# A PROPOSAL TO ESTABLISH A MONITORING PROGRAM FOR THE UNIVERSITY OF IDAHO TAYLOR RANCH FACILITY AND THE ADJACENT FRANK CHURCH RIVER-OF-NO-RETURN WILDERNESS

# EXECUTIVE SUMMARY

This proposal reviews approaches to monitoring programs for the environment, describes a representative sample of programs that are in progress, and expands from this base to a monitoring program for the University of Idaho Taylor Ranch facility in the Frank Church River-Of-No-Return Wilderness. A review of existing projects in the Big Creek drainage upon which the Taylor Ranch is located, along with the proposed course of action that would incorporate these projects into the monitoring proposal. The geology, vegetation, fire history, and Indian use within this area is reviewed as the context in which a monitoring program would exist. The value of understanding effects of increased atmospheric carbon dioxide on vegetation and fauna is discussed, with the role that monitoring may help to understand this phenomenon. The budget is purposefully kept low in order to facilitate its perpetuation and to help ensure that the monitoring program could be continued over the long-term. The Taylor Ranch facility has supported a wide variety of projects done by many agencies and individuals over its thirty-year existence. These projects provide the basis for the proposed monitoring program, which would complement and augment educational programs associated with the facility. The monitoring program will in turn provide a background of information that will stimulate formal research projects, and enhance the educational value of the facility.

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# A PROPOSAL TO ESTABLISH A MONITORING PROGRAM FOR THE UNIVERSITY OF IDAHO TAYLOR RANCH FACILITY AND THE ADJACENT FRANK CHURCH RIVER-OF-NO-RETURN WILDERNESS

Aldo Leopold (1941) was among the first to recognize the role of wilderness as a basis for understanding the effects of humans upon this world. Leopold wrote that two available ‘norms’ existed where a “base-datum” of how “healthy land maintains itself as an organism” could be obtained. These areas were lands that remained relatively natural despite centuries of human occupation, and areas where land was wilderness. While many view the value of the nation’s wilderness areas as primarily recreational, Leopold recognized that the principle value was scientific, to serve as a basis for judging man’s effects on similar areas elsewhere. The scientific value was further recognized with the establishment of the Man and the Biosphere Program (Risser and Cornelison 1979), that has designated ecological reserves across the nation and the world for the purpose of preserving representative ecosystems and to provide opportunities for study. Arcese and Sinclair (1997) considered ecological baselines essential for reconciling arguments about maintenance of biological diversity, natural state of biotic communities and ecosystems, and the range of variation that will be observed in them in the absence of human intervention.

Davis and Halvorson (1988) considered the national park ecosystems to be “miner’s canaries”, and the concept applies to many areas that are relatively undisturbed by the human presence. Monitoring of these ecosystems could develop standards that may be used to warn of impending environmental change across broader areas. A program for Great Smoky Mountains National Park is in place (Herrmann and Bratton 1977, Peine, Pyle and White 1985). The Channel Islands National Park, California, also has a monitoring and inventory program (Davis and Halvorson 1988).

The large reserves managed by the US Department of Energy and the Department of Defense are also suitable places for monitoring. A monitoring program was developed for the Hanford Site near Richland, Washington, managed by the Department of Energy (1996). Research natural areas in the northwestern states are also recognized as suitable for long-term monitoring programs (Johnson, Franklin and Krebill 1984). And Vora (1997) reported the development of a program to monitor ecosystems on the lake states national forests. There is obviously extensive interest by all federal land management agencies in monitoring.

Today, wild lands, including wilderness ecosystems, are threatened by excessive recreational use, fire suppression where fires were naturally important processes, invasion of alien plant species, various uses of waters which flow through wilderness, air pollutants, and management of adjacent lands that affects the integrity of the wilderness system (Cole and Landres 1996, Society of American Foresters 1988). However, these areas still provide as close an approximation to that “base datum” as exists in the contiguous United States. Wilderness areas have been established in national parks, national wildlife refuges, the national forests, and public lands administered by Bureau of Land Management.

As the search for better understanding of man’s effects on the natural world continues, the value of larger units of land that are intact and encompass the range of biodiversity and dynamic processes that exist at many scales becomes more clear. Likens (1992) defined ecosystems as units of land that include all organisms and components of the abiotic environment within the boundaries. This means that, ideally, all organisms that are native to the unit are present, soils and watersheds are intact, and all are functioning within some dynamic range that occurred in the absence of human interference. In order for the functioning to occur within a unit of land, the ranges of all animals should ideally be within the wilderness. In North America, these conditions may exist, except for migratory birds and insects, in a few areas. For instance, Peek (1990) proposed that the ranges of populations of the largest mammals could be used to index ecosystem boundaries in the Rocky Mountain west, and could include the grizzly bear and the elk.

Five independent factors that determine ecosystem processes include parent material, climate, topography, potential biota, and time (Jenny 1941). Chapin et al. (1996) extended this to include dynamic elements including local climate, soil resource supply (productivity), functional groups of organisms, and disturbance regime. These interactive factors both control and respond to ecosystem characteristics, and must be conserved if an ecosystem is to be sustained. In the Rocky Mountain wilderness areas, disturbance regimes, primarily the wild fire regime, and lack of major predators, a primary functional group of organisms, are among the major alterations of the associated ecosystems.

Few national parks or wilderness areas are complete, self-contained ecological units (Houston 1971). For instance, the Greater Yellowstone Ecosystem that includes Yellowstone National Park, comprises 14,000,000 acres. This areas has been substantially modified by many actions, including supplemental feeding of migratory elk in winter (Chapin et al. 1996), presence of major towns such as Jackson, Wyoming, that encourage and incorporate significant recreational installations including ski resorts, emphasis on recreational opportunities inside the Park itself, modification of elk migration and movement patterns through differential hunting pressures on the southern portions of the ecosystem (Smith and Robbins 1994), all of which modify dynamic processes.

Christensen et al. (1996) concluded that our ignorance of the dynamic processes that operate over wide ranges of spatial and temporal scales allowed designation of boundaries of management jurisdictions without considering these processes. For example, the biosphere reserves of the northwestern United States are too small to include major dynamic processes. However, in spite of this original lack of perception, some areas are relatively intact and large enough to permit natural dynamic processes to prevail. A prime example of this fortuitous designation is The Frank Church-River-of-No Return Wilderness in central Idaho, consisting of 2,361,767 acres, the largest protected area in the contiguous United States (The Wilderness Society 1989, Figure 1).

## II. DESIGN OF MONITORING PROGRAMS

Silsbee and Peterson (1992) provided reasons for monitoring programs which have general value, and various legal requirements may also provide ample justification. Simply providing information to document changes for the sake of familiarity with resources is useful, as is attainment of knowledge to obtain better understanding of the ecosystem involved. Monitoring to determine alterations to sites or habitats by human activity allows managers to make better decisions, and can provide background information that is needed by researchers and others. The reference point to which other areas may be compared is another reason for monitoring, just as Leopold (1941) recognized.

Selection of attributes for study requires understanding the values of the area and the purpose for which it is used. Attributes need to be measured accurately, easily and cheaply if at all possible, since funding for long-term collections of information must be assumed to be scarce. Sites for inventory and monitoring should be selected for their significance, should be representative of other areas, and chosen in a random manner to allow statistical inferences to be drawn from observations.

Davis and Halvorson (1988) considered the design of an ecological monitoring program to have five basic steps:

1. Determine what, where, when, and how to monitor;
2. Establish data management procedures;
3. Establish reporting procedures;
4. Document monitoring protocols;
5. Implement and institutionalize monitoring.

It is obviously not possible to monitor all species or species assemblages, much less other ecosystem attributes. However, Davis and Halvorson (1998) provided criteria for developing monitoring programs that included:

1. An array of ecological roles and examples of different trophic levels and life forms;
2. Species with special legal status such as endangered, threatened, or species of special concern;
3. Endemic and alien species;
4. Harvested species;
5. Keystone species which dominate or characterize entire communities;
6. Others with special public interest.

Garton (1984) outlined a baseline inventory for research natural areas that considered cost and time constraints. A cost-efficiency rating of methods to assess topographic, soil, geological, climate, vegetatal, and faunal attributes was provided. For instance, monitoring of terrestrial vegetation may consist of photo interpretation, the least intensive method, to mapping of plant communities on the ground, the most intensive attribute. Monitoring of terrestrial fauna may range from simple determination of a species' presence to survival/fecundity estimates, the most expensive and time consuming attribute. Decisions about which assessment will be applicable in any given area will depend upon the assessed value of the information and will vary considerably.

Indicators for monitoring biodiversity should be sufficiently sensitive to provide an early warning of change. They should be distributed over a broad geographical area and otherwise widely applicable, capable of providing a continuous assessment over a wide range of stressors. Logistical considerations are critical and indicators should be easy and cost effective to measure, collect, assay and calculate, capable of differentiating between natural and anthropogenic causes, and be ecologically significant (Noss 1990). At the landscape level, aerial photographs and other remote sensing systems can provide information on distribution and size of habitats. Time series analyses can be used to detect changes within communities and habitats. Censuses may provide assessments of population trend, while the more elaborate genetic analyses which may detect rates of gene flow and inbreeding depression may be used to assess genetic diversity. Noss (1990) provided a ten-step process for implementation a monitoring system including:

1. Determination of goals and objectives;
2. Gathering and integration of existing data sets;
3. Establishing baseline conditions;
4. Identification of ecosystems and localized areas at risk;
5. Formulation of questions to be answered by monitoring;
6. Selection of indicators;
7. Identification of control areas and treatments;
8. Design and implementation of a monitoring program;
9. Validation of relationships between indicator and goals and objectives;
10. Analysis of trends and recommendations of management actions.

Monitoring programs on public lands have been active in various configurations for extensive periods. Land management agencies have conducted condition-trend surveys and forest inventories since the 1950s, and in some cases even earlier. The US Fish & Wildlife Service has maintained a long-term monitoring program for migratory birds since 1956, and bird populations have been monitored through mid-winter counts by numerous cooperators since 1965 (Robbins et al. 1986, 1992). Many state wildlife agencies have conducted census and production-survival estimates of big game populations and other hunted species, with some records extending back some 50 years. These data sets provide useful information in assessing long-term trends in species distribution and population size, and could be incorporated wherever possible into ecosystem monitoring. Legal requirements to monitor endangered and threatened species also provide data sets of value in monitoring. Vora (1997) listed 15 organizations that are conducting national monitoring programs in Canada and the United States, some of which occur on both public and private lands, and involve the public as well as professionals.

## III. THREE EXAMPLES OF MONITORING PROGRAMS

The Great Smoky Mountains National Park monitoring system involves use of maps and aerial photography and satellite imagery, a geologic survey, soil survey, data on the hydrologic regime, climate and weather records, and check lists of vascular plant, vertebrate species, descriptions of watersheds including trout populations which are sampled on a 7-year interval, vegetation maps and human history (Herrman and Bratton 1977). In addition black bear populations have been monitored in the park since 1966 (Pelton and Van Manen 1996). The situation where a formalized monitoring program may be augmented by long-term research on specific species or situations can be capitalized upon.

The Arid Lands Ecological Reserve in south-central Washington Site provides an example of monitoring that was developed in conjunction with The Nature Conservancy. The approach was to define four levels of concern at which management actions would take place. A species list for the site is examined and the entire known flora and fauna are then classified into these levels. Level I biological recourses are those that require minimum status monitoring because of their recreational, commercial or ecological role. Mule deer and elk are species representative of this level. Level II resources are those that require legal consideration through laws such as NEPA or the Migratory Bird Treaty Act, when any activities on the Hanford Site are contemplated. Level III resources are those that are either listed by the state or federal jurisdictions and have unique or significant values or are considered to be particularly sensitive to environmental change and may require mitigation when activities are undertaken, or may preclude conducting those activities. The sage sparrow is an example of a level III species because it requires shrub-steppe habitat that has been reduced by 85-98% of its original area in Washington and Oregon since European settlement (Noss et al. 1995). Ferruginous hawk nest sites and bald eagle perches also fit into this level at Hanford. Level IV resources are those that require preservation as the primary management option because of federal legal status or regional and national significance and thus preclude activities that might jeopardize their continued existence on the Site. The fall chinook salmon is classified as endangered and thus is a Level IV classification. A GIS system is used to incorporate inventory data along with cover map of the site. The land cover map is the base map that provides the primary reference for establishing location and importance of the biota for the Site and may be referred to whenever activities are planned.

An ecosystem monitoring program for the national forests in the Lake States uses key indicators of ecological processes and biological diversity, focusing on plants and birds (Vora 1997). Using the Noss (1990) criteria as a general guide, a program for a portion of the Superior National Forest included protection of rare species habitats and rare ecosystems by checking these areas for integrity and evidence of degradation. Population trends of a few indicators including owls and woodpeckers, brook trout, ruffed grouse and large mammals (deer, moose, black bear) are obtained with the cooperation of Minnesota Dept of Natural Resources. Evaluations of controversial management practices such as use of prescribed fire to increase blueberry production is included in the monitoring program. Long-term regional monitoring programs which include assessment of reforestation, forest insect populations, changes in forest cover and reproduction of the common loon are incorporated into the monitoring program by participation with these efforts. A few long-term programs to monitor trends of a rare butterfly and use of mixed species tree and shrub plantations by neotropical migrants are added. Finally, monitoring is incorporated into other maintenance and field activities by checking use of nest boxes, evaluating success of wild rice seedings and checking reserve trees left in clearcuts.

A wide variety of programs and approaches are available for monitoring. The objectives of the agency, purposes for which the land is being managed, interests and availability of personnel, and nature of the area under consideration will all affect the nature of the monitoring effort in any given area. Each of the monitoring programs reviewed have different objectives and approaches, but all would provide inventories of important resources through time that would provide highly useful information.

Scott (1998) recommended that monitoring to estimate change in forests be done with permanently established plots on a 5-20 year cycle. Shorter survey cycles may be necessary when judging human influences on resources, but also if major events necessitate that monitoring take place more frequently, as may happen when fires occur. In situations where dramtic change may occur, as is likely in wilderness where forests are subject to fire, insect and pathogen influences, permanent plots appear to be the best approach for measuring attributes of vegetation change in forests.

Monitoring for productivity of shrubs and grasses may be done annually, and has been conducted since 1987 in the vicinity of the Taylor Ranch. Permanently established transects along which vegetation is clipped, counted or measured are in place. A 4 $m^2$ circular plot is used to measure shrubby vegetation and a 2 X 5 dm plot is used in grasslands. Sample sizes have been checked by analyzing change in mean and variance as sample size increases: 20 plots represent a compromise between logistical constraints and statistical reliability for shrubs and grasses using these plot sizes in this area.

## IV. TAYLOR RANCH FACILITY

Taylor Ranch Field Station comprises 65 acres located within the Frank Church River-Of-No-Return Wilderness, approximately 35 miles from the nearest trail head and 7 miles from the confluence of Big Creek with the Middle Fork (Figure 1). Hendee et al. (1993) provide a history of the Taylor Ranch. The University of Idaho acquired the ranch in 1969 from Jess Taylor, an outfitter. The site was originally homesteaded in 1900, with Taylor acquiring it in 1934.

The Taylor Ranch field station is intended to facilitate and support research and educational programs that are appropriate for the wilderness setting and that lead to better understanding of this ecosystem. The facility has a U.S. Weather Service reporting station with over 18 years of daily weather records and an automated solar-powered meteorological station that measures temperature, precipitation, wind speed and direction, relative humidity, barometric pressure, and solar radiation. A field laboratory with herbarium, computers, microscopes, pH meter, water filtration equipment, field sampling equipment, maps and aerial photographs is in place. A geographic information system that includes the FCRNRW is available on the University of Idaho campus.

Taylor Ranch is staffed year long with managers. Taylor Ranch is accessible by trail during snow-free months and, with its own private 750 m long airstrip, by light plane yearlong. Mail and groceries are delivered weekly by plane. Housing is available for up to 20 people. Scientists and students have three kitchens equipped with stoves, ovens and refrigerators available. A laboratory-classroom and cookhouse are suitable for group gatherings indoors. The laboratory is equipped with microscopes, glassware, reference collections of plants and animals, maps and aerial photos, basic field equipment such as binoculars, spotting scopes, sample containers, plot frames, etc. A tool shop equipped with hand tools suitable for use in wilderness and some electrical equipment is present. Pack and saddle stock are available for transportation of personnel and equipment to remote sites. A micro-hydroelectric system driven by water was recently installed to provide electricity for the facility. Radio and satellite telephone provide reliable communications.

## V. THE FRANK CHURCH RIVER-OF-NO-RETURN WILDERNESS

The Wilderness encompasses most of the Middle Fork of the Salmon River and its major tributaries, including Big Creek, draining a 360,000 acre area eastward to the Middle Fork (Figure 1). The FCRNRW is a very rugged mountainous region, drained primarily by the Middle Fork of the Salmon River and its tributaries. Elevations range from less than 600 meters to over 3,000 meters. Soils in the region are primarily derived from granitic Idaho batholith parent material. This batholith formed during the Cretaceous period over 55 million years ago. Shallow, coarse soils, interspersed with granitic outcroppings, characterize the ridges (Larson and Lovely 1972). Tisdale (1969) reported the major soil type as brown podzol, revised from Ross and Savage (1967).

On the southeastern portions of the range, Challis volcanics of tertiary age constitute the predominant formation (Ross 1937). The major portion of the area is composed of latite and andesite flows and flow breccia. Some of the area is underlain by Germer tuffaceous material, that is the result of explosive volcanic ash showers. Soils derived from the Challis Volcanics are generally very fertile (Ralm and Larson 1972).

Approximately two-thirds of the FCRNRW has recent geologic map coverage that requires compilation work, but coverage is poor in the lower Big Creek area. The Taylor Ranch area has a highly complex geological pattern, with at least three formations present, including Challis volcanics and batholith formations (Reed Lewis, Idaho Geological Survey, pers. comm. 1995). However, the available surveys conducted by Idaho Geological Survey and US Geological Survey are not supported with adequate field mapping in this area because access is so difficult (Lewis op. cit.).

Climate of the FCRNRW was described by Finklin (l988). Weather stations at Challis (5175 feet above mean sea level), Middle Fork Lodge (4480 feet), Taylor Ranch (3835 feet), and Campbell's Ferry (2310 feet, now at Yellowpine Bar) provide an indication of the variation in temperature and precipitation. Generally, a decrease in precipitation from west to east occurs. Campbell's Ferry on the main Salmon River averaged 24 inches, Taylor Ranch 15 inches, Middle Fork Lodge 17 inches, and Challis 7 inches annually. Thus the station with the lowest elevation, Campbell's Ferry, had the highest precipitation, while the highest station, Challis, had the least precipitation. The Salmon River and its South Fork lie within a 20-30 inch rainfall belt, the Middle Fork in a 10-20 inch belt, and the valleys containing the towns of Challis and Salmon lie in a rainfall belt of 10 inches or less (Finklin 1988). Riggins, Idaho, on the extreme western side of the region at 1800 feet msl, has 17 inches of annual precipitation, and that portion of the Salmon River around Riggins lies within a 15-20 inch rainfall belt, reflecting the lower elevation and the very deep canyon country of this area.

Approximately 50% of the precipitation comes during November through March, with December and January being the highest months, except in the eastern canyonlands where May and June are the wettest months. Annual snowfall averages 20 inches at Challis, 54 inches at Middle Fork Lodge, 47 inches at Taylor Ranch, and 73 inches at Campbell's Ferry.

Temperatures also show a gradient between the various portions of the study area, although they are not as pronounced as the moisture gradient. Challis has the lowest mean minimum temperature in January at 10.5$^0$F., followed by Middle Fork Lodge (13$^0$F), Taylor Ranch (14$^0$F) and Campbell's Ferry (19$^0$F). Average maximum July temperatures are 86.5$^0$F at Challis, 86.5$^0$F at Middle Fork Lodge, 87$^0$F. at Taylor Ranch, and 92$^0$F at Campbell's Ferry.

The pattern is a slightly warmer, wetter climate on the northwest portion of the region and a slightly drier, cooler climate on the eastern side. Likely, the Pacific Ocean fronts which move up the Columbia River system commonly invade the Salmon River Canyon at least up to its confluence with the Middle Fork and also into the South Fork, influence weather patterns. The eastern rangelands are located within a rain shadow and are more influenced by interior continental weather patterns.

Shrub-steppe vegetation in this region has been described by Hironaka et al.(1983), Mueggler and Stewart ( 1980), Tisdale (1986) and Peek et al. (2005). The sagebrush-grassland habitat types reported by Hironaka et al. (1983) for southern Idaho extend into the mountain rangelands of this region. Of 32 habitat types identified, 18 were dominated by bluebunch wheatgrass and/or Idaho fescue, and/or by the various subspecies of big sagebrush. Bitterbrush, mountain mahogany, threetip sagebrush, and dwarf sagebrush were components of other habitat types.

Tisdale (1986) reported on the canyon grasslands along the Snake River, Clearwater River, and lower Salmon River up to 20 miles east of Riggins, immediately adjacent to the FCRNRW. These plant communities are within the Pacific Northwest Bunchgrass Region, that is predominantly underlain by basalt with surface deposits of volcanic ash, a fertile substrate when compared with the decomposed granites of the Idaho Batholith that characterize much of the mountain grasslands in our study area. Tisdale (1986) described 8 grassland habitat types of which 5 were dominated by bluebunch wheatgrass and/or Idaho fescue. Shrub dominated communities included common snowberry and mountain mahogany, but big sagebrush was absent. Hironaka et al. (1983) speculated that the extensive cloudy periods characteristic of this region in winter prevented the nondeciduous sagebrushes from photosynthesizing sufficiently to persist, based on experimental evidence developed by Pearson (1975). Tisdale (1986) described an Idaho fescue-sedge dominated habitat type which extends into the FCRNRW.

Mueggler and Stewart (1980) described 29 habitat types for mountain rangelands of western Montana, including 22 dominated by Idaho fescue and/or bluebunch wheatgrass. Again, big sagebrush, threetip sagebrush, bitterbrush, dwarf sagebrush, and mountain mahogany were associated dominant species.

These investigations of vegetation adjacent to the central Idaho mountain rangelands have several attributes in common. First, bluebunch wheatgrass and Idaho fescue consistently occur as dominants on appropriate sites throughout the broader region encompassed by these investigations. Big sagebrush and bitterbrush also have broad distributions, although both are absent from the low elevations of the lower Salmon River and Snake River region, even as they both reappear north of these low canyons and west of the Palouse Prairie region in Washington. Needle-and-thread grass is well distributed throughout the region on drier sites, but may be represented on disturbed sites on habitat types dominated by other species.

There is a gradient of vegetation distributed from the Pacific Northwest bunchgrasses to the Great Plains shortgrasses to the arid Great Basin shrub-steppe that has representative species within the intermountain region. The occurrence of blue grama in western Montana indicates a Great Plains influence, while the sagebrushes and mountain mahogany suggests Great Basin influence . The bunchgrasses may indicate the Pacific Northwest influence, while rough fescue, distributed northerly along the eastern front of the Rocky Mountains into Canada, suggests influence from the northerly region.

The permanency of this vegetation complex is a consideration. Tisdale (1986) considered the grassland types of the lower Salmon-Snake River region to be highly stable and not likely to change without a major climatic change. However, the shrub communities appeared to be responsive to changes in fire and grazing regimes. Mountain mahogany and common snowberry may have increased their range in the absence of fire, and short-term climatic change may also make the shrub complex more responsive when environmental conditions change. However, Johnson (1986) concluded from an examination of vegetative change across the western range that changes in the sagebrush complex were site-specific and related to kind of use and site characteristics. Generally there has been no major shift in sagebrush distribution as a result of use, and the distribution of sage over a 115 year period was essentially the same.

Gruell (1983), Houston (1973), Tisdale et al. (1965) and others provide evidence from undisturbed sites that a general increase in shrubs had occurred across the west. Nevertheless, changes in habitat type require long periods encompassing significant climatic change. An example from Grays Lake, Idaho, approximately 150 miles east from the central Idaho mountains shows dramatic change over a

70,000 year period (Beiswenger 1991). A cold dry sagebrush steppe occurred from 70,000-30,000 Before Present, a conifer woodland from 30,000-11,500 BP, a juniper-forb complex from 11,500-7100 BP. The more recent cooler, moist climate has again produced increases in conifers and decreases in steppe plants. The hypothesis that changes in climate may first be noticed in shrubs seems tenable.

Shrub-steppe community classifications for the Salmon River Mountains, including the FCRNRW, provided by Peek et al. (2005) are tentative. At least 15 different habitat types are present, dominated by various sagebrushes, mountain mahogany, bitterbrush, Idaho fescue, and bluebunch wheatgrass. Three attributes of the vegetation pattern stand out for the region, coinciding with the moisture gradient. First, sagebrush communities are common and well-developed on the southern portions of the area, and become scarce and less well developed along the main Salmon River and in the South Fork. Second, there is a tendency towards a juxtaposition of more mesic habitat types with the counterpart under a sparse Douglas fir or ponderosa pine understory. Thus an Idaho fescue/bluebunch wheatgrass habitat type may be positioned next to a Douglas fir stand with the herbaceous union much the same as without the conifer component. Third, there is an increasingly larger component of forbs in the communities of the same habitat type along the southeast to northwest gradient. Appendix I provides a provisional key to the shrub-steppe communities.

Fifty-one forest habitat types were identified by Steele et al. (1981). Whitebark pine, ponderosa pine, Douglas fir, Englemann spruce, grand fir, subalpine fir, and lodgepole pine communities are present. A zone of lightning-caused fires extends across the northern edge of the FCRNRW along the Salmon River which has more fires than elsewhere in the central Idaho region or the rest of Idaho and Montana. The western portions also have a higher frequency of stand-replacing fires than the eastern portions. These patterns are related to the precipitation pattern in the region. Nevertheless, major fires have occurred in the past decade have occurred across the FCRNRW, including the 1991 Rush Creek Fire of 8487 acres, just above the Taylor Ranch (Figure 2). Appendix II provides the key to the forest communities in the region, excerpted from Steele et al. (1981).

There are highly unique habitat types in this area that may be especially important to monitor through time. A Douglas fir/mountain mahogany type represents a dominant conifer that evolved in fire-dominated habitats and a major understory species which is highly fire intolerant. Such sites likely represent a tension zone wherein the Douglas fir will be favored during more moist conditions and the mountain mahogany will be favored during droughty conditions. Over a 12-year period, seedlings of both species have been observed within these communities, but at different periods, leading to this interpretation. Again, this suggests a high sensitivity of at least some plants and plant communities to the wide variation in precipitation patterns that are characteristic of this region, and lends support to the thesis that the area may serve to provide information on long-term environmental change in the absence of local human interference.

Upper Big Creek is in a mining district that is occasionally active. The Payette National forest has been monitoring sediment trends in streams within the Big Creek drainage since 1983 (Nelson et al.1996). Water quality problems that have resulted from these dispersed mining operations include accumulations of heavy metals in sediments and fish. Cobble embeddedness is measured by placing a 60 cm hoop randomly within a stream site that approximates juvenile salmonid rearing areas and measuring the proportion of particles with maximum diameter >45 cm, < than 300 mm, and fines <6.3 mm in the hoop. Variable trends in cobble embeddedness in Monumental Creek were apparent from the 1983- 1995 period. Mitigation measures have lead to improvements in recent years, but the effects of mining remain evident. Ries et al. (1991) concluded that adverse effects on fish habitat of mining in the 1980s generally improved, which was supported by Nelson et al. (1996).

## VI. RELEVANCE OF RESEARCH IN WILDERNESS TO UNDERSTANDING GLOBAL CHANGE

Vitousek (1994) pointed out that while ecologists are often advised to learn to deal with uncertainty, it is certain that a number of components of the environment are changing and the change is human-caused. Increasing concentrations of carbon dioxide in the atmosphere, alterations in the biogeochemistry of the global nitrogen cycle and ongoing land use changes are well documented, if still controversial (Idso 1998). Land use changes in wilderness are largely discounted, but increases in atmospheric carbon dioxide and alteration of carbon and nitrogen cycles are expected to affect plant communities. Most of the increase in $CO_2$ is attributable to fossil fuel combustion rather than deforestation.

Photosynthetic rates of many plants in natural ecosystems may be enhanced by increased carbon dioxide concentrations (Bazzaz 1990). In other plants there appears to be little response, and in other cases plants grown in elevated $CO_2$ levels show a decline in photosynthetic rates. St. Omer and Horvath (1983) reported that 4 California native winter annuals varied in their ability to persist at elevated $CO_2$ levels. Bazzaz (1990) concluded from his review that rising $CO_2$ levels may enhance photosynthesis and growth, increase allocation of biomass to underground plant parts, and enhance water use efficiency, and that $CO_2$ interacts strongly with nutrients and temperature, among other environmental variables. Coughenour and Chen (1997) also reported that increased temperatures interacted with increased $CO_2$ levels in grasses. Responses of individual species may be highly variable (Strain 1969, Marshall and Zhang (1994) which may in turn eventually alter community composition. Lindroth et al. (1993) reported that aspen stored more starch at elevated atmospheric $CO_2$ while maple stored more defensive carbon compounds. Long and Hutchin (1991) concluded that there was insufficient information to predict responses of primary production to climate change, but there is obviously a substantial amount of effort being directed at the ecological effects of climate change.

While grazing changes and fire prevention are generally held responsible for changes in forest and shrub-steppe plant composition across the arid West (Madany and West 1983, Martin and Turner 1977, Gruell 1983, Austin and Urness 1998), this may also be related to the effects of rising atmospheric $CO_2$ as this affects photosynthesis, respiration, and growth of plants. Peek (Long-term rangeland vegetation trend, Middle Fork Salmon River Idaho, in Proceedings Wilderness Science in a Time of Change, Missoula, Montana, May 1999) provided evidence of declines in shrubs in several plant communities across the FCRNRW based on examination of exclosures and adjacent stands. Current fire management policies that allow fires to burn under most circumstances in this wilderness (US Forest Service 1998) could eventually eliminate the effects of past fire suppression. Grazing, primarily pack and riding stock, is now concentrated around a few inholdings and is regulated to reduce effects on plant communities. There is evidence of the effects of past grazing influences on vegetation in some areas such as the Cabin Creek area where there was a major human presence in the recent past, but much of this area is now without the influence of grazing. Also, exotic species such as knapweed (Centaurea maculosa) are invading some areas which have not been grazed appreciably in the last half-century, but thus far the presence of these aggressive invaders is localized. If fire suppression and livestock grazing have been the major influences that humans have had on these communities, then current policy which eliminates or dramatically reduces these influences means that there are substantial opportunities to investigate systems to detect natural change or climate-induced change. Evidence of change may be detected in trends in productivity of dominant plants over time. Lindroth et al (1993) reported that elevated $CO_2$ atmospheres predicted for the next century which have measurable changes for individual plant species will affect community structure and nutrient cycling on a broader level. Polley (1997) reported that transition zones between grasslands and forest may be among the initial areas experiencing species change as $CO_2$ rises or climate changes, and that trees and shrubs may increase at the expense of grasses. Among the herbivorous species, Post et al. (1997) concluded that recent trends of increasingly warm winters in northern Europe and Scandinavia would lead to reduce body size and fecundity of red deer (Cervus elaphus). If this is an indication of how global warming may affect ungulates, then interactions between predator and prey as well as between prey and forage may be affected. The opportunity to assess trends in plant and animal communities in a relatively intact ecosystem of large size where other human intrusion is minimized could materially help to understand effects of global changes in the northern Rocky Mountain region.

## VII. PAST RESEARCH IN AREA

A variety of studies have been conducted from the Taylor Ranch (Appendix III) and in the Big Creek drainage. The sampling reviewed here illustrates the value of the work for both understanding wilderness ecosystems and for application to other aspects of resource management. Work in 1964 was initiated on the mountain lion (Hornocker 1970). This work identified the social system and intrinsic regulatory mechanisms involving territoriality and land tenure which provides fundamental information needed to manage and conserve this species and other solitary cats (Hornocker and Bailey 1986). It was through this work that the mountain lion was designated a game animal in Idaho (Hornocker 1971). Subsequently, this species was designated a game animal in most states and provinces that maintain populations, and an orderly regulated harvest was then established. The population was again monitored during a 4-winter period from 1983-84 to 1986-87 (Quigley et al. 1989). A total of 13 individuals were considered resident, 3 males and 10 females in the original study area from the mouth of Big Creek to Monumental Creek. This compared with the earlier estimates of 9 residents, including 3 males and 4 to 6 females. The increase appeared to be a numerical response to a one-third increase in elk. A reduction in female home range size likely facilitated the increase.

The bobcat population was investigated during the 1982-85 period by Koehler (1989). Density of this species is low, attributable to limited prey in winter and severe winters. Voles, cottontail rabbits, and ground squirrels comprise most of the diet, with mule deer and bighorn sheep frequently occurring as winter food items for bobcats in this area. While this area is apparently premium habitat for the mountain lion, it is of poorer quality for the smaller bobcat.

Nez Perce Tribe wolf monitoring reports indicate that at least two packs of gray wolves now inhabit the Big Creek drainage. These wolves are part of the introduction that occurred in 1995 in the Middle Fork of the Salmon River. Pups have been produced by each pack, suggesting that permanent home ranges have been established by these packs. Wolves or their sign have been seen on the Taylor Ranch, east of the major elk wintering areas that appear to be the primary winter range for wolves, suggesting that the entire Big Creek drainage is within the range of wolves for a part of the year. As wolves continue to adjust to this area, opportunities to investigate their interactions with other predators, most especially the mountain lion which shares a common prey base, and to examine the effects on prey that are game species are obviously great. Robinson (1953) reported that when exploitation of the predator complement in an area is initiated, very often the larger species that are the focus of control efforts are reduced while smaller species proliferate. The restoration of large predators will likely have consequences for the smaller species in return. Both cougars and wolves are known to kill coyotes and bobcats. Investigations into the relationships of these carnivores were initiated in December 1998 in the Big Creek drainage. An assessment of the effects of combined predation upon big game populations is also ongoing.

Deer, elk, and bighorn sheep populations are monitored by Idaho Department of Fish & Game. Deer populations fluctuate with winter severity, and are the least understood. During the 1960s and 1970s, populations appeared to increase, but appear to have declined since. Elk populations increased in the area until recent years and may now be stable. Calf production and survival has been relatively low in recent years. These monitoring programs are of substantial value in evaluating effects of the introduced wolf and other investigations into habitat and relationships with associated species. For instance, Akenson (1992) concluded that bighorn sheep and mule deer were positively associated in spring while elk and bighorn were less associated at any time of year, but the relationships may change with changes in population sizes. Investigations into what may naturally limit populations in time and space in systems that are relatively intact are few, and this area provides an excellent opportunity to do so.

Mountain sheep populations in the Big Creek drainage have been relatively uninfluenced by man for at least half a century. While exploitation of ewes and lambs by whites occurred in the 1930s and 1940s, hunting has been limited to mature rams since the 1950s. Populations declined during the 1980s from highs around 200 to lows of around 40. Most of the mortality was attributed to disease (Akenson and Akenson 1992). The pathogen Pasturella haemolytica appears to be the proximal factor in most mortality. These dieoffs may be related to external stressors such as the extended drought periods of the late 1980s, coupled with high density populations (Foreyt 1989). An alternative hypothesis is that the dieoffs are internally mediated through changes in tolerance to pathogens as population densities change (Jaworski et al. 1993, Cassirer et al. 1996). While Pasturella haemolytica biotypes T, A1, and A2 found in domestic sheep (Foreyt 1989), the Pasteurella trehalosi biogroup 2 strain Idaho-1 was isolated from this mountain sheep population (Jaworski et al. 1993) and is common in wildlife, having been isolated from Dall sheep, mountain goats, elk, and deer. This provides evidence that the recent dieoff of mountain sheep in central Idaho was not related to prior contact with domestic sheep. If so, this still further implies that mountain sheep in the Big Creek drainage have been relatively uninfluenced by human activity for at least half of this century. The issue is important because influences past and present, within and beyond the wilderness boundaries, do have effects inside those boundaries. Questions as to how intact the ecosystem is, and how to define the ecosystem are raised. While mountain sheep are a highly prized species that receives extensive attention, what influences have we had on other less well-known species in the region?  At this point, it appears that these mountain sheep are naturally regulated. Table 1 shows the population monitoring efforts of Idaho Fish and Game in the Big Creek drainage.

Table 1. Summary of bighorn sheep population data for Big Creek, taken from Idaho Fish & Game Progress Reports, Project W-170-R. No data were taken in 1981, 1983-86, and 1990.

| YEAR | TOTAL | EWES | LAMBS | RAMS | UNCLASSIFIED |
|---|---|---|---|---|---|
| 1973 | 63 | 29 | 6 | 24 | 4 |
| 1974 | 83 | 36 | 22 | 25 | |
| 1975 | 95 | 46 | 23 | 26 | |
| 1976 | 110 | 60 | 13 | 37 | |
| 1977 | 68 | 41 | 9 | 18 | |
| 1978 | 114 | 47 | 43 | 24 | |
| 1979 | 102 | 61 | 19 | 20 | 2 |
| 1980 | 110 | 59 | 9 | 39 | 3 |
| 1982 | 105 | 52 | 20 | 33 | |
| 1987 | 177 | 114 | 19 | 35 | |
| 1988 | 172 | 116 | 18 | 30 | |
| 1989 | 200 | 122 | 19 | 57 | |
| 1991 | 93 | 64 | 4 | 25 | |
| 1992 | 107 | 62 | 20 | 24 | |
| 1993 | 118 | 82 | 13 | 25 | |
| 1994 | 38 | 22 | 1 | 15 | |
| 1995 | 115 | 85 | 7 | 23 | |
| 1996 | 101 | 73 | 9 | 19 | |

Seven forest owl species were investigated during the 1980s by E.O. Garton and G.D. Hayward (see appendix III for references). These owls included the pygmy, saw-whet, boreal, great-horned, and screech owls. The flammulated and long-eared owls were rare. Pygmy owls were food and habitat generalists that preyed more on birds than the other owls did. Flammulated owls specialized on forest moths, saw-whet, boreal, screech, and great-horned owls preferred mammalian prey, and each species selected different sizes of prey or different habitats, thereby minimizing competition. The largest and smallest owl species differed primarily in choice of prey while intermediate-sized owls differed most in habitat use. The boreal owl, characteristic of spruce-fir forests where the primary prey item, the redback vole, was most common, was the subject of more intensive study. With annual adult boreal owl mortality approximating 46%, the population in the Chamberlain Basin that includes the northern headwaters of Big Creek, may be dependent upon immigration from other areas to sustain itself. If this is the case, then there is again evidence that segments of this wilderness ecosystem are dependent upon a much bigger system than expected.

Archeological investigations by Leonhardy (1985) and Thomas (1988) provided a hypothesis as to how Sheepeater Indians existed within the Big Creek drainage. House pit sites within a half of a mile of the Taylor Ranch revealed that mountain sheep were a major food source. The hypothesis developed was that the small bands of Indians moved from one camp site to another as mountain sheep became less available: an optimal foraging strategy was in place. If this hypothesis is correct, then questions about the nature of sustainable use of resources are raised. What lessons do we learn from this situation where aboriginal peoples could not establish permanent camps likely because of a variable supply of resources, that may apply to contemporary resource management strategies for this region?

G. W. Minshall, Stream Ecology Center, Idaho State University, has been collecting information to define the natural range of variation of wilderness streams and to determine the effects of wildfire on streams in the Big Creek drainage. This long-term (20 year) study is defining the recovery sequence for stream communities following wildfire and testing stream ecosystem theory. Environmental, population, and community-level responses have been measured in streams, immediately after fire and over the subsequent 1 to 20 years. In addition, several streams subjected to wildfire 50 years previously have been examined. The research design utilizes comparative approaches that focus on forested watersheds in the Frank Church Wilderness of central Idaho and Yellowstone National Park. The fires on Big Creek partially burned streams that have been sampled. Subtle changes in streams are evidenced, as compared to streams in drainages that were completely burned in the Middle Fork and in Yellowstone. Thirty-two streams within the Big Creek drainage were examined for habitat heterogeneity and benthic macroinvertebrate (insect) assemblages (Minshall and Robinson 1998). Most habitat measures show highest variation within smaller streams suggesting major environmental differences between the smaller and larger streams in Big Creek drainage. Some biota were related with stream size as well. These results in Big Creek are likely more comparable to conditions following prescribed fire, again illustrating the value of research in wilderness. These investigations provide valuable insights into the fundamental processes operating in stream ecosystems, as well as information useful to resource managers concerned with the effects of fire, the establishment of guidelines concerning fire in wilderness areas, and strategies for watershed and stream habitat rehabilitation following fire.

Big Creek is a major spawning area for anadromous and non-anadromous native salmonids. Investigations were initiated as far back as 1941 with surveys of chinook salmon spawning areas and staging pools (Rich 1948). These surveys were duplicated in 1997 to assess influence of human disturbance on anadromous fish habitat in the Snake River Basin (McIntosh et al. unpublished). Chinook redd surveys were initiated in the early 1950s (Hauck 1951). Since 1957, redd counts of index areas which support the largest numbers of redds are conducted annually by Idaho Fish and Game Department employees (Hassemer 1993). In addition, US Forest Service, National Marine Fisheries Service, and the Nez Perce Tribe conduct research and monitoring in the area. Redd and parr counts of Chinook salmon are provided in Appendix IV.

Since 1995, R. Thurow (pers. comm. November 1998) has been investigating chinook salmon redd distribution and potential spawning patches to test the hypothesis that habitat area, quality, or location in relation to other spawning populations strongly influences the occurrence of spawning chinook salmon. This work involves mapping chinook redds and spawning areas in the entire Big Creek drainage, including Cave, Monumental, and Rush Creeks. In addition, Thurow (1982, 83, 84, 85, 87) assessed the distribution and status of wild steelhead, chinook salmon, cutthroat trout, redband trout, and bull trout in the Middle Fork Salmon. This research described the distribution, abundance, genetic structure and habitat preferences of steelhead plus distribution and status of the other salmonids.

Chinook salmon parr collected from lower Big Creek and Rush Creek spawning areas are among the largest of spring-run salmon in the Salmon River (Achord et al. 1996). Parr collected in July and August of 1994 averaged 75 mm long and weighed 5.3 grams, as compared to parr collected in the upper Big Creek drainage which averaged 62 mm long and weighed 3.4 grams on average. The lower Big Creek parr have the highest detection rate at dams along the Snake River as well (Achord et al. 1996). The wild fish that were larger when initially collected and released had a significantly higher rate of detection the following spring and summer than smaller parr. The larger fish also migrate in April and May, earlier than smaller fish. These investigations characterize the migration timing of different wild stocks of chinook in the Snake River drainage, determine how consistent patterns are, and identify environmental factors that influence migration timing.

Mallet (1963) and Bjornn and Mallet (1964) studied the life history and ecology of cutthroat troutin the Middle Fork, including Big Creek. This species is migratory within the drainage, and fish spawning in Big Creek moving to winter in the Middle Fork and the main Salmon River. Appendix IV includes the Idaho Fish and Game snorkel counts of these species in selected transects in Rush Creek and Big Creek.

A twelve-year record of plant production has accumulated in the Taylor Ranch area. Current year's growth of bluebunch wheatgrass, mountain mahogany, bitterbrush, sagebrush, and ninebark is measured at eight sites in late June or early July. These records provide an opportunity to produce correlations with rainfall and temperature. The graph of West Bench grass production illustrates the relationship between April-May-June precipitation and production of bluebunch wheatgrass over an eleven year period. The linear equation explains 62% of the relationship and is highly significant (P=.0022). This site is not subject to extensive grazing by wild ungulates, indicating that spring precipitation may be used to predict production. Continued collection of field data should refine the reliability of the prediction. Plant production is considered to be a fundamental influence on herbivorous species in the area so this work provides useful information for a variety of other investigations.

## VIII. PROPOSED APPROACH TO MONITORING

The above review provides several conclusions concerning the value and merits of using the Taylor Ranch facility as a base for establishing a long-term monitoring program:

(1) monitoring should be tied to educational experiences for students.

(2) the monitoring should be directed at local resources that have relevance to understanding ecosystem processes in the region including beyond the wilderness boundaries,

(3) the monitoring should include resources that are of importance to regional interests,

(4) the topographic diversity of the area which creates high biodiversity offers opportunities to evaluate ecosystem change attributable to increased $CO_2$ levels in the absence of other human influence,

(5) numerous individuals and organizations have accumulated information and demonstrated an interest in one or more resources in the area which should be capitalized upon,

(6) there is evidence of human influences within the wilderness boundary which must be considered in evaluating natural change or $CO_2$- induced change,

(7) interdisciplinary approaches to monitoring are in order.

(8) long-term monitoring must be economical and efficient.

(9) monitoring should provide a basis for research.

**A.** The following activities have been regularly continued in the Taylor Ranch area and are proposed for long-term monitoring.

<u>Bighorn sheep population inventory</u>

Census and recruitment efforts are conducted by Idaho Department of Fish & Game as often as possible. In addition, Taylor Ranch managers record numbers of sheep by sex and age when they are seen near the facilities. Inventories depend upon finances and available time, so are not as systematic or regular as desirable. Three systematic surveys should be done with either fixed-wing or helicopter. The initial survey should be done in mid-June after parturition and when lamb production and early survival can be estimated. Another aerial survey can be accomplished in early winter to further estimate lamb survival through fall. A final survey should be accomplished in March to estimate population composition, numbers, and overwinter survival.

Plant production

Grass production is indexed by clipping selected dominant species to 5 cm above ground level in 20 2 X 5 dm rectangular plots spaced at 2 m along a transect. Plots are permanently marked. Material is bagged, oven dried at $40^{0}$C for 24 hours, weighed to the nearest 0.01 gm. A 50 gm sample is selected from the collection for analysis of C, N, H, Se, Mb, P, Zn, Cd, Pb, Co, Ni, Mn, Fe, Cr, Mg, Al, Vn, Cu, Ca, and K. Seed stalk heights and percentage with seed heads are also estimated from a sample of 100 plants.

Shrub production is indexed by obtaining lengths (0.1 cm) and weights (0.01 gm) of 50 twigs (current year's growth) of each species, coupled with twig density measurements in 20 4 $m^2$ circular plots. Individual twigs are measured for length and weight in the field, and then oven-dried at $40^{0}$C for 24 hours. The oven-dried weight of the aggregate sample is subtracted from the wet weight to obtain the percentage of moisture that is lost, and the oven-dried weight/wet weight figure serves to correct all weights to the oven-dried figure. A mean twig weight may be multiplied by the estimated number of twigs per $m^2$. A 50 gm sample of twigs is selected from the oven-dried collection at each site for nutrient analysis as with the grasses.

Anadromous fish inventory

Snorkel censuses of fish are conducted in Big Creek along the Taylor Ranch reach of Big Creek by Idaho Fish and Game (Hall-Griswold and Petrosky 1998). Chinook salmon, steelhead, cutthroat, bull trout, and whitefish populations have been counted. Census is conducted when water temperatures are >10C when fish are most observable, and preceding fall outmigration (Thurow 1994). Redd counts of chinook salmon along selected transects are obtained by Idaho Fish & Game and the Nez Perce Tribe annually. These studies are funded but the attached budget includes support for redd surveys.

Campsite condition inventory

Recreation impacts on 53 sites along Big Creek were inventoried in 1986, 1994 and 1998. The purpose of the inventory is to assess the effects, if any, of recreational camping. Information on site location, vegetation, landform, mineral soil exposure, tree scarring, root exposure, trails, size of camp area and a photograph record are among the items that are examined. A rating of impacts into low, medium and high categories is assigned and a summary rating provided for each site allows calculation of a total score. This score is compared against an impact index and trends can be examined. Since Big Creek is an anadromous fish spawning stream, recreational impacts to the streambank are of particular interest.

**B**. The following activities have been undertaken but not continued regularly in the Taylor Ranch area and are proposed for long-term monitoring.

Geologic Mapping and Map Compilation.

Field work to map the geology and soils in the lower Big Creek drainage is an essential underpinning for understanding plant and animal ecology in the area. Mapping of the 15' quadrangle in the Taylor Ranch area to a final scale of 1:24,000, with a simplified version at 1:100,000 will require three months of field work. Mapping of the middle portion of Big Creek to similar scales will require similar field effort. The upper Big Creek area is mapped. These assessments will require two summers of work and may then be augmented with more detailed geologic studies.

Mountain lion investigations

At six-year intervals, the mountain lion population should be inventoried in winter in the Big Creek drainage. An effort to capture every individual between Monumental Creek and confluence of Big Creek with the Middle Fork over a three winter period, so there would be effort in three of every six years. This approach is based on experience in this area. Lions will be treed using dogs, immobilized, and marked with lip tattoos for further identification. Standard measurements, weight, sex and age of each individual will be obtained. The proportion of females with cubs will be recorded. Procedures for capture and marking are found in Hornocker (1970) and Lindzey (1987).

Stream ecosystem inventory

Overton et al. (1997) provide guidelines for fish and fish habitat inventories that are applicable to Big Creek and its tributaries. Sections of Big Creek and adjacent tributaries may be examined for habitat type, average depth, number of pools and their depth, substrate fines and composition, bank stability, undercut, temperature and woody debris. Forms provided by Overton et al. (1997) may be used to ensure that the information collected may be compared with inventories of streams elsewhere in this region.

Amphibian and reptile inventory

Sampling for amphibians may be conducted following (Bury and Corn 1991). Populations of the Pacific rattler (Crotalis viridus) and tailed frog (Scaphus truei) are proposed for monitoring. Funnel traps placed along transects are proposed to census the rattlesnake population (Heyer et al. 1994). Since adult tailed frogs are difficult to sample, sampling 30 m stream segments for tadpoles using a D-frame net on selected streams will be accomplished in August at lowest stream flows.

Breeding bird inventory

The North American breeding bird survey consists of counts under standardized conditions by skilled observers, that provides an index to population size and relative abundance (Link and Sauer 1998). Taylor Ranch offers additional information of value for this survey. A raptor population includes two known golden eagle nests in the Big Creek drainage (Thurow and Peterson 1978). These nests may be observed in June to determine whether they are occupied and if so, whether young are present, and number. Other raptors, which include accipiters, falcons, and buteos, may be surveyed along a transect consisting of the trail system along the creek up to the Monumental Creek confluence with Big Creek. A bald eagle population occupies the drainage, especially in winter, and individual sightings should be recorded as they are observed. Look-see methods have proven adequate to assess breeding raptors as long as equal time is spent studying each site in detail (Bibby et al. 1992).

Owls may be censused with night time playback tapes. A survey route has been established along Big Creek, and a camp at Rush Point serves to census owls at higher elevation in the drainage (Hayward and Garton 1988).

Breeding passerines may be censused in riparian zones, grassland and Douglas fir habitats. Ten point-count routes can be established in each habitat, using the methodology of (Ramsey and Scott 1981). Efforts to standardize bird population surveys (Ralph et al. 1995) illustrate the problems in assessing populations, and an adaptive approach to these surveys is needed to ensure that adequate sampling for this area is obtained.

Ruffed grouse and blue grouse populations are abundant in this area and are minimally hunted. Mark-recapture estimates of populations and brood surveys can be readily accomplished in the immediate vicinity of the Taylor Ranch. The Jolly-Seber method of estimating population size is appropriate for use with these grouse populations (Lancia et al. 1994).

## IX. BUDGET

| | |
|---|---|
| Personnel | |
| Student internships (4@ $1000.00/month, 2.5 months) | $10,000 |
| Principle investigators (8@ $1000.00) | 8,000 |
| Mountain lion capture specialist | 5,000 |
| Geologist salary (3 months) | 9,000 |
| Travel | |
| Principle investigators, $300.00 ea. | 2,400 |
| Flights, (20 hours @ $180.00/hour) | 3,600 |
| Operating expense | |
| Supplies and equipment | 5,000 |
| Sheep census, (4 hours @ 250.00/hour) | 1,000 |
| Mountain lion locations (20 hours @ $180.00/hour) | 3,600 |
| Total Expenses | $47,600 |

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**APPENDIX 1. KEY TO NON-FORESTED, SHRUB-STEPPE COMMUNITIES, SALMON RIVER MOUNTAINS.** This provides a listing of the extant nonforested communities, after Peek et al. (1994).

1a. Douglas fir, Ponderosa pine, or other conifer species present................................................ 2
1b. Conifers not present............................... 3a
2. Not shrub-steppe: refer to Steele et al. (1981) for identification of forested communities.
3a. Little greenbush present as more than occasional component; cliff sites. Little greenbush/mountain mahogany habitat type.
3b. Little greenbush absent or scarce; cliffs or other sites................................................. 4a
4a.Mountain mahogany present as more than occasional component. 5a
4b. Mountain mahogany absent or scarce................. 6a
5a. Idaho fescue present- Mountain mahogany /Idaho fescue habitat type.
5b. Idaho fescue absent- Mountain mahogany/Bluebunch wheatgrass habitat type.
6a.Bitterbrush present more than occasional........... 7a
6b. Bitterbrush absent or scarce....................... 8a
7a. Idaho fescue present: Bitterbrush/Idaho fescue habitat type.
7b. Idaho fescue absent: Bitterbrush/ bluebunch wheatgrass habitat type.
8a. Mountain big sagebrush present as more than occasional............................................ 9a
8b. Mountain big sagebrush absent or scarce........... 10a
9a. Idaho fescue present: Mountain sagebrush/Idaho fescue habitat type.
9b. Idaho fescue absent: Mountain sagebrush/bluebunch wheatgrass habitat type
. 10a. Threetip sagebrush present,more than occasional 11a
10b. Threetip sagebrush absent or scarce............. 12a
11a. Idaho fescue present: Threetip sagebrush/Idaho fescue habitat type.
11b. Idaho fescue absent: Threetip sagebrush/Bluebunch wheatgrass habitat type.
12a. Low sagebrush present as more than occasional 13a
12b. Low sagebrush absent or scarce 14a
13a. Idaho fescue present: low sagebrush/Idaho fescue habitat type.
13b. Idaho fescue absent: low sagebrush/bluebunch wheatgrass habitat type.
14a. Basin big sagebrush present as more than occasional: Basin big sagebrush/bluebunch wheatgrass habitat type.
14b. Basin big sagebrush absent or scarce 15a
15a Wyoming big sagebrush present as more than occasional. 16a
15b Wyoming big sagebrush absent or scarce 17a
16a. Wyoming big sagebrush/bluebunch wheatgrass habitat type.
17a. Idaho fescue present as more than oCcasional: Idaho fescue/bluebunch wheatgrass habitat type.
17b. Idaho fescue absent 18a
18a. Needle-and-thread grass absent or scarce. Bluebunch wheatgrass, Sandberg bluegrass, Arrowleaf balsamroot habitat type.
18b.Needle-and thread grass present, abundant. Bluebunch wheatgrass/Sandberg bluegrass/ needle-and-thread habitat type.

**APPENDIX II. KEY TO FORESTED COMMMUNITIES IN FCRNRW, AFTER STEELE ET AL. (1981).** This provides a listing of the extant forested habitat types.

1. Abies grandis present and reproducing more successfully than........ Abies lasiocarpa ABIES GRANDIS SERIES (item E)1. ...................................................... Abies grandis not in the indicated climax ........................................................................................ 2
2. Abies lasiocarpa present and reproducing successfully...................... ABIES LASIOCARPA SERIES (item G) ........................................................................................
2. Abies lasiocarpa not the indicated climax........................................... 3
3. Picea engelmannii present and reproducing successfully ................. PICEA ENGELMANNII SERIES (item D)
3. Picea engelmannii not the indicated climax ...................................... 4
4. Pinus flexilis a successfully reproducing dominant in old growth stands; often sharing that status with Pseudotsuga ................................................................................ PINUS FLEXILIS SERIES (item A)
4. Pinus flexilis absent or clearly seral .................................................... 5
5. Pseudotsuga menziesii present and reproducing successfully.......... PSEUDOTSUGA MENZIESII SERIES (item C)
5. Pseudotsuga menziesii not the indicated climax................................ 6
6. Pinus albicaulis well represented and reproducing successfully......... PINUS ALBICAULIS SERIES
6. Pinus albicaulis not the indicated successional dominant................... 7
7. Pinus contorta dominant and reproducing successfully..................... PINUS CONTORTA SERIES (item F)
7. Pinus contorta not the indicated successional dominant ................... 8
8. Pinus ponderosa present and reproducing successfully ..................... PINUS PONDEROSA SERIES (item B) ........................................................................................
8. Pinus ponderosa not the indicated climax .......................................... 9
9. Populus tremuloides the indicated dominant .................................... POPULUS TREMULOIDES SERIES
9. Populus tremuloides not the indicated dominant................................. Minor forest types

A. Key to Pinus flexilis Habitat Types

1. Juniperus communis well represented................................. PINUS FLEXILIS/JUNIPERUS COMMUNIS h.t.
1. J. communis poorly represented .......................................... 2
2. Cercocarpus ledifolius is well represented ............................ PINUS FLEXILIS/CERCOCARPUS LEDIFOLIUS h.t. ..............................................................
2. C. ledifolius poorly represented ............................................. 3
3. Festuca idahoensis well represented................................... PINUS FLEXILIS/FESTUCA IDAHOENSIS h.t.
3. F. idahoensis poorly represented, Hesperochloa kingii ........ (Leucopoa kingii) common PINUS FLEXILIS/HESPEROCHLOA KINGII h.t.

B. Key to Pinus ponderosa Habitat Types

1. Physocarpus malvaceus well represented......................... PINUS PONDEROSA/PHYSOCARPUS MALVACEUS h.t.
1. P. malvaceus poorly represented ......................................... 2
2. Symphoricarpos albus well represented.............................. PINUS PONDEROSA/SYMPHORICARPOS ALBUS H.T. ................................................................
2. S. albus poorly represented ................................................. 3
3. Symphoricarpos oreophilus or Prunus virginiana well represented PINUS PONDEROSA/SYMPHORICARPOS OREOPHILUS h.t.
3. S. oreophilus and P. virginiana poorly represented ........... 4
4. Purshia tridentata well represented .................................... PINUS PONDEROSA/PURSHIA TRIDENTATA h.t. ..............................................................................

a. Festuca idahoensis well represented ................................. FESTUCA IDAHOENSIS phase 4b. F. idahoensis poorly represented.................................... AGROPYRON SPICATUM phase

4. P. tridentata poorly represented.......................................... 5
5. Festuca idahoensis well represented................................ PINUS PONDEROSA/FESTUCA IDAHOENSIS h.t.
5. F. idahoensis poorly represented ...................................... 6

6. Agropyron spicatum well represented on sites in good condition
PINUS PONDEROSA/AGROPYRON SPICATUM h.t.
6. A. spicatum poorly represented on sites in good condition and Stipa spp. well represented PINUS PONDEROSA/STIPA OCCIDENTALIS h.t.

C. Key to Pseudotsuga mensiesii Habitat Types
1. Vaccinium caespitosum common...................................... PSEUDOTSUGA MENZIESII/VACCINIUM CAESPITOSUM h.t.*
1. V. caespitosum scarce ...................................................... 2
2. Linnaea borealis common ............................................ PSEUDOTSUGA MENZIESII/LINNAEA BOREALIS h.t. ............................................................ 2. L. borealis scarce 3
3. Physocarpus malvaceus and/or Holodiscus discolor well represented PSEUDOTSUGA MENZIESII/PHYSOCARPUS MALVACEUS h.t. ........
3a. Pinus ponderosa present or potentially present ................
a. Calmagrostis rubescens and/or Carex geyeri dominant;. Physocarpus forming only a broken, patchy cover ............................................................................ CALAMAGROSTIS RUBESCENS phase*
b. Not as above ........................................................... PINUS PONDEROSA phase
3b. P. ponderosa absent and unable to establish.................... PSEUDOTSUGA MENZIESII phase
3. P. malvaceus and H. discolor poorly represented.............. 4
4. Acer glabrum well represented ........................................... PSEUDOTSUGA MENZIESII/ACER GLABRUM h.t. ...............................................................................
4a. Penstemon wilcoxii and/or Clematis columbiana usually present; sites mainly west of the Big Wood River ........................................................................... ACER GLABRUM phase 4b. Pinus flexilis usually present, sites mainly east of the Big Wood River SYMPHORICARPOS OREOPHILUS phase...................................................
4. A. glabrum poorly represented............................................ 4
5. Vaccinium globulare or Xerophyllum tenax well represented PSEUDOTSUGA MENZIESII/VACCINIUM GLOBULARE h.t.
5. V. globulare and X. tenax poorly represented.................... 6
6. Symphoricarpos albus well represented............................. PSEUDOTSUGA MENZIESII/SYMPHORICARPOS ALBUS h.t. ............
6a. Pinus ponderosa present or potentially present .............. PINUS PONDEROSA phase
6b. P. ponderosa absent and unable to establish.................. SYMPHORICARPOS ALBUS phase
6. S. albus poorly represented ................................................ 7
7. Spiraea betulifolia or S. pyramidata well represented........ PSEUDOTSUGA MENZIESII/SPIRAEA BETULIFOLIA h.t. ......................................................
7a. Pinus ponderosa present or potentially present ................ PINUS PONDEROSA phase
7b. Calamagrostis rubescens well represented....................... CALAMAGROSTIS RUBESCENS phase
7c. Not as above in 7a or 7b .................................................... SPIRAEA BETULIFOLIA phase
7. S. betulifolia and S. pyramidata poorly represented .......... 8
8. Osmorhiza chilensis well represented........................... PSEUDOTSUGA MENZIESII/OSMORHIZA CHILENSIS h.t. .........................................................
8. O. chilensis poorly represented .......................................... 9
9. Calamagrostis rubescens well represented ....................... PSEUDOTSUGA MENZIESII/CALAMAGROSTIS RUBESCENS h.t. ....................................................... 9a. Pinus ponderosa present or potentially present ........................................................................... PINUS PONDEROSA phase
9b. P. ponderosa absent and unable to establish;................... Festuca idahoensis well represented ........................................................................... FESTUCA IDAHOENSIS phase
9c. Not as above in 9a or 9b .................................................... CALAMAGROSTIS RUBESCENS phase
9. C. rubescens poorly represented ...................................... 10
10. Cercocarphus ledifolius well represented and the indicated climax dominant shrub ........................................................................... PSEUDOTSUGA MENZIESII/CERCOCARPUS LEDIFOLIUS h.t. .......................................................
10. C. ledifolius poorly represented or seral ............................ 11
11. Berberis repens well represented...................................... PSEUDOTSUGA MENZIESII/BERBERIS REPENS h.t. ..............................................................

11a. Carex geyeri abundant.................................................... CAREX GEYERI phase
11b. C. geyeri not abundant, Symphoricarpos oreophilus abundant, stands never achieving closed canopies
........................................................................................ SYMPHORICARPOS OREOPHILUS phase
11c. S. oreophilus not abundant, stands eventually achieving closed canopies BERBERIS REPENS phase
11.B. repens poorly represented............................................. 12
12. Carex geyeri well represented .......................................... PSEUDOTSUGA MENZIESII/CAREX GEYERI h.t.
........................................................................................
12a. Pinus ponderosa present or potentially present .............. PINUS PONDEROSA phase
12b. P. ponderosa absent and unable to establish; Symphoricarpos oreophilus or Artemisia tridentata well represented ................................................................. SYMPHORICARPOS OREOPHILUS phase
12c. Not as above in 12a or 12b ............................................ CAREX GEYERI phase
12. C. geyeri poorly represented............................................. 13
13. Juniperus communis well represented .............................. PSEUDOTSUGA MENZIESII/JUNIPERUS COMMUNIS h.t.
13. J. communis poorly represented ....................................... 14
14. Arnica cordifolia or Astragalus miser well represented or a dominant forb of normally depauperate undergrowths ............................................................. PSEUDOTSUGA MENZIESII/ARNICA CORDIFOLIA h.t. .......................................................
14a. Arnica cordifolia well represented .................................. ARNICA CORDIFOLIA phase
14b. A. cordifolia poorly represented; Astragalus miser well represented ASTRAGALUS MISER phase .............................................................
14. A. cordifolia and A. miser poorly represented or not a dominant forb 15
15. Symphoricarpos oreophilus, Ribes cereum or Prunus virginiana well represented
..........................................................................................PSEUDOTSUGA MENZIESII/SYMPHORICARPOS OREOPHILUS h.t. ......................................................
15. S. oreophilus, R. cereum and P. virginiana poorly represented 16
16. Festuca idahoensis well represented ................................ PSEUDOTSUGA MENZIESII/FESTUCA IDAHOENSIS h.t.
16a. Pinus ponderosa present .................................. PINUS PONDEROSA phase
16b. P. ponderosa absent.......................................... FESTUCA IDAHOENSIS phase
16. F. idahoensis poorly represented; Agropyron spicatum or Melica bulbosa well represented on sites in good condition..................................................................... PSEUDOTSUGA MENZIESII/AGROPYRON SPICATUM h.t.

D. Key to Picea engelmannii Habitat Types
1. Equisetum arvense abundant............................................ PICEA ENGELMANNII/EQUISETUM ARVENSE h.t.*
1. E. arvense not abundant .................................................... 2
2. Carex disperma well represented ....................................... PICEA ENGELMANNII/CAREX DISPERMA h.t.
........................................................................................
2. C. disperma poorly represented.......................................... 3
3. Galium triflorum, Actaea rubra or Streptopus amplexifolius common either individually or collectively PICEA ENGELMANNII/GALIUM TRIFLORUM h.t.*
3. Not as above, Hypnum revolutum (a prostrate moss) well represented PICEA ENGELMANNII/HYPNUM REVOLUTUM h.t.
E. Key to Abies grandis Habitat Types
1. Clintonia uniflora present.................................................... ABIES GRANDIS/CLINTONIA UNIFLORA h.t.
1. C. uniflora absent .............................................................. 2
2. Coptis occidentalis common ................................................ ABIES GRANDIS/COPTIS OCCIDENTALIS h.t.*
........................................................................................
2. C. occidentalis scarce ........................................................ 3
3. Vaccinium caespitosum common...................................... ABIES GRANDIS/VACCINIUM CAESPITOSUM h.t.
3. V. caespitosum scarce ...................................................... 4. Linnaea borealis common ABIES GRANDIS/LINNAEA BOREALIS h.t. ....................

4a. Xerophyllum tenax common ........................................... XEROPHYLLUM TENAX phase
4b. X. tenax scarce; vaccinium globulare well represented..... VACCINIUM GLOBULARE phase
4c. Not as above in 4a or 4b ................................................. LINNAEA BOREALIS phase
4. L. borealis scarce ................................................................ 5
5. Acer glabrum, Physocarpus malvaceus or Holodiscus discolor well represented. If only common then Adenocaulon bicolor or Disporum trachycarpum present ABIES GRANDIS/ACER GLABRUM h.t.
5a. Acer glabrum well represented; if only common then at least more prevalent than Physocarpus and Holodiscus.................................................................. ACER GLABRUM phase
5b. A. glabrum poorly represented and less prevalent than Physocarpus and Holodiscus PHYSOCARPUS MALVACEUS phase
5. Not as above...................................................................... 6
6. Xerophyllum tenax well represented.................................. ABIES GRANDIS/XEROPHYLLUM TENAX h.t.*
6. X. tenax poorly represented ................................................ 7
7. Vaccinium globulare well represented............................... ABIES GRANDIS/VACCINIUM GLOBULARE h.t.
7. V. globulare poorly represented ........................................ 8
8. Spiraea betulifolia or Lathyrus nevadensis well represented ABIES GRANDIS/SPIRAEA BETULIFOLIA h.t.
8. S. betulifolia and L. nevadensis poorly requested; Calamagrostis rubescens well represented ABIES GRANDIS/CALAMAGROSTIS RUBESCENS h.t.

F. Key to Pinus contorta communities1. Calamagrostis canadensis or Ledum glandulosum well represented ..................................................................................ABIES LASIOCARPA/CALAMAGROSTIS CANADENSIS h.t.
1. C. canadensis and L. glandulosum poorly represented ...... 2
2. Streptopus amplexifolius, Senecio triangularis, Ligusticum canbyi or Trautvetteria caroliniensis well represented either individually or collectively ABIES LASIOCARPA/STREPTOPUS AMPLEXIFOLIUS h.t.
2. Not as above ........................................................................ 3
3. Clintonia uniflora present................................................... ABIES LASIOCARPA/CLINTONIA UNIFLORA h.t.
3. C. uniflora absent ............................................................... 4
4. Coptis occidentalis common ............................................... ABIES LASIOCARPA/COPTIS OCCIDENTALIS h.t. ................................................................................. or ABIES GRANDIS/COPTIS OCCIDENTALIS h.t. ..................................................................................
4. C. occidentalis scarce ......................................................... 5
5. Menziesia ferruginea well represented ............................. ABIES LASIOCARPA/MENZIESIA FERRUGINEA h.t.
5. M. ferruginea poorly represented ...................................... 6
6. Vaccinium caespitosum common ....................................... PINUS CONTORTA/VACCINIUM CAESPITOSUM H.t. ..................................................................................
6. V. caespitosum scarce ......................................................... 7
7. Linnaea borealis common ................................................... ABIES LASIOCARPA/LINNAEA BOREALIS h.t. .................................................................................. or ABIES GRANDIS/LINNAEA BOREALIS h.t.
7. L. borealis scarce ................................................................ 8
8. Alnus sinuata well represented ........................................... ABIES LASIOCARPA/ALNUS SINUATA h.t.
8. A. sinuata poorly represented ............................................. 9
9. Xerophyllum tenax well represented ................................. ABIES LASIOCARPA/XEROPHYLLUM TENAX h.t. ................................................................................. or ABIES GRANDIS/XEROPHYLLUM TENAX h.t.
9. X. tenax poorly represented ............................................... 10
10. Vaccinium globulare well represented .............................. ABIES LASIOCARPA/VACCINIUM GLOBULARE h.t. ................................................................................ or ABIES GRANDIS/VACCINIUM GLOBULARE h.t. ..................................................................................
10. V. globulare poorly represented......................................... 11
11. Spiraea betulifolia well represented .................................. ABIES LASIOCARPA/SPIRAEA BETULIFOLIA h.t. ................................................................................. or PSEUDOTSUGA MENZIESII/SPIRAEA BETULIFOLIA h.t.
11. S. betulifolia poorly represented......................................... 12

12. Luzula hitchcockii common ............................................. ABIES LASIOCARPA/LUZULA HITCHCOCKII h.t.
12. L. hitchcockii scarce ......................................................... 13
13. Vaccinium scoparium well represented ............................. PINUS CONTORTA/VACCINIUM SCOPARIUM h.t.
13. V. scoparium poorly represented ...................................... 14
14. Calamagrostis rubescens well represented ....................... ABIES LASIOCARPA/CALAMAGROSTIS RUBESCENS h.t. ........................................................ or PSEUDOTSUGA MENZIESII/CALAMAGROSTIS RUBESCENS h.t. ....
14. C. rubescens poorly represented ...................................... 15
15. Carex geyeri well represented ........................................... PINUS CONTORTA/CAREX GEYERI h.t.
15. C. geyeri poorly represented ............................................ 16
16. Juniperus communis well represented .............................. ABIES LASIOCARPA/JUNIPERUS COMMUNIS h.t. ............................................................................. or PSEUDOTSUGA MENZIESII/JUNIPERUS COMMUNIS h.t.
16. J. communis poorly represented ....................................... 17
17. Arnica cordifolia well represented or the dominant forb of normally depauperate undergrowths ....................................................................... ABIES LASIOCARPA/ARNICA CORDIFOLIA h.t. ....................................................................... or PSEUDOTSUGA MENZIESII/ARNICA CORDIFOLIA h.t.
17. Not as above; Festuca idahoensis common ...................... PINUS CONTORTA/FESTUCA IDAHOENSIS h.t.

G. Key to Abies lasiocarpa Habitat Types

1. Caltha biflora common ...................................................... ABIES LASIOCARPA/CALTHA BIFLORA h.t.
1. C. biflora scarce ................................................................. 2
2. Equisetum arvense abundant ............................................ PICEA ENGELMANNII/EQUISETUM ARVENSE h.t.
2. E. arvense not abundant ..................................................... 3
3. Carex disperma well represented ...................................... PICEA ENGELMANNII/CAREX DISPERMA h.t.
3. C. disperma poorly represented ........................................ 4
4. Calamagrostis canadensis or Ledum glandulosum well represented ABIES LASIOCARPA/CALAMAGROSTIS CANADENSIS h.t.
4a. Ledum glandulosum well represented .............................. LEDUM GLANDULOSUM phase
4b. Not as above in 4a; Vaccinium caespitosum common ...... VACCINIUM CAESPITOSUM phase
4c. Not as above in 4a or 4b; Ligusticum canbyi or Trautvetteria caroliniensis present LIGUSTICUM CANBYI phase
4d. Not as above in 4a, 4b, or 4c ........................................... CALAMAGROSTIS CANADENSIS phase
4. C. canadensis and L. glandulosum poorly represented ...... 5
5. Streptopus amplexifolius, Senecio triangularis, Ligusticum canbyi or Trautvetteria caroliniensis well represented either individually or collectively .............. ABIES LASIOCARPA/STREPTOPUS AMPLEXIFOLIUS h.t.
5a. Ligusticum canbyi or Trautvetteria caroliniensis present... LIGUSTICUM CANBYI phase
5b. L. canbyi and T. caroliniensis absent ................................ STREPTOPUS AMPLEXIFOLIUS phase
5. Not as above ....................................................................... 6
6. Clintonia uniflora present .................................................... ABIES LASIOCARPA/CLINTONIA UNIFLORA h.t.
6a. Menziesia ferruginea well represented ............................. MENZIESIA FERRUGINEA phase
6b. M. ferruginea poorly represented ...................................... CLINTONIA UNIFLORA phase
6. C. uniflora absent ................................................................ 7
7. Coptis occidentalis common .............................................. ABIES LASIOCARPA/COPTIS OCCIDENTALIS h.t.
7. C. occidentalis scarce ........................................................ 8
8. Menziesia ferruginea well represented .............................. ABIES LASIOCARPA/MENZIESIA FERRUGINEA h.t.
8a. Luzula hitchcockii common ............................................... LUZULA HITCHCOCKII phase*
8b. L. hitchcockii scarce .......................................................... MENZIESIA FERRUGINEA phase
8. M. ferruginea poorly represented ........................................ 9
9. Acer glabrum well represented ........................................... ABIES LASIOCARPA/ACER GLABRUM h.t.

9. A. glabrum poorly represented .......................................... 10
10. Vaccinium caespitosum common ..................................... ABIES LASIOCARPA/VACCINIUM CAESPITOSUM h.t.
10. V. caespitosum scarce ...................................................... 11
11. Linnaea borealis common ................................................ ABIES LASIOCARPA/LINNAEA BOREALIS h.t. ......................................................................................
11a. Xerophyllum tenax well represented............................... XEROPHYLLUM TENAX phase*
11b. X. tenax poorly represented; Vaccinium scoparium well represented VACCINIUM SCOPARIUM phase
11c. Not as above in 11a or 11b ............................................. LINNAEA BOREALIS phase
11. L. borealis scarce.............................................................. 12
12. Alnus sinuata well represented ......................................... ABIES LASIOCARPA/ALNUS SINUATA h.t
12. A. sinuata poorly represented ........................................... 13
13. Xerophyllum tenax well represented................................ ABIES LASIOCARPA/XEROPHYLLUM TENAX h.t.
13a. Vaccinium globulare or Spiraea betulifolia well represented VACCINIUM GLOBULARE phase
13b. Not as above in 13a; Luzula hitchcockii common............ LUZULA HITCHCOCKII phase
13c. Not as above in 13a or 13b; Vaccinium scoparium usually abundant VACCINIUM SCOPARIUM phase*
13. X. tenax poorly represented .............................................. 14
14. Vaccinium globulare well represented .............................. ABIES LASIOCARPA/VACCINIUM GLOBULARE h.t. ......................................................................
14a. Vaccinium scoparium abundant...................................... VACCINIUM SCOPARIUM phase*
14b. V. scoparium not abundant ............................................. VACCINIUM GLOBULARE phase
14. V. globulare poorly represented......................................... 15
15. Spiraea betulifolia well represented .................................. ABIES LASIOCARPA/SPIRAEA BETULIFOLIA h.t.
15. S. betulifolia poorly represented........................................ 16
16. Luzula hitchcockii common ............................................... ABIES LASIOCARPA/LUZULA HITCHCOCKII h.t.
16a. Vaccinium scoparium well represented .......................... VACCINIUM SCOPARIUM phase
16b. Not as above in 16a, Luzula hitchcockii well represented LUZULA HITCHCOCKII phase
16c. Not as above in 16a or 16b ............................................. 22
16. L. hitchcockii scarce........................................................... 17
17. Vaccinium scoparium well represented............................. ABIES LASIOCARPA/VACCINIUM SCOPARIUM h.t.
17a. Calamagrostis rubescens well represented.................... CALAMAGROSTIS RUBESCENS phase
17b. Not as above in 17a; Pinus albicaulis well represented .. PINUS ALBICAULIS phase
17c. Not as above in 17a or 17b ............................................. VACCINIUM SCOPARIUM phase
17. V. scoparium poorly represented ...................................... 18
18. Calamagrostis rubescens well represented...................... ABIES LASIOCARPA/CALAMAGROSTIS RUBESCENS h.t.
18. C. rubescens poorly represented...................................... 19
19. Carex geyeri well represented........................................... ABIES LASIOCARPA/CAREX GEYERI h.t.
19a. Artemisia tridentata well represented ............................ ARTEMISIA TRIDENTATA phase
19b. A. tridentata poorly represented...................................... CAREX GEYERI phase
19. C. geyeri poorly represented ............................................. 20
20. Juniperus communis well represented ............................. ABIES LASIOCARPA/JUNIPERUS COMMUNIS h.t. ......................................................................
20. J. communis poorly represented....................................... 21
21. Ribes montigenum well represented or the dominant plant of normally depauperate undergrowths .............................................. ABIES LASIOCARPA/RIBES MONTIGENUM h.t.
21. Not as above..................................................................... 22
22. Arnica cordifolia well represented or a dominant forb of normally depauperate undergrowths ABIES LASIOCARPA/ARNICA CORDIFOLIA h.t. .................
22. Not as above; Pinus albicaulis usually well represented and Abies lasiocarpa often stunted PINUS ALBICAULIS - ABIES LASIOCARPA h.t.

**APPENDIX III. BIBLIOGRAPHY OF REPORTS AND PUBLICATIONS FROM TAYLOR RANCH.**


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**APPENDIX IV. SUMMARIES OF SALMONID SURVEYS IN BIG CREEK.**

Table 1. Numbers of spring chinook salmon redds counted in upper Big Creek (Jacobs Ladder to Logan Creek) , 1957-1997, excerpted from Elms-Cockrom 1998, and from lower Big Creek (Copper Camp to Monumental Creek pack bridge)1986-1995, Nez Perce Tribe surveys) and 1957-1971 (Idaho Fish & Game Surveys), excerpted from Kucera and Blenden (1998) .

| YEAR | REDDS UPPER | REDDS LOWER | YEAR | REDDS UPPER | REDDS LOWER | YEAR | REDDS UPPER | REDDS LOWER |
|---|---|---|---|---|---|---|---|---|
| 1957 | 225 | 535 | 1971 | 32 | 52 | 1985 | 70 | 14 |
| 1958 | 129 | 338 | 1972 | 60 | | 1986 | 41 | 26 |
| 1959 | 88 | 217 | 1973 | 96 | | 1987 | 24 | 21 |
| 1960 | 155 | 352 | 1974 | 28 | | 1988 | 93 | 40 |
| 1961 | 377 | 160 | 1975 | 77 | | 1989 | 26 | 11 |
| 1962 | 223 | 360 | 1976 | 22 | | 1990 | 13 | 22 |
| 1963 | 148 | 220 | 1977 | 9 | | 1991 | 12 | 21 |
| 1964 | 51 | 121 | 1978 | 95 | | 1992 | 23 | 22 |
| 1965 | 73 | 83 | 1979 | 15 | | 1993 | 46 | 21 |
| 1966 | 123 | 55 | 1980 | 4 | | 1994 | 2 | 4 |
| 1967 | 67 | 94 | 1981 | 22 | | 1995 | 1 | 1 |
| 1968 | 90 | 33 | 1982 | 7 | | 1996 | 1 | |
| 1969 | 65 | 72 | 1983 | 27 | | 1997 | 26 | |
| 1970 | 68 | 23 | 1984 | 42 | | 1998 | 13 | |