Extent and Condition of Idaho's Major Rivers, 2010

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Abstract

To fulfill Clean Water Act reporting requirements, the Idaho Department of Environmental Quality (DEQ) initiated the Idaho Major Rivers Survey (IMRS) in 2006. The IMRS is a probability-based survey designed to provide statistically valid estimates of the condition of the entire population of major rivers in Idaho. For the IMRS, DEQ monitored 49 sites out of a potential 100 sites. All 100 sites were evaluated and either sampled or not sampled due to physical barriers, landowner denial, or classification as nontarget.

Extent estimates were calculated based on an equal-weight approach: all sites within the site file represented an equal length of the entire sample frame. Since all sites were evaluated, it was unnecessary to recalculate site weights. Each site represented approximately 73.85 kilometers (km) of Idaho's major rivers.

DEQ collected grab-samples at each site for nitrate-nitrite nitrogen (NO_3/NO_2) and total phosphorus (TP). Temperature, pH, and specific conductance were measured in situ at the GIS coordinate site, or the x-site, with a Hydrolab DS5X sonde.

DEQ collected benthic macroinvertebrates and fish to calculate multimetric indices of ecological integrity.

The total resource length in the IMRS sample frame was 7,384.9 km; an estimated 5,464.9 km (74%) of the sample frame was target (the target population), and 1,920.0 km (26%) was nontarget. The target population represented 5,464.9 km. The sampled population, or the proportion of the target population about which inferences may be made, represented 3,618.6 km, or 66% of the target population. The extent of the target population not sampled due to physical barriers represented 1,107.7 km (20% of the target population), while 738.5 km (13% of the target population) were not sampled due to landowner denial.

Temperatures ranged from 5.6 to 24.5 degrees Celsius (ºC), with 6 of 49 sites (12.2%, representing 443 km) having temperatures that exceeded the instantaneous temperature criterion of 22.0 ºC (Idaho Administrative Code, IDAPA 58.01.02.250.01.b). Measurements of pH ranged from 7.35 to 9.20; the average pH from 34 sites was 8.37 (standard deviation [SD] = 0.52). Specific conductance ranged from 22.2 microsiemens per centimeter (µS/cm) to 774.0 µS/cm; the average specific conductance among all sites was 218.7 µS/cm (SD = 180.7). NO_3/NO_2 concentration ranged from below the method detection limit (MDL) of 0.01 milligrams per liter (mg/L) to 1.70 mg/L; the average concentration of NO_3/NO_2 was 0.27 mg/L (SD = 0.47). NO_3/NO_2 concentrations were below the MDL at 16 sites representing 1,181.6 km. TP concentration ranged from below the MDL of 0.005 mg/L to 0.295 mg/L; the average TP concentration was 0.038 mg/L (SD = 0.048). Only 1 site, representing 46 km, had TP below the MDL.

Benthic macroinvertebrates were collected at all 49 sites. Macroinvertebrate condition was good at 25 sites (51.0% of the sampled population), fair at 19 sites (38.8%), and poor at 5 sites (10.2%).

Fish indices were calculated at 31 of the 49 sites. Fish condition was good at 19 sites (38.8%), fair at 1 site (2.0%), poor at 11 sites (22.4%), and unassessed at 18 sites (36.7%).

Biological condition was determined by combining macroinvertebrate and fish condition into a single measure. At sites where fish were not sampled or insufficient for assessment, the biological condition was based on the macroinvertebrate condition alone. Following this method, biological condition was good at 20 sites (40.8%), fair at 20 sites (40.8%), and poor at 9 sites (18.4%).

Recommendations for future river monitoring include improving the sample frame and including more indicators, specifically diatoms and physical habitat and chemistry.

1 Introduction

The Idaho Department of Environmental Quality (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 statute requires biennial reporting on the state's water quality. In an effort to fulfill this requirement, BURP initiated the Idaho Major Rivers Survey (IMRS) in 2006; monitoring occurred in 2006 and 2008. This report details the results of those monitoring efforts.

The IMRS was a probability-based survey designed to provide statistically valid estimates of the condition of the entire population of major rivers in Idaho. Probability-based monitoring allows statistically valid estimates of condition for the population being studied while sampling only a fraction of the population. For example, in this study DEQ was able to estimate condition for the length of major rivers in Idaho based on sampling a relatively small proportion of that entire length.

A probabilistic sampling survey is made up of several elements: the target population, sample frame, sampled population, and evaluated sites. Figure 1.1 outlines the conceptual relationship among these elements.

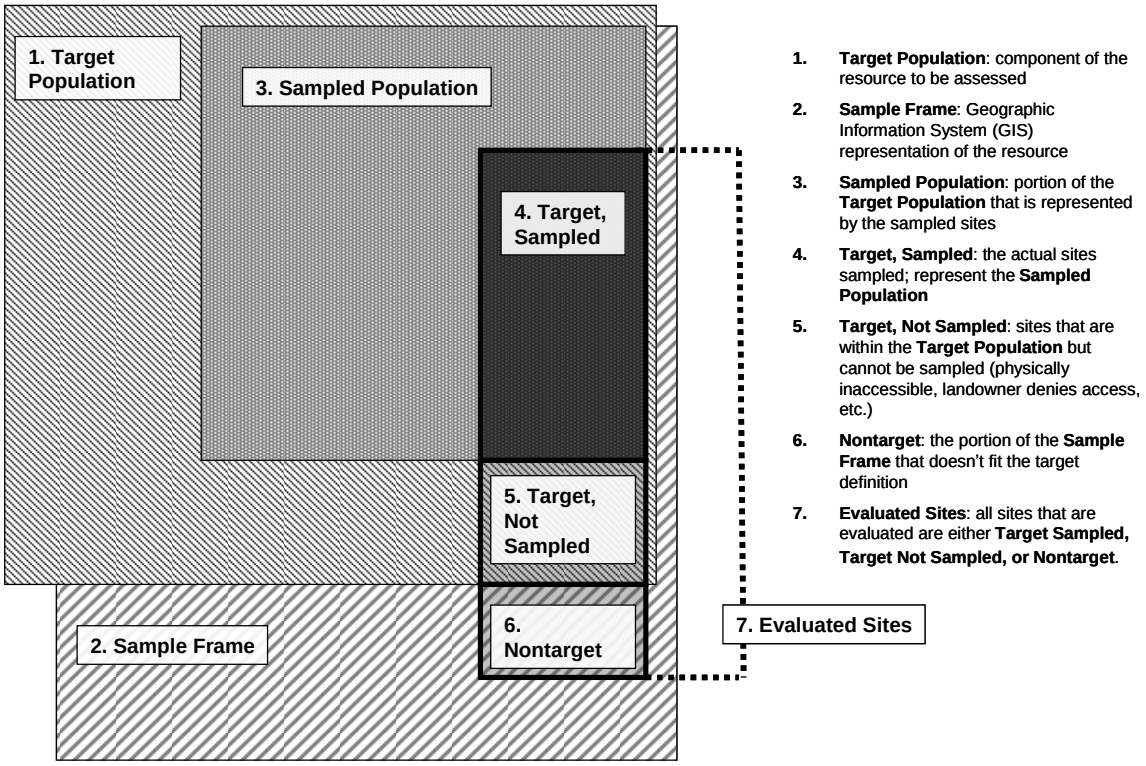


Figure 1.1. Conceptual representation of elements of a probabilistic sampling survey (modified from Olsen and Peck 2008).

The sample frame is a geographical representation of the target population from which sites are selected (Figure 1.1). It is common for the sample frame to include some elements that are not part of the target population or to exclude some elements of the target population. Elements of the sample frame that are not part of the target population are classified as nontarget. In this survey, reservoirs, lakes, or dry channels were classified as nontarget. Elements of the sample frame that are part of the target population make up the sampled population. The sampled population is the population of the resource about which researchers can make statistically valid estimates of condition based on survey results (Olsen and Peck 2008).

2 Methods

2.1 Idaho Major Rivers Survey Design

DEQ used a probability-based survey design in order to make statistically valid estimates of condition for the entire population of rivers being sampled.

The first step in survey design was to clearly identify the target population, or the resource that is to be assessed (Olsen and Peck 2008). For the IMRS, the target population was major rivers in Idaho—as identified by the DEQ major rivers geographic information system (GIS) coverage—with an active stream channel and flowing water present. This coverage includes the main stem, major forks, and major tributaries of the most well-known rivers within Idaho (e.g., Snake, Boise, Salmon, Clearwater, St. Joe, Coeur d'Alene) from their mouths (or Idaho border) to their headwaters (or Idaho border) (Figure 2.1).

For the IMRS, the sample frame was the DEQ major rivers GIS coverage (Figure 2.1). Total resource length in the sample frame was 7,384.9 kilometers (km).

Sites provided in the survey design file (Appendix A) were evaluated for inclusion in the target population. To be considered part of the target population, sites had to have an active stream channel with flowing water present.

The IMRS had an expected sample size of 50 sites, split evenly between two phases, with 25 sites to be monitored in 2006 and 25 sites to be monitored in 2008. In addition, the sample design included oversample sites (i.e., additional sites to be used in the event that the sample frame included nontarget or inaccessible sites). Including these oversample sites, the sample design included 100 total sites.

All 100 sites on the list were evaluated and either sampled or not sampled (due to physical barriers, landowner denial, or classification as nontarget). For the IMRS, DEQ monitored 49 sites. Each site was identified by geographic coordinates and monitoring occurred upstream and downstream from those coordinates. The point represented by the coordinates is known as the x-site.

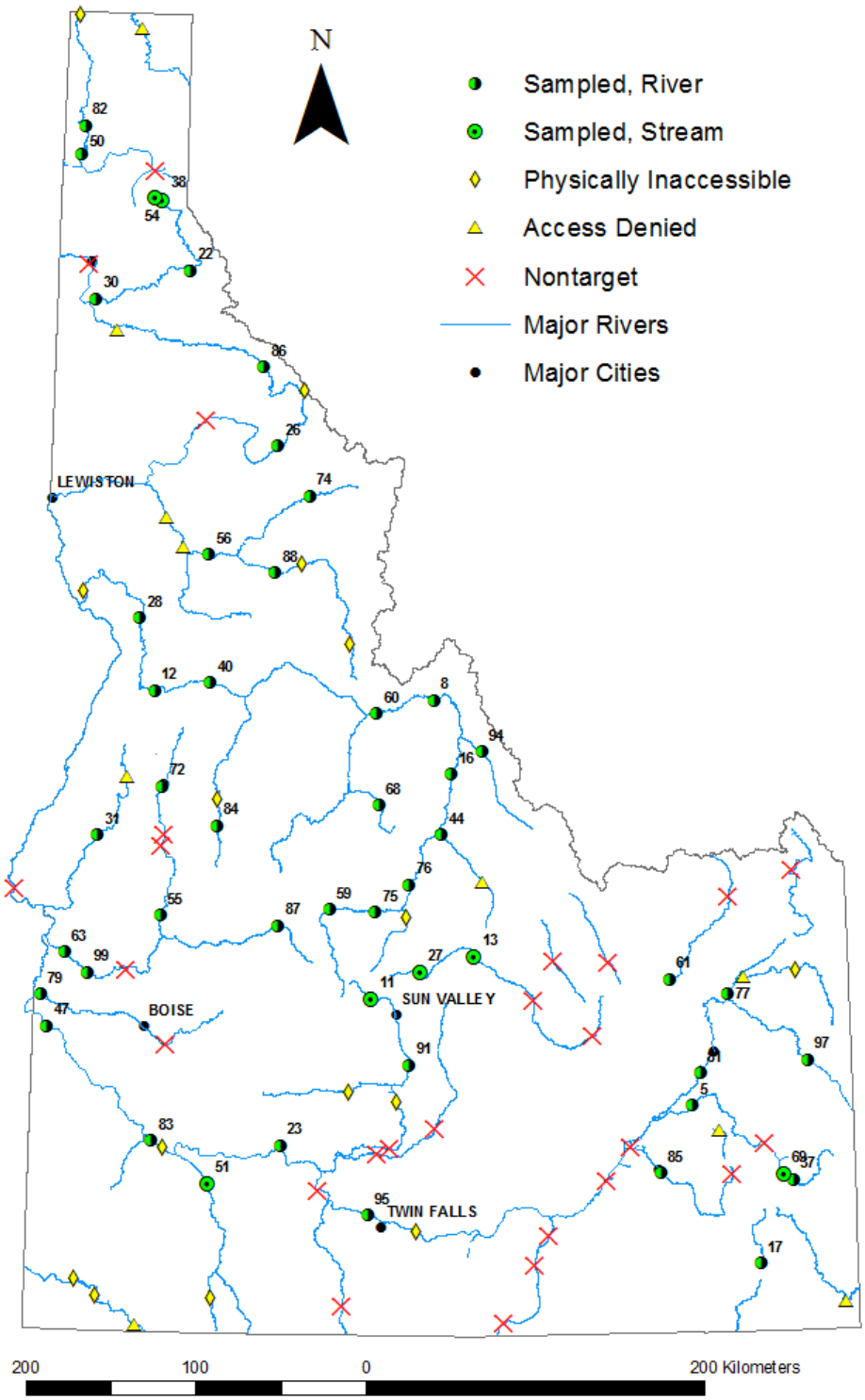


Figure 2.1. Map of Idaho, with major rivers, sample locations, and sample status displayed. Numbers correspond to Index number for each site (Appendix B).

2.2 Field Sampling

Probabilistic sites are identified by an x-site: a single set of global positioning system (GPS) coordinates falling on a point within the stream or river. The monitored reach must contain the x-site. Crews laid out monitoring reaches so that the x-site would be at or near the center of the reach.

Monitoring of sites followed protocols outlined in either the *Beneficial Use Reconnaissance Program Field Manual for Rivers* (DEQ 2006) or the *Beneficial Use Reconnaissance Program Field Manual for Streams* (DEQ 2007).

Selection of field protocol was based on water body classification as a stream or river following DEQ's water body size criteria. DEQ classifies flowing waters as streams if they meet 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 river (Grafe 2002a). Streams were included in this survey due to their occurrence at the headwaters of the major rivers.

2.2.1 Streams

Streams, as determined by the above classification scheme, were monitored following the BURP protocol for streams (DEQ 2007).

For streams, the reach length sampled was 30 times the average bankfull width at the x-site. The bankfull width is the channel width where the flow of water just fills the channel to the top of its banks and where the water begins to overflow onto the floodplain.

Reaches were sampled at six transects. DEQ collected macroinvertebrates at three transects from three separate riffle habitats using a Hess sampler. At each macroinvertebrate collection transect DEQ also performed a modified pebble count and measured canopy closure using a modified concave densiometer. At transects 10 m upstream from where the macroinvertebrates were sampled, DEQ measured bankfull width and height, wetted width and depth, distance of undercut banks, and canopy closure. DEQ assessed reachwide habitat and other physical characteristics of the stream (Figure 2.2). The entire reach was electrofished, and DEQ identified fish to species or the lowest possible taxonomic level.

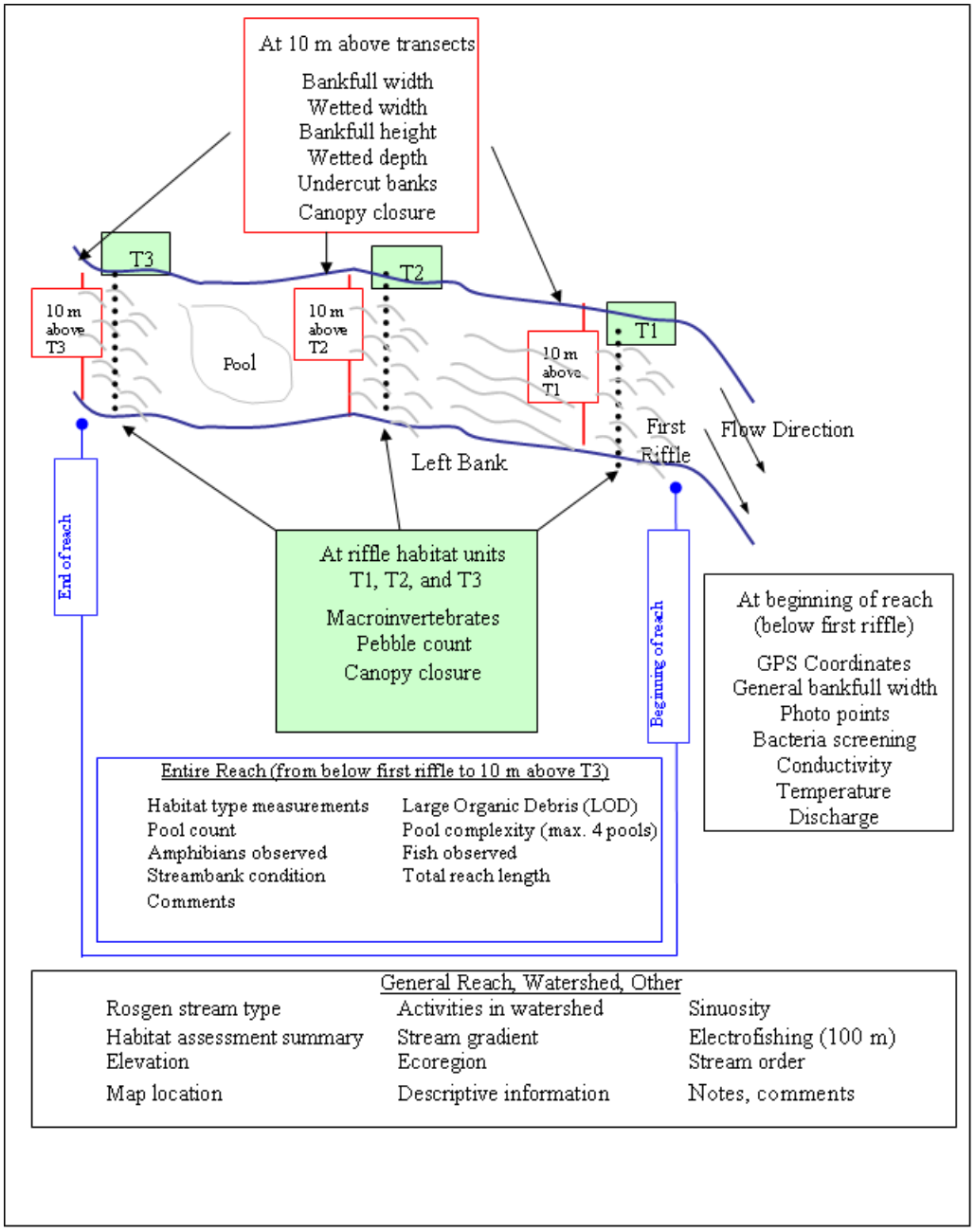


Figure 2.2. Schematic of stream monitoring reach, showing locations of sample collection

2.2.2 Rivers

Rivers were monitored following the 2006 draft BURP protocol for rivers, which was finalized in 2009 (DEQ 2009).

For rivers, the reach length sampled was 40 times the wetted width at base flow, generally determined by GIS and aerial photography. Reaches were sampled at six transects. Macroinvertebrates were collected from alternating banks at each of the six transects. DEQ recorded shoreline and bottom substrate, riparian condition and human disturbances; measured canopy closure with a modified convex densiometer; and

measured depth and erosion at each transect. Any reachwide human activities and disturbances were documented (Figure 2.3). DEQ electrofished the entire reach and identified fish to species or the lowest possible taxonomic level.

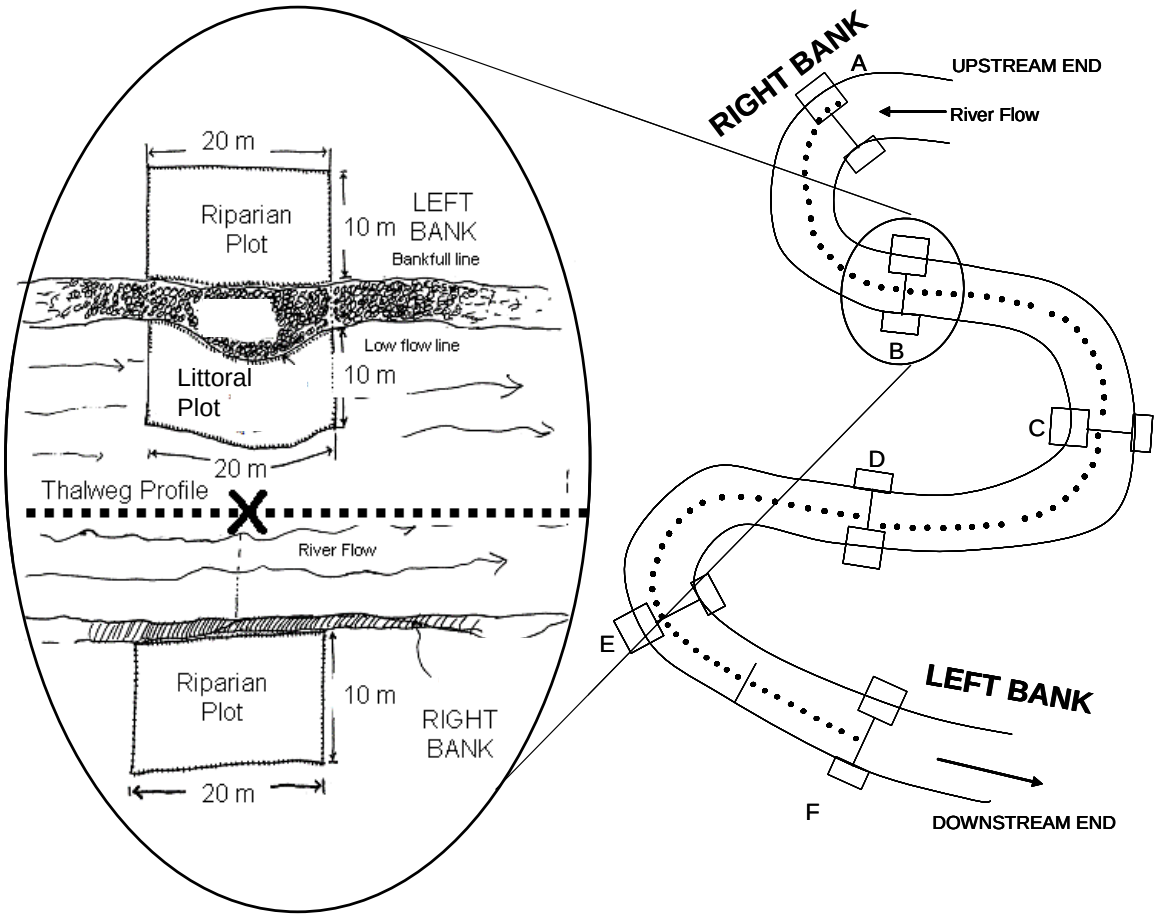


Figure 2.3. Schematic of river monitoring reach, showing locations of sample collection

2.2.3 Water Chemistry and Physical Habitat

DEQ collected grab-samples for chemical analysis from all 49 sites. Samples were collected prior to monitoring at or near the x-site for streams and at the final (i.e., downstream) transect for rivers. Water samples were analyzed for nitrate-nitrite nitrogen (NO_3/NO_2) following U.S. Environmental Protection Agency (EPA) method number 353.2 (EPA 1993a) and for total phosphorus (TP) following EPA method number 365.1 (EPA 1993b). All water analyses were provided by the Idaho Bureau of Laboratories in Boise, Idaho. Temperature, pH, and specific conductance were measured in situ at the x-site with a Hydrolab DS5X sonde.

Physical habitat data were collected at each transect and over the entire reach (Figure 2.2; Figure 2.3).

At each river transect, crews looked for the presence of 11 unique signs of human influence at each bank. Crews determined whether signs of these activities were absent, present within the 10 × 20 m riparian plot, or present outside the plot but observable from the plot (Figure 2.3).

In addition, field crews estimated the level of human activities and disturbances for the site's entire watershed. Crews evaluated whether the level of human activity and disturbance was absent, low, moderate, or high for indicators of residential, agricultural, industrial, recreational, and active management activities (DEQ 2007).

2.3 Data Analysis and Integration

2.3.1 Extent Estimate

Extent estimates were calculated based on an equal-weight approach: all sites within the site file represented an equal length of the entire sample frame. Since all sites were evaluated, it was unnecessary to recalculate site weights. Each evaluated site represented approximately 74 km of Idaho's major rivers.

2.3.2 Water Chemistry and Physical Habitat

For statistic calculations, water chemistry measurements that were below the method detection limit (MDL) were assigned the MDL. Summary statistics of water chemistry data included minimum; maximum; 5th, 25th, 75th, and 95th percentiles; median; average; and standard deviation (SD).

For streams, the habitat data were used to calculate the Stream Habitat Index (SHI), a multimetric index used to compare sample sites to a least-impacted reference condition. The SHI is composed of 10 component metrics, and the index is scaled from 0 to 100, with 100 being the best possible score (see Grafe 2002a).

For river sites, a simplified Index of Human Impact (IHI) was calculated based on observations of human influence at each of the six transects and estimates of watershed-level human activities and disturbances (DEQ 2006). A weighted sum of both human influence and human activities and disturbances was calculated by summing their impact scores (Table 2.1).

Table 2.1. Impact scores for human influence and human activities and disturbance at river monitoring sites

Human Influence (transects)	Human Activities and Disturbance (watershed)	Score
Absent	Absent	0
Present, outside plot	Low	1
Present, inside plot	Moderate	2
NA	High	3

The IHI was then calculated according to the following equation:

$$\text{IHI} = 100 - \left(\frac{\left(\frac{IS_{HumInf}}{{}^{Max}IS_{HumInf}} \right) \times 100 + \left(\frac{IS_{HumAD}}{{}^{Max}IS_{HumAD}} \right) \times 100}{2} \right)$$

Where:

IS_{HumInf} is the impact score of human influence (see Table 2.1);

${}^{Max}IS_{HumInf}$ is the maximum IS_{HumInf} possible;

IS_{HumAD} is the impact score of human activities and disturbance; and

${}^{Max}IS_{HumAD}$ is the maximum IS_{HumAD} possible.

IHI was scaled from 0 to 100, with 100 indicating the lowest possible level of human impact.

2.3.3 Benthic Macroinvertebrates

Benthic macroinvertebrate samples were composited by site. All macroinvertebrate identification and enumeration was performed by EcoAnalysts, Inc. of Moscow, Idaho. Composite samples were randomly subsampled to the first 500 organisms for identification. Issues of ambiguous taxa were resolved by substitution: distributing the ambiguous parent taxa among its children in proportion to the relative abundance of each child in the individual sample (Cuffney et al. 2007).

DEQ has developed multimetric indices for assessing stream and river macroinvertebrate communities. Both approaches compare sample sites to a least-impacted reference condition. For streams, DEQ uses the Stream Macroinvertebrate Index (SMI) to assess benthic macroinvertebrate communities. The SMI is based on nine metrics. Calculation of each metric returns a number from 1 to 100. The SMI is the average of these component metric scores; this index is then assigned a condition rating, or SMI condition score, of 1, 2, or 3 based on comparison to a bioregional reference condition (Table 2.2). For more discussion of the SMI and its development refer to the *Idaho Small Stream Ecological Assessment Framework* (Grafe 2002a).

DEQ developed the River Macroinvertebrate Index (RMI) to assess river benthic macroinvertebrate communities. The RMI is comprised of five metrics (Grafe 2002b). However, subsequent work with rivers as part of the Idaho Rivers Environmental Monitoring and Assessment Program (EMAP) project determined that the RMI lacked sensitivity in identifying moderately impacted sites. Further analysis identified a revised 3-Metric Macroinvertebrate Index (3MI) as providing the best performance in

distinguishing impacted sites from least-impacted reference sites (Remington and Kosterman 2008). The 3MI used a 1-3-5 scoring convention (Table 2.2).

Table 2.2. Scoring criteria for determining condition scores for the Stream Macroinvertebrate Index, Stream Fish Index, 3-metric Macroinvertebrate Index, and River Fish Index by comparison to reference condition.

Stream Macroinvertebrate Index (SMI)		
Condition Category	Condition Score	Condition Rating[a]
>25th percentile of bioregional reference condition	3	Good
10th-25th percentile of bioregional reference condition	2	Fair
reference minimum to <10th percentile of reference condtion	1	Poor
< reference minimum[b]	0[b]	Minimum Threshold[b]

3-Metric Macroinvertebrate Index (3MI).		
Condition Category	Condition Score	Condition Rating[a]
> 25th percentile of reference condition	5	Good
reference minimum-25th percentile of reference condition	3	Fair
< reference minimum	1	Poor

Stream Fish Index (SFI)		
Condition Category	Condition Score	Condition Rating[a]
> median of reference condition	3	Good
25th percentile-median of reference condition	2	Fair
5th-25th percentile of reference condition	1	Poor
< 5th percentile of reference condition[b]	0[b]	Minimum Threshold[b]

River Fish Index (RFI)		
Condition Category	Condition Score	Condition Rating[a]
> median of reference condition	3	Good
25th percentile-median of reference condition	2	Fair
5th-25th percentile of reference condition	1	Poor
< 5th percentile of reference condition[b]	0[b]	Minimum Threshold[b]

[a]The SMI, SFI, and RFI were not developed to determine condition; these condition ratings are for the purposes of this report alone.

[b]The minimum threshold is used for determining beneficial use support status. For the purposes of this report, all SMI, SFI, and RFI scores of 0 were assigned a poor condition rating.

2.3.4 Fish

DEQ developed multimetric indices for assessing fish communities as well. DEQ uses the Stream Fish Index (SFI) for streams. The SFI is based on six component metrics. Sites are classified into fish bioregions, which are based on a combination of Omernik ecoregion and elevation (Grafe 2002a). Sites are assigned a condition rating, or SFI condition score, of 1, 2, or 3, based on comparison to a bioregional reference condition (Table 2.2). For more discussion of the SFI and its development refer to the *Idaho Small Stream Ecological Assessment Framework* (Grafe 2002a).

DEQ developed the River Fish Index (RFI) to assess river fish communities. The RFI is composed of 10 component metrics. An RFI is calculated for any site with a minimum of

20 fish. The RFI is compared to the reference condition and assigned a condition rating, or RFI condition score of 1, 2, or 3 (Table 2.2). For more discussion of the RFI and its development refer to the *Idaho River Ecological Assessment Framework* (Grafe 2002b).

2.3.5 Biological Condition

To calculate biological condition, DEQ averaged the macroinvertebrate and fish indices. The SMI, SFI, and RFI all use a 1-2-3 scoring convention, with 1 corresponding to poor condition, or the greatest deviation from reference condition; 2 representing fair; and 3 representing good. The 3MI uses a 1-3-5 scoring convention, with 1 representing poor, or the greatest deviation from reference; 3 representing fair; and 5 representing good.

To integrate these indices into a single index of biological condition, DEQ standardized the scoring convention for the SMI, 3MI, SFI, and RFI to a 1-3-5 scoring convention.

For each site, the biological condition score is the average of the scores from the two indices (SMI and SFI for streams, 3MI and RFI for rivers). For sites where fish data were unavailable or insufficient for calculating an index score, DEQ based the biological condition score on only the macroinvertebrate index score. Biological condition scores greater than 4.25 were considered good, scores from 2.75 to 4.25 were fair, and scores less than 2.75 were considered poor.

3 Results

For a summary of all monitoring results—including water body classification, bioregion, ecoregion, water chemistry, and all index scores and conditions—see Appendix B.

3.1 Extent Estimates

The total resource length (extent) in the Idaho major rivers sample frame was 7,384.9 km; an estimated 5,464.9 km (74%) of the sample frame was target (the target population), and 1,920.0 km (26%) was nontarget. The absence of water or an active channel, inundation by a reservoir or impoundment, or inundation by a natural lake resulted in classification as nontarget.

The target population represented 5,464.9 km. The sampled population, or the proportion of the target population about which inferences may be made, represented 3,618.6 km, or 66% of the target population.

Elements of the target population not sampled due to physical barriers represented 1,107.7 km (20% of the target population), while elements of the target population not sampled due to landowner denial represented 738.5 km (14% of the target population).

A summary of extent estimates for the IMRS is provided in Figure 3.1.

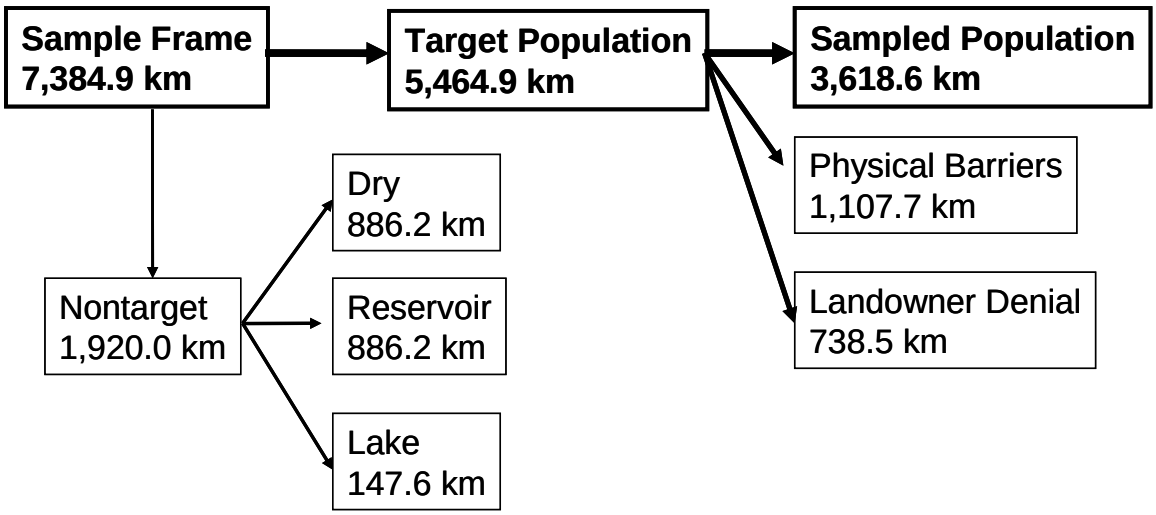


Figure 3.1. Diagram summarizing extent estimates for Idaho's major rivers

3.2 Water Chemistry and Physical Habitat

DEQ monitored a total of 42 river sites and 7 stream sites and analyzed water chemistry for each site. Temperature, pH, and specific conductance were recorded at 49, 34, and 49 sites, respectively. NO_3/NO_2 and TP were reported for 37 and 48 sites, respectively (Table 3.1).

Instantaneous temperature measurements ranged from 5.6 degrees Celsius (ºC) to 24.5 ºC; average temperature among all sites was 16.2 ºC (SD = 5.07).

The range of pH measurements was 7.35 to 9.20; the average pH from 34 sites was 8.37 (SD = 0.52). Specific conductance ranged from 22.2 microsiemens per centimeter (µS/cm) to 774.0 µS/cm; average specific conductance among all sites was 218.7 µS/cm (SD = 180.7) (Table 3.1).

Table 3.1. Summary statistics for water chemistry results (*N* = number of records for each analyte)

	Temperature		Specific Conductance	Nitrite-Nitrate N	Total Phosphorus
	ºC	pH	µS/cm	mg/L	mg/L
Minimum	5.6	7.35	22.2	**0.01**	**0.005**
5th	8.6	7.42	40.9	**0.01**	**0.005**
25th	12.1	8.04	75.0	**0.01**	0.012
75th	20.3	8.70	310.0	0.28	0.043
95th	23.2	8.84	564.8	1.42	0.094
Maximum	24.5	9.20	774.0	1.70	0.295
Median	17.5	8.60	158.2	0.03	0.024
Average	16.2	8.37	218.7	0.27	0.038
Stand Dev	5.1	0.52	180.7	0.47	0.048
N	49	34	49	37	48

Data presented in **bold** represent the method detection limit (MDL) for the analyte.

NO_3/NO_2 concentration ranged from below the MDL of 0.01 milligrams per liter (mg/L) to 1.70 mg/L; average concentration of NO_3/NO_2 was 0.27 mg/L (SD = 0.47) (Table 3.1). NO_3/NO_2 concentrations were below the MDL at 16 sites representing 1,181.6 km.

TP concentration ranged from below the MDL of 0.005 mg/L to 0.295 mg/L; average concentration of TP was 0.038 mg/L (SD = 0.048) (Table 3.1). Only 1 site, representing 46 km, had TP below the MDL.

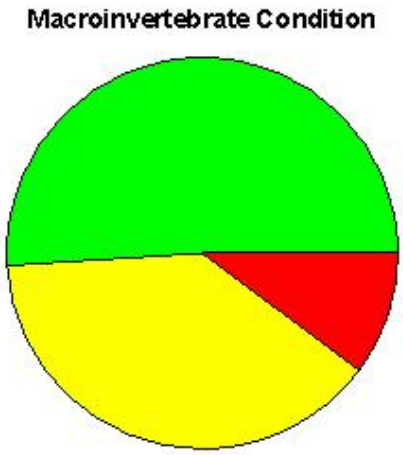
The SHI was calculated for the 7 stream sites, while the IHI was calculated for the 42 river sites. SHI scores ranged from 49 to 76. IHI scores ranged from 74 to 99 (Table 3.2).

Table 3.2. Summary statistics for Stream Habitat Index (SHI), calculated for wadeable streams, and the Index of Human Impact (IHI), calculated for non-wadeable rivers (*N* = number of sites)

	SHI	IHI
Minimum	49	74
Median	61	90
Average	61	90
Maximum	76	99
N	7	42

3.3 Benthic Macroinvertebrates

Benthic macroinvertebrates were collected at all 49 sites. Macroinvertebrate condition was good at 25 sites (51%), fair at 19 sites (38.8%), and poor at 5 sites (10.2%) (Figure 3.2).

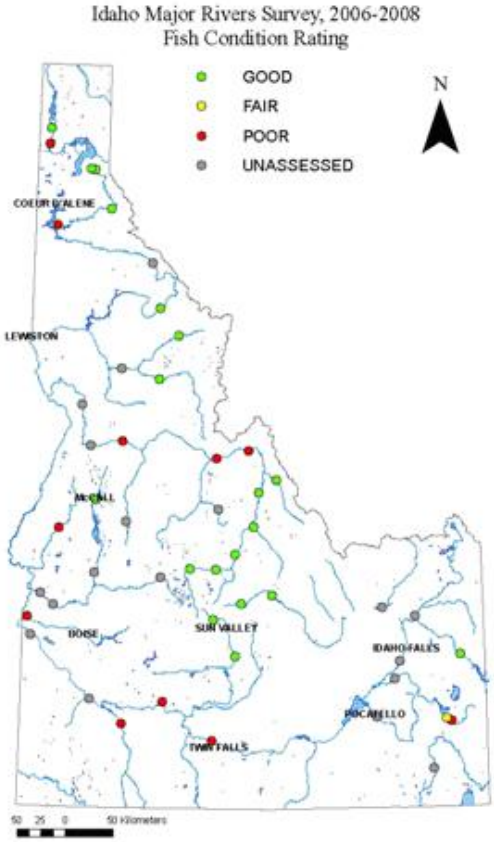


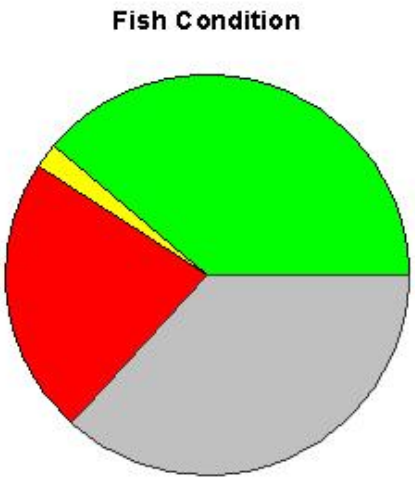
	Macroinvertebrate		
	km	SE	%
Good	1846.2	182.2	51.0
Fair	1403.1	170.6	38.8
Poor	369.2	116.0	10.2
Unassessed	0.0		0.0

Figure 3.2. Locations of Idaho Major Rivers Survey sites and macroinvertebrate condition ratings, including estimated length (km), standard error (SE), and percent of the sampled population in each condition

3.4 Fish

Fish index scores were calculated for 31 of the 49 sites. Fish condition was good at 19 sites (38.8% of the sampled population), fair at 1 site (2.0%), and poor at 11 sites (22.4%). Fish were unassessed at 18 sites (36.7% of the sampled population) (Figure 3.3).



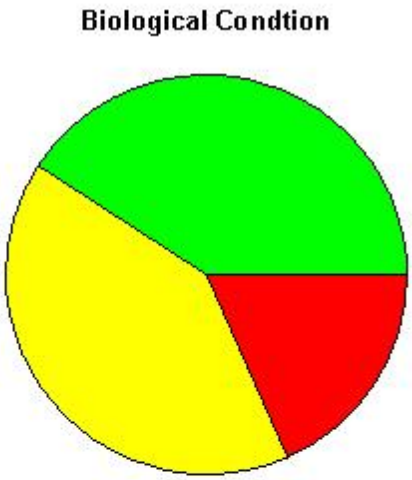


	Fish		
	km	SE	%
Good	1403.1	179.0	38.8
Fair	73.8	66.7	2.0
Poor	812.3	176.8	22.4
Unassessed	1329.3	189.5	36.7

Figure 3.3. Locations of Idaho Major Rivers Survey sites and fish condition ratings for each site, including estimated length (km), standard error (SE), and percent of the sampled population in each condition

3.5 Biological Condition

DEQ determined biological condition by combining macroinvertebrate and fish conditions into a single measure. For sites where there was insufficient data to calculate RFI, DEQ based biological condition on the macroinvertebrate condition alone. Following this method, biological condition was good at 20 sites (40.8% of the sampled population), fair at 20 sites (40.8%), and poor at 9 sites (18.4%) (Figure 3.4).



	Biological		
	km	SE	%
Good	1477.0	164.0	40.8
Fair	1477.0	198.8	40.8
Poor	664.6	168.2	18.4
Unassessed	0.0		0.0

Figure 3.4. Locations of Idaho Major Rivers Survey sites and biological condition ratings for each site, including estimated length (km), standard error (SE), and percent of the sampled population in each condition

4 Discussion

4.1 Extent Estimate

The original sample frame included 7,384.9 km of river and stream length; of this sample frame, 26% was nontarget. Nontarget designations were due to either dry, impounded, or inundated stream channels (Figure 3.1). Dry stream channels represented 12% of the sample frame (886.2 km) (Figure 3.1). Dry stream channels in the IMRS were due to upstream irrigation withdrawal, with the majority (9 out of 12 evaluated sites) in the arid Snake River Plain Level 3 Ecoregion and the remainder in the Dry Intermontane Sagebrush Valleys Level 4 Ecoregion (McGrath et al. 2001). These data indicate that irrigation withdrawal has a significant effect on the extent of flowing water resources in Idaho.

Similarly, inundation by either manmade reservoirs or natural lakes was responsible for 14% of the sample frame (1,033.8 km). This subset is an indication of inaccuracies in the sample frame's representation of the target population (Figure 3.1).

Physical barriers accounted for 15% of the sample frame (1,107.7 km) (Figure 3.1). Physical barriers included inaccessible canyons and dangerous rapids that would make sampling unsafe and sites that were too remote to be sampled practically. Since these sites would likely be in areas that had limited human disturbance, as opposed to occurring at random, it is not appropriate to include their lengths in our estimates of condition. If we did, we would be extrapolating good, fair, and poor conditions to this 15% of the sample frame in the same proportion that they occur in the sampled population. In reality, these inaccessible sites are likely to have a greater proportion in good condition due to their remoteness.

Similarly, landowner denial accounted for 10% of the sample frame (738.5 km) (Figure 3.1). The landowner denial category included sites on Indian reservations, sites where landowners did not respond to requests for access, and sites where landowners denied access. As with sites that were inaccessible due to physical barriers, it is not appropriate to include the length of streams or rivers where access was denied in our estimates of condition, as they do not occur at random.

Overall, the condition estimates were applicable to 3,618.6 km of Idaho's major rivers—only 49% of the original 7,384.9 km sample frame. Increasing the proportion of the sampled population to the sample frame requires a sample frame that better represents actual conditions on the ground.

Although the comparison is not ideal due to differences in survey design, these results are similar to extent estimates found in other probabilistic surveys of flowing water conducted in Idaho. For example, a survey of wadeable streams in Idaho found that 32% of the sample frame was nontarget (Kosterman 2008). Likewise, a survey of nonwadeable rivers in Idaho found that 30% of the sample frame was nontarget. These results, in conjunction with the estimate of 26% nontarget in the IMRS, indicate the need for more

accurate sample frames (i.e., the need for geographical data that more accurately represents geographical reality).

Furthermore, properly identifying a target population would benefit future probabilistic surveys of Idaho's water resources. For this survey, the target population was defined as major rivers in Idaho, as identified by the DEQ major rivers GIS coverage, with an active stream channel and flowing water present. One of the limitations of this target population was that it was defined by an arbitrary GIS layer. For example, this definition of the target population did not include all large rivers in Idaho, as defined by stream order or catchment area, nor was it limited to only water bodies classified by DEQ as rivers, as it included wadeable streams in the headwaters of some river systems.

4.2 Water Chemistry and Physical Habitat

Water chemistry results for the IMRS were highly variable (Table 3.1).

Temperatures ranged from 5.6 to 24.5 ºC, with 6 of 49 sites (12.2%, representing 443 km) having temperatures that exceeded the instantaneous temperature criterion of 22.0 ºC (Idaho Administrative Code, IDAPA 58.01.02.250.01.b). These temperature measurements do not necessarily coincide with the maximum temperature for any given site; measurements were often taken early in the day, before one would expect maximum daily temperature to occur. In addition, not all sample dates coincided with expected maximum annual temperature. Therefore, the likelihood of exceeding the 22.0 ºC temperature criterion is likely much higher than what is reported here.

All temperature data were collected as single, instantaneous measurements. Although comparing such a measurement to the criterion is insufficient for determining water quality impairment (Grafe et al. 2002), it does indicate that excess temperature is a common problem in Idaho's major rivers. This observation is complemented by the proportion of Idaho's streams and rivers that are impaired by temperature. In 2008, there were 15,293 stream and river miles listed as impaired by temperature (about 16% of total stream and river miles within Idaho) (DEQ 2009).

Remington and Kosterman (2008) reported on the ecological condition of large, nonwadeable rivers in Idaho. They identified reference conditions for Idaho rivers and included water chemistry. Comparing IMRS chemistry results to the reference site distribution puts the IMRS results into context. Measurements common to both the IMRS sample sites and those in the Remington and Kosterman (2008) report include specific conductance and pH. Comparison of reference conditions and IMRS results for specific conductance and pH are presented in Table 4.1.

Table 4.1. Extent of specific conductance and pH in Idaho's major rivers compared to distribution (Reference Condition Category) of least-impacted river sites from Remington and Kosterman (2008)

Specific Conductance				
Reference Condition Category	Idaho Major Rivers Survey results			
(from Remington and Kosterman 2008)	µS/cm	km	SE	%
>Maximum	> 176.0	1698.5	124.14	46.9
75th percentile-max	114.8 - 176.0	590.8	144.22	16.4
<75th percentile	< 114.8	1329.3	106.93	36.7

pH				
Reference Condition Category	Idaho Major Rivers Survey results			
(from Remington and Kosterman 2008)	Units	km	SE	%
>Maximum	> 8.87	147.7	81.22	4.1
75th percentile-max	8.55 - 8.87	1329.3	217.91	36.7
<75th percentile	< 8.55	1107.7	220.90	30.6

When compared to reference condition, a high proportion of Idaho's major rivers have high specific conductance. For example, the 75th percentile of specific conductance for the IMRS was 310.0 (Table 3.1), compared to 114.8 for the reference condition (Table 4.1). On the other hand, the range and distribution of pH in Idaho's major rivers is similar to the reference condition for large nonwadeable rivers. For example, the 75th percentile of pH for the IMRS was 8.70 (Table 3.1), compared to 8.55 for reference (Table 4.1).

EPA has recommended nutrient reference values for rivers based on aggregated ecoregions. There are two nutrient ecoregions in Idaho, the Western Mountains and the Xeric West. For the IMRS, 32 sites fall within the Western Mountains ecoregion while the remaining 17 fall within the Xeric West ecoregion.

Compared to EPA's recommended reference values for the Western Mountains nutrient ecoregion (EPA 2000a), NO_3/NO_2 concentrations were relatively good, with only 15.6% of sites in the Western Mountains exceeding the recommended reference concentration of 0.014 mg/L. However, results from the IMRS exceeded the recommended reference TP concentration of 0.010 mg/L at 68.8% of sites in the Western Mountains (Table 4.2).

Table 4.2. Idaho Major Rivers Survey chemistry results compared to the EPA's recommended nutrient reference condition for the Western Mountains and Xeric West nutrient ecoregions

Nitrite-Nitrate Nitrogen			
Category	mg/L	Number of Samples	%
<Method Detecion Limit (MDL)	<0.010	14	43.8
MDL-25th Percentile	0.010-0.014	1	3.1
>25th Percentile	>0.014	5	15.6
Total Phosphorus			
Category	mg/L	Number of Samples	%
<MDL	<0.005	1	3.1
MDL-25th Percentile	0.005-0.010	8	25.0
>25th Percentile	>0.010	22	68.8

b) Xeric West

Nitrite-Nitrate Nitrogen			
Category	mg/L	Number of Samples	%
<MDL	<0.010	2	11.8
MDL-25th Percentile	0.010-0.025	0	0.0
>25th Percentile	>0.025	15	88.2
Total Phosphorus			
Category	mg/L	Number of Samples	%
<MDL	<0.005	0	0.0
MDL-25th Percentile	0.005-0.022	1	5.9
>25th Percentile	>0.022	16	94.1

In the Xeric West nutrient ecoregion, IMRS NO_3/NO_2 concentration was above the recommendation of 0.025 mg/L at 88.2% of sites and above the TP recommendation of 0.022 mg/L at 94.1% of sites (EPA 2000b) (Table 4.2).

Evidence from wadeable streams suggests that the EPA’s recommendations may be too stringent in these nutrient ecoregions. Herlihy and Sifneos (2008) found that among least-impacted wadeable streams, the 75th percentile for TP was 0.019 mg/L and 0.040 mg/L for the Western Mountains and Xeric West, respectively. Using these numbers as thresholds, the IMRS results exceed the recommended TP levels at only 34.4% of sites in the Western Mountains and only 76.5% of the sites in the Xeric West (Table 4.3).

Table 4.3. Idaho Major Rivers Survey total phosphorus compared to the wadeable stream assessment reference condition (Herlihy and Sifneos 2008) for sites in the Western Mountains and Xeric West nutrient ecoregions

a) Western Mountains

Total Phosphorus			
Category	mg/L	Number of Samples	%
<Method Detection Limit (MDL)	<0.005	1	3.1
MDL-75th Percentile	0.005-0.019	19	59.4
>75th Percentile	>0.019	11	34.4

b) Xeric West

Total Phosphorus			
Category	mg/L	Number of Samples	%
<MDL	<0.005	0	0.0
MDL-75th Percentile	0.005-0.040	4	23.5
>75th Percentile	>0.040	13	76.5

Regardless of the disagreement in how to set nutrient reference values, the fact remains that Idaho's major rivers generally have nutrients above the suggested reference value.

Previous studies in Idaho have found that TP is an important stressor of ecological condition in wadeable streams, affecting both macroinvertebrate community integrity and taxa loss (Kosterman 2008). Excess nitrogen and phosphorus have likewise been associated with significant impairment of macroinvertebrate communities in wadeable streams, both nationally and regionally in the West (Van Sickle and Paulsen 2008). However, Idaho code establishes a narrative nutrient criterion, as opposed to a numeric criteria (IDAPA 58.01.02).

Physical habitat data indicate that human activities and disturbances to Idaho's major rivers varied throughout the state (Table 3.2).

For the seven stream sites, SHI ranged from 49 to 76. Of the seven sites, only one was below its ecoregional threshold, meaning it was below the lowest SHI among reference sites. In other words, SHI scores at six of the seven stream sites were within the range expected for reference sites in the appropriate bioregion (Grafe 2002a).

While DEQ does use the SHI as a tool for assessing impairment in wadeable streams, a similar physical habitat index for assessing habitat for nonwadeable rivers is not available. The IHI presented here is a useful tool for summarizing human impacts, but it has not been developed for use as a multimetric indicator of ecological integrity. Thus, a reference condition does not exist and DEQ is unable to assign condition ratings to the IHI scores.

4.3 Biological Condition

Benthic macroinvertebrate condition was considered good for 51.0% (1,846.2 km) of Idaho's major rivers, fair for 38.8% (1,403.1 km), and poor for 10.2% (369.2 km) (Figure 3.2).

These estimates are in line with those found in other estimates of condition for flowing waters in Idaho. For example, Kosterman (2008) found that 10.42% of wadeable perennial stream length in Idaho was in poor condition. In a survey of large, nonwadeable rivers in Idaho, Remington and Kosterman (2008) reported that macroinvertebrate condition was good for 37% of river kilometers, fair for 52%, and poor for 11%.

Nationwide assessments of the biological condition of nonwadeable rivers are currently unavailable. However, for illustrative purposes it may be helpful to compare results from the IMRS to results from the national wadeable stream assessment (EPA 2006). When compared to national and regional estimates of macroinvertebrate condition in wadeable streams, major rivers in Idaho are in relatively good condition. The EPA (2006) found that just 28.2% of wadeable stream miles nationwide were considered to be in good condition based on macroinvertebrates, while nearly 42% were in poor condition. Although conditions in the West were better (45.1% good, 25.8% fair, and 27.4% poor), Idaho's major rivers were still in better shape.

As might be expected, the highest benthic macroinvertebrate index scores occurred in upstream reaches, with the lowest scores found in the Snake River and the lower reaches of the Big Lost River and Camas Creek (Figure 3.2). This finding is also similar to results reported by Remington and Kosterman (2008): river reaches in the lower elevation Southern Basins Bioregion accounted for the river lengths classified as poor.

There are two possible explanations for why this pattern appears: 1) the lower elevation plains are where the greatest human perturbations to the aquatic and upland environment occur, and 2) the 3MI overestimates ecological potential for lower-elevation sites.

In order to compare sampled sites to reference condition, it is necessary to account for natural variability. In bioassessments, this is usually accomplished through site classification or regionalization based on physical environmental factors. A common classification system includes ecoregions (McGrath et al. 2001). For streams, DEQ uses bioregions (Grafe 2002a). However, for large, nonwadeable rivers, DEQ uses a single statewide index and reference condition for assessments (Grafe 2002b), which may result in comparisons to an inappropriate reference condition.

Fish condition was considered good for 38.8% (1,403.1 km) of Idaho's major river length, fair for 2.0% (73.8 km), poor for 22.4% (812.3 km), and was unassessed for 36.7% (1329.3 km) (Figure 3.3). Fish were not sampled for the national wadeable streams assessment (EPA 2006) or the Idaho rivers assessment (Remington and Kosterman 2008); therefore, comparing fish condition in Idaho to the West or the nation as a whole is not possible.

DEQ was unable to assess a large proportion of sites for fish condition due to insufficient fish abundance or federal permit restrictions. Calculating RFI requires at least 20 fish at a sample site, so any river site with less than 20 fish was categorized as unassessed. Also, under the terms of DEQ's Endangered Species Act scientific research permit, DEQ is restricted from electrofishing in waters known to support anadromous fish when water temperatures exceed 18 ºC or when adult salmon are observed.

Of the 18 sites unassessed for fish, 16 had insufficient fish abundance and 2 had permit restrictions.

Assigning a poor condition rating to all sites with insufficient fish data adjusts the condition estimates would drastically change the fish condition estimates and the overall biological condition estimates; however, it is not an appropriate substitution. Many factors can lead to insufficient fish data, including crew inefficiency, low stream conductivity, or dangerous conditions that may make electrofishing prime habitat difficult or impossible. In addition, crews were only able to devote a single day to monitoring at each site due to field schedules.

Given these limitations, this survey based the biological condition on macroinvertebrate condition alone when fish condition was unassessed. Although this strategy is less than ideal, it is more appropriate than downgrading all sites with insufficient fish data to a poor fish condition.

4.4 Recommendations

It is important for DEQ to continue probabilistic monitoring. Probabilistic surveys provide cost-efficient, statistically valid estimates of geographically large and diverse resources and are very useful tools for assessing streams and rivers in Idaho. However, the target population must be properly defined prior to selecting a sample frame. The IMRS targeted both streams and rivers but not all streams or rivers within the state. The survey was limited to the mainstem and major forks and tributaries of only the most well-known rivers within Idaho (e.g., Snake, Boise, Salmon, Clearwater, St. Joe, and Coeur d'Alene Rivers).

For future surveys, it might be better to separate nonwadeable rivers and streams into two separate surveys, or to have a single, statewide survey of all flowing waters within Idaho.

Refined river assessment tools could provide better, more meaningful results. The results of this study may be biased because DEQ does not have a geographical classification scheme for large, nonwadeable rivers. Furthermore, this survey relied on only two indices for assessing river condition (3MI and RFI). When fish data were unavailable or insufficient, biological condition was based on the 3MI data alone. However, DEQ has developed both a River Diatom Index and a River Physicochemical Index for assessing river condition (DEQ 2006). Due to resource limitations, we were unable to collect the necessary parameters for calculating these two indices; future river monitoring efforts should collect these parameters to ensure multiple indices can be used for assessing condition.

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Appendix A. Idaho Major Rivers Survey Design File

Idaho Major River
Survey Design 2006-2008

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Description of Sample Design

Target population: Major rivers in Idaho, as identified by Idaho.

Sample Frame: To identify the target population streams, Mary Anne Nelson provided the GIS stream coverage. It is based on NHD with only major rivers included. Note that it appears that run-of-the-river reservoirs were included in the GIS coverage. They were included in the design.

Survey Design: A Generalized Random Tessellation Stratified (GRTS) survey design for a linear resource was used. The GRTS design includes reverse hierarchical ordering of the selected sites.

Multi-density categories: None

Stratification: None.

Panels: Two panels to be visited in two different years: Panel_2006 and Panel_2008.

Expected sample size: Expected sample size 25 sites per panel.

Over sample: 200% (100 sites).

Site Use: Within State, the base design has 50 sites. Sites are listed in SiteID order and must be used in that order. All sites that occur prior to the last site used must have been evaluated for use and then either sampled or reason documented why that site was not

used. As an example, if 50 sites are to be sampled and it required that 80 sites be evaluated in order to locate 50 sampleable stream sites, then the first 80 sites in SiteID order would be used.

If the design is implemented over two years, then use the sites in siteID order within year and then continue with the next siteID in the next year. If want to identify revisit sites, use the first 5 sites in siteID order that were actually sampled in the field each year.

Sample Frame Summary

Total stream length (in km) in the sample frame is 7384.939 km.

Site Selection Summary

Number of sites in sample

```
mdcaty OverSamp Panel_2006 Panel_2008   Sum
Equal     50        25        25        100
Sum       50        25        25        100
```

Description of Sample Design Output:

The dbf file for the shapefile ("ID Major Rivers 2006-08 Sites") has the following variable definitions:

Variable Name	Description
SiteID	Unique site identification (character)
x	x-coordinate from map projection (see below)
y	y-coordinate from map projection (see below)
mdcaty	Multi-density categories used for unequal probability selection
weight	Weight (in km), inverse of inclusion probability, to be used in statistical analyses
stratum	Strata used in the survey design
panel	Identifies base sample by panel name and Oversample by OverSamp
EvalStatus	Site evaluation decision for site: TS: target and sampled, LD: landowner denied access, etc (see below)
EvalReason	Site evaluation text comment

auxiliary variables	Remaining columns are from the sample frame provided

Projection Information

PROJCS["IDTM83",
GEOGCS["GCS_North_American_1983",
DATUM["D_North_American_1983",
SPHEROID["GRS_1980",6378137.0,298.257222101]],
PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],
PROJECTION["Transverse_Mercator"],
PARAMETER["False_Easting",2500000.0],
PARAMETER["False_Northing",1200000.0],
PARAMETER["Central_Meridian",-114.0],
PARAMETER["Scale_Factor",0.9996],
PARAMETER["Latitude_Of_Origin",42.0],
UNIT["Meter",1.0]]

Evaluation Process

The survey design weights that are given in the design file assume that the survey design is implemented as designed. Typically, users prefer to replace sites that can not be sampled with other sites to achieve the sample size planned. The site replacement process is described above. When sites are replaced, the survey design weights are no longer correct and must be adjusted. The weight adjustment requires knowing what happened to each site in the base design and the over sample sites. EvalStatus is initially set to "NotEval" to indicate that the site has yet to be evaluated for sampling. When a site is evaluated for sampling, then the EvalStatus for the site must be changed. Recommended codes are:

EvalStatus Code	Name	Meaning
TS	Target Sampled	site is a member of the target population and was sampled
LD	Landowner Denial	landowner denied access to the site
PB	Physical Barrier	physical barrier prevented access to the site
NT	Non-Target	site is not a member of the target population

NN	Not Needed	site is a member of the over sample and was not evaluated for sampling
Other codes		Many times useful to have other codes. For example, rather than use NT, may use specific codes indicating why the site was non-target.

Statistical Analysis

Any statistical analysis of data must incorporate information about the monitoring survey design. In particular, when estimates of characteristics for the entire target population are computed, the statistical analysis must account for any stratification or unequal probability selection in the design. Procedures for doing this are available from the Aquatic Resource Monitoring web page given in the bibliography. A statistical analysis library of functions is available from the web page to do common population estimates in the statistical software environment R.

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Web Page: http://www.epa.gov/nheerl/arm

Appendix B. Idaho Major River Survey results

Index	Site ID	Latitude	Longitude	Stream Name	Assessment Unit	River/Stream
5	RDEQA005	43.20823262	-112.2040229	Blackfoot River	ID17040207SK002_05	RIVER
8	RDEQA008	45.37520808	-114.0851319	Salmon River	ID17060203SL032_07	RIVER
11	RDEQA011	43.78078818	-114.5422267	Big Wood River	ID17040219SK018_04	STREAM
12	RDEQA012	45.40676405	-116.1918644	Salmon River	ID17060209SL019_017	RIVER
13	RDEQA013	44.00972489	-113.785473	Big Lost River	ID17040218SK015_05	STREAM
16	RDEQA016	44.98105701	-113.9506986	Salmon River	ID17060203SL047_06	RIVER
17	RDEQA017	42.36036898	-111.7366043	Bear River	ID16010202BR009_06a	RIVER
22	RDEQA022	47.64395744	-116.0004195	Coeur d'Alene River	ID17010301PN001_05	RIVER
23	RDEQA023	43.00191789	-115.1959558	Snake River	ID17050101SW005_07	RIVER
26	RDEQA026	46.72020295	-115.2917605	North Fork Clearwater River	ID17060307CL016_05	RIVER
27	RDEQA027	43.92715417	-114.1877979	North Fork Big Lost River	ID17040218SK027_03	STREAM
28	RDEQA028	45.78965179	-116.3200576	Salmon River	ID17060209SL008_07	RIVER
30	RDEQA030	47.47841607	-116.7357553	Coeur d'Alene River	ID17010303PN007_06	RIVER
31	RDEQA031	44.62918787	-116.5858832	Weiser River	ID17050124SW007_05	RIVER
37	RDEQA037	42.80111959	-111.4851504	Blackfoot River	ID17040207SK010_05	RIVER
38	RDEQA038	48.0130755	-116.2349596	Coeur d'Alene River	ID17010301PN015_03	STREAM
40	RDEQA040	45.45502241	-115.7723364	Salmon River	ID17060207SL001_07	RIVER
44	RDEQA044	44.65886238	-114.0238402	Pahsimeroi River	ID17060202SL001_05	RIVER
47	RDEQA047	43.60654178	-116.9108773	Snake River	ID17050103SW001_07	RIVER
50	RDEQA050	48.24202062	-116.8838657	Priest River	ID17010215PN001_05	RIVER
51	RDEQA051	42.78957541	-115.7176667	Bruneau River	ID17050102SW009_06	STREAM
54	RDEQA054	48.02246891	-116.2931202	Coeur d'Alene River	ID17010301PN015_02	STREAM
55	RDEQA055	44.21363422	-116.1065647	North Fork Payette River	ID17050123SW001_06a	RIVER
56	RDEQA056	46.13813429	-115.8031572	Middle Fork Clearwater River	ID17060304CL001_05	RIVER
59	RDEQA059	44.26134045	-114.8552667	Salmon River	ID17060201SL047_05	RIVER
60	RDEQA060	45.30510992	-114.5147221	Salmon River	ID17060203SL001_07	RIVER
61	RDEQA061	43.88176745	-112.3516264	Camas Creek	ID17040214SK001_06	RIVER
63	RDEQA063	44.00356829	-116.8034669	Payette River	ID17050122SW001_06	RIVER
68	RDEQA068	44.81758463	-114.4926779	Camas Creek	ID17060206SL025_04	RIVER

Index	Site ID	Latitude	Longitude	Stream Name	Assessment Unit	River/Stream
69	RDEQA069	42.82622541	-111.5550703	Blackfoot River	ID17040207SK010_05	STREAM
72	RDEQA072	44.8984902	-116.1113132	North Fork Payette River	ID17050123SW016_04	RIVER
74	RDEQA074	46.45874783	-115.0403715	Lochsa River	ID17060303CL013_05	RIVER
75	RDEQA075	44.24841125	-114.5152617	Salmon River	ID17060201SL027_05	RIVER
76	RDEQA076	44.39209921	-114.2665013	Salmon River	ID17060201SL016_06	RIVER
77	RDEQA077	43.79708069	-111.9271381	Henrys Fork	ID17040203SK001_06	RIVER
79	RDEQA079	43.77617738	-116.9671266	Boise River	ID17050114SW001_06	RIVER
81	RDEQA081	43.37859283	-112.1384088	Snake River	ID17040206SK022_04	RIVER
82	RDEQA082	48.39442597	-116.8682652	Priest River	ID17010215PN001_05	RIVER
83	RDEQA083	43.01458793	-116.1318004	Snake River	ID17050103SW006_07	RIVER
84	RDEQA084	44.6950125	-115.701563	South Fork Salmon River	ID17060208SL010_04	RIVER
85	RDEQA085	42.85069438	-112.4417685	Portneuf River	ID17040208SK001_05	RIVER
86	RDEQA086	47.13974792	-115.4080598	Saint Joe River	ID17010304PN041_04	RIVER
87	RDEQA087	44.17139676	-115.2346016	South Fork Payette River	ID17050120SW001_04	RIVER
88	RDEQA088	46.04566095	-115.2964006	Selway River	ID17060302CL006_06	RIVER
91	RDEQA091	43.43431019	-114.2624782	Big Wood River	ID17040219SK004_05	RIVER
94	RDEQA094	45.10052707	-113.7268014	Lemhi River	ID17060204SL001_06	RIVER
95	RDEQA095	42.63546108	-114.5580063	Snake River	ID17040212SK007_07	RIVER
97	RDEQA097	43.43576117	-111.3576361	Snake River	ID17040104SK008_06	RIVER
99	RDEQA099	43.90082863	-116.6332831	Payette River	ID17050122SW001_06	RIVER

Index	Site ID	DEQ Bioregion	Level 3 Ecoregion	Aggregate Ecoregion
5	RDEQA005	Basins	Snake River Plain	Xeric
8	RDEQA008	Central and South Mountains	Idaho Batholith	Western Mountains
11	RDEQA011	Central and South Mountains	Idaho Batholith	Western Mountains
12	RDEQA012	Central and South Mountains	Idaho Batholith	Western Mountains
13	RDEQA013	Basins	Middle Rockies	Western Mountains
16	RDEQA016	Central and South Mountains	Middle Rockies	Western Mountains
17	RDEQA017	Basins	Northern Basin and Range	Xeric
22	RDEQA022	Northern Mountains	Northern Rockies	Western Mountains
23	RDEQA023	Basins	Snake River Plain	Xeric
26	RDEQA026	Northern Mountains	Northern Rockies	Western Mountains
27	RDEQA027	Central and South Mountains	Idaho Batholith	Western Mountains
28	RDEQA028	Central and South Mountains	Blue Mountains	Western Mountains
30	RDEQA030	Northern Mountains	Northern Rockies	Western Mountains
31	RDEQA031	Central and South Mountains	Snake River Plain	Xeric
37	RDEQA037	Basins	Middle Rockies	Western Mountains
38	RDEQA038	Northern Mountains	Northern Rockies	Western Mountains
40	RDEQA040	Central and South Mountains	Idaho Batholith	Western Mountains
44	RDEQA044	Basins	Middle Rockies	Western Mountains
47	RDEQA047	Basins	Snake River Plain	Xeric
50	RDEQA050	Northern Mountains	Northern Rockies	Western Mountains
51	RDEQA051	Basins	Snake River Plain	Xeric
54	RDEQA054	Northern Mountains	Northern Rockies	Western Mountains
55	RDEQA055	Central and South Mountains	Idaho Batholith	Western Mountains
56	RDEQA056	Northern Mountains	Idaho Batholith	Western Mountains
59	RDEQA059	Central and South Mountains	Idaho Batholith	Western Mountains
60	RDEQA060	Central and South Mountains	Idaho Batholith	Western Mountains
61	RDEQA061	Basins	Snake River Plain	Xeric
63	RDEQA063	Basins	Snake River Plain	Xeric
68	RDEQA068	Central and South Mountains	Idaho Batholith	Western Mountains

Index	Site ID	DEQ Bioregion	Level 3 Ecoregion	Aggregate Ecoregion
69	RDEQA069	Basins	Northern Basin and Range	Xeric
72	RDEQA072	Central and South Mountains	Idaho Batholith	Western Mountains
74	RDEQA074	Northern Mountains	Idaho Batholith	Western Mountains
75	RDEQA075	Central and South Mountains	Idaho Batholith	Western Mountains
76	RDEQA076	Central and South Mountains	Middle Rockies	Western Mountains
77	RDEQA077	Basins	Snake River Plain	Xeric
79	RDEQA079	Basins	Snake River Plain	Xeric
81	RDEQA081	Basins	Snake River Plain	Xeric
82	RDEQA082	Northern Mountains	Northern Rockies	Western Mountains
83	RDEQA083	Basins	Snake River Plain	Xeric
84	RDEQA084	Central and South Mountains	Idaho Batholith	Western Mountains
85	RDEQA085	Basins	Snake River Plain	Xeric
86	RDEQA086	Northern Mountains	Northern Rockies	Western Mountains
87	RDEQA087	Central and South Mountains	Idaho Batholith	Western Mountains
88	RDEQA088	Northern Mountains	Idaho Batholith	Western Mountains
91	RDEQA091	Basins	Snake River Plain	Xeric
94	RDEQA094	Basins	Middle Rockies	Western Mountains
95	RDEQA095	Basins	Snake River Plain	Xeric
97	RDEQA097	Central and South Mountains	Middle Rockies	Western Mountains
99	RDEQA099	Basins	Snake River Plain	Xeric

Index	Site ID	Nitrate-Nitrite (mg/L)	TP (mg/L)	Water Temperature (ºC)	pH	Sp. Cond. (µS/cm²)
5	RDEQA005	0.3	0.08	20.6		288
8	RDEQA008		0.026	23	8	193
11	RDEQA011	**0.01**	0.02	6.4		174.2
12	RDEQA012		0.012	17.7	7.56	158.2
13	RDEQA013	0.01	0.023	10.7		322
16	RDEQA016		0.014	20.2	8.4	194
17	RDEQA017	0.58	0.086	21		652
22	RDEQA022		0.009	16.8	7.35	65.3
23	RDEQA023	1.5	0.078	17.7	7.45	508
26	RDEQA026	**0.01**	0.0064	9.5	8.6	63
27	RDEQA027	**0.01**	0.0107	10.4		216
28	RDEQA028	**0.01**	0.016	15.9	8.8	143
30	RDEQA030	**0.01**	0.025	19.5	8	83
31	RDEQA031	**0.01**	0.03	17	8.6	97
37	RDEQA037	**0.01**	0.028	19.2	8.8	310
38	RDEQA038	**0.01**	0.0053	12.4		48
40	RDEQA040	**0.01**	0.016	8.7	8.7	147
44	RDEQA044	0.28	0.026	9.6	8.7	344
47	RDEQA047	1.4	0.12	24.5	8.7	422
50	RDEQA050	**0.01**	0.0096	22.7	8.8	75
51	RDEQA051	1	0.033	20.6		308
54	RDEQA054	**0.01**	0.0064	8.5		50
55	RDEQA055		0.028	20.5	8.16	36.3
56	RDEQA056		0.016	18.3	7.5	46.8
59	RDEQA059		0.005	15.7	8.5	90.2
60	RDEQA060		0.018	22.6		180
61	RDEQA061	1.1	0.024	12.5		270
63	RDEQA063	0.14	0.052	23.4		154.3
68	RDEQA068	**0.01**	0.018	5.6	8.7	115

Index	Site ID	Nitrate-Nitrite (mg/L)	TP (mg/L)	Water Temperature (ºC)	pH	Sp. Cond. (µS/cm²)
69	RDEQA069	**0.01**	0.041	14.6		455
72	RDEQA072		0.027	14	7.36	22.2
74	RDEQA074			17.8		53.6
75	RDEQA075	0.22	0.016	19	8.7	120
76	RDEQA076		0.011	17.5	8.6	137
77	RDEQA077	0.05	0.041	21.3		183
79	RDEQA079	1.7	0.295	18.2		395
81	RDEQA081	0.05	0.043	17.5	7.52	347
82	RDEQA082		0.011	19.9	7.51	59
83	RDEQA083	0.6	0.088	23.5	8.9	774
84	RDEQA084	**0.01**	0.043	10.1	8.6	53
85	RDEQA085	0.049	0.0886	19.9	8.6	600
86	RDEQA086	**0.01**	0.0056	9.6	8.6	92
87	RDEQA087	0.034	**0.005**	10.2	8.6	66
88	RDEQA088	**0.01**	0.0083	13.2	8.5	37
91	RDEQA091	0.065	0.0126	12.1	8.4	238
94	RDEQA094	0.034	0.094	11.4	8.6	512
95	RDEQA095	0.76	0.093	21.1	9.2	467
97	RDEQA097	0.049	0.0222	12.2	8.8	262
99	RDEQA099	0.037	0.0444	20.3	8.6	90

Index	Site ID	RMI	RMI Score	RMI Condition	3MI	3MI Score	3MI Condition
5	RDEQA005	17	3	GOOD	11	3	FAIR
8	RDEQA008	15	2	FAIR	9	3	FAIR
11	RDEQA011						
12	RDEQA012	11	1	POOR	9	3	FAIR
13	RDEQA013						
16	RDEQA016	15	2	FAIR	9	3	FAIR
17	RDEQA017	14	2	FAIR	9	3	FAIR
22	RDEQA022	23	3	GOOD	15	5	GOOD
23	RDEQA023	10	0	POOR	5	1	POOR
26	RDEQA026	23	3	GOOD	15	5	GOOD
27	RDEQA027						
28	RDEQA028	23	3	GOOD	13	5	GOOD
30	RDEQA030	9	0	POOR	9	3	FAIR
31	RDEQA031	23	3	GOOD	15	5	GOOD
37	RDEQA037	19	3	GOOD	9	3	FAIR
38	RDEQA038						
40	RDEQA040	21	3	GOOD	9	3	FAIR
44	RDEQA044	19	3	GOOD	11	3	FAIR
47	RDEQA047	14	2	FAIR	7	3	FAIR
50	RDEQA050	23	3	GOOD	15	5	GOOD
51	RDEQA051						
54	RDEQA054						
55	RDEQA055	14	2	FAIR	9	3	FAIR
56	RDEQA056	23	3	GOOD	15	5	GOOD
59	RDEQA059	21	3	GOOD	13	5	GOOD
60	RDEQA060	17	3	GOOD	13	5	GOOD
61	RDEQA061	14	2	FAIR	5	1	POOR
63	RDEQA063	21	3	GOOD	9	3	FAIR
68	RDEQA068	19	3	GOOD	11	3	FAIR

Index	Site ID	RMI	RMI Score	RMI Condition	3MI	3MI Score	3MI Condition
69	RDEQA069						
72	RDEQA072	23	3	GOOD	15	5	GOOD
74	RDEQA074	21	3	GOOD	13	5	GOOD
75	RDEQA075	23	3	GOOD	15	5	GOOD
76	RDEQA076	23	3	GOOD	15	5	GOOD
77	RDEQA077	17	3	GOOD	9	3	FAIR
79	RDEQA079	14	2	FAIR	11	3	FAIR
81	RDEQA081	17	3	GOOD	9	3	FAIR
82	RDEQA082	23	3	GOOD	15	5	GOOD
83	RDEQA083	13	1	POOR	5	1	POOR
84	RDEQA084	23	3	GOOD	15	5	GOOD
85	RDEQA085	19	3	GOOD	9	3	FAIR
86	RDEQA086	23	3	GOOD	15	5	GOOD
87	RDEQA087	23	3	GOOD	15	5	GOOD
88	RDEQA088	23	3	GOOD	15	5	GOOD
91	RDEQA091	17	3	GOOD	13	5	GOOD
94	RDEQA094	19	3	GOOD	13	5	GOOD
95	RDEQA095	15	2	FAIR	5	1	POOR
97	RDEQA097	10	0	POOR	11	3	FAIR
99	RDEQA099	16	2	FAIR	11	3	FAIR

Index	Site ID	SMI	SMI Score	SMI Condition	RFI	RFI Score	RFI Condition
5	RDEQA005						
8	RDEQA008				31.87386088	0	POOR
11	RDEQA011	82.8	3	GOOD			
12	RDEQA012						
13	RDEQA013	45	1	POOR			
16	RDEQA016				64.65488774	1	GOOD
17	RDEQA017						
22	RDEQA022				100	3	GOOD
23	RDEQA023				20.29187549	0	POOR
26	RDEQA026				83.10677979	3	GOOD
27	RDEQA027	75.2	3	GOOD			
28	RDEQA028						
30	RDEQA030				29.59088035	0	POOR
31	RDEQA031				22.44847627	0	POOR
37	RDEQA037				36.03092762	0	POOR
38	RDEQA038	77.9	3	GOOD			
40	RDEQA040				43.82168776	0	POOR
44	RDEQA044				90.31309106	3	GOOD
47	RDEQA047						
50	RDEQA050				35.84450689	0	POOR
51	RDEQA051	61	3	GOOD			
54	RDEQA054	74.2	3	GOOD			
55	RDEQA055						
56	RDEQA056						
59	RDEQA059				95.26749149	3	GOOD
60	RDEQA060				31.9937941	0	POOR
61	RDEQA061						
63	RDEQA063						
68	RDEQA068						

Index	Site ID	SMI	SMI Score	SMI Condition	RFI	RFI Score	RFI Condition
69	RDEQA069	57.5	3	GOOD			
72	RDEQA072				55.58293874	1	GOOD
74	RDEQA074				65.70160211	1	GOOD
75	RDEQA075				84.02265953	3	GOOD
76	RDEQA076				91.41058896	3	GOOD
77	RDEQA077						
79	RDEQA079				19.79071277	0	POOR
81	RDEQA081						
82	RDEQA082				70.32260257	3	GOOD
83	RDEQA083						
84	RDEQA084						
85	RDEQA085						
86	RDEQA086						
87	RDEQA087						
88	RDEQA088				100	3	GOOD
91	RDEQA091				80.72465249	3	GOOD
94	RDEQA094				63.51304181	1	GOOD
95	RDEQA095				12.83122735	0	POOR
97	RDEQA097				99.53941344	3	GOOD
99	RDEQA099						

Index	Site ID	SFI	SFI Score	SFI Condition	Biological Condition
5	RDEQA005				POOR
8	RDEQA008				POOR
11	RDEQA011	83.3	3	GOOD	GOOD
12	RDEQA012				POOR
13	RDEQA013	92.5	3	GOOD	GOOD
16	RDEQA016				POOR
17	RDEQA017				POOR
22	RDEQA022				POOR
23	RDEQA023				POOR
26	RDEQA026				POOR
27	RDEQA027	79.15	2	GOOD	GOOD
28	RDEQA028				POOR
30	RDEQA030				POOR
31	RDEQA031				POOR
37	RDEQA037				POOR
38	RDEQA038	100	3	GOOD	GOOD
40	RDEQA040				POOR
44	RDEQA044				POOR
47	RDEQA047				POOR
50	RDEQA050				POOR
51	RDEQA051	49	1	POOR	GOOD
54	RDEQA054	83	3	GOOD	GOOD
55	RDEQA055				POOR
56	RDEQA056				POOR
59	RDEQA059				POOR
60	RDEQA060				POOR
61	RDEQA061				POOR
63	RDEQA063				POOR
68	RDEQA068				POOR

Index	Site ID	SFI	SFI Score	SFI Condition	Biological Condition
69	RDEQA069	76.6	2	FAIR	GOOD
72	RDEQA072				POOR
74	RDEQA074				POOR
75	RDEQA075				POOR
76	RDEQA076				POOR
77	RDEQA077				POOR
79	RDEQA079				POOR
81	RDEQA081				POOR
82	RDEQA082				POOR
83	RDEQA083				POOR
84	RDEQA084				POOR
85	RDEQA085				POOR
86	RDEQA086				POOR
87	RDEQA087				POOR
88	RDEQA088				POOR
91	RDEQA091				POOR
94	RDEQA094				POOR
95	RDEQA095				POOR
97	RDEQA097				POOR
99	RDEQA099				POOR