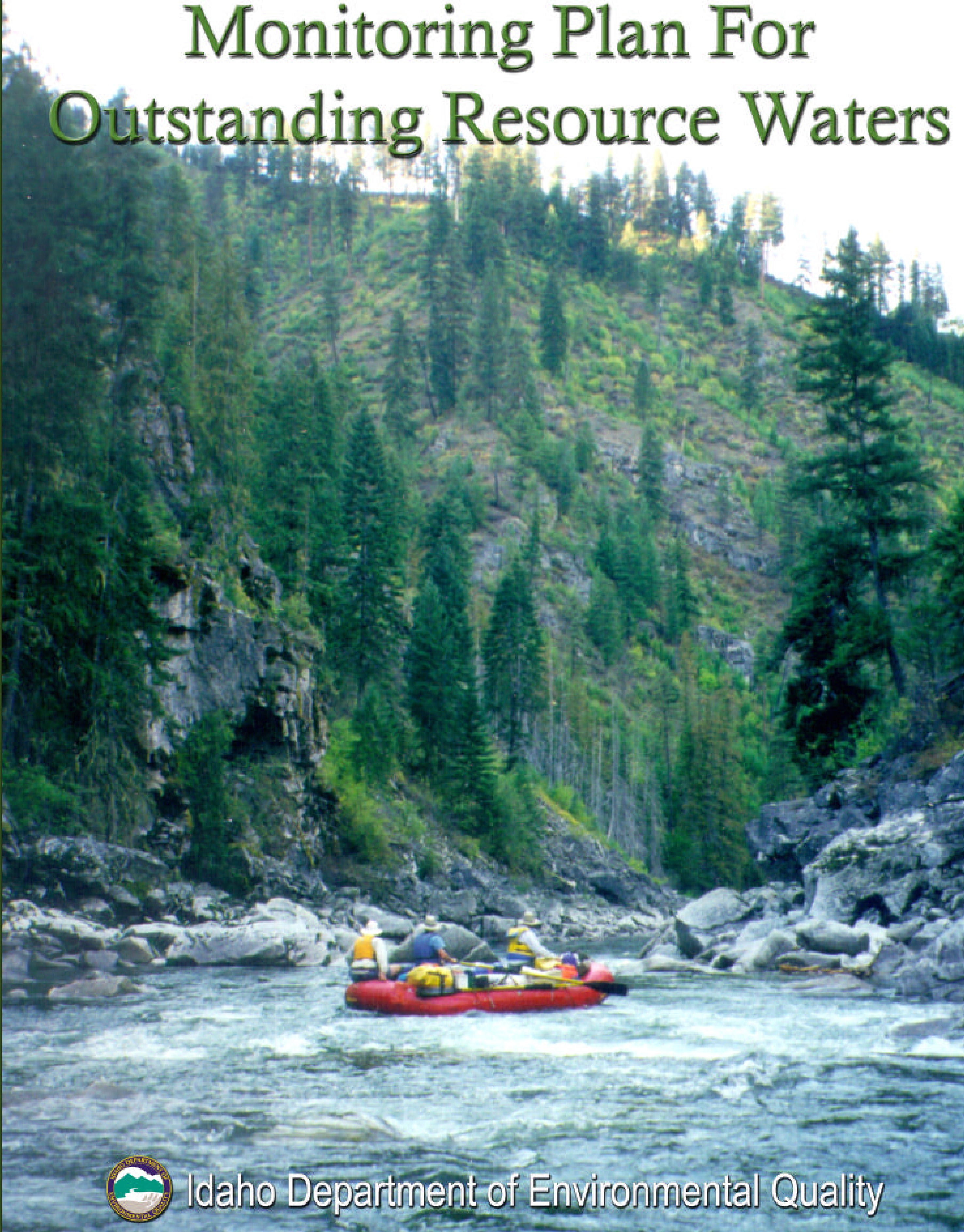
Monitoring Plan For Outstanding Resource Waters



Idaho Department of Environmental Quality

MONITORING PLAN FOR OUTSTANDING RESOURCE WATERS

A Report prepared for Idaho Board of Environmental Quality

Prepared by

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Monitoring Plan for Outstanding Resources Waters: the Selway and Middle Fork of the Salmon Rivers and Selected Tributaries.

Intent

This report describes how Idaho Department of Environmental Quality (IDEQ) proposes to monitor the Selway and Middle Fork of the Salmon Rivers to determine whether the current level of water quality observed for these sites is being maintained or degraded. This document was requested by the Board of Environmental Quality to accompany a proposal to the Legislature for listing segments of the Selway and Middle Fork of the Salmon Rivers as Outstanding Resource Waters (ORW).

Proposal

IDEQ proposes four types of monitoring: 1) biological monitoring of fish, macroinvertebrates, and diatoms; 2) chemical monitoring of nitrogen, phosphorus; conductivity, turbidity, total suspended solids, dissolved oxygen, chlorophyll a, and pH; 3) physical monitoring of temperature and habitat; and 4) physical monitoring of increases or changes in human activities. The sampling design for ORW sites differs from IDEQ's Beneficial Use Reconnaissance Program (BURP) and Water Body Assessments monitoring and assessment programs for Idaho rivers and streams in two ways. First, comparisons are not made to reference condition or best available condition at other sites as they are with the BURP or Water Body Assessments; rather the comparison for each river or stream is to itself. For ORW's, we are interested in detecting changes to this resource, not changes relative to other sites. Second, increased human activity will automatically trigger additional monitoring specific to the type of potential degradation associated with that activity. Baseline data at the site(s) most likely influenced by a new or increased activity will be specifically monitored.

Purpose of monitoring

Two hundred years ago, people couldn't imagine how we could ever run out of wilderness in the West. However, the Western mountain states (Montana, Idaho, Utah, Nevada, Wyoming, Colorado, Arizona and New Mexico) are now among the fastest-growing states in the nation (25.4 % increase from 1990-1999 according to U.S. Census Bureau, 1999), and pressures on wild landscapes increase every year. It's hard to see these changes happening, which is why we need scientific monitoring to test for changes before they become pervasive and obvious to a casual human observer.

As the population of the United States grows, especially in the West, pressure to recreate in the outdoors increases as well. As an indication of this growth we've used some statistics on tourism in Idaho to better illustrate this phenomena. Tourism generated approximately $1.7 billion in Idaho in 1997, supporting 24,000 jobs and generated $134 million in local and state tax revenues according to Dean Runyan Associates (1999). Couple this with increased need for basic natural resources to support ever-increasing population growth and one begins to see the pressures that will be brought to bear on islands of solitude and beauty like the Selway and Middle Fork of the Salmon Rivers. Most types of human disturbance are incremental, but even small increments add up, and disturbance is cumulative. Monitoring of the type described here is intended to detect degradation of water quality at its earliest stages, which allows resource managers to make necessary changes in land management activities in time to prevent impairment of the beneficial uses so dependent on that water quality. There is great truth in the adage "an ounce of prevention is worth a pound of cure." Prevention of water quality degradation will also prevent loss of key fisheries and unique habitats only found in the Selway and Middle Fork Rivers. Prevention of water quality degradation also means continued maintenance of the strong economic benefits these waters produce for the state of Idaho and its communities.

Lastly, ORW's are a part of the federal Clean Water Act, §303.d(4)(b) and federal regulations, 40 Federal Code of Regulations §131.12. ORW's are also referenced in Idaho's Water Quality Standards, IDAPA 58.01.02.051 and 055 and state statute, Idaho Code §39:3601. The Idaho Conservation League submitted nominations to the Board of Health and Welfare in April of 2000 in accordance to the rules and statutes noted above. The Board of Environmental Quality (with Department status in July 2000, IDEQ created a new board separate from the Board of Health and Welfare) passed a motion at their October meeting to recommend portions of the Selway and Middle Fork of the Salmon Rivers as ORW's (Figures 1 and 2). The board also asked IDEQ to determine how to set baseline water quality conditions for these two systems as well as describe a monitoring plan that would yield data sufficient to determine if water quality was being degraded.

Biological Monitoring

IDEQ proposes to focus mainly on biological parameters for the following reasons: 1) biology is the best direct measure of water quality, 2) biology integrates water quality changes, and 3) biology is the most efficient parameter in terms of cost and logistics. The animals and plants living in a river or stream provide the best indicators of the water body's overall health and ecological condition. Human activities that alter a watershed and interfere with the natural processes of a river or stream have immediate as well as long-lasting effects on the animals and plants that live there.

Monitoring is based on three biological groups: diatoms, macroinvertebrates, and fish. Diatoms are single-celled plants that transform solar energy into food and inorganic nutrients into biologically active organic compounds. They form the base of the food chain for invertebrates and fish.

We monitor macroinvertebrates because they represent an enormous diversity of body shapes, survival strategies, and adaptations. Like salmonids (salmonids refers to fish in the family salmonidae, which include rainbow trout, cutthroat trout, mountain white fish, brook trout, etc.) many macroinvertebrates require clear, cool water, adequate oxygen, stable flows, and a steady source of food in order to complete their life cycles.

Macroinvertebrates are an important food source for fish, including salmonids, and many birds, such as herons and kingfishers. Scientific literature related to biological monitoring supports the idea that multimetric indexes based on macroinvertebrate communities vary little from year to year when the type of intensity of human disturbance remains constant (Minshall et al. 1995, Richards and Minshall 1992, Wallace et al. 1996, DeShon 1995, Karr and Chu 1999, Fore et al. 2001). For this reason we believe macroinvertebrates will be a good sentinel of water quality changes brought on by human influences.

We base our assessment on all the fish collected even though game fish such as salmonids are commercially and culturally most important to society. Sculpins are sensitive to many types of disturbances and are more dependent on a site because they travel less than salmonids. Exotic species increase with warmer temperatures and can displace native fishes.

Biological metrics measure different aspects of stream biology including taxonomic richness and composition, tolerance and intolerance, habitat, reproductive strategy, feeding ecology, and population structure. These metrics have been tested in Idaho and other states for their association with many types of degradation. IDEQ currently relies on several different indexes based on size of the water body of concern. Sampling and subsequent analysis differ for wadable streams versus large rivers. There are two biological indexes for wadable systems: 1) Stream Macroinvertebrate Index (SMI); and 2) Stream Fish Index (SFI). Large rivers have three biological indexes: 1) River Macroinvertebrate Index (RMI); 2) River Fish Index (RFI); and 3) River Diatom Index (RDI). Diatoms are most common forms of algae that occur in running waters.

Chemical and physical monitoring

High elevation water bodies in this region tend to be naturally nutrient poor. Many human activities increase nutrients. Erosion associated with development increases can increase nitrogen. Wastewater and livestock excrements can also increase nutrients above natural levels. Chemical monitoring for typical nutrients is designed to detect changes before they damage fish or invertebrate assemblages.

Changes in pH, total suspended solids, or conductivity are not likely to be detected unless they are large. Nonetheless, these variables are inexpensive to monitor and can detect large changes associated with spills or erosion.

Roads and mines can be sources of heavy metals, such as zinc or cadmium, which degrade water bodies and adversely affect diatoms, macroinvertebrates, and fish. Protocols for metals require careful collection and sample storage; lab effort also represents a significant cost. Therefore, this type of sampling will be reserved for testing associated with specific human activities, for example, increased road traffic associated with an increase in tourism.

Monitoring of human activities

Much of the land associated with these watersheds is in designated Wilderness areas; therefore, dramatic increases in human disturbances are not anticipated. Nonetheless, as population density increases, pressures inevitably increase and new activities constantly arise. Typically monitoring in Idaho assumes that routine monitoring is sufficient to detect significant degradation from reference condition– the condition in the absence of human influence. For ORW sites, a more inclusive monitoring approach is designed to anticipate changes in the watershed before they degrade the receiving waters. To that effect, changes in human uses will trigger additional monitoring at the sites experiencing an increase or change in human use. Examples include, but are not limited to, an increase of X % in visits to the wilderness or float permits, increases in wastewater or septic systems, and changes in land cover detected from GIS analysis.

Because of Wilderness and Wild and Scenic river designations for both of these river systems, significant changes in human activities are not anticipated, but should they arise, they would be assessed through either an Environmental Assessment or Environmental Impact Statement. In both cases, IDEQ reviews and comments on these types of documents for water quality impacts. These two notification mechanisms would encompass water-based and administrative changes made by the U.S. Forest Service. For changes in land-based activities IDEQ would look to the Idaho Outfitters and Guides Licensing Board for notification of changes. For changes relative to private in-holdings IDEQ will rely on notification by the appropriate health district for changes in facilities.

Sampling design

The results of biological and chemical assessments may be affected by natural variability in the ecosystem or by human-induced changes associated with disturbance. A good monitoring protocol is relatively immune to natural variables such as weather or stream size, but sensitive to human activities that result in degradation such as erosion and nutrient enrichment. We propose to collect repeat samples through time and from multiple locations to evaluate the measurement error associated with each variable being monitored (Table 1). Estimates of variability are needed to define what amount of change represents a significant difference.

Samples collected in the first year (2000) can be used to estimate variability associated with differences in sampling location (Tables 2 and 3, Figures 3 and 4). Data collected in 2001 from the same sites as in 2000 will be used to estimate the variability associated with differences in that year. A paired-samples test can be used to compare subsequent years with baseline data collected in 2000-2001 from fixed stations. As data accumulate in subsequent years, the power to detect changes at each site increases. Multiple visits through time can be tested for trends for each site. Thus, we will test for change in two ways: (1) using a paired-samples test to compare each subsequent year to baseline; and (2) with trend analysis to test for changes at each site. Significant differences for either test will indicate potential degradation to the water body.

Table 1. Parameters sampled during September 2000 field visits.

Parameter Type	Parameter	*River*	Stream
Biological	Fish		✓
	Macroinvertebrates	✓	✓
	Periphyton	✓	✓
Physicochemical	Chlorophyll a	✓	
	Temperature	✓	
	Conductivity	✓	✓
	pH	✓	
	Dissolved Oxygen	✓	
	Ammonia + Nitrate + Nitrite	✓	✓
	Total Phosphorus	✓	✓
	Turbidity	✓	✓
	Total Suspended Solids	✓	✓
Physical Habitat	Width (wetted and bankfull)	✓	✓
	Depth	✓	✓
	Canopy cover	✓	✓
	Substrate size	✓	✓
	Habitat type		✓
	Bank stability	✓	✓
	Riparian vegetation characterization	✓	✓
	Pool complexity		✓
	Large woody debris		✓
	Stream channel classification		✓
	Channel constraint/alteration characterization	✓	
	Human disturbance characterization	✓	

Table 2. Location of Selway River 2000 monitoring sites.

Water Body Monitoring Category	**Location**
River	Selway above Bear Creek
	Selway below Bear Creek
	Mouth of Moose Creek
Stream	Mouth of Running Creek
	Mouth of Bear Creek
	Mouth of Bitch Creek

Table 3. Location of Middle of Salmon River 2000 monitoring sites.

Water Body Monitoring Category	**Location**
River	Middle Fork of Salmon below Boundary Creek
	Middle Fork of Salmon below Indian Creek
	Middle Fork of Salmon above Loon Creek
	Mouth of Loon Creek
	Middle Fork of Salmon above Camas Creek
	Mouth of Camas Creek
	Mouth of Big Creek
Stream	Mouth of Indian Creek
	Mouth of Marble Creek
	Mouth of Wilson Creek
	Mouth of Papoose Creek
	Mouth of Ship Island Creek

For three consecutive years, a set of fixed sites will be sampled for the four types of monitoring noted above. These same sites will then be sampled in subsequent three-year periods, or more frequently as warranted and tested for changes in biology, temperature or chemistry. Site location will be modified to capture those river and stream segments designated in the final legislation.

Additional sampling will be triggered by 1) changes in biological or chemical integrity at the fixed locations or 2) changes in human activity near the water body or within its watershed. If changes are detected in the annual monitoring, and the source or cause is not know, additional sampling upstream of the degraded locations may be necessary to identify the source. Increases in the intensity of type of human activities already present will also trigger additional sampling to monitor those new or increased uses.

Defining degradation

We calculated the variability of the Stream Macroinvertebrate Index using repeat visits to the same site (Table 4). We used this estimate of variance to determine how large a difference we would need to observe to define a statistically significant change to the water resource. Variability calculations were based on 36 sites from across the state, none of the sites were on the Selway or Salmon Rivers, therefore, we substituted these values until actual estimates are available for the ORW sites. We expect that variance for these sites will be less than for sites across the state, and it is unlikely that the variance will actually be higher. Thus, for now, our estimates are statistically conservative.

Two statistical models are described here for determining change to the resource, a paired and a two-sample design. If the same sites are to be sampled each year, a paired comparison can be used such that each sampling site is compared to itself at a previous time. For a paired *t*-test, each site is paired with its previous index value and the average is calculated. If the average is greater than zero, and larger than expected considering the variance, then the sites are significantly different and have been degraded.

If the same sites are not to be sampled each year, then a paired test cannot be done. We would instead perform a two-sample test, such as a *t*-test. In this case, we would calculate an average of the index values for the first year and compare that average with the average of the index values from a subsequent year. This test is less powerful, that is, less likely to detect a difference, than the paired test. Consequently, the sensitivity is less and a larger change must be observed to say that the river has been degraded.

The sensitivity of the test depends on the sample design (Tables 2 and 3). More sample sites make it easier to detect differences. If the index is less variable at ORW sites, we will also be able to more easily detect a change. We assumed that sampling would yield at least 300 individual macroinvertebrates, but variability of the index increases with smaller sample sizes (i.e., small numbers of macroinvertebrates in the sample).

Table 4. Estimated change in Stream Macroinvertebrate Index values that would be detectable using a paired *t*-test or a standard *t*-test (for a one-sided comparison). The detectable change is smaller for larger number of sampling sites. Provided are the number of sites sampled (n), the estimate of variance for the index (s^2), ν, *t* for alpha = 0.05 for a one-sided test, *t* for beta = 0.8, and the change in index value that could be reliably detected.

A. Paired *t*-test (two-sided comparison).

n	s^2	ν	t-alpha	t-beta	change
2	134	1	6.3	1.4	62.9
3	134	2	2.9	1.1	26.6
4	134	3	2.4	1.0	19.3
5	134	4	2.1	0.9	15.9
6	134	5	2.0	0.9	13.9
7	134	6	1.9	0.9	12.5
8	134	7	1.9	0.9	11.4
9	134	8	1.9	0.9	10.6
10	134	9	1.8	0.9	9.9

B. Standard *t*-test (one-sided comparison).

n	s^2	ν	t-alpha	t-beta	change
2	134	2	2.9	1.1	46.1
3	134	4	2.1	0.9	29.0
4	134	6	1.9	0.9	23.3
5	134	8	1.9	0.9	20.1
6	134	10	1.8	0.9	18.0
7	134	12	1.8	0.9	16.4
8	134	14	1.8	0.9	15.2
9	134	16	1.7	0.9	14.2
10	134	18	1.7	0.9	13.4

Baseline data for comparison

To use as a baseline for comparison with future years, macroinvertebrate, diatom, and water chemistry samples were collected from three sites on the Selway River and six on the Middle Fork of the Salmon River in the fall of 2000 (see Tables 2, 3, and Figures 3 and 4). IDEQ also sampled three tributaries of the Selway and six of the Middle Fork of the Salmon. IDEQ collected fish data for the tributaries, but not for the larger river sites. IDEQ is not set-up to sample fish on large rivers, thus, IDEQ will rely on data from several outside sources (Idaho Department of Fish and Game, Bonneville Power

Administration, and others) This data will be used in calculation of the River and Stream Fish Index.

Summary

IDEQ believes it is possible to monitor water quality in wilderness settings in a short time frame at reasonable costs. We also believe it is possible to describe current water quality conditions in the Selway and Middle Fork of the Salmon River and key tributaries using data and information collected in 2000 by IDEQ and from other entities collected previous to 2000. The data thus, described can then be used to set a baseline for water quality. With several years of data, using basic assessment tools and statistical tests, IDEQ believes it is possible to detect a measurable adverse change over time. Measurable means a statistically significant change in a biological index or statistic. A measurable change would indicate a lowering of water quality.

A sampling plan developed by IDEQ would collect a number of biological, chemical and physical water quality parameters at designated ORW's in the Selway and Middle Fork of the Salmon. Data collected/sampled in 2000 would be supplemented by additional samples collected from these same locations in 2001 and 2002. Future monitoring would occur every third year thereafter or as dictated by changing management activities. The data collected at these benchmarked locations would then be the basis for determining measurable change by comparing the results of new monitoring to previous results or baseline. Since these are some of the most pristine waters in the nation there is no "reference" to compare them to, they are the "reference" by definition. Finally, IDEQ believes this monitoring and sampling design provide us with the necessary information and tools to protect and maintain the high water quality occurring in these water bodies.

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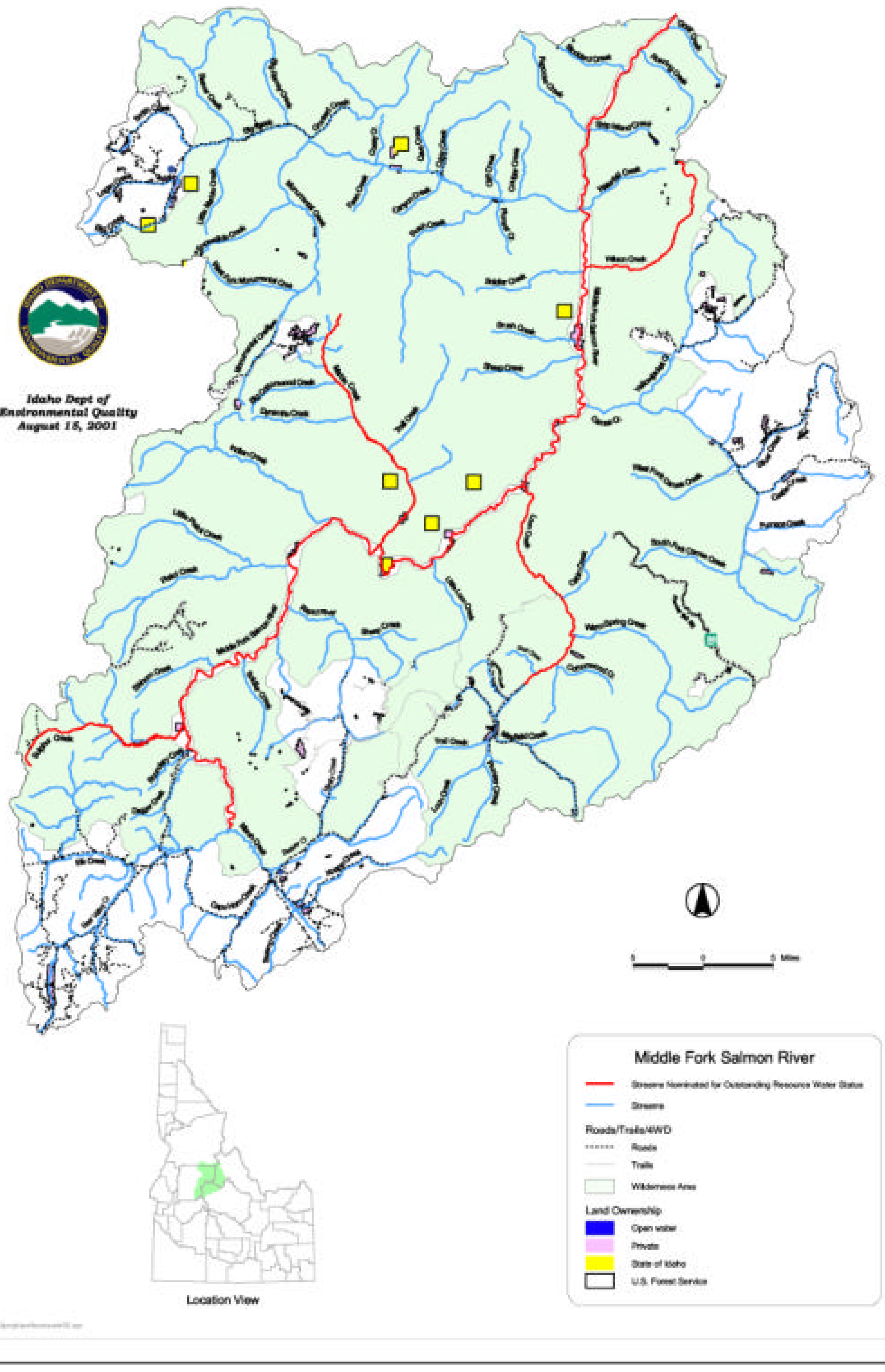
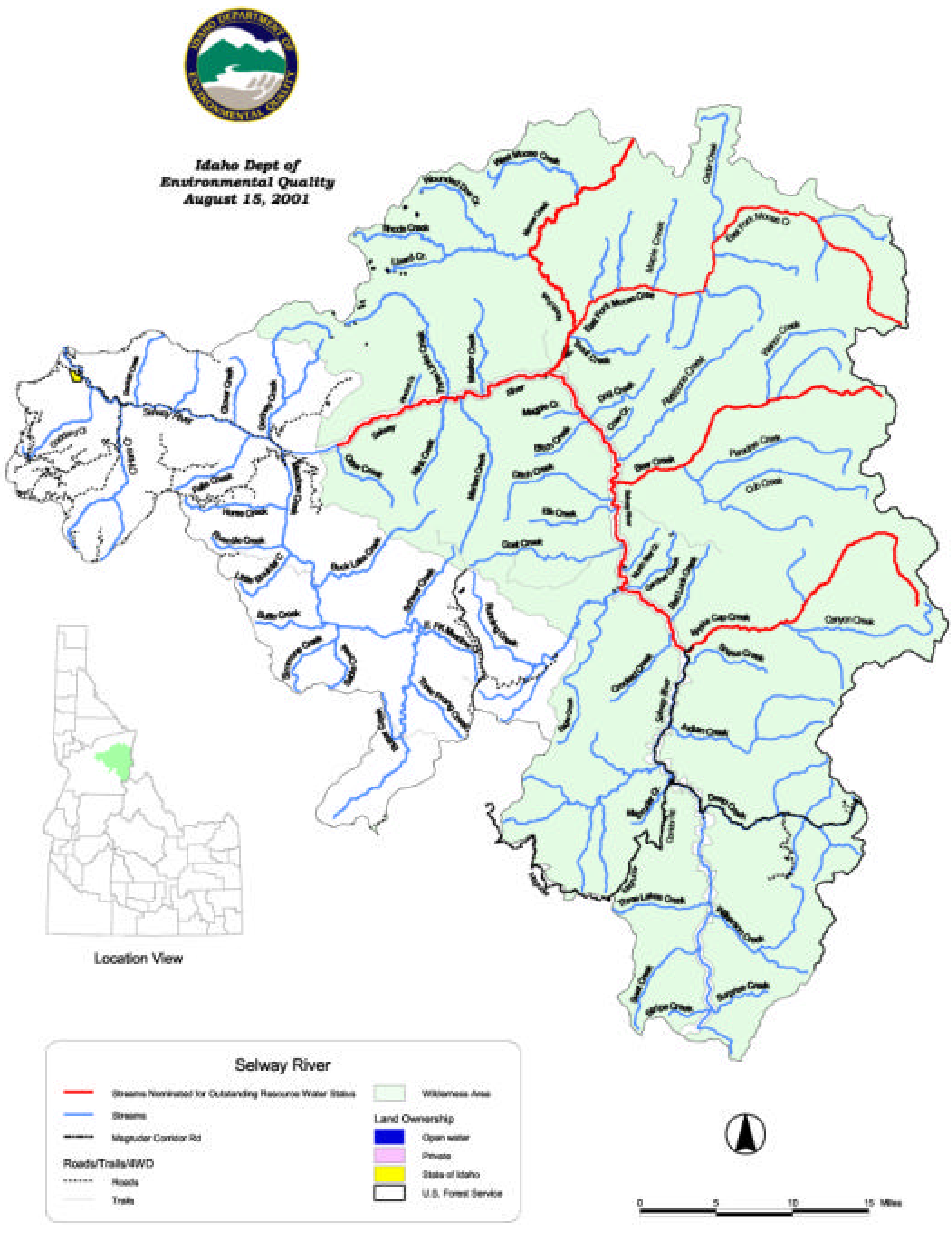
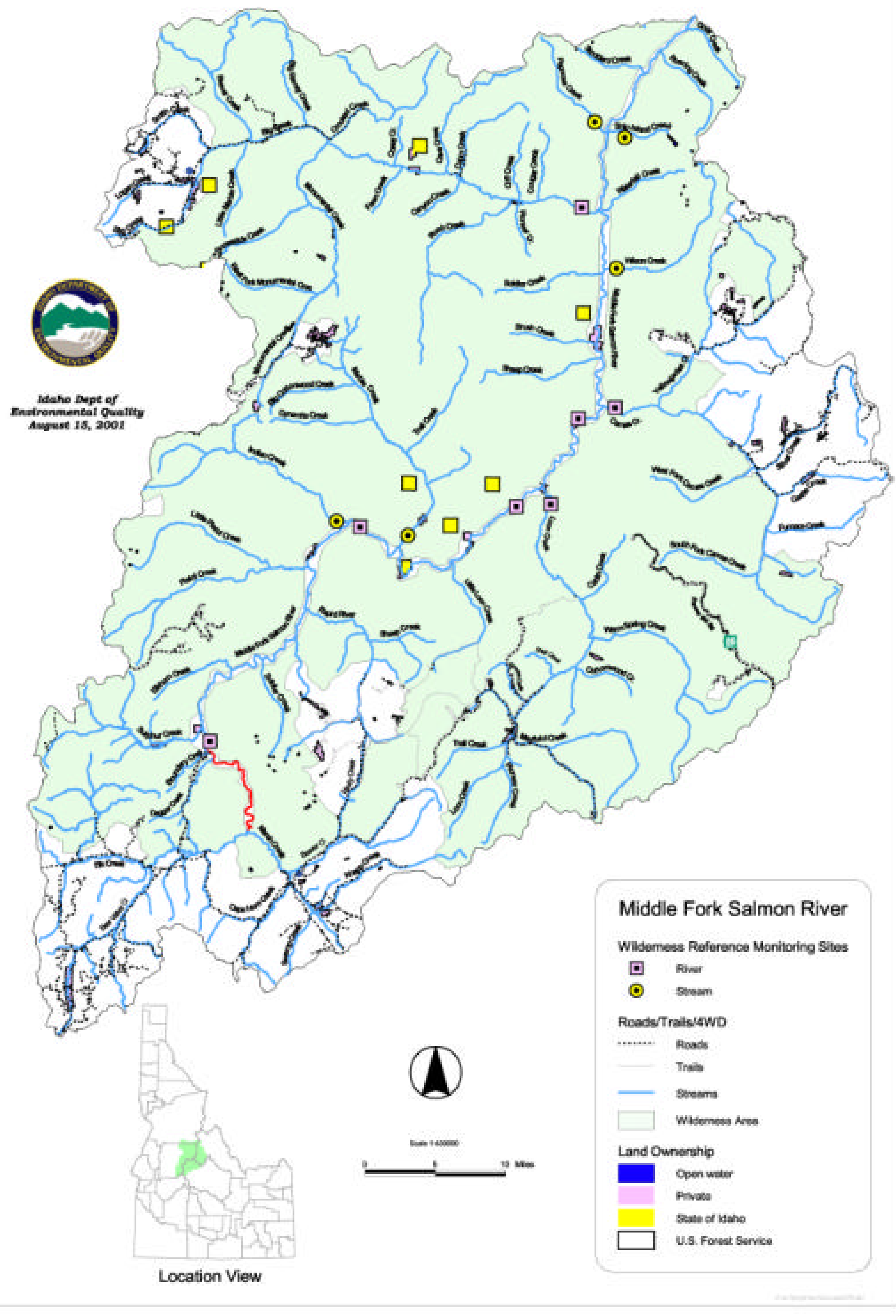
Middle Fork Salmon River with Outstanding Resource Water Nominees



Selway River with Outstanding Resource Water Nominees



Middle Fork Salmon River
Wilderness Reference Monitoring



Selway River
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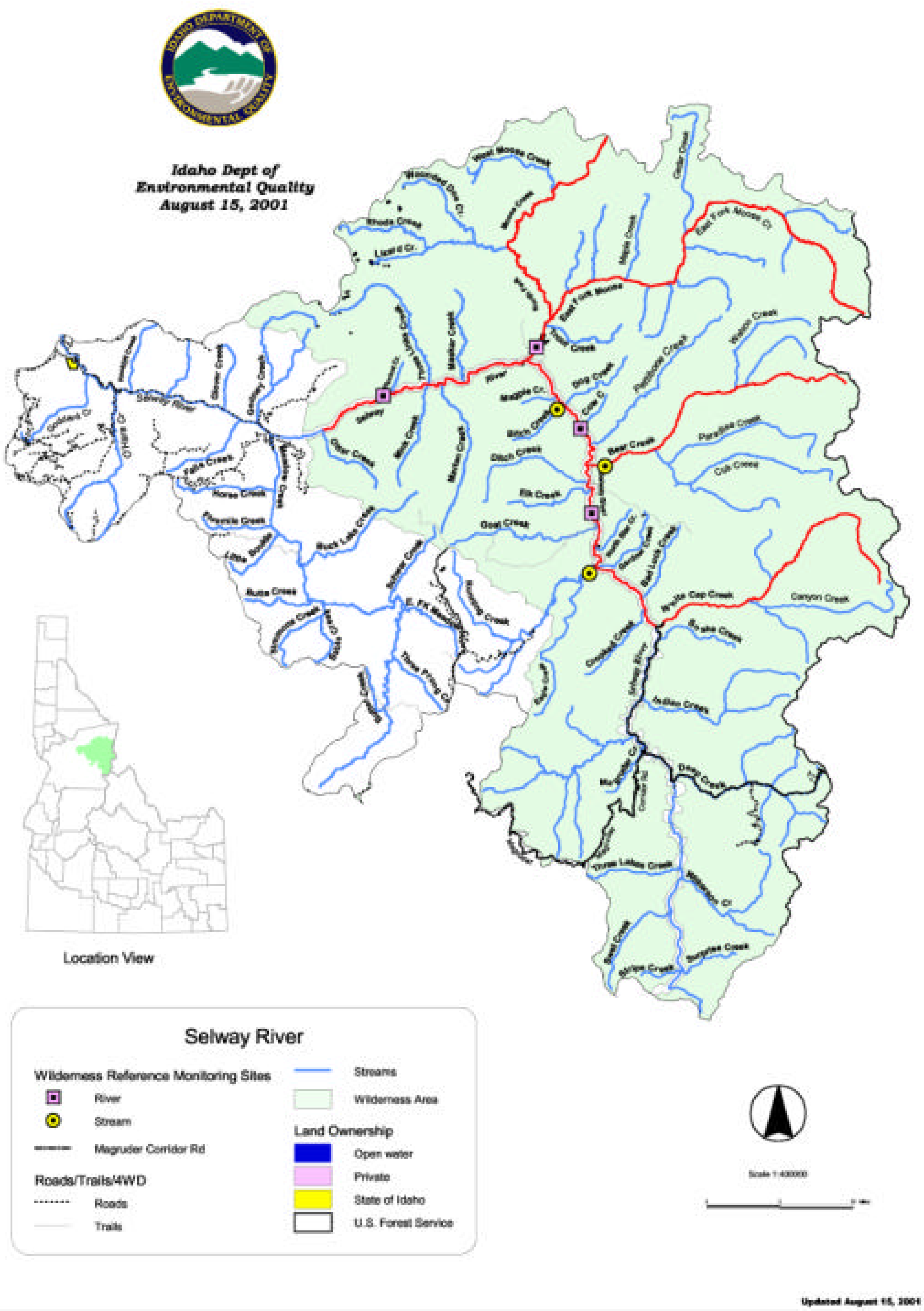

Selway River
Wilderness Reference Monitoring