.3)	30	18.1 (2.80)	712 (110.2)	27	21.8 (3.15)	857 (123.6)	5	5.2 (1.77)	204 (69.6)

Note: kilometer (km); standard error (SE)

3.2 Ecological Condition Estimate

3.2.1 Macroinvertebrate Condition

Statewide, 71.3% (SE = 3.35) of the sampled population, or 10,371 km, was in good condition for macroinvertebrates; 10.6% (SE = 2.20), or 1,540 km, was fair; and 18.1% (SE = 2.6), or 2,632 km, was poor (Figure 4).

The Boise Region had the highest proportion of stream length classified as good for macroinvertebrates, at 80.2% (SE = 6.82). The Pocatello Region had the lowest proportion of stream length classified as good for macroinvertebrates, at 38.8% (SE = 7.29). All other regions had over 68% of stream length classified as good for macroinvertebrates. Similarly, the Boise Region had the lowest proportion of stream length classified as poor for macroinvertebrates, at 5.2% (SE = 1.52), compared to the Pocatello Region, which had 47.6% (SE = 6.58) of stream length classified as poor for macroinvertebrates (Figure 4).

Generally, macroinvertebrate conditions decreased as stream order increased (Figure 5).

3.2.2 Fish Condition

For fish condition, 33.0% (SE = 4.80), or 4,799 km, of the sample frame was good statewide; 38.6% (SE = 6.04), or 5,611 km, was fair; and 28.4% (SE = 4.87), or 4,134 km, was poor (Figure 4).

The Coeur d'Alene Region had the highest proportion of stream length classified as good for fish, at 58.6% (SE = 11.59). The Pocatello Region had the lowest proportion of stream length classified as good for fish, at 7.5% (SE = 2.48). The Idaho Falls Region had the second lowest proportion of stream length classified as good for fish, at 16.1% (SE = 10.34). The other three regions ranged from 30.5 to 35.9% of stream length classified as good for fish (Figure 4).

Fish condition was generally consistent among stream orders, with the proportion of stream length classified as good ranging from 31.5 to 37.8% (Figure 5).

3.2.3 Habitat Condition

For habitat condition, 66.6% (SE = 3.32), or 9,684 km, of the sample frame was good statewide; 17.5% (SE = 2.76), or 2,549 km, was fair; and 15.9% (SE = 2.35), or 2,310 km, was poor (Figure 4).

The Twin Falls Region had the highest proportion of stream length classified as good for habitat, at 76.6% (SE = 8.39). The Pocatello Region had the lowest proportion of stream length classified as good for habitat, at 30.1% (SE = 8.30). All other regions had over 65.9% of stream length classified as good for habitat (Figure 4).

Generally, habitat conditions decreased as stream order increased (Figure 5).

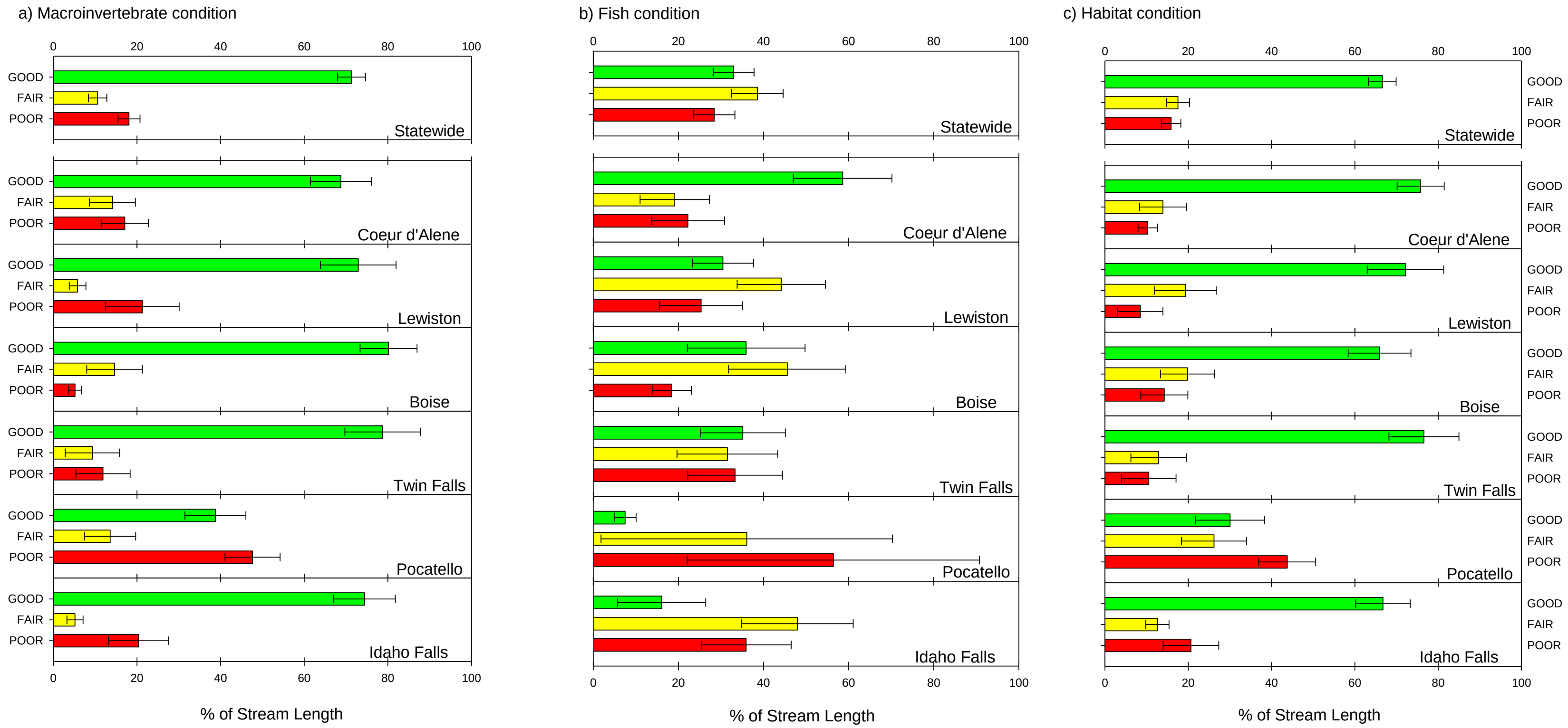


Figure 4. Macroinvertebrate, fish, and habitat condition estimates statewide and by DEQ region. Error bars represent standard error.

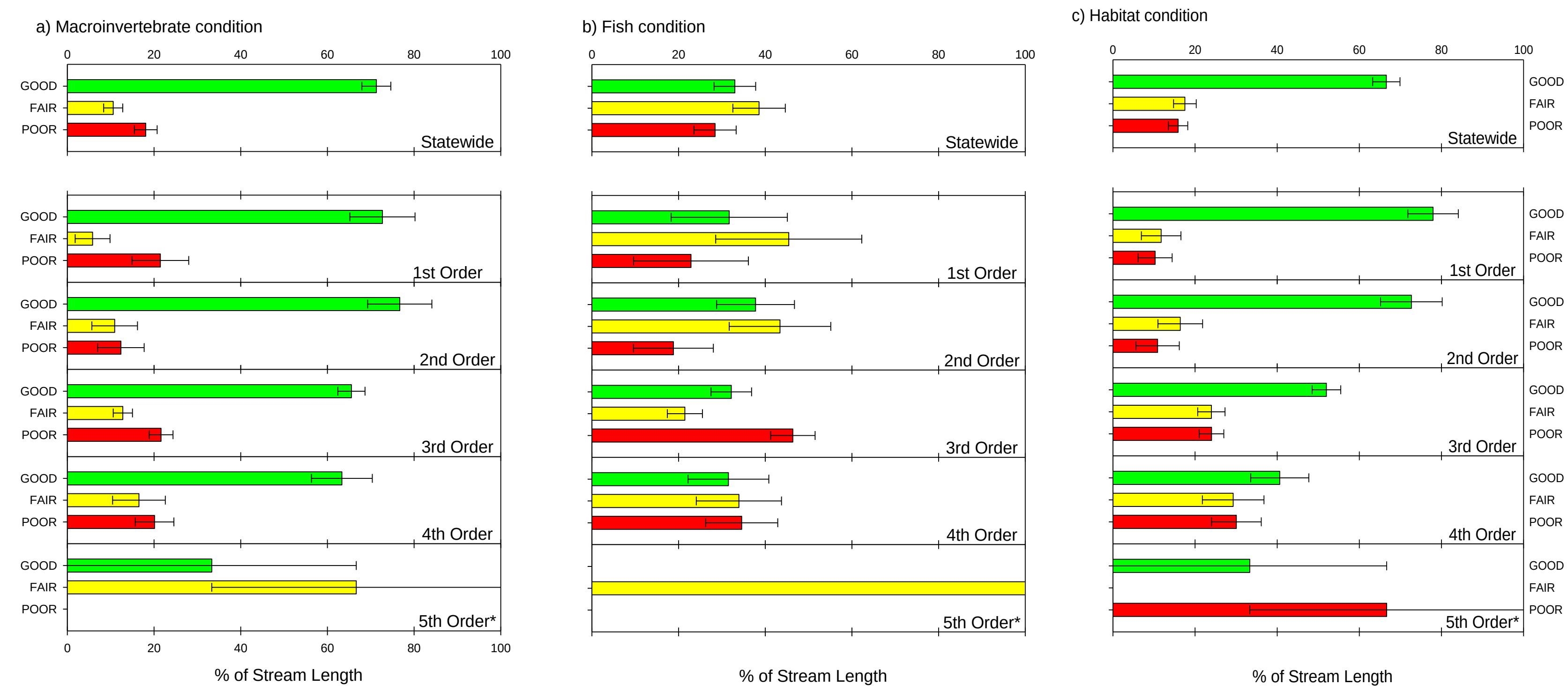


Figure 5. Macroinvertebrate, fish, and habitat condition estimates statewide and by Strahler stream order. Error bars represent standard error. *Note: 5th-order streams were underrepresented in the Idaho Wadeable Stream Survey.

3.2.4 Combined Ecological Condition

Statewide, 57.7% (SE = 3.311) of the sampled population, or 8,392 km, was in good overall ecological condition; 14.4% (SE = 2.05), or 2,091 km, was fair; and 27.9% (SE = 3.09), or 4,061 km, was poor (Figure 6).

Ecological condition varied by stream order but generally decreased as stream order increased (Figure 7).

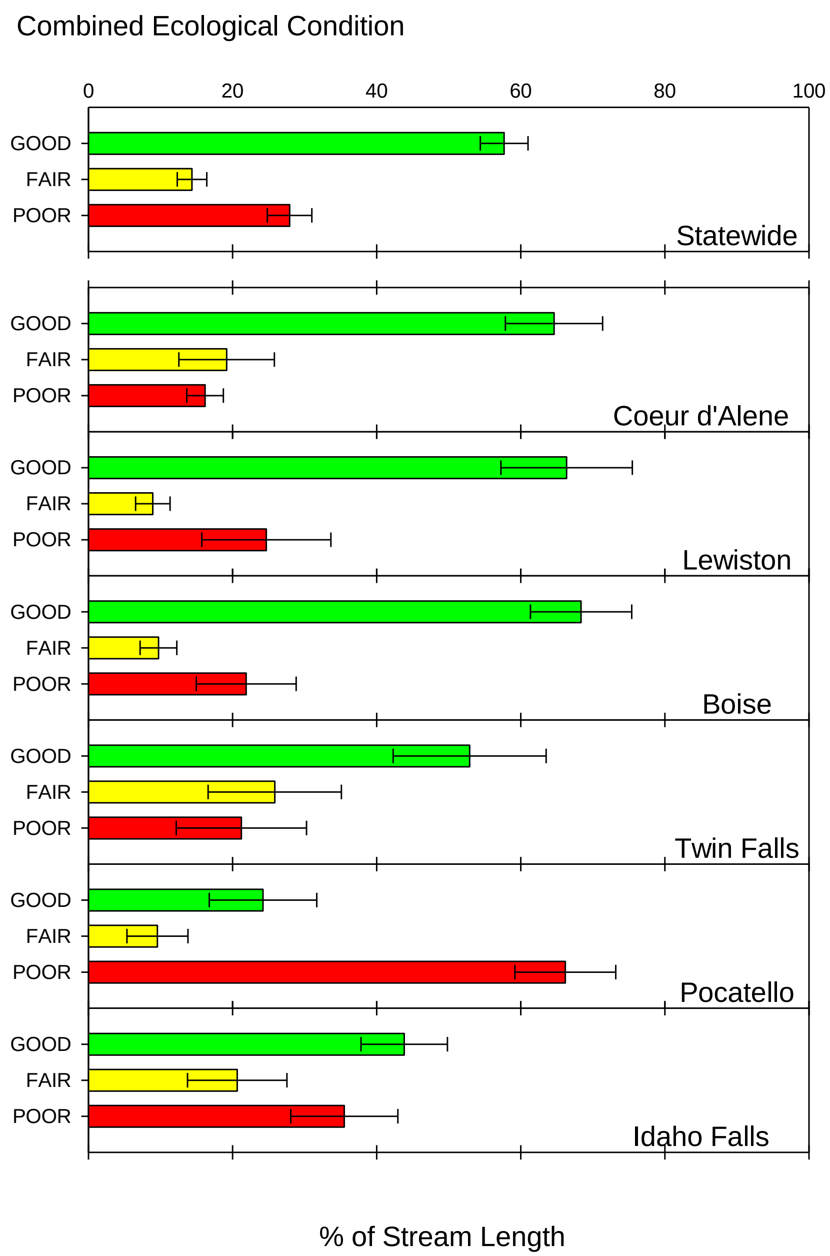


Figure 6. Ecological condition estimates statewide and by DEQ region. Error bars represent standard error.

Figure 7. Ecological condition estimates statewide and by Strahler stream order. Error bars represent standard error. *Note: 5th-order streams were underrepresented in the Idaho Wadeable Stream Survey.

3.3 Support Status Determination

Statewide, 72.1% (SE = 3.09) of the sampled population, or 10,482 km, was considered fully supporting cold water aquatic life according to ecological condition, while 27.9% (SE = 3.09), or 4,061 km, was considered not fully supporting (Figure 8).

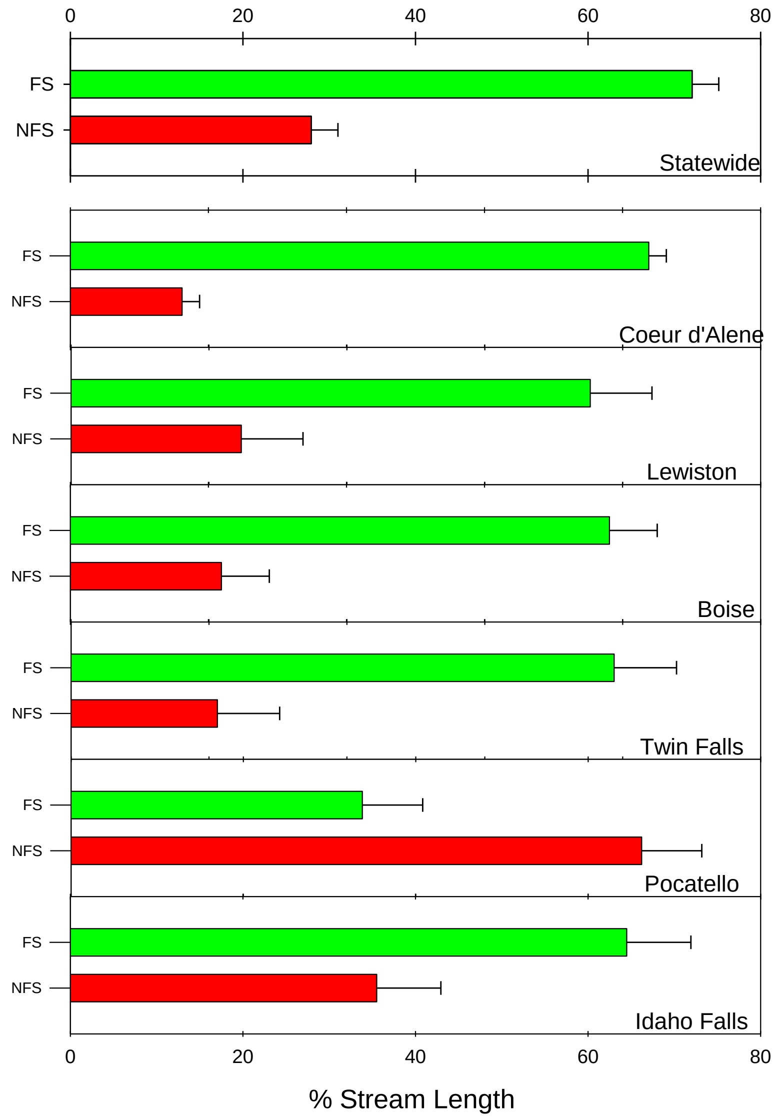


Figure 8. Support status (fully supporting [FS] or not fully supporting [NFS]) estimates statewide and by DEQ region. Error bars represent standard error.

4 Discussion

4.1 Extent

The target population reflects only 45.3% of the sample frame. The most common reason for rejecting sites as non-target was dry, meaning that flowing water was not present at the time of sampling. In general, these streams are intermittent stream channels that are mistakenly coded as perennial streams according to NHDPlusV2 (Table 5). Most of these dry channels occurred in low-order headwater streams (Table 6). These data indicate that NHDPlusV2 overestimates the length of perennial streams.

This finding is consistent with other wadeable stream surveys. For example, Olsen and Peck (2008) found that only 45.7% of EPA's Wadeable Stream Assessment sample frame consisted of target streams, with dry channels or intermittent streams accounting for the majority of non-target stream length. These findings underscore a need to find a better sample frame to represent perennial streams in Idaho.

Among DEQ regions, estimates of target and non-target stream length varied. The Twin Falls Region had the highest proportion of dry streams (67.9%). Conversely, the Lewiston Region had only 27.9% of stream length categorized as dry (Table 5). These finding are expected based on climatic and ecoregional differences between the two regions. In fact, the southern Idaho regions (Boise, Twin Falls, and Pocatello) each had over 50% of stream length categorized as dry, whereas the Coeur d'Alene, Lewiston, and Idaho Falls Regions each had less than half of their stream length categorized as dry. When the DEQ regions are compared with the aggregated Omernik level III ecoregions (McGrath et al. 2001), the majority of the area in the southern Idaho regions is in the drier Xeric West ecoregion, while the northern Idaho regions are in the more humid Western Mountains ecoregion (Figure 9).

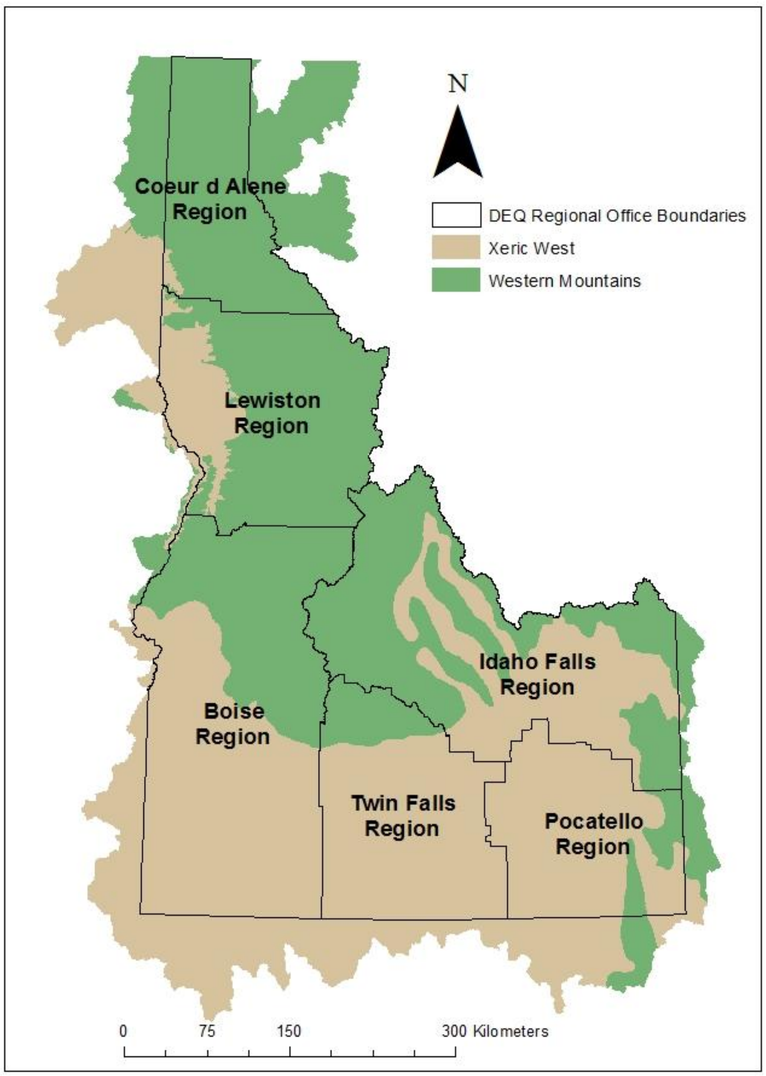


Figure 9. DEQ regions in relation to Omernik level III aggregated ecoregions (McGrath et al. 2001).

The Idaho Falls and Lewiston Regions had the highest proportion of target sites but also the highest proportion of inaccessible sites (Table 5). Again, these findings are expected since both regions encompass large areas of designated wilderness and relatively remote mountain streams, where sampling is either unsafe or impractical.

Landowner access denial was highly variable, with the Idaho Falls Region only reporting 3.1% stream length being denied access, compared to 24.4% for the Pocatello Region. Landowner denial could be affected by several factors, including the distribution of sites on public versus private land. For example, the Idaho Falls Region had the lowest proportion of private land (21%), while the Pocatello Region had the highest (51%), including tribal land (Table 7).

Although this likely explains much of the variability in access denial among regions, other factors may also contribute, such as the effectiveness of the individual coordinator in obtaining permission to access the site, and perhaps the local attitude toward DEQ and government in general.

Table 7. Proportion of public and private land, by DEQ region. Private land includes Indian reservations.

Regional Office	Public Land (Acres)	Private Land (Acres)	Total Land (Acres)	Percent Private
Coeur d'Alene	3,197,168	1,878,064	5,075,232	37
Lewiston	6,025,592	2,543,785	8,569,377	30
Boise	10,425,884	3,580,524	14,006,408	26
Twin Falls	4,715,934	2,666,854	7,382,788	36
Pocatello	2,927,119	3,104,693	6,031,812	51
Idaho Falls	9,776,632	2,586,405	12,363,037	21

Ideally, the sampled population, target population, and sample frame for a survey would be exactly the same (i.e., the squares in Figure 1 would perfectly overlap). Because of mapping inconsistencies and accessibility, this is not realistic. However, for the Idaho Wadeable Stream Survey, the sampled population was not only a small fraction of the sample frame (9.8%) but was also a small fraction of the target population (21.6%).

The Idaho Wadeable Stream Survey relied on NHDPlusV2 as a sample frame. DEQ believes that NHDPlusV2 overestimates perennial stream miles in Idaho. This is supported by the extent estimates from the Idaho Wadeable Stream Survey. DEQ contracted with the US Geological Survey to develop a model to predict perennial flow in Idaho (Wood et al. 2009), and when this information is integrated into the sample frame it should decrease the proportion of the sample frame that is dry.

DEQ used stream order as a surrogate for stream size in the Idaho Wadeable Stream Survey. Although, stream order is generally an appropriate surrogate for stream size, other factors could be used to better estimate stream size. For example, Hughes et al. (2011) found that other easily derived geographic information system (GIS) variables could better explain stream size, such as catchment area and predicted flow.

In addition, a better definition of the target population would improve efficiency of the probabilistic monitoring. For the Idaho Wadeable Stream Survey, we defined the target population as all sampleable, wadeable streams ≤5th order within Idaho. This definition includes a large proportion of streams that are located within Idaho's vast wilderness. In general, DEQ assumes that waters within the wilderness are not impaired, since they have very limited human disturbance within their watersheds. By including them in our target population, we ended up with a large proportion of our sample frame categorized as inaccessible.

4.2 Ecological Condition

Of the three ecological indicators, macroinvertebrates generally scored higher than either fish or habitat (Figure 4). Habitat may be a leading indicator; the first perturbations to a stream system may come from habitat alteration that may not have caused a subsequent decrease in macroinvertebrate condition or hasn't yet reached a threshold where macroinvertebrate communities are degraded.

Fish communities were more variable, with generally less stream length classified as good and more stream length classified as fair than for other indicators (Figure 4). One possible explanation for this result is a possible bias in sites that are electrofished. Not all sites monitored as part of the Idaho Wadeable Stream Survey were electrofished. Often, sites were not electrofished because of the presence of anadromous fish or because of the difficulty of accessing the site with electrofishing equipment. Sites that either provided habitat for anadromous fish or were difficult to access were probably less likely to have human disturbance and therefore less likely to have poor water quality. By limiting electrofishing in these waters, we are likely biasing our fish sampling towards poorer quality sites.

The majority of Idaho's streams are in good or fair ecological condition (Figure 6). This finding is consistent with other Idaho statewide condition assessments. For example, Pappani (2010) found that for overall ecological condition, 40.8% of Idaho's major river length was good, 40.8% was fair, and 18.4% was poor. Similarly, Kosterman et al. (2008) found that 10.42% of wadeable perennial stream length in Idaho was in poor condition; for large, non-wadeable rivers, macroinvertebrate condition was good for 37% of river kilometers, fair for 52%, and poor for 11%.

By contrast, only 28% of stream length nationally was considered to be in good condition, with 25% considered fair and 42% considered in poor condition. However, for the western United States, results are more similar to Idaho's statewide assessment: 45% good, 36% fair, and 27% poor (Paulsen et al. 2008). In general, Idaho stream condition is in line with stream condition in the West.

Furthermore, these data indicate that the general trend of water quality in Idaho is relatively stable; we are not seeing dramatic shifts in stream length from good to poor. Although these studies all used different indicators of ecological health, they do all follow scientifically defensible, valid measures of stream health. The agreement among results indicates that, at least at the gross level, the methods are comparable.

In general, all regions followed the statewide trend, with the majority of stream length being either good or fair, with the exception of the Pocatello Region (Figure 6). In contrast to the rest of the state, the Pocatello Region had a much higher proportion of stream length categorized as poor than good or fair (Figure 6).

The relatively poor condition of streams in the Pocatello Region, as compared to the rest of the state, may be due to several factors. Compared to other regions, the Pocatello Region had the second smallest sample frame, with the highest proportion of sites rejected due to landowner access denial and the lowest proportion of inaccessible sites (Table 5). Furthermore, the Pocatello Region has by far the greatest land area in private ownership (Table 7). These data indicate that the streams in the Pocatello Region are more likely to be in close proximity to human influences that would lead to habitat alteration and subsequent changes in macroinvertebrate and fish communities, leading to the higher proportion of poor stream length.

Condition also varied considerably based on stream order. In general, as stream size (stream order) increased, condition decreased (Figure 7). This is likely because as one heads upstream, the general trend is away from human settlement, with human perturbations decreasing as one approaches more remote headwaters (lower-order streams).

4.3 Support Status

The Idaho Wadeable Stream Survey results indicate that, using DEQ's assessment procedures, approximately 72.1% of Idaho's wadeable stream length is fully supporting cold water aquatic life, while 27.9% is not fully supporting (Figure 8). DEQ's 2010 Integrated Report (DEQ 2011) indicated that approximately 35% of Idaho's river and stream length was not fully supporting beneficial uses. Although this is slightly higher than the Idaho Wadeable Stream Survey findings, much of the difference may be attributed to the more comprehensive nature of the Integrated Report. For example, the Integrated Report includes assessment for additional beneficial uses, such as recreational uses, and includes all flowing waters, including non-wadeable rivers that are more likely to have significant human impacts and subsequent impairment. However, both the Integrated Report and the Idaho Wadeable Stream Survey indicate that the vast majority of Idaho flowing waters are supporting beneficial uses.

5 Conclusion

Continued probabilistic surveys will enable DEQ to continue monitoring overall statewide stream condition and any trends in overall water quality throughout the state. However, improvements to survey design should be pursued to improve the efficiency and quality of survey results. Future efforts should focus on (1) improving the representativeness of the sample frame, (2) better defining the target population, and (3) standardizing efforts for accessing sites and obtaining permission to access private property. Similarly, DEQ should work to eliminate any bias in electrofishing, and crews should strive to electrofish at every sample site.

The Idaho Wadeable Stream Survey indicates that the majority of Idaho's wadeable stream length is in good ecological condition and supports cold water aquatic life. When taken in context with other lake, stream, and river assessments, the Idaho Wadeable Stream Survey confirms the high quality of Idaho waters.

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Appendix A. Idaho Wadeable Stream Survey Design Documentation

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Idaho Wadeable Stream Design

Contact:

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Description of Sample Design

Target Population: All perennial, wadeable streams within Idaho that have sufficient size to be sampled by Idaho's BURP protocol. Streams that are within wilderness areas or on tribal lands may be excluded from the target population during sampling. They will be included in the survey design.

Sampling Frame: Provided by Idaho Department of Environmental Quality. It consists of their version of NHD, which includes Strahler order. Only include Strahler orders 1st through 5th in the frame for the design. A separate GIS coverage defines the 10 Idaho DEQ regions that will be used in the survey design.

Survey Design: GRTS for a linear network with RHO: Generalized random tessellation stratified survey design for a linear network with reverse hiearchical ordering.

Stratification: None

Multi-Density Categories: Two features will define the categories. First, the 6 DEQ regions are one categorization. Second, the Strahler order groups: 1st2nd (1st and 2nd order), 3rd (3rd order), 4th5th: (4th and 5th orders). Assume they are independent to generate the combined multi-density categories. Please review to determine the expected number of sites withen each DEQ region by Strahler order group.

Panels: 5 panels of sites that are state-wide. Panel 1 will be visited in year 1, year 6, year 11, etc. Panel 2 will be visited in year 2, year 7, year 12, etc. and so on.

[NOTE: There is no note in the design documentation about oversample sites, but in consultation with Tony Olsen it was decided to use a 200% oversample so there will be twice as many backup sites as base sample sites.]

Sample sizes: 250 sites total. 50 in each panel. Each year expect 10 in each DEQ region. Sample sizes by Strahler group: 50% in 1st2nd, 30% in 3rd, and 20% in 4th5th.

1

Expectation is that the non-target rate and inaccessible rate will be greater in 1st2nd order group (and in particular 1st order streams).

[NOTE: With n=50 and six regions, there will be slightly less than 9 sample sites expected in each region.]

QA Revisit sites: No additional constraints on the design requirements for the survey design are needed to identify QA revisit sites. Since the sites will be provided in spatially-balanced random order by SiteID, the first (lowest SiteID) target sampled site in each DEQ region should be used as a QA site each year. That will result in a total of 56 site-visits (6 in each DEQ region) each year. It is recommended that each of these sites also be revisited twice in the following year (4 total visits to the same site). This will enable all four sources of variation (sites, years, sites by years, and local) to be estimated and used for determining power for trend detection. If 4 site visits can not be made, then possible to reduce to 3 site-visits where one year has two visits and another year has one visit.

[NOTE: Fifty base sample sites plus a re-visit for each region will yield fifty-six visits on fifty sites in the first year. Re-visits in the subsequent panels would yield the above fifty-six visits plus an additional two visits for each of the region QA sites of the previous year, producing a total of sixty-eight visits on fifty-six sites for each year after Year One.]

Description of Sample Design Output:

To achieve an expected sample size of sites in the target population, an appropriate sample size was selected for each separate study area. The extra/reserve samples are available as alternate sites for base sites which do not conform to target population rules (e.g. non-wadeable, mis-mapped features), are inaccessible due to safety concerns, or where access is denied by landowners. A design has a base set of samples spread over five panels, one panel per year. The design has a 200% oversample, i.e. 100 reserve sites for each sample of fifty, for a total of 150 potential sample sites per panel.

The sites must be evaluated for use in numerical order. Numerical order is determined by the SiteID within each EPA Region. The base sites have an "oversamp" code of "0". The oversample sites ("oversamp" code = 1) should be used, as needed, in numerical order.

The following tables show the distribution of the frame information, as well as the sample sites, for each separate design (stratum).

2

Sums of Multipliers for Sample Design
ID Wadeable Streams 2004

region	Frequency	Percent	Cumulative Frequency	Cumulative Percent
EIRO	69843.44	16.80	69843.44	16.80
NCIR	67067.93	16.13	136911.4	32.92
NIRO	71561.19	17.21	208472.6	50.13
SCIR	69578.46	16.73	278051	66.87
SEIR	67099.86	16.14	345150.9	83.00
SWIR	70682.2	17.00	415833.1	100.00

ordcat	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1-2	208355.5	50.11	208355.5	50.11
3	124396.9	29.92	332752.3	80.02
4-5	83080.72	19.98	415833.1	100.00

ordcat	region	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1-2	EIRO	34582.16	8.32	34582.16	8.32
1-2	NCIR	35245.16	8.48	69827.32	16.79
1-2	NIRO	34236.84	8.23	104064.2	25.03
1-2	SCIR	34631.5	8.33	138695.7	33.35
1-2	SEIR	35223.37	8.47	173919	41.82
1-2	SWIR	34436.45	8.28	208355.5	50.11
3	EIRO	19942.6	4.80	228298.1	54.90
3	NCIR	19397.77	4.66	247695.9	59.57
3	NIRO	23726.71	5.71	271422.6	65.27
3	SCIR	19589.29	4.71	291011.9	69.98
3	SEIR	19022.73	4.57	310034.6	74.56
3	SWIR	22717.76	5.46	332752.3	80.02
4-5	EIRO	15318.68	3.68	348071	83.70
4-5	NCIR	12425	2.99	360496	86.69
4-5	NIRO	13597.64	3.27	374093.7	89.96
4-5	SCIR	15357.66	3.69	389451.3	93.66
4-5	SEIR	12853.76	3.09	402305.1	96.75
4-5	SWIR	13527.99	3.25	415833.1	100.00

3

Sums of Multipliers for Sample Design
ID Wadeable Streams 2004

RxOmult	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	34436.45	8.28	34436.45	8.28
1.211	34582.16	8.32	69018.61	16.60
1.53	35245.16	8.48	104263.8	25.07
2.423	34631.5	8.33	138895.3	33.40
2.571	35223.37	8.47	174118.6	41.87
2.997	34236.84	8.23	208355.5	50.11
4.962	13527.99	3.25	221883.5	53.36
5.631	22717.76	5.46	244601.2	58.82
6.008982	15318.68	3.68	259919.9	62.51
6.819141	19942.6	4.80	279862.5	67.30
7.59186	12425	2.99	292287.5	70.29
8.61543	19397.77	4.66	311685.3	74.95
12.022926	15357.66	3.69	327042.9	78.65
12.757302	12853.76	3.09	339896.7	81.74
13.643913	19589.29	4.71	359486	86.45
14.477301	19022.73	4.57	378508.7	91.02
14.871114	13597.64	3.27	392106.4	94.29
16.876107	23726.71	5.71	415833.1	100.00

MD_CATY values for ID Wadeable Streams 2004
sums are in meters

md_caty	numbering scheme for design strata	RxOmult	region	ordcat	sum of units	sum of weighted units
1	1	1.0000	SWIR	1-2	34436446.93	34436446.93
2	1	1.2110	EIRO	1-2	28556696.28	34582159.19
3	1	1.5300	NCIR	1-2	23036052.24	35245159.92
4	1	2.4230	SCIR	1-2	14292820.80	34631504.80
5	1	2.5710	SEIR	1-2	13700261.72	35223372.89
6	1	2.9970	NIRO	1-2	11423705.33	34236844.88
7	1	4.9620	SWIR	4-5	2726317.79	13527988.85
8	1	5.6310	SWIR	3	4034409.73	22717761.18
9	1	6.0090	EIRO	4-5	2549296.46	15318676.56
10	1	6.8191	EIRO	3	2924503.96	19942604.83
11	1	7.5919	NCIR	4-5	1636621.39	12425000.44
12	1	8.6154	NCIR	3	2251514.46	19397765.19
13	1	12.0229	SCIR	4-5	1277364.60	15357660.08
14	1	12.7573	SEIR	4-5	1007560.75	12853756.83
15	1	13.6439	SCIR	3	1435753.27	19589292.69
16	1	14.4773	SEIR	3	1313969.10	19022726.19
17	1	14.8711	NIRO	4-5	914365.88	13597639.22
18	1	16.8761	NIRO	3	1405935.03	23726709.95

4

Selected Sites for ID Wadeable Streams 2004

Table of nest_id by oversamp

nest_id

Frequency	oversamp(If 0: routine site; Else a reserve site) 0	1	Total
1	250	500	750
Total	250	500	750

Table of region by oversamp

region

Frequency	oversamp(If 0: routine site; Else a reserve site) 0	1	Total
EIRO	41	84	125
NCIR	40	81	121
NIRO	44	87	131
SCIR	41	81	122
SEIR	42	79	121
SWIR	42	88	130
Total	250	500	750

Table of ordcat by oversamp

ordcat

Frequency	oversamp(If 0: routine site; Else a reserve site) 0	1	Total
1-2	126	247	373
3	69	154	223
4-5	55	99	154
Total	250	500	750

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Selected Sites for ID Wadeable Streams 2004

Table of order by oversamp

order(Strahler order for stream)
oversamp(If 0: routine site; Else a reserve site)

Frequency	0	1	Total
1	103	189	292
2	23	58	81
3	69	154	223
4	36	55	91
5	19	44	63
Total	250	500	750

Table 1 of ordcat by oversamp
Controlling for region=EIRO

ordcat
oversamp(If 0: routine site; Else a reserve site)

ordcat	Frequency / Percent / Row Pct / Col Pct	0	1	Total
1-2	Frequency	22	51	73
	Percent	17.60	40.80	58.40
	Row Pct	30.14	69.86	
	Col Pct	53.66	60.71	
3	Frequency	5	15	20
	Percent	4.00	12.00	16.00
	Row Pct	25.00	75.00	
	Col Pct	12.20	17.86	
4-5	Frequency	14	18	32
	Percent	11.20	14.40	25.60
	Row Pct	43.75	56.25	
	Col Pct	34.15	21.43	
Total		41	84	125
		32.80	67.20	100.00

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Table 2 of ordcat by oversamp
Controlling for region=NCIR

ordcat — oversamp(If 0: routine site; Else a reserve site)

ordcat	Statistic	0	1	Total
1-2	Frequency	15	45	60
	Percent	12.40	37.19	49.59
	Row Pct	25.00	75.00	
	Col Pct	37.50	55.56	
3	Frequency	14	24	38
	Percent	11.57	19.83	31.40
	Row Pct	36.84	63.16	
	Col Pct	35.00	29.63	
4-5	Frequency	11	12	23
	Percent	9.09	9.92	19.01
	Row Pct	47.83	52.17	
	Col Pct	27.50	14.81	
Total	Frequency	40	81	121
	Percent	33.06	66.94	100.00

Table 3 of ordcat by oversamp
Controlling for region=NIRO

ordcat — oversamp(If 0: routine site; Else a reserve site)

ordcat	Statistic	0	1	Total
1-2	Frequency	20	39	59
	Percent	15.27	29.77	45.04
	Row Pct	33.90	66.10	
	Col Pct	45.45	44.83	
3	Frequency	13	31	44
	Percent	9.92	23.66	33.59
	Row Pct	29.55	70.45	
	Col Pct	29.55	35.63	
4-5	Frequency	11	17	28
	Percent	8.40	12.98	21.37
	Row Pct	39.29	60.71	
	Col Pct	25.00	19.54	
Total	Frequency	44	87	131
	Percent	33.59	66.41	100.00

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```
Table 4 of ordcat by oversamp
Controlling for region=SCIR

ordcat
          oversamp(If 0: routine site; Else a reserve site)
Frequency|
Percent  |
Row Pct  |
Col Pct  |       0|       1|  Total
---------+--------+--------+
1-2      |     23 |     36 |     59
         |  18.85 |  29.51 |  48.36
         |  38.98 |  61.02 |
         |  56.10 |  44.44 |
---------+--------+--------+
3        |     13 |     24 |     37
         |  10.66 |  19.67 |  30.33
         |  35.14 |  64.86 |
         |  31.71 |  29.63 |
---------+--------+--------+
4-5      |      5 |     21 |     26
         |   4.10 |  17.21 |  21.31
         |  19.23 |  80.77 |
         |  12.20 |  25.93 |
---------+--------+--------+
Total          41       81      122
            33.61    66.39   100.00


Table 5 of ordcat by oversamp
Controlling for region=SEIR

ordcat
          oversamp(If 0: routine site; Else a reserve site)
Frequency|
Percent  |
Row Pct  |
Col Pct  |       0|       1|  Total
---------+--------+--------+
1-2      |     26 |     38 |     64
         |  21.49 |  31.40 |  52.89
         |  40.63 |  59.38 |
         |  61.90 |  48.10 |
---------+--------+--------+
3        |      9 |     25 |     34
         |   7.44 |  20.66 |  28.10
         |  26.47 |  73.53 |
         |  21.43 |  31.65 |
---------+--------+--------+
4-5      |      7 |     16 |     23
         |   5.79 |  13.22 |  19.01
         |  30.43 |  69.57 |
         |  16.67 |  20.25 |
---------+--------+--------+
Total          42       79      121
            34.71    65.29   100.00
```

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Table 6 of ordcat by oversamp
Controlling for region=SWIR

ordcat — oversamp(If 0: routine site; Else a reserve site)

Frequency / Percent / Row Pct / Col Pct

ordcat		0	1	Total
1-2	Frequency	20	38	58
	Percent	15.38	29.23	44.62
	Row Pct	34.48	65.52	
	Col Pct	47.62	43.18	
3	Frequency	15	35	50
	Percent	11.54	26.92	38.46
	Row Pct	30.00	70.00	
	Col Pct	35.71	39.77	
4-5	Frequency	7	15	22
	Percent	5.38	11.54	16.92
	Row Pct	31.82	68.18	
	Col Pct	16.67	17.05	
Total	Frequency	42	88	130
	Percent	32.31	67.69	100.00

Table 1 of oversamp by panel
Controlling for region=EIRO ordcat=1-2

oversamp(If 0: routine site; Else a reserve site) — panel(Years)

Frequency / Percent / Row Pct / Col Pct

oversamp		0	1	2	3	4	5	Total
0	Frequency	0	3	7	5	3	4	22
	Percent	0.00	4.11	9.59	6.85	4.11	5.48	30.14
	Row Pct	0.00	13.64	31.82	22.73	13.64	18.18	
	Col Pct	0.00	100.00	100.00	100.00	100.00	100.00	
1	Frequency	51	0	0	0	0	0	51
	Percent	69.86	0.00	0.00	0.00	0.00	0.00	69.86
	Row Pct	100.00	0.00	0.00	0.00	0.00	0.00	
	Col Pct	100.00	0.00	0.00	0.00	0.00	0.00	
Total	Frequency	51	3	7	5	3	4	73
	Percent	69.86	4.11	9.59	6.85	4.11	5.48	100.00

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Table 2 of oversamp by panel
Controlling for region=EIRO ordcat=3

oversamp(If 0: routine site; Else a reserve site) panel(Years)

oversamp	Frequency / Percent / Row Pct / Col Pct	0	1	2	3	4	5	Total
0	Frequency	0	3	0	0	0	2	5
	Percent	0.00	15.00	0.00	0.00	0.00	10.00	25.00
	Row Pct	0.00	60.00	0.00	0.00	0.00	40.00	
	Col Pct	0.00	100.00	.	.	.	100.00	
1	Frequency	15	0	0	0	0	0	15
	Percent	75.00	0.00	0.00	0.00	0.00	0.00	75.00
	Row Pct	100.00	0.00	0.00	0.00	0.00	0.00	
	Col Pct	100.00	0.00	.	.	.	0.00	
Total		15	3	0	0	0	2	20
		75.00	15.00	0.00	0.00	0.00	10.00	100.00

Table 3 of oversamp by panel
Controlling for region=EIRO ordcat=4-5

oversamp(If 0: routine site; Else a reserve site) panel(Years)

oversamp	Frequency / Percent / Row Pct / Col Pct	0	1	2	3	4	5	Total
0	Frequency	0	1	3	4	4	2	14
	Percent	0.00	3.13	9.38	12.50	12.50	6.25	43.75
	Row Pct	0.00	7.14	21.43	28.57	28.57	14.29	
	Col Pct	0.00	100.00	100.00	100.00	100.00	100.00	
1	Frequency	18	0	0	0	0	0	18
	Percent	56.25	0.00	0.00	0.00	0.00	0.00	56.25
	Row Pct	100.00	0.00	0.00	0.00	0.00	0.00	
	Col Pct	100.00	0.00	0.00	0.00	0.00	0.00	
Total		18	1	3	4	4	2	32
		56.25	3.13	9.38	12.50	12.50	6.25	100.00

Table 4 of oversamp by panel
Controlling for region=NCIR ordcat=1-2

oversamp(If 0: routine site; Else a reserve site)   panel(Years)

oversamp	Frequency / Percent / Row Pct / Col Pct	0	1	2	3	4	5	Total
0	Frequency	0	4	3	3	2	3	15
	Percent	0.00	6.67	5.00	5.00	3.33	5.00	25.00
	Row Pct	0.00	26.67	20.00	20.00	13.33	20.00	
	Col Pct	0.00	100.00	100.00	100.00	100.00	100.00	
1	Frequency	45	0	0	0	0	0	45
	Percent	75.00	0.00	0.00	0.00	0.00	0.00	75.00
	Row Pct	100.00	0.00	0.00	0.00	0.00	0.00	
	Col Pct	100.00	0.00	0.00	0.00	0.00	0.00	
Total		45	4	3	3	2	3	60
		75.00	6.67	5.00	5.00	3.33	5.00	100.00

Table 5 of oversamp by panel
Controlling for region=NCIR ordcat=3

oversamp(If 0: routine site; Else a reserve site)   panel(Years)

oversamp	Frequency / Percent / Row Pct / Col Pct	0	1	2	3	4	5	Total
0	Frequency	0	3	1	2	6	2	14
	Percent	0.00	7.89	2.63	5.26	15.79	5.26	36.84
	Row Pct	0.00	21.43	7.14	14.29	42.86	14.29	
	Col Pct	0.00	100.00	100.00	100.00	100.00	100.00	
1	Frequency	24	0	0	0	0	0	24
	Percent	63.16	0.00	0.00	0.00	0.00	0.00	63.16
	Row Pct	100.00	0.00	0.00	0.00	0.00	0.00	
	Col Pct	100.00	0.00	0.00	0.00	0.00	0.00	
Total		24	3	1	2	6	2	38
		63.16	7.89	2.63	5.26	15.79	5.26	100.00

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Table 6 of oversamp by panel
Controlling for region=NCIR ordcat=4-5

oversamp(If 0: routine site; Else a reserve site) panel(Years)

Frequency / Percent / Row Pct / Col Pct	0	1	2	3	4	5	Total
0	0	1	3	3	1	3	11
	0.00	4.35	13.04	13.04	4.35	13.04	47.83
	0.00	9.09	27.27	27.27	9.09	27.27	
	0.00	100.00	100.00	100.00	100.00	100.00	
1	12	0	0	0	0	0	12
	52.17	0.00	0.00	0.00	0.00	0.00	52.17
	100.00	0.00	0.00	0.00	0.00	0.00	
	100.00	0.00	0.00	0.00	0.00	0.00	
Total	12	1	3	3	1	3	23
	52.17	4.35	13.04	13.04	4.35	13.04	100.00

Table 7 of oversamp by panel
Controlling for region=NIRO ordcat=1-2

oversamp(If 0: routine site; Else a reserve site) panel(Years)

Frequency / Percent / Row Pct / Col Pct	0	1	2	3	4	5	Total
0	0	6	4	5	3	2	20
	0.00	10.17	6.78	8.47	5.08	3.39	33.90
	0.00	30.00	20.00	25.00	15.00	10.00	
	0.00	100.00	100.00	100.00	100.00	100.00	
1	39	0	0	0	0	0	39
	66.10	0.00	0.00	0.00	0.00	0.00	66.10
	100.00	0.00	0.00	0.00	0.00	0.00	
	100.00	0.00	0.00	0.00	0.00	0.00	
Total	39	6	4	5	3	2	59
	66.10	10.17	6.78	8.47	5.08	3.39	100.00

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Table 8 of oversamp by panel
Controlling for region=NIRO ordcat=3

oversamp(If 0: routine site; Else a reserve site)   panel(Years)

oversamp	Frequency / Percent / Row Pct / Col Pct	0	1	2	3	4	5	Total
0	Frequency	0	3	3	2	4	1	13
	Percent	0.00	6.82	6.82	4.55	9.09	2.27	29.55
	Row Pct	0.00	23.08	23.08	15.38	30.77	7.69	
	Col Pct	0.00	100.00	100.00	100.00	100.00	100.00	
1	Frequency	31	0	0	0	0	0	31
	Percent	70.45	0.00	0.00	0.00	0.00	0.00	70.45
	Row Pct	100.00	0.00	0.00	0.00	0.00	0.00	
	Col Pct	100.00	0.00	0.00	0.00	0.00	0.00	
Total		31	3	3	2	4	1	44
		70.45	6.82	6.82	4.55	9.09	2.27	100.00

Table 9 of oversamp by panel
Controlling for region=NIRO ordcat=4-5

oversamp(If 0: routine site; Else a reserve site)   panel(Years)

oversamp	Frequency / Percent / Row Pct / Col Pct	0	1	2	3	4	5	Total
0	Frequency	0	0	2	2	2	5	11
	Percent	0.00	0.00	7.14	7.14	7.14	17.86	39.29
	Row Pct	0.00	0.00	18.18	18.18	18.18	45.45	
	Col Pct	0.00	.	100.00	100.00	100.00	100.00	
1	Frequency	17	0	0	0	0	0	17
	Percent	60.71	0.00	0.00	0.00	0.00	0.00	60.71
	Row Pct	100.00	0.00	0.00	0.00	0.00	0.00	
	Col Pct	100.00	.	0.00	0.00	0.00	0.00	
Total		17	0	2	2	2	5	28
		60.71	0.00	7.14	7.14	7.14	17.86	100.00

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Table 10 of oversamp by panel
Controlling for region=SCIR ordcat=1-2

oversamp(If 0: routine site; Else a reserve site)   panel(Years)

oversamp	Frequency / Percent / Row Pct / Col Pct	0	1	2	3	4	5	Total
0	Frequency	0	4	6	4	4	5	23
	Percent	0.00	6.78	10.17	6.78	6.78	8.47	38.98
	Row Pct	0.00	17.39	26.09	17.39	17.39	21.74	
	Col Pct	0.00	100.00	100.00	100.00	100.00	100.00	
1	Frequency	36	0	0	0	0	0	36
	Percent	61.02	0.00	0.00	0.00	0.00	0.00	61.02
	Row Pct	100.00	0.00	0.00	0.00	0.00	0.00	
	Col Pct	100.00	0.00	0.00	0.00	0.00	0.00	
Total		36	4	6	4	4	5	59
		61.02	6.78	10.17	6.78	6.78	8.47	100.00

Table 11 of oversamp by panel
Controlling for region=SCIR ordcat=3

oversamp(If 0: routine site; Else a reserve site)   panel(Years)

oversamp	Frequency / Percent / Row Pct / Col Pct	0	1	2	3	4	5	Total
0	Frequency	0	4	1	2	3	3	13
	Percent	0.00	10.81	2.70	5.41	8.11	8.11	35.14
	Row Pct	0.00	30.77	7.69	15.38	23.08	23.08	
	Col Pct	0.00	100.00	100.00	100.00	100.00	100.00	
1	Frequency	24	0	0	0	0	0	24
	Percent	64.86	0.00	0.00	0.00	0.00	0.00	64.86
	Row Pct	100.00	0.00	0.00	0.00	0.00	0.00	
	Col Pct	100.00	0.00	0.00	0.00	0.00	0.00	
Total		24	4	1	2	3	3	37
		64.86	10.81	2.70	5.41	8.11	8.11	100.00

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Table 12 of oversamp by panel
Controlling for region=SCIR ordcat=4-5

oversamp(If 0: routine site; Else a reserve site) panel(Years)

Frequency / Percent / Row Pct / Col Pct	0	1	2	3	4	5	Total
0	0	1	1	2	0	1	5
	0.00	3.85	3.85	7.69	0.00	3.85	19.23
	0.00	20.00	20.00	40.00	0.00	20.00	
	0.00	100.00	100.00	100.00	.	100.00	
1	21	0	0	0	0	0	21
	80.77	0.00	0.00	0.00	0.00	0.00	80.77
	100.00	0.00	0.00	0.00	0.00	0.00	
	100.00	0.00	0.00	0.00	.	0.00	
Total	21	1	1	2	0	1	26
	80.77	3.85	3.85	7.69	0.00	3.85	100.00

Table 13 of oversamp by panel
Controlling for region=SEIR ordcat=1-2

oversamp(If 0: routine site; Else a reserve site) panel(Years)

Frequency / Percent / Row Pct / Col Pct	0	1	2	3	4	5	Total
0	0	5	6	5	4	6	26
	0.00	7.81	9.38	7.81	6.25	9.38	40.63
	0.00	19.23	23.08	19.23	15.38	23.08	
	0.00	100.00	100.00	100.00	100.00	100.00	
1	38	0	0	0	0	0	38
	59.38	0.00	0.00	0.00	0.00	0.00	59.38
	100.00	0.00	0.00	0.00	0.00	0.00	
	100.00	0.00	0.00	0.00	0.00	0.00	
Total	38	5	6	5	4	6	64
	59.38	7.81	9.38	7.81	6.25	9.38	100.00

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Table 14 of oversamp by panel
Controlling for region=SEIR ordcat=3

oversamp(If 0: routine site; Else a reserve site) panel(Years)

Frequency / Percent / Row Pct / Col Pct		0	1	2	3	4	5	Total
0	Frequency	0	3	1	2	3	0	9
	Percent	0.00	8.82	2.94	5.88	8.82	0.00	26.47
	Row Pct	0.00	33.33	11.11	22.22	33.33	0.00	
	Col Pct	0.00	100.00	100.00	100.00	100.00	.	
1	Frequency	25	0	0	0	0	0	25
	Percent	73.53	0.00	0.00	0.00	0.00	0.00	73.53
	Row Pct	100.00	0.00	0.00	0.00	0.00	0.00	
	Col Pct	100.00	0.00	0.00	0.00	0.00	.	
Total		25	3	1	2	3	0	34
		73.53	8.82	2.94	5.88	8.82	0.00	100.00

Table 15 of oversamp by panel
Controlling for region=SEIR ordcat=4-5

oversamp(If 0: routine site; Else a reserve site) panel(Years)

Frequency / Percent / Row Pct / Col Pct		0	1	2	3	4	5	Total
0	Frequency	0	1	1	1	2	2	7
	Percent	0.00	4.35	4.35	4.35	8.70	8.70	30.43
	Row Pct	0.00	14.29	14.29	14.29	28.57	28.57	
	Col Pct	0.00	100.00	100.00	100.00	100.00	100.00	
1	Frequency	16	0	0	0	0	0	16
	Percent	69.57	0.00	0.00	0.00	0.00	0.00	69.57
	Row Pct	100.00	0.00	0.00	0.00	0.00	0.00	
	Col Pct	100.00	0.00	0.00	0.00	0.00	0.00	
Total		16	1	1	1	2	2	23
		69.57	4.35	4.35	4.35	8.70	8.70	100.00

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```
Table 16 of oversamp by panel
Controlling for region=SWIR ordcat=1-2

oversamp(If 0: routine site; Else a reserve site)     panel(Years)

Frequency|
Percent  |
Row Pct  |
Col Pct  |       0|       1|       2|       3|       4|       5|  Total
---------+--------+--------+--------+--------+--------+--------+
       0 |      0 |      3 |      3 |      4 |      5 |      5 |     20
         |   0.00 |   5.17 |   5.17 |   6.90 |   8.62 |   8.62 |  34.48
         |   0.00 |  15.00 |  15.00 |  20.00 |  25.00 |  25.00 |
         |   0.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
---------+--------+--------+--------+--------+--------+--------+
       1 |     38 |      0 |      0 |      0 |      0 |      0 |     38
         |  65.52 |   0.00 |   0.00 |   0.00 |   0.00 |   0.00 |  65.52
         | 100.00 |   0.00 |   0.00 |   0.00 |   0.00 |   0.00 |
         | 100.00 |   0.00 |   0.00 |   0.00 |   0.00 |   0.00 |
---------+--------+--------+--------+--------+--------+--------+
Total          38        3        3        4        5        5       58
            65.52     5.17     5.17     6.90     8.62     8.62   100.00


Table 17 of oversamp by panel
Controlling for region=SWIR ordcat=3

oversamp(If 0: routine site; Else a reserve site)     panel(Years)

Frequency|
Percent  |
Row Pct  |
Col Pct  |       0|       1|       2|       3|       4|       5|  Total
---------+--------+--------+--------+--------+--------+--------+
       0 |      0 |      4 |      1 |      4 |      3 |      3 |     15
         |   0.00 |   8.00 |   2.00 |   8.00 |   6.00 |   6.00 |  30.00
         |   0.00 |  26.67 |   6.67 |  26.67 |  20.00 |  20.00 |
         |   0.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
---------+--------+--------+--------+--------+--------+--------+
       1 |     35 |      0 |      0 |      0 |      0 |      0 |     35
         |  70.00 |   0.00 |   0.00 |   0.00 |   0.00 |   0.00 |  70.00
         | 100.00 |   0.00 |   0.00 |   0.00 |   0.00 |   0.00 |
         | 100.00 |   0.00 |   0.00 |   0.00 |   0.00 |   0.00 |
---------+--------+--------+--------+--------+--------+--------+
Total          35        4        1        4        3        3       50
            70.00     8.00     2.00     8.00     6.00     6.00   100.00
```

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Table 18 of oversamp by panel
Controlling for region=SWIR ordcat=4-5

oversamp(If 0: routine site; Else a reserve site) panel(Years)

Frequency / Percent / Row Pct / Col Pct	0	1	2	3	4	5	Total
0	0	1	4	0	1	1	7
	0.00	4.55	18.18	0.00	4.55	4.55	31.82
	0.00	14.29	57.14	0.00	14.29	14.29	
	0.00	100.00	100.00	.	100.00	100.00	
1	15	0	0	0	0	0	15
	68.18	0.00	0.00	0.00	0.00	0.00	68.18
	100.00	0.00	0.00	0.00	0.00	0.00	
	100.00	0.00	0.00	.	0.00	0.00	
Total	15	1	4	0	1	1	22
	68.18	4.55	18.18	0.00	4.55	4.55	100.00

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The attached comma-delimited, ASCII file (idw04451.csv) has the following variable definitions:

Site_ID	Sample Identifier assigned to each site 14 characters
Site Name	Name (if provided) 30 characters
Long-DD	Longitude, Decimal Degrees 12.6 numeric
Lat-DD	Latitude, Decimal Degrees 12.6 numeric
Stratum	Stratum (1 stratum defined in this design) 2 integer
Panel	Used if Multiple years/seasons/etc. sample 1 integer
Oversamp	Defines “backup” or “oversample” sites. 1 = oversample site, 0 = expected sample site 1 integer
Division	Division breaks down panels and expected/replicate sites. 1 integer
MD_Caty	Multi-Density weight category - defined above. 2 integer
Nest_ID	More than one if multiple levels/classes of samples drawn. 1 integer
Nest1	Defines sites within this nest class (1 = within, 0 = not in) 1 integer
Nest1_N	Expected number of samples for initial design categories. 2 integer
Nest1_wt	Initial Design weight for the site. 12.7 numeric
Strahler	Strahler Order - generated from RF3 1 integer
DEQ_REG	Idaho DEQ Region abbreviation 4 character
Long-DMS	Longitude, Degrees Minutes Seconds 20 characters
Lat-DMS	Latitude, Degrees Minutes Seconds 20 characters

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The location information is based on the 1927 North American Datum projection – Idaho Transverse Mercator. The Arc/INFO export files, if delivered with these data, have the following projection parameters:

Projection	Transverse Mercator
Datum	NAD27
Spheroid	Clarke 1866
Units	Meters

Scale factor at central meridian	0.9996
Longitude of central meridian	-114 00' 00"
projection origin	42 00' 00"
false easting	500000.00000
false northing	100000.00000

Description of Statistical Analysis:

The statistical analysis of the data requires the weighting and stratification variables be used, even if computation of descriptive statistics (means, medians, standard errors, etc.) is all that is desired. After fieldwork and sampling, information on sampled and unsampled sites, along with reasons for non-sampling, need to be used to adjust sample weights. Otherwise, incorrect estimates for the target population will occur. See references for estimation procedures, or contact Tony Olsen.

For any questions about these data, please contact:

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Appendix B. R Script for extent and condition estimates for the Idaho Wadeable Stream Survey

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```
#File: Condition and Extent Estimation for Idaho's Probability Design
Survey
#Purpose: To calculate the adjusted weights of random sites for the Idaho
Random Survey.
#Date: October 15, 2012
#Libraries Required: spsurvey (current version is 2.3)

#Comments:  This script takes input from the initial design file including
the initial framesize and site evaluations
#to calculate adjusted weights for the extent and condition estimates.
The first input data file must be a .csv
#file and contain the following columns:
#Site_ID, Long_DD, Lat_DD, DEQ_REG, Strahler, MD_Caty, Nest1_wt,
Evaluated, TNT, Site_Cond,
#Samp_bugs, Samp_fish, SMI_Cond, SFI_Cond, and SHI_Cond.

#Evaluated, Samp_bugs and Samp_fish are TRUE/FALSE columns.  Those sites
that are determine to not be needed
#('Evalreason' = notneeded) should have the 'Evaluated' field value set to
"FALSE" to avoid skewing the extent
#and condition estimates.

#TNT is a column that identifies the site as either target (T) or non-
target(NT).
#Latitude and Longitude must be in decimal degrees.  The MD_Caty and
Nest1_wt are from the initial site design file.
#This script will calculate and add columns for the adjusted weights.
#SMI_Cond, SFI_Cond and SHI_Cond should be either 0 through 3 (relating to
Idaho's condition ratings for the various indices),
#or Poor/Fair/Good for condition estimates).

#The other file required when using this script is the initial framesize
from the design file.
#The framesize file requires the following columns:
#MD_Caty, sum_of_units.  R is a case sensitive language so all field names
must match exactly the names called in this script.
#This framesize will be used to calculate the adjusted weights for the
extent estimates.
#From this calculation a new framesize will be derived based on the
MD_Caty and the target sampled
#population determined in the extent estimate.  This new framesize
#will be used to evaluate the condition of the target population.

# Data Required: RandomSites.csv with the above listed columns and
Framesize.csv



# read in data.  The file name can be changed here to reflect the file
name containing the data to be analyzed.
      Random_Sites <- read.csv('Original
Data/BURPRandomsEvalComplete.csv')

# To calculate final weights for sites
```

```
      sites<-Random_Sites$Evaluated
      wgt <- Random_Sites$Nest1_wt
      wtcat <- Random_Sites$MD_Caty

# The dataframe "framesize" is populated with information from the initial
# design.  This table must be populated with all categories and the sum of
# weights from the initial sample design
      framesize.dataframe <- read.csv('Original Data/Framesize.csv')
      framesize <- framesize.dataframe$sum_of_units_orig
      names(framesize) <- framesize.dataframe$MD_Caty
      {
      wgtsum <-tapply(wgt[sites],wtcat[sites],sum)
      adjfac <- framesize/wgtsum[match(names(framesize),names(wgtsum))]
      wtadj <- adjfac[match(wtcat,names(adjfac))]
      adjwgt <- wgt *wtadj
      adjwgt[!sites] <- 0
      as.vector(adjwgt)
      }
      Random_Sites$Wgt_Extent <- as.vector(adjwgt)

# Population extent estimates for Target/NonTarget, Status and MD_Caty
Categories
# How many stream km in each?
# Construct Target/NonTarget Indicator
# record levels to T=Target and NT=NonTarget, in some cases a warning or
error message may be displayed.  Ignore.
      levels(Random_Sites$TNT) <- list(T=c('IA', 'TS', 'DA'), NT=c('DR',
'LA', 'MA', 'MM', 'NF', 'NW', 'OT'))

# Need equal area coordinates for variance estimation
# use x-site coordinates when available and design coordinates otherwise
      tmp <- marinus(Random_Sites$Lat_DD, Random_Sites$Long_DD)
      Random_Sites$xmarinus <- tmp[,'x']
      Random_Sites$ymarinus <- tmp[,'y']

# Set up data for estimation
# Determine which sites to use for calculating extent estimates

      sites.ext <- data.frame(siteID=Random_Sites$Site_ID,
                              Use = (Random_Sites$Evaluated == 'TRUE' &
!is.na(Random_Sites$Wgt_Extent)))

# Create estimates for subpopulation including region, strahler order and
MD_Caty
      subpop <- data.frame(siteID = Random_Sites$Site_ID,
                           State = rep("ID", nrow(Random_Sites)),
                           DEQ_REG = Random_Sites$DEQ_Reg,
                           St_Order = Random_Sites$Strahler,
                           Caty = Random_Sites$MD_Caty)

# Provide design information
      dsgn.ext <- data.frame(siteID=Random_Sites$Site_ID,
                             stratum=Random_Sites$MD_Caty,
                             wgt=Random_Sites$Wgt_Extent,
```

```
                              xcoord=Random_Sites$xmarinus,
                              ycoord=Random_Sites$ymarinus)

# Provide categorical indicator data
      data.cat <- data.frame(siteID=Random_Sites$Site_ID,
                              TNT=Random_Sites$Site_Cond3,
                             SiteStatus=Random_Sites$Site_Cond)

# Do status population estimation for extent
      popstatus.ext <- cat.analysis(sites = sites.ext,
                                    subpop = subpop,
                                    design = dsgn.ext,
                                    data.cat = data.cat,
                                    vartype = "Local",
                                    conf = 95)

# The following lines use the population size determined by the extent
estimates to create a new framesize that
# is correlated only to the size of the targeted and sampled population.
      tempFrame <- data.frame(MD_Caty = popstatus.ext$Subpopulation,
sum_of_units = popstatus.ext$Estimate.U,
                                    Use = (popstatus.ext$Type == "Caty" &
popstatus.ext$Indicator == "SiteStatus"
                                    & popstatus.ext$Category == "TS" ))

      units <- tempFrame$sum_of_units
      Caty <- tempFrame$MD_Caty
      Use <- tempFrame$Use

      adjFrame <- c(1:18)
      j <-1
      for (i in 1:length(units)) {
            if (Use[i] == "TRUE") {
            adjFrame[j] <- units[i]
            j <- j+1
            next
            }
            else {
                  next
            }
      }

# If the names in the original framesize are something other than 1
through 18 then the following line of code needs to be
# changed to accurately reflect the names in the original framesize file.
Also, if there are more or less than 18 categories
# in the framesize the previous line of code 'adjFrame <- c(1:18)' must be
changed to reflect the appropriate number of categories.
      names(adjFrame) <- c(1:18)

# The following calculates the adjusted weight for those sites that are
targeted, sampled and have macroinvertebrate data.
      sites2<-Random_Sites$Samp_bugs
      wgt <- Random_Sites$Nest1_wt
```

```
      wtcat <- Random_Sites$MD_Caty
      {
      wgtsum2 <-tapply(wgt[sites2],wtcat[sites2],sum)
      adjfac2 <- adjFrame/wgtsum2[match(names(adjFrame),names(wgtsum2))]
      wtadj2 <- adjfac2[match(wtcat,names(adjfac2))]
      adjwgt2 <- wgt *wtadj2
      adjwgt2[!sites2] <- 0
      as.vector(adjwgt2)
      }
      Random_Sites$Wgt_Cond_Bugs <- as.vector(adjwgt2)

# The following calculates the adjusted weight for those sites that are
targeted, sampled and have fish data.  Since
# there are occasionally sites that have macroinvertebrate and habitat
data but no fish data, a different weight is
# calculated for those sites that have all three indices.
      sites3<-Random_Sites$Samp_fish
      wgt <- Random_Sites$Nest1_wt
      wtcat <- Random_Sites$MD_Caty
      {
      wgtsum3 <-tapply(wgt[sites3],wtcat[sites3],sum)
      adjfac3 <- adjFrame/wgtsum3[match(names(adjFrame),names(wgtsum3))]
      wtadj3 <- adjfac3[match(wtcat,names(adjfac3))]
      adjwgt3 <- wgt *wtadj3
      adjwgt3[!sites3] <- 0
      as.vector(adjwgt3)
      }
      Random_Sites$Wgt_Cond_Fish <- as.vector(adjwgt3)

# Write out the results to a table that will now be used for calculating
the condition estimates for the various indices,
# condition categories and support status.
      write.table(Random_Sites, 'Original
Data/Adj_Random_Site_Weights.csv',sep = ",",col.names=NA)


# Read in condition class data
      assess <- read.csv('Original Data/Adj_Random_Site_Weights.csv')
      names(assess)

# Change Condition Class variables to factors to work with cat.analysis
program
# and treat missing value as missing, not as a class level.  Variables may
be added or removed as needed at this point
# however, this list must correspond with the list further on in the code
that sets up the categorical indicator data.
      assess$SMI_COND <- as.factor(assess$BUGCOND)
      assess$SHI_COND <- as.factor(assess$HABCOND)
      assess$SFI_COND <- as.factor(assess$FISHCOND)
      assess$ALL_COND <- as.factor(assess$ALLCOND)
      assess$SUPPORT <- as.factor(assess$SUPPORT)

# Set up data for estimation
# which sites to use?
```

```
# create separate site files for macroinvertebrate/habitat and fish since
not all sites have fish data
      sites.cond <- data.frame(SiteID=assess$Site_ID,
                           Use=(assess$Samp_bugs=='TRUE'&
!is.na(assess$Wgt_Cond_Bugs)))
      sites.ftiscond <- data.frame(SiteID=assess$Site_ID,
                            Use=(assess$Samp_fish=='TRUE' &
!is.na(assess$Wgt_Cond_Fish)))

# want estimates for what subpopulations?
# Create subpop variables
      subpop.cond <- data.frame(SiteID=assess$Site_ID,
                                State=rep('ID', nrow(assess)),
                                DEQ_Reg=assess$DEQ_Reg,
                                St_Order=assess$Strahler)

# Provide design information
#  -- changed wgt variable for biology/habitat and fish
      dsgn.cond <- data.frame(siteID=assess$Site_ID,
                              stratum=assess$MD_Caty,
wgt=assess$Wgt_Cond_Bugs,
                              xcoord=assess$xmarinus,
ycoord=assess$ymarinus)

      dsgn.fishcond <- data.frame(siteID=assess$Site_ID,
                                  stratum=assess$MD_Caty,
wgt=assess$Wgt_Cond_Fish,
                                  xcoord=assess$xmarinus,
ycoord=assess$ymarinus)

# Provide categorical indicator data.  This list should match the list
provided above.  In the instance shown here
# two datasets are defined since the macroinvertebrate/habitat dataset
uses one set of weights and the fish dataset uses anoth.
      data.cat.cond <- data.frame(siteID=assess$Site_ID,
assess$SMI_COND,assess$SHI_COND, assess$ALL_COND, assess$SUPPORT)

      data.cat.fishcond <-
data.frame(siteID=assess$Site_ID,assess$SFI_COND)

# Do status population estimation for macroinvertebrate and habitat
indicators
      popstatus.cond <- cat.analysis(sites = sites.cond,
                                  subpop = subpop.cond,
                                  design = dsgn.cond,
                                  data.cat = data.cat.cond,
                                  vartype = "Local",
                                  conf = 95)

# Do status population estimation for fish  condition
      popstatus.fishcond <- cat.analysis(sites = sites.ftiscond,
                                  subpop = subpop.cond,
                                  design = dsgn.fishcond,
                                  data.cat = data.cat.fishcond,
```

```
                                   vartype = "Local",
                                   conf = 95)


# write results out
      write.table(popstatus.ext,'Output
Files/ID_Random_Extent_StatusEst.csv',sep = ",",col.names=NA)

# combine and write results out
      write.table(rbind(popstatus.cond, popstatus.fishcond ), 'Output
Files/ID_Assessment_Est.csv',
                sep = ",", col.names=NA)
```