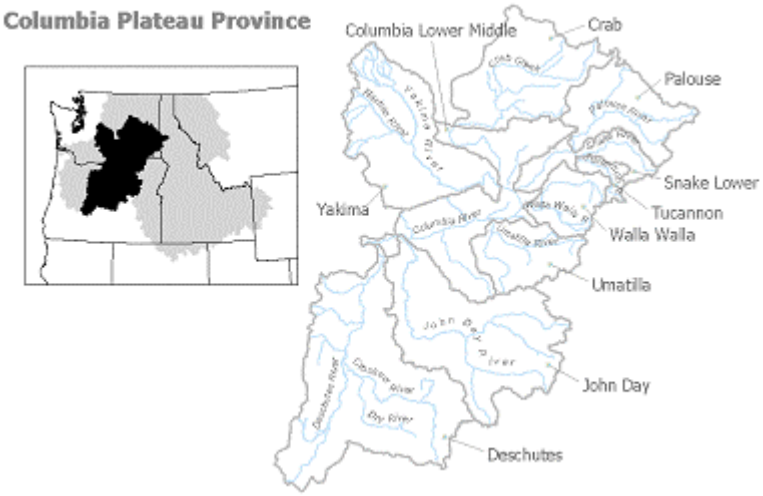
Crab Creek Subbasin Plan



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Prepared for the Washington Department of Fish and Wildlife and Lincoln County Conservation District

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Crab Creek Subbasin Plan Approach and Public Involvement

Outreach

The Washington Department of Fish and Wildlife and Lincoln County Conservation

District partnered to coordinate Subbasin Planning for the Crab Creek Subbasin. Lincoln County Conservation District has been responsible for outreach and public involvement. The timeline established by the Northwest Power and Conservation Council (NPCC) has necessitated a very compressed process that has allowed little flexibility in stakeholder involvement. The rigorous schedule and limited budget have restricted the time available for outreach. In addition, the volume of work to be completed has resulted in many long meetings.

The Washington Department of Fish and Wildlife and Lincoln County Conservation District's commitment is to make it possible for local stakeholders to continue to be heard, and to contribute to decisions about issues that affect both their livelihoods and their quality of life. The NWPCC proposed a three year rolling review of subbasin plans, will make the plans relevant and enable them to be updated regularly, and adapted to new knowledge and information.

The Washington Department of Fish and Wildlife and Lincoln County Conservation District staff and contractors have used the media and a series of public meetings to communicate with the general public about Subbasin Planning in the Crab Creek subbasin. In addition, the Coordinators delivered press releases to media representatives, and recruited stakeholders to represent local interests on the Subbasin Core Team (SCT).

Outreach list

In February, 2004, the Coordinators assembled an initial outreach list comprising about 50 names. The list included representatives of the following interests:

- Agriculture
- Business
- Conservation and the environment
- Government (including local government, and local and regional representatives of state, tribe and federal agencies)
- Media
- Recreation

The list has continued to grow as individuals express interest in Subbasin Planning. It has been used throughout Subbasin Planning to promulgate information, extend invitations, and issue updates on the progress of the process and changes to the planning schedule.

Information sheet

The Washington Department of Fish and Wildlife and Lincoln County Conservation District used an information sheet, "Subbasin Planning 101", provided by the NWPCC to introduce Subbasin Planning to stakeholders and the media and explain opportunities for public involvement. The information included a telephone number and email, postal mail, and web site addresses that individuals could use to obtain more information.

Infrastructure and Organization

Subbasin Core Team

The Washington Department of Fish and Wildlife and Lincoln County Conservation District initiated formation of the Subbasin Core Team (SCT) with kickoff meetings in Harrington and Moses Lake on February 10, 2004. Twenty-three stakeholders attended

the meeting in Harrington and sixteen stakeholders attended the meeting in Moses Lake. The agenda included an introduction to Subbasin Planning, an overview of the process, an explanation of the assessment methodology and work undertaken to date, and a description of anticipated roles and the SCT meeting schedule.
The SCT met four times in February, 2004 and twice in March, 2004 for a reach designation and five Qualitative Habitat Assessment (QHA) meetings. At those meetings, Technical Group members presented QHA outcomes based on their initial assessment work, and worked with SCT members to refine the outcomes based on local knowledge and to develop preliminary lists of management strategies appropriate to the limiting factors indicated by the QHA outcomes.
The SCT meetings occupied most of each day (9 AM-5 PM) due to the amount of time needed to review the QHA outcomes.

Approach

Start up

The coordinators used the outreach list to invite stakeholders to participate in Subbasin Planning, and to release information to the media. Those avenues were used to initiate public involvement as follows:

- February 1, 2004: Mailing of initial press release to all members of the outreach list

Briefings to introduce Subbasin Planning and explain the process, timeline, and roles:

- February 10, 2004: Two kickoff meetings were held; one in Harrington and one in Moses Lake
- February and March, 2004; QHA model were and reviewed by stakeholders

Drafts will be placed in local public libraries and sent to stakeholders on request. Stakeholders will have two weeks to submit comments on the first draft, and 90 days to comment on the final draft during the formal public review period. The meetings have been advertised, and releases sent to local media outlets. The media releases include an update on Subbasin Planning, outline next steps, and invite stakeholder participation.

Public comments

Comments collected at public meetings and during public review of draft Subbasin Plans have been appended to this plan as Appendix D.

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Executive Summary

Purpose and Scope

In October of 2000, the Northwest Power Planning Council adopted a revised Fish and Wildlife Program for the Columbia River Basin. The new program is intended to be more comprehensive than, but complimentary to, regional efforts related to the Endangered Species Act, State-sponsored recovery and watershed planning and coordination efforts, and tribal recovery initiatives.

The revised Program calls for an ecosystem-based approach for planning and implementing fish and wildlife recovery. To accomplish this, the Program divides the Columbia Basin into ecological provinces that are further divided into individual subbasins.

At the heart of the Program is the subbasin plan, consisting of a comprehensive description of the basin general ecology including the identification of specific fish and wildlife needs. Future action strategies and project funding are to be based upon these identified needs.

Subbasin summaries were developed in 2001 as an interim step to organize key planning attributes, to allow near-term implementation of the revised Fish and Wildlife Program until comprehensive subbasin plans can be completed.

The Crab Subbasin is the subject of one of 10 subbasin plans being generated from within the Columbia Plateau Ecoprovince. Columbia Plateau North includes the Columbia River and all tributaries upstream of The Dalles Dam up to and including Wanapum Dam on the north and west bank and Crab Creek**.** Columbia Plateau South includes the Columbia River and all tributaries on the south bank upstream of The Dalles Dam up to the confluence with the Snake River; Snake River and all tributaries from Lewiston, Idaho to the confluence with the Columbia River.

The Crab Subbasin Plan draws from the Crab Subbasin Summary (NWPCC 2001), which included an information summary for fish and wildlife, relevant land use planning, human population patterns, and overall management issues for subwatersheds and tributaries. Most of the information contained in the Overview section of this subbasin plan was obtained directly from the Crab Subbasin Summary. The subbasin plan will also draw from a significant body of additional science to facilitate coordinated recovery planning for the Crab ecosystem.

The Crab Creek Subbasin Plan addresses the limiting factors for fish and wildlife ecosystems in the Crab Creek Watershed. However, the needs of watershed residents and their critical role in ecosystem stewardship have been expressly considered as part of

overall ecosystem recovery and its benefits.

Crab Creek, sometimes referred to as the longest ephemeral stream in North America, possesses many unique characteristics not found in other subbasins. Numerous stream reaches and lake chains did not exist prior to the USBR Columbia Basin Project and modern irrigation practices. Because of this, new habitat has been created which now support diverse populations of fish and wildlife. Resident salmonids are present in the Crab Creek Subbasin and were historically. Through a combination of hatchery supplementation and natural production, resident salmonids now support high quality recreational fisheries in many locations throughout the subbasin. Warmwater species have been introduced throughout most of the subbasin and now support important fisheries in lakes and reservoirs. Anadromous salmonids, including ESA listed Upper Columbia River Summer Steelhead, also currently utilize the subbasin, but only in the lower most reaches. However, the specific origin of these fish and their historical presence are unknown. These and other data gaps must be filled before comprehensive management plans can be developed.

Aquatic habitat areas that did not exist prior to the Columbia Basin Project have no true restoration value. However, these same areas are important to the current culture and economics of the subbasin and can be enhanced. The Crab Creek Subbasin offers enormous opportunity to conduct fisheries enhancement to help mitigate for other fisheries that have been lost.

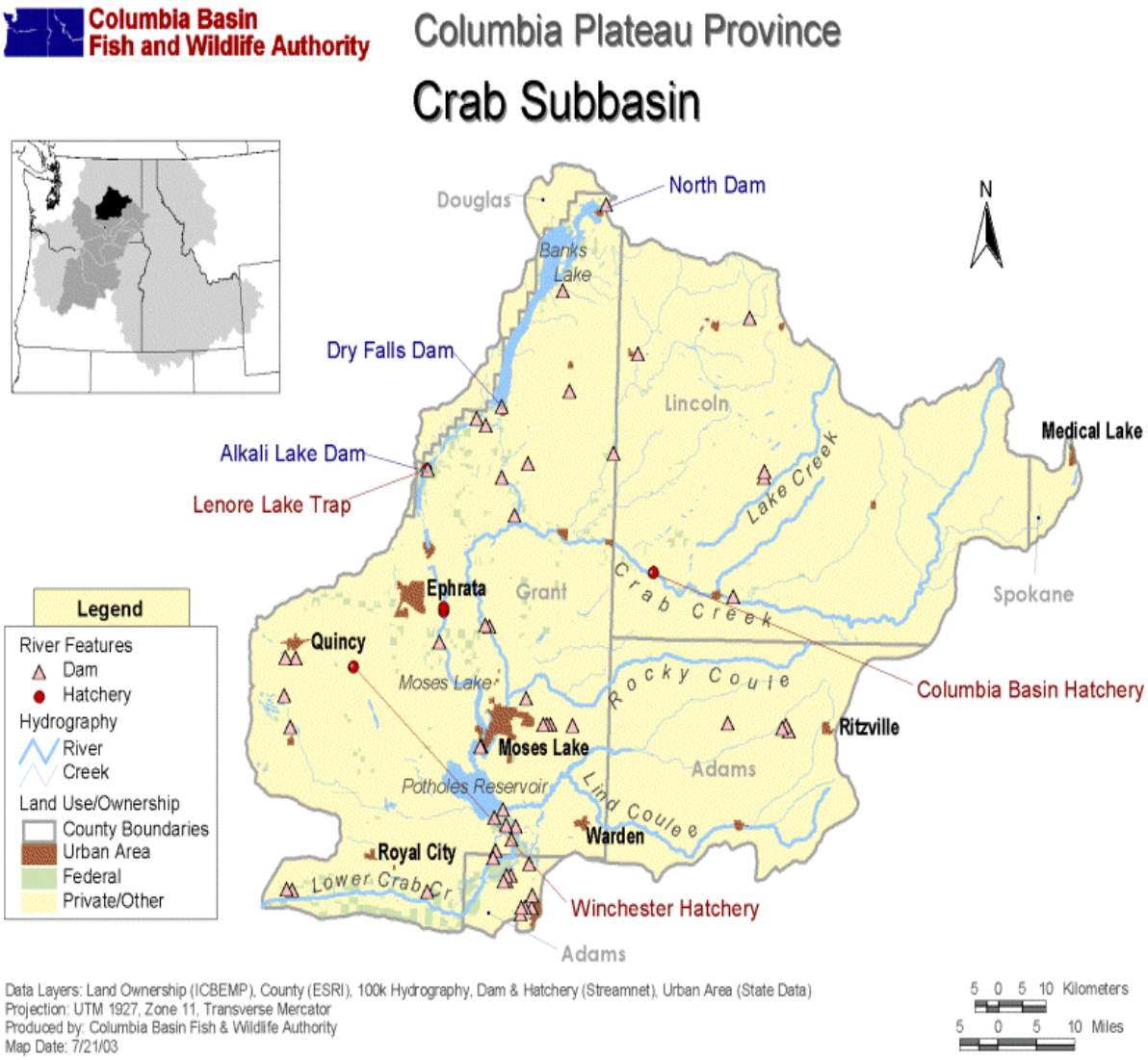

Figure 1. Crab Creek subbasin, land ownership, hydrography, county, and dam and hatchery, urban area.

The Crab Creek Subbasin Plan addresses the limiting factors for fish and wildlife ecosystems in the Crab Creek Watershed. However, the needs of watershed residents and their critical role in ecosystem stewardship have been expressly considered as part of overall ecosystem recovery and its benefits.

Socio-economic Objectives

The socio-economic objectives achieved through the Crab Creek Subbasin Plan are intended to include the scope of tribal trust/cultural needs and responsibilities, recreational fisheries, and other regional economic aspects of fisheries.
The resulting recovery of salmonid populations and the resulting benefits are expected to flow to recreational fishers and other stakeholders.

Overview

Subbasin Overview and Regional Context

The revised Columbia Basin Fish and Wildlife Program calls for an ecosystem-based approach for planning and implementing fish and wildlife recovery. The Crab Creek Subbasin Plan will lay the foundation to achieve this goal by integrating fish and wildlife assessments, inventories and management plans in a manner that begins to connect communities of science, interest and place in the Crab Creek Subbasin.

The Crab Creek Subbasin is located in central Washington in portions of Douglas, Lincoln, Adams, Grant, and Spokane counties, within the Columbia Plateau Province (Figure 1). It is bounded on the east by the Palouse Subbasin, on the south by the Lower Mid-Columbia Mainstem Subbasin, on the west by the Upper Mid-Columbia Mainstem Subbasin, and on the north by the Rufus Woods and Roosevelt Lake Subbasins. The head waters begin in Lincoln County near the town of Reardan approximately 30 km west of Spokane and include a small part of western Spokane County 13 km west of Cheney. Crab Creek flows southwest for approximately 225 km draining into the Columbia River near the town of Schwana in Grant County, five miles south of the Wanapum Dam.

Figure 2. Location of Crab Creek Subbasin in the Columbia Plateau

Crab Creek Watershed

Sometimes referred to as the longest ephemeral stream in North America, Crab Creek

defies simple description. Some 225 km in length, it drains a vast area of some 13,200 square kilometers. The creek winds through scabrock channels for most of its length, channels believed carved by floods of ancient Lake Missoula. For ease of discussion, we separate the creek into to three reaches in the following: (1) Upper Crab Creek—from its source near Reardon, Washington downstream to Brook (Stratford) Lake; (2) Middle Crab Creek— from Brook Lake to, and including, Potholes Reservoir; (3) Lower Crab Creek— from below Potholes Reservoir to the Columbia River.

Upper Crab Creek was historically, and remains to present-day, a disappearing stream---reaches of permanent flow interspersed with miles of dry creek beds, or at best, isolated, stagnant pools during most of the year. Whether modern land use has changed flow volume and the lengths of permanent reaches is unknown, yet as discussed earlier, the ground water table has dropped some 45 m (150 ft.) over the past few decades. Over a century of livestock use within the upper watershed have likely changed the amount and character of riparian vegetation somewhat, but has not obliterated it entirely. Tillage of the uplands for wheat production has undeniably increased soil erosion and contributed to heavy silt transport during snowmelt and rainwater runoff. Yet in spite of this perturbation, permanent reaches in general lack heavy deposits of silt and run cool enough in summer, at least near springs, to hold rainbow trout[1]. Perhaps the greatest impact on salmonids are carp. Carp are established at least as far upstream as 2.4 km west of Odessa.

Portions of creek between Odessa and Brook Lake have been channeled and diked to reduce spring flooding of farm crops in the coulee floor. Numerous springs occur throughout the upper basin. One rather large drainage--Lake Creek, with its numerous lakes and recreational trout population--feeds southwest to within a few miles of Crab Creek before disappearing into the ground. There is likely subterranean contact with the Crab channel.

Water quality could be enhanced in the Upper Crab Creek basin from a practical standpoint. Removal of dikes, where found in channeled reaches could lessen soil transport to, and deposition in, Middle Crab Creek (especially Moses Lake) by allowing diffusion of flows (velocity reduction) over the valley bottom. Improved soil conservation practices on croplands throughout the upper basin could further benefit downstream areas, as well as permanent flows in the upper watershed.

Middle Crab Creek is the most heavily populated reach within the Crab Creek subbasin, with Moses Lake as the main human population center. It is this reach that bears the brunt of winter and spring runoff that carry agricultural chemicals and eroded soils from Upper Crab, although Brook Lake intercepts Crab flows and acts as a sump for much of the silt and chemicals.

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[1] Much of the Overview section of this document was obtained directly from the Crab Creek Subbasin Summary (NWPPC 2001) which often refers to fish by common name only. Genus and species information is listed in Table 2.

Historical information indicates that long before irrigation development perennial connection between Crab Creek at Brook and/or Round lakes and Moses Lake did not occur (Evermann and Nichols 1909). Groves (1951) states that only two tributaries fed Moses Lake: Rocky Ford Creek, and a small tributary emanating from two points above Parker Horn (probably in the Willow Lakes area and at Homestead Creek). Only during high water conditions did Upper Crab thread its way through the present Willow Lakes area and on to Moses Lake at Parker Horn. Today, several springs join the Crab Creek channel in this reach, a result of elevated groundwater from irrigation development. The springs creating the seven miles of Rocky Ford Creek are widely accepted now as connected by underground flows to Crab Creek in the vicinity of Round and Willow lakes (Bain 1990).

Groves (1951) also mentions that an Indian legend held that Moses Lake was once dry. The concept has plausibility given that shifting sand created large dunes on the south end of the lake, effectively damming the outlet. A disastrous flood in 1904 washed through the dune and lowered the lake eight feet. Groves (1951) leaves a telling note: “Soon after the great flood of 1904 when the Moses Lake overflow reached the Columbia River, carp were noticed.” The deduction then is that Crab Creek did not reach the Columbia River except during flood events. At least temporary connections with the Columbia undoubtedly occurred off and on prior to 1904, as Northern pikeminnow, a species indigenous to the Columbia River, was one of the original inhabitants of Moses. Common carp were first introduced to the Northwest in 1880, and escaped into the Columbia in 1881 (Lampman 1946).

Water quality has been touched on earlier in this document. More detail for this section can be found in Williamson, et al. (1998). Several waters are on the federal Clean Water Act “303 (d) list” as not meeting water quality standards. With one exception, listed waters fail to meet standards for one or more of the parameters temperature, pH and dissolved oxygen (Weaver 1999). Dieldrin has been found in edible fish tissue (largemouth bass and lake whitefish) in Potholes Reservoir. Moses Lake has come of interest to the Washington Department of Ecology in the last 15 years because of high levels of nutrients (primarily nitrates and phosphates). On-farm demonstration projects sought to lower nutrient discharge to Moses Lake (Bain 1990). While effective, the methods have not been widely employed. Flushing the lake with fresh water directly out of canals has had some benefits, where water is poured into Rocky Coulee Wasteway, which drains into Crab Creek a short ways above Parker Horn

The middle section of Crab Creek suffers from muddy water during spring through summer from several causes: flood-born silt from eroded soils in the upper watershed; carp that stir up mud in shallow areas of lakes and streams; and irrigation return water bearing silt and fertilizers from croplands. The repository for these flows is Moses Lake. Temperature and dissolved oxygen, while unsatisfactory at times and contributing to small, localized losses of fish during summer, do not presently have major negative impacts on fish life within either Middle Crab Creek or Moses Lake. Further increases in nutrient loading may at some point, however, have detrimental effects on existing fisheries.

Lower Crab Creek (from below O'Sullivan Dam on Potholes Reservoir to the Columbia River): This is the only reach supporting anadromy. Fall Chinook and steelhead have been found upstream as far as, and into, Red Rock Coulee[2]. Chinook in significant numbers spawn in Red Rock Coulee (Bowen et al. 2003). Steelhead also spawn in Red Rock , and may be the progeny of steelhead smolt releases made several decades ago (NWPCC 2001). Adults have long been known to move into the stream in spring, and occasionally steelhead have been caught by anglers near the mouth of Red Rock and in the creek itself over the years (NWPCC 2001). That steelhead show some affinity to the creek hints that reproduction may be successful, at best in the cooler and cleaner waters of Red Rock. The converse is that these adults are pioneers from another run. This seems most probable, considering the long freshwater life of juvenile steelhead. Requiring two or more years of rearing in freshwater before heading seaward, young steelhead would, in Lower Crab Creek probably succumb to temperatures that approach the high 80s from late spring to late summer. Fall Chinook are better adapted to such places with their fall spawning habit (during cool temps) and the departure of age-0 young prior to summer heat (Bowen et al. 2003). The small rainbow trout of Red Rock are of undefined origin. The U.S. Bureau of Reclamation is completing a report on two years of inventory of anadromous fish in the Columbia Basin Project. This will be the most thorough work to date on presence, distribution, spawning sites and habitat use and may shed more light on steelhead origins and use within the drainage.

The extent of anadromous passage upstream is uncertain. A falls just downstream of McManamon Road is probably a formidable barrier. Private land below the road has not been assessed for passage barriers.

From O'Sullivan Dam where several springs join into the renewal of Crab Creek, WDFW for many years stocked fingerling rainbow and brown trout in the stream, and as well the many nearby lakes whose outlets contribute to Crab Creek flow. The section down to McManamon Road produced fat and large trout, some well over 2.3 kg. This fishery was maintained for several years with periodic rotenone treatments to control carp and other competitor species. Unable to prevent the return of carp, and a change in management emphasis by the U.S. Fish and Wildlife Service (Columbia National Wildlife Refuge) on key parts of the area, led WDFW abandoning efforts to maintain this fishery. Below the falls near McManamon Road, there is little opportunity to develop a notable fishery for any species. Too much of the fish biomass is comprised of sunfish, carp, sculpins and several other species to allow even a modest warmwater fishery.

The stream passes through an area dotted with scores of small lakes and marshes. Nearly all contain fish. Many are managed solely for warmwater species, primarily largemouth bass, bluegill, black crappie. Several lakes support a large mix of warmwater fishes, in

[2] "Red Rock Coulee" is the common name (Bowen et al. 2003) for the tributary located in Grant County in Lower Crab Creek. The Quincy Columbia Basin Irrigation District also refers to this as a wasteway.

addition to the species listed above: smallmouth bass, yellow perch, walleye, pumpkinseed sunfish, bullhead and channel catfish, and may also contain carp. These latter lakes generally yield low catch rates to anglers and offer sporadic success. Very popular trout fisheries exist in many other lakes. The management aim here is to keep these lakes free of non-salmonid species to maintain high yield to anglers. Lakes that have gained high notoriety over years include the ten-lake Pillar-Widgeon group, Hampton Lakes, Hutchinson and Shiner Lakes. All of the above lie on the Columbia National Wildlife Refuge. Elsewhere, anglers favor the Warden Lakes, Corral, Canal, Heart and the Windmill group of lakes. The darlings of Washington's fly anglers are Lenice, Merry and Nunnally near the mouth of Crab Creek. This Lower Crab Creek reach of the subbasin has a long history as a destination fishery, providing lowland lakes fisheries equal to the best that Washington has to offer. Almost 75 percent of the anglers using this area reside outside the Crab Creek drainage, with over 60 percent originating in Western Washington.

Water quality and habitat of the stream itself is poor throughout and contaminants include PCBs and dieldrin (Weaver 1999). Temperatures reach lethal levels for salmonids in the lower end. Soil laden irrigation return flows, the activities of carp, and occasional flooding disallow good water clarity during warm months and have left much of the streambed buried in muck, mostly that downstream of Highway 26. Much of the Lower Crab reach from below Highway 26 and west to its juncture with Red Rock Coulee is contained within dikes to protect adjacent croplands. Cattle operations over past 100 years and poor tillage practices have directly and indirectly stripped channel banks of riparian cover. [0]Changes in amount and duration of flows within the Crab Creek drainage has also contributed to erosion. The amount of riparian cover was also likley limited, as well since Crab Creek did not flow year-round.

Irrespective of these perturbations, Lower Crab Creek flows in quantities far above historic levels (pre-irrigation development), and it flows year around. This alone makes the lower reach better habitat for fish and wildlife than it ever was during pre-settlement. Water temperatures are elevated to extreme levels in summer, as much a natural condition for desert streams as a consequence of warmed discharge of lakes and irrigation return flows high in the reach.

Banks Lake and Billy Clapp Reservoir are artificial reservoirs located within the Crab Creek Subbasin which were created through the Columbia Basin Project. Banks Lake, part of the Columbia Basin Project, is an equalizing reservoir created by building two rock-faced, earthfill dams (North Dam and Dry Falls Dam) at the north and south ends of the Ice-Age channel of the Columbia River, now known as Grand Coulee. Major features forming and serving Banks Lake are the feeder canal with a capacity of 26,000 cubic feet per second, North Dam, 2 miles southwest of Grand Coulee Dam, and Dry Falls Dam and Main Canal headworks near Coulee City, 29 miles south of Grand Coulee Dam. North Dam is located on the northern edge of the area underlain by the Columbia Plateau lava. The structure is in the center of a deep, relatively flat bottomed, steep-walled canyon about 1.6 km downstream from the Columbia River gorge. Basalt flows and interbedded Latah beds underlie the northern part of North Dam. Dry Falls Dam is located 43 km

within the area underlain by the massive basalt flows of the Columbia Plateau lava. Banks Lake is formed by these two dams and is 27 miles long with 27,000 water surface acres. This reservoir, with an active storage capacity of 715,000 acre-feet, feeds Columbia River water into the Main Canal. In addition, it provides water on a return flow basis to produce power when the pump generating units are operating in the generating mode.

In conjunction with the addition of the six pump/generating units the canal size was increased. The south side of the canal was removed, the base widened from 50 feet to 80 feet, an entire new south wall constructed, 8 feet added to the top of the north wall, and a new flume section was added to bypass a duplex tunnel cut-and-cover section. This increased the operating capacity to 26,000 cubic feet per second. Reconstruction was completed in 1981.

The fisheries of Banks Lake have undergone many changes, both favorable as well as adverse since its construction in 1951. There are 22 fish species in Banks Lake of which 11 are actively pursued by anglers. This reservoir fishery offers anglers one of the very best year round freshwater fishing opportunities in the state (WDG 1982).

The Game Department made several kokanee fry plants in the 1960's and 1970's. However, the kokanee population is more dependent upon lake shore spawning to perpetuate the population and fishery. Kokanee are the mainstay of the fishery in Banks Lake which is considered to be the premier kokanee fishery in Washinton. Unfortunately kokanee are also the most sensitive fish species in the lake to environmental manipulations (WDG 1982).

Planting of hatchery rainbow trout fingerlings have resulted in a successful non-seasonal boat and bank fishery. This species is the third most sought after gamefish in Banks Lake, well behind kokanee and yellow perch. Environmental manipulations impact rainbow trout far less than kokanee. However, lake shore spawning of rainbow trout is not significant and annual hatchery fingerling plants must be made to sustain a viable fishery (WDG 1982).

Warmwater gamefish initially held the spotlight in Banks Lake, however, these populations have declined and stabilized. Today yellow perch are the second most popular fish species with anglers on Banks Lake. The average size has decreased some, yet this species provides an excellent year round fishery (WDG 1982).

Largemouth bass once the main attraction in the 1950's and 1960's hold the number four slot with Banks Lake anglers today. This species, though widespread throughout the lake, is somewhat confined to specific areas of preferred habitat.

Current management is for mixed species recreational fisheries including smallmouth bass, largemouth bass, yellow perch, rainbow trout, walleye, kokanee, black crappie, bullhead, and lake whitefish. A cooperative rainbow trout rearing project between WDFW, an Electric City sportsmen's group and Coulee City Chamber of Commerce

offers has been conducted to improve trout fishing. Several public access areas are well-developed, including a state park about mid-way up the lake and a city park at Coulee City on the south end.

Billy Clapp Reservoir is formed by Pinto Dam which is part of the Columbia Basin Project. The Main Canal begins at the headworks at Dry Falls Dam and consists of unlined and concrete- lined sections. Total length of the canal, including siphons, tunnels, and Billy Clapp Lake, is 18.4 miles. The first 1.8 miles from Dry Falls Dam to the Bacon Siphon and Tunnel structures has been increased in capacity from 13,200 to 19,300 cubic feet per second. Bacon Siphon and Tunnel structures consist of two siphons, each about 1,000 feet long, and two tunnels, each about 2 miles long, that carry the water to Billy Clapp Lake. This lake, some 6 miles long and formed by the construction of the earthfill Pinto Dam, is a segment of the canal system. Construction of an equal length of very difficult and expensive canal was thus avoided.

Billy Clapp Reservoir is a 1000 acre equalizing reservoir 10.5 miles downstream from Banks Lake. The lake is basically a wide spot in the main canal with an average inflow/outflow rate of 6500 cfs of water during normal irrigation demand periods. This results in a rather rapid turnover rate for the reservoir, less retention of nutrients, and a more lotic environment than Banks Lake. These characteristics complicates intensive management for this water body. Synonymous with irrigation waters is a continuous recruitment of the twenty plus fish species present. Gamefish as well as less desirable fish such as carp, northern pikeminnow, pumkinseed sunfish and suckers are common (WDG 1982).

Historically Billy Clapp was a very popular kokanee and walleye fishery. These two fish species accounted for around 95% of the fishing effort (Stober 1978). Stober's study gave evidence that Billy Clapp's kokanee fishery was somewhat dependent upon adult kokanee that emigrated from Banks Lake via the main canal. The installation of an outlet barrier net at Banks Lake from 1978-1981 appeared to have a negative impact on the Billy Clapp fisheries (WDG 1982).

The walleye fishery may also be dependent upon Banks Lake recruitment. Walleye fisheries in both Banks and Billy Clapp have declined rapidly in recent years. The high spring irrigation withdrawals may result in a significant loss of both spawning adult walleye and newly hatched fry (WDG 1982).

The future of Billy Clapp Reservoir is complicated with the installation of two low head hydro plants on the canal between Banks Lake and Billy Clapp Reservoir. Plants of hatchery fry may be the only option left to maintain the important kokanee and walleye fisheries. Additionally, inflows may double with future irrigation demands.

Lands around the 1,010 acre lake are included in a wildlife reserve program. Access is limited. Summer Falls State Park is located on the north end of the lake. The Department of Wildlife provides public access and the only boat ramp at the south end. Management is for mixed species recreational fisheries including yellow perch, black crappie, rainbow

trout, and walleye.

Topography/Geomorphology

Uplands areas of the Plateau are characterized by gently rolling loess-covered hills interspersed with channeled scablands – wide basalt terraces with steep walls. The landscape within much of this Subbasin was sculpted by the torrential Spokane Floods which took place approximately 12,000 to 15,000 years ago. Glaciated areas in portions of Lincoln and Douglas counties are marked with small water bodies, most of which are shallow ephemeral ponds that are watered in wet cycles and dry during drought years. The substrate consists of unconsolidated quaternary sediments and Columbia River basalt. Most of the soils in the subbasin are related to the volcanic history or the subsequent effects of glaciation, runoff, and flooding. The main soils in cropland-dominated areas are Bagdad, Broadax, Hanning, Renslow, Ritzville, Shano, Touhey, Willis, and Zen (Beieler 1978, Stockman 1978). The Aquolls, Haploxerolls, and Esquatzel soils are prone to wetness and/or flooding. The typical soils in rangeland areas include Anders, Bakeoven, Benge, Heytou, Lickskillet, Rock Creek, Roloff, Stratford, and Tucannon. Ponderosa pine areas tend to be dominated with Badge, Ewall, and Springdale soils.

Climate

The average temperatures in the Crab Creek Subbasin are 51°F minimum and 83°F maximum during summer and 21°F minimum and 36°F maximum during winter (U.S. Weather Service Website). The record minimum temperature was - 33°F recorded in Moses Lake and the record maximum temperature was 115°F recorded in Ephrata and Wilson Creek. Reardan tends to be the coldest location in the subbasin during winter; other locations tend to be 4 - 6°F warmer. Reardan, Wilbur, and Harrington tend to be the coolest locations during summer (50 - 80°F typical range). The other locations typically reach the mid-80°F range for summer highs and about 50°F for summer lows, with 2 exceptions; Ephrata and Quincy are typically in the upper 50°F range for summer lows.

The average precipitation in the subbasin is 10.1 inches. The driest locations (< 10 inches/year) include Quincy, Ephrata, Moses Lake, Wilson Creek, Lind, and Othello. Locations in the 10 – 12 inch precipitation zone include Ritzville, and Odessa. Harrington and Wilbur are in the > 12 inch precipitation zone. The driest year was 3 inches recorded for Ephrata in 1976. Winter is typically the wettest season in the subbasin, with substantial portions of the precipitation falling as snow. The average annual snowfall is 21.4 inches. Othello receives the smallest amount at < 10 inches; Odessa, Moses Lake, Quincy, Lind, Ephrata, and Ritzville average 10 – 20 inches; Harrington and Wilson Creek average 20 – 30 inches.

Vegetation

Habitats that are not converted are typically shrubsteppe. Daubenmire (1970) described shrubsteppe as vegetative communities consisting of one or more layers of perennial grass with a conspicuous but discontinuous overstory layer of shrubs. In the Crab Creek Subbasin, shrubsteppe also includes ‘meadowsteppe’ and ‘steppe’ habitats which may

have a relatively low frequency of shrubs. The dominant shrubs include sagebrush (*Artemisia spp.*), rabbitbrush (*Chrysothamnus spp*.), bitterbrush (*Purshia tridentate*), grease wood (*Sarcobatus spp*.), and Spiny hopsage (*Grayia spinosa*). The dominant grasses include native bunchgrasses (*Poa*, *Stipa*, and *Agropyron spp*.) and non-native downy brome (*Bromus tectorum*). Riparian vegetation consists of willows (*Salix spp*.), rose (*Rosa spp.*), water birch (*Betula occidentalis*), black cottonwood (*Populus angustifolia*), aspen (*P. termuloides*), hawthorn (*Crataegus douglasii*), and service berry (Amelanchier anifolia).

Land Use and Demographics

The economy is dominated by agriculture. Although the area has a long history of occupation by native peoples (Coullier et al. 1942), large-scale conversion of and from shrubsteppe to cropland began in the late 1800's and expanded when irrigation became widespread after the damming of the Columbia River in the 1930's (National Research Council 1995). The delivery of irrigation water to the Columbia Basin Irrigation Project in 1952 dramatically changed the appearance and ecology of the southwest corner of this Subbasin from mostly shrubsteppe to a huge system of reservoirs, canals, wasteways, and irrigated farmland. The Columbia Basin Project irrigates greater than 2500 square kilometers of land. Outside of the Irrigation Project dry-land wheat farming and cattle grazing dominate. The major crops in the eastern and northern Crab Creek Subbasin are cereal grains. Agriculture within the irrigation project is more diverse and crops include alfalfa, wheat, corn, potatoes, various tree fruits and many different seed crops. Vineyards and pulp farms have begun to appear recently. The major municipalities within this Subbasin are Moses Lake (pop. 14,290), Ephrata (pop. 6,170), Othello (pop. 5,445), Quincy (pop. 4,185), Warden (pop. 2,335), Ritzville (1,730), Royal City (pop. 1,680), and Odessa (pop. 987).

Cropland

Crop production is the most abundant current land use within the Crab Creek Subbasin. Most croplands are in irrigated or dryland crops or cattle pasture (Jacobson and Snyder 2000, Johnson and O'Neil, 2001). The major crops include cereal grains like wheat, barley, and corn, potatoes, onions, and fruit (apples, cherries, peaches, and pears). Most of the cereal grains (other than corn) are produced without irrigation; the other crops are typically irrigated, most with the benefit of the Columbia Basin Irrigation Project. Although certain amounts of cropland have been shown to benefit wildlife, particularly when configured appropriately with native habitat, the widespread and continuous nature of the current croplands have been shown to be detrimental for most species (Buss and Dziedzic 1955).

The deep soil habitats were the first areas to be used for commercial crops by the earliest pioneers. Buss (1965) indicated that the first pioneers were homesteading in the valleys and canyons and that domestic livestock created ecological disturbances which helped to modify the wildlife community. For example, as agriculture became more common in the

Crab Creek Subbasin, Canada geese[3] became year round residents and nested here (Buss, 1965), and sandhill cranes became less common except during migration. Generally, "monoculture agriculture" has greatly changed the distribution and abundance of wildlife species in this subbasin. Examples are sharp-tailed grouse, sage grouse, mule deer, and neotropical migrants (sage sparrow, sage thrasher, loggerhead shrike, and others).

CRP

CRP (Conservation Reserve Program) is a federal program with contracts of at least 10 years that resulted in the 'set-aside' of approximately 25% of the cropland in the Crab Creek Subbasin. These habitats were planted with perennial grasses starting in the mid-1980's. Although most of the earlier CRP was planted in a monoculture of crested wheatgrass (*Agropyron cristatum*), most of the recent CRP includes a diversity of native grasses, forbs, and shrubs. Research has indicated that CRP may benefit key species of wildlife within the Crab Creek Subbasin including sage grouse and sharp-tailed grouse (Schroeder et al. 2000a, b). This benefit appears be due, in part, to a synergistic relationship between CRP and native shrubsteppe habitat. The quality of CRP appears to be improved when it's adjacent to shrubsteppe and the quality of shrubsteppe appears to be improved when the remaining native habitat is interconnected by CRP.

Cliffs

Barren ground such as steep canyon walls and cliffs can offer protective habitat for numerous species of wildlife. [0]Cliffs may also support rare, threatened, or endangered plants, as these areas generally do not experince the disturbance or amount of disturbance as other areas. This may include nesting and roosting habitat, perches for hunting, and hibernacula for winter. Cliffs form a relatively small but important part of the habitat within this Subbasin. Indirect impacts to this habitat and the species that depend on it include conversion and alteration of the surrounding habitats and direct disturbance from mining and human recreation (target shooting, rock climbing, camping near bat roost sites, etc.).

Open Water

Water is an important resource in the Crab Creek Subbasin, especially for wildlife. The usefulness of open water is increased when the adjacent habitats are of high quality and quantity and offer necessary cover for nesting, roosting, and feeding. In addition, the negative consequences of poor land use in adjacent habitats can negatively impact the quality of the open water by adding numerous chemicals such as pesticides, herbicides, and fertilizers (Williamson et al. 1998). These chemicals can impact wildlife directly through poisoning or indirectly through reduction and/or alteration of the food base.

Riparian and Wetland

Riparian and wetland habitats are limited geographically and are vulnerable to loss and degradation through human activities and land use decisions. Since the arrival of settlers

[3] Genus and species information for all wildlife referred to by common name are listed in Table 1.

in the early 1800's, 50 to 90% of riparian habitat in Washington has been lost or extensively modified (Buss 1965). Protecting riparian habitat may yield the greatest gains for fish and wildlife while involving the least amount of area (Knutson and Naef 1997). Negative impacts of fragmentation on wildlife require that increased attention be given to buffer zone design around riparian habitats (O'Connell et at. 2000). Currently, riparian buffers average 9.1 m for Crab Creek tributaries (NWPCC 2001).

Other Habitats

Other habitats include infrequent types like sand dunes, forest/shrubs, and urban. Although none of these habitats are abundant, urban habitats are increasing in size, distribution, and influence throughout the Crab Creek Subbasin. The subbasin has grown in popularity as a preferred area for primary residential and secondary recreational home sites. As the population increases, more impacts to habitat and water quality are inevitable. Residential growth is moderate in most communities in this subbasin with the exception of Moses Lake where growth is occurring rapidly. Development is particularly rapid along lakeshores and streams.

Hydrologic Function

The size of this Subbasin is 13,200 square kilometers. Major tributaries of Crab Creek include the following creeks Blue Stem, Rock (Lincoln County), Lords, Coal, Duck, Lake, Canniiwai, Wilson, Homestead Creek and Rocky Ford, and various intermittent and permanent irrigation return-flow (wasteways) of the Columbia Basin Irrigation Project. In addition several coulees that had intermittent streams prior to the Columbia Basin Project now support perennial flow, and include Rocky, Lind, and Red Rock coulees. Crab Creek flows through several lakes starting with Sylvan Lake in south-central Lincoln County, then Brook Lake, Round Lake, Willow Lake, Moses Lake, and Potholes Reservoir in Grant County. In many areas along its way Crab Creek flows below the surface. Changes in adjacent hydrology affect when and where the creek may resurface which can vary from year to year. The ground-water table in lower Crab Creek has risen between 50 and 500 ft since 1950, as a result of the Irrigation Project. During the same time period upper Crab Creek's ground-water table has declined 150 ft, because of increased ground water withdrawals for irrigation.

The Bureau of Reclamation's Columbia Basin Irrigation Project has the greatest influences on hydrology within the Crab Creek Subbasin (www.usbr.gov). More water is pumped into the Subbasin from the Columbia River than all natural sources within the Subbasin. Return flows after irrigation use, excess water, and leakage from the project all contribute considerable water to this system. O'Sullivan Dam impounds Crab Creek below Moses Lake and collects Columbia Basin Irrigation water to create Potholes Reservoir (11,100 hectares). O'Sullivan Dam restricts upstream fish travel. This lower section below the dam contains approximately 40 linear miles of perennial stream habitat. Many lakes now occur as a result of the Irrigation Project that supports significant recreational fisheries.

Crab Creek has been described as the longest intermittent creek in North America. However, the upper portion of Crab Creek, many of its tributaries (such as Sinking

Creek), actually have perennial flow of water that occurs immediately below the surface layer of basalt. This pattern of flow has resulted in creeks that fluctuate between surface and subsurface depending on the specific location, time of year, and weather conditions. In contrast, lower Crab Creek now has perennial surface flow as a result of return flow from the Columbia Basin Irrigation Project. Lower Crab Creek has four to five times the flow that occurred prior to the irrigation project (http://wa.water.usgs.gov). This section of the creek has been highly modified with irrigation diversions, watercontrolstructures, and channelization. These modifications along with increased flow have caused severe erosion, bank sloughing, and head cutting. Fish passage, habitat, and water-quality have all been compromised.

Information regarding water quantity, quality, insteam flow, habitat is being assembled through the Watershed Planning Process in WRIA 43 (Upper Crab Creek). Information pertaining to water quality and quantity is also collected at locations throughout the subbasin by various entities including irrigation districts, USBOR, USFWS, GCPUD, WDFW, USGS, and WDOE.

Fish distribution

Comprehensive quantitative fish distribution information was not available for the Crab Creek Subbasin and is therefore not presented here. However, determination of salmonid presence/absence for all stream reaches is an essential component of the Qualitative Habitat Analysis (QHA) used in the Assessment portion of this Subbasin Plan. Existing information pertaining to salmonid presence (WDFW planting records, survey data, Streamnet data) was used where available to improve the confidence ratings within the QHA model. In cases where documentation indicating salmonids presence was lacking, expert opinion and local knowledge where relied upon to complete the model.

Artificial Production

Artificial production in the Crab Creek Subbasin differs greatly in the lower and upper halves of the basin. In the lower half (WDFW Region 2) production is to support non-native recreational fisheries including warm water fisheries. Salmonids are planted in lake systems for put and take and include brown trout, tiger trout, rainbow trout (including triploid), cutthroat trout (including Lahontan strain), eastern brook, and kokanee. These are planted as fingerlings or at catchable size. Warmwater fish are planted to support natural production of warmwater species in lakes and reservoirs. These have included largemouth bass (including Florida strain), smallmouth bass, bluegill, black crappie, walleye, and channel catfish. Tiger muskellunge, a sterile hybrid cross between northern pike and muskellunge, have also been planted in Red Rock Lake and Evergreen Lake to control undesirable fish species and to support a put and take fishery. Hatchery facilities that provide fish for the portion of the Crab Creek Subbasin managed through the WDFW Region 2 Office include: Columbia Basin Hatchery (WDFW), Omak Hatchery (WDFW), Ford Hatchery (WDFW), Meseberg (WDFW-Warmwater), Spokane Tribal Hatchery (Spokane Tribe), and Trout Lodge (Private).

The upper half of the free-flowing portion of the subbasin (WDFW Region 1 from the confluence of Wilson Creek upstream to the headwaters) is currently managed for natural

trout production. Both indigenous and non-indigenous salmonids have been planted in past years . Salmonids are currently planted in multiple lakes in the Lake Creek drainage from the WDFW Spokane Hatchery facility. Yellowstone cutthroat from the Henry's Fork of the Snake River and Yellowstone Lake in tributaries of Crab Creek in 1900 (Ravenal 1901), 1901 (Ravenal 1902), 1903 and 1906 (Bowers 1907). Their plantings predate, by two to eight years, the first recorded report of a cutthroat from the Crab Creek drainages in 1908 (Evermann and Nichols 1909). Additionally, westslope cutthroat trout (Lake Chelan stock) were introduced into Crab Creek in 1907 and 1908 (Riseland 1909). Since that time hatchery rainbow trout (primarily Spokane stock originally derived from coastal steelhead/rainbow from the McCloud River), which spawn in the fall (*i.e*. *O. mykiss irideus*), brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), kokanee (*O. nerka*), and a variety of other species have been stocked (NWPCC 2001).

Terrestrial / Wildlife Resources

Many of the wildlife species found in the Crab Creek Subbasin (Table 1) are listed by the state of Washington or the U.S. government as sensitive, threatened, endangered or as candidates for listing. The presence, distribution, and abundance of these species has been affected by habitat losses due to several factors including hydropower, agriculture, irrigation, urbanization, road construction, legal and illegal wildlife harvest, livestock grazing, and introduction of noxious weeds.

Specific habitat-population impacts have been documented for many of the species in Table 1. For some, like many species of bats, complete life history information is lacking.

Table 1. Wildlife Species of Interest within Crab Creek Subbasin

Common Name	Scientific Name	Status[1]	Behavior[2]	References
MAMMALS: Mammals are addressed in general by the WDFW's Priority Habitat and Species Program (WDFW 2000b).				
Merriam's Shrew	*Sorex trowbridgii*	SC	Y, S	WDFW 2000b
Northern Grasshopper Mouse	*Onychomys leucogaster*		Y, S	WDFW 2000b
Washington Ground Squirrel	*Spermophilus washingtoni*	C, FC	Y, S	WDFW 2000b
Sagebrush Vole	*Lagurus curtatus*		Y, S	WDFW 2000b
Pygmy Rabbit	*Sylvilagus idahoensis*	E, SC	Y, S	WDFW 1995c, 2000b; Musser and McCall 2000
White-tailed Jackrabbit	*Lepus townsendii*	C	Y, S	WDFW 2000b
Black-tailed Jackrabbit	*Lepus californicus*	C	Y, S	WDFW 2000b
Mountain Cottontail	*Sylvilagus nuttalli*	G	Y, S, R, U, D, F	WDFW 2000b
Badger	*Taxidea taxus*	G	Y, S	WDFW 2000b
Bobcat	*Lynx rufus*	G	Y, S, C	WDFW 2000b
Gray Wolf	*Canis lupus*	G	Y, S, C	WDFW 2000b
Raccoon	*Procyon lotor*	G	Y, R, I, F, G, W	WDFW 2000b
Columbian Ground Squirrel	*Citellus columbianus*	G	Y, S	WDFW 2000b
Mink	*Mustela vison*	G	Y, R, W	WDFW 2000b
Muskrat	*Ondatra zibethica*	G	Y, W, R	WDFW 2000b
Beaver	*Castor canadensis*	G	Y, W, R	WDFW 2000b
River Otter	*Lutra canadensis*	G	Y, W, R	WDFW 2000b
Cougar	*Felix concolor*	G	Y, S, C	WDFW 2000b
Black Bear	*Ursus americanus*	G	Y, R, F	WDFW 2000b
Myotis bats: The WDFW's Priority Habitat and Species Program identifies roosting areas for Myotis bats as a priority.				
Little Brown Bat	*Myotis lucifugus*		M, S, C	WDFW 2000b
Yuma mMotis	*Myotis yumanensis*	SC	M, S, C	WDFW 2000b
Keen's Myotis	*Myotiz keenii*		M, S, C	WDFW 2000b
Fringed Myotis	*Myotis thysanodes*		M, S, C	WDFW 2000b

Common Name	Scientific Name	Status[1]	Behavior[2]	References
Small-footed Myotis	*Myotis subulatus*		M, S, C	WDFW 2000b
Long-eared Myotis	*Myotis evotis*		M, S, C	WDFW 2000b
Fringed Myotis	*Myotis thysanodes*		M, S, C	WDFW 2000b
Long-legged Myotis	*Myotis volans*		M, S, C	WDFW 2000b
California Myotis	*Myotis californicus*		M, S, C	WDFW 2000b
Silver-Haired Bat	*Lasionycteris noctivagans*		M, S, C	WDFW 2000b
Western Pipistrelle	*Pipistrellus hesperus*		M, S, C	WDFW 2000b
Big Brown Bat	*Eptesicus fuscus*		M, S, C	WDFW 2000b
Pallid Bat	*Antrozous pallidus*		M, S, C	WDFW 2000b
Hoary Bat	*Lasiurus cinereus*		M, S, C	WDFW 2000b
Townsend's Big-eared Bat	*Corynorhinus townsendii*	C, SC	M, S, C	WDFW 2000b
Spotted Bat	*Euderma maculata*		M, S, C	WDFW 2000b
Mule Deer	*Odocoileus hemionus*	G	Y, G	WDFW 2000b
White-tailed Deer	*Odocoileus virginianus*	G	Y, G	WDFW 2000b
Birds: Birds are addressed in general by the WDFW's Priority Habitat and Species Program (Hickman 1987, Smith et al. 1997, Schroeder 2000, WDFW 2000b).				
Common Loon	*Gavia immer*	S	M, W	Lewis et al. 2000
American White Pelican	*Pelecanus erythrorhynchos*	E	M, W	Doran et al. 2000
Black-crowned Night Heron	*Nycticorax nycticorax*		M, W, R	Smith et al. 1997
Great Blue Heron	*Ardea herodias*		M, W, R	Quinn and Milner 2000
American Bittern	*Botaurus lentiginosus*		B, W, R	WDFW 2000b
Double Crested Cormorant	*Phalacrocorax auritus*		B, W, R, F	WDFW 2000b
Common Egret	*Casmerodius albus*		B, W, R, F	WDFW 2000b
Western Grebe	*Aechmophorus occidentalis*		B, W	WDFW 2000b
Clarks Grebe			B, W	WDFW 2000b
Horned Grebe	*Podiceps auritus*		B, W, R	WDFW 2000b
Eared Grebe	*Podiceps caspicus*		B, W, R	WDFW 2000b
Terns: The Washington Department of Fish and Wildlife's Priority Habitat and Species Program identifies areas where terns breed as a priority.				

Common Name	Scientific Name	Status[1]	Behavior[2]	References
Black Tern	*Chlidonias niger*		M, W	Smith et al. 1997
Caspian Tern	*Sterna caspia*		M, W	Smith et al. 1997
Forster's Tern	*Sterna forsteri*		B, M, W	WDFW 2000b
Swans: The Washington Department of Fish and Wildlife's Priority Habitat and Species Program identifies areas where native swans occur as a priority.				
Tundra Swan	*Cygnus columbianus*	G	M, W, D, I	WDFW 2000b
Trumpeter Swan	*Cygnus buccinator*	G	M, W, D, I	WDFW 2000b
Waterfowl concentrations: Significant breeding areas and locations where regular large concentrations occur are identified as a priority by the WDFW's Priority Habitat and Species Program.				
Greater White-Fronted Goose	*Anser albifrons frontalis*	G	M, W, D, I	WDFW 2000b
Tule White-Fronted Goose	*Anser albifrons gambelli*	G	M, W, D, I,	WDFW 2000b
Canada Goose (multiple subspecies)	*Branta canadensis spp.*	G	M, B, W, D, I	Smith et al. 1997, WDFW 2000b
Mallard	*Anas platyrhynchos*	G	M, B, W, D, I	Smith et al. 1997, WDFW 2000b
Gadwall	*Anas strepera*	G	M, B, W, D, I	Smith et al. 1997, WDFW 2000b
Green-winged Teal	*Anas crecca*	G	M, B, W, D, I	Smith et al. 1997, WDFW 2000b
American Wigeon	*Anas americana*	G	M, B, W, D, I	Smith et al. 1997, WDFW 2000b
Northern Pintail	*Anas acuta*	G	M, B, W, D, I	Smith et al. 1997, WDFW 2000b
Northern Shoveler	*Anas clypeata*	G	M, B, W, D, I	Smith et al. 1997, WDFW 2000b
Blue-Winged Teal	*Anas discors*	G	M, B, W, D, I	Smith et al. 1997, WDFW 2000b
Cinnamon Teal	*Anas cyanoptera*	G	M, B, W, D, I	Smith et al. 1997, WDFW 2000b

Common Name	Scientific Name	Status[1]	Behavior[2]	References
Ruddy Duck	*Oxyura jamaicensis*	G	M, B, W	Smith et al. 1997, WDFW 2000b
Canvasback	*Aythya valisineria*	G	M, B, W	Smith et al. 1997, WDFW 2000b
Redhead	*Aythya Americana*	G	M, B, W	Smith et al. 1997, WDFW 2000b
Ring-necked Duck	*Aythya collaris*	G	M, B, W	Smith et al. 1997, WDFW 2000b
Lesser Scaup	*Aythya affinis*	G	M, B, W	Smith et al. 1997, WDFW 2000b
Bald Eagle	*Haleaeetus leucocephalus*	T, FT	Y, G	Smith et al. 1997, WDFW 2000b
Golden Eagle	*Aquila chrysaetos*	C	Y, S, C	Smith et al. 1997, WDFW 2000b
Swainson's Hawk	*Buteo swainsoni*		B, S	WDFW 2000b
Ferruginous Hawk	*Buteo regalis*	T, SC	B, S	Richardson et al. 2000, WDFW 1996
Northern Goshawk	*Accipiter gentilis*	C, SC	M, R, F	Smith et al. 1997, WDFW 2000b
Merlin	*Falco columbarius*	C	M, R, F, U	Smith et al. 1997, WDFW 2000b
Peregrine Falcon	*Falco peregrinus*	E, SC	Y, C	Hays and Milner 2000
Prairie Falcon	*Falco mexicanus*	G[3]	Y, S, C	Hays and Dobler 2000
Gyrfalcons	*Falco rusticolus*	G[4]		WDFW 2000b
Sharp-tailed Grouse	*Tympanuchus phasianellus*	T, SC	Y, S, R, D	WDFW 1995b, Hays et al. 1998b, Schroeder et al. 2000a

Common Name	Scientific Name	Status[1]	Behavior[2]	References
Sage Grouse	*Centrocercus urophasianus*	T, SC	Y, S, D	WDFW 1995a, Hays et al. 1998a, Schroeder et al. 2000b
Blue Grouse	*Dendragapus obscurus*	G	B, S, F	Ware 2000, WDFW 2000b
California Quail	*Lophortyx californicus*	G	Y, S, R, R	WDFW 2000b
Gray Partridge	*Perdix perdix*	G	Y, S, D	WDFW 2000b
Chukar	*Alectoris chukar*	G	Y, S, C	Ware and Tirhi 2000a
Ring-necked Pheasant	*Phasianus colchicus*	G	Y, S, I, R	Ware and Tirhi 2000b
Wild Turkey	*Meleagris gallopavo*	G	B, S, D, R, F	Hickman 1998, Ware and Hickman 1999, Morgan et al. 2000
Sandhill Crane	*Grus canadensis*	E	M, D	Bettinger and Milner 2000
Upland Sandpiper	*Bartramia longicauda*	E	X, S	Smith et al. 1997, WDFW 2000b
Long-billed Curlew	*Numenius americanus*	N	B, S	Smith et al. 1997
Phalaropes, avocets, and stilts: The Washington Department of Fish and Wildlife's Priority Habitat and Species Program identifies breeding areas for phalaropes, avocets, and stilts as a priority.				
Wilson's Phalarope	*Phalaropus tricolor*	N	B, W	Smith et al. 1997
American Avocet	*Recurvirostra Americana*	N	B, W	Smith et al. 1997
Black-necked Stilt	*Himantopus mexicanus*	N	B, W	Smith et al. 1997
Yellow-billed Cuckoo	*Cuccyzus americanus*	C, SC	X, R, F	Smith et al. 1997, WDFW 2000b
Snowy Owl	*Nyctea scandiaca*		M	WDFW 2000b
Burrowing owl	*Athene cunicularia*	C, SC	B, S	Smith et al. 1997, WDFW 2000b
Lewis' Woodpecker	*Melanerpes lewis*	C	Y, R, S	Smith et al. 1997, WDFW 2000b

Common Name	Scientific Name	Status[1]	Behavior[2]	References
Olive-sided Flycatcher	*Contopus borealis*	SC	B, R	Smith et al. 1997, WDFW 2000b
Willow Flycatcher	*Empidonax traillii*	SC	B, R	Smith et al. 1997, WDFW 2000b
Sage Thrasher	*Oreoscoptes montanus*	C	B, S	Smith et al. 1997, WDFW 2000b
Loggerhead Shrike	*Lanius ludovicianus*	C, SC	B, S	Smith et al. 1997, WDFW 2000b
Sage Sparrow	*Amphispiza belli*	C	B, S	Smith et al. 1997, WDFW 2000b
Brewer's Sparrow	*Spizella breweri*		B, S	Smith et al. 1997
Grasshopper Sparrow	*Ammodramus savannarum*		B, S	Smith et al. 1997
Reptiles: Reptiles are addressed in general by the WDFW's Priority Habitat and Species Program (Larsen 1997, WDFW 2000b).				
Sagebrush Lizard	*Sceloporus graciosus*	SC	Y, S	WDFW 2000b
Pygmy horned Lizard	*Phrynosoma douglassi*		Y, S	WDFW 2000b
Striped Whipsnake	*Masticophis taeniatus*	C	Y, S	Nordstrom and Whalen 1997
Ringneck Snake	*Diadophis punctatus*	C	S	WDFW 2000b
Western Rattlesnake	*Crotalus veridus*		Y, S, C	WDFW 2000b
Night Snake	*Hypsiglena torquata*		Y, S, C	WDFW 2000b
Amphibians: Amphibians are addressed in general by the WDFW's Priority Habitat and Species Program (Larsen 1997, WDFW 2000b).				
Columbia Spotted Frog	*Rana luteiventris*	C, SC	Y, W, R	Nordstrom and Milner 1997
Northern Leopard Frog	*Rana pipiens*	E	Y, W, R	Nordstrom 1997
Western Toad	*Bufo boreas*	C, SC	Y, W, R	WDFW 2000b
Invertebrates: Invertebrates are addressed in general by the WDFW's Priority Habitat and Species Program (Larsen et al. 1995, WDFW 2000b).				
Yuma Skipper	*Ochlodes yuma*	C	W, R	Larsen et al. 1995
Silver-bordered Bog Fritillary	*Boloria selene atrocostalis*	C	R	Larsen et al. 1995

[1]Status: C = State candidate; T = State threatened; E = State endangered; S = State sensitive; G = Game animal subject to harvest regulations; SC = Federal species of concern; FC = Federal candidate; FT = Federal threatened; and FE = Federal endangered; N=no special status
[2]Behavior and habitat designations: B = Breeding; M = Migratory and/or winter; Y = yearlong resident; X = Extinct in area; S = Shrub steppe; W = Open water; R = Riparian and wetland; C = Cliffs; U = urban; I = Irrigated cropland; D = Nonirrigated cropland; F = forest; and G = General use of most or all habitats.
[3]Take of prairie falcons for recreational purposes (falconry) is by state and federal permits
[4]Take of gyrfalcons for recreational purposes is restricted by state permit to 5 per year; most are taken from the Crab Creek Subbasin.

Birds

Shrubsteppe Obligates

The vast majority of the Crab Creek Subbasin historically consisted of shrubsteppe (Daubenmire 1970). Many of the species of interest (Table 1) are those that require shrubsteppe habitat for all, or a substantial portion, of their annual life cycle. Many of these species have been adversely impacted by habitat conversion to alternate uses, such as irrigated and dry land agriculture, water impoundments associated with dams, and urban/residential development. Changes in the landscape related to habitat conversion that have affected shrubsteppe wildlife include: fragmentation of extant shrubsteppe habitat, differential loss of deep-soil communities, and alteration of the vegetation community resulting from grazing by livestock, invasion by exotic plants, and increased fire frequencies (Vander Haegen et al. 2001).

Sage Grouse

Sage grouse were historically found in shrubsteppe habitats throughout eastern Washington. The current population in Washington is estimated to be around 1000, with about 700 of the birds residing in a contiguous subpopulation in Douglas and Grant counties; almost entirely within the Crab Creek Subbasin (Schroeder et al. 2000b). An additional subpopulation of 300 birds is found in Yakima and Kittitas counties, approximately 50 km from the Crab Creek population. The two populations are largely separated by the Columbia Basin Project in western Grant County. Their populations are continuing to decline in Washington due to long-term effects of habitat conversion, degradation, fragmentation, and population isolation (Hays et al. 1998, Schroeder et al. 2000b). Sage grouse in Washington declined 77% between 1960 and 1999 (Schroeder et al. 2000b).

Sharp-tailed Grouse

Sharp-tailed grouse were historically found in shrubsteppe and deciduous shrub communities throughout eastern Washington. The current population in Washington is estimated to be 600, with about one third of the birds residing in the Crab Creek Subbasin (Schroeder et al. 2000a). Sharp-tailed grouse populations in Washington declined 94% between 1960 and 2000. The remaining birds are found in eight relatively small, isolated, subpopulations; one subpopulation is found entirely within the Crab Creek Subbasin (Lincoln County), and two other subpopulations are on the edge of the subbasin (NW and

NE Douglas County). Subpopulations are separated from adjacent subpopulations by at least 20 km. Sharp-tailed grouse are continuing to decline in Washington due to long-term effects of habitat conversion, degradation, fragmentation, and population isolation (Hays et al. 1998b, Schroeder et al. 2000a).

Ferruginous Hawk

Ferruginous hawks were historically found in shrubsteppe habitat throughout the Crab Creek Subbasin. Data from 1995 – 1997 indicate that < 30% of at least 222 historic breeding territories were occupied, mostly along Moses Coulee and Crab Creek (WDFW 1996; WDFW, unpubl. data). The regional decline in abundance of ferruginous hawks has been tied to shrubsteppe habitat alteration associated with cultivation and grazing, and with subsequent declines in abundance of prey species.

Historic information suggests black-tailed jackrabbits, white-tailed jackrabbits, and Washington ground squirrels were important prey for nesting ferruginous hawks in Washington (Watson and Pierce 2000). All three species of mammals currently are candidates for listing within Washington due to their low and/or declining abundance; the Washington ground squirrel is also a candidate for federal listing (Table 1). Research on the Hanford Nuclear Reservation confirmed that adult ferruginous hawks were flying up to 15 km off site to forage for pocket gophers, a small alternate prey species (Leary 1996). These long flights to foraging areas may reduce adult nest attendance and potentially may increase mortality of young.

Golden Eagles

Golden eagles are prominent raptors in shrubsteppe habitats throughout Washington. Data collected since 1987 suggests that < 50% of 200 historic golden eagle territories in Washington are currently occupied (WDFW, unpubl. data). Thirteen golden eagle territories have been documented in the Crab Creek Subbasin, primarily north of Quincy Reasons for low site occupancy in the subbasin may be related to low prey abundance in shrubsteppe habitats near nest sites. Principal prey, such as blacktailed jackrabbits, white-tailed jackrabbits, and Washington ground squirrels, have declined dramatically, largely as a result of conversion and degradation of shrubsteppe habitat. A further concern may be toxic lead poisoning, possibly associated with pesticide residues in orchards along the Columbia River (W. Yake, WDOE, pers. comm.) or with lead shot or bullets in the carcasses of prey (E. Stauber, Washington State University, pers. comm.; T. Talcott, University of Idaho, pers. comm.).

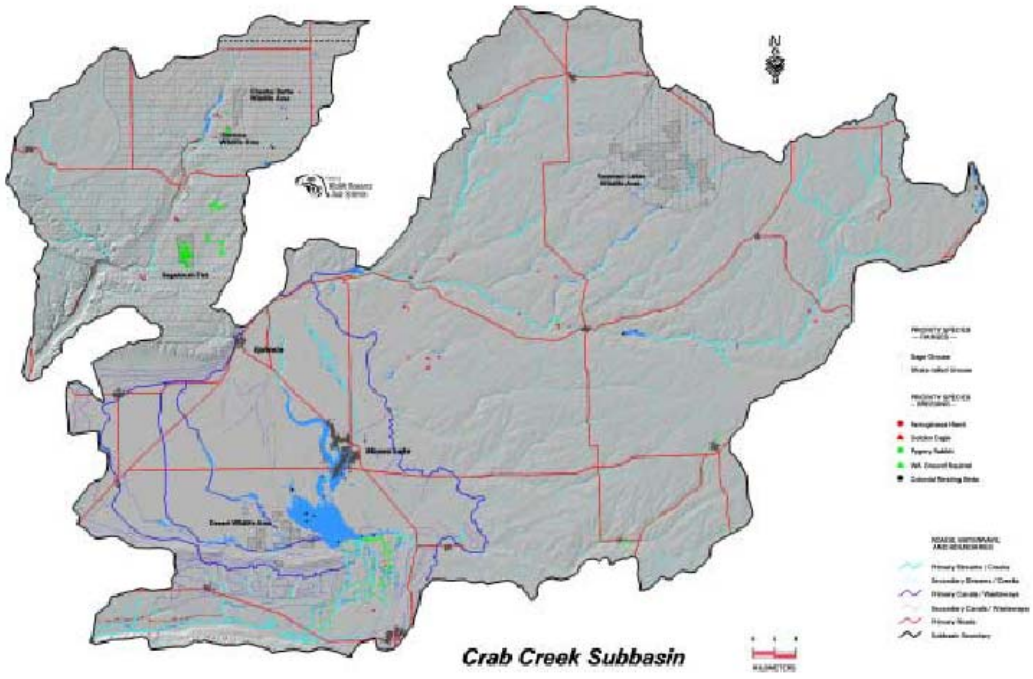

Figure 3. Priority Species

Other Shrubsteppe Obligates

Sage thrasher, loggerhead shrike, sage sparrow, and Brewer's sparrow are neotropical migrants that appear to be closely associated with shrubsteppe habitat (Vander Haegen et al. 2000). Populations of most shrubsteppe-associated songbirds appear to be declining (Saab and Rich 1997). Fragmentation and degradation of shrubsteppe adversely affect some species, although relatively few have been studied. Sage sparrows are less abundant (Vander Haegen et al. 2001) and Brewer's sparrows and sage thrashers are less productive (WDFW, unpubl. data) in fragmented landscapes. In addition, Brewer's sparrows and sage thrashers are less abundant in shrubsteppe habitats of relatively poor quality (Vander Haegen et al. 2001). Habitat-specific population parameters, including productivity, dispersal, and adult and juvenile survival are unknown for most of these species. Numerous species, including sage sparrows and grasshopper sparrows, are not monitored adequately by the Breeding Bird Survey and will require specialized monitoring to detect and monitor population changes (Saab and Rich 1997).

Colonial Nesting Birds

American white pelicans, Caspian terns, black-crowned night herons, double crested cormorants, common Egrets and great blue herons are known to nest in relatively clustered and identifiable locations, typically referred to as colonies (Smith et al. 1997, NWPCC 2001). Because of the identifiable, and potential limiting nature of colonial habitats their protection is an important consideration in management. For example, blackcrowned night herons, great blue herons, common egrets, and double crested

cormorants, use specific riparian habitats in the Columbia Basin Irrigation Project for nesting. In contrast, Caspian terns tend to nest on specific islands that have resulted from the Columbia Basin Irrigation Project, i.e. Potholes Reservoir. Some of these colonial nesters feed on young salmonids in the Columbia River. Their foraging habits and impacts on anadromous fish may be substantial.

Burrowing Owl

Burrowing owls appear to be associated with open habitats, particularly shrubsteppe, in Washington. Although these sites are often relatively disturbed, burrowing owls appear to be declining in the subbasin, based on incidental observations and recent inventories (Bartels and Tabor 1999). Some of the declines appear to be related to long-term loss in availability of potential burrows. The decline in number of burrows may be an indirect result of declines of mammals including pygmy rabbits, badgers, and ground squirrels whose deserted burrows are readily used by burrowing owls. In some parts of the subbasin, however, burrowing owls have declined at locations where burrows were available. The explanation for these declines is not clear.

Upland Game Birds

Ring-necked pheasant, an introduced species, is the most popular game animal in the subbasin. Although pheasant numbers increased dramatically as a result of the Columbia Basin Project and establishment of irrigated farming in the subbasin, they have declined dramatically in the last 20 years (WDFW 2000a). The specific causes of the decline in recent years have not been accurately identified but are suspected to be related to changing agricultural practices and loss of winter habitat. The other upland game birds (chukar, gray partridge, California quail, wild turkey) have been influenced both negatively and positively by changes in the Subbasin, depending on the species, habitat, and location.

Waterfowl

Waterfowl are seasonally abundant in the Crab Creek Subbasin. The semiarid climate and irregular precipitation patterns support highly productive ephemeral and semi-permanent wetlands, particularly in Lincoln and Douglas counties. During years with adequate precipitation, these wetlands support the most productive and diverse waterfowl breeding communities in the Pacific Northwest. Grasslands and shrubsteppe habitats surrounding these wetlands provide habitat for upland nesting ducks The Columbia Basin Irrigation Project has created numerous wetlands that are more persistent but less productive for breeding waterfowl as a result of wetland succession and invasion by exotic, undesirable vegetation. The cereal grains, corn, and other crops that are grown in this Subbasin, in concert with large reservoirs, wetlands, canals, and wasteways provide ideal conditions for migrating and wintering waterfowl. In general, the Columbia Basin Project has provided major benefits for waterfowl and waterfowlrelated recreation.

Other Birds

Common loons, Wilson’s phalaropes, American avocets, and black-necked stilts are associated with open water and/or the shallower portions of large bodies of open water.

Although populations of these species appear to be declining throughout their broader ranges, there is little evidence that their respective declines are due to declining habitat quantity and quality within the Crab Creek Subbasin. Bald eagles also utilize the open water areas of the Crab Creek Subbasin, primarily for winter habitat and foraging. Although little recent nesting by bald eagles has been recorded in this subbasin, historic nesting was common. Maintaining high quality habitat for prey species, (fish and waterfowl), potential nesting sites, and winter roost sites is critical to encourage and perpetuate eagle use of the area.

Numerous species such as the olive-sided flycatcher and willow flycatcher are associated with riparian areas during the breeding season. In contrast, sharptailed grouse (a shrubsteppe obligate) may use riparian areas during periods of harsh winter weather. Because of the small size, poor condition, and isolated nature of much of the riparian habitat in the Crab Creek Subbasin, this habitat type is critical in its overall importance.

Mammals

Shrubsteppe Obligates

Washington Ground Squirrel

Washington ground squirrels are endemic to Washington and Oregon (Betts 1990), and have declined dramatically in both states (Betts 1999). They are associated with relatively deep soils within shrubsteppe communities (Dobler et al. 1996, Betts 1990, 1999). Because deep soil habitats were preferred areas for conversion, most are now used for irrigated and dryland agriculture. The widespread loss and fragmentation of shrubsteppe has resulted in dramatic declines in the statewide population of Washington ground squirrels (Dobler et al. 1996). Most of the known populations of ground squirrels are within the Crab Creek Subbasin (Figure 3). The remaining populations appear to be at risk of extinction due to their isolation and the continued risk of habitat conversion, fragmentation, and degradation. Recent research in Grant County may reveal additional information on the species (Sherman 1999, 2000).

Pygmy Rabbit

Pygmy rabbit populations are associated with relatively deep soils dominated by shrubsteppe habitat (WDFW 1995c). However because the deep soil habitats were preferred areas for conversion, most are now used for irrigated and dryland crops. The widespread loss and fragmentation of shrubsteppe has resulted in dramatic declines in the statewide population of pygmy rabbits (Musser and McCall 2000). There are only three small and isolated populations of pygmy rabbits remaining in the state, all within the Crab Creek Subbasin (Figure 3). Lack of genetic diversity in the remaining populations of pygmy rabbits may also be contributing to their decline (K. Warheit, WDFW, pers. comm.).

White-tailed Jackrabbits and Black-tailed Jackrabbits

White-tailed jackrabbits and black-tailed of jackrabbits are closely associated with shrubsteppe habitats, and consequently, their populations have shown the same downward trends as other shrubsteppe obligates. White-tailed jackrabbits tend to be closely associated with the more mesic shrubsteppe habitats, and black-tailed jackrabbits with the relatively arid and/or disturbed sites. Although population figures are not available, the long-term declines appear to be dramatic.

Other Shrubsteppe Obligates

Other species including the sagebrush vole are largely restricted to shrubsteppe habitat and populations appear to be declining. Unfortunately the population, behavior, and habitat information is insufficient to understand the long-term relationships between populations and declining quality and quantity of shrubsteppe.

Mule Deer and White-tailed Deer

Mule deer and white-tailed deer occur primarily in shrubsteppe habitat in the subbasin but also use other habitats including cereal crops if the cropland is near shrubsteppe. Both species are important game species in the subbasin although whitetails are not as widely distributed as mule deer. Neither species appears to have declined in recent years, but both species have been impacted by the changing landscape in the Columbia Province in general, and the Crab Creek Subbasin in particular. This has occurred because of the loss of winter habitat at lower elevations and the fact that winter habitat within higher elevations of the Crab Creek Subbasin has declined in both quantity and quality.

Irrigation canals in the Columbia Basin Irrigation Project are problematic for mule deer. These large (approx. 20 ft deep x 100 ft wide) concrete lined and steeply banked canals trap and kill many deer and occasionally moose and elk when stray into the Columbia Basin Irrigation Project within the subbasin. The total number of deer lost in the main canals is estimated at 200-300 per year in the Grant County portion of the subbasin.

Fur Bearers

Raccoon, coyote, bobcat, badger, mink, muskrat, beaver, and river otter are the primary furbearers in the Crab Creek Subbasin. All but the coyote and muskrat are significantly lower in abundance than they were historically. In general, the declines appear to be related to an overall decline in habitat quality with an associated decline in food and/or prey abundance (J. Tabor, WDFW, pers. comm.)

Bats

The Crab Creek Subbasin is an important area in the state for bats because of their abundance and diversity and because of the presence of unique and/or limiting habitat features. For example, although water is the most limiting factor in the distribution of bats in arid areas, it is available adjacent to roosting, breeding, and wintering (hibernacula) sites in this subbasin. Cliffs, mines, caves, and buildings provide the structures needed to form breeding colonies and hibernacula for most species. Although some species are flexible in their use of these structural features, other species require

specific elevations, aspects, and temperature ranges. Spotted Bats appear to be exclusive cliff dwellers during the young rearing period. The Crab Creek Subbasin probably represents a significant core of Washington's Spotted Bat distribution. Buildings provide a significant source of roosting habitat in areas where water occurs but no suitable geological roost features exist. Townsend's Big-eared bats are found almost exclusively roosting in buildings in cave-deficient areas. Risks to bats in the Crab Creek Subbasin include loss or degradation of roosting and feeding habitat (mine closure, shrub removal), loss of available clean water, and disturbance of roost, breeding, and hibernation sites.

Reptiles and Amphibians

Shrubsteppe obligates

Eight reptile and two amphibian species in Washington State are Columbia Basin dependent, i.e., their ranges in Washington are contained mostly or entirely within the Columbia Basin. Of these 10 species, the short-horned lizard (*Phyrnosoma douglassi*), sagebrush lizard (*Sceloporus graciosus*), side-blotched lizard (*Uta stansburiana*), night snake (*Hypsiglena torquata*), striped whipsnake (*Masticophis taeniatus*), California mountain kingsnake (*Lampropeltis zonata*), and blotched tiger salamander (*Ambystoma mavortium melanostictum* [formerly *A. tigrinum melanostictum*) are considered at risk (Cassidy et al. 1997). Two species, the California mountain kingsnake and striped whipsnake are also listed as State Candidate species. Three cryptozoic reptiles, the ring-necked snake (*Diadophis punctatus*), the sharp-tailed snake (*Contia tenuis*), and the southern alligator lizard (*Elgaria multicarinata*) reach the northwest limits of their respective distributions in the western margin of the Columbia basin, and are likely to be particularly vulnerable at the edge of their range. Both the blotched tiger salamander the Great Basin spadefoot (*Spea intermontana*), may be especially vulnerable to the hydrological modification of their habitat.

Other Reptiles and Amphibians

The northern leopard frog has declined dramatically throughout its historic range; the Crab Creek Subbasin is one of the few regions where they remain. The historic distribution was principally along wetlands of the Columbia River and its tributaries (McAllister et al. 1999). Surveys since 1992 have located leopard frogs in 2 of 18 historic locations in Washington, both within the Crab Creek Subbasin. Loss of wetland habitat along the Columbia River and its tributaries, competition and predation by non-native fish, and introduced bullfrogs (*Rana catesbiana*) may be significant factors in the decline of northern leopard frogs. Current populations also appear to be influenced by fluctuations in water levels within the Columbia Basin Irrigation Project. The Snake River may have provided an aquatic corridor to historically abundant leopard frog populations in Idaho and Montana (McAllister et al. 1999). Alteration of the major rivers and tributaries appears to be a major cause of the current population problems with the northern leopard frog.

Columbia spotted frog (*Rana luteiventris*) is distributed within the Crab Creek subbasin in portions of Lincoln County (i.e., Coal Creek, Wilson Creek, mainstem Crab Creek @

Rocky Ford). Basically the channeled scabland flood coulees with perennial water sources. Columbia spotted frog appears to be declining for the same reason most reptiles and amphibians are declining in the Columbia Basin, habitat loss and fragmentation.

Wildlife Limiting Factors

Isolation and fragmentation of native habitat are the biggest factors influencing the long-term changes in abundance and distribution of wildlife populations in the Crab Creek Subbasin (Buss and Dziedzic 1955, Buss 1965, Swenson et al. 1987, McDonald and Reese 1998). This habitat alteration has occurred due to conversion of native habitat for production of irrigated and dryland crops, degradation of remaining native habitat, development and urbanization, road construction, and hydropower. Fragmentation has severely reduced habitat for area-sensitive species. Sage sparrows, for example, are generally found only in blocks of shrubsteppe greater than 1,000 ha (2,470 acres) (Vander Haegen et al. 2001). Populations of species with small home ranges and limited dispersal capabilities are likely to become isolated and vulnerable to extirpation. The isolation and fragmentation of shrubsteppe habitat also has reduced the integrity of the remaining populations of sharp-tailed grouse, thus putting them at risk of extinction. Wildlife populations in fragmented habitats may be more vulnerable to predation. In Washington, Brewer's sparrows, lark sparrows, and sage thrashers had greater nest predation rates in fragmented habitats than in continuous habitats (WDFW, unpubl. data).

Agricultural conversion has decreased the overall quantity of habitat for many native species, but loss of specific communities may be particularly critical for habitat specialists. Pygmy rabbits, for example, require deep-soil big sagebrush communities. This community type has been severely reduced on the landscape (Vander Haegen et al. 2001), possibly driving pygmy rabbits towards extirpation.

Lack of knowledge for some species but in particular regarding herptiles further imperils these Columbia Basin dependent species. Specifically, our lack of understanding of habitat-use patterns and the population dynamics under different land use scenarios prevents us from making reasonable management recommendations that would protect these species where they still occur.

The single most significant habitat alteration in the subbasin occurred as a direct result of the construction of Grand Coulee Dam (NWPCC 2001). The Bureau of Reclamation's Columbia Basin Irrigation Project (CBIP), which began water deliveries in 1952, essentially resulted in the conversion of approximately 750,000 acres of irrigated farmland 70% of which occurs in the Crab Creek Subbasin.

The CBIP caused the formation of numerous new wetlands, wasteways, reservoirs and canals that have provided significant benefits for some species of wildlife in terms of surface water and an interspersion of irrigated agriculture. These conditions have been particularly beneficial for migrating waterfowl and nesting ring-necked pheasants. However these benefits have been countered to some degree by negative impacts including: 1) relatively low nesting success for breeding waterfowl (NWPCC 2001); 2) direct mortality of 200-200 deer in irrigation canals (WDFW 1997; J. Tabor, WDFW,

pers. comm.); and 3) expansion of non-native species of plants, fish, and wildlife. Non-native species have resulted in reduction and extirpation of many native species; a trend that will likely continue without intervention. For example, introduced bullfrogs and nonnative fish have likely contributed to the decline of the endangered northern leopard frog (McAllister et al. 1999).

Restoration direction in the subbasin is limited by a lack of information on the type, distribution, quality, and quantity of habitat, and the wildlife response to habitat management activities. The CRP (Conservation Reserve Program) is one example of current restoration activities. Lands enrolled in CRP appear to be improving the situation for numerous species of interest including sage grouse, sharp-tailed grouse, and some species of waterfowl (Schroeder et al. 2000a, b). This improvement appears to be related to the direct increase in quantity of shrubsteppe habitat (CRP), the indirect enhancement of habitats adjacent to CRP, and the improvement in the science of restoration.

Fish Resources

Aquatic / Fish Relationships

The Crab Creek Sub basin hosts a rather large assemblage of piscine fauna (Table 2). Much of this assemblage has developed over the past 100 years as human settlement in the region contributed to establishment of many alien species and stocks. However, trout were one of the native fishes of Crab Creek. Perhaps the earliest recorded observations of fish in Crab Creek came from Strong (1906), who spoke of Crab Creek: “At its source near Medical Lake it is a mere brook, and here in 1870, there were trout, little fingerlings, by the hundreds.” No mention was made as to the species. This was prior to the first of many hatchery stockings in this watershed, the earliest being two releases of eastern brook trout in 1903 and 1904, followed by two releases of Westslope cutthroat of Lake Chelan origin in 1907 and 1908 (Riseland 1905; Riseland 1909). The U.S. Bureau of Fisheries workers collected trout in 1908 at a road crossing north of Ritzville, and many miles west of Strong’s 1870 observations. They established the trout of Crab Creek as cutthroat (Evermann and Nichols 1909). Dr. Robert J. Behnke, a world authority on trout taxonomy, pondered the descriptions of these trout and concluded they belonged to the Yellowstone cutthroat subspecies *Oncorhynchus clarki bouveri*, a cutthroat not known from any other Washington waters, although he also thought this subspecies might have been in the Palouse Watershed as well (Behnke 1992).

The primary species of commercial or recreational importance within the watershed are lake whitefish, steelhead and rainbow trout, brown trout, Lahontan cutthroat trout, Chinook salmon (summer/fall run), kokanee, brown bullhead, walleye, largemouth bass, smallmouth bass, bluegill, black crappie and yellow perch. More details on the abundance and distribution of these, and a few other species of interest, is presented in the following.

Table 2: Fish species of Interest within the Crab Creek Subbasin

Table 1. Fish species of Interest within the Crab Creek Subbasin.

Common name	Scientific name	Status[1]	Locations/*abundance*
Pacific lamprey	*Entosphenus tridentatus*	N	Possibly sub-basin tributary mouths; *infrequent*
White sturgeon	*Acipenser transmontanus*	Food, G	Moses Lake, likely Banks and Billy Clapp lakes; *rare occurrences*
Lake whitefish	*Coregonus clupeaformis*	G	Banks, Billy Clapp, Moses, Potholes Res., Soda, Long, Crescent lakes; *abundant*
Mountain whitefish	*Prosopium williamsoni*	G	Crab Creek below Hwy. 26; Red Rock Creek; *uncommon*
Brown trout	*Salmo trutta*	G	Several tribs and most perennial reaches of Crab Creek; several lakes; *common*
Cutthroat trout, Lahontan	*Oncorhynchus clarki*	G	A few lakes connected to Crab Creek; Grimes Lk. (Moses Coulee drainage); *common*
Rainbow trout	*Oncorhynchus gairdneri*	G	Most waters w/in sub-basin; *abundant*
Steelhead, Summer, Upper Columbia stock	*O. gairdneri*	G, SC, FE	Lower Crab Ck; Red Rock Ck; Lower Sand Hollow Ck; mouths of several tribs to Col. River; *uncommon*

Common name	Scientific name	Status[1]	Locations/*abundance*
Brook trout	*Salvelinus fontinalis*	G	A few lakes and streams entering Crab Creek; *locally common*
Lake trout	*Salvelinus namaycush*	G	Deep Lk., Grant County only; *rare*
Chinook salmon, summer/fall run	*Oncorhynchus tshawytscha*	Food, G	Lower Crab, Red Rock, Lower Sand Hollow Cks.; *common in fall*
Sockeye salmon	*Oncorhynchus nerka*	Food, G	Lower Sand Hollow Ck. (observed in 1991 only); *uncommon*
Kokanee	*O. nerka*	G	Banks, Billy Clapp Lks; *common*
Tiger muskellunge	*Esox lucius X E. masquinongy*	G	Evergreen and Red Rock reservoirs; *uncommon*
Common carp	*Cyprinus carpio*	N	Ubiquitous
Grass carp	*Ctenopharyngodon idella*	N	Few small ponds and irrigation ditches; *uncommon*
Goldfish	*Carassius auratus*	N	Moses Lake; *uncommon*
Tench	*Tinca tinca*	N	Lower Crab Ck.; *uncommon*
Redside shiner	*Richardsoni balteatus*	N	Lower Crab Ck.; *locally common*
Longnose dace	*Rhinichthys cataractae*	N	Uncertain distribution
N. pikeminnow	*Ptychocheilus oregonensis*	N	Small numbers in all major reservoirs w/in sub-basin; Lower Crab Cr.; *common*
Tui chub	*Gila bilcolor*	N	Lower Crab Cr.; *uncommon*
Peamouth	*Mylocheilus caurinus*	N	Uncertain distribution
Leopard dace	*Rhinichthys falcatus*	N	Uncertain distribution
Speckled dace	*Rhinichthys osculus*	N	Occurs in a few isolated lakes; all major reservoirs; *locally common*
Largescale sucker	*Catostomus macrocheilus*	N	All major reservoirs w/in sub-basin; Lower Crab Cr.; *common*
Bridgelip sucker	*Catostomus columbianus*	N	Uncertain distribution

Common name	Scientific name	Status[1]	Locations/*abundance*
Channel catfish	*Ictalurus punctatus*	G	All major reservoirs w/in sub-basin; *uncommon*
Brown bullhead	*Ictalurus nebulosus*	G	Ubiquitous
Burbot	*Lota lota*	G	Small numbers in Banks, Billy Clapp, Moses Lks., Potholes Res; *rare*
Three-spine stickleback	*Gasterosteus aculeatus*	N	Ubiquitous
Sandroller	*Percopsis transmontana*	N	Columbia River, possibly tributary mouths; *rare*
Largemouth bass	*Micropterus salmoides*	G	All major reservoirs, many isolated lakes; Crab Cr. below Brook Lake; *abundant*
Smallmouth bass	*Micropterus dolomieui*	G	All major reservoirs, Crab Cr. Below Brook Lk.; *abundant*
Black crappie	*Pomoxis nigromaculatus*	G	All major reservoirs; Crab Cr. below Brook Lk.; *abundant*
White crappie	*Pomoxis annularis*	G	Moses Lake; *uncommon*
Bluegill	*Lepomis macrochirus*	G	All major reservoirs and several isolated lakes; Crab Cr. below Brook Lk.; *abundant*
Pumpkinseed	*Lepomis gibbosus*	G	Ubiquitous
Walleye	*Stizostedion vitreum*	G	All major reservoirs, few isolated lakes; Crab Cr. below Brook Lk.; *common*
Yellow perch	*Perca flavescens*	G	Ubiquitous
Torrent sculpin	*Cottus rhotheus*	N	Uncertain distribution
Prickly sculpin	*Cottus asper*	N	Ubiquitous
Mottled sculpin	*Cottus bairdi*	N	Uncertain distribution

[1]Status: SC = State candidate; G = Game species subject to harvest regulations; FE = Federal endangered; N=no special status; Food = Food fish of commercial value (modified from PHS WDFW 1991; WDFW 1999).

The primary species of commercial or recreational importance within the watershed are lake whitefish, steelhead and rainbow trout, brown trout, Lahontan cutthroat trout, chinook salmon (summer/fall run), kokanee, brown bullhead,

White Sturgeon
Sturgeon are resident in the Columbia River, including upstream of Grand Coulee Dam. White sturgeon reside in the mainstem Columbia River and may use the confluence area of Crab Creek[4]. A few fish have been seen and/or rescued from the Banks Lake feeder canal during dewatering in the fall. One sturgeon was caught by an angler in Moses Lake in the early 1990s and pictured in the Moses Lake Herald newspaper. Their occurrence is likely in other large waters connected to the irrigation canal system.

Pacific Lamprey
Pacific lamprey are of high cultural importance to many tribal groups. However, presence and distribution of this anadromous species within the Crab Creek Subbasin are unknown. Pacific Lamprey radio telemetry research funded by the Grant County Public Utility District was conducted in years 2001 and 2002 in the mainstem Columbia River and included monitoring at the mouth of Crab Creek. Radio tagged Pacific lamprey were not observed to enter Crab Creek during the study period (Nass et al. 2003, GCPUD 2003).

Lake Whitefish
Lake whitefish, an alien species, attract a small following of anglers, primarily in Banks Lake, but the species is widespread and abundant in all major lakes/reservoirs of the sub-basin: Banks, Billy Clapp, Brook (Stratford), Moses, Soda, Crescent, and Long lakes, and in Potholes and Red Rock reservoirs. All of these waters have direct connection with Crab Creek. They gained access to the sub-basin via water withdrawal from Franklin D. Roosevelt Lake (Columbia River) into Banks Lake, thence through the irrigation water delivery system. Nothing is known about their biology and interaction with other species within the sub-basin, although limited summer die-offs have been noted in Moses Lake and Potholes reservoirs (J. Foster, WDFW, pers. obs.)

Mountain Whitefish
While not of recreational importance within the sub-basin, of note is that this species has been found in Red Rock Coulee, a tributary entering Crab Creek at about stream km 26 from the Columbia River (R. Starkey, former USFWS biologist, pers. comm.). There is no information on reproduction here, or of this species occurring in other parts of the sub-basin.

Brown Trout
The WDFW regularly stocks fingerling brown trout in several lakes and flowages within the sub-basin, many of which have direct connection with Crab Creek. The upper permanent flowing reaches of the creek (generally in Lincoln County) have received hatchery releases intermittently in the past, as have some of the main tributaries in the upper Crab Creek basin. Stocking records indicate releases of browns in upper Crab

[4] White sturgeon research has been conducted by the GCPUD in the mainstem Columbia River including the subbasin boundary area located at the Crab Creek/Columbia River confluence. For more information regarding this work see GCPUD 2003.

Creek in eight of the years spanning 1946 – 1996. Most, if not all, were released at the bridge on Rocky Ford Road, a crossing historically known as Rocky Ford. In the permanent flowing section, between Moses Lake and upstream to Willow Lakes area (including Homestead Creek and Homestead Lake), brown trout are stocked either annually or every two years. Browns do not appear to reproduce well anywhere within the Crab Creek watershed and outside of the lakes, they support very little angling activity. Their overall distribution within flowing waters of the sub-basin is sketchy at best. Hatchery releases of browns are a regular part of the stocking program for many trout lakes, where they grow well, have minimal impact on rainbow fry releases, and are well received by anglers.

Steelhead Trout

The presence of steelhead (adults) have only been confirmed within Red Rock Coulee. Anglers have caught steelhead in April at the mouth of Red Rock Coulee (M. Spence, retired WDFW biologist, pers. comm.). Steelhead may be able to ascend higher in Crab Creek, but potential passage barriers have not been thoroughly described for most of the reach, which is privately owned. Even so, a natural falls south of McManamon Road may pose a barrier, about 56 km above the mouth. However, NOAA Fisheries describes the end of anadromy on Crab Creek as the base of O'Sullivan Dam. As with Chinook salmon, steelhead use of Crab Creek prior to irrigation development was probably very limited, and most certainly the stream would not have produced smolts, given its ephemeral character. With present perennial flows, no information has yet been discovered that indicates lower Crab Creek produces smolts. Spawning habitat within Crab Creek appears to be limited due to high silt loads, temperature and water quality. Conceivably, young parr may move out of Crab Creek and finish rearing in the Columbia. Due to the large presence of rainbow trout (stocked and naturally reproducing), it has beem difficult to determine if steelhead par are migrating to the Columbia to rear. The presence of resident rainbows in Red Rock suggests that steelhead might well be successful in producing smolts in this tributary. Documentation exists indicating that steelhead were planted in both upper and lower Crab Creek in the past (WDG 1982). However, we were unable to find specific planting information regarding dates, specific locations, numbers of fish, or origin. Rainbows were released in Red Rock Lake several times after it first formed in 1966, but the last release was in 1976 (WDFW file data).

Rainbow Trout

Rainbow trout provide the mainstay of recreational fishing in the subbasin, rainbow trout stocking totals 1.5 million fish annually, mostly all fry or fingerling size, within the sub-basin. In upper Crab Creek (presumably at Rocky Ford Road crossing), rainbows have been stocked during all but nine years between 1946 and 1996. Most of these were released at "catchable" sizes, i.e., about 17 - 25 cm (WDFW file data). Roughly, 100 lakes within the subbasin are managed solely for trout angling. Others are managed for both trout and warmwater species, but in these waters, rainbows are usually released at a size of 17 - 25 cm. Although there is no evidence of redband rainbow being native to the subbasin, unconfirmed reports of trout with external characteristics of of redband exist from upper Crab Creek (Van Buren, pers comm.). Little scientific documentation exists

regarding existing trout species and their current distribution in upper Crab Creek and its tributaries (Lawlor, WDFW pers. comm.). Although the origin of *O. mykiss* in the Crab Creek Subbasin is unknown, native presence cannot be dismissed. As mentioned previously, cutthroat were the only known trout indigenous to the upper permanent reaches of Crab Creek, and likely for its permanent tributaries as well. The original cutthroat stock (*O. c. bouveri*) is believed extirpated early in the twentieth century by any number of causes. However, thorough surveys have not been done in the watershed, leaving the question of cutthroat presence somewhat clouded.

Chinook Salmon

The spring-run race of Chinook, listed under the Federal Endangered Species Act as endangered of extinction, has not been identified within the Crab CreekSubbasin. [One documented release of 45,840 Chinook (race unknown) into Banks Lake, averaging 53 fish/kg (24/lb.), was made by the former Wash. Department of Fisheries in September 1976.] However, the summer/fall race of Chinook has long been noted by WDFW biologists as entering Crab Creek. Crab Creek annually attracts several adults in the extreme lower end, but the success of their spawning is not clear. Stream survey work, now underway by the U.S. Bureau of Reclamation(BOR), shows that adults travel as far upstream in Crab Creek as the mouth of Red Rock Coulee, and on into Red Rock Coulee. Spawning redds have been found in Red Rock Coulee (Bowen et al. 2003). This effort is the most intensive to date on the use of Crab Creek by anadromous species, although the work is restricted to flows within the Columbia Basin Irrigation Project. Given that Crab Creek was not a perennial stream prior to irrigation development, Chinook, with their fall spawning habit, were unlikely to have used Crab Creek historically. According to Strong (1906), Crab Creek below Moses Lake disappeared into the ground.

Kokanee

Kokanee gained access to Banks Lake from water pumped out of the Columbia River at Grand Coulee. Stober et al. (1979) determined they were successfully reproducing in Banks Lake, at least until the late-1970s. However, kokanee were also stocked in Banks as early as 1962 and sporadically thereafter (based on availability). Uninterrupted annual stocking of fry or fingerlings has been done since 1992, with numbers varying between a low of 159,000 and a high of 1,678,000 (WDFW file data). The fishery for kokanee was excellent and very popular during the 1960s and 1970s, based on creel checks by biologists for the former Wash. Dept. of Game (now WDFW)(WDFW file data) and by the later work done by Stober et al. (1979). By mid-1980s, however, kokanee harvest dropped to the point that anglers gave up targeting kokanee.

Cyprinids and Suckers

Redside shiner and speckled dace were native to upper Crab Creek watershed where flows were perennial. Several other species may have been as well, but a thorough examination of early-day writings has not been attempted, nor have more recent surveys been conducted. While the species assemblage of the overall subbasin is large, the majority of this is found within the Columbia Basin Irrigation Project (Project), and obviously a consequence of distribution through the irrigation system and illegal species

introductions. Today, vast areas of the subbasin are populated with the near ubiquitous carp, both in waters isolated from and directly connected to the Project. Until the late 1970s when markets declined, carp were an important commercial species, processed into fish feed meal and as fresh fish for table fare. The carp fishery on Moses Lake was the most productive of any in Washington. During the heyday of commercial netting (1959 – 1977), harvests ranged from a low of about 10 tons to a high of over 400 tons, averaging about 305 tons (avdp. measure) per year (WDFW file data).

Brown Bullhead

Another widespread species that occurs throughout Crab Creek and connected reservoirs, the brown bullhead is present in great abundance, especially Moses Lake and Potholes Reservoir where it commonly exceeds 30 cm. The species is not as avidly sought as are other game fish, but do contribute to the fishing enjoyment of juveniles and culinary fare of many ethnic groups. Brown bullhead continues to be a perennial competitor in many waters managed for trout, and as well in lakes dedicated to centrarchid management. Once established, the species all but defies eradication attempts and can quickly deplete productivity of a water for other management species.

Centrachids

All centrarchids are alien species to Washington. Within the Crab Creek subbasin, pumpkinseed sunfish, largemouth and smallmouth bass, black crappie and bluegill are the most abundant and widespread of the centrarchids present. They occur both in several flowing waters, including Crab Creek below Brook (Stratford) Lake, and in many small lakes and all reservoirs. With the exception of the diminutive pumpkinseed, these species are highly sought after by anglers. The Crab Creek Subbasin has the distinction of being noted as the best warmwater fishery in the state with thousands of anglers from across the state attracted to its waters. At least 40 percent of the state's bass tournaments take place in the subbasin. Yet as popular as these species are, their numbers have waned since the early 1980s for reasons undefined. Intensive research is underway on Moses Lake, and to a lesser degree effort is being directed at Potholes Reservoir, to discover remedial actions.

Percids

Yellow perch has long been a staple of the general angler and tremendous numbers were harvested annually until the early 1980s in all major reservoirs of the subbasin. The Potholes Reservoir perch fishery grew to legendary status, surpassing in importance (angler participation and harvest) all fisheries of any other single water body in Central Washington. Other major reservoirs also produced well. But declines began to be noticed in the late 1970s, and by the mid-1980s, the excellence of this fishery faded away to almost nothing. During this same period walleye began appearing commonly in the catches from Banks Lake, and thence down through the irrigation system to Billy Clapp, Moses lakes, Potholes Reservoir, and other waters connected by surface flow to the irrigation system. Both species alien to Washington and are widespread in the subbasin and the Columbia River. Perch in particular, have also been illegally transplanted to many waters reserved for trout production with consequences unfavorable to trout

angling. Walleye are now as nearly as popular in the subbasin with warmwater anglers as fishing for bass, and the subbasin is one of the state's most preferred locations for walleye tournaments. The origin of walleye in Washington is unclear but generally believed from a release made in the Columbia River upstream of Grand Coulee Dam in the 1950s (WDFW 1996).

Caspian Terns Predation

In 1980, at least 3000 pairs of Caspian terns bred at only three locations in Washington (Gray's Harbor, Willapa Bay, and the Potholes Reservoir), and a total of only 200 pairs bred in one location in Oregon (WDFW unpublished data; Craig et al., in press). By 2000, more than 9,500 pairs bred in the Columbia River Estuary on Rice and East Sand islands (Roby et al. 1998, Collis et al. 1999) with additional pairs breeding in at least four locations in eastern Washington, including the persistent colony at the Potholes Reservoir. About 75 pairs of Caspian terns bred at the Potholes Reservoir in 2000 (Roby et al., unpubl. data). At the tern colonies in the Columbia River estuary, between 44% and 91% of their diet is juvenile salmonids, resulting in a total annual depredation of 5 – 15 million juvenile salmonids (6 - 21% of all juvenile salmonids)(Roby et al., unpubl. data). At the site in Commencement Bay near Tacoma, 50% of the Caspian tern diet is juvenile salmonids. At the Potholes Caspian tern colony, nearly 2000 PIT tags were recovered in 2000 from juvenile salmonids, including about 2% of all Steelhead tagged in the mid-Columbia. Although over 80% of juvenile salmonids consumed by terns are hatchery-reared, there is concern that terns may consume sufficient juvenile wild salmonids, including ESA-listed stocks, to pose a significant threat to the future viability of these stocks. In addition, the tern colony on East Sand Island in the Columbia River estuary is the largest in the World, representing about 25% of all Caspian terns in North America, and more than 70% of the west coast population.

Major Limiting Factors

Fisheries

Most of the fishery in the Crab Creek Subbasin is non-native and/or altered dramatically by widespread changes in land-use. For example, rainbow trout survive in many Crab Creek stream reaches despite marginal habitat quality. Artificial habitats (islands for nesting Caspian terns) and altered fish and wildlife communities have resulted in high levels of predation and competition. Restoration of native fisheries is also limited by the direct and indirect impacts of runoff from croplands including extreme water flows (quantity and speed), movement of sediments and chemicals, and alteration of habitat. The current definition of riparian corridors and standards for protection of riparian buffers appear to be insufficient to protect Crab Creek and the associated tributaries from damage due to agricultural runoff.

Assessment

Focal Species

Selection Criteria

A focal species has special ecological, cultural, or legal status and represent a management priority in the subbasin and by extension the ecoprovince. Focal species are used to evaluate the health of the ecosystem and the effectiveness of management actions. Criteria used in selecting the focal species include a) designation as *Federal* endangered or threatened species, or management priority as designated by a management authority b) cultural significance, c) local significance and d) ecological significance, or ability to serve as indicators of environmental health for other species. Each of the focal fish species for the Crab Creek Subbasin is described below.

It should be noted here that all of the focal non-salmonid species listed below are all non-indigenous to the Crab Creek Subbasin. However, much of the fish habitat currently existing within the subbasin is artificially derived and in many cases more suitable for warmwater species or mixed species fisheries than for salmonids alone. Because of this, non-salmonids have been introduced and now support important fisheries throughout the Crab Creek Subbasin and rate high in management priority. These non-salmonid focal species, although non-indigenous, all meet the focal species criteria listed above.

Fish Assessment

Salmonids

Salmonid Focal Species 1: Summer/fall Chinook (*Oncorhynchus tshawytscha*)

Rationale for Selection

In 1995, NMFS concluded that summer Chinook salmon in the mid-Columbia River are not a "distinct population segment" of a species (as defined by Waples 1991) or ESU as defined by the NMFS Policy on the Definition of Species under the U. S. Endangered Species Act (56 FR 58612 58618). Rather, they are part of a larger ESU that includes all late run (summer and fall) ocean type Chinook salmon from the mainstem Columbia River and its tributaries (excluding the Snake River) between Chief Joseph and McNary dams (Waknitz et al. 1995). For the purposes of sub-basin planning, it is assumed that there is one large metapopulation of summer/fall Chinook between the confluence of the Snake River and Chief Joseph Dam, but specific tributaries, in addition to limited areas of mainstem Columbia spawning, contain independent populations that need to be considered in management actions.

In the 1997 “Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California”, NMFS indicated that summer/fall Chinook salmon in this ESU were not in

danger of extinction as a metapopulation, nor were they likely to become so in the foreseeable future (Myers et al.1998). Summer/fall Chinook are one of two anadromous salmonid species known to utilize the Crab Creek sub-basin. USFWS spawning surveys have confirmed that fish continue to return to spawn in Red Rock Coulee year after year which suggests that reproduction has been successful in this area. However, population trends, the extent of habitat use below O'Sullivan Dam, and juvenile survival rates and residence time within the subbasin are unknown.

Key Life History Strategies, Relationship to Habitat
The distribution of Chinook salmon is known upstream to Red Rock Lake within Red Rock Coulee. Known Summer/fall Chinook spawning is limited to Red Rock Coulee, however there may additional spawning areas on Crab Creek, upstream of the confluence with Red Rock Coulee. Specific life history information for Summer/fall Chinook within the Crab Creek Subbasin has not been documented but generally adults in this ESU typically arrive at natal streams from July through late September, and spawn from late September through early November, peaking in mid-October. (Peven and Duree 1997, Murdoch and Miller 1999). Usually 50% or more of spawning adults have a total age of 5 years, with the remainder predominantly 4 year old fish (Murdoch and Miller 1999). Juveniles generally emigrate to the ocean during the first year of life as subyearling smolts, leaving the natal stream from one to four months after emergence. However, there is evidence in the Columbia Cascade Ecoprovince that some juvenile Summer/fall Chinook undergo an extended residence period, with a protracted downstream migration. Many subyearlings rear in the mid-Columbia impoundments for various periods of time during their outmigration (Peven and Duree 1997).

Relationship with Other Species
Known Summer/fall Chinook spawning during the fall months is limited to the same stream reach within Red Rock Coulee as that used for steelhead spawning in the spring. Interactions between these species within the Crab Creek Subbasin have not been studied or documented, however, potential interactions between these species include:

- Superimposition of summer/fall Chinook redds by steelhead,
- Competition for food and space by juveniles of both species during the spring/summer rearing period,
- Consumption of newly emergent fall Chinook fry by rearing steelhead parr of sufficient size.

Salmonid Focal Species 2: Steelhead/Rainbow Trout (*Oncorhynchus mykiss)*

Rationale for Selection
O. mykiss are the dominant salmonid within the Crab Creek Subbasin. They occur primarily as resident rainbow trout and support quality fisheries in numerous stream reaches and lake systems throughout the subbasin. *O. mykiss* also occur within this subbasin as anadromous summer run steelhead which are considered part of the Upper Columbia Summer Steelhead ESU, and were listed as endangered on August 18, 1997.

Key Life History Strategies, Relationship to Habitat
O. mykiss inhabit lake, tributary and mainstem reaches within the Crab Creek Subbasin. Spawning occurs in the spring where suitable habitat exists. Steelhead spawning is known to occur in Red Rock Coulee in the same area (albeit at different times of the year) as used by spawning fall Chinook. Resident forms of *O. mykiss* remain within the subbasin throughout their entire life cycle while anadromous steelhead juveniles remain in freshwater for at least one year prior to seaward outmigration. Both resident and anadromous forms are therefore exposed to the full spectrum of environmental changes including annual changes in water quality and quantity.

Relationship with Other Species
Steelhead are known to spawn in the same areas as Summer/fall Chinook. Potential interactions between the two species are the same as listed for summer/fall Chinook above and include:

- Superimposition of summer/fall Chinook redds by steelhead,
- Competition for food and space by juveniles of both species during the spring/summer rearing period,
- Consumption of newly emergent fall Chinook fry by rearing steelhead parr of sufficient size.

In addition, cutthroat trout (*O. clarki*) are indiginous to the Crab Creek Subbasin and share similar life history and habitat requirements with resident rainbow trout. Potential interactions between the two species include:

- Competition at all life stages for food and habitat,
- Consumption of juveniles by adults,
- Interbreeding.

Salmonid Focal Species 3: Kokanee (*Oncorhynchus nerka*)

Rationale for Selection
Kokanee were introduced into Banks Lake and Billy Clapp Reservoir and have provided excellent recreational fisheries in the past. Although the fishery has declined somewhat in recent years, management for kokanee remains a high priority in this system. Historically, natural production made a significant contribution to the kokanee fishery. The kokanee fishery has more recently been maintained through hatchery plants, although natural production through shoreline spawning may also occur.

Key Life History Strategies, Relationship to Habitat
Sockeye salmon differ from other pacific salmon in that they require a lake environment for part of their life cycle. Kokanee are a landlocked form of sockeye salmon that remain in freshwater for their entire lives and feed on zooplankton or aquatic insects. They prefer water temperatures close to 50^0F and inhabit the pelagic zone of lakes throughout most of their life cycle. Kokanee reach a length of maturity of 8 to more than 15 inches typically by age 3 or 4. Females produce between 1,000 and 1, 700 eggs. Kokanee spawn in lake

tributaries or along the lake shoreline where ground water percolates through the gravel. Spawning occurs in the fall or winter with eggs or larval fish remaining in the gravel for another 8 to 12 weeks until emerging as feeding fry the following spring. All kokanee die after spawning (Wydoski and Whitney 2003).

Relationship with Other Species
Potential interactions with other species of gamefish include:

- Competition for food with juvenile forms of other gamefish.
- Prey for other gamefish.

Non-salmonids

Centrarchidae

Non-Salmonid Focal Species 1: Smallmouth Bass (*Micropterus dolomieu*)

Rationale for Selection
In 1881, James Henshall described smallmouth bass as "inch for inch and pound for pound, the gamiest fish that swims" (Wydoski and Whitney 2003). Smallmouth bass are non-indigenous to Washington waters but provide important recreational fisheries throughout the Crab Creek Subbasin. For example, Banks Lake and Potholes Reservoir are two of the most popular bass tournament waters within the state of Washington and attract thousands of bass anglers each year. Although smallmouth bass are desirable gamefish, their habitat preference and their piscivorous tendency suggest that they may have a greater negative impact on salmonids, especially migrating smolts, than would largemouth bass. Some overlap does exist, but generally the habitat requirements of smallmouth bass differ from those of largemouth bass, and each are therefore considered separately as focal species in this subbasin.

Key Life History Strategies, Relationship to Habitat
Smallmouth bass usually inhabit cool clear lakes and streams. They generally inhabit areas of larger shallow gradient streams with boulders, rock, or gravel. In lakes they prefer areas with rocky reefs, littoral zone drop-offs, or gravel bars (Wydoski and Whitney 2003). They are territorial with a strong homing ability and typically establish a specific home range. Migration distances are usually short, although larger fish tend to have larger home ranges and spawning migrations of up to 40 miles have been documented in the Columbia Basin (Wydoski and Whitney 2003). Spawning occurs in the spring at water temperatures between 55^0F and 65^0F. Female smallmouth bass produce between 2,000 and 20,285 eggs (Wydoski and Whitney 2003). Following the pattern of other centrarchid fishes, the male excavates a shallow depression for a nest and guards it until the fry leave (Wydoski and Whitney 2003).

Smallmouth bass begin to feed extensively when water temperatures rise above 50^0F but feed most actively at their prefered temperature of 68^0F. Smallmouth bass fry eat crustaceans such as copepods and cladocerans and when large enough, transition to a diet

of insects and larval fishes (Wydoski and Whitney 2003). Adult fish are opportunistic feeders and typically feed on sculpins, cyprinids (including juvenile northern pikeminnow), catastomids, and crayfish, depending upon availability. Juvenile salmonids, where abundant, may comprise a significant portion of the diet of smallmouth bass. Smallmouth bass are generally long-lived, and may reach an age of 14 years and a size of 8 pounds in Washington waters.

Relationship with Other Species
Competition with other gamefish for food and habitat.
Predation upon other gamefish.
Juvenile life stages provide forage for other gamefish.

Non-Salmonid Focal Species 2: Largemouth Bass (*Micropterus salmoides*)

Rationale for Selection
Largemouth bass are non-indigenous to Washington waters but provide important recreational fisheries in lakes and reservoirs throughout the Crab Creek Subbasin. The current state record largemouth bass was taken from Banks Lake, which is one of the most popular bass tournament waters within the state of Washington and attracts thousands of bass anglers each year. Although some overlap does exist, the habitat requirements of largemouth bass differ from those of smallmouth bass, and each are therefore considered separately as focal species in the Crab Creek Subbasin.

Key Life History Strategies, Relationship to Habitat
The largemouth bass is tolerant of warm water and does best in shallow, weedy lakes and backwaters of rivers with clear water and bottoms of mud, sand, and organic material, which provide the best substrate for rooted aquatic vegetation. They prefer areas with objects that provide cover, such as brush, logs, pilings, submerged trees, reeds, and lily pads. They generally inhabit shallow areas with water depths of 10 feet or less (Wydoski and Whitney 2003).

Largemouth bass establish home ranges which restrict their movements in lakes, but also adjust their home ranges in relation to forage densities. The optimal temperature for largemouth bass is 68^0F (range 48^0F to 75^0F) and they can tolerate dissolved oxygen levels down to 2ppm (Wydoski and Whitney 2003). They are generally long-lived and individual bass may reach an age of 16 years and attain a size of 11 pounds in Washington waters (Wydoski and Whitney 2003).

Spawning occurs in the spring when water temperatures reach approximately 68^0F and usually takes place in shallow depths of 1 to 4 feet over substrates of sand, gravel, or rubble. Females produce from 2,000 to 109,314 eggs with larger fish producing more eggs. Like other centrarchids, male largemouth bass dig the nest and defend it until the fry disperse (Wydoski and Whitney 2003).

The diet of largemouth bass fry is composed principally of small crustaceans and insects. Subadult and adult largemouth bass are opportunistic feeders, with fish (including

salmonids when available) and crayfish normally composing the majority of the diet. Other dietary items include frogs, salamanders, and insects (Wydoski and Whitney 2003).
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Relationship with Other Species

- Competition with other gamefish for food and habitat.
- Predation upon other gamefish.
- Juvenile life stages provide forage for other gamefish.

Non-Salmonid Focal Species 3: Bluegill (*Lepomis macrochirus*)

Rationale for Selection

Bluegills are non-indigenous to Washington waters, but because of their fine table quality, good fighting ability, and ease of capture, provide popular recreational fisheries in many of the lakes of the Crab Creek Subbasin managed for warmwater species. Bluegills, like other panfish, attain a relatively small maximum size (usually 6 to 10 inches), are long lived, and therefore can provide an important forage base for other larger gamefish. Bluegills are highly fecund, and can easily overpopulate lakes without sufficient harvest or predator populations. As a result, stunting (slow growth due to high population density), can be a major problem in managing bluegill populations, particularly in small lakes.

Key Life History Strategies, Relationship to Habitat

Bluegill inhabit warm shallow lakes with rooted vegetation. All sizes (and therefore ages) show a strong orientation to habitat with cover or structure. The young remain in shallow water during summer. High turbitidity is probably detrimental to successful reproduction and good growth in this species. Bluegill are relatively long lived and are known to reach an age of 11 years in Washington waters. Bluegills typically spawn in the spring when water temperatures exceed 67^0F. As with other members of the family Centrarchidae, males select spawning sites over sandy bottoms in shallow water and vigorously protect and clean the nest after spawning. The number of eggs produced by a female varies from 2,360 to 81,104 depending upon her size, with larger fish producing more eggs. Bluegill fry eat zooplankton, principally crustaceans such as copepods and cladocerans. As they increase in size, they eat increasing proportions of various aquatic insects. Other foods include: molluscs, small crayfish, amphipods, fish eggs, and larval or small juvenile fish. During summer, bluegills may eat plants such as algae or rooted equatic vegetation (Wydoski and Whitney 2003).

Relationship with Other Species

- Competition with other gamefish for food and habitat, primarily with younger life stages of other gamefish.
- Predation upon eggs and fry of other gamefish.
- Prey for other gamefish.

Non-Salmonid Focal Species 4: Black Crappie (*Pomoxis nigromaculatus*)

Rationale for Selection

Black crappie are non-indigenous to Washington waters but support popular recreational fisheries in the Crab Creek Subbasin, primarily in the Potholes area. Black crappie are generally easy to catch, and catch per unit effort rates can be quite high. As a result, crappie fisheries in the Crab Creek Subbasin attract anglers from all areas of the state. Black crappie populations in Moses Lake have declined but the source of this decline remains unclear. Crappies, like bluegills are highly fecund, and can overpopulate lakes without sufficient harvest or predator populations. As a result, stunting (slow growth due to high population density), can be a potential problem in managing crappie populations.

Key Life History Strategies, Relationship to Habitat
Black crappie are generally found in clear waters of large streams, reservoirs, and in medium sized lakes and prefer dense aquatic vegetation over bottoms of sand, muck, and organic debris. They can be highly mobile in lakes and reservoirs and generally are found in water depths of 10 feet or less in the spring but move to deeper areas during the summer months. Individual fish may live up to 10 years and reach a size of 17 inches, but 5 to 6 years and a size of 10 inches is more common (Wydoski and Whitney 2003).

Spawning occurs in the spring when water temperatures reach 58^0F to 64^0F. Males dig the nest in soft mud bottoms usually in water depths of 8 feet or less and guard the nest until the fry disperse. Females produce between 11,000 and 188,000 adhesive demersal eggs with larger fish producing more eggs (Wydoski and Whitney 2003).

Young crappie feed principally on zooplankton. As they grow, black crappie feed more on small larval aquatic insects and large fish generally depend upon fishes for food (Wydoski and Whitney 2003).

Relationship with Other Species
- Competition with other gamefish for food and habitat, primarily with younger life stages of other gamefish.
- Predation upon eggs and fry of other gamefish.
- Prey for other gamefish.

Percidae

Non-Salmonid Focal Species 5: Walleye (*Stitzostedion vitreum vitreum*)

Rationale for Selection
Walleye are non-indigenous to the Crab Creek Subbasin but the popularity of recreational walleye fisheries within this subbasin have increased in recent years with walleye tournaments now occuring on Banks Lake, Moses Lakes, and Potholes Reservoir. Walleye broodstock are collected annually from Moses Lake and used in hatchery production to support walleye fisheries in the Crab Creek Subbasin and elsewhere in Washington state. Walleye are both a popular gamefish and an effective piscivorous predator, potentially impacting other gamefish populations to a high degree.

Key Life History Strategies, Relationship to Habitat

Walleye are generally found in large lakes or streams and travel in loose schools on or near the bottom. They can tolerate water temperatures of 32^0F to 90^0F but prefer waters with a summer maximum of 77^0F. In summer, feeding is often nocturnal with walleyes invading the shallows to feed at night and returning to deeper areas during daylight hours (Wydoski and Whitney 2003).

Walleyes are highly mobile and may travel great distances (100 miles) within river or lake systems to spawn. Spawning occurs in the early spring when water temperatures reach 38^0F to 44^0F. Prefered spawning sites are over gravel, rubble, or bedrock bottoms in areas with current such as rapid areas of streams or wind blown shorelines of lakes. Males arrive at the spawning grounds first and remain in these areas longer than females. Walleyes are known to leave Moses Lake (Assessment Unit 3) in the late winter-early spring and ascend mainstem Crab Creek (Assessment Unit 4) to spawn. Females may produce between 40,000 and 600,000 eggs with larger females producing more eggs than smaller females. Spawning typically occurs at night. The eggs are broadcast over the spawning area and are adhesive when first spawned but become free floating after water hardening. Walleye fry are not highly mobile and often depend upon currents to move them to suitable rearing areas (Wydoski and Whitney 2003).

Fingerling walleye begin to feed on planktonic crustaceans and gradually change diet to insects as they grow larger. As they continue to grow, they convert to a diet composed of a high proportion of fish. Yellow perch, where avalable, are often an important dietary component. Salmonids are also consumed by walleye, although usually secondary to other fishes such as cyprinids (including northern pikeminnow) and catastomids. Walleyes are relatively long-lived and my reach an age of 13 years and attain a size of 18 pounds in Washington waters (Wydoski and Whitney 2003).

Relationship with Other Species

- Predation upon other gamefish.
- Competition with other gamefish for food and habitat.
- Juveniles provide forage for other gamefish.

Non-Salmonid Focal Species 6: Yellow Perch (*Perca flavescens*)

Rationale for Selection

Yellow perch are non-indigenous to the Crab Creek Subbasin but like other focal species support unique and important recreational fisheries. They have markedly different life history and habitat requirements from focal centrarchid panfish species such as bluegill and black crappie. Yellow perch, like bluegill and black crappie, also can provide an important forage base for other focal predator species such as walleye and largemouth bass. In past years, thousands of recreational anglers have traveled from all areas of the state to fish for yellow perch in Potholes Reservoir. Today, the perch population has declined but may be cyclic with the walleye population.

Key Life History Strategies, Relationship to Habitat

Yellow perch usually travel in loose schools that often are composed of fish of the same

sex, size, and age. They prefer lakes with a modest amount of vegetation and clear water. Adult perch generally live near the bottom but are known to suspend off the bottom in depths of 15 to 25 feet. Fingerling perch are usually found in shallow water but move to open and deeper water in late fall. Populations in large lakes are not considered to be highly mobile and tend to inhabit the same general area throughout the year. (Wydoski and Whitney 2003).

Yellow perch move shoreward in the spring to spawn in the spring when water temperatures reach 45^0F to 50^0F. At this time males and females school separately. Males precede females to the spawning areas and females are in these areas only for a short time, when they are ready to spawn. Spawning takes place on vegetation or submerged brush and other objects over various types of bottoms (sand, gravel, and rubble). Eggs are deposited in a gelantenous ribbonlike mass about 2 to 3 inches wide and 2 to 7 feet long. Females can produce between 18,000 and 140,000 eggs with larger females producing more eggs than smaller females (Wydoski and Whitney 2003).

Young perch feed in shallow areas on zooplankton, particularly copepods and cladocerans. As the fish grow, they begin to feed on immature insects. Large perch feed on forage fish when available. Yellow perch generally live less than 8 years and attain an average size of about 10 inches (Wydoski and Whitney 2003).

Relationship with Other Species

- Competition with other gamefish for food and habitat, primarily with younger life stages of other gamefish.
- Predation upon eggs and fry of other gamefish.
- Prey for other gamefish.

Assessment Methods

Scientific Conceptual Foundation

Application of the Qualitative Habitat Analysis in the Crab Creek Subbasin Planning Process

The QHA was found to be a useful tool to organize and summarize a large amount of information into a useable format as necessary to complete the Assessment portion of the Crab Creek Subbasin plan. The QHA tool was used as a guide to illustrate 1) what environmental changes have occurred in the Subbasin since pre-European settlement, and 2) to what degree can salmonid habitat be enhanced and protected in the Crab Creek subbasin. It is fundamentally important to understand that the QHA is not intended to provide quantitative information in the context of *absolute* values for habitat attribute ratings. Rather, the QHA is qualitative, and attribute ratings are intended to be *relative values* that indicate a relative (high, moderate or low) amount of change in environmental conditions.

The Qualitative Habitat Analysis (QHA) was developed for use by the Northwest Power and Conservation Council subbasin planning. The QHA is intended for use in stream

environments at the subbasin scale. The QHA provides a structured, qualitative approach to analyzing the relationship between the focal species and habitat conditions. The assessment examines eleven environmental attributes considered important for biologic productivity. Attributes were assessed for 70 stream reaches within the Crab Creek subbasin.

The QHA relies on the expert knowledge of natural resource professionals and citizens with experience in a local area to describe physical conditions in the target stream. These individuals are also asked to describe how focal species may have used habitats in the past, and how fish distribution has likely changed as a result of changing habitat attributes. From this assessment, planners are able to develop hypotheses about the population and environmental relationships of the focal species. The ultimate result is an indication of the relative importance for restoration and/or protection management strategies at the sub-watershed scale addressing specific habitat attributes.

The QHA is a sophisticated analytical model. The QHA simply supplies a framework for reporting information and analyzing relationships between a species and its environment. It is up to local scientists, managers, and planners to interpret the results and make decisions based upon these relationships.
One of the primary objectives of the subbasin planning process is to provide a clear rationale for selecting management recommendations. Embedded in this discussion must be credible information (and assumptions) identifying key factors limiting biologic productivity of focal species. Currently, only the Ecosystem Diagnosis and Treatment (EDT) methodology has the power to describe biologic productivity of the focal species as envisioned by the NPCC Technical Guide for Subbasin Planners. However, to adequately employ the EDT method requires a substantial commitment of time and resources necessary to develop the datasets and to run the EDT model. Time and resource constraints in the Crab Creek Subbasin planning process negated the development of a credible EDT model. Therefore Crab Creek subbasin planners chose to use the QHA because it is a simple means to organize and summarize large volumes of information and professional experience.

The QHA analysis is capable of displaying information about three key conditions[5] fundamental to the assessment, including:

Historic/Reference Condition

- How are habitat attributes characterized for each reach prior to European influence and specifically prior to installation of the BOR's Columbia Irrigation Project (c.1940)?
- How might salmonid populations have been distributed in the subbasin in the historic condition?

Current Condition

[5] Reference conditions are prescribed in the Technical Guide to Subbasin Planners.

- How are habitat attributes characterized for each reach today?
- How do we characterize the distribution and abundance of salmonid distribution throughout the subbasin today?

Potential or "Desired" Future Condition

- What geographic areas are most likely to be restored and/or protected?
- How might salmonid distribution and abundance be affected as a result of these changes?

As previously mentioned, the primary strength of the QHA is its ability to conveniently store and summarize a substantial amount of information relating focal species to their habitats. Planners used this assessment technique as a tool for examining three fundament questions:

Where have significant habitat changes occurred since the historic reference condition?
What changes are thought to have most significantly affected the distribution /abundance of focal species?,
Where are the greatest opportunities to protect and / or restore habitat attributes that will potentially provide the greatest benefits to salmonid populations within the subbasin?

Stream reaches and the QHA habitat rating values were described by the Technical Group and reviewed (and modified as needed) by all interested community stakeholders. Current and historic habitat conditions were described by ranking eleven habitat attributes for each of the stream reaches. Additionally, current and historic focal species distribution was described by ranking focal species use for each of the stream reaches. The QHA values were compared to existing literature where available to insure consistency and credibility.

QHA is a modeling tool specific to salmonds. The Crab Creek Subbasin is unique in that much of subbasin consists of natural or artificial lakes which are managed for warm water species to which QHA reach and habitat attribute ratings do not apply. QHA was therefore applied in the context of rating habitat suitability for salmonids only and warmwater species habitat was considered separately from this assessment.

QHA generally employs a "single generic salmonid" approach to evaluating salmonid habitat throughout the subbasin which can be problematic in subbasins with multiple salmonid species with major life history differences. However, only two focal salmonid species were identified within the Crab Creek Subbasin; steelhead/rainbow trout and summer/fall Chinook. *O. mykiss* exists throughout the subbasin primarily as resident rainbow trout, but also as steelhead in the anadromous zones of lower reaches. Cutthroat trout are indigenous to the Crab Creek Subbasin, but were not selected as a focal species because they: 1) are not as widespread as rainbow trout, but 2) do have extremely similar habitat requirements, and 3) do not exhibit anadromous life history characteristics in this subbasin, as ESA listed steelhead do. Summer/fall Chinook differ in life history characteristics from *O. mykiss* but appear to utilize the same or very similar freshwater habitat in the Crab Creek subbasin. For example, the only known spawning reach for

either Chinook or steelhead is within Red Rock Coulee. Owed to the year round rearing requirements of steelhead juveniles, factors limiting salmonid production in this reach and the anadromous corridor located downstream were considered to be important to both species but most pronounced for steelhead. Therefore, with regards to habitat attribute and life stage ratings, *O. mykiss* were used as the representative species. This was considered to be the most appropriate and conservative approach under the assumptaion that habitat protection/restoration actions would likely benefit both species but be most beneficial to steelhead given the potentially longer residence time.

One underlying assumption of the QHA technique is that reference conditons (i.e., *historical condtions prior to European influence*) were similar to Properly Functioning Conditions (PFC) and that current conditions are either the same or degraded from reference. The Crab Creek Subbasin is unique in that much of the subbasin did not exist prior to European influence and the Columbia Basin Irrigation Project. It should be noted here that identification and prioritization of habitat restoration (i.e., *restoring salmonid habitat from a degraded current condition to an improved condition similar to that which existed historically)* potential is a primary function of the QHA. Reference ratings of zero were given in Crab Creek reaches where the subbasin did not exist historically. Therefore, in many cases, habitat conditions were found to improve from reference conditions and therefore had no (or negative) restoration potential. However, although not directly identified through the QHA assessment, these same areas could still be important to salmonids and considered as having potential for habitat "enhancement" (i.e., *improvement of current conditions beyond reference conditions*) although no true restoration potential.

Also generally inherent to the QHA is the concept that the existing habitat could provide a Properly Functioning Condition. This was found to often not be the case in the Crab Creek Subbasin. As mentioned above, many Crab Creek Stream Reaches did not exist historically and most certainly were not Properly Functioning with regards to salmonid habitat. Supplying of water artifically to these areas has in many cases allowed the expansion of fish population ranges but has not created Properly Functioning Conditions or the potential for PFC. For example, much of lower Crab Creek was considered to be dry or intermittent historically, but now is perrenial. Lack of spawning habitat due to sediment is a primary limiting factor to salmonid production in many of these areas because sand is the dominant substrate. However, sand is also the dominant geological feature in many of these same areas which largely negates the potential for suitable spawning substrate. Likewise, in areas where water now flows through basalt canyons, the potential for riparian vegetation is zero. To allow identification and prioritization of protection and restoration reaches, habitat attribute ratings were equally applied among all stream reaches for both reference and current conditions as compared to ideal or Properly Functioning Conditions for salmonids without regard to whether these conditions could actually be achieved.

In summary, the QHA was used in the Crab Creek subbasin planning process for two fundamental reasons; 1) the tool is a straight forward means to summarize a substantial amount of information in an accessible manner, and 2) the tool could be used and results

completed given very tight budget and temporal constraints. The subbasin planners have developed various approaches to communicate the findings of the QHA to the general public and scientific community as a basis for the development of management strategy recommendations. The methodology was successful in its intent in describing the fundamental environmental changes that have occurred in the Crab Creek subbasin and has served as a guide for describing future management direction. The results of the QHA are summarized below and included in Appendix A.

Assessment Units

The Crab Creek Subbasin was divided into seventy stream reaches for QHA assessment. These were grouped into five Assessment Units based upon reach similarities. The Banks Lake system is considered the sixth Assessment Unit as it is part of the Crab Creek Subbasin. However, as it is entirely the result of irrigation with the only surface connection to Crab Creek via irrigation wasteways, it was therefore not included in the QHA assessment.

Assessment Results

Crab Creek Assessment Unit 1 – Lower Crab Creek.

Description

This Assessment Unit begins at the mouth of Crab Creek and and terminates at the headwaters of Red Rock Coulee. Tributaries include Red Rock Coulee and the Burkett Lake System. This Assessment Unit was selected as unique in that it includes the entire range for in which anadromous fish presence has been observed and confirmed. It should be noted that NOAA Fisheries defines the end of anadromy for Crab Creek as the upper most boundary of Assessment Unit 2 at the base of O'Sullivan Dam. Although anadromous fish may well be present upstream of Assessment Unit 1, we could find no documentation to confirm this.

This is the first of six assessment units of the Crab Creek Subbasin. Historically, mainstem Crab Creek was thought to exist in this AU, although supporting lower flows than currently. The Burkett Lake Stream system and Red Rock Coulee are thought not to have existed historically and exist now as a result of irrigation practices. Anadromous steelhead and summer/fall Chinook are known to utilize mainstem Crab Creek as a passage corridor and spawn in the lower portion of Red Rock Coulee. Steelhead are included within the Upper Columbia ESU and are listed as Endangered under ESA. Management of the Burkett Lake system is split between WDFW and GCPUD. WDFW manages Lake Lenice, Lake Nunnally, and Merry Lake (Bul3) for quality resident trout fisheries. GCPUD owns and is currently developing a management strategy for Burkett Lake (Bul1 and Bul2).

Ten specific stream reaches were identified within this Assessment Unit. These are illustrated in Apprendix B and described below:

Mainstem Crab Creek1 (CC1) – From the mouth of Crab Creek (confluence with Columbia River) extending upstream to the end of the quality riparian zone.

Mainstem Crab Creek 2 (CC2) – Relatively short braided section of mainstem Crab Creek which extends from the upstream boundary of CC1 to just above the railroad crossing where braided habitat changes to channelized habitat.

Burkett Lake Stream 1 (Bul1) – From confluence with mainstem Crab Creek upstream to man-made fish barrier structure at the outlet of Burkett Lake.

Burkett Lake Stream 2 (Bul2) – From man-made barrier at Burkett Lake outlet upstream to inlet of Lake Lenice.

Burkett Lake Stream 3 (Bul3) – Mainstem Burkett Lake Stream from inlet of Lake Lenice upstream to headwaters.

Burkett Lake Stream 4 (Bul4) – Tributary from confluence with mainstem Burkett Lake Stream (above Lake Lenice) upstream to source at springs.

Red Rock Coulee 1 (RRC1) – From the confluence with mainstem Crab Creek upstream to the Red Rock Road (E SW) crossing.

Red Rock Coulee 2 (RRC2) – From the first county road Red Rock Road (E SW) crossing upstream to the outlet of Red Rock Lake.

Red Rock Coulee 3 (RRC3) – From the outlet of Red Rock Lake upstream to the base of the natural falls at Red Rock Lake inlet.

Red Rock Coulee 3 (RRC3) – From and including the natural falls at the inlet of Red Rock Lake upstream to the end of the channel.

Focal Fish Species

- Summer/fall Chinook Salmon
- Steelhead/Rainbow Trout

Limiting Factors

Based upon expert knowledge and interpretation of the results of the QHA, primary factors limiting salmonid production in AU1 were determined to be:

- Lack of suitable spawning substrate due to sedimentation
- Elevated summer water temperatures
- Low primary and secondary productivity (phytoplankton, zooplankton, and benthic macro-invertebrates) although not identifiable through the QHA analysis were also considered to a likely limiting factor.

Key Findings

Restoration Value: Stream reaches within AU1 were ranked as having no (or negative) restoration values as current conditions for salmonids are believed to have improved from reference conditions. This is due to increased stream flows resulting from current irrigation practices. Mainstem Crab Creek is believed to have been intermittent and Red Rock Coulee and the Burkett Lake Stream system were believed to have been non-existent historically.

Protection Value: Stream reach Red Rock Coulee 4 (Upper Red Rock Wasteway) received a protection score of zero as it is currently not believed to be inhabited by salmonids and fish passage is blocked by a natural falls at the downstream end of the reach. Red Rock Coulee 3 (Red Rock Lake) received a relatively low protection score as this area is managed largely for warmwater species. All other stream reaches received moderate to high protection scores due to the known presence of salmonids, including ESA listed species. The Burkett Lake Stream system, although not inhabited by a anadromous salmonids, received the highest protection scores due to the high quality trout fishery it supports.

Data Gaps

Substantial data gaps were found to exist within this Assessment Unit. These are listed below.

- Primary/secondary productivity.
- Juvenile anadromous fish presence and distribution.
- Juvenile anadromous fish survival to adulthood.
- Natural production of resident trout in Lenice, Nunnally, and Merry Lakes.
- Impact of listed species presence on irrigation system.
- Spawning habitat in mainstem Crab Creek.
- Genetic origin of anadromous fish.

Crab Creek Assessment Unit 2 - Refuge.

Description

Assessment Unit 2 begins at the confluence of Red Rock Coulee and continues upstream to the base of O'Sullivan Dam. This is the second of six assessment units of the Crab Creek Subbasin. The upper portion is contained largely within USFWS wildlife refuge boundaries. Much of the lower portion is private land with areas channelized and impacted by land use practices. Manmade and natural barriers may occur throughout this AU. Mainstem Crab Creek, now perennial, was believed to have existed historically but with lower possibly intermittent flows. With the exception of lower Owl Creek, all tributaries in this AU were believed to have been dry historically. Several tributaries within this AU consist of lake systems connected by surface flow. These systems are currently managed for resident trout or warm water species fisheries. Irrigation practices made possible by the USBR Columbia Basin Project are believed to have increased stream flows in this AU above historical levels. This Assessment Unit was selected as

unique because it includes the USFWS Columbia National Wildlife Refuge and the defined end of anadromy to the base of O'Sullivan Dam.

Assessment Unit 2 contains a total of fourteen stream reaches. These are illustrated in Appendix B and described below.

Mainstem Crab Creek 3 (CC3) - Channelized section that begins at upstream boundary of CC2 and continues upstream to just above the Corfu Road crossing.

Mainstem Crab Creek 4 (CC4) – Natural channel section that begins just above the Corfu Road crossing and continues upstream to the beginning of the next channelized section.

Mainstem Crab Creek 5 (CC5) – Channelized reach within Grant County that begins at upstream boundary of CC4 and continues upstream to the Adams County line.

Mainstem Crab Creek 6 (CC6) – Begins at Adams County line and continues upstream to the confluence with the Black Lake Tributary.

Mainstem Crab Creek 7 (CC7) – Extends upstream from the confluence with Black Lake Tributary to the first man-made fish passage barrier located within the USFWS National Wildlife Refuge.

Mainstem Crab Creek 8 (CC8) – Extends upstream from the CC7 uppermost boundary to the outlet of Pond #1 located within the USFWS National Wildlife Refuge.

Mainstem Crab Creek 9 (CC9) – Extends upstream from the outlet of Pond #1 on the USFWS National Wildlife Refuge to the base of O'Sullivan Dam.

Owl Creek 1 (OC1) – From mouth upstream to Barton Road crossing.

Owl Creek 2 (OC2) – From Barton Road Crossing to the headwaters. Includes June Lake, Windmill Lake, and others.

Royal Lake Tributary (RL1) – From mouth to headwaters. Includes Royal Lake.

Hutchinson Lake Tributary (HL1) – From mouth to headwaters. Includes Pillar Lake, Widgeon Lake, Hampton Lake, Juvenile Lake, McManamon Lake, and the Coyote and Bobcat drainages.

Black Lake Tributary (BL1) – From mouth to headwaters. Includes Upper and Lower Goose Lakes, Shoefly Lake, and Black Lake.

Corral Lake Drainage (CL1) – From mouth to headwaters. Includes Corral Lake, Blythe Lake, Chukar Lake, and Scaup Lake.

Goldeneye Lake Tributary (GE1) – From mouth to source. Includes Goldeneye Lake and

O’Sullivan Dam emergency spillway.

Focal Fish Species
Salmonids:

- Summer/fall Chinook Salmon
- Steelhead/Rainbow Trout

Non-salmonids:

- Smallmouth Bass
- Largemouth Bass
- Bluegill
- Black Crappie
- Walleye
- Yellow Perch

Limiting Factors

Based upon expert knowledge and interpretation of the results of the QHA, primary factors limiting salmonid production in AU2 were determined to be:

- Lack of spawning substrate (sedimentation).
- High summer water temperatures (*O. mykiss*).
- Barriers
- Channel confinement
- Riparian condition

Key Findings

Resoration Value: Similar to Assessment Unit 1, all stream reaches within Assessment Unit 2 were scored as having no (or negative) restoration value as current conditions have improved over reference. This is due to increased flow resulting from the USBR Columbia Basin Project. Mainstem Crab Creek in AU2 is currently a perennial stream but, although not well documented, was believed to be intermittent historically. With the exception of lower Owl Creek, all tributary systems in AU2 result from the current Columbia Basin Project, primarily seepage from O’Sullivan Dam, and did not exist historically.

Protection Value: The Black Lake Tributary and the Royal Lake Tributary received protection scores of zero as these system currently do not support salmonids. The Black Lake system is currently managed for warmwater species. All other stream reaches were scored as having protection value with Upper Owl Creek, the Goldeneye Lake Tributary, and the Corral Lake Drainage receiving the highest scores due to the presence of resident trout fisheries within these systems. On mainstem Crab Creek, stream reaches CC6 and CC7 received the highest protection scores. These are located within the boundaries of the USFWS National Wildlife Refuge.

Data Gaps
Substantial data gaps were found to exist within this Assessment Unit. These are listed below.

- Fish presence and distribution.
- Barriers assessment.
- Instream habitat assessment.
- Comprehensive stream temperature data.
- Extent of channel confinement.
- Primary/secondary productivity.

Crab Creek Assessment Unit 3 – Potholes/Moses Lake

Description
Assessment Unit 3 begins at the face of O'Sullivan Dam and includes Potholes Reservoir and wasteways, Moses Lake, Rocky Ford Creek, and the Sun Lake Chain. This is the third of six assessment units in the Crab Creek Subbasin. Historically, Moses Lake existed as a natural lake fed by Rocky Ford Creek and Crab Creek. Potholes Reservoir did not exist historically but mainstem Crab Creek is thought to have occurred intermittently within this area. The wasteways are entirely the result of recent irrigation practices and did not exist historically. Anadromous fish are not present, and likely were never present in this AU. Potholes and Moses Lake support quality mixed species fisheries, primarily for warm water species, but also including resident trout. The wasteways do support resident trout fisheries in some sections, largely as a result of hatchery supplementation with limited natural production (Lind Coulee). The Sun Lake Chain is connected to the Crab Creek System via sub-surface flow and becomes increasingly saline downstream. This Assessment Unit was selected as unique in that it consists primarily of lake habitat.

Assessment Unit 3 contains a total of seven stream reaches. These are illustrated in Appendix B and described below.

Mainstem Crab Creek 10 (CC10) – From the face of O'Sullivan Dam upstream to the outlet structures of Moses Lake. Includes all of Potholes Reservoir.

Mainstem Crab Creek 11 (CC11) – From outlet structures of Moses Lake upstream to the Highway 17 crossing. Includes all of Moses Lake.

Winchester Wasteway 1 (WWW1) – From the confluence with Potholes Reservoir upstream to the source.

Frenchman Hills Wasteway 1 (FHW1) – From the confluence with Potholes Reservoir upstream to the source.

Lind Coulee Wasteway 1 (LCW1) - From the confluence with Potholes Reservoir upstream to the source.

Rocky Ford Creek 1 (RF1) – From confluence with Moses Lake extending approximately seven miles upstream to private hatchery springs.

Sun Lakes Chain 1 –SLC1 (formerly referred to as Rocky Ford Creek 2 - RF2)– From the upstream boundary of RF1 continuing upstream to the base (outlet) of Banks Lake Dam. This reach includes by subsurface connection the Sun Lakes, Lake Lenore, Soap Lake and Ephrata Lake.

Focal Fish Species

Salmonids:

- Rainbow Trout

Non-salmonids:

- Smallmouth Bass
- Largemouth Bass
- Bluegill
- Black Crappie
- Walleye
- Yellow Perch

Limiting Factors

Based upon expert knowledge and interpretation of the results of the QHA, primary factors limiting salmonid production in AU3 were determined to be:

- Spawning habitat
- High summer water temperatures
- Water quality

Key Findings

Recovery Value: Both mainstem reaches (Potholes Reservoir and Moses Lake) received negative restoration scores as current conditions are more favorable to salmonids than reference. Potholes Reservoir did not exist prior to the Columbia Basin Irrigation Project and construction of O'Sullivan Dam. Mainstem Crab Creek in this area was thought to be intermittent. Moses Lake did exist historically as a natural lake but lake level and salmonid habitat have increased under current conditions due to the presence of man-made outlet structures. Frenchman Hills Wasteway, Winchester Wasteway, and Lind Coulee Wasteway have no restoration value as they did not exist historically and are the result of modern irrigation practices. Lakes within the Sun Lake Chain were believed to have existed historically as natural lakes and received a moderately low restoration score. Rocky Ford Creek was believed to have existed historically owing to the natural spring source and received the highest restoration score for this Assessment Unit.

Protection Value: Rocky Ford Creek received the highest protection score for this

Assessment Unit due to the high quality trout fishery it currently supports. The Sun Lakes Chain received a slightly lower protection score than Rocky Ford Creek due primarily to the high quality trout fishery present in Lake Lenore. Potholes Reservoir and Moses Lake both received moderate protection scores as each support mixed species fisheries which include resident trout. Winchester Wasteway, Frenchman Hills Wasteway, and Lind Coulee Wasteway all received similar moderately low protection scores as resident trout fisheries do currently exist in these systems supported largely by hatchery production.

Data Gaps
Substantial data gaps were found to exist within this Assessment Unit. These are listed below.

- Species/habitat interactions.
- Current level and extent of natural fish production.
- Recreational impacts.
- Urban impacts.
- Extent and source of contamination.
- Effect of contaminants on resident fish populations.

Crab Creek Assessment Unit 4 – Upper Middle Crab Creek

Description
This Assessment Unit begins on just upstream of Moses Lake and continues upstream to the railroad crossing near Crab Lake and is the fourth of six assessment units in the Crab Creek Subbasin. This area is largely characterized by intermittent flow. Tributaries in this AU include Homestead Creek, Magpie Creek, Loan Springs Creek, Gloyd Springs Creek, and Rocky Coulee Wasteway. Anadromous fish are not present in this AU and management is primarily for resident trout with secondary consideration for warm water species. Water quality is generally high. Tributaries include extensive emergent wetland areas. Walleye spawning occurs in lower portion of mainstem Crab Creek. This Assessment Unit was selected as unique in that it is characterized largely of by intermittent stream flows.

Assessment Unit 4 contains a total of ten stream reaches. These are illustrated in Appendix B and described below.

Mainstem Crab Creek 12 (CC12) – from Highway 17 crossing upstream to the confluence with Skane Creek.

Mainstem Crab Creek 13 (CC13) – From the confluence with Skane Creek upstream to the confluence with Loan Creek.

Mainstem Crab Creek 14 (CC14) – From the confluence with Loan Creek upstream to the Highway 28 crossing.

Mainstem Crab Creek 15 (CC15) – From the Highway 28 crossing upstream to the Brook

Lake inlet, including Brook Lake.

Mainstem Crab Creek 16 (CC16) – From the inlet of Brook Lake upstream to the railroad crossing near Crab Lake.

Rocky Coulee Wasteway 1 (RCW1) – From the confluence with Crab Creek to the source.

Skane (Gloyd Springs) Creek 1 (SK1) – From the confluence with Crab Creek to the source.

Loan Springs Creek 1 (LSC1) - From the confluence with Crab Creek to the source.

Magpie Creek 1 (MPC1) - From the confluence with Crab Creek to the source.

Homestead Creek (HC1) - From the confluence with Crab Creek to the source.

Focal Fish Species

- Rainbow Trout

Limiting Factors

Based upon expert knowledge and interpretation of the results of the QHA, primary factors limiting salmonid production in AU4 were determined to be:

- Low stream flows
- High summer water temperatures
- Low dissolved oxygen
- Sedimentation
- Habitat connectivity

Key Findings

Restoration Value: Mainstem Crab Creek Stream Reach 15 received a negative restoration score as current conditions are believed to have improved over reference. Rocky Coulee Wasteway received a restoration score of zero as it did not exist historically prior to modern irrigation practices. Mainstem Crab Creek Stream Reach 12 and Loan Springs Creek also received restoration scores of zero as current conditions are believed to be comparable to reference. Mainstem Crab Creek Stream Reaches 13, 14, and 16, and Skane Creek, Magpie Creek, and Homestead Creek all received moderately low restoration scores. Overall, Magpie Creek received the highest restoration score for this Assessment Unit.

Protection Value: Skane Creek and Homestead Creek received the highest protection scores due to the quality trout fisheries present in each. These stream reaches also include

well developed wetlands. Mainstem Crab Creek Stream Reaches 12 and 13, Magpie Creek, and Loan Springs Creek all received moderate protection scores. Mainstem Crab Creek Stream Reaches 14, 15, 16, and Rocky Coulee Wasteway all received relatively low protection scores.

Data Gaps

Information regarding the following was found to be lacking or incomplete in this Assessment Unit.

- Comprehensive stream flow data
- Comprehensive water temperature data
- Comprehensive dissolved oxygen data
- Resident trout carrying capacity
- Resident trout spawning areas
- Resident trout baseline population level
- Resident trout localized migratory needs and habits
- Affect of flow reductions on resident trout populations
- Ground water/surface water interactions
- Hatchery/natural interactions

Crab Creek Assessment Unit 5 – Upper Crab Creek

Description
This Assessment Unit extends from approximately Crab Lake to the headwaters of Crab Creek and includes the South Fork of Crab Creek and numerous tributaries. This is the fifth of six assessment units in the Crab Creek Subbasin and is characterized by a mix of perennial and intermittent stream reaches. Fish management in this area is for resident trout. Unlike many areas in lower Crab Creek, all stream reaches in this Assessment Unit are believed to have existed historically. This Assessment Unit supports a quality resident trout fishery and therefore contains reaches with high protection value (habitat currently intact) and reaches with high restorative value (habitat degraded from historic condition). Anadromous fish do not occur in this Assessment Unit. This Assessment Unit was selected as unique in that it is largely characterized by perennial stream flows.

Assessment Unit 5 contains a total of 29 stream reaches. These are illustrated in Appendix B and described below.

Mainstem Crab Creek 17 (CC17) – From railroad crossing at upper boundary of CC16 (Assessment Unit 4) extending upstream to the end of intermittent flow.

Mainstem Crab Creek 18 (CC18) – From upper boundary of CC17 extending upstream to the end of perennial flow.

Mainstem Crab Creek 19 (CC19) – From upper boundary of CC18 extending upstream to

the end of intermittent flow located just downstream from the town of Irby.

Mainstem Crab Creek 20 (CC20) – From the upper boundary of CC19 extending upstream to the end of perennial flow located just above the Napier Road crossing.

Mainstem Crab Creek 21 (CC21) - From the upper boundary of CC20 extending upstream to the end of intermittent flow near the town of Odessa.

Mainstem Crab Creek 22 (CC22) - From the upper boundary of CC21 extending upstream to just above the inlet to Sylvan Lake. Sylvan Lake is included in this stream reach.

Mainstem Crab Creek 23 (CC23) – From the upper boundary of CC22 extending upstream to the base of the first fish barrier dam.

Mainstem Crab Creek 24 (CC24) – From and including the fish barrier dam at the upper boundary of CC23 extending upstream to the natural (non-barrier) falls.

Mainstem Crab Creek 25 (CC25) – From the natural falls located at the upper boundary of CC25 extending upstream to the confluence with the South Fork of Crab Creek.

Mainstem Crab Creek 26 (CC26) – From the confluence with the South Fork of Crab Creek extending upstream to the springs located on U.S. Bureau of Land Management land.

Mainstem Crab Creek 27 (CC27) – From the upper boundary of CC26 extending upstream to end of intermittent flow.

Mainstem Crab Creek 28 (CC28) - From the upper boundary of CC27 extending upstream to a set of natural barrier falls.

Mainstem Crab Creek 29 (CC29) – From and including the natural barrier falls located at the upper boundary of CC28 extending upstream to just above the confluence with Bluestem Creek.

Mainstem Crab Creek 30 (CC30) – From the upper boundary of CC29 extending upstream to the Reardon Ponds located in the headwaters.

Wilson Creek 1 (WC1) – From confluence with Crab Creek upstream to the lower boundary of WC2.

Wilson Creek 2 (WC2) – From upper boundary of WC1 to the headwaters.

Cannawai Creek 1 (CaC1) – From confluence with Crab Creek to the source.

Lake Creek 1 (LC1) – From confluence with Crab Creek to where to the headwaters.

Duck Creek 1 (DC1) – From confluence with Crab Creek to the source.

Coal Creek 1 (CoC1) - From confluence with Crab Creek to the source.

South Fork Crab Creek 1 (SFCC1) – From confluence with Crab Creek to the source.

Knapp Creek 1 (KC1) - From confluence with Crab Creek to the source.

Little Creek 1 (LitC1) - From confluence with Crab Creek to the source.

Lords Creek 1 (LoC1) - From confluence with Crab Creek to the source.

Battle Creek 1 (BatC1) - From confluence with Crab Creek to the source.

Bluestem Creek 1 (BC1) - From confluence with Crab Creek to the source.

Canby Creek 1 (CbC1) - From confluence with Crab Creek to the source.

Rock Creek 1 (RC1) - From confluence with Crab Creek to the source.

Tuttle Creek 1 (TC1) - From confluence with Crab Creek to the source.

Focal Fish Species

- Rainbow Trout

Limiting Factors

Based upon expert knowledge and interpretation of the results of the QHA, primary factors limiting salmonid production in AU5 were determined to be:

- Habitat connectivity
- Low summer flows
- High summer water temperatures
- Riparian condition

Key Findings

Restoration Value: Restoration scores on mainstem Crab Creek were relatively low in the lower portion (Reaches 17-23) of Assessment Unit 5 and in the very headwaters (Reach 30) and moderate to high in the remaining upper portion (reaches 23-29). All of the tributaries had relatively high restoration scores. Overall, Wilson Creek 1 (WC1) received the highest restoration score as this heavily channelized intermittent stream reach separates upper Wilson Creek (WC2), which supports a quality trout fishery, from mainstem Crab Creek.

Protection Value: On mainstem Crab Creek, reaches 26 and 29 received relatively high protection scores due to their current perennial nature and high quality trout fisheries. All other mainstem reaches received moderate to low protection scores. Protection scores were generally higher in the tributaries than in the mainstem. Little Creek and Canby Creek received the first and second highest protection scores (respectively) owing largely to superior quality riparian habitat currently present compared to other tributary reaches. Cannawai Creek received a protection score of zero as salmonids are not currently present in this tributary.

Data Gaps

Critical data gaps in Assessment Unit 5 were found to be:

- Resident trout carrying capacity
- Resident trout spawning areas
- Resident trout baseline population level
- Resident trout localized migratory needs and habits
- Affect of flow reductions on resident trout populations
- Ground water/surface water interactions
- Trout genetics
- Hatchery/natural interactions

Crab Creek Assessment Unit 6 – Banks Lake.

Description
This Assessment Unit consists of Banks and Billy Clapp Lakes and extends from Pinto Ridge Dam on Billy Clapp Lake to the inlet structure on Banks Lake. This is the sixth of six assessment units in the Crab Creek Subbasin and is characterized by lake habitat which supports a mixed species fishery including resident salmonids. Salmonid production is largely through hatchery supplementation. Natural production has not been assessed. Anadromous fish do not occur in this Assessment Unit. Kokanee are unique to this Assessment Unit and have been introduced into both Banks and Billy Clapp Lakes.

QHA was not performed in this Assessment Unit because this system is currently the result of irrigation with the only surface flow connection to mainstem Crab Creek through irrigation wasteways.

Limiting Factors

- Low reservoir retention time resulting in low primary/secondary productivity.
- Inter and intra-specific competition.
- Lack of spawning habitat.
- Predation.

Focal Fish Species

Salmonids:

- Rainbow Trout
- Kokanee

Non-salmonids:

- Smallmouth Bass
- Largemouth Bass
- Bluegill
- Black Crappie
- Walleye
- Yellow Perch

Key Findings

QHA analysis was not performed on Assessment Unit 6. Banks and Billy Clapp Reservoirs did not exist historically and are entirely the result of the Columbia Basin Irrigation Project. Therefore these reservoirs have no true restoration value. However, these systems do support popular recreational fisheries for both salmonids and non-salmonids that potentially can be enhanced.

Data Gaps

- Natural salmonid production.
- Species interactions.
- Primary/secondary productivity.

Summary of Limiting Factors, Focal Species, Key Findings, and Data Gaps for the Entire Crab Creek Subbasin

Limiting Factors

- Overall, factors found to limit salmonid production in the Crab Creek Subbasin were:
- High summer water temperatures
- Low stream flows
- Lack of suitable spawning substrate
- Barriers
- Channel confinement
- Riparian condition
- Water quality
- Low dissolved oxygen
- Sedimentation

- Habitat connectivity
- Riparian condition

Low primary and secondary productivity (phytoplankton, zooplankton, and benthic macro-invertebrates) although not identifiable through the QHA analysis were also considered to a likely limiting factor.

Focal Fish Species

Salmonids:
- Summer/fall Chinook Salmon
- Steelhead/Rainbow Trout

Non-salmonids:
- Largemouth Bass
- Smallmouth Bass
- Walleye
- Yellow Perch
- Bluegill
- Black Crappie

Key Findings

The QHA provides a ranking of stream reaches by restoration and protection priority for the Crab Creek Subbasin as a whole. The top priority restoration and protection reaches are summarized below. QHA information for all stream reaches is available in Appendix A.

Restoration Value: Overall, Mainstem Crab Creek Stream Reaches 12, 23, 24 and Wilson Creek Stream Reach 1 received top priority restoration rankings. The primary habitat attributes in need of restoration for each of these stream reaches are indicated below in prioritized order.

Mainstem Crab Creek Stream Reach 12
Channel stability
High temperature
Habitat diversity

Mainstem Crab Creek Stream Reach 23
High Temperature
Low Flow
Riparian Condition

Mainstem Crab Creek Stream Reach 24
High Temperature
Low Flow
Riparian Condition

Wilson Creek Stream Reach 1
Low Flow
Riparian Condition(tie)
Habitat Diversity(tie)

Protection Value: Overall, Mainstem Crab Creek Stream Reaches 6 and 13, and Burkett Lake Stream Reach 4, Owl Creek Stream Reach 2, and Skane Creek received top priority protection rankings. The primary habitat attributes in need of protection for each of these stream reaches are indicated below in prioritized order.

Mainstem Crab Creek Stream Reach 6
Low Flow
High Temperature (tie)
Habitat Diversity (tie)
Channel Stability (tie)

Mainstem Crab Creek Stream Reach 13
Channel Stability
High Temperature
Habitat Diversity

Burkett Lake Stream Reach 4
Low Flow
Riparian Condition (tie)
Channel Stability (tie)
Habitat Diversity (tie)

Owl Creek Stream Reach 2
Low Flow
High Temperature
Habitat Diversity (tie)
Channel Stability (tie)

Skane Creek Stream Reach 1
Low Flow
High Temperature
Dissolved Oxygen

Data Gaps
The following critical data gaps were found to exist in the Crab Creek Subbasin:

- Salmonid presence and distribution.
- Impact of listed species presence on irrigation system.
- Genetic origin of anadromous fish and resident trout.
- Barriers assessment.

- Instream habitat assessment.
- Extent of channel confinement.
- Extent and source of contamination.
- Effect of contaminants on resident fish populations.
- Species/habitat interactions.
- Current level and extent of natural fish production.
- Recreational impacts.
- Urban impacts.
- Comprehensive stream flow data.
- Comprehensive water temperature data.
- Comprehensive dissolved oxygen data.
- Resident trout carrying capacity.
- Resident trout spawning areas.
- Resident trout baseline population level.
- Resident trout localized migratory needs and habits.
- Affect of flow reductions on resident trout populations.
- Ground water/surface water interactions.
- Hatchery/natural interactions.
- Primary/secondary productivity.

Wildlife Assessment

Shrubsteppe

The historic habitat within the Crab Creek Subbasin included shrubsteppe (including, meadow steppe, and steppe [grass]), forest/shrub, cliffs, open water, and riparian (Daubenmire 1970) (Figure 4). Shrubsteppe habitat types were clearly the most dominant, covering > 95% of the overall subbasin. Habitat within the subbasin has been dramatically altered (Dobler et al. 1996, Jacobson and Snyder 2000) (Figure 5). Substantial portions (> 60%) of the shrubsteppe have been converted, primarily for the production of irrigated and dryland crops. Significant quantities of original habitat have also been converted to urban, commercial, and residential sites in addition to being altered by road construction, canal construction, and recreational development and use. Moreover, the pattern of cropland conversion has resulted in a disproportionate loss of deep soil communities (Vander Haegen et al. 2000). In addition, much of the remaining shrub steppe has been fragmented into relatively small patches of habitat that are degraded in quality (Dobler et al. 1996). Ownership in the Crab Creek Subbasin is extremely diverse (Figure 12). Although most of the land is privately owned, there are substantial quantities owned by local, state, and federal government agencies (Table 5).

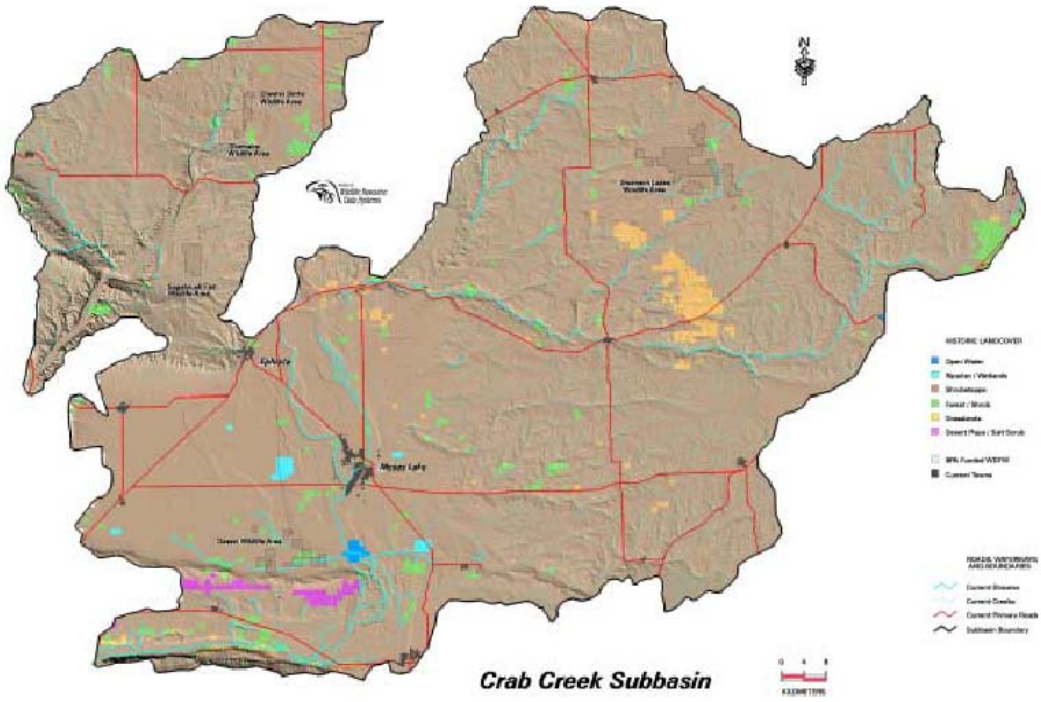

Figure 4. Historic Landcover

Figure 5. Current Landcover

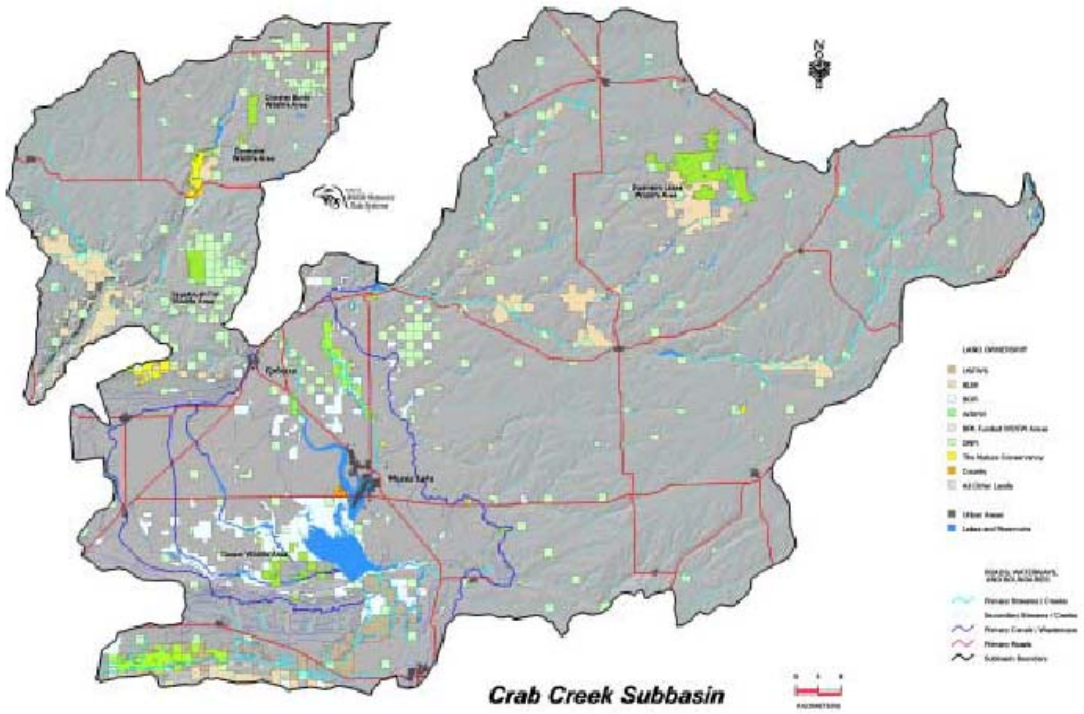

Figure 6. Current Ownership

Table 3. Historic Landcover Type by Ownership

Table 3. Historic Landcover Type by Ownership (Johnson and O'Neil, 2001)

Historic Land Cover by Ownership in Hectares

Ownership	Water	Wetlands and Riparian	Shrubsteppe	Forest/ Shrub	Cropland	Urban	Grasslands	Salt Scrub	Background (no data)	Total Hectres by Entity
Private	132	2240	1117951	22183	0	0	16826	4941	6439	**1170713**
Unknown	2	0	5392	67	0	0	0	0	0	**5461**
TNC		0	2810	0	0	0	0	0	202	**3012**
NSFWS	0	0	10860	378	0	0	261	0	8	**11508**
BLM	0	0	35815	1183	0	0	459	0	164	**37622**
Dept of Energy	0	0	50	0	0	0	0	0	0	**50**
Bureau of Reclamation	1189	60	39436	1945	0	0	182	96	162	**43069**
WDFW	0	0	21083	747	0	0	468	0	73	**22371**
Wa State Parks	0	0	0	0	0	0	0	0	1	**1**
Wa DNR	0	0	56228	1269	0	0	480	59	288	**58324**
City	0	0	278	0	0	0	0	0	0	**278**
Other	0	0	346.85545	0	0	0	0	0	29.781987	**377**
Total Hectres by class	**1323**	**2300**	**1290252**	**27773**	**0**	**0**	**18676**	**5096**	**7367**	**1345420**
									1352787	

Table 4. Current Landcover Type by Ownership (Jacobson and Synder 2000)

Current Land Cover by Ownership in hectares

Ownership	Water	Wetlands and Riparian	Shrubsteppe	Forest/ Shrub	Cropland	CRP Lands	Urban	Grass	Total Hectres by Entity	% of Total
Private	7754	9453	281691	904	715309	135899	7875	126	**1159012**	**86.47**
Unknown	368	206	3988	0	892	1	0	0	**5457**	**.41**
TNC	16	2	2729	0	38	7	0	0	**2792**	**.21**
NSFWS	482	788	9008	6	1223	0	0	0	**11507**	**.86**
BLM	381	240	34631	18	1950	363	11	0	**37594**	**2.80**
Dept of Energy	0	0	50	0	0	0	0	0	**50**	**00**
Bureau of Reclamation	8695	3139	25506	8	5566	114	36	0	**43064**	**3.21**
WDFW	733	1210	16925	1	3046	455	0	0	**22370**	**1.67**
Wa State Parks	0	0	1	0	0	0	0	0	**1**	**.00**
Wa DNR	753	834	29455	126	24451	2083	122	53	**57877**	**4.32**
University	0	0	0	0	0	0	0	0	**0**	**.00**
County	0	0	0	0	0	0	0	0	**0**	**.00**
City	2	23	68	0	105	0	80	0	**278**	**.02**
Other	22	33	16	17	68	0	211	8	**376**	**.03**
Total Hectres by class	**19207**	**15928**	**404070**	**1080**	**752650**	**138922**	**8334**	**188**	**1340380**	**100**

Wildlife Assessment at the Ecoprovince Level

Wildlife assessments were completed for both the Columbia Cascade and the Columbia Plateau Ecoprovinces. The Crab Creek Subbasin lies within the Columbia Plateau but is considered to be ecologically more similar to to the Cascade Ecoprovince and was therefore included in the Columbia Cascade Ecoprovince Wildlife Assessment. Funding was not available to complete an adequate Wildlife Assessment specific to the Crab Creek Subbasin. However, the Columbia Cascade Ecoprovince Wildlife Assessment provides a useful assessment framework, and is presented below.

Historic Reference Condition

Dramatic changes in fish and wildlife habitat have occurred throughout the Crab Creek subbasin since pre-European settlement (circa 1850). These changes have occurred primarily in focal riparian wetland and shrubsteppe habitats (Figure 7).

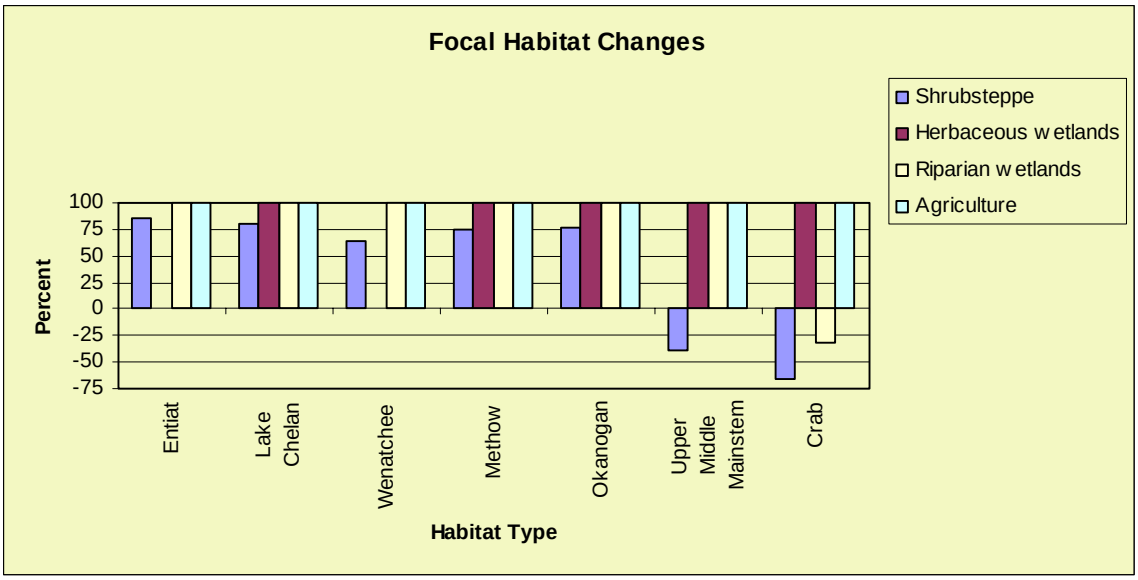

Figure 7. Changes in focal wildlife habitat types in the Columbia Cascade Ecoprovince, Washington (IBIS 2003).

Agricultural land use has significantly changed the composition and structure of shrub and steppe vegetation communities from historic conditions. Livestock grazing tends to decrease perennial graminoids (i.e. steppe and/or grasslands and increase shrub density). Most of the native grasses and forbs are poorly adapted to heavy grazing and trampling by livestock (Cassidy 1997).

True interior grassland habitat was not likely historically present in the subbasin and may be more appropriately described as central arid steppe.

The IBIS data also suggest that all wetland habitat types have increased over historic amounts. This in part may be due to the construction of tributary dams and the creation of reservoirs. However, accurate habitat type maps, especially those detailing the desired diversity of riparian and wetland habitats, are needed to improve assessment quality and support management strategies/actions.

Subbasin wildlife managers believe that significant physical and functional losses have occurred to these important wetland habitats from agricultural and residential development and livestock grazing.

Ponderosa Pine

Historic

The change in ponderosa pine distribution in the Crab Creek subbasin from circa 1850 to 1999 is illustrated in Figures 11 to 13 of the Columbia Cascade Ecoprovince Wildlife Assessment and Inventory. Large, widely spaced, fire-resistant trees and an understory of forbs, grasses, and shrubs characterized these forests. Periodic fires maintained this

habitat type. With the settlement of the EcoProvince, most of the old pines were harvested for timber, and frequent fires have been suppressed. As a result, much of the original forest has been replaced by dense second growth of Douglas fir and ponderosa pine with little understory.

Current

The ponderosa pine zone is most narrowly defined as the zone in which ponderosa pine is virtually the only tree. Cassidy (1997) defined this zone more broadly to encompass most warm, open-canopy forests between the steppe vegetation zone and closed forest, thus it includes stands where other trees, particularly Douglas-fir, may be codominant with ponderosa pine.

Ecoprovince planners have used Cassidy's definition of the ponderosa pine vegetation zone. The aspect dependence of this zone creates a complex inter-digitization between the steppe and ponderosa pine stands, so that disjunct steep zone fragments occur on south-facing slopes deep within forest while ponderosa pine woodlands reach well into the steppe along drainages and north slopes.

The major defining structural feature of this zone is open-canopy forest or a patchy mix of open forest, closed forest, and meadows. Frequent disturbance by fire is necessary for the maintenance of open woodlands and savanna (Cassidy 1997). Fire suppression favors the replacement of the fire-resistant ponderosa pine by the less tolerant Douglas-fir and grand fir.

Heavy grazing of ponderosa pine stands has led to swards of Kentucky bluegrass (*Poa pratensis*) and Canada bluegrass (*Poa compressa*) and replacement of native understory species by introduced annuals, especially cheat grass (*Bromus tectorum*). Four exotic *Centaurea* species are spreading rapidly through the ponderosa pine zone and threatening to replace cheat grass as the dominant increaser after grazing (Cassidy 1997). Open canopy conifer forest, the defining feature of this zone, covers slightly more than half the area of the zone. The status of ponderosa pine protection in the Okanogan subbasin in relation to other Upper Columbia River subbasins in illustrated in Figure 8.

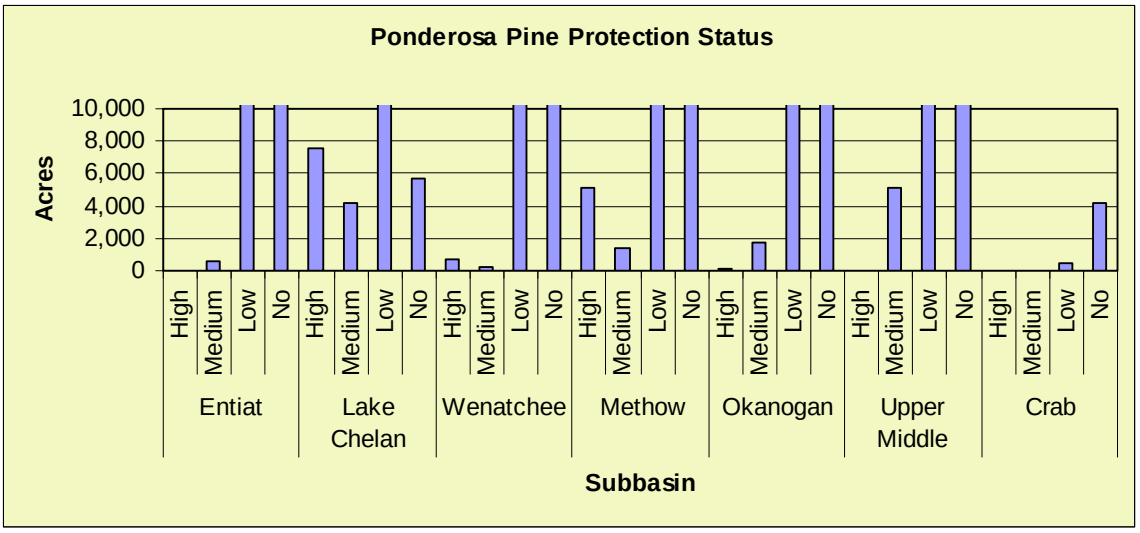

Figure 8. Protection status of ponderosa pine in the Columbia Cascade Ecoprovince, Washington (IBIS 2003).

Desired Future Condition

Recognizing that extant ponderosa pine habitat within the Ecoprovince currently covers a wide range of seral conditions, Ecoprovince planners identified three general ecological/management conditions that, if met, will provide suitable habitat for multiple wildlife species at the Ecoprovince scale within the ponderosa pine habitat type. These ecological conditions correspond to life requisites represented by a species' assemblage that includes white-headed woodpecker (*Picoides albolarvatus*), flammulated owl (*Otus flammeolus*), pygmy nuthatch (*Sitta pygmaea*), and gray flycatcher (*Empidonax wrightii*). Species information (life requisites, distribution, status and trends) is included in the Columbia Cascade Ecoprovince Wildlife Assessment and Inventory. These species may also serve as a performance measure to monitor and evaluate the results of implementing future management strategies and actions.

Ecoprovince wildlife/land managers will review the conditions described below to plan and, where appropriate, guide future enhancement/protection actions on ponderosa pine habitats. Specific desired future conditions, however, are identified and developed within the context of individual management plans at the subbasin level.

Condition 1a – mature ponderosa pine forest: The white-headed woodpecker represents species that require/prefer large patches (>350 acres) of open mature/old growth ponderosa pine stands with canopy closures between 10 - 50 percent and snags (a partially collapsed, dead tree) and stumps for nesting (nesting stumps and snags > 31 inches DBH). Abundant white-headed woodpecker populations can be present on burned or cut forest with residual large diameter live and dead trees and understory vegetation that is usually very sparse. Openness however, is not as important as the presence of mature or veteran cone producing pines within a stand (Milne and Hejl 1989).

Condition 1b – mature ponderosa pine forest: The pygmy nuthatch represents species that

require heterogeneous stands of ponderosa pine with a mixture of well-spaced, old pines and vigorous trees of intermediate age and those species that depend on snags for nesting and roosting, high canopy density, and large diameter (greater than 18 inches DBH) trees characteristic of mature undisturbed forests. Connectivity between suitable habitats is important for species, such as pygmy nuthatch, whose movement and dispersal patterns are limited to their natal territories.

Condition 2 – multiple-canopy ponderosa pine mosaic: Flammulated owls represent wildlife species that occupy ponderosa pine sites that are comprised of multiple-canopy, mature ponderosa pine stands or mixed ponderosa pine/Douglas-fir forest interspersed with grassy openings and dense thickets. Flammulated owls nest in habitat types with low to intermediate canopy closure (Zeiner et al. 1990), two layered canopies, tree density of 508 trees/acre (9-foot spacing), basal area of 250 ft.2/acre (McCallum 1994b), and snags >20 inches DBH 3-39 ft. tall (Zeiner et al. 1990). Food requirements are met by the presence of at least one snag >12 inches DBH/10 acres and 8 trees/acre > 21 inches DBH.

Shrubsteppe

Historic

Historically, sage dominated steppe vegetation occurred throughout the majority of the Subbasin. Shrublands were historically co-dominated by shrubs and perennial bunchgrasses with a microbiotic crust of lichens and mosses on the surface of the soil.

Dominant shrubs were sagebrush of several species and subspecies: basin, Wyoming, and mountain big sagebrush; low sagebrush; and early, rigid, and three-tip. Bitterbrush also was important in many shrubsteppe communities. Bunchgrasses were largely dominated by four species: bluebunch wheatgrass, Idaho fescue, needle and thread grass, and Sandberg's bluegrass. Soils, climate and topography acted to separate out distinct plant communities that paired sagebrush species with specific bunchgrasses across the landscape.

Within the shrubsteppe landscape there also were alkaline basins, many of which contained large lakes during wetter pluvial times, where extensive salt desert scrub communities occur. This characteristic Great Basin vegetation contained numerous shrubs in the shadscale group including greasewood which has wide ecological amplitude, being equally at home in seasonally flooded playas and on dunes or dry hillsides.

Current

In recent years, several exotic plant species have become increasingly widespread. Russian starthistle (*Centaurea repens*) is particularly widespread, especially along and near major watercourses. A 1981 assessment of range conditions rated most of the rangelands in this zone in poor to fair range condition (Cassidy 1987). Agricultural land use dominates the central arid steppe vegetation zone in the subbasin.

The three-tip sage vegetation zone also occupies the central portion of the Crab Creek Subbasin (Figure 17 of the Columbia Cascade Ecoprovince Wildlife Assessment and Inventory). The average shrub cover is about 12 percent and ranges from near 0 Percent to greater than 30 percent. In recent years, tumble knapweed (*Centaurea diffusa*) has spread through this zone and threatens to replace other exotics as the chief increaser after grazing.

A 1981 assessment of rangelands rated most of this zone in fair range condition, with smaller amounts in good and poor range condition (but ecological condition is generally worse than range condition) (Cassidy 1987). Thirty-nine percent of this vegetation zone is in agricultural production statewide.

Livestock grazing practices have led to trampled streambanks, increased bank erosion and sedimentation, and changes in vegetation, including loss of native grasses, impacts to woody vegetation, and establishment of noxious weeds (NPPC 2002e).

According to NRCS definitions, rangelands in fair to excellent condition provide adequate ground cover to protect the soil resource. Rangeland in poor to fair condition may not protect the soil, depending on the species composition and density. Areas in poor to fair condition may be prone to accelerated erosion.

Accelerated erosion will likely degrade water quality. The status of shrubsteppe protection in the Crab Creek subbasin in relation to other Upper Columbia River subbasins in illustrated in Figure 9.

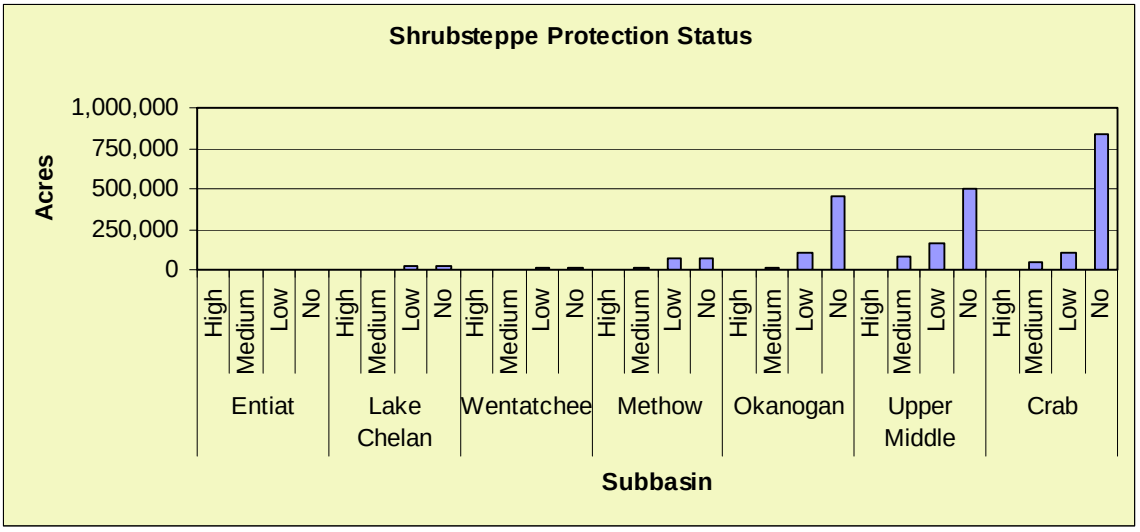

Figure 9. Protection status of shrubsteppe in the Columbia Cascade Ecoprovince, Washington (IBIS 2003).

Desired Future Condition

Shrub dominated Shrubsteppe

The general recommended future condition of sagebrush dominated shrubsteppe habitat includes expansive areas of high quality sagebrush with a diverse understory of native grasses and forbs (non-native herbaceous vegetation less than 10 percent). More specific desired conditions include large unfragmented multi-structured patches of sagebrush with shrub cover varying between 10 and 30 percent.

Good-condition shrubsteppe habitat has very little exposed bare ground, and supports mosses and lichens (cryptogammic crust) that carpet the area between taller plants. Similarly, subbasin land managers will manage diverse shrubsteppe habitats to protect and enhance desirable shrub species such as bitterbrush while limiting the spread of noxious weeds and increaser native shrub species such as rabbitbrush.

Ecoprovince planners have identified general ecological/management conditions that, if met, will provide suitable habitat for multiple wildlife species at the Ecoprovince scale within the shrubsteppe habitat type. Mule deer (*Odocoileus hemionus hemionus*), sage thrasher (*Oreoscoptes montanus*), sage grouse (*Centrocercus urophasianus*), and pygmy rabbit (*Brachylagus idahoensis*) were selected to represent the range of habitat conditions required by wildlife species that utilize sagebrush dominated shrubsteppe (shrubland) habitat within the Ecoprovince.

Species information (life requisites, distribution, abundance, status and trends) is included the Columbia Cascade Ecoprovince Wildlife Assessment and Inventory. These wildlife species may also serve as a performance measure to monitor and evaluate the results of implementing future management strategies and actions.
Subbasin wildlife/land managers will review the conditions described below to plan and, where appropriate, guide future enhancement/protection actions on shrubsteppe habitats. Specific desired future conditions, however, are identified and developed within the context of individual management plans at the subbasin level.

Condition 1 – Sagebrush dominated shrubsteppe habitat: Sage thrasher was selected to represent shrubsteppe obligate wildlife species that require sagebrush dominated shrubsteppe habitats and that are dependent upon areas of tall sagebrush within large tracts of shrubsteppe habitat (Knick and Rotenberry 1995; Paige and Ritter 1999; Vander Haegen et al. 2001). Suitable habitat includes 5 to 20 percent sagebrush cover greater than 2.5 feet in height, 5 to 20 percent native herbaceous cover, and less than 10 percent non-native herbaceous cover.

Condition 2 – Diverse shrubsteppe habitat: Mule deer were selected to represent species that require and prefer diverse, dense (30 to 60 percent shrub cover less than 5 feet tall) shrubsteppe habitats (Ashley et al. 1999) comprised of bitterbrush, big sagebrush, rabbitbrush, and other shrub species (Leckenby 1969; Kufeld et al. 1973; Sheehy 1975; Jackson 1990) with a palatable herbaceous understory exceeding 30 percent cover (Ashley et al. 1999).

Steppe/Grassland dominated Shrubsteppe

The general recommended future condition of steppe/grassland dominated shrubsteppe habitat includes contiguous tracts of native bunchgrass and forb plant communities with less than five percent shrub cover and less than ten percent exotic vegetation. In xeric, brittle environments and sites dominated by shallow lithosols soils, areas between bunchgrass culms should support mosses and lichens (cryptogamic crust). In contrast, more mesic (greater than12 inches annual precipitation), deep soiled sites could sustain dense (greater than 75 percent cover) stands of native grasses and forbs (conclusions drawn from Daubenmire 1970). Sharp-tailed grouse (*Tympanuchus phasianellus*) was chosen to represent the range of habitat conditions required by steppe/grassland obligate wildlife species. Ecoprovince wildlife/land managers recommend the following range of conditions:

Greater than 40 percent native bunchgrass cover
Grater than 30 percent native forb cover
Less than 5 percent non-native herbaceous cover
Visual obstruction readings (VOR) of at least 6 inches
Greater than 75 percent deciduous shrub and tree cover
Multi-structured fruit/bud/catkin-producing deciduous trees and shrubs dispersed throughout the landscape (10 to 40 percent of the total area), or within 1 mile of sharp-tailed grouse nesting/broodrearing habitats

Eastside (Interior) Riparian Wetland

Historic

Historically, riparian wetland habitat was characterized by a mosaic of plant communities occurring at irregular intervals along streams and dominated singularly or in some combination by grass-forbs, shrub thickets, and mature forests with tall deciduous trees. Beaver activity and natural flooding are two ecological processes that affected the quality and distribution of riparian wetlands.

Current

Today, agricultural conversion, altered stream channel morphology, and water withdrawal have played significant roles in changing the character of streams and associated riparian areas. Woody vegetation has been extensively suppressed by grazing in some areas, many of which continue to be grazed. At lower elevations, agricultural conversions have led to altered stream channel morphology, loss of riparian vegetation and water withdrawals for irrigation. Large areas once dominated by cottonwoods, which contribute considerable structure to riparian habitats, are being lost. The implications of riparian area degradation and alteration are wide ranging for many wildlife populations that utilize these important habitats for breeding, nesting, foraging, and resting activities.

Shallow water habitats typically connected to the mainstem of the river via culverts or small channels, provide special wildlife values. The reduced water fluctuation and protection from wave action is beneficial to wildlife, directly and indirectly, and as a

result those conditions promote diverse riparian and wetland vegetative communities.

Natural flooding regimes, which promote important ecological process in riparian areas, were altered by the development of hydropower on the Columbia River. In general, there has been a decline in the diversity of riparian habitats, but an increase in the amount of habitat due to the stability the upstream storage projects provide in periods of high flows. For some species of wildlife such as migrant or wintering waterfowl, suitable habitat has increased due to increased open water associated with the reservoirs. The status of shrubsteppe protection in the Crab Creek subbasin in relation to other Upper Columbia River subbasins in illustrated in Figure 10.

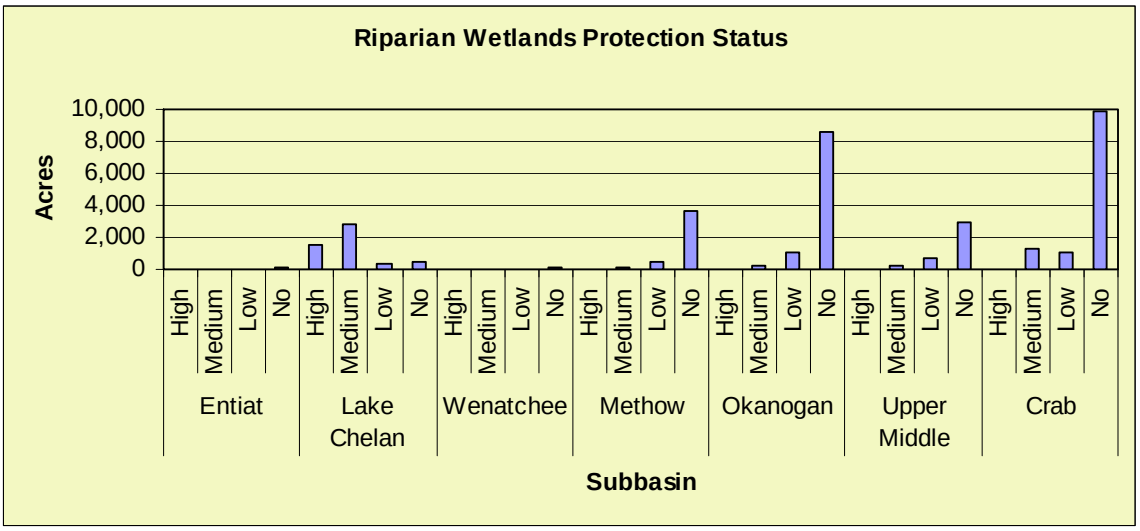

Figure 10. Protection status of riparian wetlands in the Columbia Cascade Ecoprovince, Washington (IBIS 2003).

Desired Future Condition

At the Ecoprovince level, wildlife/land managers focused on riparian (riverine) wetland habitats due to its prevalence throughout the Ecoprovince, close association with salmonid habitat requirements, and relationship to water quality issues. Subbasin level planners have the option to address lacustrine and palustrine wetland habitats at the local level.

Ecoprovince planners have identified general ecological/management conditions that, if met, will provide suitable habitat for multiple wildlife species at the Ecoprovince scale within the riparian wetland habitat type. Ecoprovince and subbasin level planners selected red-eyed vireo (*Vireo olivaceus*), yellow-breasted chat (*Icteria virens*), and beaver (*Castor canadensis*) to represent the range of habitat conditions required by wildlife species that utilize Eastside (Interior) Riparian Wetland habitat within the Ecoprovince.

Species information (life requisites, distribution, abundance, status and trends) is

included in the Columbia Cascade Ecoprovince Wildlife Assessment and Inventory. These wildlife species may also serve as a performance measure to monitor and evaluate the results of implementing future management strategies and actions.
Ecoregion wildlife/land managers will review the conditions described below to plan and, where appropriate, guide future enhancement/protection actions on riparian wetland habitats. Specific desired future conditions, however, are identified and developed within the context of individual management plans at the subbasin level.

Wildlife/land managers have a wide array of conditions to consider. Recognizing the variation between existing riparian wetland habitat and the dynamic nature of this habitat type, recommended conditions for riparian wetland habitat focus on the following habitat/ anthropogenic attributes:

The presence and/or height of native hydrophytic shrubs and trees
Shrub and/or tree canopy structure, tree species and diameter (DBH)
Distance between roosting and foraging habitats
Human disturbance

Ecoprovince wildlife/land managers recommend the following range of conditions for the specific riparian wetland habitat attributes:

Greater than 60 percent tree canopy closure
Mature deciduous trees greater than 160 feet in height and 21 inches DBH
Greater than 10 percent young cottonwoods
Tree cover less than 20 percent
30 to 80 percent native shrub cover
Multi-structured shrub canopy greater than 3 feet in height
Snags greater than 16 inches DBH

Agriculture

The status of shrubsteppe protection in the Crab Creek subbasin in relation to other Upper Columbia River subbasins in illustrated in Figure 11.

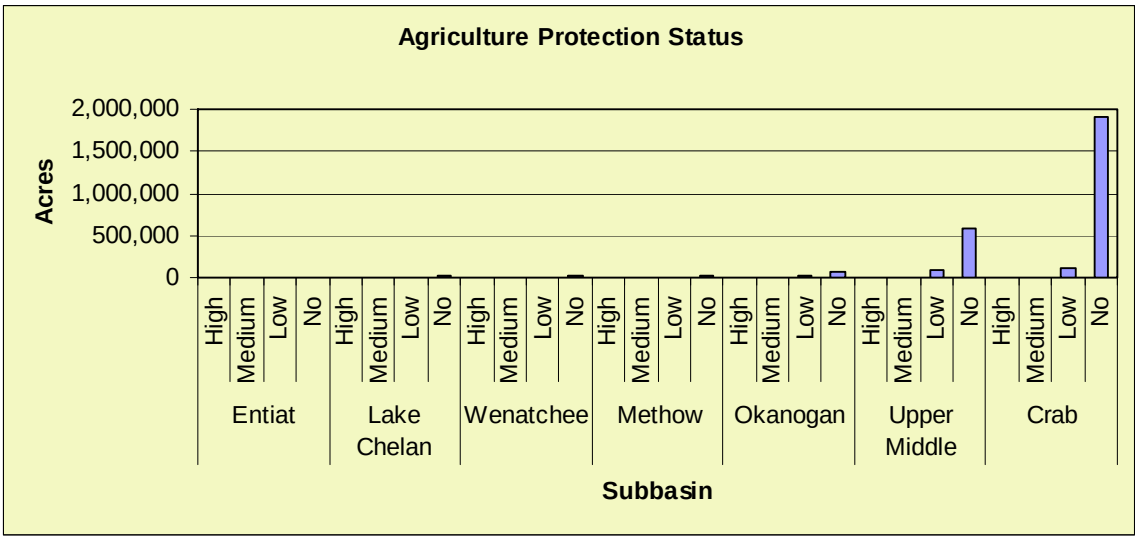

Figure 11. Protection status of agriculture in the Columbia Cascade Ecoprovince, Washington (IBIS 2003).

Cliffs, Caves, and Talus Slopes

Cliffs, caves, and talus slopes within the Subbasin are very important and provide unique habitat for many birds and reptile species. Because vast areas of shrubsteppe habitat are virtually treeless, rock outcroppings provide critical nesting habitat for several raptor species.

Rock outcroppings are also used by reptiles for thermoregulation. Barren ground such as steep canyon walls and cliffs can offer protective habitat for numerous species of wildlife. This may include nesting and roosting habitat, perches for hunting, and areas for hibernating in the winter.

The Columbia River has sheer cliffs along much of its length that provide roosts for some bat species and nest sites for some bird species. Cliff-dwelling bats and birds forage in the adjacent steppe and over the river. The cliffs themselves are in little danger of development, but cliff-dwelling animals may be affected by habitat alteration of the surrounding steppe and the riparian strip (Cassidy 1997).

Species that rely on the combination of sheer cliffs and large rivers have no alternate refuge. An important management consideration is the maintenance of the continuity of riparian areas and protection of the link between cliffs, caves, and talus slopes and adjacent steppe.

Agricultural Development

Agricultural development in the Crab Creek subbasin has altered or destroyed vast amounts of native shrubsteppe habitat and fragmented riparian/floodplain habitat. Agricultural operations have increased sediment loads and introduced herbicides and

pesticides into streams. Conversion to agriculture has decreased the overall quantity of habitat for many native species, but loss of specific communities may be particularly critical for habitat specialists.

Conversion of shrubsteppe communities to agricultural purposes throughout the Ecoprovince, and eastern Washington in general, has resulted in a fragmented landscape with few extensive tracts of interior grassland or shrubsteppe remaining (Dobler et al. 1996).

Agricultural land uses in the Ecoprovince include dry land wheat farms, irrigated agricultural row crop production, and irrigated agriculture associated with fruit and livestock production (alfalfa and hay). Agriculture conversions concentrated in low elevation valleys have significantly affected valley bottom grasslands, shrublands, and cottonwood dominated riparian areas.

Agricultural development has altered or destroyed vast amounts of native steppe/grassland and shrubsteppe habitat in the lowlands and fragmented riparian wetland habitat within the Ecoprovince. Agricultural operations have also increased sediment loads and introduced herbicides and pesticides into streams.

Conversion of any wildlife habitat type to agriculture adversely affects wildlife in two ways: native habitat in most instances is permanently lost, and remaining habitat is isolated and embedded in a highly fragmented landscape of multiple land uses, particularly agriculture.

Although the magnitude of agricultural conversion of Washington's shrubsteppe is impressive, its effect on wildlife may be magnified by a pattern of land alteration that has resulted in extreme fragmentation of remaining habitats. Species tend to evolve in concert with their surroundings, and for shrubsteppe wildlife this means that species adapted to expansive landscapes of steppe and shrubsteppe communities. When landscapes are fragmented by conversion to land use types different from what occurred naturally, wildlife dependent upon the remnant native habitat may be subjected to adverse population pressures, including:

isolation of breeding populations;
competition from similar species associated with other, now adjacent, habitats;
increased predation by generalist predators;
increased nest loss through parasitism by brown-headed cowbirds;
creation of population sinks; and
increased conflict between wildlife species and economic agricultural crops, i.e., crop depredation.

Fragmentation of previously extensive landscapes can influence the distribution and abundance of birds through redistribution of habitat types and through the pattern of habitat fragmentation, including characteristics such as decreased patch area and increased habitat edge (Ambuel and Temple 1983; Wilcove et al. 1986; Robbins et al.

1989; Bolger et al. 1991, 1997).

Fragmentation also can reduce avian productivity through increased rates of nest predation (Gates and Gysel 1978; Wilcove 1985), increased nest parasitism (Brittingham and Temple 1983; Robinson et al. 1995), and reduced pairing success of males (Gibbs and Faaborg 1990; Villard et al. 1993; Hagan et al. 1996).

It is not known to what extent these population pressures affect birds and other wildlife species in fragmented shrubsteppe environments, although a recent study from Idaho (Knick and Rotenberry 1995) suggests that landscape characteristics influence site selection by some shrubsteppe birds.

Most research on fragmentation effects on birds has occurred in the forests and grasslands of eastern and central North America, where conversion to agriculture and suburban/urban development has created a landscape quite different from that which existed previously. The potential for fragmentation to adversely affect shrubsteppe wildlife in Washington warrants further research.

Even though the conversion of native habitats to agriculture severely impacted native wildlife species such as the sharp-tailed grouse, agriculture did provide new habitat niches that were quickly filled with introduced species such as the ring-necked pheasant (*Phasianus colchicus*) chukar (*Alectoris chukar*), and the gray partridge (*Perdix perdix*). Moreover, native ungulate populations took advantage of new food sources provided by croplands and either expanded their range or increased in number.

Wildlife species/populations that could adapt to and/or thrived on “edge” habitats increased with the introduction of agriculture until the advent of “clean farming” practices and monoculture cropping systems.

Residential Development

Residential development has resulted in the loss of large areas of habitat and increased the harassment of wildlife. Urban sprawl has eliminated large areas of lowland wintering range of native wildlife. As the human population continues to grow, residential areas continue to spread into once wild areas that may have been prime habitat for wildlife. Disturbance by humans in the form of highway traffic, noise and light pollution, and various recreational activities have the potential to displace wildlife and force them out of their native areas or forces them to use less desirable habitat.

While urban areas comprise only a small percentage of the land base within the Crab Creek Subbasin, their habitat impacts are significant.

Channelization and development along water courses has eliminated riparian and wetland habitats. Expansion of urban areas affects drainage, and homes built along streams have affected both water quality and the ability of the floodplain to function normally. Removal of woody, overhanging vegetation along stream corridors has increased stream temperatures to the point that they are unable to support coldwater biota.

Livestock Grazing

Livestock grazing can result in the reduction of cover that is used by wildlife such as rodents, birds, deer and elk. In grazing areas near water sources, the riparian vegetation is often trampled down and soils have become compacted resulting in a loss of habitat for wildlife that utilize these areas. Bank erosion may also be increased with riparian livestock grazing, resulting in increased sedimentation in streams.

Exotic Species

The spread of non-native plant and wildlife species poses a threat to wildlife habitat quality and to wildlife species themselves. For example, noxious weeds can threaten the abundance of native plant species fed upon by wildlife, and introduced wildlife species can compete with native wildlife for resources, potentially leading to the decline of the native species. Eurasian water milfoil surveys conducted by the Chelan County Public Utility District during the mid 1980s found that milfoil is infiltrating native aquatic weed beds and displacing these native plant species (NPPC 2002e).

Hydropower Development and Operation

The development and operation of the hydropower system has resulted in widespread changes in riparian, riverine, and upland habitats in the Subbasin. Biological effects related to hydropower development and operations on wildlife and its habitats may be direct or indirect. Direct effects include stream channelization, inundation of habitat and subsequent reduction in some habitat types, degradation of habitat from water level fluctuations and construction and maintenance of power transmission corridors. Indirect effects include the building of numerous roads and railways, presence of electrical transmissions and lines, the expansion of irrigation, and increased access to and harassment of wildlife.

Fire

Fire is a natural occurrence in most shrubsteppe ecosystems and has been one of the primary tools humans have used to manage this habitat type. Fire prevents woody vegetation from encroaching, removes dry vegetation, and recycles nutrients. Conversely, fire suppression allows shrubs and trees to encroach/increase on areas once devoid of woody vegetation and/or promotes decadence in undisturbed native steppe/grassland communities.

Although fire can benefit steppe/grassland habitat, it can be harmful too—particularly when fires become much more frequent than is natural. If too frequent, fire can remove plant cover and increase soil erosion (Ehrlich et al. 1997:201) and can promote the spread of annual grasses to the detriment of native plants (Whisenant 1990). Fires covering large areas of shrubsteppe habitat can eliminate shrubs and their seed sources and create grassland habitat to the detriment of sage dependent wildlife species such as sage grouse. Fires that follow heavy grazing or repeated early season fires can result in annual

grasslands of cheatgrass, medusahead, knapweed, and/or yellow starthistle.

In Ecoprovince forest habitats, fire suppression has resulted in the loss of climax forest communities and, in some instances, wildlife species diversity by allowing the spread of shade tolerant species such as Douglas-fir and grand fir. Prior to fire suppression, wildfires kept shade-tolerant species from encroaching on established forest communities. The lack of fire within the ecosystem has resulted in significant changes to the forest community and has negatively impacted wildlife. Changes in forest habitat components have reduced habitat availability, quality, and utilization for wildlife species dependent on timbered habitats.

Long-term fire suppression can lead to changes in forest structure and composition, and result in the accumulation of fuel levels that can lead to severe crown fires that replace entire stands of trees. The higher elevation forests have evolved with high fire severity regimes, and fire suppression effects are not detectable. Thunderstorms bring lightning ignition to forested areas susceptible to fire.

Recreational use accounts for 60 percent of fire ignitions in the Chiwawa River watershed (25-year period approximately 1972-1997) (NPPC 2002c). As forest stands become more layered, homogenous, and loaded, the potential for catastrophic fire increases. Attempts to restore ponderosa pine forests to their pre- European structure and function (i.e. conditions prior to forest suppression) should have positive impacts on some resident bird species, such as pygmy nuthatch, but too little information is currently available (Ghalambor 2003).

Because fire is an important natural process in ponderosa pine forests and is an important factor in creating snags, the restoration of natural fire regimes has been proposed as a management tool (e.g. Covington and Moore 1994; Arno et al. 1995; Fule and Covington 1995). In particular, the use of prescribed fires to reduce fuel loads has been suggested as being necessary in order to return fire regimes to more “natural” conditions (e.g. Covington and Moore 1994; Arno et al. 1995). Because frequent, low intensity ground fires play an important role in maintaining the character of natural ponderosa woodlands (Moir et al. 1997), prescribed low intensity ground fires are presumed to have beneficial effects on the resident bird species such as pygmy nuthatch.

The current level of information makes it difficult to accurately predict the effects of fire on some species of resident birds. However, it seems reasonable to conclude that low intensity ground fires would have little or no negative effects, whereas high intensity crown fires would have significant negative short-term effects because of the reduction in foraging habitat.

Synthesis and Interpretation

Terrestrial / Wildlife

The following synthesis of findings is drawn from the Columbia Cascade Ecoprovincial

Review and provides a regional context for findings in the subbasin.
Ecoprovince level planners reviewed the subbasin summaries (NPPC 2002a-g) for information on factors impacting focal habitats and limiting wildlife populations and abundance. These are summarized in
Table .

The principal post-settlement conservation issues affecting focal habitats and wildlife populations include habitat loss and fragmentation resulting from conversion to agriculture, habitat degradation and alteration from livestock grazing, invasion of exotic vegetation, and alteration of historic fire regimes. Anthropogenic changes in shrub and grass dominated communities has been especially severe in the state of Washington, where over half the native shrubsteppe has been converted to agricultural lands (Dobler et al. 1996). Similarly, little remains of the interior grasslands that once dominated the Ecoprovince.

Table 4. Wildlife habitat limiting factors analysis for the Columbia Cascade Ecoprovince, Washington (Source: NPPC 2002a-g)

Subbasin	Limiting Factor									
	Residential Development	Fire Suppression	Livestock Grazing	Road Development	Hydropower Development	Exotic Vegetation	Agriculture	Mining	Timber Harvest	Number of Limiting Factors Identified in Subbasin
Entiat	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	**7**
Lake Chelan	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	**6**
Wenatchee	No	Yes	No	Yes	No	No	No	Yes	Yes	**4**
Methow	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	**7**
Okanogan	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes	**6**
Upper Middle Mainstem Columbia River	Yes	No	Yes	No	Yes	Yes	Yes	No	No	**5**
Crab	Yes	No	No	Yes	Yes	No	Yes	No	No	**4**
Number of Subbasins in Which Limiting Factor was Identified	**6**	**4**	**4**	**4**	**6**	**3**	**5**	**3**	**4**	

Unlike forest communities that can regenerate after clearcutting, shrubsteppe and interior grasslands that have been converted to agricultural crops are unlikely to return to a native plant communities even if left idle for extended periods because upper soil layers (horizons) and associated microbiotic organisms have largely disappeared due to water and wind erosion and tillage practices. Furthermore, a long history of grazing, fire, and invasion by exotic vegetation has altered the composition of the plant community within much of the extant shrubsteppe and grassland habitat in this region (Quigley and Arbelbide 1997; Knick 1999).

The loss of once extensive interior grasslands and shrubsteppe communities has substantially reduced the habitat available to a wide range of habitat dependent obligate wildlife species including several birds found only in these community types (Quigley and Arbelbide 1997; Saab and Rich 1997).

Sage sparrows, Brewer’s sparrows, sage thrashers, and sage grouse are considered shrubsteppe obligates, while numerous other species such as grasshopper sparrow and sharp-tailed grouse are associated primarily with steppe/grassland vegetation. In a recent analysis of birds at risk within the interior Columbia Basin, the majority of species identified as of high management concern were shrubsteppe/grassland species. Moreover, according to the North American Breeding Bird Survey, over half these species have experienced long-term population declines (Saab and Rich 1997).

Residential development and hydropower development were identified as limiting factors in 86 percent of the subbasins, while mining and exotic vegetation were identified in only 43 percent. The limiting factors analysis also indicates that the Entiat and Methow subbasins contain the highest number of limiting factors (seven each) in the Ecoprovince, while the Wenatchee and Crab subbasins contain the fewest (four each). Clearly, residential development, hydropower development, and agriculture are common limiting factors that are pervasive throughout the entire Ecoprovince.

Technologies Employed

Technical experts involved in providing information for the subbasin summaries identified nine habitat/wildlife-related limiting factors, including mismanaged livestock grazing, agricultural development, the spread of exotic vegetation, fire suppression, road development, hydropower development, residential development/urbanization, mining, and timber harvest.

Inventory

Introduction

Inventory of existing activities is a key element of the subbasin plans. The following section summarizes agency activities or role in the subbasin and assesses current management strategies.

Federal, state and provincial agencies, local municipalities, tribal groups, and public interest groups all manage, regulate, or otherwise are involved in land and water usage within their respective jurisdictions. For the most part, these governing bodies and stakeholders have policies and guidelines to control the demands placed upon the watershed and their mandates include the management of natural resources for society while maintaining a level of protection of water, land, fish, and wildlife resources.

An inventory of programs and projects follows, with the express purpose of identifying what and where projects are occurring and to describe their effectiveness. This inventory is designed to be compared with the needs for fish and wildlife identified in this plans Assessment. The difference between the needs identified in the Assessment, minus the programs and projects identified in the Inventory will provide insight into the future recommendations in the Management Plan.

Purpose and Scope

Programs and projects in the subbasin relating to fish and wildlife are primarily directed at rebuilding or maintaining anadromous and resident fish, wildlife, and habitat result from many of the direct and indirect impacts within the basin. Such impacts include hydroelectric facilities and their operations, water consumption, water management, urban development, infrastructure, agriculture, forestry, water quality, ground disturbances, out right habitat loss, and introduced species.

Subbasin Management

Federal Government

Management within the Crab Creek Subbasin is coordinated by numerous federal agencies including The Bureau of Reclamation, the U.S. Fish and Wildlife Service, and the Bureau of Land Management. Most lands are managed with considerations of agricultural requirements and compromises between resource use and protection. Current policies give priority to areas and/or habitats occupied by sensitive, threatened, and/or endangered species.

Bureau of Land Management

The Bureau of Land Management (BLM) administers approximately 100,900 acres of federal lands within the subbasin (Table 2). These lands are located primarily in the Moses Coulee area and along upper Crab Creek. The lands vary from scattered small tracts of less than 40 acres to blocks of approximately 15,000 acres. All of the larger blocks were created by land tenure adjustments, primarily through land exchange. BLM has had an active land exchange program since the mid 1970’s, however the majority of

the consolidation has occurred in the last 10 years. Some lands also have been acquired by purchase with federal Land and Water Conservation Funds and by donation. The BLM has been targeting acquisition of shrubsteppe and associated riparian area in their land tenure adjustment program. This program is expected to continue at least in the near future.

Most of the BLM lands in the subbasin are classified as shrubsteppe. About 2% of the BLM lands are converted dryland wheat fields or old CRP. The BLM also manages an estimated 40 miles of important riparian habitat along Douglas Creek, upper Crab Creek, and the major tributaries of Crab Creek (Lake Creek, Coal Creek, and Rock Creek). The BLM also manages lakeshore habitat on several lakes in the upper Crab Creek drainage. The BLM lands are managed under the principle of multiple use. Dispersed recreation and grazing are common uses of BLM lands. Access to public lands has been a major component in their consolidation program. BLM policy gives priority to habitat for sensitive species and riparian areas.

Bureau of Reclamation

The Bureau of Reclamation (BOR) owns about 144,600 acres in the Crab Creek Subbasin (Figure 6). Most of this acreage is in the Potholes Reservoir area and is managed as part of the Columbian Basin Wildlife Areas by the WDFW or as part of the Columbia National Wildlife Refuge by the U.S. Fish and Wildlife Service. The lands were acquired as part of the Columbia Basin Irrigation Project.

State Government

Washington Department of Fish and Wildlife

The Department of Fish and Wildlife has the responsibility to preserve, protect, and perpetuate all fish and wildlife resources in the state of Washington. The WDFW also enforces all laws pertaining to fish and wildlife resources within the state including marine and fresh waters. The Wild Salmonid Policy (WSP)(State of Washington 1997) is one of the guidance documents used to review and modify current management goals, objectives, and strategies related to wild salmonids and their ecosystems to sustain ceremonial, subsistence, commercial, recreational, and non-consumptive fisheries, and other related cultural and ecological values. The WSP will serve as the primary basis for watershed-based plans that insure adequate habitat protection.

The Washington Department of Fish and Wildlife (WDFW) administers the Columbia Basin Wildlife Areas, 14 scattered management units encompassing approximately 200,000 acres in the subbasin. These lands include owned lands (38,000 acres) with the balance administered through agreements with other state and federal landowners. Most of the Columbia Basin Wildlife Areas, 142,000 acres, are U.S. Bureau of Reclamation lands acquired as part of the Columbia Basin Irrigation Project. The Columbia Basin Wildlife Areas were established in 1952 by a 50 year Management Agreement between U.S. Bureau of Reclamation and Washington State. Land acquisitions adding to the wildlife areas were mostly completed by 1984.

The three most common habitats in the Columbia Basin Wildlife Areas are open water (63,500 acres), shrubsteppe (106,500 acres), and riparian (7,200 acres). The open water and riparian areas are almost entirely a result of the irrigation project. Both of these habitats were probably shrubsteppe before 1950. The wildlife areas are managed to preserve priority habitats and to benefit a variety of wildlife. Although the highest priority wildlife are native species listed as threatened or endangered, the shrubsteppe habitats within the Columbia Basin Wildlife Areas are managed primarily for introduced exotics (ring-necked pheasants), small game, and native wildlife species. Riparian and shallow areas of open water are managed primarily for dabbling ducks. Open water is managed for game fish, waterfowl and native wildlife.

Compatible recreation is allowed in all of the Columbia Basin Wildlife Areas. The total use on the wildlife areas is estimated to be over 800,000 visitors per year. Fishing is the most popular recreation activity on the Wildlife Areas and accounts for 50% of the total. Hunting accounts for about 10% of the use and other uses, such as water sports, camping, horseback riding, rock climbing, and wildlife viewing, make up the balance. There are fifteen grazing agreements and nineteen farming agreements on the wildlife areas that involve about 27,000 acres. All but two of these leases are on federal land.

Between 1991 and 1994 the WDFW purchased 18 properties (1,117 acres) within the Columbia Basin Irrigation Project. These are managed along with 19 other parcels (600 acres owned or managed) for farmland wildlife. Activities on these properties include noxious weed control, and habitat development primarily for ring-necked pheasant.

WDFW continues to work cooperatively with the Natural Resources Conservation Service, the Farm Service Agency, and private landowners on implementation of the Conservation Reserve Program. To date, over 280 water guzzlers have been installed and thousands of acres enhanced on private lands (150 Habitat Protection Agreements with private landowners) within the subbasin by WDFW's Upland Wildlife Restoration Program.

Washington Department of Ecology

The mission of the Department of Ecology (Ecology) is to protect, preserve, and enhance Washington's environment, and to promote the wise management of its air, land, and water for the benefit of current and future generations. Ecology's goals are to prevent pollution, clean up existing pollution, and support sustainable communities and natural resources. A major role is to allocate surface and ground water rights between industry, agriculture, homes, and wildlife.

Ecology has administered two water quality monitoring grants performed by Lincoln County Conservation District, and in October 2000 funded the Initiating Phase of an Upper Crab (WRIA 43) Watershed Planning Act project authorized under HB 2514. Ecology also participates on the local planning unit representing the State of Washington.

Ecology will soon begin working with local jurisdictions, agricultural interests and others to develop clean-up plans, or Total Maximum Daily Loads (TMDLs) for pollutants

exceeding state water quality criteria in upper Crab Creek. The initial primary concern is phosphorus loading to Moses Lake, and pH. More data is required to determine if Crab Creek exceeds other parameters, such as temperature, fecal coliform bacteria, and dissolved oxygen.

Washington Department of Natural Resources

The Department of Natural Resources (DNR) manages approximately 144,000 acres in the subbasin (Table 2). Approximately 69,800 acres are in rangeland, 43,700 acres are in dryland agriculture, and 6,500 acres are in irrigated agriculture. These lands are managed to generate revenue for state trust beneficiaries. The DNR's land management activities are designed to provide good stewardship and resource protection necessary to ensure that state trust lands provide support to the beneficiaries in perpetuity.

Approximately 480 acres of DNR land within the subbasin are managed as Natural Area Preserves. These areas are set aside for research and education and help to maintain Washington's native biological diversity. They protect the highest quality examples of native ecosystems and rare plant and animal species, as well as features of state, regional or national significance.

Local Stakeholder Groups

Irrigation Districts

The U.S. Bureau of Reclamation's Columbia Basin Project (CBP) is a Congressionally authorized mulitpurpose development located in central Washington. The three irrigation districts operating the Columbia Basin Project are the East Columbia Basin Irrigation District (East District), the Quincy-Columbia Basin Irrigation District (Quincy District) and the South Columbia Irrigation District (South District).

The project's principal multiple use facility, Grand Coulee Dam, is on the main stem of the Columbia River about 90 miles west of Spokane, Washington at the head of the Grand Coulee. Project irrigation works extend southward on the Columbia Plateau for 125 miles to the vicinity of Pasco, Washington, at the confluence of the Snake and Columbia Rivers. Beginning near Quincy, the Columbia Rivers forms the western project boundary; the eastern project boundary is about 60 miles east near the communities of Lind and Odessa. Columbia Basin Project lands include portions of Grant, Lincoln, Adams, Franklin and Walla Walla Counties, with some northern facilities located in Douglas County. Construction of the Columbia Basin Project began in 1933 with Grand Coulee Dam which is the source of water and energy for the Project. World War II delayed construction of the irrigation project with wartime efforts being focused at bringing Grand Coulee's hydroelectric facilities online to support the war effort. Construction of irrigation facilities resumed following the war. Direct pumping to Block 1 near Pasco began in 1948, and water delivery from Grand Coulee Dam began in 1952. Irrigation development continued throught the next two decades. Irrigation facilities

were largely completed in the 1070's. Farm development has now caught up with the capacity of the "first half" canal and drainage system with approximately 621,000 acres being irrigated currently. The project is currently authorized to irrigated 671,000 acres and was planned to irrigate 1,095,000 acres at its completion.

In January 1969, the U.S. Bureau of Reclamation (Reclamation) transferred the operations and maintenance responsibilities for much of the irrigation and drainage systems withing the CBP to the three Districts. These facilities are contractually known as "transferred works". Reclamation has kept control of certain "reserved works" which generally are facilities serving more than one irrigation district.

Reclamation continues to operate Grand Coulee facilities, Banks Lake which is the CBP's main equalizing or regulating reservoir, the Main Canal including Billy Clapp Lake, which is another regulating reservoir, and the Potholes Reservoir. Reclamation also controls the headworks to the West, Potholes and East Low Canals. The three irrigation districts pay all the operations and maintenance costs for Reclamation to operate the irrigation portions of these facilities.

The Quincy Columbia Basin Irrigation District, headquartered in Quincy operates and maintains the West Canal system. The Potholes Canal system is operated and maintained by the South Columbia Basin Irrigation District from Pasco. The East Columbia Basin Irrigation District, headquartered in Othello, operates the East Low Canal system.

In the 1980's, the three districts developed seven small hydroelectric generating plants on CBP facilities. The total generating capacity of those seven plants is 144.6 megawatts (MW). The Grand Coulee Project Hydroelectric Authority, which is a separate entity formed by the three irrigation districts, operates five of the hydroelectric plants. Two are operated by Grant County P.U.D.

Adams County Conservation District

The Adams Conservation District's resource management efforts are focused upon three sub drainages all of which flow into Crab Creek. Recognizing the large volume of sediment that has accumulated in the Lind Coulee Arm of the Potholes Reservoir, the primary emphasis has been toward developing solutions that would quickly educate cooperators about methods to control and reduce future storm water runoff events. One major concern was from conventional tillage practices by dry land wheat farmers, which left 50% of agriculture ground in a fallow condition resulting in tremendous sediment erosion events.

In support of that concern a four-year Odessa aquifer erosion control study was initiated to seek solutions and this project concluded in 1989. A DOE funded Weber Coulee "Watershed Plan" followed and was completed in 1992. A Weber Coulee "Implementation Program" supported by NRCS technical assistance developed cost effective sediment containment projects in addition to numerous upland treatment concepts. The introduction of the Conservation Reserve Program (CRP) also idled thousands of acres of Adams County farm ground resulting in significant increases in the

wildlife population habitat.

Through support from Washington Conservation Commission, Department of Ecology and Environmental Protection Agency additional funding was located to initiate the development of a larger "Agriculture Best Management Practice" project. Through this program GIS mapping technology was developed and offered producers improved farm conservation plans with useful maps for
documenting specific tasks associated to targeted goals. An "Irrigation Water Monitoring" (IWM) program provided informative and useful data for identifying specific water application rates for avoiding over the application of water. One new concept that has been on leading edge technology for the agriculture industry is minimum tillage direct seed concepts where we maintain annual cover crops. While the concept works in most of the areas, selling the method takes a great deal of persuasion. Numerous other conservation practices were implemented. A final report was submitted in March 2000.

Among the long term goals and objectives are to develop a harmony between agriculture needs while expanding the habitat needs as required for our wildlife through natural resource preservation and conservation opportunities.

Native Americans

Wanapum Tribe

The Wanapum are a people who have lived on the Middle Columbia River since time immemorial, whose homesite has been located within the Central Columbia Basin for all of this time. The Crab Creek drainage is a central part of their past. Millennia of trade, marriages and all manner of ceremonies have taken place their; the importance of the Crab Creek drainage and central interior Plateau to Wanapum culture is beyond words.

For the Wanapum people, the Crab Creek drainage holds one of the densest concentrations of intact, undisturbed cultural and archaeological resources in all of central Washington – even more than along the mainstem Columbia River. All of the locations are of highest importance as they represent more than 12,000 years of Wanapum cultural practices and traditions that the Wanapum people continue to exercise. The Crab Creek drainage holds the highest importance possible to the Wanapum people. For fish, wildlife and all other economic resources, it has served them throughout the past and continues to serve their subsistence and ceremonial needs (May 3, 2004 Letter from Rex Buck Jr., Wanapum leader, Pat Wyena, Wanapum Elder, to Paul Wagner, KWA).

Other Native American Tribes

Attempts were made to involve all known tribes with historical use of the Crab Creek, but no additional information has as yet been received.

The Nature Conservancy

The Nature Conservancy (TNC) owns 3,500 acres within Moses Coulee, 325 acres on

Badger Mountain, and 5,000 acres in the Beezley Hills. TNC also has 2,800 acres in a conservation easement within Moses Coulee near Sagebrush Flats (Rimrock Meadows). The lands are owned and managed primarily for the protection and restoration of shrubsteppe habitat and associated wildlife, although educational, research and permitted recreational uses are allowed.

Programs

Federal Government

Americorps

Program: Washington Conservation Corps
Abstract: Washington Conservation Corps is an A-Corps Program that does environmental/fishery project work. They have completed projects as well as work on on-going monitoring projects in the Columbia Plateau Province.

Bonneville Power Administration

Program: Fish and Wildlife Program
Abstract: Establishment of prescriptions (goals, strategies, and procedural requirements) that apply to future BPA-funded wildlife mitigation projects.

BPA implements its responsibilities under the Power Act and the Endangered Species Act through a variety of projects and associated contracts. Individual project summary descriptions are available grouped by regions defined by the Northwest Power Planning Council's Fish and Wildlife Program. Individual project summaries are also available through a flexible project summary query. The project information service is evolving as technology and time permits. The following two programs fall under the Fish and Wildlife Program

Program: Watershed Management Program (DOE/EIS-0265)
Abstract: Establishment of prescriptions (goals, strategies, and procedural requirements) that apply to future BPA-funded watershed management projects.

Program: Wildlife Mitigation Program
Abstract: Establishment of prescriptions (goals, strategies, and procedural requirements) that apply to future BPA-funded wildlife mitigation projects.

The development of the Federal Columbia River Power System has impacted many species of wildlife. Throughout much of the 1980's BPA funded Losses Assessments to determine the net effects on wildlife. The Northwest Power Planning Council amended the wildlife losses and gains into the Columbia River Basin Fish and Wildlife Program. In 1990, BPA began implementing project proposals to mitigate for wildlife impacts. The Region has achieved a significant amount of high quality mitigation under the Northwest Power Act.

Program: The Pollution Prevention and Abatement Program
Abstract: The Pollution Prevention and Abatemen(PP&A) program coordinates the management and disposal of wastes generated as a result of BPA work practices associated with the operation, maintenance, and construction of Bonneville's transmission system and its facilities.

The program is responsible for analyzing environmental laws, regulations, and policy initiatives for their implications on the operation and maintenance of the power system, and managing Bonneville's environmental investigation, remediation and restoration projects, including pollution prevention activities and Superfund liabilities. Additionally, PP&A: administers Bonneville's environmental land audit programs oversees PCB equipment replacement efforts develops and monitors practices regarding hazardous materials management is responsible for external relations and negotiations with environmental regulatory agencies.

In its role to provide technical advice to Transmission Services and other client organizations within BPA, PP&A coordinates with the region to ensure water protection compliance, oversees research and technological development initiatives in the pollution prevention and abatement field, and develops standards and curriculum for its Environmental Training Program.

National Oceanic and Atmospheric Administration (NOAA Fisheries)

Program: Federal Columbia River Power System (FCRPS)
Abstract: This branch provides biological, hydrologic, and engineering expertise for review and approval of fish passage facility designs and operations at the dams and reservoirs that comprise the FCRPS, including the coordination of those projects with related Canadian and non-Federal projects. Specific program responsibilities include: development of new fish passage technologies and implementation of state-of-the-art passage technologies at Corps dams on the mainstream Columbia and Lower Snake rivers, the Corps' juvenile fish transportation program, project and system operations for salmon including reservoir management, flow augmentation, fish passage spill, and project-specific operations for fish passage, the salmon predator control program, and system-wide gas abatement measures and temperature control operations. Branch staff provides technical advice and guidance to Corps' management and project personnel on measures to reduce take of listed and unlisted salmon. Staff conducts on-site inspections of fish passage structures and monitoring facilities.

FCRPS branch staff chair and administer the Implementation Team (IT). The IT invites senior policy representatives of the regional fish and wildlife agencies, Federal Action Agencies (BPA, Corps, USBOR), EPA, and Tribes to participate in making FCRPS operating recommendations that benefit salmonids. Staff also represents NMFS in the in-season Technical Management Team process that provides for nearly year round systemwide operations. Staff chair the System Configuration Team (SCT), which is an inter-agency team charged with overseeing the Corps' approximately $100 million annual Columbia River Fish Mitigation Program. This program focuses on the study and

implementation of structural fish passage and water quality improvements to most of the Federal mainstream dams. Staff co-chairs the Water Quality Team (WQT), whose mission is to provide scientific and technical recommendations, advice and guidance on water quality issues to the various technical committees advising the Regional Forum related to the 2000 FCRPS Biological Opinion, and other regional Columbia River entities for decisions that impact aquatic resources.

FCRPS branch staff serves as the NMFS representative to the Columbia Basin Fish and Wildlife Authority (CBFWA). Branch staff represents NMFS before the Mid-Columbia Coordinating Committee particularly on operations to implement the Vernita Bar Agreement. Branch staff also reviews the effects of Hells Canyon and other Idaho Power Company projects on the middle and upper Snake River and the operation of USBOR irrigation projects in the Upper Snake River.

Program: Cumulative Risk Initiative (CRI)

Abstract: The Cumulative Risk Initiative (CRI) is an ongoing effort of the Northwest Fisheries Science Center (NWFSC) that assesses salmonid population trends and the impact of various actions on those trends. This project uses the following approach. First, the group analyzes data regarding the "Four Hs" (habitat, harvest, hatcheries, and hydrosystems) to assess the impact of these factors on salmonid population growth. Concurrently, the team assesses the risk of extinction and constructs population models for each species, using current survivorships for each life-stage. These models can identify the times or stages at which changing survivorship will yield the largest impact on population growth rates. Follow-up work entails examining whether such changes in survivorship are biologically feasible and what management options will yield the best results. Finally, as conservation actions are implemented, the National Marine Fisheries Service (NMFS), in collaboration with other regional scientists, will be engaging in ecological experiments to test hypotheses about the relationships between management actions in the 4 H's and salmon populations.

As part of their efforts to provide scientifically rigorous support for salmonid conservation and recovery planning, CRI scientists are committed to conducting consistent and transparent analyses.

One main goal of the CRI effort is to organize data where they exist, and to provide an analytical framework for integrating the effects of taking actions in different portions of fish life cycles. This framework allows us to evaluate how actions in different portions of the salmon life cycle may improve survival, reduce risks, and foster recovery. The approach being used involves four facets:
Data exploration
Identification of key risk factors
Detailed analyses and evaluation of management options
Adaptive Management: Opportunities for pathbreaking science

Program: Ecotoxicology and Environmental Fish Health Program

Abstract: The core mission of the Ecotoxicology and Environmental Fish Health Program is to determine the impacts of human activities on the health of wild fish, especially Pacific salmon and marine fish. To do this, the program has five research teams, four of which focus on different aspects of fish physiology and biology, and one of which focuses on assessing risks posed to fish health by human activities, especially the releases of chemical contaminants into freshwater, estuarine, and marine waters.

While the primary expertise of the Program is in ecotoxicology, there is substantial effort made to assess the normal physiology of wild fish, and natural variations in response to non-anthropogenic factors, as a backdrop against which human activities, such as the release of toxic chemicals, can be assessed. In addition to determining the effects of toxic contaminants on fish health, an important part of our research also examines the recovery of fish health after remedial activities are undertaken to clean up contaminated sites. This important line of research allows us to determine the efficacy of cleanup operations, and better determine the accuracy of our models which predict risk to our living aquatic resources.

Program: Environmental Assessment Program
Abstract: The Environmental Assessment Program researches the impacts of human activities on the health of fish and marine mammals. The program has three research teams, two of which measure contaminant levels in tissues of marine animals and develop new methods for measuring and understanding the impact of persistent contaminants. The third team supports these research projects in managing and communicating data. The primary expertise of the program is in chemistry, both organic and inorganic. However, program members also have experience in information technology, including database management and GIS. The program's researchers use state-of-the-art analytical methods to not only carry out research on contaminants and their possible impacts on marine mammal health, but also to provide chemical contaminant data vital to other programs within the EC Division as well as to state and other federal agencies.

Program: Fish Passage Program
Abstract: The Fish Passage, Migrational Behavior, and Riverine Survival Programs are part of the Riverine Ecology Group within the Fish Ecology Division. Staff from these combined programs, with support from the Fisheries Engineering Program, conduct multi-pronged investigations to assess the effects and influence of the Columbia River hydropower system on the long-term viability of anadromous fish stocks, particularly salmonids listed as threatened or endangered under the U.S. Endangered Species Act (ESA).

Field research efforts cover a broad suite of studies, including: development and tests of equipment and structures at dams designed to alleviate hazardous conditions for migrant fish, evaluation of transportation of juvenile fish as a means to alleviate direct mortality at dams, evaluation of juvenile and adult fish survival as migrants pass dams under different structural and operational conditions, determination of passage timing to and through the hydropower system as related to hydrographic influences, and studies on juvenile fish behavior related to changes in velocity to provide a better foundation for

development of effective passage structures. Research includes the design, construction, and evaluation of new or improved techniques and equipment to study fish in large river systems, including use of radio telemetry and remote antenna systems, PIT-tags and means to detect them at dams and within free-flowing streams and rivers, and acoustic tags usable in small fish. Analytical efforts include evaluating adult returns of salmonids PIT-tagged as juveniles to determine the extent of influences of habitat, hatcheries, hydropower, and ocean conditions on return rates.

The overall goal of the research is to determine the extent to which the hydropower system impacts anadromous fish, with emphasis on how it influences the salmonid life cycle and spawner to spawner and spawner to recruit relationships

Program: Genetics and Evolution Program
Abstract: Scientists in the Genetics and Evolution Program work in two broad areas:

Evaluating how genetic processes contribute to species viability;
Developing and using genetic tools for addressing resource management problems.

Research areas in which the Program is particularly active include evaluating the genetic effects of artificial propagation, estimating effective population size, and understanding the effects of natural selection on molecular genetic diversity. In addition to being important for the viability of a species, genetic diversity provides a source of "genetic markers" that can be used to answer critical resource management questions. For example, Program scientists are using genetic markers to help identify and manage mixed-stock fisheries, to delineate conservation units and to assist with wildlife forensic investigations.

Program: Salmon Harvest Program
Abstract: The Harvest Program provides technical expertise to regional management entities and develops new and improved tools for use in salmon harvest management.

Program: Full Utilization Program
Abstract: The Full Utilization Program improves fish processing methods to more fully utilize each fish caught--to relieve pressure on the resource, reduce waste released into habitat, and to benefit the fishing industry.

Program: Integrative Fish Biology Program
Abstract: The Integrative Fish Biology Program develops fundamental biological understanding of fish development, growth, reproduction, smolt quality, fish health and disease diagnosis and control.

Program: Mathematical Biology and Systems Monitoring Program
Abstract: Research efforts of the Mathematical Biology and Systems Monitoring Program include studies on how to most effectively monitor populations that are part of large scale spatially varying environments. The Program also works on monitoring projects that take into account the ecological surprises that inevitably arise in complex

systems, including evaluating possible scenarios associated with global climate change.

Program: Migrational Behavior Program
Abstract: The Migrational Behavior, Riverine Survival, and Fish Passage Programs are part of the Riverine Ecology Group within the Fish Ecology Division. Staff from these combined programs, with support from the Fisheries Engineering Program, conduct multi-pronged investigations to assess the effects and influence of the Columbia River hydropower system on the long-term viability of anadromous fish stocks, particularly salmonids listed as threatened or endangered under the U.S. Endangered Species Act (ESA).

Field research efforts cover a broad suite of studies, including: development and tests of equipment and structures at dams designed to alleviate hazardous conditions for migrant fish, evaluation of transportation of juvenile fish as a means to alleviate direct mortality at dams, evaluation of juvenile and adult fish survival as migrants pass dams under different structural and operational conditions, determination of passage timing to and through the hydropower system as related to hydrographic influences, and studies on juvenile fish behavior related to changes in velocity to provide a better foundation for development of effective passage structures. Research includes the design, construction, and evaluation of new or improved techniques and equipment to study fish in large river systems, including use of radio telemetry and remote antenna systems, PIT-tags and means to detect them at dams and within free-flowing streams and rivers, and acoustic tags usable in small fish. Analytical efforts include evaluating adult returns of salmonids PIT-tagged as juveniles to determine the extent of influences of habitat, hatcheries, hydropower, and ocean conditions on return rates.

The overall goal of the research is to determine the extent to which the hydropower system impacts anadromous fish, with emphasis on how it influences the salmonid life cycle and spawner to spawner and spawner to recruit relationships.

Program: Northwest Salmon Recovery Planning
Abstract: Over the past several decades, populations of salmon and steelhead throughout the West Coast have declined to dangerously low levels. These population declines and extinctions are the result of numerous habitat-affecting factors (such as economic development, resource extraction, and other land uses), harvest practices, hatchery production, and other factors. Human actions that depress population abundance have also caused salmon to be more susceptible to natural environmental fluctuations such as poor ocean conditions and drought. If this pattern is to be reversed, it is critical that comprehensive, focused recovery efforts take place throughout the region. In 1991, the National Marine Fisheries Service (NMFS) began a comprehensive review of the status of salmonid and steelhead throughout Washington, Oregon, Idaho, and California. NMFS is committed to this effort, and are implementing and planning West Coast salmon and steelhead recovery.

Program: Operations Management and Information Program
Abstract: The Office of Operations, Management and Information is directed by the

Chief Financial Officer/Chief Administrative Officer, and provides advice, support and guidance in the following areas: administrative processes, budget formulation and execution, strategic planning, facility management, grants coordination, planning, organizational development, human resource management, internal and external relationships and communications, and information management. The Office coordinates the development of advice to the Assistant Administrator and Executive Board on the selection and priority of NMFS-wide program goals, objectives, and measures of accomplishment; monitors the use of resources and provides advice to the Assistant Administrator (AA) and Executive Board on the most effective and efficient distribution among the Financial Management Centers. It coordinates all national planning and development efforts, ensuring that the appropriate internal and external stakeholders are involved. The Office provides advice and assistance to Headquarters, Regional Offices, and Science Centers on human resource management requirements and guidance from the Office of Personnel Management, the Department of Commerce, and NOAA. It provides leadership for NMFS national information resource management matters including planning, technical standards, security and network operations; manages internal and external communications; and manages all budget processes, including execution, development, and formulation. The Office coordinates administrative operations (e.g. correspondence, foreign travel operations, responses and reporting in conjunction to Inspector General and Government Accounting Office reviews/investigations). It coordinates the NMFS-wide infrastructure issues and the NMFS grants program; coordinates policy development; manages NMFS diversity; provides staff support to the Executive Board; and prepares/maintains current NMFS organization charts, functional statements, and staffing plans. The Office develops and executes a viable Equal Employment Opportunity Program throughout NMFS.

Program: Population Biology Program
Abstract: The research in the Population Biology Program helps to form the foundation for conservation and recovery efforts of endangered species. Scientists in this Program identify the risk factors involved in the decline and the recovery of fish populations. They also contribute to development of monitoring and evaluation tools and investigate factors influencing salmon straying, colonization and the survival and distribution of migrating fish.

Program: Riverine Survival Program
Abstract: The Riverine Survival, Migrational Behavior, and Fish Passage Programs are part of the Riverine Ecology Group within the Fish Ecology Division. Staff from these combined programs, with support from the Fisheries Engineering Program, conduct multi-pronged investigations to assess the effects and influence of the Columbia River hydropower system on the long-term viability of anadromous fish stocks, particularly salmonids listed as threatened or endangered under the U.S. Endangered Species Act (ESA).

Field research efforts cover a broad suite of studies, including: development and tests of equipment and structures at dams designed to alleviate hazardous conditions for migrant fish, evaluation of transportation of juvenile fish as a means to alleviate direct mortality

at dams, evaluation of juvenile and adult fish survival as migrants pass dams under different structural and operational conditions, determination of passage timing to and through the hydropower system as related to hydrographic influences, and studies on juvenile fish behavior related to changes in velocity to provide a better foundation for development of effective passage structures. Research includes the design, construction, and evaluation of new or improved techniques and equipment to study fish in large river systems, including use of radio telemetry and remote antenna systems, PIT-tags and means to detect them at dams and within free-flowing streams and rivers, and acoustic tags usable in small fish. Analytical efforts include evaluating adult returns of salmonids PIT-tagged as juveniles to determine the extent of influences of habitat, hatcheries, hydropower, and ocean conditions on return rates.

The overall goal of the research is to determine the extent to which the hydropower system impacts anadromous fish, with emphasis on how it influences the salmonid life cycle and spawner to spawner and spawner to recruit relationships.

Program: Salmon Enhancement Program
Abstract: The Salmon Enhancement Program resolves existing and developing challenges associated with captive rearing, hatchery technology, and behavioral ecology of salmon to sustain and rebuild endangered or depleted stocks and to increase world seafood supply. The program is composed of two teams (the Hatchery Technology Team and the Behavioral ecology team) that conduct basic and applied research in fish behavior, and ecological interactions for cultured salmonids. These activities focus on studying husbandry methodologies and developmental biology, growth, nutrition, survival, and behavioral and ecological fitness of cultured organisms. Research is applied to improve efficacy of production and conservation hatcheries, and captive broodstock and supplementation programs for recovery of endangered fish species.

Program: Science Synthesis and Coordination Program
Abstract: The Office of the Science Director provides overall leadership and coordination for the Center's science programs. It ensures that adequate resources are available to accomplish research priorities and that the Center's science is responsive to regional and national management needs. The Office of the Science Director also oversees collaborative partnerships and manages small scientific programs in emerging areas.

Program: Science Synthesis for Ecosystem-based Management Initiative (SEMI)
Abstract: The goal of the Science for Ecosystem-based Management Initiative (SEMI) is to research the ecological interactions and processes necessary to sustain ecosystem composition, structure and function in the environments in which fish and fisheries exist. Understanding the factors that sustain the ecosystem will provide the scientific underpinnings needed to inform ecosystem-based management of groundfish in the Pacific Northwest.

Ecosystem-based management can be an important complement to existing approaches of fisheries management. By understanding the complex ecological relationships within

which exploited fishes exist, researchers can better anticipate the effects of the ecosystem on fisheries and the effects of fishing on the ecosystem.

The SEMI will draw upon expertise from within and outside the NWFSC to address the following five research foci:

- Interactions of a target fish stock with predators, competitors and prey
- The effects of weather and climate on target species and their ecological communities
- The effects of fishing on marine ecosystems and fish habitat
- Interactions between fishes and their habitat
- Marine Protected Areas as a fisheries conservation and management tool

Program: Watershed Program
Abstract: The Watershed Program conducts research on physical and biological processes that influence aquatic ecosystems in the Pacific Northwest, effects of land management on those ecosystems, and ensuing effects on the health and productivity of anadromous fish populations. Program scientists provide technical support to NOAA Fisheries policy makers and regulatory staff, and collaborate with other agencies, tribes, and educational institutions on research and education related to the management of Pacific salmon (Oncorhynchus spp.).

The Watershed Program has four teams that focus on three primary research themes:

- Quantify fish responses to changes in watershed, habitat, or ecosystem conditions (Fish-Habitat Relationships);
- Quantify the effects of natural or human disturbance on watershed processes and habitat conditions (Natural Processes and Human Disturbances); and
- Evaluate the effectiveness of various habitat and watershed restoration strategies or techniques (Restoration).

Research in all of the above areas relates to recovery planning for listed species of Pacific salmon and steelhead.

U.S. Environmental Protection Agency

Program: Environmental Monitoring and Assessment Program (EMAP)
Abstract: The Environmental Monitoring and Assessment Program (EMAP) was developed by EPA to assess the condition of the nation's ecological resources. The Western EMAP project will cover western states: Idaho, Oregon, Washington, California, Montana, South Dakota, North Dakota, Nevada, Utah, Colorado, Wyoming, and Arizona. Western EMAP is a partnership between EPA's Office of Research and Development, Regions 8, 9, 10 and others.
Western EMAP has 3 main components: coastal, rivers and streams, and landscapes. The objective of Western EMAP is to assess the ecological condition of coastal waters and rivers and streams across the western United States. EMAP is designed to monitor indicators of pollution and habitat condition and seek links between human-caused

stressors and ecological condition.

Program: Partners for the Environment – Surf Your Watershed
Abstact: Surf Your Watershed contains the following databases: Adopt Your Watershed, Wetlands Restoration Projects, American Heritage Rivers Services, and SURF-Environmental Websites Database. A profile is given for every watershed that information is available for and links to "Know Your Watershed" and "Science in Your Watershed" are also provided. In the Chelan subbasin, Surf Your Watershed provides links to eight environmental web sites and four citizen-based groups involving the Chelan watershed. No partnerships are identified in the National Watershed Network, however if you select this link it shows information is available from the Environmental Statistics Group in Montana from their Hydrologic Units Project. There are also links to EPA database information available on air, community water sources, water discharges, toxic releases, hazardous waste, and superfund sites in the watershed. The profile also includes links to USGS gaging stations, 1990 water use, and selected USGS water resource abstracts. The information can be accessed at http://cfpub.epa.gov/surf/huc.cfm?huc_code=17020009.

Program: Total Maximum Daily Load Program
Abstract: A TMDL specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and allocates pollutant loadings among point and nonpoint pollutant sources. By law, EPA must approve or disapprove lists and TMDLs established by states, territories, and authorized tribes. If a state, territory, or authorized tribe submission is inadequate, EPA must establish the list or the TMDL. EPA issued regulations in 1985 and 1992 that implement section 303(d) of the Clean Water Act - the TMDL provisions. The TMDL process involves identification of impaired water bodies, prioritization of waters/watersheds for TMDL development, and then TMDL development. State and territorial water quality agencies* are responsible for implementing the TMDL process. EPA reviews and approves lists of quality-limited waters and specific TMDLs. If EPA disapproves lists or TMDLs, EPA is required to establish the lists and/or TMDLs.

As a result of the TMDL program The Washington State Department of Ecology and the Lake Chelan Water Quality Committee are developing a TMDL or water cleanup plan and coordinating local cleanup activities.

EPA is doing the technical analysis and planning to issue temperature TMDLs for the Columbia/Snake River Mainstem in Oregon and Washington. EPA will be doing the technical analysis and issuing temperature TMDLs for Indian reservation waters in the Upper Columbia, including Lake Roosevelt.

EPA is addressing Columbia and Snake River water quality improvement implementation activities in other policy forums. For the mainstem Columbia/Snake River, EPA is engaged with the Federal Columbia River Power System (FCRPS) action agencies - the U.S. Army Corps of Engineers, the Bonneville Power Administration, and the Bureau of

Reclamation, in the development of a Columbia River Water Quality Plan. The Water Quality Plan was called for in the 2000 FCRPS Biological Opinion in Appendix B to address water quality actions needed for the Columbia but were considered outside the boundaries of species recovery. EPA is participating in other regional forums including the Federal Regional Executives, the NMFS Implementation Forum, and the Transboundary Gas Group to provide representation on Clean Water Act policy and technical decisions for the Columbia River.

EPA has provided technical and scientific support to federal agencies, states and tribes through the development of a one dimensional temperature model for the Columbia/Snake Mainstem that will provide a critical foundation for future implementation decisions for the Columbia and Snake River Mainstem. This temperature model is a vital addition to state of the art knowledge of the temperature in the Columbia and Snake River system.

EPA has continued to provide support to the states of Oregon, Washington, and Idaho to continue ongoing TMDL water quality improvement planning and water quality improvement projects to improve water quality throughout Columbia Basin tributaries. These water quality improvement plans are being developed over the next ten year period are expected to be completed by 2012. The states have the lead in water quality improvement implementation effort.

As a result of the TMDL program there is a Quality Assurance Project Plan for the Total Maximum Daily Load Study: DDT Contamination and Transport in the Lower Mission Creek Basin which an assessment of DDT contamination and transport in the Mission Creek basin and will provide technical information for development of a TMDL., and a Wenatchee Watershed Multi-Parameter TMDL plan. Both are available through the Department of Ecology at http://www.ecy.wa.gov/programs/wq/tmdl/watershed/index.html#cro.

U.S. Department of Energy

Program: Hydropower Program
Abstract: The mission of the U.S. Department of Energy's (DOE's) Hydropower Program is to develop, conduct, and coordinate research and development with industry and other Federal agencies to improve the technical, societal, and environmental benefits of hydropower. The Office of Power Technologies administers the program through the DOE Idaho Operations Office.

The U.S. DOE Hydropower Program, managed by the Idaho National Engineering and Environmental Laboratory (INEEL), supports the development of environmentally sound hydroelectric resources and is conducting research on the unresolved environmental issues associated with hydropower development. Successful, cost-effective mitigation of environmental impacts is a critical element in successful project development. Recommendations to DOE from the hydropower industry, the Federal Energy Regulatory

Commission, power marketing administrations, and the public have identified environmental research and development as a continuing need.

The Advanced Hydropower Turbine Systems Program is a part of the Hydropower Program. The goal of DOE's Advanced Hydropower Turbine System (AHTS) Program is to develop technology that will allow the nation to maximize the use of its hydropower resources while minimizing adverse environmental effects. Conceptual designs of environmentally friendly hydropower turbines have been completed under the DOE-industry program. Potential injury mechanisms caused by turbine passage have been identified. Research is being performed to understand the effects of these injury mechanisms on fish and to develop methods for reducing their severity.

United States Department of Interior Bureau of Land Management

The Spokane Resource Management Plan (RMP) of 1985, the Record of Decision (ROD) of 1987, and the RMP Amendment of 1992 directed that the management efficiency of BLM public lands in eastern Washington be enhanced through a land tenure adjustment program. The mechanism established to accomplish this goal was the consolidation of public land ownership through the exchange of isolated parcels of public lands which were identified as difficult and uneconomic to manage, for other lands which would meet the specified goals for the management areas set forth in the RMP.

The 1992 RMP Amendment provided additional guidance regarding the Spokane District Land Tenure Adjustment program. The management plan describes that the highest land tenure adjustment priority would be placed on consolidation of public lands through land exchanges and purchases into, between and within the ten management areas identified in this RMP Amendment.

Further RMP guidance directs that Exchanges would be accomplished to acquire specific tracts that: provide greater expanses of uninterrupted high value wildlife habitats, possess recreational values that can be better managed and/or developed in public ownership, provide legal access to other public lands, qualify as an ACEC, have high scenic values, enhance the value/manageability of other public land, or possess other resource values of public interest that would be devalued or lost if retained in private ownership.

In an effort to meet RMP land tenure adjustment goals of protecting important wildlife habitat, providing public access, and promoting the efficient management of public lands, over 70,000 acres of important riparian and shrub-steppe habitat in Lincoln, Spokane, Whitman, Douglas, Grant and Yakima Counties have been acquired. The majority of this acreage has been acquired in the Upper Crab Creek and Moses Coulee Recovery Units identified in the WDFW Sage-grouse Recovery Plan, in draft.

In August of 1997, the Bureau adopted new Standards and Guidelines for Rangeland Health . These Standards for Rangeland Health and Guidelines for Livestock Grazing Management for Public Lands in Oregon and Washington were developed in consultation with Resource Advisory Councils, Provincial Advisory Committees, tribes and other interested parties. These standards and guidelines meet the requirements and intent of 43 Code of Federal Regulations, Subpart 4180 (Rangeland Health). The objectives of the Rangeland Health Standards and Guides are: to promote healthy sustainable rangeland ecosystems, to accelerate restoration and improvement of public rangelands to properly functioning conditions; and to provide for sustainable industry and communities dependent upon healthy rangelands. Although the focus of these standards is on domestic livestock grazing on BLM lands, on-the-ground decisions must consider the effects and impacts of all uses.

Shrub-steppe restoration efforts have been focused on recently acquired former agricultural lands including over 1200 acres in Lincoln County (Upper Crab Creek Recovery Unit) and 100 acres in Douglas County (Moses Coulee Recovery Unit).

United States Army Corps of Engineers

Section 10 Permit - Work in Navigable Waters

A Corps permit is required when locating a structure, excavating, or discharging dredged or fill material in waters of the United States or transporting dredged material for the purpose of dumping it into ocean waters. Typical projects requiring these permits include the construction and maintenance of piers, wharfs, dolphins, breakwaters, bulkheads, groins, jetties, mooring buoys, and boat ramps.

However, not every activity requires a separate, individual permit application. Certain activities and work can be authorized by letters-of- permission, nationwide permits, or regional permits. Some activities authorized by these permits are permitted in advance. Typically, little or no paperwork is required, and consequently permitting time is reduced. So, before submitting an application, contact the District Engineer's office for current information about the type of permit required.

Activity which requires the Permit: Locating a structure, excavating, or discharging dredged or fill material in waters of the United States or transporting dredged material for the purpose of dumping it into ocean waters. Fees are variable.

Statewide Contact:

US Army Corps of Engineers, Seattle District Regulatory Branch, PO Box 3755, Seattle, WA98124-2255. Telephone: (206) 764-3495 Fax: (206) 764-6602

* Permit information last updated 10/1/1998.

401 Water Quality Certification

Applicants receiving a section 404 permit from the Army Corp of Engineers, a Coast Guard permit or license from the Federal Energy Regulatory Commission (FERC), are required to obtain a section 401 water quality certification from the Department of Ecology. Issuance of a certification means that the Ecology anticipates that the applicant’s project will comply with state water quality standards and other aquatic resource protection requirements under Ecology's authority. The 401 Certification can

cover both the construction and operation of the proposed project. Conditions of the 401 Certification become conditions of the Federal permit or license.

For 404 permits the Corps has developed Nationwide permits to streamline the process for specific activities. The Corps reviews a proposed project to determine if an individual 404 permit is required, or if the project can be authorized under a Nationwide permit. The Nationwide permits also need 401 Certification from Ecology. Ecology has already approved, denied or partially denied specific Nationwide permits.

If approved, no further 401 Certification review by Ecology is required. If partially denied without prejudice, an individual certification or Letter of Verification from Ecology is required. If denied without prejudice, an individual certification is required for all activities under that nationwide permit.

Activity which requires the Permit: Applying for a federal permit or license to conduct

any activity that might result in a discharge of dredge or fill material into water or non-

isolated wetlands or excavation in water or non-isolated wetlands.

Fees: No fee for certification

Online Application: The application for an individual permit, which is called Joint Aquatic Resources Permit Application Form (JARPA), is online and can be downloaded at http://www.ecy.wa.gov/programs/sea/pac/jarpa.html

Application Requirements: If applicable to the project: Mitigation plans, Operation and maintenance plans, Stormwater site plans and Restoration plans.

Permit Dependencies: In most cases State Environmental Policy Act (SEPA) compliance is needed. If you live within any of Washington's 15 coastal counties then you may need a Coastal Zone Consistency Determination (CZM).

Permit Time Frame: Individual 401's: Minimum twenty day public notice; up to one year to approve, condition, or deny. Usually less than three months, see notes/comments. Nationwide permits that have been partially denied may take a few days or weeks, after receipt of the JARPA and a letter from the Corps issuing a LOV. Letter of Verification (LOV): Usually takes 30 days but can take up to 180 days.
Permit Review Process: Review is conducted in Shoreline and Environmental Assistance within each regional office (except dredging and WSDOT projects which are done at Ecology's Headquarters). Regional staff review the applications for completeness and send out a letter or call if additional information is needed. Once the application is considered complete the regional staff starts reviewing the project to recommend approval or denial. Modifications to plans submitted maybe required. Also a site visit maybe required as part of the process.

Permit Duration: 401 Certification becomes part of the Federal permit or license. The duration of the 401 Certification would be in effect for same time period as the permit or license, however Ecology issues 401 Certifications as 90.48 administrative orders, so they may have conditions that apply to the project longer than the Federal permit or license.

Permit Appeal Information: Appealable to Pollution Control Hearings Board within thirty days of Ecology's decision. P.C.H.B. may not hear case for six or more months.
Notes / Comments: If an applicant receives a nationwide permit and Ecology issues a LOV, there is no public notice requirements under 401 certification for that specific project. If the applicant receives a nationwide permit but is required to obtain an individual 401 Certification, public notice is required.

Legal Authority:
- Chapter 173-201A State Water Quality Rule WAC
- Chapter 173-225 Federal Clean Water Act, Section 401 WAC
- Chapter 90.48 State Water Quality Law RCW

Statewide Contact:
Department of Ecology, 300 Desmond Drive, Lacey, WA98503. Telephone: (360) 407-6000

* Permit information last updated 10/23/2003.

Section 404 Permit - Discharge of Dredge and Fill Material
A Corps permit is required when locating a structure, excavating, or discharging dredged or fill material in waters of the United States or transporting dredged material for the purpose of dumping it into ocean waters. Typical projects requiring these permits include the construction and maintenance of piers, wharfs, dolphins, breakwaters, bulkheads, groins, jetties, mooring buoys, and boat ramps.

However, not every activity requires a separate, individual permit application. Certain activities and work can be authorized by letters-of- permission, nationwide permits, or regional permits. Some activities authorized by these permits are permitted in advance. Typically, little or no paperwork is required, and consequently permitting time is reduced. So, before submitting an application, contact the District Engineer's office for current information about the type of permit required.

Activity which requires the Permit: Locating a structure, excavating, or discharging dredged or fill material in waters of the United States or transporting dredged material for the purpose of dumping it into ocean waters.

Fees: Variable

Statewide Contact:
US Army Corps of Engineers, Seattle District Regulatory Branch. PO Box 3755, Seattle, WA98124-2255. Telephone: (206) 764-3495. Fax: (206) 764-6602

* Permit information last updated 10/1/1998.

United States Department of Agriculture

Natural Resource Conservation Service
The Natural Resources Conservation Service (NRCS) is the technical agency of the US Department of Agriculture that provides assistance to conservation districts and individuals in planning and carrying out conservation activities.
NRCS has the expertise and experience to provide technical assistance to owners and managers of private grazing land for the long-term productivity and ecological health of grazing land. NRCS assists with public awareness activities to inform the public on the values and benefits of private grazing land.

Program: Conservation Securities Program
Abstract: This program, expected to begin in 2004, rewards landowners who have demonstrated good land stewardship. The NRCS will pay the landowners an annual sum to continue their good work. It is expected to be used in most of the subbasins.

Program: Conservation Technical Assistance
Abstract: The Conservation Technical Assistance (CTA) program provides voluntary conservation technical assistance to land-users, communities, units of state and local government, and other Federal agencies in planning and implementing conservation systems. This assistance is for planning and implementing conservation practices that address natural resource issues. It helps people voluntarily conserve, improve and sustain natural resources.

Objectives of the program are to:
Assist individual landusers, communities, conservation districts, and other units of State and local government and Federal agencies to meet their goals for resource stewardship and assist individuals to comply with State and local requirements. NRCS assistance to individuals is provided through conservation districts in accordance with the memorandum of understanding signed by the Secretary of Agriculture, the governor of the state, and the conservation district. Assistance is provided to land users voluntarily applying conservation and to those who must comply with local or State laws and regulations.

Assist agricultural producers to comply with the highly erodible land (HEL) and wetland (Swampbuster) provisions of the 1985 Food Security Act as amended by the Food, Agriculture, Conservation and Trade Act of 1990 (16 U.S.C. 3801 et. seq.) and the Federal Agriculture Improvement and Reform Act of 1996 and wetlands requirements of Section 404 of the Clean Water Act. NRCS makes HEL and wetland determinations and helps land users develop and implement conservation plans to comply with the law.
Provide technical assistance to participants in USDA cost-share and conservation incentive programs. (Assistance is funded on a reimbursable basis from the CCC.)
Collect, analyze, interpret, display, and disseminate information about the condition and

trends of the Nation's soil and other natural resources so that people can make good decisions about resource use and about public policies for resource conservation. Develop effective science-based technologies for natural resource assessment, management, and conservation.

This program is active in all subbasins as the basic operating budget to write contracts and perform ongoing maintenance.

Program: Emergency Watershed Protection
Abstract: The purpose of the Emergency Watershed Protection (EWP) program is to undertake emergency measures, including the purchase of flood plain easements, for runoff retardation and soil erosion prevention to safeguard lives and property from floods, drought, and the products of erosion on any watershed whenever fire, flood or any other natural occurrence is causing or has caused a sudden impairment of the watershed.

It is not necessary for a national emergency to be declared for an area to be eligible for assistance. Program objective is to assist sponsors and individuals in implementing emergency measures to relieve imminent hazards to life and property created by a natural disaster. Activities include providing financial and technical assistance to remove debris from streams, protect destabilized streambanks, establish cover on critically eroding lands, repairing conservation practices, and the purchase of flood plain easements. The program is designed for installation of recovery measures.
Work is authorized by section 216, P.L. 81-516, (33 U.S.C. 701b1) and Sections 403-405, P.L. 95-334, (16 U.S.C. 2203-2205).

Funding from this program was used in the aftermath of the wildfires in the Chelan Basin in 2001.

Program: Farm and Ranchland Protection Program
Abstract: This new program is similar to the Wetlands Protection Program. It is designed to protect farm and ranchland from being sold out to development. NRCS contributes up to 50% of the appraised value of the land in order to create an easement and put the land in trust. A third party conservation or land trust group contributes the remaining price for the land, and takes responsibility for overseeing the easement.

Program: Forestry Incentives Program
Abstract: The Forestry Incentives Program (FIP) supports good forest management practices on privately owned, non-industrial forest lands nationwide. FIP is designed to benefit the environment while meeting future demands for wood products. Eligible practices are tree planting, timber stand improvement, site preparation for natural regeneration, and other related activities. FIP is available in counties designated by a Forest Service survey of eligible private timber acreage. FIP is closely related to the Stewardship Incentive Program, and both are usually managed by DNR.

Program: Grassland Reserve Program
Abstract: This new program, silmilar to the RC&D program, aims to prevent range and

pasture land from being subdivided.

Contracts for this program are expected to be created in 2004.

Program: Grazing Lands Conservation Initiative (GLCI)
Abstract: The Grazing Land Conservation Initiative (GLCI) is a nationwide collaborative process of individuals and organizations working to maintain and improve the management, productivity, and health of the Nation's privately owned grazing land. This process has formed coalitions that represent the grass root concerns that impact private grazing land. The coalitions actively seek sources to increase technical assistance and public awareness activities that maintain or enhance grazing land resources.

Grazing lands provide opportunities for improved nutrient management from land application of animal manure and other by-product nutrient sources, reduces soil erosion from wind and water, reduces potential for flooding, less sediment in streams and reservoirs, and has a major impact on economic and social stability in rural communities.

The Grazing Lands Conservation Initiative is a nationwide collaborative process of individuals and organizations working together to maintain and improve the management, productivity, and health of the Nation's privately owned grazing land. GLCI was developed to provide for a coordinated effort to identify priority issues, find solutions, and effect change on private grazing land. This initiative will complement and enhance existing conservation programs.

Program: Resource Conservation & Development Program
Abstract: The purpose of the Resource Conservation and Development (RC&D) program is to accelerate the conservation, development and utilization of natural resources, improve the general level of economic activity, and to enhance the environment and standard of living in designated RC&D areas. It improves the capability of State, tribal and local units of government and local nonprofit organizations in rural areas to plan, develop and carry out programs for resource conservation and development. The program also establishes or improves coordination systems in rural areas. Current program objectives focus on improvement of quality of life achieved through natural resources conservation and community development which leads to sustainable communities, prudent use (development), and the management and conservation of natural resources. RC&D areas are locally sponsored areas designated by the Secretary of Agriculture for RC&D technical and financial assistance program funds.

Program: Soil Survey Programs
Abstract: The National Cooperative Soil Survey Program (NCSS) is a partnership led by NRCS of Federal land management agencies, state agricultural experiment stations and state and local units of government that provide soil survey information necessary for understanding, managing, conserving and sustaining the nation's limited soil resources.

Soil surveys provide an orderly, on-the-ground, scientific inventory of soil resources that

includes maps showing the locations and extent of soils, data about the physical and chemical properties of those soils, and information derived from that data about potentialities and problems of use on each kind of soil in sufficient detail to meet all reasonable needs for farmers, agricultural technicians, community planners, engineers, and scientists in planning and transferring the findings of research and experience to specific land areas. Soil surveys provide the basic information needed to manage soil sustainably. They also provide information needed to protect water quality, wetlands, and wildlife habitat. Soil surveys are the basis for predicting the behavior of a soil under alternative uses, its potential erosion hazard, potential for ground water contamination, suitability and productivity for cultivated crops, trees, and grasses. Soil surveys are important to planners, engineers, zoning commissions, tax commissioners, homeowners, developers, as well as agricultural producers. Soil surveys also provide a basis to help predict the effect of global climate change on worldwide agricultural production and other land-dependent processes.

Program: Soil and Water Conservation Assistance
Abstract: Soil and Water Conservation Assistance (SWCA) provides cost share and incentive payments to farmers and ranchers to voluntarily address threats to soil, water, and related natural resources, including grazing land, wetlands, and wildlife habitat. SWCA will help landowners comply with Federal and state environmental laws and make beneficial, cost-effective changes to cropping systems, grazing management, nutrient management, and irrigation.

This program had a one year life span, in 2000. It was a spin off of EQUIP.

Program: Snow Survey and Water Supply Forecasting
Abstract: The purpose of the program is to provide western states and Alaska with information on future water supplies. NRCS field staff collect and analyze data on depth and water equivalent of the snowpack at more than 1,200 mountain sites and estimate annual water availability, spring runoff, and summer streamflows. Individuals, organizations, and state and Federal agencies use these forecasts for decisions relating to agricultural production, fish and wildlife management, municipal and industrial water supply, urban development, flood control, recreation power generation, and water quality management. The National Weather Service includes the forecasts in their river forecasting function.
The objectives of the program are to:
Provide water users with accurate forecasts of surface water supply within the first 5 working days of each month, Jan.-June.
Efficiently obtain, manage, and disseminate high quality information on snow, water, climate, and hydrologic conditions.

Develop and apply technology necessary to meet changing needs of water users.

Program: Stewardship Incentive Program
Abstract: The Stewardship Incentive Program (SIP) provides technical and financial assistance to encourage non-industrial private forest landowners to keep their lands and natural resources productive and healthy. Qualifying land includes rural lands with

existing tree cover or land suitable for growing trees and which is owned by a private individual, group, association, corporation, Indian tribe, or other legal private entity. Eligible landowners must have an approved Forest Stewardship Plan and own 1,000 or fewer acres of qualifying land. Authorizations may be obtained for exceptions of up to 5,000 acres.

This program is tied to the FIP, andis usually managed by DNR.

Program: Watershed Protection, Watershed Surveys, and Flood Prevention
Abstract: The Watershed Protection and Flood Prevention Act, P.L. 83-566, August 4, 1954, (16 U.S.C. 1001-1008) authorized this program. Prior to fiscal year 1996, watershed planning activities and the cooperative river basin surveys and investigations authorized by Section 6 of the Act were operated as separate programs. The 1996 appropriations act combined the activities into a single program entitled the Watershed Surveys and Planning program. Activities under both programs are continuing under this authority.

The purpose of the Watershed Program, including River Basin operations, is to assist Federal, State, local agencies, local government sponsors, tribal governments, and program participants to protect and restore watersheds from damage caused by erosion, floodwater, and sediment, to conserve and develop water and land resources, and solve natural resource and related economic problems on a watershed basis. The program provides technical and financial assistance to local people or project sponsors, builds partnerships, and requires local and state funding contribution.
Resource concerns addressed by the program include watershed protection, flood prevention, erosion and sediment control, water supply, water quality, opportunities for water conservation, wetland and water storage capacity, agricultural drought problems, rural development, municipal and industrial water needs, upstream flood damages, water needs for fish, wildlife, and forest-based industries, fish and wildlife habitat enhancement, wetland creation and restoration, and public recreation in watersheds of 250,000 or fewer acres. Both technical and financial assistance are available.
Types of surveys and plans include watershed plans, river basin surveys and studies, flood hazard analyses, and flood plain management assistance. The focus of these plans is to identify solutions that use conservation practice and nonstructural measures to solve resource problems.

Watershed plans involving contribution in excess of $5,000,000 for construction, or construction of any single structure having a capacity in excess of 2,500 acre feet, require Congressional approval. Other plans are administratively authorized. After approval, technical and financial assistance can be provided for installation of works of improvement specified in the plans.

Project sponsors are provided assistance in installing planned land treatment measures when plans are approved. Surveys and investigations are made and detailed designs, specifications, and engineering cost estimates are prepared for construction of structural measures. Areas where sponsors need to obtain land rights, easements, and rights-of-way

are delineated. Technical assistance is also furnished to landowners and operators to accelerate planning and application of needed conservation measures on their individual land units. There are presently over 1600 projects in operation.

Conservation of Private Grazing Land Program
The Conservation of Private Grazing Land Program (CPGL) is a voluntary program that helps owners and managers of private grazing land address natural resource concerns while enhancing the economic and social stability of grazing land enterprises and the rural communities that depend on them. To find out more information contact the USDA Service Center or the Lincoln County Conservation District.

Wildlife Habitat Incentives Program
The Wildlife Habitat Incentives Program (WHIP) is a voluntary program that encourages creation of high quality wildlife habitats that support wildlife populations of National, State, Tribal, and local significance. Through WHIP, NRCS provides technical and financial assistance to landowners and others to develop upland, wetland, riparian, and aquatic habitat areas on their property. Contact the USDA Service Center for more information.

Conservation Reserve Program
The Conservation Reserve Program (CRP) is a voluntary program for agricultural landowners. Through CRP, you can receive annual rental payments and cost-share assistance to establish long-term, resource conserving covers on eligible farmland. The Commodity Credit Corporation (CCC) makes annual rental payments based on the agriculture rental value of the land, and it provides cost-share assistance for up to 50 percent of the participant's costs in establishing approved conservation practices. Participants enroll in CRP contracts for 10 to 15 years. The program is administered by the CCC through the Farm Service Agency (FSA), and program support is provided by NRCS, Cooperative State Research and Education Extension Service, state forestry agencies, and local Soil and Water Conservation Districts. To find out more information contact the USDA Service Center or the Lincoln County Conservation District.

Conservation Security Program
The Conservation Security Program is a voluntary program that provides financial and technical assistance for the conservation, protection, and improvement of soil, water, and related resources on Tribal and private lands. The program provides payments for producers who historically have practiced good stewardship on their agricultural lands and incentives for those who want to do more. The program will be available in fiscal year 2003. It is expected that the Senate Appropriations Committee will continue to support CSP funding for FY 2004, and that the program will emerge from any Appropriations Conference Committee with full funding for a national program open to all producers. For the latest updated information on the status of the Conservation Security Program funding and USDA-NRCS program implementation visit: www.mnproject.org/csp.

Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) is a voluntary conservation program that promotes agricultural production and environmental quality as compatible national goals. Through EQIP, farmers and ranchers may receive financial and technical help to install or implement structural and management conservation practices on eligible agricultural land. Contact the USDA Service Center for more information.

Farmland Protection Program

The Farmland Protection Program provides funds to help purchase development rights to keep productive farmland in agricultural uses. Working through existing programs, USDA joins with State, tribal, or local governments to acquire conservation easements or other interests from landowners. USDA provides up to 50 percent of the fair market easement value. To qualify, farmland must: be part of a pending offer from a State, tribe, or local farmland protection program; be privately owned; have a conservation plan; be large enough to sustain agricultural production; be accessible to markets for what the land produces; have adequate infrastructure and agricultural support services; and have surrounding parcels of land that can support long-term agricultural production. Depending on funding availability, proposals must be submitted by the government entities to the appropriate NRCS State Office during the application window. Contact the USDA Service Center for more information.

Resource Conservation and Development Program

The Resource Conservation and Development Program (RC&D) encourages and improves the capability of civic leaders in designated RC&D areas to plan and carry out projects for resource conservation and community development. Program objectives focus on “quality of life” improvements achieved through natural resources conservation and community development. Such activities lead to sustainable communities, prudent land use, and the sound management and conservation of natural resources. Contact the USDA Service Center for more information.

Wetlands Reserve Program

The Wetlands Reserve Program is a voluntary program that provides technical and financial assistance to eligible landowners to address wetland, wildlife habitat, soil, water, and related natural resource concerns on private land in an environmentally beneficial and cost effective manner. The program provides an opportunity for landowners to receive financial incentives to enhance wetlands in exchange for retiring marginal land from agriculture. The program is implemented by the Natural Resource Conservation Service (NRCS). Contact Ross Lhren at (509) 323-2971.

United States Fish & Wildlife Service

The Columbia National Wildlife Refuge

The Columbia National Wildlife Refuge (CNWR) includes 23,200 acres of core lands surrounding Crab Creek downstream from O’Sullivan Dam. The refuge was established in 1944 as a feature of the Columbia Basin Irrigation Project (CBIP). A majority of the refuge was purchased in fee title, but more than 2,600 acres, mostly along the dam face and Potholes Canal, are owned by U.S. Bureau of Reclamation and managed by the U.S.

Fish and Wildlife Service. The refuge was established “for use as an inviolate sanctuary, or for any other management purpose, for migratory birds” and “as a refuge and breeding ground for migratory birds and other wildlife.”

The original acquisition boundary of the refuge included the entire length of Crab Creek below Potholes Reservoir to its junction with the Columbia River. More than 6,000 acres outside the current primary management area were acquired from Public Domain lands and through fee purchase. Priorities for purchase were reduced when the Columbia Basin Irrigation Project was scaled back and the flood zone associated with using Crab Creek as a wasteway capable of sustained 2000 cubic-feet-per-second flows was no longer needed. Approximately 4,000 acres of intermingled refuge lands along lower Crab Creek are currently managed through agreement by WDFW. The U.S. Fish and Wildlife Service owns an additional 5,787 acres adjacent to Lake Lenore (once a national wildlife refuge) that is managed cooperatively by WDFW.

The most common habitats on CNWR are wetland (including lake, marsh and riparian) and shrubsteppe (19,000 acres). Before the CBIP changed the hydrology of the refuge area, the scenery was dominated by scablands combining expansive rock outcrops carved by glacial flood flows 12-15,000 years ago. The Refuge is the largest single land holding in the Drumheller Channels National Natural Landmark, designated in 1986 for its scenic beauty and geologic history. Water was restricted to a few shallow lakes and Crab Creek, which was reduced to intermittent and subsurface flows during the summer. The majority of the vegetation was shrubsteppe. Leakage through O’Sullivan Dam, the Potholes Canal, a higher water table, and drainage via wasteways has increased the wetland acreage from less than 300 to the current 3,800 acres, and has turned lower Crab Creek into a stream with perennial surface flow.

Program: Refuge Comprehensive Conservation Planning Program
Abstract: The US Fish and Wildlife Service is implementing a program that will have all 540+ refuges in the National Wildlife Refuge System complete comprehensive planning documents within the next ten years. Columbia National Wildlife Refuge (CNWR) is the only refuge in the system within the Crab Creek Subbasin, and is scheduled to complete the plan in 2008. The last management plan for Columbia NWR was completed in 1986. The Comprehensive Conservation Plan (CCP) typically addresses all major management issues facing an individual refuge, with step-down plans used to deal with specific programs. Among the step-down plans already written for CNWR are: Grazing, Integrated Pest Management, Grassland Management, Cropland Management, Hunting, Fisheries Management, and Wetland Management. Additional plans and revisions to current plans will be part of the CCP process.

Program: Fish and Wildlife Management Assistance Program
Abstract: The Fish and Wildlife Management Assistance program consists of fish and wildlife management professionals in seven Regional offices and 64 field offices, located in 33 states.These field offices – e.g. Fishery Resources Offices, Fish and Wildlife Management Assistance Offices, Fish and Wildlife Offices, Coordination Offices, Marine Mammals Management Office – staff about 300 professional fishery biologists and other

experts.

The Fish and Wildlife Management Assistance program fills a vital role in restoring and maintaining the health of the Nation's fish and wildlife resources. Program biologists monitor the health of fish and wildlife resources, diagnose ailments, prescribe remedies, refer specific problems to specialists, and coordinate diverse efforts to restore and maintain health. The program helps avoid listing actions under the Endangered Species Act. The American people benefit from healthier ecosystems and resulting increases in fishing and other recreational opportunities.
Responsibilities of the Fish And Wildlife Management Assistance Program include Native Fish Conservation, Native American Tribal Assistance, Federal Lands Assistance, Marine Mammal Management, Fish Passage Program, Interjurisdictional Fisheries Assistance, Alaska Subsistence Fisheries Management, Outreach and Other Duties.

Program: Partners for Fish and Wildlife
Abstract: The Partners for Fish and Wildlife Program is a voluntary partnership program that helps private landowners restore wetlands and other important fish and wildlife habitats on their own lands. For over 15 years, the Partners for Fish and Wildlife Program has been providing financial and technical assistance to private landowners through voluntary cooperative agreements.

Washington State has several natural regions defined by their climate, elevation, and geology. These include: forests, shrub-steppe grasslands, freshwater systems, and marine systems. Over thousands of years, fish and wildlife species have evolved and adapted to this array of ecosystems. Forests cover about half of the State, and our soils and climate make Washington one of the few areas in the nation capable of rapidly growing high-quality timber.

Current habitats of special concern include: streams and riparian (streamside) areas, wetlands, prairies, oak woodlands and shrub-steppe. Wildlife species of concern include bull trout (federally threatened), salmon, cutthroat trout, bald eagle, black tern, Columbia spotted frog and pygmy rabbit. Plant species of concern include the federally listed golden paintbrush and water howellia.

The Partners for Fish and Wildlife Program in Washington works with willing landowners, land managers and a variety of partners to restore habitat for the Pacific Northwest's imperiled bull trout, salmon, steelhead, native trout stocks and a host of terrestrial wildlife species. We emphasize restoration projects that help restore overall watershed health for the long-term, and benefit a diverse array of fish and wildlife species. For example, the Partners Program contributed funding and technical assistance to restore a perpetual easement encompassing more than 300 acres of riparian, wetland and upland habitat in Grays Harbor County. The project benefited bald eagle, bull trout, steelhead, cutthroat, coho and chum salmon, and other migratory and resident fish and wildlife species.

For stream, wetland and riparian habitat restoration across the State, costs vary widely

due to the large variety of project types in these habitats. The average cost is $8,000 per acre for these different habitat types.

Program: Fishery Resource Program
Abstract: The Fisheries Program in the Pacific Region is headquartered in Portland, Oregon. This office is responsible for policy guidance, budget, planning, oversight and coordination of the diverse activities of the Fisheries Program in this Region.
There are 19 National Fish Hatcheries in the Pacific Region that annually produce over 60 million fish. All of these hatcheries, along with our many other Fishery Program offices, are important components of an integrated approach to the management and restoration of aquatic species and their environments.

Hatcheries have long played an important role in supporting recreational, commercial, and international fisheries, as well as in meeting our Tribal Trust responsibilities, and continue to do so today. However, with the decline and endangerment of many native species, Pacific Region hatcheries must now also play an important role in supporting the restoration and recovery of these species.
Salmon remain the focus of most hatchery efforts in the Pacific Region, though some work is done with other anadromous and resident species as well.

Program: Hatchery Assessment Program
Abstract: This office conducts production planning, marking, monitoring, and post-stocking evaluations for National Fish Hatcheries in the Columbia River Basin. Over 15 million fish were marked in 2001. Marking can include fin clips, coded-wire tags, and PIT tags. To keep track of hatchery programs, this office maintains the Columbia River information System (CRiS), and participates in the interagency StreamNet database. They also develop hatchery and Genetic Management Plans and Section 7 Biological Assessments for Endangered Species Act compliance. They develop collaborative projects to investigate diet, release, and rearing density to improve hatchery performance, as well as develop in-stream studies using traps, radio telemetry, and snorkeling to investigate behavior, wild and hatchery interactions and habitat use.

Program: Native American Tribal Assistance Program
Abstract: The U.S. Fish and Wildlife Service, through the Fish and Wildlife Management Assistance program, strive to fulfill Federal trust responsibilities to Native American Tribes. The program works with Native American Tribes to conserve and manage fish and wildlife resources on Tribal lands and ceded territories.

Native American cultures are closely connected to fish and wildlife resources for sustenance, cultural enrichment, and economic support. Tribal governments manage or have influence over some of the Nation’s most important fish and wildlife resources.

There are 572 federally recognized tribes in the United States, including 224 village groups in Alaska. “Federally recognized” means these tribes and governments have a special, legal relationship with the U.S. government.

The U.S. government is legally obligated to protect tribal trust resources, including fish and wildlife. The *Native American Policy of the U.S. Fish and Wildlife Service*, dated June 1994, articulates general principles that guide the Service's government-to-government relationship with Native American governments in the conservation of these resources.

The following programs are part of the National Fish and Wildlife Management Assistance Program carried out by the Columbia River Fisheries Program Office:

Program: Habitat and Population Evaluation

Abstract: The Habitat and Population Evaluation Team conducts surveys to describe populations of fish and other aquatic organisms and their habitats. Surveys are used to monitor such factors as the distribution, abundance, life history characteristics, and habitat use of populations. Methods used to collect information on these factors include a combination of traditional techniques (such as using fish traps and gill nets) and developing technologies (such as using specialized electrofishing strategies, radio telemetry, and passive integrated transponder (PIT) tags). The analysis of population and habitat information is useful for describing the status of select species, assessing habitat needs, and identifying restoration approaches, which are essential in developing and implementing effective resource management strategies.

Fish species that the team is presently focused include lampreys (particularly Pacific lamprey and western brook lamprey; contact Jen Stone), chum salmon (contact Nancy Uusitalo), and native trout (primarily coastal cutthroat trout; contact Joe Zydlewski). The lamprey project is an evaluation of habitat use and population dynamics of lampreys inhabiting Cedar Creek, a tributary of the Lewis River. The chum salmon project is an evaluation of factors limiting populations in the Columbia River Gorge chum salmon populations, namely in Hardy and Hamilton creeks. The coastal cutthroat trout project is an investigation of coastal cutthroat trout movements in the lower Columbia River, select tributaries, and the estuary. The team is also investigating the distribution and habitat use of the western pearl shell mussel in Cedar Creek (contact Jen Stone).

Program: Conservation Assessment Program

Abstract: The recent Endangered Species Act (ESA) listings in combination with the decline of many fish stocks in the Columbia basin has increased the Service's need for analytical evaluations of stock assessment, extinction probabilities, and the development of sound, biologically and technically defensible recovery strategies. Because many of these fish stocks are still harvested, spawn and rear in freshwater habitat, and are supplemented with hatchery fish from many of the Service's hatcheries, decisions about their protection and recovery require cooperation among the different federal, state, and tribal governments. The effective management and restoration of Columbia River salmon, steelhead, bull trout, sturgeon, and other aquatic resources depends on both our analytical capability to evaluate stock status and recovery options as well as the ability of the different agencies to communicate effectively, resolve differences, develop unified positions, and work together in a spirit of cooperation in various interagency forums to

solve basin-wide problems. As such the Conservation Assessment Team (CAT-Team) was formed in 2000.

The mission of the CAT-Team is to promote the Service's position and interests through interagency forums, local governments and coordination groups operating in the Columbia River basin and ensure that the decisions made by these groups result in the adoption of the best scientifically-based management measures for resident and anadromous fish and wildlife resources. More specifically, the CAT-Team is responsible for developing and evaluating life-cycle, harvest, and production simulation models for endangered and threatened aquatic species (e.g. salmon and resident fish) in the Columbia River basin. The FWS is represented by the CAT-Team at (1) multi-agency technical forums developed to formulate and test hypotheses and resolve uncertainties in the fundamental biological issues surrounding the recovery of endangered salmon in the Columbia River basin and (2) the Pacific Salmon Commission, Chinook Technical Team, an international technical forum developed to evaluate and implement the international treaties regulating harvest of Pacific salmon. CAT-Team members assist in formulating and technically evaluating Service policy and positions relative to stock assessment and recovery planning issues in the Columbia River basin. The CAT-Team may also provide guidance on experimental design, modeling and analysis for FWS research and monitoring projects, develop and review research and monitoring funding proposals, and provide information and education to the public. CAT-Team members are often called upon to brief the FWS, Department of Interior staff, and members of Congress on scientific issues surrounding management decisions.

The team includes six members. Tim Cummings has been at the CRFPO since 1989. His current focus is on bull trout recovery planning. Bao Le has been with the CRFPO since 2000. His current focus is on GIS technology. Ron Rhew came to the CRFPO in 2002. His current focus is on subbasin planning. Tim Whitesel joined the CRFPO in 2001. His current focus is on ESA implementation. Paul Wilson came to the CRFPO in 1999. His current focus is on population assessments. Henry Yuen has been at the CRFPO since 1995. His current focus is on harvest management.

Program: Water Management and Evaluation Program

Abstract: Construction and operation of the Columbia River hydro system has been a major factor in the decline anadromous fishes and attributed to subsequent Endangered Species Act listing of Columbia River basin salmon and steelhead. In response to this situation, several groups have been created to recover and restore these populations of fish.

Office staff coordinates and manage issues in the Columbia River basin that affect Service responsibilities through several regional forums. Examples include: coordinating and balancing spawning flows needed for endangered Kootenai River white sturgeon with instream flow needs for threatened Columbia and Snake river salmonids; developing flow requirements for listed Columbia River Chum below Bonneville Dam; scheduling releases of fish from Service hatcheries with requests for increased flows from Columbia and Snake river dams; and incorporating the requirements of anadromous fish in the

Columbia River into Federal Energy Regulatory Committee relicensing processes of the Snake River and mid-Columbia River hydroelectric projects.

http://columbiariver.fws.gov/images/substrateworkfull.jpgOffice staff have significant experience and expertise in instream flow methodologies, river hydraulics, and physical/biological habitat evaluations for anadromous and resident fish and wildlife in the Pacific Northwest and Columbia River basin. Instream flow assessments, hydraulic and habitat modeling, and species specific biological evaluations provide the information necessary to establish stream flows which are required to maintain or enhance habitat for fish and wildlife. Instream flow expertise is critical for successfully supporting stream flow recommendations for fish and wildlife habitat that is affected by the construction and operation of the hydro system as well as water diversions, and for other activities directed at the recovery and restoration of fish and wildlife populations on and off of Service lands.

Program: Fish and Wildlife Mitigation Program

Abstract: To be effective in resolving resource management conflicts and species recovery challenges in the wildlife mitigation arena of the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program (Program), the Columbia River Basin Mitigation Coordinator (Coordinator) position was established in 1997 to insure that the U.S. Fish and Wildlife Service (FWS) provided an advocate for wildlife-specific habitat needs within the Columbia River Basin (Basin) ecosystem, which is structurally diverse in both space and time.

Congress enacted the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Act) to insure low-cost electricity to the Pacific Northwest while protecting, mitigating, and enhancing the fish and wildlife resources that were affected and continue to be affected by the development and operation of the Federal Columbia River Power System (FCRPS). Balancing the economic benefits of the hydro-power system with fish and wildlife values continues to be an ongoing challenge. As a result of the Act, a multi-tiered, multi-faceted process evolved. The Northwest Power Planning Council (NWPPC, Council), an interstate (Idaho, Montana, Oregon, and Washington) compact agency was created and the Council's Fish and Wildlife Program was established to mitigate for FCRPS impacts to fish and wildlife resources. The Program is funded through the region's electricity users or rate payers and is administered through the Bonneville Power Administration (BPA) in coordination with the region's federal and state fish and wildlife management agencies, Northwest Indian tribes, and other stakeholders. The Columbia Basin Fish and Wildlife Authority (CBFWA), a consortium of nineteen federal and state agencies and Indian tribes, was formed as a collaborative association of Basin fish and wildlife managers to insure comprehensive, consistent, and coordinated decisions are made in matters relating fish and wildlife resources and scientifically credible projects are proposed that reflect Basin-wide priorities. The NWPPC, BPA, and CBFWA, in partnership with local governments, environmental advocacy groups, industry, and the scientific community, work to develop policies and projects that can effectively recover and restore impacted fish and wildlife populations and their habitats through a system-wide approach that factors in the ecological variability of fifty tributary subbasins.

The Coordinator plays a key role in promoting the FWS ecosystem goals and resource priorities when addressing FCRPS impacts that transcend political boundaries across the Basin. Through cooperative efforts with other agencies, tribes, non-governmental organizations, and private citizens, the Coordinator participates in the development of Basin-wide priorities, conflict resolution strategies, effective habitat management and restoration techniques, and monitoring and evaluation protocols to bring about the recovery efforts of the FWS through the Council's Program. The position requires a significant coordination effort, as multiple objectives and strategies evolve in response to the various legal, political, and technical agendas and interests that often produce conflicting demands on natural resources. Participation in the Council's Fish and Wildlife Program process, which is supported by a current annual budget of $186 million, is critical to insure that FWS interests are represented in an arena that can net significant benefits to fish and wildlife species and their associated habitats. Within this dynamic process, the FWS continually refines its own resource objectives and strategies to maximize its effectiveness in resolving natural resource problems within the Basin. The Coordinator assists National Wildlife Refuge managers within the Basin in identifying mitigation projects that address Program and FWS priorities and provides direction in the development of funding proposals through the Council's Rolling Provincial Review process. The Coordinator also acts as the FWS liaison/conduit of information to other FWS branches to insure that duplicative efforts are minimized and restoration activities are complimentary between aquatic and terrestrial eco-types.

Program: Information, Education and Outreach Program

Abstract: The Information and Education Program promotes public stewardship of fish and wildlife resources and fosters support for conservation activities through outreach strategies. It is focused on providing the public; elected officials; media; other federal, state, and local agencies; Tribes; and nongovernmental organizations with current information on Columbia River Fisheries Program Office activities.

Program: Jobs in the Woods Program

Abstract: The Jobs in the Woods (JITW) Program is part of the U.S. Fish and Wildlife Service's (Service) contribution to the Northwest Forest Plan. The Service uses congressionally appropriated funds to participate in watershed restoration projects in northern California, Oregon, and Washington. Program funds are used to complete watershed restoration activities on nonfederal lands that include private, city, county, state, and tribal lands.

The main goals of the Program are:

- improve or restore watershed health.
- complement ongoing watershed restoration efforts on federal lands.
- benefit federally significant fish, wildlife, and plant species that include listed and proposed species, sensitive and at-risk species, migratory birds, anadromous fish, and their habitats.
- support timber-dependent communities through employment and training

opportunities for local workers.

Program: Habitat Conservation Planning Program

Abstract: After passage of the Endangered Species Act (ESA) of 1973, both the Federal government and non-Federal landowners became concerned that a property owner's otherwise lawful activity that might result in the unintentional take of a listed species would be prohibited, even if the landowner was willing to plan activities to conserve the species.

To resolve this problem, Congress amended section 10 of the ESA in 1982 to authorize "incidental take" through the development and implementation of Habitat Conservation Plans or HCPs. Private landowners, corporations, state or local governments, or other non-Federal landowners who wish to conduct activities on their land that might incidentally harm (or "take") a species listed as endangered or threatened must first obtain an incidental take permit from the U.S. Fish and Wildlife Service.

To obtain a permit, the applicant must develop a *Habitat Conservation Plan* (HCP), designed to offset any harmful effects the proposed activity might have on the species. The HCP process allows development to proceed while promoting listed species conservation. The "No Surprises" policy provides assurances to landowners participating in HCP efforts.

As of April 10, 2003, 541 Habitat Conservation Plans have been approved, covering approximately 38 million acres and protecting more than 525 endangered or threatened species.

Program: Partners in Flight

Abstract: The Office of Migratory Bird Management (MBMO) emphasizes the wise management and conservation of neotropical migratory birds. Through the Partners in Flight (PIF) network, MBMO has successfully developed numerous bird conservation projects that help ensure the continuation of migration.

Partners in Flight is a consortium of hundreds of private organizations, natural resource agencies, private businesses, industry associations, private landowners, foundations, universities, and individual citizens dedicated to maintaining healthy bird populations in the United States and throughout the Western Hemisphere. PIF is dedicated to 'Keeping Common Birds Common,' but many of their efforts are also aimed at less common species and at developing ways to avoid collision between wildlife conservation and economic development. Through those partnerships, PIF has been able to raise awareness of the value of migratory birds and the need for their protection. Before PIF, most people were not aware of any problem.

Program: Conservation Planning

Abstract: Through the Conservation Planning program and Section 10 of the Endangered Species Act, the Service works with private landowners, local and state governments, corporations, and other entities to conserve and protect listed and unlisted species on non-Federal lands. Habitat Conservation Plans, Safe Harbor Agreements and Candidate Conservation Agreements with Assurances promote species and habitat conservation through innovative partnerships. Conservation of fish and wildlife and their habitats on private lands is critical to maintaining our ecological biodiversity. Endangered species grants are also managed by this division.

U.S. Bureau of Land Management

Program: Abandoned Mine Land Program
Abstract: The initial BLM abandoned mine-land inventory effort identified 323 abandoned mines on Public Lands managed by BLM in Oregon and Washington. In general, these are old, historic mines worked during the mid- to late-1800's and early 1900's, long before our current awareness of environmental hazards. Some of these mines have hazardous mine openings, and some have acidic, metal-laden waters that discharge into adjacent streams. With its partners, BLM Oregon/Washington's Abandoned Mined-Lands Program has begun the cleanup of the mines that have the greatest impact on public safety and the Nation's water resources.

Of the 323 abandoned mines, approximately 50 have been determined to be in need of some form of remediation. Current site assessment and/or remediation work is being done on six of the higher priority sites (two in Washington and four in Oregon).

Program: Environmental Education Information

Abstract: It is BLM's vision that public participation in environmental education programs will lead to healthier and more productive ecosystems and that informed citizens will assist BLM in solving and preventing complex environmental problems on public lands.

BLM has four main environmental education goals:

Stewardship: Work with educators and environmental education partners to educate the public about the need to sustain the health and productivity of ecosystems on public and private lands.
Education: Where possible, make public land resources available to all citizens for lifelong learning.
Community: Help strengthen communities by providing opportunities where possible for citizens to "experience" the outdoors and invest in their surroundings.
Partnerships: Work with environmental education partnerships to increase effectiveness and maximize use of resources.

Program: Federal Recreation Pass Program

Abstract: The Land and Water Conservation Fund Act (LWCFA), passed by Congress in 1965, and the Emergency Wetlands Resources Act (EWRA), passed by Congress in 1986, require Federal recreation fees in some National Parks, Forests, Wildlife Refuges, or Outdoor Recreation Areas.

Three types of fees may be charged

1. Entrance Fees

For entering designated federal recreation areas.

2. Use Fees

For using visitor services such as campgrounds, swimming areas, boat launches, parking, waterfowl blinds, cave tours, or specialized interpretive services in designated federal recreation areas.

3. Special Recreation Permit Fees

For specialized uses that require a permit, such as group activities,

Program: Interior Columbia Basin Ecosystem Management Project
Abstract: In July 1993, President Clinton directed the Forest Service to "develop a scientifically sound and ecosystem-based strategy for management of eastside forests." Responding to this direction, the project was initiated by the United States Department of Agriculture Forest Service and the United States Department of Interior Bureau of Land Management.

The Project received more than 83,000 public comments on two Draft EIS documents released in June 1997. The comment period on these documents lasted 335 days. In response to the public comments, new scientific information, agency review, and direction from the Secretaries of Agriculture and Interior, a Supplemental Draft EIS (SDEIS) was released in March 2000. Approximately 525 comments were received during the 90-day comment period. The project released a Final EIS and Proposed Decision in December 2000. The release of the Final EIS initiated a protest process that began on December 15, 2000 and ended January 16, 2001. Seventy-four protest letters were received.

In January 2003 the Regional Executives for the USDA Forest Service, Forest Service Research, USDI Bureau of Land Management, US Fish and Wildlife Service, the National Marine Fisheries Service and the Environmental Protection Agency signed a Memorandom of Understanding completing the Project. The agencies signing the MOU agree to cooperatively implement *The Interior Columbia Basin Strategy.*

Program: Integrated Weed Management Program
Abstract: The IWMP in the Spokane District involves site specific EA's on BLM land, including existing conditions and proposed treatment methods. The EA's are tiered to the BLM's programmatic EA for vegetation. The BLM inventories the species listed on the state's priority list. County weed boards. A complete programmatic EA for noxious weeds in the Spokane District is expected to begin within the next two years.

Program: Land Exchange Program

Abstract: In managing the 264 million acres of public lands under its jurisdiction, the Bureau of Land Management (BLM) provides for acquisition, use, disposal, and adjustment of land resources; determines the boundaries of Federal land; and, maintains historic records for these ownership transactions.

Acquisition, through exchange, purchase of land and easements, and donation is an important component of the BLM's land management strategy. The Bureau acquires land when it is in the public interest and consistent with publically-approved land use plans. The BLM's land acquisition program is designed to:

improve management of natural resources through consolidation of Federal, State and private lands;

secure key property necessary to protect endangered species, promote biological diversity, increase recreational opportunities, and preserve archaeological and historical resources; and,

implement specific acquisitions authorized by Acts of Congress by acquiring minimal non-Federal lands or interest in lands.

Exchange

The process of "trading" or "swapping" lands is referred to as exchange. Public lands may be exchanged by the BLM for lands owned by corporations, individuals, States or local governments. Exchanges are only pursued with willing landowners. The lands to be exchanged must be of equal monetary value and located within the same State. Through exchanges, non-Federal parties can acquire lands with development or economic potential - commercial, industrial, residential, or agricultural. In turn, the Federal Government acquires lands offering public recreation, wildlife, and resource values.

Purchase

The BLM is authorized to receive funding from Land and Water Conservation Fund (LWCF) appropriations to acquire lands. This allows the BLM to purchase lands needed to manage key natural resources or to acquire legal ownership to lands which enhance the management of existing public lands and resources. Funding is Congressionally limited to specific project areas. Major project areas include Wabayuma Peak Wilderness Area in Arizona, the Rogue National Wild and Scenic River in Oregon, and the Pacific Crest National Scenic Trail and King Range National Conservation Area in California.

Easements for Conservation, Access Roads, Trails, and Improvements

Easements allow the government to control certain rights on private property which usually involve access or development. The lands remain in private ownership with limited rights owned by the government.

Donation

Generally accepted as a gift to the United States if the lands are contiguous to and "block-up" existing public lands and the need for public ownership is identified in land use

plans.

There are currently land exchange projects underway in all subbasins in the province.

The Central Washington Assembled Land Exchange (CWALE) is a two phase project that began in 1997 that would exchange 5,930 acres of federal land for 9,665 acres of private land in an effort to consolidate scattered and isolated tracts of land. There are lands involved in all subbasins in the province. The Environmental Analysis is available at http://www.or.blm.gov/Spokane/planningdocs/CWALE/cwale_ea.pdf/

The Hallauer Exchange involves a trade of BLM land in Ferry County for a 400-500 acre inholding on Palmer Mountain, near Loomis, in the Okanogan subbasin.

There is also a small land exchange underway in the Wenatchee Subbasin a trade of 360 acres on federal land, for a 340 acre parcel on private property.

Program: Leave No Trace
Abstract: Leave No Trace is a National Educational Program designed to promote responsible use of Public Lands to recreationists participating in human-powered activities.
The National Outdoor Leadership School and Leave No Trace, Inc, a non-profit education program, unites four federal agencies- the Bureau of Land Management, National Park Service, U.S. Fish and Wildlife Service and the U.S. Forest Service- with manufacturers, outdoor retailers, user groups, educators, and individuals who share a commitment to maintaining and protecting our public lands for future enjoyment. Together with the federal government, private organizations play a crucial role in promoting LNT outdoor skills and ethics.

The leave No Trace message is more than a campaign for clean campsites. It's a program dedicated to building awareness, appreciation, and most of all, respect for our public recreation places. The LNT educational program is all about discovering, enjoying, and maintaining the great outdoors---for ourselves, our children and the unique communities of plants and animals that inhabit these lands.
LNT Masters in Oregon/Washington focus on working with youth and other outdoor groups to pave the way for better awareness among future visitors to public lands. Presentations are given to groups such as Cub Scouts, Boy Scouts, Girl Scouts, the Nature Conservancy, and the Oregon State Police Game Warden Division.

Program: Watchable Wildlife Initiative
Abstract: BLM, in cooperation with the Defenders of Wildlife, is enhancing wildlife viewing opportunities through the development of the Watchable Wildlife Initiative. Our first step is to provide detailed information to public land visitors to help them discover areas where different wildlife species are likely to be observed. Interpretive signs will be installed at many of the wildlife viewing sites to provide additional understanding and appreciation of wildlife in the Northwest. BLM maintains a website dedicated to the Watchable Wildlife Initiative.

There are two Watchable Wildlife locations in the Columbia Cascade Province: Palmer Lake in the Okanogan Basin, and Douglas Creek in the X Basin.

U.S. Bureau of Reclamation

Program: Federal Columbia River Power System BiOp Habitat Mitigation Program
Abstract: The Biological Opinion on operation of the Federal dams on the Columbia River directs the Reclamation to work in specific subbasins on fish passage, fish screens, and instream water. The Methow and Entiat subbasins are two of the first group of subbasins targeted by this program. A Reclamation liaison is present in each subbasin. Under this program, Reclamation will cooperate with existing watershed restoration efforts by working with landowners and local, regional, State, Tribal, and Federal entities to coordinate and assist with:
Instream fish passage problems on private and non-federal lands alon the mainstem and major tributaries to the Methow and Entiat Rivers
Fish screens, and
Aquisistions of instream flows to help salmon and steelhead, in accordance with Washington law.

Program: Research, Monitoring, and Evaluation Program
Abstract: The RM&E Program is mandated by the BiOp in RP183. The BiOp states that the Bureau will participate in a salmonid monitoring program that will cover the entire US portion of the Columbia River Basin. Funding is currently being secured for this program.

The Bureau will cooperate with local and regional agencies in this effort. The program will have be 3-tiered. Tier 1 will involve a GIS scale assessment. Tier 2 will be a mid-scale assessment, with an emphasis on compliance monitoring tied to the Endangered Species Act. Tier 3 will involve effectiveness monitoring of specific projects.

The Methow and Wenatchee watersheds have been selected for Tiers 2 and 3 in the first round of the program.

U.S. Geological Survey

Program: National Streamflow Information Program
Abstract: The USGS's National Streamgaging Network consists of a core of USGS funded and operated stream gages, stream gages operated by the USGS but funded in cooperation with other agencies, and stream gages funded and operated by other agencies that provide data appropriate to meet NSIP goals. The U.S. Geological Survey operates and maintains approximately 7,000 stream gages, which provide long-term, accurate, and unbiased information that meets the needs of many diverse users. Although the National

Stream gage Network is operated primarily by the USGS, it is funded by a partnership of 800 agencies at the Federal, State, Tribal, and local levels.

U.S. Forest Service

Program: PACFISH
Abstract: In 1994, the U.S. Department of Agriculture Forest Service (FS) and the U.S. Department of the Interior Bureau of Land Management (BLM) developed an ecosystem-based, aquatic habitat and riparian-area management strategy (commonly referred to as PACFISH) for Pacific salmon, steelhead, and sea-run cutthroat trout habitat on lands they administer. The strategy was developed in response to information documenting broad declines in naturally reproducing Pacific salmon, steelhead, and sea-run cutthroat trout, and widespread degradation of habitat upon which these anadromous fish depend. This environmental assessment analyzes a range of interim strategies for arresting the degradation and beginning the restoration of aquatic and riparian ecosystems during the next 18 months while a longer-term strategy is developed and evaluated.

Program: INFISH
Abstract: The Inland Native Fish Strategy environmental assessment is intended to provide interim direction to protect habitat and populations of resident native fish outside of anadromous fish habitat. Long-term management direction is being developed through two ecosystem-based environmental impact statements that are being developed for National Forest System lands, and lands administered by the Bureau of Land Management in the Interior and Upper Columbia River Basins.

Program: Pacific Northwest Fisheries Program
Abstract: Efforts under this program that affect aquatic resources in the Columbia Cascade Province include Environmental Education and Habitat Management. The environmental education programs include "FishWatch", National Fishing Week, Pacific Northwest Aquatic Training Program, "Fish On", and Respect the River.

Habitats of the Pacific Northwest National Forests Region are managed by an Aquatic Conservation Strategy, consisting of:

Riparian reserve network, with special management guidelines for activities;
Key Watersheds, a system of refugia for at-risk fish species;
Watershed Analysis to define needs for monitoring and restoration activities;
Watershed Restoration, comprehensive, long-term programs designed from the whole watershed perspective.

Program: Respect the River
Abstract: Respect the River is a multi-faceted restoration and education program designed to balance the need for preservation of riparian and flood prone areas with the needs of the public. It seeks to do this by accomplishing the following goals:

Identifying and addressing water quality issues that have developed from recreational use
Educating the public about habitat, habitat needs and on-going restoration projects
Creating a program and materials that are easily adaptable to other forests and agencies
Creating community partnerships

Respect the River originated in the Forest Service Pacific Northwest Region 6 on the Methow Valley Ranger District, Okanogan National Forest in 1993. In the Methow Valley Ranger District, dozens of degraded and "unofficial" or dispersed campsites were scattered near prime salmon spawning habitat in the headwaters of the Columbia River. Many had been used by generations of locals and visitors. Recognizing that closing well-loved areas would be both unpopular and unfortunate, the Forest Service searched for an alternative. The result was Respect the River, a program begun to improve fish habitat and protect endangered fish species while reducing the impacts of recreation in riparian areas.

Friendly to both fish and people, Respect the River works on two fronts: education and restoration. It uses contact rangers, newspaper and radio ads, brochures, and interpretive signs in combination with restoration treatments such as fence and boulder barriers, scarification, and revegetation. Only through education will recreationists understand the importance of protecting riparian and riverine habitats and take ownership in conserving and restoring those areas across the region. No new illegal roads, user trails, or dispersed campsites have developed in the Respect the River focus areas since the programs inception. The quality of camping has improved; sites are better defined, smaller and more vegetated. There is less trash and human waste. Soil and vegetation damage caused by illegal motorized vehicle use has been dramatically decreased. Bank erosion and illegal firewood cutting have decreased. Recreationists are parking their vehicles and RVs away from the stream banks and helping water revegetated sites. Most importantly, campsites have remained open and recreationists are receiving a consistent message.

The program has expanded to include the entire Okanogan-Wenatchee National Forest and Forests beyond the Columbia Cascade Province, as far away as New Mexico.

Program: Northwest Forest Plan

Abstract: The Northwest Forest Plan was approved on April 14, 1994 and provides for coordinated land management for lands administered by the USFS and Bureau of Land Management (BLM) within the range of the northern spotted owl. Over 88% of the Entiat sub-basin is under the jurisdiction of the Forest Service and subject to the Northwest Forest Plan. This region-wide management direction will provide overall coordination across administrative units, provinces, and watersheds in Forest Service and BLM lands, for the areas and resources covered by the final Supplemental Environmental Impact Assessment (SEIS) issued in February 1994. The Plan is divided into two main sections: aquatic and terrestrial. The aquatic conservation strategy is aimed at restoring and maintaining the ecological health of watersheds. The strategy is designed to provide a scientific basis for protecting aquatic ecosystems and to enable planning for sustainable

resource management. The goals of the terrestrial section of the plan are (1) to maintain late-successional and old growth species habitat and ecosystems on federal land and (2) to maintain biological diversity associated with native species and ecosystems in accordance with laws and regulations (Kaputa 2001).

State Government

Washington Department of Fish & Wildlife

Washington Landowner Incentive Grants
Approximately $1.5 million in landowner incentive grants will be distributed throughout Washington. Of that 100,000 has been set aside for grants up to $3,000 each for smaller enhancement and restoration projects. For major projects, qualifying property owners can typically receive up to $50,000 in program funds. All grants require a 25 percent non- federal contribution, which may be cash or in-kind. The program is managed by the Washington Department of Fish and Wildlife (WDFW) and grants must be received by 27 February 2004. Contact Ginna Correa at (360) 902-2478 or check the WDFW web site.

Eastern Washington Pheasant Habitat Enhancement Grant Program
Approximately $50,000 is available annually for private landowners, nonprofit corporations, cooperative groups, and federal and state agencies to implement pheasant enhancement projects. Grant requests may be up to $5,000 per year without providing matching sources. The deadline for applications is 31 December of each year and funds are available on 1 July of the following year. Contact the Washington Department of Fish and Wildlife at (509) 456-4082 (Region 1) or (509) 754-4624 (Region 2).

Fish and Wildlife and the Growth Management Act
The Growth Management Act (GMA) (RCW 36.70A) is intended to avoid the possibility of uncoordinated and unplanned growth inherent in anticipated population increases. It requires county and city governments to adopt locally-derived plans and regulations around a basic framework of natural resources issues defined by the state legislature.

One of the primary intents of the GMA is to prevent unwise use of natural resource and critical areas in accommodating urban growth. Each jurisdiction must classify and designate their resource lands and critical areas, and each must adopt development regulations for their critical areas. In addition, some jurisdictions must adopt planning policies and comprehensive plans that address many aspects of urban growth and development that are expected to occur in the county, including land use, housing, utilities, transportation, and others. Subsequent amendments to the GMA require that counties and cities include the best available science in developing policies and development regulations to protect the functions and values of critical areas. In addition, counties and cities must give special consideration to conservation or protection measures necessary to preserve or enhance anadromous fisheries.

The Washington Department of Fish and Wildlife (WDFW) has biologists in 5 of its 6 regions who provide technical assistance to local jurisdictions in complying with the requirements of the GMA regarding fish and wildlife resources. One of the primary goals of WDFW is to integrate its Priority Habitats and Species (PHS) program into the local jurisdictions' GMA planning activities.

Road Maintenance/Transportation

RCW 77.55.060 requires that "a dam or other obstruction across or in a stream shall be provided with a durable and efficient fishway approved by the director." Culverts and other stream crossing structures often create obstructions to upstream or downstream fish passage. Water diversions can result in significant mortality to juvenile fishes. WDFW has developed the Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual (contact Dave Caudill, Habitat Technical Applications Division, 360-902-2486), which includes protocols for assessing fish passage barrier status at culverts and other instream structures, and juvenile fish screening and bypass status at water diversions. WDFW conducts fish passage barrier assessments and provides protocol training to other agencies and grant groups interested in conducting fish passage barrier assessments. WDFW also maintains a statewide Fish Passage and Diversion Screening Inventory database (contact Brian Benson, Habitat Science Division, 360-902-2570) that includes information on barrier status of inventoried culverts and other stream crossing structures, as well as known diversion screening information.

The WDFW Habitat Program Technical Applications Division (TAPPS) also provides technical assistance to fish passage, screening, and habitat restoration project sponsors, to help them develop habitat-related projects. In addition, WDFW in cooperation with other state and federal agencies have developed Aquatic Habitat Guidelines technical guidance documents for certain types of habitat projects. The two guidance documents currently available include the Fish Passage Design at Road Culverts and Integrated Streambank Protection Guidelines (ISPG); soon to be available will be Salmon Habitat Restoration Guidelines (SHRG). Information on technical assistance opportunities and contacts are available on the WDFW website at http://wdfw.wa.gov/hab/tapps.index.htm

The Hydraulic Code and Hydraulic Code Rules

The Hydraulic Code (Chapter 77.55 RCW) and the associated Hydraulic Code Rules provide WDFW with a regulatory mechanism to protect fish life and their habitat from the impacts of most hydraulic projects. The Hydraulic Code requires that "in the event that any person or government agency desires to construct any form of hydraulic project or perform other work that will use, divert, obstruct, or change the natural flow or bed of any of the salt or fresh waters of the state, such person or government agency shall, before commencing construction or work thereon and to ensure the proper protection of fish life, secure the approval of the department as to the adequacy of the means proposed for the protection of fish life."

WDFW's authority extends only to the protection of fish life. Fish life is broadly defined

to be “all fish species, including but not limited to food fish, shellfish, game fish, and other nonclassified fish species and all stages of development of those species.” Furthermore, "protection of fish life" is defined to mean “prevention of loss or injury to fish or shellfish, and protection of the habitat that supports fish and shellfish populations.” Even though other animals such as amphibians, reptiles or birds may be impacted by hydraulic projects, the Hydraulic Code is specific to fish life and HPAs may not be conditioned to protect species other than fish. Measures to protect fish life imposed in HPAs often have multi-species benefits, though, because many species share the same habitat.

Hydraulic project proponents must apply to WDFW for authorization to conduct their projects. With the exception of emergency projects and pamphlet HPAs, which may be applied for verbally, applications must be submitted in writing. Processing time for complete applications is mandated by statute to be no greater than 15-days for expedited projects and 45-days for standard projects. Projects declared to be emergencies by county legislative authorities or by WDFW must be granted approval immediately upon request.

Procedures administering the Hydraulic Code, including mitigation requirements and appeal rights, are specified in Chapter 220-110 WAC. Site-specific requirements and mitigation for unavoidable impacts to fish life are written into the HPA by the local Area Habitat Biologist.

Resident Fish Management Program

WDFW manages extensive resident fish populations in the Crab Creek Subbasin. Most, but not all, of these provide recreational angling. Species intensively managed include salmonids (primarily rainbow trout, but also brown trout, kokanee, eastern brook trout, mackinaw, and tiger trout), whitefish, spiny rayed species (primarily largemouth and smallmouth bass, walleye, yellow perch, black crappie, bluegill, catfish, bullheads, and tiger musky). In the mid through lower portions of the Crab Creek subbasin, the advent of the Columbia Basin Reclamation Project and the resulting rise in groundwater level provided many lakes and streams with either surface or subterranean connections to the Crab Creek drainage. The vast majority of this newly formed surface water has never had anadromous fishes or native fishes. These waters provide an excellent opportunity to manage recreational fisheries with little or no impact to native fishes in general and listed species specifically. This portion of the subbasin has already been used for off-site substitute mitigation for lost recreational fisheries in the blocked area (NWPCC’s Moses Lake and Banks Lake projects). Besides providing for the maintenance, regulation, monitoring, and evaluation of these waters, several others of WDFW’s programs aid in the managing of these fisheries, including the hatcheries (trout and warm water), hydraulic approval, and rehabilitation programs.

WDFW Hatcheries Program

Washington Department of Fish and Wildlife operates four trout hatcheries and one warmwater fish hatchery that contribute the bulk of the fish stocked in the Crab Creek subbasin. A small number of trout are also obtained from a local (Grant County) private hatchery. Trout broodstock for all state hatcheries have been in-state for decades and

consist mostly of Spokane, Goldendale, and Mt Whitney rainbow, Lk Whatcom kokanee and brook, brown, and tiger trout from Ford. Warmwater broodstocks are either captured from in-state fisheries or obtained from out of state (tiger musky, walleye, crappie, and catfish). Almost all of these fish are stocked in lakes, some of which have surface connections directly to Crab Creek and others with only subterranean connections. The objective of all fish stocked from these facilities is to produce recreational angling. There are currently no supplemental stocking programs for trout, and supplemental stocking to enhance warmwater fisheries is on a relatively small scale.

Columbia Basin Hatchery (CBH), located about four miles north of Moses Lake (Grant County), produces the majority of the fish stocked in the Crab Creek subbasin. CBH currently produces about 1.5 million trout, mostly rainbow fingerlings (2-5 inches), 90,000 rainbow catchables (9-10 inches), and 50-100,000 brown, eastern brook, and tiger trout fingerlings annually. Almost all of these fish are stocked in the mid to lower portions of the Crab Creek subbasin (Grant and Adams counties). The resident fish management plan calls for stocking most of these trout as fingerlings to be grown in-situ to yearling size or older for recreational anging harvest. Where undesirable species or mixed species fisheries occur, trout are either stocked as catchables or fingerlings are placed in net pens for further rearing to catchable size before release. Typically, about 1 million fingerlings are stocke directly into lakes most of which have little of no direct connection to the creek.. Another 390-530,000 are reared in net pens in Moses Lake, Banks Lake, and Potholes Reservoir. Only about 15,000 are stocked directly into mid-Crab Creek, between Moses Lake and Stratford Lake.

Ford Hatchery, in Stevens County, produces roughly 1 million kokanee fingerlings which are stocked directly or reared in net pens in Banks Lake. The number of kokanee produced is variable based on availability and is often supplemented with kokanee reared at the nearby Spokane Tribal Hatchery. Omak Hatchery, in Okanogan County, collects Lahontan cutthroat eggs at Lake Lenore and rears fingerlings primarily for Lake Lenore (40-80,000) and a few smaller lakes (15-20,000). Meseberg Hatchery, a relatively new facility at Ringold Springs in Franklin County raises warmwater fishes (black crappie, channel catfish, walleye, bass, tiger musky), which are stocked into carefully selected waters in the Crab Creek subbasin. Lastly, a variable number of rainbow trout, ~ 30-80,000 fish depending on the size stocked, are obtained from Trout Lodge, a private hatchery in Grant County. Among these rainbow are some triploid primarily used in the quality trout fisheries.

Rehabilitation Program

WDFW maintains the expertise and infrastructure to chemically treat aquatic habitats to reduce undesirable populations of fish. The rehabilitation program has been extensively and successfully used to manage recreational fisheries since the 1950's and to a lesser extent several decades previously. Rehabilitation reduces predation and competition by undesirable species, providing the most economically feasible method of producing recreational angling. Without this tool, stocking fingerling fish would not provide much of a fishery in most waters, and the management of recreational trout fisheries especially, and even smaller warm water, mixed species fisheries would incur many times the cost.

Aquatic Education Program
WDFW has several projects related to environmental education, schools, hunter/angler education, and publications geared toward educating and involving the public in salmon issues. For example, Salmon in the Classroom is a project in which about 600 schools statewide participate. Students receive 500 eggs from a designated hatchery and care for "their" salmon while learning about life histories and habitat requirements. By becoming salmon stewards, these students are more aware of local waterways and more conscious of and knowledgeable about water quality issues. Students release the salmon as fry after studying the streams and creeks into which the fish will be released.

One publication, “SALMON SMART: A guide to Help People Help Salmon” explains how simple life choices people make can improve the situation for salmon. The document is fully downloadable from the WDFW website.

Aquatic Habitat Guidelines Program
In 1999, the governor's Salmon Recovery Office commissioned the Departments of Fish and Wildlife (WDFW), Ecology, and Transportation (WSDOT) to develop technical assistance guidance for those who want to protect and restore salmonid habitat. The scope of the program has recently broadened and now includes the promotion, protection, and restoration of fully functioning marine, freshwater, and riparian habitat through comprehensive and effective management of activities affecting Washington's aquatic and riparian ecosystems. Participation in the project has also expanded with the addition of the United States Army Corps of Engineers (USACE) and the United States Fish and Wildlife Service (USFWS) to the list of contributing agencies.

Hydraulic Approval Program
The HPA program is the vehicle through which WDFW regulates activities which affect the bed or flow of waters of the state for the protection of fish life. WDFW regulation of these activities has historically been controversial and the legislature has responded over the years with numerous changes in that authority. 6000 to 8000 permits are issued per year.

Lead Entity Program
The Lead Entity Program was created in the WDFW through the Salmon Recovery Act of 1998 (Chapter 77.85 RCW). Lead Entities are organizations that function to solicit, develop, prioritize, and submit habitat protection and restoration projects for funding to the Salmon Recovery Funding Board (SRFB). Lead Entity areas typically follow Water Resource Inventory Areas (WRIAs). They consist of a coordinator (usually a county, conservation district, or tribal staff), a committee of local technical personnel, and a committee of local citizens. The local technical experts assist in development of salmon recovery strategies, and identification and prioritization of projects. The local citizen committee is responsible for developing the final prioritized project list and submitting it to the SRFB for funding consideration.

Lead Entities receive assistance from WDFW's Watershed Stewardship Team in their local areas and from WDFW's Lead Entity Program staff and Interagency Committee

(IAC) project managers in Olympia. Currently, there are 26 Lead Entities operating across the state. They are funded by the Legislature through WDFW/SRFB. Funding is provided to support the infrastructure and capacity needs of Lead Entities to help them make effective habitat decisions for salmon recovery.

Nature Mapping
Nature Mapping is a joint outreach program (developed by the Washington Department of Fish and Wildlife and the University of Washington Gap Analysis Project) to promote biodiversity studies through citizens and school-based data collection and research. The objective is to empower citizens to plan and manage resources for a community within a watershed. It was created to enlist citizens to help WDFW's mission to preserve and protect fish and wildlife in Washington. The expected outcome of NatureMapping is to involve the public in the mission of the Washington Department of Fish and Wildlife, as a means to educate and develop stewardship for fish and wildlife.

It creates a user-friendly way for fish, wildlife, stream and habitat data gathered by NatureMappers to be digitally entered into a public data layer established by the UW Gap Analysis Project. Future product development will allow participants to receive feedback on their and others' data. Data go into the state biological survey, and may be used for local watershed planning.

Priority Habitats and Species Program
The Priority Habitats and Species program (PHS) provides comprehensive information on important fish, wildlife, and habitat resources in Washington. Initiated in 1989, the PHS Program was identified as the agency's highest priority. Today, the PHS Program serves as the backbone of WDFW's proactive approach to the conservation of fish and wildlife.

PHS is the principal means by which WDFW provides important fish, wildlife, and habitat information to local governments, state and federal agencies, private landowners and consultants, and tribal biologists for land use planning purposes. PHS is the agency's primary means of transferring fish and wildlife information from our resource experts to those who can protect habitat.

PHS provides the information necessary to incorporate the needs of fish and wildlife in land use planning by identifying habitats and species determined to be priorities based on defensible criteria; mapping the known locations of priority habitats and species using GIS technology; providing information on the conditions required to maintain healthy populations of priority species and viable, functioning priority habitats using best available science; providing consultation and guidance on land use issues affecting priority habitats and species; distributing this information and making it easily accessible.

Salmonid Stock Inventory (SaSI)
SaSI is a standardized, uniform approach to identifying and monitoring the status of Washington's salmonid fish stocks. It is a compilation of data on all wild stocks and a scientific determination of each stock's status as: *healthy, depressed, critical, unknown,*

or extinct. SaSI thus is a basis for prioritizing recovery efforts and for measuring the results of future recovery actions. SaSI is a cooperative product of the Washington Department of Fish and Wildlife and the tribal co-managers. SaSI development began in 1992, as an effort by 20 western Washington tribes and the Washington Department of Fish and Wildlife's predecessor agencies, the Washington Department of Fisheries and the Washington Department of Wildlife. The updated, 24K Salmonid Stock Status Inventory is nearly complete in WRIAs 44 - 49, and will be completed in its entirety by Fall, 2003.

SSHIAP

The Salmon and Steelhead Habitat Inventory and Assessment Program (SSHIAP) is a partnership-based information system that characterizes freshwater and estuary habitat conditions and distribution of salmonid stocks in Washington at the 1:24,000 scale. The SSHIAP system delineates streams into segments based on physical characteristics and habitat types. These segments provide a consistent spatial data framework for integrating a wide variety of habitat information and for subsequent analyses. The SSHIAP system quantitatively characterizes habitat conditions, incorporates Salmonid Stock Inventory (SaSI) stock distribution and status, and links habitat conditions and stock distribution with productivity modeling efforts. Begun in 1995, the western Washington Treaty Indian Tribes and the Washington Department of Fish and Wildlife (WDFW) are the co-managers on the project. SSHIAP currently covers Water Resource Inventory Areas (WRIA's) 1-23; work is underway to extend SSHIAP coverage to WRIA's 24-62. WDFW will have fish distribution, barriers to fish passage, and stream characteristics for individual stream segments (gradient, elevation, waterbody type) available by the end of June for the Columbia Cascade.

Watershed Recovery Inventory Project

The Watershed Recovery Inventory Project was created to develop a comprehensive inventory of watershed restoration projects and watershed information needed to respond effectively to the challenges and opportunities presented by the potential salmonid listings under the Endangered Species Act (ESA). Information on the several parameters that affect salmonid productivity was collected for each Watershed Resource Inventory Area of the state. Information provided by the WRIP included water quality issues, current (at the time) and recommended supplementation activities, and a database directory of information that would be of value in salmonid recovery planning and project identification.

Water Resource Inventory Areas were ranked according to priority for salmonid restoration project implementation in order to reverse the trend of declining salmon, steelhead, bull trout, and cutthroat populations.

Wildlife Research

The Wildlife Research Division's primary responsibility is to conduct scientific investigations of priority wildlife species and habitats in Washington. In addition we provide expertise, technical information and quantitative analysis to other programs both inside and outside the Agency. The Division produces progress and final reports,

publications in peer reviewed literature, presents seminars and workshop of significant results, and writes management recommendations for species studied.

Statewide Fish Screening, Yakima Screen Shop
Fish screening projects provide tangible and significant improvements to juvenile fish survival (compared to obsolete screen technology), with both immediate and long-term beneficial impacts. New fish screens comply with current state and federal biological protection criteria to reduce direct mortality and indirect mortality (caused by stress and injury) to both anadromous and resident salmonids, including ESA-listed spring Chinook and steelhead (Endangered), and bull trout (Threatened) in Entiat River basin. In addition, screening projects complement and enhance other investments in upstream passage, habitat restoration, and hatchery supplementation of wild stocks by reducing injury and mortality of fish associated with legal gravity and pump diversions (Egbers 2001).

Washington Department of Ecology

Watershed Planning

In 1998, the Washington State legislature approved ESHB 2514 to create RCW 90.82. This RCW enables local stakeholders within their watersheds to develop management strategies related to water quantity (required by the bill), water quality (optional), instream flow (optional), and habitat (optional).

There is no RCW 90.82 watershed management plan at this time.

Program: HB2514 Watershed Planning WRIA 43.
Abstract: A number of technical assessments are being conducted for Water Resource Inventory Area (WRIA) 43, which comprises the Upper Crab Creek-Wilson Creek basin. The assessments (water quantity, instream flow, water quality, and habitat) are part of Phase II activities, defined under the State's Watershed Planning program (Chapter 90.82 RCW). Lincoln County is the Lead Agency overseeing completion of the assessments on behalf of the WRIA 43 Watershed Planning Unit (PU). Based on the results and findings of these assessments, the PU will make management decisions regarding the use of WRIA's water resources. These decisions will be included in a management plan to be developed as part of the Phase III Watershed Planning program.

The long-term goals of the WRIA stakeholders are to prevent intrusion of unnecessary regulations into local decisions regarding WRIA water resources and to protect WRIA water as a sustainable resource. To accomplish these long-term goals, based on an understanding of PU member intents, the following specific goals are proposed for the watershed planning effort:

1. Balance in-stream and out-of-stream uses of water with water supply availability.

2. Protect the water resources against over-draft and over-allocation.

3. Protect the quality of water resources.

4. Conserve water resources.

5. These specific goals are intended to guide the development of the watershed plan. The framework involves the recognition of, and a roadmap for, specific management steps.

To achieve the above specific goals, the following objectives are proposed:

- Availability and quality of water resources
- Water recharge and discharge relationships
- Existing water rights
- Water use and projected demand.
- Develop strategies to increase availability of water supplies, where needed.
- Identify water quality impairments, evaluate causes, and define approaches to improve quality, where needed. (Draft Memorandum, from Said Amali (Kennedy/Jenks) to David Lundgren (LCCD), August 6, 2003 http://kjweb1.kennedyjenks.com/projectwebsitev2/projframe.asp).

Program: Columbia River Regional Initiative (CRI) – Water Resource Program
Abstract: The purpose of the Columbia River (Regional) Initiative (CRI) is to develop an integrated state program for managing Columbia River water resources - to allow access to new water withdrawals while providing support for salmon recovery.

The CRI will result in a rule that defines how the Department of Ecology will carry out its dual obligations to allocate water and preserve a healthy environment.

The Columbia River Initiative's objectives are to develop a workable and sustainable state water-management program for the Columbia River that allows the basin's economy to grow, diversify and be sustained, reflects scientifically sound information, and meets the needs of a growing population and a healthy economy while also meeting the needs of fish and healthy watersheds.

Program: Environmental Assessment Program
Abstract: The Program Mission is to provide objective, reliable information about environmental conditions that can be used to measure the effectiveness of the program, inform the public, and help focus the use of limited resources. The program is responsible for monitoring and reporting environmental status, trends, and results to ensure that agency staff, citizens, governments, tribes, and businesses have access to high quality environmental information. Most of the Environmental Assessment Program monitoring and investigation efforts focus on threats to water or sediment quality, while many of its directed studies are conducted in support of clients in other agency programs.

Program: Shoreline and Environmental Assistance Program (SEA) – Flood Control Assistance Account Program (FCAAP)
Abstract: The mission of this program is to work in partnership with communities to

support healthy watersheds and promote statewide environmental interests. Includes Conservation Corps, Office of Regulatory Assistance, Padilla Bay National Estuarine Research Reserve, SEPA, Watersheds, and Wetlands.

Program: Water Quality Program

Abstract: The mission of the Washington State Department of Ecology's Water Quality Program is " To Protect and Restore Washington's Waters." The Water Quality Program focus is on a geographic basin management approach that includes regulation, prevention, and enforcement. The program continues to focus efforts on increasing technical assistance, public involvement, and education to help the public, governments, businesses, and industries to understand and comply with environmental laws and regulations.

The watershed approach to water quality management geographically targets water quality assessments, watershed permitting, and nonpoint source programs. The approach establishes 23 water quality management areas (basins) within the state, synchronizes water quality assessments and wastewater permitting, and schedules permitting and enforcement activities within management areas according to a five year rotating cycle. In July 1993 the Water Quality Program initiated the approach.

Since beginning the watershed approach, the program has also maintained its baseline program of permitting, monitoring, inspections, and enforcement actions statewide. The program is focused on addressing the most significant and critical environmental problems, responding to permit applications from new wastewater treatment plant facilities, and responding to other mandated obligations.

The objectives of the Water Quality Program are:

- To protect, preserve, and enhance the quality of the state surface and ground water, ensuring the wise environmentally sound use of the state's water resources;
- Prevent generation of pollutants; and
- Achieve a water quality stewardship ethic and an educated public.

Program Activities:

Wastewater discharge permits: Ecology is responsible for issuing wastewater discharge permits under the State Water Pollution Control Act (Chapter 90.48).

Nonpoint sources of pollution: The program also focuses on nonpoint sources of pollution. Ecology nonpoint water pollution prevention work is largely voluntary focusing on agriculture, urban runoff, and general water quality complaints.

Water quality standards: The program is responsible for developing surface and ground water quality standards.

Financial and technical assistance: The program is also responsible for working with local communities and public agencies to improve the water quality of Washington by providing financial and technical assistance.

Water Quality Management Areas

The State of Washington has been divided into 23 water quality management areas (WQMAs). Ecology has four regional offices located throughout the state. Each region has approximately five WQMAs within its boundaries, with the exception of Eastern Regional Office which has eight (for a total of 23). The WQMAs have been named and an identified staff "lead" has been assigned to coordinate watershed processes and activities within the area.

Other water quality technicians and research staff are also targeted to these 23 WQMAs across the state. Point source permits for municipal and industrial facilities are scheduled, within individual watersheds, to be issued during the same year to ensure equity, consistency, and predictability (see schedule below). Nonpoint source pollution controls, along with technical and financial assistance programs, are being integrated to complete the comprehensive system.

Five Step - Five Year Cycle

Each year, approximately four or five WQMAs are scheduled into a cycle. Within each cycle, there are five steps with each step consuming one year. The steps are: Scoping, Data Collection/Analysis, Technical Report Development, and Implementation.

Approximately five WQMAs are scheduled each year to enter the process. The schedule below shows the WQMA names in the left-hand column organized into year groups. These groups are moved through the five step, five year process outlined above. In this way, the entire state will be covered within a period of five years. It is important to note that statewide coverage is ensured by scheduling WQMAs rather than prioritizing them. Scheduling avoids the priority trap, that is, placing all assets into one area only to find too much work leading to excluding other areas for treatment.

Activities Schedule for Watersheds Under 5-year Cycle										
Water Quality Management Areas	State Fiscal Year (July 1 through June 30)									
	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11
Skagit/Stillaguamish, Columbia Gorge, Horseheaven/Klickitat,	R	I	S	D	A	R	I	S	D	A

Upper Columbia, Pend Oreille										
Island/Snohomish, South Puget Sound, Okanogan, Crab Creek, Esquatzel	A	R	I	S	D	A	R	I	S	D
Nooksack/San Juan, Western Olympic, Wenatchee, Upper Snake, Lower Snake	D	A	R	I	S	D	A	R	I	S
Kitsap, Lower Columbia, Upper Yakima, Mid Columbia	S	D	A	R	I	S	D	A	R	I
Cedar/Green, Eastern Olympic, Lower Yakima, Spokane	I	S	D	A	R	I	S	D	A	R

I = Permits Issued; Other Actions Started

S = Scoping

D = Data Collection

A = Data Analysis

R = Technical Report

Program: Water Resource Program

Abstract: This program encompasses many smaller programs. Summaries for these are below.

Major Program Activities:

1. Administer Water Rights

The agency is responsible for making decisions on applications for new water rights and changes and transfers to existing water rights. The 2001 legislature adopted HB 1832, which allows the agency to provide priority to processing water right changes and provided a budget increase that more than doubled the number of staff dedicated to processing water rights.

2. Local Watershed Management

The Water Resources Program works with local watershed planning groups, other programs within the agency, other state agencies, and tribes to address water issues under

the Watershed Management Act. Activities include:

Providing technical support to local watershed planning groups to develop new or amended stream flows.

Providing basic watershed planning support services, including hydrology, water law, water right processing, and data.

3. Restoring and Maintaining Stream flows – INSTREAM FLOWS

The agency has responsibility for restoring and maintaining stream flows. The passage of HB 1832, along with additional funding, allows the program to improve its capacity in this area. Activities include:

Conducting technical studies and adopting stream flow rules in fish critical basins not engaged in watershed planning.

Acquiring water to maintain and restore stream flows in fish critical basins through donations, leases, and purchases of trust water rights.

4. Water Rights Compliance

The agency has responsibility to ensure compliance with water rights. Activities include:

Metering 80 percent of water use (by volume) in fish-critical basins – the agency's top compliance priority, per court order.

Strategically enforcing in egregious cases, for ESA needs, and high water use sectors.

5. Conservation and Re-use of Agricultural and Municipal Water Supplies – WATER AQUISTION

The agency supports conserving and re-using water supplies, including:

Promoting water right transfers and changes to make better use of existing water supplies and reducing pressure on new sources.

Providing project specific technical assistance.

6. Adjudication

The agency is responsible for initiating and supporting the adjudication of water rights. Adjudication is a judicial determination of existing water rights and water right claims, including federal, tribal, and non-tribal claims, to determine their validity and scope. Activities include:

Supporting the Yakima River Basin adjudication. At the current level of effort, it is anticipated that the adjudication will be 90 percent complete in the year 2003.

Present information regarding adjudication to watershed planning groups.

7. Well Construction Regulation

The agency carries out its well drilling responsibilities by:

Licensing and regulating well drillers, investigating complaints, approving variances, and providing continuing education to well drillers.

Administering the program in partnership with delegated counties and providing

technical assistance to homeowners, well drillers, tribes, and local governments.

8. Dam Safety

The agency staff oversees the safety of the state's dams by:

Inspecting more than 300 existing dams situated above populated areas, focusing primarily on structural integrity and flood and earthquake safety.

Conducting engineering reviews, approvals, and inspections of new construction and repair of existing dams and taking regulatory, enforcement, or emergency actions.

9. Drought Response

The agency provides services to mitigate the effects of droughts and to prepare for future drought by:

Providing information, financial assistance, and coordinating drought response efforts.

Providing water via emergency transfers, changes, and temporary wells.

10. Support Activities

Two functions provide the support necessary to carry out the major Water Resources Program activities:

Data management, communication and outreach services. This includes the development of a new water rights data system.

Policy and planning support, including consultation, analysis, and implementation tools (manuals, procedures and rules).

Program: Columbia River Instream Resource Protection Program – Water Resource Program

Abstract: The purpose of the Columbia River Instream Resource Protection Program is to establish the state's policies "for insuring the future viability of instream resource values of the main stem of the Columbia River . . ., including fish, wildlife, recreation, aesthetics, navigation, and hydropower resource values" (WAC 173-531-060). Ecology is undertaking this project with full knowledge of the limitations of the State of Washington. It realizes that management of the Columbia River involves other states, many federal agencies, and Canada. This program addresses the main stem of the Columbia River.

Program: Trust Water Rights Program – Water Resources Program

Abstract: In 1991 the Washington state legislature instructed Ecology to develop a state trust water rights program in response to "the need to develop and test means to facilitate the

voluntary transfer of water and water rights, including conserved water, to provide water

for presently unmet and emerging needs".

The trust water rights program codified at Chapter 90.42 RCW applies to ten water resource inventory areas (WRIAs) of the state. Two areas have been designated for implementation: the two regional pilot planning areas, the Methow and Dungeness-Quilcene basins. (Also see abstract below.)

Up to eight additional areas containing critical water supply problems, four on each side of the Cascade Mountains, may be identified for program implementation. The trust water rights concept will be tested and more information gathered for refinement of the guidelines and the legislation. An earlier trust rights statute, Chapter 90.38 RCW, applies only to the Yakima basin and is not directly administered through these trust water rights guidelines.

Program: Water Aquisition Program - Water Resources Program

Abstract: The state has launched the Washington Water Acquisition Program, a voluntary program to increase stream flows in 16 watersheds with vulnerable salmon and trout populations. The program is backed by strong interest and support from local, state, federal and tribal governments and private entities. State agencies involved include the departments of Ecology, Fish and Wildlife and Washington Conservation Commission.

Using state and federal funds, program sponsors are providing an opportunity for farmers, ranchers and other water-right holders to participate in salmon recovery by selling, leasing or donating their water where critically low stream flows limit fish survival.

All water obtained through the program will be returned to the creeks, streams and rivers where it was originally withdrawn. Program sponsors have developed criteria and guidance to help ensure water-right acquisitions receive fair market value and are targeted in areas that will most benefit fish.

Efforts will be concentrated in 16 basins across the state (where low flows are a known limiting factor to salmon populations.) These basins have been identified by the governor’s statewide salmon recovery strategy. In Eastern Washington, the basins are: Lower Yakima, Methow, Middle Snake, Naches, Okanogan, Upper Yakima, Walla Walla and Wenatchee. In Western Washington, the basins are: Cedar-Sammamish, Chambers-Clover, Elwha-Dungeness, Green-Duwamish, Nooksack, Puyallup-White, Quilcene-Snow and Snohomish. Acquisitions within the 16 basins will be targeted to small tributaries with good fish habitat located in areas where there is willingness and interest from water right holders and the local community.

Participants in the state Water Irrigation Efficiencies Program:

May voluntarily place all or part of water saved into trust to enhance stream flows.

Grants awarded are based on demonstrated need and environmental benefit, and are administered by local conservation districts.

Proportion of saved water placed in the trust water rights program must be at least equal to the percentage of public investment in the conservation measure or irrigation efficiency.

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The Water Trust works with the State's Trust Water Rights Program (in the Methow) using Ecology & BPA funding to purchase or lease water for instream use. Water Trust Contact: Lisa Pelly (206) 675-1585.

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Washington State Parks and Recreation Commission

Program: State Parks

Abstract: The Washington State Parks and Recreation Commission manages a diverse system of 120 parks and a variety of recreation programs, including boating, cross-country skiing and snowmobiling. A board of commissioners who guide and direct the agency governs State Parks. State Parks has a current biennial (two-year) budget of $90 million and employs approximately 500 full-time employees. The agency is headquartered in Olympia, Wash., and operates regional offices in Wenatchee (Eastern region), Burlington (Northwest region), Auburn (Puget Sound region) and Olympia (Southwest region).

The Washington State Parks and Recreation Commission acquires, operates, enhances and protects a diverse system of recreational, cultural, historical and natural sites. The Commission fosters outdoor recreation and education statewide to provide enjoyment and enrichment for all, and a valued legacy to future generations. They also protect and preserve important habitat.

Washington State Department of Transportation

WSDOT is engaged in a number of wetland and fish & wildlife activities in the Columbia Plateau Province. Most of this work relates to either maintanence of existing projects (e.g. bridge repair) or the "delivery" of new projects (e.g., road widening, safety improvements). In the process of planning these projects, WSDOT has both wetland and fish & wildlife biologists that conduct site inventories and characterizations, wetland delineations, surveys, etc. in order to avoid, minimize the effects of project and, when appropriate, to develop mitigation plans. WSDOT have environmental staff operating in both its regions and out of its Headquarters to address environmental issues. There are environmental staff in the North Central (Wenatchee), South-Central (Yakima) and Eastern (Spokane) Regions. In addition, environmental staff are located at the WSDOT Headquarters (Olympia). The environmental staff in the regions typically operate out of an "environmental section." At WSDOT Headquarters, the Environmental Services Office has a Biology Program consisting of Wetland, Alternative Mitigation, and Fish & Wildlife Teams. Each of the Teams provide technical support on Regional Projects. In addition, the Environmental Services Office in headquarters has a Watershed Program which gets involved in more long-range project planning.

Washington State Conservation Commission

Program: Agriculture, Fish and Water (AFW)
Abstract: This collaborative process called Agriculture, Fish and Water (AFW) is aimed at voluntary compliance. The AFW process involves negotiating changes to the existing Field Office Technical Guide (FOTG) and the development of guidelines for Irrigation Districts to be used to enhance, restore, and protect habitat for endangered fish and wildlife species, and address state water quality needs. This two-pronged approach has developed into two processes; one involving agricultural interests and the second one concerns Irrigation Districts across the state. The negotiated agreement must assure the long-term economic viability of agriculture in Washington State.

Program: Conservation Reserve Enhancement Program (CREP)
Abstract: The Conservation Reserve Enhancement Program (CREP) is a joint partnership between the State of Washington and USDA, administered by the Washington State Conservation Commission and the Farm Services Agency (FSA). The agreement was signed in 1998 and provides incentives to restore and improve salmon and steelhead habitat on private land.

The program is voluntary for landowners; the land enrolled in CREP is removed from production and grazing under 10 or 15 year contracts. In return, landowners plant trees and shrubs to stabilize the stream bank and to provide a number of additional ecological functions. Landowners receive annual rent, incentive and maintenance payments and cost share for practice installations. These payments made by FSA and the Conservation Commission, can result in no cost to the landowner for participation.

Program: Salmon Habitat Limiting Factors
Abstract: In 1998, the Washington State Conservation Commission was tasked in House Bill 2496 with assessing the habitat-based factors limiting the success of salmonids in Washington State. The Commission's role is now encoded in the Revised Code of Washington Chapter 77.85.070. Habitat limiting factors are assessed for individual watershed resource inventory areas.

Washington State Department of Natural Resources

Program: Aquatic Lands Enhancement Account (ALEA)
Abstract: Washington Department of Natural Resources (DNR) Aquatic Lands Enhancement Account (ALEA) Grant Program invests in projects that enhance and protect wildlife and fish habitat and provide places for people to enjoy Washington’s salt and fresh water shorelands and tidelands.
Projects under this program include:

- Restoring important freshwater and marine habitat for fish and birds.
- Developing low-impact shoreline access projects such as trails, viewing platforms, and non-motorized boat launches.

- Buying waterfront properties to create public access and protect shorelines and habitat.
- Creating interpretive sites and displays focusing on aquatic resource education.

Program: Washington Natural Heritage Program
Abstract: The WNHP collects data about existing native ecosystems and species to provide an objective, scientific basis from which to determine protection needs. The program also develops and recommends strategies for protection of the native ecosystems and species most threatened in Washington. Landowners, state and federal government agencies, consulting firms, planning departments, and conservation groups use this information to support the state's environmental and economic health.

Program: Washington State Natural Areas Program
Abstract: Two types of areas are managed by the Department of Natural Resources: Natural Area Preserves, and Natural Resource Conservation Areas. Natural Area Preserves protect the best remaining examples of many ecological communities including rare plant and animal habitat. Conservation areas protect outstanding examples of native ecosystems, habitat for endangered, threatened and sensitive plants and animals, and scenic landscapes. Environmental education and low impact public use are appropriate on conservation areas where they do not impair the resource values of the area protected. There is one Natural Area Preserve in the Entiat Subbasin, three in the Columbia Upper Middle Mainstem Subbasin, and one in the Wenatchee Subbasin. There are four Natural Area Preserves and one Natural Resource Conservation Area in the Okanogan subbasin.

(WRIAs). Northwest Indian Fisheries Commission (NWIFC),Washington Department of Fish and Wildlife and local conservation districts all play key roles in the development of limiting factors analyses. Limiting factors are defined as conditions that limit the ability of habitat to fully sustain populations of salmon. These factors are primarily associated with fish passage barriers, degraded estuarine areas, riparian corridors, stream channels and wetlands.

Local Stakeholder

Local Government

Local public utility districts, conservation districts, water boards, noxious weed boards, county commissions, and city governments have an impact on resource planning within the Crab Creek Subbasin. Because the economy of this subbasin is largely driven by agriculture, there is a tremendous involvement by local governments in resource-related issues, particular those related to water.

Lincoln County is Lead Agency for the Upper Crab (WRIA 43) Watershed Planning Unit, which will address water supply, and consider water quality, fish and wildlife habitat, and instream flows. Lincoln County Conservation District facilitates the Planning Unit, which, after completing the Initiating Phase, will have four years to produce a

watershed assessment and develop a plan to address water supply and related issues.

Adams County Conservation District

The Adams County Conservation District recently (March 2000) submitted a final report to Department of Ecology for a three year Agriculture BMP Implementation plan that addresses specific conservation practices for that conservation district. They have previously completed a comprehensive Weber Coulee Watershed Plan, and followed with a Weber Coulee Implementation plan.

Douglas County HCP

The Foster Creek Conservation District in Douglas County is developing a countywide Habitat Conservation Plan (HCP). The District's mission in undertaking this project is to enhance the local quality of life in Douglas County by protecting and increasing wildlife species habitat while at the same time providing regulatory certainty and protection from incidental takings for local farmers, ranchers, and orchardists.

Grant County Public UtilityDistrict

Program: Fish and Wildlife Research

Abstract: The Grant County Public Utility District, a customer-owned utility, is committed to responsible management and operation of the utility's power production and energy delivery services including the stewardship of our natural resources in order to provide clean, affordable, and renewable hydropower energy. They collaborate with other agencies and Tribes to find new and better ways to protect the water, air and land on which all life depends. They track fish counts at the Priest Rapids facility and water quality at both Priest Rapids and Wanapum facilities.

Program: Education

Abstract: Grant County Public Utility District works to develop and provide educational materials for students. These include an interactive CD-ROM entitled "It's Hydrological" and a hands-on Science Curriculum for students entitled "The Nature of Water Power."

Program: Priest Rapids Project License Application (FERC NO. 2114)

Abstract: For nearly half a century, the Priest Rapids Project has provided Grant County citizens and millions of other homes and businesses in the Northwest with clean, renewable, reliable and affordable electricity. The Project is owned, operated and managed by the original developer, Public Utility District No. 2 of Grant County, Washington (Grant PUD) as authorized and regulated under the Federal Energy Regulatory Commission (FERC) license issued November 4,No. 1955 (FERC P -2114). Grant PUD is a consumer-owned electric utility operating as a municipal corporation of the state of Washington. Established in 1938 by a vote of the people, Grant PUD is governed by a five-member Board of Commissioners composed of local citizens, elected on a nonpartisan basis.

The relicensing process is designed to ensure that the Priest Rapids Project (Project) is

operated to serve the public interest from both an economic and an environmental perspective. Grant PUD believes the Final License Application for the Priest Rapids Project submitted to FERC in October 2003 presents a well supported plan for the future operations of the Project. It recognizes the important role the Project plays in maintaining the local and regional economy and a healthy environment.

Grant PUD is applying for a new 50-year license for the Project, the largest non-federal hydroelectric project of its kind in the country, with 1,755 megawatts of installed capacity. Electricity from the Project is sold on a non-profit retail basis to Grant PUD customers and wholesale to twelve utilities serving customers in Washington, Oregon, Idaho, Montana, Wyoming, California and Utah. The Project produced a total of 8.85 billion kilowatt hours of electricity in 2002, equivalent to the energy consumed in a year by a city the size of Seattle, Washington.

The Federal Energy Regulatory Commission has authority under the Federal Power Act to issue licenses for non-federal hydroelectric projects. The current 50-year license for the Priest Rapids Project expires on October 31, 2005. The Project includes two hydroelectric developments: Wanapum and Priest Rapids. Grant PUD seeks to relicense the Project and continue operating it for the benefit of its ratepayer-owners and millions of consumers throughout the Northwest.

This Final License Application developed pursuant to the relevant relicensing regulations (18 CFR §4.51), contains a detailed description of the Project, how it has operated historically, and how Grant PUD proposes to operate it in the future. Included are proposals for capital improvements and operational changes in all resource areas. These include land use, recreation, aesthetics, fisheries resources, wildlife, cultural resources, terrestrial resources and project operations. Described in the application are the environmental resources affected by the Project and the proposed additional protection, mitigation and enhancement programs for the next license term.

Included in the Grant PUD Final License Application are a comprehensive set of protection, mitigation, and enhancement measures that addresses the impacts on fish, wildlife and botanical resources of the Priest Rapids Project Area. These measures are focused on improving or enhancing existing conditions in the Project Area.

Proposed measures include the development of management plans and enhancements activities for the lower five miles of Crab Creek. Reasons for considering enhancements in Crab Creek include the following:
(1) Many of the lands in the lower five miles of Crab Creek were purchased with Grant PUD monies or purchased jointly with WDFW as mitigation for original inundation (Article 40 and supplemental agreements) and are included within the Priest Rapids Project Area;

(2) In 1986 WDFW approached Grant PUD with an enhancement plan/proposal for lower Crab Creek. At that time both parties agreed that issues in Crab Creek would be addressed in relicensing;

(3) Grant PUD received several issues related to Crab Creek during the Solution Group Process (USFWS and WDFW);

(4) Enhancements in the lower five miles of Crab Creek could benefit several resource areas (wildlife, water quality, resident fish, and recreation); and

(5) Developing a concept (for lower Crab Creek) supported by as many stakeholders and agencies as possible would illustrate support for Grant PUD's license application and PME proposal. This would allow Grant PUD to have some control in the decision

A number of fisheries enhancement strategies have been proposed for the lower five miles of Crab Creek including a fish barrier at the mouth to exclude anadromous fish.

Lincoln County Conservation District

Lincoln County Conservation District has completed four years of baseline water quality monitoring at 19 locations along Crab Creek and its tributaries. They have worked with local crop and livestock producers to reduce erosion and nonpoint pollution utilizing programs such as Conservation Reserve Program (CRP), Environmental Quality Incentive Program (EQUIP), Conservation Reserve Enhancement Program (CREP), Centennial Clean Water Funds, and EPA Section 319 nonpoint source funds. LCCD is also serving as facilitator for Watershed Planning in WRIA 43, Upper Crab Creek/Wilson Creek Watershed.

Program: CRP Tree Planting

Abstract: The Lincoln County Conservation District has served a vendor for conservation trees and shrubs adapted to the local area for CRP plantings for the last several years. Many farmers in the higher rainfall areas of northeastern Lincoln County who needed to plant trees and shrubs as part of their CRP (Conservation Reserve Program) contracts have purchased these plants and had them planted by the District. The District ordered and prepared the trees and shrubs for planting and then contracted with the Department of Natural Resources prison crew to plant these stems on CRP ground. In some years the District has planted as many as 100,000 or more stems on CRP ground. However, due to changes in the CRP program under the current farm bill, farmers are no longer being given any special points for planting trees and shrubs on new CRP ground and so the farmers are planting native grasses and forbs instead. The District's CRP tree planting program has been severely curtailed due to lack of interest.

Program: Annual Tree Sale

Abstract: The District has offered trees and shrubs for sale to local residents at the annual tree sale held every April for the past 15 to 20 years or more. Five different categories of trees and shrubs, including Conifers, Hedges & Conservation, Ornamental, Riparian/Wetland, and Shade have been offered for sale. The District typically orders between 8,000 and 10,000 trees and shrubs and sells them to about 100 to 150 customers each year.

Program: CRP Guzzlers
Abstract: The District has recently begun selling CRP guzzlers or "wildlife watering facilities" to farmers in Lincoln County and Spokane County who need one or more guzzlers for the recent CRP signup. The District has purchased a large order of 100 guzzlers and lids and is able to pass on the savings to the farmers. These large guzzlers meet NRCS specifications and hold 500 gallons of water. District staff will install about 1/3 of these guzzlers on CRP ground this summer.

Program: Riparian Restoration Projects
Abstract: The District worked on two riparian restoration projects in 2003 in fullfilment of part of the requirements for the Crab Creek's Contribution to Moses Lake TMDL grant from the Washington State Department of Ecology. Additional grant money to remove the vehicles from Downs Road was received from the Terry Husseman grant. The Downs Road project on Crab Creek involved the removal of abandoned vehicles from the creek bank and creek, rebuilding an existing fence farther back from the creek, applying erosion control fabric, and planting riparian trees and shrubs along the stream bank to help stabilize the stream bank. The Rocky Ford Road project on the South Fork of Crab Creek involved the fencing out of a spring, planting riparian trees and shrubs, the installation of two off-stream watering troughs, and the installation of an armored water gap across the creek as a back up source of water that will also reduce sedimentation to the creek.

Program: Conservation Commission Implementation Grant
Abstract: The District solicits local farmers for conservation project proposals with 50% cost share available up to $3,500 for each farmer. About 5 to 10 farmers in each grant funding cycle are selected to fund their conservation project. The implementation grant has funded diverse projects such as grassed waterways, spring developments and cross fencing.

Program: Water Quality Monitoring
Abstract: The District has received four grants from the Department of Ecology to conduct water quality monitoring in WRIA 43 (Upper Crab Creek/Wilson Creek Watershed) over the past eight years. Those grants include the Crab Creek I grant, the Lake Creek Watershed Water Reuse Feasibility Study, the Crab Creek II grant, and the current Crab Creek's Contribution to Moses Lake TMDL grant. The purpose of the grants was/is to collect baseline data on water quality in Crab Creek and its tributaries in WRIA 43, identify stream reaches with significant water quality impairment (if possible), and implement some riparian restoration projects.

Program: Watershed Planning
Abstract: The District has served as facilitator for HB 2514 Watershed Planning for WRIA 43 (Upper Crab Creek/Wilson Creek Watershed) since January 2001. The Planning Unit is now in Phase 2 Assessment and is currently addressing the Water Quantity, Instream Flow, Water Quality, and Habitat planning elements. The Planning Unit also recently applied for the Water Storage grant.

Program: 6th Grade Education Day
Abstract: The District has sponsored a 6th grade education day for the last 15 to 20 or more years. The District contacts local experts in their field to make brief 15 minute presentations to 9 to 12 separate groups of 6th grade students from around Lincoln County for a total of about 200 students each year. The local experts teach a diverse array of subjects to the kids, including wildlife, bird watching (Audubon Society), beekeeping, forestry, soils, water quality, outdoor survival, weeds, and other subjects.

Projects

NPCC Approved/BPA Funded Projects

A number of programs are available that provide project resources to address offsite mitigation for salmon entrainment in downstream dams, as well as programs to address endangered species recovery and clean water management. Habitat conservation plans prescribe mitigation for habitat and fish losses associated with development etc.

Project: Banks Lake Fishery Evaluation Project
Program: NPCC, CRFWP, BPA, WDFW Fish Program
Abstract:. The Banks Lake project (BPA Project #2001-028-00) was instigated by WDFW and is funded within the NWPCC's Columbia River Fish and Wildlife Program as mitigation for the loss of anadromous salmon and recreational angling above Chief Joseph and Grand Coulee Dams. Banks Lake once supported a popular and successful fishery for kokanee and various warmwater fish. These fisheries have declined in recent years, and the current limiting factors need to be determined. The limiting factors to be examined include water quality, habitat, food limitation, exploitation, predation, and entrainment. The project seeks to link environmental conditions to habitat use to understand the physical and chemical limitations of the system. Estimates of zooplankton biomass and production will be used to establish the potential of the forage base and carrying capacity for various planktivorous fishes. Predator prey interactions between piscivore and prey-fish will be quantified through diet analysis and bioenergetics modeling. The emigration and immigration of sportfish through the irrigation and hydroelectric facilities will be monitored to understand which species and size classes are likely gained and lost during hydro operations. Substrate type, habitat complexity, littoral productivity, and spawning success will be determined before and after the summer draw down period to assess impacts of the proposed change in hydro operations outlined in the 2000 NMFS Biological Opinion. The outcome will consist of management recommendations to WDFW and BPA regarding harvest, regulations, stocking numbers and timing. The goal of these actions will be to maintain a quality fishery for large predatory species (walleye, bass, and burbot) while simultaneously increasing panfish and salmonid harvest opportunities.

Project: Factors Affecting the Recreational Fishery in Moses Lake, Washington
Program: NPCC, CRFWP, BPA, WDFW Fish Program
Abstract: The Moses Lake project (BPA Project #1995-028-00) was instigated by WDFW and is funded within the NPCC's Columbia River Fish and Wildlife Program as

mitigation for the loss of anadromous salmon and recreational angling above Chief Joseph and Grand Coulee Dams. The Moses Lake project's goal is to restore the failed recreational fishery for panfish species (black crappie, bluegill and yellow perch) in Moses Lake. The Project consists of three phases. Phase 1 was the assessment of all currently available physical and biological information, the collection of baseline biological data, the formulation of testable hypotheses, and the development of a detailed study plan to test the hypotheses. Phase 2 was the implementation of the study plan including data collection, quantification, hypotheses testing, and the formulation of a management plan. Phase 3 of the project implements the management plan, and includes monitoring and evaluation of the recommendations. The Moses Lake project has completed Phase 1 and is currently in the last year of Phase 2 of the project. Limiting factors investigated included water quality, specifically temperature and dissolved oxygen, habitat availability, over-harvest, food limitations, recruitment, and predation. The fishs' environmental conditions will be linked to their habitat use to understand the physical and chemical limitations of the system. Estimates of zooplankton and macroinvertebrate biomass and production will be established to determine the potential of the forage base, carrying capacity and competitive interactions for various planktivorous and insectivorous fishes. Substrate type, habitat complexity, and littoral productivity will be determined, before and after the fall drawdown and spring fill up. Predator prey interactions between piscivores and prey-fish will be quantified through diet analysis and bioenergetics modeling. Bioenergetics modeling will be used to provide quantitative estimates of fish consumptive demand to compare to forage supply. Additionally, panfish harvest will be quantified to determine if over-harvest is limiting panfish production in Moses Lake. Identified limiting factors will be ranked to determine which had the greatest impacts on the fishery, and a management plan that best addresses the limiters to panfish production in Moses Lake will be developed. Finally, implementation of the management plan, monitoring and evaluation of the implemented recommendations will complete the project.

Swanson Lakes Wildlife Area (BPA Project # 199106100)

The 8,094 hectare (20,000 acre) Swanson Lakes Wildlife Area (SLWA) is located in Lincoln County, Washington approximately 21 kilometers (35 miles) southeast of Grand Coulee Dam (Figure 7). This wildlife area was established in 1992 primarily to support the recovery of sharp-tailed grouse and to partially mitigate for wildlife losses resulting from the construction of Grand Coulee and Chief Joseph Dams. More than 16,000 sharp-tailed grouse habitat units (HUs) were lost due to construction of Grand Coulee Dam and over 1,000 HUs were lost at Chief Joseph Dam (both totals reflect only state losses – not tribal losses). The SLWA is comprised of lands purchased and/or owned by WDFW (2,517 hectares/6,220 acres), Bonneville Power Administration (5,059 hectares/12,500 acres), and the Washington Department of Natural Resources (518 hectares/1,280 acres). In addition, the Bureau of Land Management (BLM) owns approximately 6,071 hectares (15,000 acres) that adjoins SLWA on the south.

Figure 12. Location of the Swanson Lakes Wildlife Area in Crab Creek Subbasin

Shrubsteppe is the dominant cover type on the SLWA (Table 6). WDFW manages the SLWA principally for shrubsteppe obligate wildlife species such as sharp-tailed grouse and sage grouse and to provide public recreational opportunities. Mule deer is also a high priority management species because of its high recreational value (Anderson and Ashley 1993). Sharp-tailed grouse, sage grouse, and mule deer are loss-assessment species associated with Grand Coulee and Chief Joseph Dams (Howerton 1986, Berger and Kuehn 1992).

Table 5. Habitat type and quantity on the Swanson Lakes Wildlife Area.

Habitat type	Acres
Shrubsteppe (including meadowsteppe and steppe)	14,676
Ephemeral pond	98
Lacustrine (includes semi-permanent water)	132
Wetland	83
Wet meadow	1,754
Riparian shrub	35
Ponderosa pine	1
Cliff/talus	485
Agriculture	275
Conservation Reserve Program (includes 'soil bank' fields)	2,396
Farmstead	65
Total	20,000

Swanson Lakes Wildlife Area management strategies address several critical landscape scale limiting factors, such as shrubsteppe habitat conversion, degradation, and fragmentation (Hays et al. 1998b, Schroeder et al. 2000a), as well as species-specific limiting factors. Management activities that have been implemented to address habitat conversion and degradation factors include seeding agricultural fields to native-like vegetation, removing livestock, protecting and maintaining existing habitat, and controlling introduced vegetation (Anderson and Ashley1993, WDFW 1998). These activities and strategies also address factors that limit local populations of sharp-tailed grouse and sage grouse such as quality and availability of nesting and wintering habitat (WDFW 1995a, b). The large project acreage and contiguous nature of the parcels that comprise the wildlife area reduces shrub-steppe habitat fragmentation within this portion of the subbasin.

Swanson Lakes Wildlife Area management goals, objectives, and strategies for sharp-tailed grouse (see section on Sagebrush Flat Wildlife Area for information on goals and objectives for sage grouse) support WDFW statewide goals and objectives for this species (WDFW 1995b). The sharp-tailed grouse population in Washington will be considered secure when statewide objectives have been met or exceeded for 10 consecutive years. Management goals and objectives for sharp-tailed grouse on the SLWA are listed below.

Goal 1: Establish and maintain a viable sharp-tailed grouse population at the Swanson Lakes Wildlife Area. This goal is consistent with the statewide goal to increase the population size and distribution of sharp-tailed grouse (WDFW 1995b). This goal is also consistent with the Crab Creek Subbasin goal to recover sharp-tailed grouse populations to viable levels within the subbasin.

Objective 1: Conduct research on sharp-tailed grouse on the SLWA through 2005 in conjunction with WDFW's statewide sharp-tailed grouse research program.

Strategy: Monitor population size, determine population viability, and evaluate population responses to habitat alteration.

Objective 2: Increase the number of sharp-tailed grouse from approximately 180 (estimated number currently occupying SLWA [M. Schroeder, pers. comm.) to 400 by 2010. This objective is consistent with the statewide objective to increase the breeding population of sharp-tailed grouse to more than 2,000 distributed throughout four management zones (SLWA is considered the 'core' property in WDFW's Sharp-tailed Grouse Management Zone 4, Figure 8). This objective also is consistent with the Crab Creek Subbasin objective to establish a population of at least 1,000 sharp-tailed grouse by 2010.

Goal 2: Protect, enhance, and maintain 20,000 acres of shrubsteppe habitat for sharp-tailed grouse and other shrubsteppe obligates. This goal is consistent with the statewide goal to protect, enhance, and increase shrubsteppe habitat (WDFW 2000b).

Objective 1: Implement management activities and schedules described in the SLWA Enhancement Plan (Anderson, J. Ashley, P. R. 1993). This objective is consistent with the statewide objective to protect at least 98,000 acres of high quality, relatively contiguous (<2 mile gaps) habitat that is currently occupied (WDFW 1995b). This objective also is consistent with the Crab Creek Subbasin objective to improve the quantity, quality, and configuration of shrubsteppe habitat necessary to support a viable population of sharp-tailed grouse by 2010.

Objective 2: Monitor wildlife and habitat response to protection, maintenance, and enhancement measures annually. This objective is consistent with the Crab Creek Subbasin objective to evaluate habitat restoration activities.

Figure 13. WDFW Sharp-Tailed Grouse Management Zones

Monitoring
(WDFW 1995b). Swanson Lakes Wildlife Area is located in zone 4. Sharp-tailed grouse leks (traditional display sites for concentrations of males) have been monitored on and near SLWA annually since the early 1970s. Sharptailed grouse movements have also been documented with the aid of radio telemetry. In addition, WDFW personnel and/or volunteers conduct neotropical bird surveys, sage grouse surveys, mule deer production counts, and hunter harvest surveys annually. Although less frequent, small mammal transects, winter raptor counts, and habitat data are also conducted on the SLWA.

This BPA funded mitigation project provides habitat for several threatened and endangered species and is an important link in WDFW's ongoing efforts to reverse downward population trends in shrubsteppe obligate wildlife species such as sharp-tailed grouse and sage grouse. Continued funding and support for the SLWA is crucial to addressing impacts caused by fragmentation, degradation and conversion of shrubsteppe habitat. (for more information see Appendix C).

Projects Funded Outside the NPCC Fish & Wildlife Program

Program: Wetland Restoration
Project: Marsh Unit 3 Restoration, Columbia National Wildlife Refuge.
Project Abstract: Columbia NWR has nearly completed the first planning phase of the Marsh Unit 3 restoration. During the 1950s shallow marsh impoundments in the floodplain were created for waterfowl using a dike system and diversions from Crab Creek. During 1980 the Crab Creek channel was severely incised due to flood evacuation flows from Potholes Reservoir. Maintenance issues have increased and wildlife management objectives have changed, and restoration of a functional riparian system, including large woody vegetation sustained by periodic flooding, is the goal. This habitat will provide shading for the creek and habitat for resident and migratory birds and other wildlife. Implementation of the restoration would return the channel closer to its original alignment, increase channel sinuosity and reduce channel depth while re-connecting the creek to the floodplain.

Table 6. Lincoln County Conservation District Projects

Project	Participating Agencies	Program	Cost	Start Date	End Date
Downs Road Riparian Restoration Project, Crab Creek	Lincoln County Conservation District, Department of Ecology, Department of Fish and Wildlife	Riparian Restoration Projects, Crab Creek's Contribution to Moses Lake TMDL grant, Terry Husseman grant	$30,000	4/1/03	10/31/2004
Rocky Ford Road Riparian Restoration Project, South Fork of Crab Creek	Lincoln County Conservation District, Department of Ecology, Department of Fish and Wildlife	Riparian Restoration Projects, Crab Creek's Contribution to Moses Lake TMDL grant	$20,000	4/1/03	10/31/2004
Facilitator for Watershed Planning, WRIA 43	Lincoln County Conservation District, Department of Ecology, Department of Fish and Wildlife, Lincoln County, WRIA 43 Planning Unit	Watershed Planning	$450,000	01/012001	6/30/2005
Water Quality Monitoring, Crab Creek and its Tributaries in WRIA 43	Lincoln County Conservation District, Department of Ecology	Water Quality Monitoring, Crab Creek's Contribution to Moses Lake TMDL grant	$200,000	8/1/2002	10/31/2004

Water Quality Monitoring, Lower Half of Crab Creek in WRIA 43	Lincoln County Conservation District, Department of Ecology	Water Quality Monitoring, Crab Creek II grant	$200,000	8/1/2000	7/31/2002
Water Quality Monitoring, Lake Creek Sub-Watershed	Lincoln County Conservation District, Department of Ecology	Water Quality Monitoring, Lake Creek Watershed Reuse Feasibility Study	$200,000	8/1/1998	7/31/1999
Water Quality Monitoring, Upper Half of Crab Creek in WRIA 43	Lincoln County Conservation District, Department of Ecology	Water Quality Monitoring, Crab Creek I grant	$200,000	9/1/1996	8/31/1997
WRP Project on Crab Creek at Canby Bridge Road, WRIA 43	Natural Resources Conservation Service, others	Wetland Reserve Program	unknown	unknown	unknown
WRP Project, Crab Creek at Crab Lake just east of Wilson Creek, WRIA 43	Natural Resources Conservation Service, others	Wetland Reserve Program	unknown	unknown	unknown

Organization: Lincoln County Conservation District
Project: Downs Road Riparian Restoration Project on Crab Creek
Program: Riparian Restoration Projects, Crab Creek's Contribution to Moses Lake TMDL grant and Terry Husseman grant
Project Abstract: The Downs Road project on Crab Creek involved the removal of abandoned vehicles from the creek bank and creek, rebuilding an existing fence farther back from the creek, applying erosion control

fabric, and planting riparian trees and shrubs along the stream bank to help stabilize the stream bank.

Organization: Lincoln County Conservation District
Project: Rocky Ford Road Riparian Restoration Project on the South Fork of Crab Creek
Program: Riparian Restoration Projects, Crab Creek's Contribution to Moses Lake TMDL grant
Project Abstract: The Rocky Ford Road project on the South Fork of Crab Creek Involved the fencing of a spring, planting riparian trees and shrubs, the installation of two off-stream watering troughs, and the installation of an armored water gap across the creek as a back up source of water that will also reduce sedimentation to the creek.

Organization: Lincoln County Conservation District
Project: Facilitator for Watershed Planning, WRIA 43
Program: Watershed Planning
Project Abstract: The District has served as facilitator for HB 2514 Watershed Planning for WRIA 43 (Upper Crab Creek/Wilson Creek Watershed) since January 2001. The Planning Unit is now in Phase 2 Assessment and is currently addressing the Water Quantity, Instream Flow, Water Quality, and Habitat planning elements. The Planning Unit also recently applied for the Water Storage grant.

Organization: Lincoln County Conservation District
Project: Water Quality Monitoring, Crab Creek's Contribution to Moses Lake TMDL grant
Program: Water Quality Monitoring
Project Abstract: The purpose of this grant is to collect water quality data along the entire length of Crab Creek and also selected tributaries in WRIA 43, identify stream reaches with significant water quality impairment (if possible), and implement some riparian restoration projects.

Organization: Lincoln County Conservation District
Project: Water Quality Monitoring, Crab Creek II grant
Program: Water Quality Monitoring
Project Abstract: The purpose of this grant was to collect baseline water quality on the lower half of Crab Creek and its tributaries in WRIA 43

Organization: Lincoln County Conservation District
Project: Water Quality Monitoring, Lake Creek Watershed Water Reuse Feasibility Study
Program: Water Quality Monitoring
Project Abstract: The purpose of this grant was to collect baseline water quality on the Lake Creek system and to assess the feasibility of taking treated

sewage water from the Spokane sewage treatment plant, piping it to the head of Lake Creek sub-watershed between Davenport and Creston, and introducing the water to Lake Creek to help rehydrate the Lake Creek system.

Organization: Lincoln County Conservation District
Project: Water Quality Monitoring, Crab Creek I grant
Program: Water Quality Monitoring
Project Abstract: The purpose of this grant was to collect baseline water quality on the upper half of Crab Creek and its tributaries in WRIA 43

Organization: Natural Resources Conservation Service
Project: WRP project on Crab Creek at Canby Bridge Road, WRIA 43
Program: Wetland Reserve Program
Project Abstract: Wetland Reserve Program project on Inland Northwest Land Trust along Crab Creek

Organization: Natural Resources Conservation Service
Project: WRP project, Crab Creek at Crab Lake just east of Wilson Creek, WRIA 43
Program: Wetland Reserve Program
Project Abstract: Wetland Reserve Program project on ground along Crab Creek that is typically flooded/ponded for long periods about every 5 out of 10 years or more.

Management Plan

Vision Statement

The Crab Creek subbasin will support healthy and diverse populations of fish and wildlife and their habitats while preserving the economies, customs, cultures, subsistence and recreational opportunities within the basin, while recognizing that the lower portion of the basin is largely dependent upon the water supplied by the Columbia Basin Irrigation Project. Decisions to improve and protect fish and wildlife populations, their habitats and ecological function are made using open and cooperative processes that respect different points of view and statutory responsibilities, and are made for the benefit of current and future generations.

Hypothesis statements were written for each of the six assessment units and measurable biological objectives identified for each statement. These are described below along with management strategies to achieve the stated objectives.

Fish Management

Assessment Unit 1 – Lower Crab Creek

Mainstem Crab Creek and Red Rock Coulee

Hypothesis Statement 1: Anadromous fish species in this Assessment Unit are genetically unique.

Objective 1. Fill Data Gap - Determine genetic origin of summer/fall Chinook.

Objective 2. Fill Data Gap – Determine genetic origin of steelhead.

Hypothesis Statement 2: Lack of spawning habitat does limit anadromous production in this mainstem Crab Creek and Red Rock Coulee.

Objective 1. Fill Data Gap – Where information does not exist, assess spawning habitat in mainstem Crab Creek and in Red Rock Coulee.

Hypothesis Statement 3: High summer water temperatures limit summer rearing for juvenile steelhead (but not for juvenile summer/fall Chinook) in mainstem and Red Rock Coulee rearing areas.

Objective 1. Fill Data Gap - Determine presence, distribution, and survival of juvenile salmonids in mainstem Crab Creek and Red Rock Coulee.

Hypothesis Statement 4: Current resident fisheries do not impact anadromous fish.
Objective 1. Adopt regulations preventing take, harvest, or harassment of listed anadromous salmonids.

Hypothesis Statement 5: Primary/secondary productivity (phytoplankton/zooplankton/macro-invertebrate) does limit juvenile salmonid rearing potential in anadromous zones.

Objective 1. Fill Data Gap - Determine primary/secondary phytoplankton/zooplankton/macro-invertebrate) productivity in anadromous zones.

Hypothesis Statement 6: Presence of ESA listed species within constructed irrigation facilities may impact irrigation practices.

Objective 1. Support the recovery of listed species while minimizing impacts to irrigation practices.

Objective 2. Set barriers in place to keep protected species out of irrigation project[6].

Hypothesis Statement 7: Enhancement of riparian condition will decrease instream temperature.

Objective 1. Enhance riparian condition.

Objective 2. Control non-native invasive vegetation species.

Management Strategy: Redd count data is collected annually for summer/fall Chinook and steelhead in Red Rock Coulee by the USFWS, USBOR, GCPUD and habitat information for a portion of this Assessment Unit has been collected by the USBR and USFWS. However, substantial data gaps regarding anadromous fish and habitat still exist. Steelhead in the Crab Creek Subbasin are considered to be part of the Upper Columbia ESU which are currently listed as Endangered under ESA, although the actual origin of this stock is unknown. Consideration has been given to blocking this area to anadromous fish passage as a potential management strategy to eliminate the possibility of detrimental impacts related to operation of the irrigation system. [0]Anadromous fish would be forced to spawn in more suitable and productive habitat. For example, a large spawning area (with suitable habitat) has been identified for fall Chinook downstream of Wanapum Dam. Steelhead would be forced to use more suitable, habitat in higher quality tributaries outside the Crab Creek Subbasin. However, this potential strategy appears to be based on a mis-intreptiation of RPA 37 under the FCRPS BiOp. Clarification was provided by NOAA Fisheries (Letter from Brian J. Brown (NOAA Fisheries) to William D. Gray (USBOR), March 9, 2004):

"Action 37 should not be interpreted by the Bureau as a requirement to erect fish passage

[6] As supported by Quincy Columbia Basin Irrigation District.

barriers in natural streams that receive return flows from the CBP, such as Crab Creek, without consideration of their habitat value to anadromous fish. The intent of this action was to prevent the further loss of listed salmonid species by being falsely attacted into CBP wasteways where they would be unable to successfully reproduce or rear. The extenent of steelhead and fall Chinook salmon spawing in Crab Creek suggest the creek has significant habitat value in its present condition".

This strategy is currently supported by local irrigation districts but not by federal and state fish management agencies and remains unresolved. An alternative management strategy is to consider the presence of these fish within this Assessment Unit as beneficial and to develop management strategies to assist in their recovery and/or enhancement.

Data gaps must be filled before a specific management strategies can be adopted. These, as outlined in the objectives listed above, include: steelhead and summer/fall Chinook genetics; primary/secondary productivity; juvenile salmonid presence, distribution, and survival; and extent of suitable spawning habitat. Once these data gaps are filled, specific management strategies can be developed to encourage Best Management Practices regarding land and water use. These strategies may include:

Determination of the impact of ESA listed salmonids on the irrigation system and, in cooperation with irrigation districts, determine if irrigation return flows can be used to enhance/support salmonid habitat.

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Control of invasive plant species and overall improvement of riparian condition to buffer stream temperatures to improve salmonid survival.

Determination of the impact of resident fisheries on anadromous fish and adopt and enforce angling regulations that prevent take, harassment, or harvest of listed species (steelhead) as necessary.

Burkett Lake System

Hypothesis Statement 8: Portions of the Burkett Lake system managed by WDFW provide an excellent resident salmonid population and fishery largely supported by hatchery stocking.

Objective 1. Maintain high quality trout fisheries in Lake Lenice, Lake Nunnally, and Merry Lake.

Objective 2. Fill Data Gap - Determine level of resident trout natural production.

Management Strategy: Lake Lenice, Lake Nunnally, and Merry Lake are managed by WDFW to maintain a high quality trout sport fishery (i.e., greater number of large fish than normal). Current management practices include low density hatchery stocking, undesirable species control, use of selective gear, and conservative catch limits. This system is currently monitored through creel and biological surveys. Habitat management

considerations are to minimize the eutrophication of this system which will involve management actions to control vegetation and siltation. Work with sterile (triploid and hybrid) salmonids to minimize the potential impact on other stocks is also ongoing. The management strategy is to continue current management practices and evaluate the following:

- Natural salmonid production in the Burkett Lake system upstream from Burkett Lake (Stream Reaches Bul3 and Bul4).
- Improving flow to Stream Reaches Bul3 and Bul4 to enhance natural fish production in cooperation with irrigation districts.
- Burkett Lake to the confluence with Crab Creek (Stream Reaches Bul1 and Bul2) is owned by GCPUD and a specific management strategy for this area is in development.

Assessment Unit 2 – Refuge.

Hypothesis Statement 1: Salmonid production is limited by barriers.

Objective 1. Fill Data Gap - Determine fish use and distribution.

Objective 2. Fill Data Gap – Conduct barrier assessment.

Hypothesis Statement 2: Lack of spawning substrate limits salmonid production.

Objective 1. Fill Data Gap - Determine distribution of salmonid populations (see #1).

Objective 2. Fill Data Gap - Quantify habitat.

Hypothesis Statement 3: Salmonid production is limited by high summer water temperatures.

Objective 1. Fill Data Gap -Quantify stream temperatures where data currently non-existent.

Hypothesis Statement 4: In-stream habitat diversity, and complexity is limited by channel confinement.

Objective 1. Fill Data Gap - Assess channel confinement.

Objective 2. Re-connect floodplain where appropriate.

Objective 3. Re-establish wetland connectivity.

Hypothesis Statement 5: Salmonid production limited by land use practices

Objective 1. Implement Best Management Practices regarding land use.

Hypothesis Statement 6: Enhancement of riparian condition will decrease instream temperature.

Objective 1. Enhance riparian condition.

Objective 2. Control non-native invasive vegetation species

Hypothesis Statement 7: Primary/secondary productivity (phytoplankton/zooplankton/macro-invertebrate) does limit fish production.

Objective 1. Fill Data Gap - Determine primary/secondary (phytoplankton/zooplankton/macro-invertebrate) productivity.

Management Strategy: Much of this Assessment Unit lies within the boundaries of Columbia National Wildlife Refuge which is managed by the USFWS. The management strategy is to continue to protect fish and wildlife habitat within these areas. Upper Owl Creek, the Goldeneye Lake Tributary, and the Corral Lake Drainage, and Mainstem Crab Creek Stream Reaches 6 and 7 received the highest QHA protection scores and therefore merit a maximum level of protection. Best Management Practices regarding land and water use should be continued in areas throughout this Assessment Unit where currently implemented and adopted in areas where not. Lake systems within this Assessment Unit support resident trout fisheries primarily through hatchery plantings where habitat is most suitable for salmonids. Lakes with habitat less suitable for salmonids are managed for warm water species. This management strategy should be continued. The extent of salmonid (both anadromous and resident) distribution in stream systems within this AU is largely unknown. These salmonids potentially include ESA listed Upper Columbia River Summer Steelhead. Salmonid habitat throughout most of this Assessment Unit has not been fully assessed and represents a significant data gap. Channel confinement has not been fully assessed but may limit habitat diversity and floodplain/wetland connectivity. Barriers and high water temperatures have also been identified as potential limiting factors but have not been fully assessed. Primary/secondary productivity is also unknown but is thought to potentially limit salmonid production. These data gaps must also be filled before more specific management strategies can be developed.

Similar to Assessment Unit 1, Assessment Unit 2 has no true restoration potential as current conditions have improved over reference due to increased stream flows resulting from irrigation. However, current conditions can be enhanced beyond present to further promote salmonid survival. Once data gaps as identified above have been filled, enhancement strategies may include:

- Improvement of floodplain and wetland connectivity.
- Barrier removal or modification to all fish passage.
- Control of invasive plant species and riparian enhancement to buffer stream temperatures.

This Assessment Unit offers many excellent opportunities for fisheries enhancements with little or no additional impacts to anadromous fishes.

Assessment Unit 3 – Potholes/Moses Lake

Hypothesis Statement 1: This AU supports many excellent resident fish populations and fisheries.

Objective 1. Rehabilitate system as necessary (includes carp exclusion and vegetation control practices) to maintain current status of resident fisheries.

Objective 2. Fill Data Gap - Determine species/habitat interactions.

Hypothesis Statement 2: Restoration/enhancement of riparian condition will decrease instream temperature.

Objective 1. Enhance/restore riparian condition where appropriate.

Objective 2. Control non-native invasive vegetation species

Hypothesis Statement 3: Recreational activities impact fish and wildlife resources.

Objective 1. Manage impacts to fish and wildlife resources.

Hypothesis Statement 4: Urban development in the Moses Lake and Sun Lake Chain areas has impacted fish and wildlife habitat resources.

Objective 1. Fill Data Gap - Assess impacts due to urban development.

Hypothesis Statement 5: Contaminant input may limit fish populations.

Objective 1. Fill Data Gap - Assess source and extent of contaminant input.

Objective 2. Fill Data Gap - Assess effect of contaminants on fish populations.

Management Strategies: This Assessment Unit differs from that of Assessment Units 1 and 2 in that it:

- is characterized largely by lake/reservoir habitat,
- does not include anadromous salmonids (either listed or non-listed),
- is surrounded by the largest metropolitan area (Moses Lake) in the subbasin, and
- receives the highest recreational use in the subbasin.

Similar to Assessment Units 1 and 2, much of the fish habitat in Assessment Unit 3 did

not exist prior to the USBR Columbia Basin Project and modern irrigation practices which reduces restoration potential to zero in many locations. Exceptions to this are the Sun Lakes Chain, and Rocky Ford Creek. It should be noted here that the local irrigation districts objected to the inclusion of Frenchman Hills, Lind Coulee, and Winchester Wasteways (and all other wasteways) with regards to Fish Habitat Assessment and Management Planning in this subbasin plan as these are artificially generated waterways and management of such areas should by appropriate authority and jursidiction (Appendix D – letter from irrigation districts). These wasteways were included in the Assessment portion of this subbasin plan as they do support salmonids largely through hatchery planting with limited natural production. However, in terms of salmonid habitat, they have no true restoration value and the lowest protection scores in the AU. The issue as to whether these wasteways should be included in this subbasin plan for management consideration remains unresolved.

Current management in this Assessment Unit is for both salmonids and warmwater species depending upon the suitability of the habitat. Mixed species fisheries occur in Potholes and Moses Lake with heavy management emphasis on warmwater species owing to the marginal salmonid habitat as supported by expert opinion and the QHA results. In contrast Rocky Ford Creek (RF1) and Lake Lenore (SLC1) are managed for and support quality trout fisheries. Rocky Ford Creek received the highest QHA protection and restoration score for the AU. Control of invasive plant species to restore riparian condition would help buffer stream temperatures and be most beneficial in this stream reach.

As in Assessment Units 1 and 2, substantial data gaps exist in Assessment Unit 3. The management strategy for this AU is to continue current management practices for both salmonids and non-salmonids with consideration for increased impacts related to urban growth and increased recreational use. In addition, existing data gaps must be filled so that management strategies can be further developed and implemented. Species interactions in systems such as Moses Lake and Potholes which support both salmonids and non-salmonids are complex, not well understood, and represent a significant data gap. Water quality issues exist in this AU, and the Washington Department of Ecology is currently developing a TMDL for phosphorus in Moses Lake. However, the effect of such contaminants on all focal species is largely unknown and represents another significant data gap. Development of TMDLs should continue in this Assessment Unit. Specific impacts of urban growth to both fish and wildlife resources represent another data gap which must be filled before long term management strategies can be developed and Best Management Practices for land and water use can be developed and implemented. Potentially irrigation return flows may be used to further enhance fish habitat. Management strategies pertaining to water use and fish habitat should be developed in full cooperation with all affected parties.

This Assessment Unit offers many excellent opportunities for fisheries enhancements with little or no additional impacts to anadromous fishes.

Assessment Unit 4 – Upper Middle Crab Creek

Hypothesis Statement 1: Low flows limit salmonid production. Results in:

- Intermittent flow
- High summer water temperatures
- Low dissolved oxygen

Objective 1. Fill Data Gap - Determine seasonal hydrograph and relate to salmonid production.

Objective 2. Fill Data Gap – Determine water temperature profile.

Objective 3. Fill Data Gap – Determine dissolved oxygen levels.

Hypothesis Statement 2: Sedimentation limits spawning success.

Objective 1. Reduce sedimentation to improve salmonid spawning habitat.

Hypothesis Statement 3: Lack of habitat connectivity due to intermittent surface flow limits salmonid production.

Objective 1. Fill Data Gap - Determine resident trout baseline population level in this AU.

Objective 2. Fill Data Gap - Determine resident trout carrying capacity in this AU.

Objective 3. Fill Data Gap – Determine potential effects of habitat connectivity in intermittent reaches.

Objective 4. Fill Data Gap - Determine migratory needs and habits of resident trout in this AU.

Objective 5. Fill Data Gap - Identify all important resident trout spawning areas.

Objective 6. Determine feasibility of flow enhancement.

Hypothesis Statement 4: Improvement in riparian condition where degraded will increase salmonid production.

Objective 1. Improve riparian condition in degraded stream reaches.

Objective 2. Control non-native invasive vegetation species.

Hypothesis Statement 5: Salmonid habitat is influenced by land and water use practices.

Objective 1. Implement Best Management Practices regarding land and water use.

Objective 2. Fill Data Gap - Quantify current habitat conditions.

Hypothesis Statement 6: Ground water input to Crab Creek is a vital component supporting fish habitat.

Objective 1. Fill Data Gap – Determine groundwater/surface water interaction.

Hypothesis Statement 7: This AU provides good resident salmonid populations and fisheries.

Objective 1. Maintain system as necessary (includes stocking, carp exclusion and spiny ray control practices) to continue current status of resident trout fishery.

Management Strategy: The management strategy for Assessment Unit 4 is to continue current management practices and adapt these practices as more information becomes available through the filling of identified data gaps. This Assessment Unit differs from Assessment Units 1-3 in that AU4 consists largely of stream habitat and is managed primarily for resident trout fisheries. Both indigenous and non-indigenous trout species have been planted in the past and planting continues to occur. This area is not currently managed for natural trout production. Anadromous fish are not currently present and were not believed to have been present historically and are not considered in current management.

As in the previous three Assessment Units, substantial data gaps exist in Assessment Unit 4. Existing data gaps must be filled so that management strategies can be further developed and implemented. Currently this Assessment Unit is managed for trout fisheries with emphasis on recreation. This includes carp exclusion and spiny ray control practices where necessary. Data gaps to be filled are listed under the objectives above. This Assessment Unit is characterized by intermittent stream flow and of primary interest are the effects of intermittent flow on water temperature, dissolved oxygen, and the migrational needs, and survival of resident salmonids. Stream flows as well as the influence of groundwater on surface flow should be thoroughly assessed. Baseline population levels and system carrying capacity should also be determined. Current habitat condition were rated through the QHA, but these ratings were largely based upon expert opinion. Current habitat conditions should be quantified. Potentially such information can be used to develop management strategies such as to connect discontinuous habitat areas to increase resident salmonid populations to target levels once carrying capacities have been determined. Best Management Practices for both land and water use can also be developed and implemented.

With the exception of Rocky Coulee Wasteway, all of the stream reaches in this AU existed historically. These reaches currently possess moderate to low restoration value but moderate to high protection value. Gloyd Springs Creek (SK1) is characterized by high water quality and this should be protected and maintained. Wetland areas are an important part of the ecology of this Assessment Unit and these should be protected. In reaches where riparian vegetation has been degraded (primarily tributary reaches),

riparian vegetation should be restored or enhanced to buffer stream temperatures. Control of non-native invasive plant species should accompany this strategy. Sedimentation has been identified as factor limiting salmonid production by reducing spawning habitat. Sources of sedimentation should be identified and corrective strategies developed.

This Assessment Unit offers many excellent opportunities for fisheries enhancements with little or no additional impacts to anadromous fishes.

Assessment Unit 5 – Upper Crab Creek.

Hypothesis Statement 1: Lack of habitat connectivity limits salmonid production.

Objective 1. Fill Data Gap - Determine resident trout baseline population level in this AU.

Objective 2. Fill Data Gap - Determine resident trout carrying capacity in this AU.

Objective 3. Fill Data Gap – Determine potential effects of habitat connectivity in intermittent reaches.

Objective 4. Fill Data Gap - Determine migratory needs and habits of resident trout in this AU.

Objective 5. Fill Data Gap - Identify all important resident trout spawning areas.

Hypothesis Statement 2: Improvement in riparian condition where degraded will increase salmonid production.

Objective 1. Improve riparian condition in degraded stream reaches.

Objective 2. Control non-native invasive vegetation species.

Hypothesis Statement 3: High summer water temperatures limit salmonid production.

Objective 1. Reduce summer water temperatures to acceptable levels.

Hypothesis Statement 4: Salmonid habitat is influenced by land and water use practices.

Objective 1. Implement Best Management Practices regarding land and water use.

Objective 2. Fill Data Gap - Quantify current habitat conditions.

Hypothesis Statement 5: Ground water input to Crab Creek is a vital component supporting fish habitat.

Objective 1. Fill Data Gap – Determine groundwater/surface water interaction.

Hypothesis Statement 6: Hatchery supplementation impacts natural trout populations.

Objective 1. Fill Data Gap – determine genetic composition of natural trout population

Objective 2. Fill Data Gap – determine hatchery/natural trout population interactions.

Hypothesis Statement 7: Increased recreational fisheries will impact natural aquatic populations and habitat.

Objective 1. Increase management effort to protect natural aquatic populations and habitat.

Hypothesis Statement 8: This AU provides an excellent resident salmonid population and fishery.

Objective 1. Maintain system as necessary (includes carp exclusion and spiny ray control practices) to continue current status of resident trout fishery.

Management Strategy: Assessment Unit 5 is very similar to Assessment Unit 4. The primary difference is that AU5 consists of a higher proportion of stream reaches with perennial flow although intermittent reaches do exist. Recreational angling effort is also higher in AU5 than in AU4 and merits additional consideration.

As in Assessment Unit 4, the management strategy for Assessment Unit 5 is to continue current management practices and adapt these practices as more information becomes available through the filling of identified data gaps. This strategy should include management for the impacts of increased future recreational use. Current management is for natural trout production although both indigenous and non-indigenous trout species have been planted in the past and planting continues to occur. Anadromous fish are not currently present and were not believed to have been present historically and are not considered in current management.

As in all previous Assessment Units, substantial data gaps exist in Assessment Unit 5. Existing data gaps must be filled so that management strategies can be further developed and implemented. Currently this Assessment Unit is managed for trout fisheries with emphasis on natural production. This includes carp exclusion and spiny ray control practices where necessary. Data gaps to be filled are listed under the objectives above. The effects of intermittent flow and low summer flow on water temperature, dissolved oxygen, and the migrational needs, survival, and natural production of resident salmonids should be assessed. Stream flows as well as the influence of groundwater on surface flow should be thoroughly assessed. Baseline population levels, spawning areas, and system carrying capacity should also be determined. Current habitat conditions were rated through the QHA, but these ratings were largely based upon expert opinion. Current habitat conditions should be quantified. Potentially such information can be used to develop management strategies such as the development of water storage projects to

increase summer stream flows to increase fish habitat, connect discontinuous habitat areas, and lower summer water temperatures. Management strategies pertaining to stream flows will require coordination with all affected stakeholders and HB2514 Watershed Planning conducted by the Washington Department of Ecology in this subbasin. Through coordinated effort, Best Management Practices for both land and water use can be developed and implemented. The effect of hatchery plantings on natural populations of trout has not been assessed and represents another significant data gap. Assessment of genetic changes, predation, and competition at all life stages should be conducted to determine if current hatchery practices should be modified.

All stream reaches existed historically within AU5 with habitat conditions generally better than at present. Therefore all stream reaches in this Assessment Unit have restoration value. Tributary and mainstem stream reaches included in AU5 received the highest QHA restoration scores in the entire subbasin. Riparian condition has been degraded throughout most of this Assessment Unit and is identified as a primary limiting factor. Specific management strategies should be developed to restore riparian condition when habitat conditions have been fully quantified. Control of non-native invasive plant species should accompany this strategy.

Existing qualitative data on the fishery in the system suggests that fish are growing and reproducing at rates commensurate with the finest blue ribbon trout fisheries in the Pacific Northwest (Al Scholz, EWU Fisheries Professor, Personal communication). Fish condition is noted to be very good and specimens as large as 4 pounds (estimated) are common. This information, along with other anecdotal evidence suggests that, although habitat conditions aren't necessarily pristine, from a textbook perspective, they are very functional.

However, very little is known about the population(s) and their interaction with the habitat. It is known that DO concentrations in some areas drop well below the minimum desirable concentration of 5 mg/l and pH levels regularly exceed 9. This, combined with high summer densities, indicates that a slight shift in any habitat parameter may result in stressors that cause the population to crash. Therefore it is imperative that existing conditions are protected and maintained while studies examine the extent of the population(s), interactions with the habitats, and detail surface water/groundwater dynamics and the extent to which they regulate habitat conditions.

To begin, a thorough hydrogeologic analysis is needed. The methods of the study should focus on describing the locations and magnitudes of surface and groundwater exchanges and should be done at a level of detail sufficient enough to identify individual aquifers and their recharge zone(s). Meanwhile, specific channel typing and habitat inventories should be systematically conducted throughout the watershed and overlaid on the information gathered in the hydrogeologic study. Finally, a thorough fish population inventory needs to be conducted to estimate habitat utilization at different life history stages and seasons along with potential migration patterns. At the point that these three items are understood, comprehensive restoration programs can begin to be designed. Prior to that understanding improving habitat conditions can be done by preventing

degradation.

While research is being conducted to enhance the knowledge of the watershed, common, non- invasive, restoration practices can be implemented. Such practices include riparian restoration, water conservation, and wetland restoration. Stream bank and channel restoration projects should be delayed until the hydrogeologic conditions are clearly understood. Well intended channel modifications could result in the creation of a losing zone or block an important area of groundwater infusion.

Riparian restoration projects will generally be planting native, bank stabilizing, trees, grasses, and/or shrubs or fencing to control grazing impacts on stream banks. Vigorous riparian plant communities offer stream shade, which limits solar heat flux and attenuates diurnal temperature fluctuations; increases overhead cover to fish, protecting them from potential overhead predation; increases invertebrate habitat, which results in increased food production for fish; and offer wildlife resting and travel corridors. However, riparian restoration efforts must be specifically designed for each proposed location due to the physical diversity and size of the watershed.

The size of the Crab Creek Watershed traverses many different microclimates and over 80 different soil types (Soil Conservation Service 1981, 1984), which are critical for determining the restoration species composition. Lincoln County Soil Survey and the Grant County Soil Survey identified 3 soil types within the bankfull channel and potential riparian area of Crab Creek, their erosion potential, and substrate size within soil horizons. While we assume that the soil surveys accurately reflect the soil types of the region, we do not recommend following the species suggested for environmental plantings.

Many of the species suggested in the soil surveys are actually detrimental to riparian restoration, wildlife habitat, and agriculture production and many are not native to the area (e.g. Russian olive). Evidence from surveys conducted in the late 1800’s confirms that in many places along Crab Creek riparian areas were very dense and contained timber that was deemed to be harvestable. Tree species such as willow, cottonwood, birch, and alder were specifically mentioned due to their commercial value; however, a dense community of shrubs and herbaceous plants was no doubt present. Riparian and wetland plants that are native to the area should be used in restoration of riparian areas and wetlands. Species specific communities and densities should be designed to meet the soil and climate of the proposed restoration site.

Fences that exclude livestock from accessing riparian areas are effective riparian restoration measures. It is a non-invasive technique that prevents livestock from loitering in and around the stream, which has been shown to limit plant vigor and destabilize stream banks. Exclusion fencing allows plants to establish deep dense root masses, which stabilize banks and ultimately leads to stream channel stability. In many cases, livestock exclusion, and the lack of persistent disturbance, allows the riparian zone to restore itself. However, planting the appropriate riparian vegetation may assist the project area to respond faster.

Fences, however, are subject to flood damage and may not be the most cost effective or efficient methods to exclude livestock from riparian corridors. In many cases, permanent exclusion is not necessary. Limiting livestock exposure to time sufficient enough to graze available grasses, then excluding them, facilitates the economic interest of the rancher and protects the delicate ecological balance of the riparian zone. Hard crossings, nose pumps, and solar pumps are examples of ways a rancher can provide water to their livestock to encourage livestock to water outside of the riparian area.

Groundwater infusion into Crab Creek and its tributaries is likely one of the primary factors in maintaining suitable habitat conditions. Water conservation strategies such as wetland restoration and enhancement promote groundwater recharge by capturing surface flows, preventing flashy surface water runoff, and storing the water in shallow aquifers, which can resurface at downstream locations.

If water runs off rapidly, during high water events, it is not available for surface water infusion during low flow periods and may carry increased loads of pollutants. Wetlands allow water to slow long enough for water to infiltrate into shallow aquifers where it can be stored at temperatures approximately 10-13º C. In so doing, water is naturally treated by physical and biological processes, thereby promoting increased water quality at infusion points downstream.

Assessment Unit 6 – Banks Lake.

Banks Lake and Billy Clapp Reservoir.

Hypothesis Statement 1. Banks and Billy Clapp Reservoirs provide quality mixed-species recreational fisheries.

Objective 1. Fill Data Gap - Determine focal species interactions to maintain quality mixed species fishery.

Hypothesis Statement 2. Primary/secondary productivity limit fish production in Banks and Billy Clapp Reservoirs.

Objective 1. Fill Data Gap - Determine primary/secondary productivity.

Hypothesis Statement 3. Natural salmonid production occurs in Banks and Billy Clapp Reservoirs.

Objective 1. Fill Data Gap – Determine level of natural salmonid production in Banks and Billy Clapp Reservoirs.

Hypothesis Statement 4. Gamefish populations can be severely impacted by irrigation or hydroelectric operations of reservoir.

Objective 1. Determine the impacts of current reservoir water level fluctuations on gamefish populations, including weekly manipulations for hydropower and seasonal drawdowns.

Objective 2. Determine the impacts of current flows and retention times on reservoir productivity.

Objective 3. Determine current impacts of entrainment.

Objective 4. Maintain or increase kokanee sport fishery harvest at 70,000 fish or greater at an average size greater than 13 inches. Investigate the following:

- Manage lake level to provide optimal shoreline spawning and high fry emergent survival.
- Utilize a self-sustaining shoreline spawning kokanee
- Monitor harvest and relative magnitude of adult kokanee population annually.
- Develop methodology to monitor and predict relative size of spawning population
- Stock at least 1 million and as many as 5 million kokanee fingerlings or larger cohorts, depending on natural production levels and stocked fish survival.
- Develop regional kokanee egg source.
- Provide imput on future environmental impacts

Objective 2. Increase angler opportunity and diversity for additional salmonid species. Investigate the following:

- Annual stocking of at least 200,000 rainbow trout fingerlings at 20/lb in size. Rear in net pens where feasible.
- Evaluate cost/benefit ratios of various trout introductions and planting schemes.
- Increase creel census efforts to monitor relative changes in program success.

Hypothesis Statement 5. Lake whitefish population is currently under utilized and constitutes a significant proportion of the total biomass in the system.

Objective 1. Increase utilization of lake whitefish.

- Increase media and angler awareness of sport fishery opportunities.
- Investigate new types of fisheries.

Management Strategy: The management strategy for Assessment Unit 6 is to continue current management practices and adapt these practices as more information becomes available through the filling of identified data gaps. Currently this system is managed for mixed species fisheries. Data gaps to be filled are identified under the objectives above.

Anadromous fish do not currently and have never existed in this Assessment Unit and are not considered under the current management program. Banks Lake and Billy Clapp offer many excellent opportunities for fisheries enhancements with little or no additional impacts to anadromous fishes.

Wildlife Management

Overall Goal: Protect, enhance, and restore native habitats, particularly shrubsteppe, to provide the quality and continuity necessary to support viable populations of wildlife within the Crab Creek Subbasin.

Habitat Distribution
Habitat mapping within the Crab Creek Subbasin in particular, and eastern Washington in general, is a priority for numerous agencies and organizations including the WDFW (Dobler et al. 1996; Jacobson and Snyder 2000; Hays et al., in prep.), DNR (R. Crawford, pers. comm.), BLM (T. Thompson, pers. comm.), TNC (N. Warner, pers. comm.), and the Foster Creek Conservation District (M. Mazola, pers. comm.). Although the distribution of basic habitats such as shrubsteppe and cropland is known (Figure 5), the distribution of specific variations in the types and condition of shrubsteppe is not. In addition, the location of CRP was mapped based on NRCS data from the mid-1990's; the current distribution of CRP is different and it has not been mapped.

Status: Shrubsteppe is considered a priority habitat by the WDFW (2000b). A general map of shrubsteppe habitat in eastern Washington and in the Crab Creek Subbasin was completed in 2000 (Jacobson and Snyder).

Limiting Factors: The lack of an adequate map of distribution of specific shrubsteppe habitats is adversely impacting management efforts in the Crab Creek Subbasin.

Goal 1: Map specific types of shrubsteppe habitat within the Crab Creek Subbasin.

Objective: Map all habitat within the subbasin using a method that permits evaluation of habitat potential, habitat condition, and endemic features of the landscape such as slope, aspect, soil, and weather by the year 2005.

Task 1: Use current habitat map for subbasin (Jacobson and Snyder 2000) as a 'starting point' for distribution of habitat by general habitat category.

Task 2: Define specific habitat types within general categories that reflect variation in habitat potential (Daubenmire 1970), habitat condition, and endemic features of the landscape such as slope, aspect, soil, and weather.

Task 3: Map CRP with aid of aerial photography in county offices of the National Resources Conservation Service.

Task 4: Use digitized maps for soil type (when and where available) to refine current maps on habitat potential.

Task 5: Use satellite data to refine mapped distributions of habitat.

Task 6: Use ground-reconnaissance data to evaluate specific variation within general habitat categories and to refine and finalize subbasin habitat maps.

Goal 2: Monitor periodic changes in habitat distributions.

Objective: Develop a system for monitoring changes in habitat on a regular 5-year interval by the year 2005.

Goal 3: Inventory all wetlands.

Objective: Develop a wetland management plan.

Monitoring and Evaluation Program for the Crab Creek Subbasin

Note: The first sections of this plan addresses fish exclusively and is derived from a variety of sources including the PNAMP guidance. Following fish we provide a general framework for terrestrial (wildlife) monitoring. The wildlife section is adapted from Paquet, Marcot and Powell 2004.

Introduction

To allow the subbasin plan authors to track the progress of specific objectives and goals over time, a disciplined and well coordinated monitoring and evaluation (M&E) program is proposed. This program is designed to help confirm our scientific assumptions, resolve key scientific uncertainties, and provide the basis for performance tracking and adaptive management. The goals for this coordinated program are to maximize efficiencies; avoid duplication, and improve experiments to minimize confounding factors or actions.

This effort will begin to provide essential information on habitat conditions and fish populations beginning in 2004. This will also allow state, federal and tribal programs to operate in a manner consistent with efforts to detect the trends and effectiveness between and among other subbasins, ESUs, programs and across a broader group of “H’s” and planning efforts.

The monitoring plan described in this document is not another regional monitoring strategy. Rather, this plan draws from the existing strategies and outlines an approach specific to the Crab Creek subbasin and the Upper Columbia region.

The plan described here addresses the following five basic questions:

1. What are the current habitat conditions and abundance, distribution, life-stage survival, and age-composition of anadromous fish in the Crab Creek subbasin (status monitoring)?

2. How do these factors change over time (trend monitoring)?

3. What effects do tributary habitat actions have on fish populations and habitat conditions (effectiveness monitoring)?

4. What effects do fishery management actions have on fish populations (effectiveness monitoring)?

5. Are the goals, vision and objectives of the subbasin plan being met?

Assumptions

Monitoring and evaluation coordination and implementation will be an ongoing activity at the reach, subbasin, and regional levels. The subbasin planners assume these iterative, concurrent processes at different scales will be coordinated to optimize when and where implementation occurs to increase learning from broader scale monitoring both within and across subbasins.

Monitoring that is proposed will be more effective if it fits within a broader programmatic network of status monitoring programs and intensively monitored watersheds. The subbasin planners assume that M&E efforts will be able to rely on broader monitoring frameworks and programmatic activities (where they exist) to meet some of their needs.

The subbasin planners assume that local, bottom-up approaches developed within subbasins will have a higher likelihood for successful funding and meaningful results if they reflect the approaches being developed within the comprehensive state, tribal initiatives, and federal pilot projects (Wenatchee, John Day, and Upper Salmon), and the top-down framework and considerations being developed by PNAMP.

Approach

A coordinated and comprehensive approach to the monitoring and evaluation of status and trends in anadromous and resident salmonid populations and their habitats is needed to support restoration efforts in the Columbia Cascade Province, and in the Crab Creek subbasin in particular. Currently, independent research projects and some monitoring activities are conducted by various state and federal agencies, tribes, and to some extent by watershed councils or landowners, but to date there has been no overall framework for coordination of efforts or for interpretation and synthesis of results.

Guidance for this M&E Program

Three primary documents make up this framework plan for Crab Creek. They are:

- The Upper Columbia Monitoring Strategy (Hillman, et. al. 2004)
- Considerations for Monitoring in Subbasin Plan (PNAMP 2004)
- Considerations for Monitoring Wildlife in Subbasin Plan (NPCC, 2004)

The authors also used a variety of programs and plans to help construct the Crab Creek Monitoring Framework. Examples used include:

- The Pacific Northwest Aquatic Monitoring Partnership (PNAMP)—Draft Guidance to the State, Feds and Tribes for Monitoring (2004)
- The Coordinated System Wide Monitoring and Evaluation Project (CSMEP) Work Plan.
- 2003 ISAB Review of Supplementation
- Federal Research Evaluation and Monitoring (RME) Plan
- The Pacific Coastal Salmon Recovery Fund (PCSRF) Performance Standards
- The Pacific Coastal Salmon Recovery Fund Data Definitions
- A Data Management Protocol (Wolf, Jordan, Toshach et al—in press)
- BPA Pilot Studies in Wenatchee and John Day (data dictionary and geospatial database structure)
- The Washington Coordinated Monitoring Strategy
- The Oregon Monitoring Plan
- The subbasin authors/planners also suggest use of the following resources in implementing the M&E plan:
- The Yakima Klickitat Fisheries Project: http://www.ykfp.org
- The Northeast Oregon Hatchery: http://www.cbfwa.org/2001/projects/198805301.htm
- The Columbia Basin Fish and Wildlife Authority (M&E): http://www.cbfwa.org/rme.htm
- The State of Washington: Outline for Salmon Regional Recovery Plans. http://www.wdfw.wa.gov/recovery/recovery_model.htmCoordinated Management Strategy. http://www.iac.wa.gov/srfb/monitoring.htm

Principles, Goals and Objectives

The following principles will guide M&E in the Crab Creek Subbasin:

Resource Policy and Management: The purpose of monitoring efforts is to provide the most important scientific information needed to inform public policy and resource management decisions.

Acknowledge each party's mandates, objectives, and management milestones.
Construct a monitoring program that meets each party's milestones and objectives through coordinating and sharing monitoring resources.
Develop a monitoring program that is sufficiently robust to meet public policy needs;

demonstrate the links between public policy needs and monitoring efforts.
Develop a monitoring program that demonstrates compliance.
Commit to resolving scientifically the most important policy and management questions using an adaptive management approach.

Efficiency and Effectiveness:

- Cooperative monitoring will enhance efficiencies and effectiveness of our respective and collective efforts.
- Participate fully in the PNAMP, including the identification of contact(s) for monitoring issues.
- Identify and coordinate goals, objectives, and budgets, and demonstrate resource savings over short and longer time frames.
- Cooperatively adapt programs and budgets to address monitoring gaps.
- State and federal agencies and the tribes commit to long term inter- and intra-agency monitoring programs.
- Encourage staff exchanges and shared training to learn what each other are doing (e.g., new innovations) and ensure consistency across programs.
- Develop common monitoring approaches, including quality control/quality assurance programs; shared evaluation tools; integrated status and trend monitoring efforts; land use, land cover, and riparian vegetation categorization; core data for representative subset of watersheds in all represented states.
- Perform all monitoring activities in a timely manner.

- Scientifically Based: Environmental monitoring must be scientifically sound.

- Develop an integrated monitoring program (e.g., issues, disciplines, and values).
- Monitoring program is based on shared goals and objectives (e.g., census level, regional status and trends, cause and effect questions, effectiveness of regional efforts, identification of trouble spots).
- Address multiple spatial and temporal scales.
- Develop and use compatible data collection and analysis protocols.
- Recognize inherent diversity and variability and dynamic inter-relationships or resource conditions in monitoring design, analysis and interpretation.
- All environmental data should have a known level of precision.
- All baseline data on ecosystems are known and compiled between agencies.
- Shared Information: Monitoring data should be accessible to all on a timely basis.
- Make strategic investments in information systems needed to make data useful.
- Monitoring databases would integrate a number of issues, disciplines and values.
- Data management systems and protocols provide a linkage for sharing data between agencies.
- Adopt and use common data sharing protocols.
- Adopt and use common database/s of core metadata, data, and electronically connected distribution systems.

The primary ***goal*** of this M&E framework is:

To combine, coordinate, and standardize the activities of multiple agencies working on fisheries related issues in the Crab Creek subbasin and establish a measure of success or failure of habitat and hatchery practices directed towards rehabilitation of fish and wildlife populations.

<u>Specific</u> goals of the Crab Creek subbasin M&E plan include:

- Assess status and trends of watershed conditions and salmon populations regionally.
- Monitor habitat, water quality, biotic health, and salmon in select watersheds.
- Analyze habitat, water quality and population trends at the landscape scale.
- Document conservation and restoration projects, activities and programs.
- Evaluate effectiveness of restoration and management efforts locally.
- Evaluation the combined effectiveness of restoration and conservation efforts in select watersheds.
- Standardize monitoring, collection, management and analysis efforts.
- Coordinate and support public-private monitoring partnerships.
- Integrate information and product data products and reports.

Specific Questions (Long List of possible questions):

How are the annual abundance and productivity of salmon by species, ESU, and life stage changing over time?

What improvements are occurring in restoring the geographic distribution of salmon by ESU, species, and life stage to their historic range?

Are the unique life history characteristics of salmon within a Salmon Recovery Region changing over time because of human activities?

What are the trends in the climate of the Pacific Northwest that will allow the State to anticipate and account for such conditions in initiating and monitoring management actions for watershed health and salmon recovery? What trends in climate may mask or expose the status of freshwater habitat and its role in salmon recovery?

What are the trends in effects of hatchery production on the survival and productivity of wild salmon populations within each ESU?

How are surface water quality conditions changing over time?

How effective are clean water programs at meeting water quality criteria?

What are the trends in water quantity and flow characteristics?

What are the status and trends in habitat-forming landscape processes in riverine ecosystems as they relate to watershed health and salmon recovery?

Are habitat improvement projects effective?

What is the condition of salmon populations at the ESU, Subbasin and watershed scale?

What is the status and what are the trends in aquatic habitats, water quality, and stream flow?

What are the critical factors that limit watershed function and salmon productivity?

What constitutes detectable and meaningful change in habitat condition and populations?

What changes are occurring in watersheds that improve stream habitat quality?

What are the management practices and programs that enhance or restore watershed functions and salmon populations?

What habitat changes and biotic responses result from these projects, practices, and programs?

What are the abundances, productivity, and distributions of Columbia River? Basin (CRB) fish populations relative to performance standards or objectives?

What is the biological, chemical, and physical status of CRB fish habitat relative to performance standards or objectives?

What are the relationships between fish populations and freshwater and estuary/ocean habitat conditions that determine population-limiting factors?

What is the effect of a specific mitigation or management action on the habitat and/or population performance of CRB fish?

What is the combined effect of multiple watershed level mitigation on management actions on the habitat and/or population performance of CRB fish?

Are Federal and state mitigation actions achieving the necessary survival changes identified in the All H Federal Caucus Program and the FCRPS BO for each ESU?

Priority Needs

- Fill Data Gap – Determine genetic origin of steelhead.
- Support the recovery of listed species while minimizing impacts to irrigation practices.
- Fill Data Gap - Determine fish use and distribution.

- Fill Data Gap - Quantify current habitat conditions.
- Fill Data Gap -Quantify stream temperatures where data currently non-existent.
- Reduce summer water temperatures to acceptable levels.
- Enhance/restore riparian condition where appropriate.
- Fill Data Gap - Determine focal species interactions to maintain quality mixed species fishery.
- Fill Data Gap – Determine potential effects of habitat connectivity in intermittent reaches.

Measurable Objectives
[7](Long List of Questions that the Crab Creek Basin M&E plan will address). [8]

- Support the recovery of listed species while minimizing impacts to irrigation practices.
- Adopt regulations preventing take, harvest, or harassment of listed anadromous salmonids.
- Maintain high quality trout fisheries in the Burkett Lake system.
- Re-connect floodplain where appropriate.
- Re-establish wetland connectivity.
- Enhance/restore riparian condition where appropriate.
- Control non-native invasive vegetation species
- Increase management effort to protect natural fish and wildlife populations and habitat where appropriate.
- Implement Best Management Practices regarding land and water use.
- Reduce sedimentation to improve salmonid spawning habitat where appropriate.
- Reduce summer water temperatures to acceptable levels.
- Maintain system as necessary (includes carp exclusion and spiny ray control practices) to continue current status of resident trout fishery.
- Fill Data Gap - Quantify current habitat conditions.
- Fill Data Gap - Determine genetic origin of summer/fall Chinook.
- Fill Data Gap – Determine genetic origin of steelhead
- Fill Data Gap – Where information does not exist, assess spawning habitat in

[7] Please also refer to the individual Assessment Unit summaries for a long list of detailed habitat objectives by geographic area. The M&E plan is developed to capture the variables and indicators necessary to determine whether progress is being made to achieve this list of habitat and artificial production objectives

[8] The monitoring plan proposed requires a long-term commitment as most outcomes will not be realized for 7 to 20+ years. This project is designed to address the following priority objectives:

mainstem Crab Creek and in Red Rock Coulee.

- Fill Data Gap - Determine presence, distribution, and survival of juvenile salmonids in mainstem Crab Creek and Red Rock Coulee.
- Fill Data Gap - Determine primary/secondary (phytoplankton/zooplankton/macro-invertebrate) productivity.
- Fill Data Gap - Determine level of resident trout natural production.
- Fill Data Gap - Determine fish use and distribution.
- Fill Data Gap – Conduct barrier assessment.
- Fill Data Gap -Quantify stream temperatures where data currently non-existent.
- Fill Data Gap – Determine dissolved oxygen levels where critical information is lacking.
- Fill Data Gap - Assess channel confinement.
- Fill Data Gap - Assess impacts due to urban development.
- Fill Data Gap - Determine seasonal hydrograph and relate to salmonid production.
- Fill Data Gap - Assess source and extent of contaminant input.
- Fill Data Gap - Assess effect of contaminants on fish populations.
- Fill Data Gap - Determine species/habitat interactions.
- Fill Data Gap - Determine resident trout baseline population levels in Assessment Units 4 and 5.
- Fill Data Gap - Determine resident trout carrying capacity in Assessment Units 4 and 5.
- Fill Data Gap – Determine potential effects of habitat connectivity in intermittent reaches.
- Fill Data Gap - Determine migratory needs and habits of resident trout.
- Fill Data Gap - Identify all important resident trout spawning areas.
- Fill Data Gap – Determine groundwater/surface water interaction.
- Fill Data Gap – determine genetic composition of natural trout population.
- Fill Data Gap – determine hatchery/natural trout population interactions
- Fill Data Gap - Determine focal species interactions to maintain quality mixed species fishery.
- Fill Data Gap – Determine level of natural salmonid production in Banks and Billy Clapp Reservoirs.

The plan is designed to address these questions and at the same time eliminate duplication of work, reduce costs, and increase monitoring efficiency. The implementation of valid statistical designs, probabilistic sampling designs, standardized data collection protocols, consistent data reporting methods, and selection of sensitive indicators will increase monitoring efficiency.[9]

[9] An efficient monitoring plan reduces “error” to the maximum extent possible.

For this plan to be successful, all organizations involved must be willing to cooperate and freely share information. Cooperation includes sharing monitoring responsibilities, adjusting or changing sampling methods to comport with standardized protocols, and adhering to statistical design criteria. In those cases where the standardized method for measuring an indicator is different from what was used in the past, it may be necessary to measure the indicator with both methods for a few years so that a relationship can be developed between the two methods. Scores generated with a former method could then be adjusted to correct for any bias.

Specific Elements of the Plan

Program Setup

In order to setup a monitoring program, it will be important to follow a logical sequence of steps. By proceeding through each step, the planner will better understand the goals of monitoring and its strengths and limitations. These steps will aid the implementation of a valid monitoring program that reduces duplication of sampling efforts, and thus overall costs, but still meets the needs of the different entities. The plan assumes that all entities involved with implementing the plan will cooperate and freely share information. Setup steps are:

- Identify the populations and/or subpopulations of interest (e.g., steelhead, summer/fall Chinook).
- Identify the geographic boundaries (areas) of the populations or subpopulations of interest.
- Describe the purpose for selecting these populations or subpopulations (i.e., what are the concerns?).
- Identify the objectives for monitoring.
- Select the appropriate monitoring approach (status/trend or effectiveness monitoring or both) for addressing the objectives.
- Identify and review existing monitoring and research programs in the area of interest.
- Determine if those programs satisfy the objectives of the proposed program.
- If monitoring and evaluation data gaps exist, implement the appropriate monitoring approach by following the criteria outlined in 9-13.
- Classify the landscape and streams in the area of interest.
- Complete a data management needs assessment. Describe how data collection and management needs will be met and shared among the different entities.

One can think of error as unexplained variability, which can reduce monitoring efficiency through the use of invalid statistical designs, biased sampling designs, poorly selected indicators, biased measurement protocols, and non-standardized reporting methods.

- Identify an existing database for storing biological and physical/environmental data.
- Estimate costs of implementing the program.
- Identify cost-sharing opportunities.

Suggested Table of Contents (for any entity implementing an M&E element)

1. Statement of Need and Program Outline
2. Summary of Indicators and Program Elements
3. Summary of Monitoring and Evaluation Priorities
4. Program Set Up Statistical Design
5. Sampling Design

a. Sample Size
b. Measurement Error

6. Fish Population Monitoring Overview
7. Habitat Monitoring Overview
8. Biological Variables
10. Physical/Environmental Variables
11. Spatial Scales
12. Performance Standards
13. Classification
14. Indicators to be used
15. Measuring Protocols to be used
16. Status Trend Monitoring
17. Effectiveness Monitoring
18. Data Management Needs Assessment and Data Management Plan
19. Peer Review and Annual Reporting
20. Adaptive Management
21. References
22. Appendices as needed

Basic Statistical Considerations

This document defines "statistical design" as the logical structure of a monitoring study. It does not necessarily mean that all studies require rigorous statistical analysis. Rather, it implies that all studies, regardless of the objectives, be designed with a logical structure that reduces bias and the likelihood that rival hypotheses are correct. The purpose of this section is two-fold. First, it identifies the minimum requirements of valid statistical designs and second it identifies the appropriate designs for status/trend and effectiveness monitoring. The following discussions draw heavily on the work of Hairston (1989), Hicks et al. (1999), Krebs (1999), Manly (1992, 2001), and Hillman and Giorgi (2002). (See: Hillman et al. 2004) section 3, pages 9-13.)

Sampling Design Considerations

Once the investigator has selected a valid statistical design, the next step is to select "sampling" sites. *Sampling* is a process of selecting a number of units for a study in such a way that the units represent the larger group from which they were selected. The units selected comprise a *sample* and the larger group is referred to as a *population*.[10] All the possible sampling units available within the area (population) constitute the *sampling frame*.[11] The purpose of sampling is to gain information about a population. If the sample is well selected, results based on the sample can be generalized to the population. Statistical theory assists in the process of drawing conclusions about the population using information from a sample of units.

Defining the population and the sample units may not always be straightforward because the extent of the population may be unknown, and natural sample units may not exist. For example, a researcher may exclude livestock grazing from sensitive riparian areas in a watershed where grazing impacts are widespread. In this case the management action may affect aquatic habitat conditions well downstream from the area of grazing. Thus, the extent of the area (population) that might be affected by the management action may be unclear, and it may not be obvious which sections of streams to use as sampling units.

When the population and/or sample units cannot be clearly defined, the investigator should subjectively choose the potentially affected area and impose some type of sampling structure. For example, sampling units could be stream habitat types (e.g., pools, riffles, or glides), fixed lengths of stream (e.g., 150-m long stream reaches), or reach lengths that vary according to stream widths (e.g., see Simonson et al. 1994). Before selecting a sampling method, the investigator should define the population, size and number of sample units, and the sampling frame. (See: Hillman et al. 2004) section 4, pages 9-13).

Spatial Scale

Because monitoring will occur at a range of spatial scales, there may be some confusion between the roles of status/trend monitoring and effectiveness monitoring. Generally, one thinks of status/trend monitoring as monitoring that occurs at coarser scales and effectiveness monitoring at finer scales. In reality, both occur across different spatial scales, and the integration of both is needed to develop a valid monitoring program (ISAB 2003; AA/NOAA Fisheries 2003; WSRFB 2003).

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[10] This definition makes it clear that a "*population*" is not limited to a group of organisms. In statistics, it is the total set of elements or units that are the target of our curiosity. For example, habitat parameters will be monitored at sites selected from the *population* of all possible stream sites in the watershed.

[11] The *sampling frame* is a "list" of all the available units or elements from which the sample can be selected. The sampling frame should have the property that every unit or element in the list has some chance of being selected in the sample. A sampling frame does not have to list all units or elements in the population.

The scale at which status/trend and effectiveness monitoring occurs depends on the objectives of the study, the size or distribution of the target population, and the indicators that will be measured. In status/trend monitoring, for example, the objective may be to measure egg-parr survival of summer/fall Chinook salmon in the Crab Creek Basin, but because the Crab Creek subbasin may have consisted of multiple sub populations of Chinook, status/trend monitoring can occur at various scales depending on the distribution of the population of interest.

In the same way, effectiveness monitoring can occur at different spatial scales. That is, one can assess the effect of a tributary action on a specific Recovery Unit or ESU (which may encompass several populations), a specific population (may include several sub-populations), at the sub-population level (may encompass a watershed within a basin), or at the reach scale. Clearly, the objectives and hence the indicators measured dictate the spatial scale at which effectiveness monitoring is conducted. For example, if the objective is to assess the effects of nutrient enhancement on egg-smolt survival of spring Chinook in the Chiwawa Basin (a sub-population of the Wenatchee spring Chinook population), then the spatial scale covered by the study should include the entire area inhabited by the eggs, fry, parr, and smolts. If, on the other hand, the objective is to assess the effects of a sediment reduction project on egg-fry survival of a local group of spring Chinook (i.e., Chinook within a specific reach of stream), then the study area would only encompass the reach of stream used by spawners of that local group.

In theory there might be no limit to the scale at which effectiveness monitoring can be applied, but in practice there is a limit. This is because as the spatial scale increases, the tendency for multiple treatments (several habitat actions) affecting the same population increases. That is, at the spatial scale representing a Recovery Unit, ESU, or population, there may be many habitat actions within that area. Multiple treatment effects make it very difficult to assess the effects of specific actions on an ESU. Even though it may be impossible to assess specific treatment effects at larger spatial scales, it does not preclude one from conducting effectiveness monitoring at this scale. Indeed, one can assess the combined or cumulative effects of tributary actions on the Recovery Unit, ESU, or population. However, additional effectiveness monitoring may be needed at finer scales to assess the effects of individual actions on the ESU or population. (See: Hillman et al. 2004, section 5, pages 31-33.)

Classification

Both status/trend and effectiveness monitoring require landscape classification. The purpose of classification is to describe the "setting" in which monitoring occurs. This is necessary because biological and physical/environmental indicators may respond differently to tributary actions depending on landscape characteristics. A hierarchical classification system that captures a range of landscape characteristics should adequately describe the setting in which monitoring occurs. The idea advanced by hierarchical theory is that ecosystem processes and functions operating at different scales form a nested, interdependent system where one level influences other levels. Thus, an understanding of one level in a system is greatly informed by those levels above and

below it.

A defensible classification system should include both ultimate and proximate control factors (Naiman et al. 1992). Ultimate controls include factors such as climate, geology, and vegetation that operate over large areas, are stable over long time periods, and act to shape the overall character and attainable conditions within a watershed or basin. Proximate controls are a function of ultimate factors and refer to local conditions of geology, landform, and biotic processes that operate over smaller areas and over shorter time periods. These factors include processes such as discharge, temperature, sediment input, and channel migration. Ultimate and proximate control characteristics help define flow (water and sediment) characteristics, which in turn help shape channel characteristics within broadly predictable ranges (Rosgen, 1996).

The UCMS plan proposes a classification system that incorporates the entire spectrum of processes influencing stream features and recognizes the tiered/nested nature of landscape and aquatic features. This system captures physical/environmental differences spanning from the largest scale (regional setting) down to the channel segment. The Action Agencies/NOAA Fisheries RME plan proposes a similar classification system. By recording these descriptive characteristics, the investigator will be able to assess differential responses of indicator variables to proposed actions within different classes of streams and watersheds. Importantly, the classification work described here fits well with Level 1 monitoring under the ISAB (2003) recommend strategies for restoring tributary habitat. Classification variables and recommend methods for measuring each variable are defined below. (See: Hillman et al. 2004) section 6, pages 33-45.).

The Upper Columbia Recovery Plan process is currently collecting information (GIS-based) to include this element.

Indicators

The Crab Creek subbasin planners have identified the following as a subset of key indicators: temperature, low flow, habitat diversity, channel stability, sediment, barriers, invertebrates, and riparian characteristics.

Additional indicators that provide information for use in assessing fish population structure and distribution and habitat conditions as described generally in the EDT analytical model and method are also targeted in the Crab Creek Monitoring and Evaluation Program.

Theses indicators represent a subset of variables that should be measured. Investigators can measure additional variables depending on their objectives and past activities. For example, reclamation of mining-impact areas may require the monitoring of pollutants, toxicants, or metals. Some management actions may require the measurement of thalweg[12] profile, placement of artificial instream structures, or livestock presence.

[12] "Thalweg" is defined as the path of a stream that follows the deepest part of the channel (Armantrout 1998).

Adding other needed indicators will supplement the core list.

Indicator variables identified in the UCMS template are consistent with those identified in the Action Agencies/NOAA Fisheries RME Plan and with most of the indicators identified in the WSRFB (2003) monitoring strategy. The Action Agencies/NOAA Fisheries selected indicators based on their review of the literature (e.g., Bjornn and Reiser 1991; Spence et al. 1996; and Gregory and Bisson 1997) and several regional monitoring programs (e.g., PIBO, AREMP, EMAP, WSRFB, and the Oregon Plan). They selected variables that met various purposes including assessment of fish production and survival, identifying limiting factors, assessing effects of various land uses, and evaluating habitat actions. Their criteria for selecting variables were based on the following characteristics:

Indicators should be sensitive to land-use activities or stresses.
They should be consistent with other regional monitoring programs.
They should lend themselves to reliable measurement.
Physical/environmental indicators would relate quantitatively with fish production.

Table 7. Biological indicator variables (with conceptual protocols) to be monitored in the Crab Creek Baseline M&E Program.

General characteristics	Specific indicators	Recommended protocol	Sampling frequency	HGMP Performance Indicator

Adults	Escapement/Number	Dolloff et al. (1996); Reynolds (1996); Van Deventer and Platts (1989)	Annual	--Total number of fish harvested in Colville Tribes summer/fall fisheries. --Annual number of summer/fall Chinook spawners in each spawning area, by age (Similkameen River, Crab CreekRiver, Columbia River above Wells Dam). Etc.
	Age structure	Borgerson (1992)	Annual	To be completed as above
	Size	Anderson and Neumann (1996)	Annual	To be completed as above
	Sex ratio	Strange (1996)	Annual	To be completed as above
	Origin (hatchery or wild)	Borgerson (1992)	Annual	To be completed as above
	Genetics	WDFW Genetics Lab	Annual	To be completed as above
	Fecundity	Cailliet et al. (1986)	Annual	To be completed as above

Redds	Number	Mosey and Murphy (2002)	Annual	To be completed as above
	Distribution	Mosey and Murphy (2002)	Annual	To be completed as above
Parr/Juveniles	Abundance/Distribution	Dolloff et al. (1996); Reynolds (1996); Van Deventer and Platts (1989)	Annual	To be completed as above
	Size	Anderson and Neumann (1996)	Annual	To be completed as above
Smolts	Number	Murdoch et al. (2000)	Annual	To be completed as above
	Size	Anderson and Neumann (1996)	Annual	To be completed as above
	Genetics	WDFW Genetics Lab	Annual	To be completed as above
Macroinvertebrates	Transport	Wipfli and Gregovich (2002)	Annual/Monthly	To be completed as above
	Composition	Peck et al. (2001)[1]	Annual	To be completed as above

Measuring Protocols

An important component of all regional monitoring strategies (ISAB, Action Agencies/NOAA Fisheries, and WSRFB) is that the same measurement method be used to measure a given indicator. The reason for this is to allow comparisons of biological and physical/environmental conditions within and among watersheds and basins.[13] This section identifies methods to be used to measure biological and physical/environmental indicators. The methods identified in this plan are consistent with those described in the Action Agencies/NOAA Fisheries RME Plan and, for the most part, consistent with EMAP and WSRFB protocols.

[13] Bonar and Hubert (2002) and Hayes et al. (2003) review the benefits, challenges, and the need for standardized sampling.

PNAMP is supporting an initiative to coordinate a side-by-side comparison of protocols and will communicate to subbasin planners which protocols will be included in the test. This comparison, which is proposed to take place in 2005, will be done to identify which protocols are best for determining watershed condition status and trend. It's possible a pilot study in the John Day basin will take place in 2004 if funding and logistical constraints are resolved.

The Action Agencies/NOAA Fisheries monitoring group reviewed several publications, including the work of Johnson et al. (2001) that describe methods for measuring indicators. Not surprisingly, there can be several different methods for measuring the same variable. For example, channel substrate can be described using surface visual analysis, pebble counts, or substrate core samples (either McNeil core samples or freeze-core samples). These techniques range from the easiest and fastest to the most involved and informative. As a result, one can define two levels of sampling methods. Level 1 (extensive methods) involves fast and easy methods that can be completed at multiple sites, while Level 2 (intensive methods) includes methods that increase accuracy and precision but require more sampling time. The Action Agencies/NOAA Fisheries monitoring group selected primarily Level 2 methods, which minimize sampling error, but maximizes cost.

Before identifying measuring protocols, it is important to define a few terms. These terms are consistent with the Action Agencies/NOAA Fisheries RME Plan.

Reach (effectiveness monitoring) – for effectiveness monitoring, a stream reach is defined as a relatively homogeneous stretch of a stream having similar regional, drainage basin, valley segment, and channel segment characteristics and a repetitious sequence of habitat types. Reaches are identified by using a list of classification (stratification) variables. Reaches may contain one or more sites. The starting point and ending point of reaches will be measured with Global Positioning System (GPS) and recorded as Universal Transverse Mercator (UTM).

Although the level of accuracy expected from GPS reporting of stream locations may not be sufficient for all subbasin monitoring and evaluation purposes, the researchers for the John Day and Upper Columbia projects are planning to use it for the subbasin pilot efforts.

Reach (status/trend monitoring) – For status/trend monitoring, this section refers only to a "sampling reach" as defined by the EMAP design and referenced in the UC Strategy document. This is one method to consider using to initially locate a reach, with the "X" point being the place where bankfull width is determined. From this location the extent of the upstream and downstream boundaries (total reach length) are determined according to the protocol used. Data collected in the sampling reach should be linked to the best available hydrograpghy layers to facilitate mapping and use in a GIS. Typically the 1:100,000 scale has been used, but a routed 1:24,000 scale hydrography may soon become available.

Note: Standardized GIS and post processing of spatial data will require a standardized

protocol that does not currently exist. In the interim PNAMP recommends the following: 1. all GIS data should be provided with Federal Geographic Data Committee compliant metadata, including information on projection used; 2. data should be linked to a standardized stream each identification system to facilitate mapping and use in GIS; and, 3. use existing 1:100,000 and 1:24,000 hydrography layers where they have been cleaned and routed, and if not, use the best available information.

Site (effectiveness monitoring) – a site is an area of the effectiveness monitoring stream reach that forms the smallest sampling unit with a defined boundary. Site length depends on the width of the stream channel. Sites will be 20 times the average bankfull width with a minimum length of 150 m and a maximum length of 500 m. Site lengths are measured along the thalweg. The upstream and downstream boundaries of the site will be measured with GPS and recorded as UTM. For purposes of re-measurements, these points will also be photographed, marked with permanent markers (e.g., orange plastic survey stakes), and carefully identified on maps and site diagrams. Site lengths and boundaries will be "fixed" the first time they are surveyed and they will not change over time even if future conditions change.

Transect – a transect is a straight line across a stream channel, perpendicular to the flow, along which habitat features such as width, depth, and substrate are measured at pre-determined intervals. Effectiveness monitoring sites and status/trend monitoring reaches will be divided into 11 evenly spaced transects by dividing the site into 10 equidistant intervals with "transect 1" at the downstream end of the site or reach and "transect 11" at the upstream end of the site or reach. The number of transects varies for different attributes.

Habitat Type – Habitat types, or channel geomorphic units, are discrete, relatively homogenous areas of a channel that differ in depth, velocity, and substrate characteristics from adjoining areas. This plan recommends that the investigator identify the habitat type under each transect within a site or reach following the Level II classification system in Hawkins et al. (1993). That is, habitat will be classified as turbulent fast water, non-turbulent fast water, scour pool, or dammed pool (see definitions in Hawkins et al. 1993). By definition, for a habitat unit to be classified, it should be longer than it is wide. Plunge pools, a type of scour pool, are the exception, because they can be shorter than they are wide. (See: Hillman et al. 2004) section 8, pages 59-76)

Status/Trend Monitoring

If the objective of the monitoring program is to assess the current status of populations and/or environmental conditions, or to assess long-term trends in these parameters, then the following steps will help the investigator design a valid status/trend monitoring program.

Problem Statement and Overarching Issues:

- Identify and describe the problem to be addressed.
- Identify boundaries of the study area.

- Describe the goal or purpose of the study.
- List hypotheses to be tested.

Statistical Design (see Section 3 of UCMS Strategy):

- Describe the statistical design to be used (e.g., EMAP design).
- List and describe potential threats to external validity and how these threats will be addressed.
- If this is a pilot test, explain why it is needed.
- Describe descriptive and inferential statistics to be used and how precision of statistical estimates will be calculated.

Sampling Design (see Sections 4 & 5 of UCMS Strategy):

- Describe the statistical population(s) to be sampled.
- Define and describe sampling units.
- Identify the number of sampling units that make up the sampling frame.
- Describe how sampling units will be selected (e.g., random, stratified-random, systematic, etc.).
- Describe variability or estimated variability of the statistical population(s).
- Define Type I and II errors to be used in statistical tests (the plan recommends no less than 0.80 power).

Measurements (see Sections 7 & 8 of UCMS Strategy):

- Identify indicator variables to be measured.
- Describe methods and instruments to be used to measure indicators.
- Describe precision of measuring instruments.
- Describe possible effects of measuring instruments on sampling units (e.g., core sampling for sediment may affect local sediment conditions). If such effects are expected, describe how the study will deal with them.
- Describe steps to be taken to minimize systematic errors.
- Describe QA/QC plan, if any.
- Describe sampling frequency for field measurements.

Results:

Explain how the results of this study will yield information relevant to management decisions.

Subbasin planners should include a section regarding how the data from the study (with metadata) will be stored, managed and made available to others. A starting point for some subbasin data collection efforts, could be the data definitions document for the Upper Columbia and John Day pilot projects once it has been reviewed. Proponents for the Upper Columbia and John Day projects are reviewing the final data dictionary on

which their data system will be developed. The mechanics of data management in the Upper Columbia and John Day systems are being developed by the respective project teams and need significant additional work.

Data Management

Several forms of analysis will be required as data are gathered. Statistical tests, design components, database management architecture, and various reporting format requirements are things the sponsor will take into consideration. A data management protocol will be established following the general outline:

1. Develop Data Dictionary
1.1 Other Documentation
1.1.1 Develop Data Flow Diagram
1.1.2 Process Flow Diagram
1.1.3 Prepare Data Management Plan (who, what when how)
2. Develop Forms
2.1 Develop Field Forms
2.1.1 Create list of useful existing forms
2.1.3 Create Rough Drafts of needed Forms
2.1.4 Edit Forms to coincide with Finalized Data Dictionary (when complete)
2.1.5 Finalize Field Forms
2.2 Develop PDA Forms
2.3 Develop Data Loggers
3. Establish Data Collection and Reporting Standards
3.1 Establish appropriate level of granularity
3.2 Create/Adopt Chain of Custody Protocols
3.3 Create/Adopt QA/QC Protocols
3.4 Create/Adopt All Methods, Indicators, Metrics and Protocols (sampling and statistical design)
4.Create/Adopt Field Manuals
4.1 Field Forms
4.2 PDAs
4.3 Data Loggers
4.4 Test Field manuals and equipment
5. Training of all field crews and outside contractors
6. Collect Data
6.1 Field Forms
6.2 PDAs
6.3 Data Loggers
7. Data Reporting Timelines, Protocols and Formats
8. QA/QC
9. Data Transition
9.1 Develop data transition methods (including 10.0 Below)
9.1.1 Field Forms to Electronic Entry Form
9.2.1 Data Loggers to Individual PCs
9.2.1.1 Individual PCs to Central Server
9.3.1 PDAs to Individual PCs

9.3.1.1 Individual PCs to Central Server
9.4 Test data transitions
10. All data to single repository
10.1 Develop Repository capability
10.2 Test Repository capability
11. Final Testing Check off
12. **Documentation** From steps above to derive a program Data Management Protocol

Some additional considerations include:

All M&E data will be held within the data archive system developed for the Crab Creek M&E Plan. This system will consist of standardized Access/Excel database (Geospatial data base structure and data dictionary being developed for the John Day will be used in the Upper Columbia) formats and will be compatible with other industry and BPA structures. Data will be unrestricted and available to all resource management agencies and subbasin planners. It will remain in this data archive system until delivered to BPA, the Upper Columbia RTT, CBFWA, and other basin database systems such as StreamNet, IBIS, and SSHIAP etc.

Finally, data should follow a common form for definitions. The Pacific Costal Salmon Recovery Fund project has a set of draft definitions that are currently under review by PNAMP and others, and could be used.

WILDLIFE:

Following is a suggested template and outline for considering a terrestrial Monitoring and Evaluation section in subbasin plans.

1. Overview of Monitoring and Evaluation – Background and Concepts

1.1 Why is Monitoring and Evaluation important in subbasin planning?

1.1.1 Direction from Technical Guide for Subbasin Planners (Council Document 2001-20)

1.1.1.1 “Each subbasin plan must have a monitoring plan component that describes how strategies to be implemented are achieving the stated biological objectives…”

1.1.1.2 “The measures are the improvement in conditions of habitat or population overall – the trends within the subbasin.

1.1.1.3 Address if the strategies selected and implemented address the “limiting factors” as anticipated

1.1.1.4 Verify that the “limiting factors” are elements that limit the environmental expression and biological performance desired.

1.1.1.5 Not to be project-specific (that follows later).

1.1.1.6 Four fundamental questions for M&E design: (1) what indicator variables will actually be monitored? (2) Who collects the information and how? (3) How is the information evaluated and used? (4) How much will it cost?

1.1.1.7 To answer the four fundamental questions listed above, five steps to consider during the design of M&E plans for subbasin implementation strategies: (1) adopt elements of an ecological management framework; (2) define monitoring objectives (address indicators, address management needs, resolve scale issues, conduct early planning of the evaluation component); (3) establish monitoring needs (address sampling design, indicators, performance standards, and pilot studies); (4) develop a data and information archive (address QA/QC, data management and analysis, and report preparation); and (5) evaluation (conduct a scientific evaluation, a decision-making evaluation, and a public evaluation)

1.1.2 Guidance in “A Technical Guide for Developing Wildlife Elements of a Subbasin Plan” (Scheeler et al. 2003)

1.1.2.1 Merely mentions section 5.6 Research, Monitoring and Evaluation as part of the Outline for Subbasin Plan

1.1.3 Existing direction and protocols for aquatic monitoring and evaluation

1.1.3.1 Pacific Northwest Aquatic Monitoring Partnership (PNAMP) draft “Recommendations for Monitoring in Subbasin Plans”

1.1.3.1.1 Involved aquatic monitoring, including resident and anadromous fish

1.1.3.1.2. Will describe how to monitor, not what or why

1.1.3.1.3 Was reviewed by ISRP/ISAB: needs to address multiscale benefits (subbasin, province, state, and region) of a collaborative approach

1.1.3.2 Other aquatic monitoring protocols, for information:

1.1.3.2.1 Aquatic Ecological Unit Inventory draft technical guide (http://www.fs.fed.us/emc/rig/includes/aeui_draft_april04.pdf)

1.1.3.3.2 Pacfish/Infish Biological Opinion monitoring

(http://www.fs.fed.us/biology/resources/pubs/feu/rmrs_gtr_121.pdf)

1.1.4 Need to coordinate and integrate terrestrial monitoring and evaluation with aquatic monitoring and evaluation

1.1.4.1 Efficiencies of effort by coordinating monitoring of parameters, sites conditions,

etc.

1.1.4.2 Both should use top-down and bottom-up approaches, collaborative development

of monitoring priorities, etc.

1.2 Other attributes of a successful monitoring program (Reid ca. 1994, with our additions)

- Statisticians and regulatory staff are involved in planning the program from the earliest stages
- There is an institutional commitment to completing the program
- The overall program has a well-defined objective
- The monitoring strategy is designed to achieve the objectives of the program
- The study is designed using prior knowledge of:
    - what will change
    - where it will change
    - how much it will change
    - when it will change
- A detailed plan for collecting baseline conditions is developed before monitoring begins
- Monitoring parameters are appropriately sensitive to expected change
- Methods other than monitoring may be used if they are more efficient for answering question
- Monitoring methods for each study are designed specifically to answer the question proposed
- Monitoring protocols are consistent through the duration of a study
- A detailed plan for analyzing the data is developed and tested before monitoring begins
- All aspects of the monitoring plan are tested during an initial pilot study
- There is a clear tie between results and user needs; results will provide useful information
- A mechanism is included for communicating and applying the results

Also with good advice on monitoring are:

- Convention on Biological Diversity, with guidelines on designing national-level monitoring programs (http://www.biodiv.org/doc/meetings/sbstta/sbstta-09/official/sbstta-09-10-en.doc)
- Other federal guidance on monitoring, such as internal USDA Forest Service guidance on forest plan monitoring and evaluation.

1.3 General objectives for monitoring. Examples from Reid (ca. 1994):

Objective	Comments	Examples
Early warning:		
Of large events	long-term; accuracy more important than consistency, so improved methods are incorporated as developed	National Weather Service rainfall records used in flood forecasting
Of detrimental trends	long-term; consistency as important as accuracy	Atmospheric CO2; Christmas bird counts
Evaluate effectiveness of a practice or method	timing and attributes keyed to knowledge of response mechanism; may be short-term; usually is effectiveness or validation monitoring	USFS BMPEP
Test hypotheses of associative or causal relations	timing and attributes keyed to hypothesis and knowledge of response mechanism; may be short-term	Many research experiments
Regulatory oversight:		
Was action carried out?	implementation monitoring; timing keyed to timing of activity, attributes to wording of regulations; long-term. If standards defined by implementation, may be same as compliance monitoring.	County building permit inspections
Was goal attained?	compliance monitoring; attributes keyed to wording of regulations, timing to knowledge of response mechanism and timing of activity; long-term	EPA water quality
Define resource to facilitate planning:		
Through time	baseline monitoring, usually short term	Stream gauging for reservoir planning

Through space	inventory, usually carried out once	Forest stand inventory
Describe something	not a valid objective; for what purpose is it to be described?	Many inventories
Compare areas	not a valid objective; for what purpose are they to be compared?	Many inventories

1.4 Examples of specific objectives of natural resource planning monitoring

Examples of specific objectives can be found on http://www.fs.fed.us/oonf/reports/det2.html (source: USDA Forest Service), which include monitoring parameters of (1) ecosystem condition, health, and sustainability; (2) sustainable multiple forest and range benefits; and (3) organizational effectiveness.

Many other examples are available in the literature and on the Web. Specific to monitoring within the Columbia River basin is the publication by Bisbal (2001):

Abstract:

A logical sequence of seven steps is proposed as a generic template to design plans for monitoring and evaluating fish and wildlife in the Columbia River ecosystem. Management programs for these resources fail to include coordinated monitoring and evaluation plans. This short-coming is indicative of pervasive management conflicts detected from regional to local geographic scales. In the absence of a cohesive ecological management framework, monitoring and evaluation activities proceed without a clear understanding of what uncertainty they are intended to address, nor is there a clear description of the process to utilize the information gained. As a result, the accountability for the investment of public funds for fish and wildlife restoration is poor, information collected from the environment is not included in decision-making, and the ability to gain knowledge while taking management actions is compromised. The sequence of steps discussed here does not identify or describe distinct monitoring activities or methodologies at any particular location or listed under any specific monitoring plan. Instead, it concentrates on the generic elements necessary for the design and implementation of coordinated fish and wildlife monitoring plans. It is proposed that at least four major issues demand considerable attention in order to improve regional monitoring and evaluation capabilities: The first is adoption of an ecological framework for the management of fish and wildlife at relevant geographic scales within the ecosystem. Such a framework must include an explicit identification of goals, objectives, and actions to steer coordinated decisions across the boundaries of technical disciplines, management jurisdictions, and institutional responsibilities. The second is that the identification of these management goals for the geographic location of interest must precede the design of monitoring and evaluation plans from the top down. Third, the evaluation component must be considered early on in the planning process, so that it blends smoothly with

monitoring at the time of implementation. Fourth, decision-makers and scientists engaged in the planning of fish and wildlife monitoring and evaluation efforts in the region must have a close collaborative relationship. Monitoring and evaluation plans designed under these premises may enhance our collective observational capabilities, promote cost-effectiveness and adequate evaluation, and provide a useful tool to adjust our management practices to the challenges of complex ecosystems.

2.0 Types of monitoring and evaluation

The following terminology on "tiers" derives from the Independent Scientific Review Panel, with additional terminology from federal agency usage (viz., USDA Forest Service and USDI Bureau of Land Management).

2.1 Tier 1 Trend (Change) Monitoring (generally similar to "implementation monitoring") – Did the agencies, landowners, and managers implement the management guidelines? Implementation monitoring is sometimes viewed as an administrative accounting of actions.

2.2 Tier 2 Statistical Monitoring (generally similar to "effectiveness monitoring") – Did the management guidelines have the expected results? Effectiveness monitoring is viewed as tracking results as a specific outcome of management activities.

2.3 Tier 3 Research Monitoring (generally similar to "validation monitoring") – Are the scientific assumptions underlying the management guidelines correct? Validation monitoring is viewed as testing the scientific basis for the management guidelines, and may entail research.

2.4 Evaluation – should be integrated into the cycle of objective-setting, planning, monitoring, evaluation of results, and revising objectives. Part of the adaptive management cycle and as a feedback loop back into the monitoring plan.

3 Prioritizing and Selecting What to Monitor (a proposed list)

3.1 Criteria for selecting parameters to monitor

3.1.1 Identify and list the key assumptions underlying the management guidelines. For wildlife, examples include such concepts as functional redundancy imparting greater resilience of ecosystems to perturbations; and use of focal species as "umbrella species" that represent the habitat needs and ecological roles of other species. Validating some key assumptions may extend into the realm of research, although some may be tested with Tier 2 Statistical Monitoring (or effectiveness monitoring) activities.

3.12 Identify and list habitats, species, and key ecological functions most at risk. These form the basis from which specific parameters (habitat area, habitat patch size, species presence, population density and trend, inferred redundancy of key ecological functions, etc.) are determined and tracked through Tier 2 Statistical Monitoring (or effectiveness

monitoring) activities.

3.1.3 List the management activities resulting from the subbasin plan, that would be instituted to meet the plan objectives. An example of such management activities is controlling pollution or re-establishing the channel complexity of the Willamette River. Management activities can be identified at scales broader than the individual project scale. Tier 1 Trend (Change) Monitoring (or implementation monitoring) would track whether the management activities are being carried out as stated in the plan.

3.1.4 Identify and list limiting factors that most guide the outcome and form of the subbasin plan and associated management guidelines. An example may be the need to quickly slow or reverse the spread of noxious weeds or exotic species. Tier 2 Statistical Monitoring (or effectiveness monitoring) could track such parameters.

3.1.5 Identify and list which habitats, species, and key ecological functions are most effectively (and positively) influenced by management activities and guidelines for conservation or restoration. That is, Tier 2 Statistical Monitoring (or effectiveness monitoring), especially, is best aimed at parameters that management can influence, rather than other system conditions for which management may have little to no direct influence.

3.1.6 Identify and list parameters most directly and severely affecting desired ecosystem services. Such parameters may include specific wildlife-habitat types, and categories of key ecological functions, key environmental correlates, and other factors. A combination of Tier 2 Statistical Monitoring (or effectiveness monitoring) (to track trends in parameters) and Tier 3 Research Monitoring (or validation monitoring) activities could be used to test the underlying causal links to amounts and patterns of ecosystem services.

3.6 Identify parameters by spatial scale. Some parameters may need to be determined at the scale of a subbasin, others finer than a subbasin, and others broader than a subbasin (e.g., Ecoprovince). For the last of these, each subbasin would contribute their share of sampling that, collectively across the appropriate set of subbasins, would provide sample sizes and locations by which to judge conditions and trends of specified parameters at the desired level of statistical confidence.

3.7 Parameters would be identified from both bottom-up (local issues and needs) and top-down (Basin, Ecoprovince, and other broader issues and needs) priorities and procedures

3.8 Integrate terrestrial with aquatic, and wildlife with fish, monitoring activities and needs assessments. This will help address ecosystem more as a whole, and provide efficiencies in monitoring budgets and operations.

4 Specific Examples for Subbasin Planning

Some examples of monitoring and evaluation at the subbasin planning level within the Columbia River basin:

4.1 Draft Walla Walla Subbasin Wildlife Assessment and Inventory (Paul R. Ashley, Stacey H. Stovall, 2004; “Originally Appendix J of the Southeast Wildlife Ecoregion Wildlife Assessment and Inventory [WDFW 2004]): “Draft Subbasin Management Plan Terrestrial Research, Monitoring and Evaluation”

Lists 4 major assumptions used to focus subbasin planning (use of focal habitats; use of umbrella species as focal species; managing for focal species’ “recommended management conditions” would provide for functional focal habitats; focal species assemblages adequately represent focal habitats)

Presents an “Ecoregion Assessment and Inventory Synthesis Cycle”, an adaptive management process

{Presents a Research, Monitoring and Evaluation Plan, which lists research needs, data gaps, and methods for monitoring focal habitats and focal species

Presents focal habitat and species monitoring methodology, including general methods for vegetation and wildlife, and specific parameters to monitor for each focal habitat and species.

5 The Role of Research

5.1 The "R" component of “RM&E” may come later - research

5.2 Subbasin plans can be used to help list key uncertainties and assumptions to test.

5.3 Monitoring can be designed to answer some research questions, in the sense of adaptive management. Implementing the subbasin plans can be done as management experiments to track and test.

5.4 As an example, the main hypotheses and key assumptions pertaining to the “key ecological functions” part of the IBIS database can be listed (see http://www.spiritone.com/~brucem/kef1.htm#Hypotheses) as a basis for selected research studies.

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Acronyms and Abbreviations

BLM	Bureau of Land Management
BPA	Bonneville Power Administration
BOR	Bureau of Reclamation
BiOP	Biological Opinion
cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers
CRITFC	Columbia River Inter-Tribal Fish Commission
CRMP	Cultural Resources Management Plan
CWA	Clean Water Act
DOE	U. S. Department of Energy
DOI	U.S. Department of the Interior
EA	Environmental Assessment
Ecology	Washington State Department of Ecology
ECP	Eco-regional Conservation Planning
EDT	Ecosystem Diagnostic & Treatment
EIS	Environmental Impact Statement
EMS	Energy Management System
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission

FWS	U.S. Fish and Wildlife Service
GIS	Geographic Information System
HCP	Habitat Conservation Plan
HEP	Habitat Evaluation Procedure
HGMP	Hatchery Genetic Management Plan
huc	habitat
IBIS	Interactive Biological Information System
ISRP	Independent Scientific Review Panel
JFC	Joint Fisheries Committee
LFA	Limiting Factors Analysis
NEPA	National Environmental Policy Act
NGO	Non-governmental Organization
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPCC	Northwest Power Planning and Conservation Council
PA	Programmatic Agreement
PFRCC	Pacific Fisheries Resource Conservation Council
PUD	Public Utility District
RM	river mile
SSHIAP	Salmon and Steelhead Habitat Inventory and Assessment Project
TMDL	Total Maximum Daily Load
TSS	Total Suspended Sediment
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WQI	water quality index
WDFW	Washington Department of Fish and Wildlife
WSCC	Washington State Conservation Commission
Yakama Nation	Confederated Tribes and Bands of the Yakama Indian Nation
YFRM	Yakama Fisheries Resource Management