City of Corvallis
Salmon Response Plan

Prepared for:

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Appendix 8

Description of Habitat for
Upper Willamette River Spring Chinook ESU
Technical Memorandum
March 3, 2003

technical memorandum

DESCRIPTION OF HABITAT FOR UPPER WILLAMETTE RIVER SPRING CHINOOK ESU (Evolutionarily Significant Unit)

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INTRODUCTION

One of the most widely used, and least clearly defined, terms in discussing ESA-listed species is habitat. Recently, practitioners in the fields of wildlife and fisheries biology have noted this, and have expressed concern over the wide range of meanings attributed to this word. The associated ambiguity and imprecision resulting from these many definitions create a great deal of problems in understanding the scope of habitat use by plants and animals. This, in turn, causes problems in the measurement of associated variables and, ultimately, the recovery of listed species.

What follows is a description of critical habitat for the Upper Willamette River Spring Chinook ESU taken from the National Marine Fisheries Service (NMFS, 1997): the status review for Chinook salmon, definitions of habitat and associated concepts, and a discussion of the streams in the Corvallis area as spring chinook salmon.

LIFE HISTORY AND DISTRIBUTION OF THE UPPER WILLAMETTE RIVER SPRING CHINOOK ESU

Upper Willamette River Spring Chinook salmon represent the stream-type life history, as opposed to the ocean-type. Stream-type juveniles are much more dependent on freshwater stream ecosystems because of their extended residence in these areas. A stream-type life history may be adapted to those watersheds, or parts of watersheds, that are more consistently productive and less susceptible to dramatic changes in water flow, or which have environmental conditions that would severely limit the success of sub-yearling smolts (Miller and Brannon 1982, Healey 1991).

General Life History Traits of Spring Chinook Salmon

Stream-type chinook salmon juveniles disperse downstream following emergence from the redds (spawning beds) and occupy a variety of habitats during their freshwater residence. This dispersal appears to be related to resource allocation and migration to overwintering habitat and is not associated with saltwater osmoregulatory competence (ability to tolerate salt water) (Hillman et al. 1987, Levings and Lauzier 1989, Taylor 1990a, Healey 1991). There is a tendency for juveniles to move into deeper water, farther from bank shelter, as they grow older. If suitable overwintering habitat, such as large cobble, is not available then the fish will migrate downstream (Bjornn 1971, Bustard and Narver 1975, Hillman et al. 1987). At the time of saltwater entry, spring chinook (yearling) smolts are much larger, averaging 73 to 134 mm depending on the river system, than their fall (sub-yearling) counterparts and are therefore able to move offshore relatively quickly (Healey 1991).

Upper Willamette River Spring Chinook

Willamette Falls (River Kilometer or RKm 42) has historically limited access to the upper river and thus defines the boundary of a distinct geographic region. High flows over the falls provided a window for returning Chinook salmon in the spring, while low flows prevented fish from ascending the falls in the autumn (Howell et al. 1985). The predominant tributaries to the Willamette River that historically supported spring-run Chinook salmon include the Molalla (Rkm 58), Santiam (RKm 174), McKenzie (RKm 282), and Middle Fork Willamette Rivers (RKm 301), all of which drain the Cascades to the east (Mattson 1948, Nicholas 1995). Since the Willamette Valley was not glaciated during the last epoch (McPhail and Lindsey 1970), the reproductive isolation provided by the falls probably has been uninterrupted for a considerable time period. This isolation has provided the potential for significant local adaptation relative to other Columbia River populations. Three major populations of spring-run Chinook salmon are presently located above Willamette Falls; the McKenzie River, and North and South Forks of the Santiam River (Kostow 1995).

Chinook salmon typically rear in large streams, then spend 3 to 4 years in the ocean before returning to spawn. Spring Chinook return to freshwater beginning in February, and spawn from August to November. Spawning generally occurs at the head of gravel riffles, typically in pool tailouts, at depths of 0.3 to 1.2 m^2, in the mainstem of the stream. Water temperatures are cool (40 to 55^o F) and turbidity low. Depth and velocity requirements for spawning are highly variable, suggesting that Chinook salmon have a wide tolerance range. Redd size ranges from 4 to 15 m^2, depending to a large extent on the size of the fish. Sub-gravel, or hyporheic, flow is quite important. Spawning gravels range from 1.3 to 10 cm (.51 to 4.01 inches). Accepted percentages of fine sediments are considered to be no greater than 20%, although Chinook in the Red River in northern Idaho have successfully spawned in areas with percentages of fines exceeding that (up to 25%). Depth of egg burial ranges from 10 to 33 cm, with a mean of 18.8 cm.

Juveniles emerge from the gravel in winter or early spring, remaining as freshwater residents for up to 18 months. Juvenile survival increases in coarser gravels. Fry tend to displace downstream after emergence and rear in pools, river edges, backwaters, back eddies, behind fallen trees, undercut tree roots, and other bank cover. Upstream movements into smaller tributaries can occur during periods of high flow, but these movements are related to seeking streams of lesser turbidity and cooler temperatures. Overwintering chinook also utilize rock and boulder interstices as overwintering habitat. Downstream movement appears to be related to increases in stream discharge, with the fish showing a tendency to overwinter in the mainstem in deep pools and crevices. Velocity and turbidity appear to be the major determinants, with fish not utilizing still or excessively fast water. Movement to the ocean may occur at any time, although June appears to be the major movement period.

ENDANGERED SPECIES ACT CRITICAL HABITAT DESIGNATION

The Endangered Species Act of 1973 (ESA) requires that critical habitat be defined for a threatened or endangered species. Critical habitat is defined in section 3(5)(A) of the ESA as ''(i) the specific areas within the geographical area occupied by the species...on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species...upon a determination by the Secretary [of Commerce (Secretary)] that such areas are essential for the conservation of the species.'' The term ''conservation,'' as defined in section 3(3) of the ESA, means ''...to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this chapter are no longer necessary'' (see U.S.C. 1532(3)).

In designating critical habitat, NMFS considers the following requirements of the species: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing of offspring; and, generally, (5) habitats that are protected from disturbance or are representative of the historical geographical and ecological distributions of the species (see 50 CFR 424.12(b)). In addition to these factors, NMFS also focuses on the known physical and biological features (primary constituent elements) within the designated area that are essential to the conservation of the species and that may require special management considerations or protection. These essential features may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation.

In February 2000, the NMFS declared the entire Willamette River, as critical habitat for the Upper Willamette River Chinook Salmon ESU, except some stream reaches above long-standing natural barriers and several identified dams. However, following a court ruling in February 2002 on a critical habitat designation by the United States Fish and Wildlife Service (USFWS) for the southwestern willow flycatcher, a bird species in New Mexico, the NMFS issued a consent decree withdrawing this critical habitat designation. "Under the provisions of the Endangered Species Act, NOAA Fisheries is required to analyze the economic impacts on affected businesses, communities and individuals when designating critical habitat for salmon and steelhead trout populations. The 10th Circuit Court of Appeals held that the analysis of economic impacts for such designations must be much more specific than the current approach. While that case, *New Mexico Cattle Growers Association v. U.S. Fish and Wildlife Service,* involved a different species – the Southwestern willow flycatcher – the type of analysis reviewed by the court was similar to that used by NOAA Fisheries in its salmon and steelhead critical habitat designations." (from NOAA-Fisheries press release, March 11, 2002)

HABITAT DEFINITIONS

The definitions below are taken from a paper published in The Wildlife Society Bulletin (*The habitat concept and a plea for standard terminology*; L.S. Hall, P.R. Krausman, and M.L. Morrison" WSB 25 [1]:173-182), and represent those used by the authors of the Corvallis 4 (d) Plan.

"Habitat comprises the resources and conditions present in an area that produce occupancy-including survival and reproduction-by a given organism. Habitat is the sum of the specific resources that are needed by organisms. Whenever an organism is provided with resources that allow it to survive, that is habitat."

"Habitat use defines the way an organism uses (or consumes) a collection of physical and biological components. Habitat preference represents the consequence of habitat selection, resulting in the disproportional use of some resources over others. Habitat quality is the ability of the environment to provide conditions appropriate for individual and population persistence." From the standpoint of Corvallis' urban streams the question becomes, what habitat is available for Chinook salmon spawning and rearing?

"Habitat selection consists of a hierarchical process involving a series of innate and learned behavioral decisions made by an organism about what habitat it would use at different scales of the environment." Again, from the standpoint of Corvallis' stream the question becomes, "What life stages of Chinook salmon could be present in Corvallis' streams and do they have the capability to actively select habitat?"

"Habitat availability describes the accessibility and procurability of physical and biological components of a habitat by organisms. How accessible is the available habitat in the area?"

Critical habitat, as mentioned above in the discussion of the ESA, is a legal term describing the physical or biological features essential to the conservation of a species. Hall et al. (1997) and Murphy and Noon (1991) suggest that this definition should be linked with, and limited to, the concept of high-quality habitat, as it is equivalent to the ability of the area in question to provide the resources necessary for persistence of the population.

CORVALLIS STREAM HABITAT DESCRIPTIONS

Chinook salmon selectively spawn in the tributaries to major rivers, in third- to fifth-order streams. In order for any of the Corvallis streams to be considered this complex, it would be necessary to include the uppermost tributaries of Dixon and Oak Creek, which have low or no year-round flow, and are unsuitable for spawning or rearing. Chinook spawn in streams classified as Rosgen-type C-3. This describes a stream with moderate sinuosity (winding or meandering), a gradient less than 2%, and a high depth to width ratio, with numerous pool-riffle complexes and side channels. Again, this describes no streams in Corvallis, except in terms of gradient. Stream surveys show Corvallis streams to more closely resemble Rosgen-type G-3 streams; low to no sinuosity and low width to depth ratio, lacking only the high gradient typically associated with this stream classification.

Chinook salmon require gravel to cobble substrates in riffle areas for spawning (approximately $16m^2$ per redd or spawning site), with high amounts of groundwater flow to irrigate the eggs, and low (less than 25%) amount of fine substrate materials that tend to clog intra-gravel spaces (Healey 1991). Spawning area preference seems to be for the transitional areas between pools and riffles. This provides downwelling of streamflow into the gravels at the heads of riffles (Bjornn and Reiser 1991, Geist et al. 2002). Surveys in the Corvallis streams found none of this habitat present.

Chinook salmon spawn in a variety of depths throughout their range. Water velocities vary as well. The lack of any gravel, high degree of incision evidenced by these streams, and their low flow rates make them unsuitable for Chinook salmon spawning. It is possible that adult Chinook salmon do indeed venture up Corvallis streams, and indeed one was caught in Dixon Creek in the 1950's, but as spawning adults do indeed select habitat and show a preference for certain habitat features, it is clear that they would not be able to spawn in Corvallis streams, as the necessary habitat remains non-existent.

After hatching, spring chinook salmon spend a more extended portion of their life cycle in fresh water, unlike fall chinook, which migrate to the estuaries after a few weeks. Rearing areas consist generally of side channel areas with deep pool-riffle complexes with an abundance of overhead cover, cool temperatures, and drifting stream insects. These pool-riffle complexes play an important role in salmonid growth and survival (Healey 1991). As salmon are visual predators, water clarity is highly important. None of the surveyed streams contain any of these elements; flows are often intermittent, even in the main stems of some of the streams (e.g. Squaw Creek), and temperatures are high. As well, when flows are high the water is quite turbid, and essential pool-riffle complexes are generally absent. Existing pools are quite shallow. What very small areas of gravel substrate that do exist in these streams are highly embedded (filled in by sand or silt). This "armoring" makes them quite difficult to use effectively, whether by juvenile salmon as cover, or as habitat for macroinvertebrate prey species. The lack of these necessary elements of summer Chinook rearing habitat makes Corvallis streams unsuitable for this life history stage, as any rearing habitat in Corvallis streams would be of extremely low quality.

When juvenile Chinook salmon move from one habitat to another upon hatching, this movement initially goes downstream, not up, as it is almost a drift. The fact that juvenile Chinook salmon barely swim fast enough to stay ahead of the river current strongly suggests that they can spend little time or effort searching out tributary habitat upstream of where they end up, and indeed, likely find themselves transported by flood flows into areas not suitable for rearing (Healey 1991).

Juveniles generally don't drift for long before finding suitable habitat within their natal stream. As mentioned above, juvenile salmon will move as much as 6 km from their natal stream in search of suitable habitat (cold, clear pool-riffle complexes to overwinter; Murray and Rosenau 1989). Therefore, juvenile Chinook salmon spawned in the Mollala and Santiam Rivers are not likely to seek habitat upstream, particularly when this necessitates swimming against the Willamette River current. Once residence is established, movements become relatively restricted (Richards and Cernera 1989).

The vast majority of fish moving downstream from the tributaries of the McKenzie and Coast Fork Willamette Rivers likely find sufficient suitable habitat associated with those streams. Studies done as part of the McKenzie Confluence Study and the McKenzie Subbasin Assessment confirm this. Very few fish were found in the mainstem Willamette River and the lower McKenzie River during the studies, despite the presence of "above-average" habitat. At best, what habitat may exist in the Corvallis area would likely be winter refuge habitat, which would be occupied when flows in the Willamette River become too strong for fish to maintain their position in the stream. This would be quite simple habitat that would merely provide some depth without the high flows seen in the mainstem Willamette River. During the winter months, flows in Corvallis streams, though quite flashy, are large enough to ensure no barriers to access to the Marys River and the lower ends of Oak and Dixon Creeks.

There is no question that some juvenile salmon occasionally occupy the streams in Corvallis, but this habitat certainly does not fit the ESA definition of "critical habitat" and this habitat is certainly not critical to the survival of the ESU, nor is it likely to supply the basic energetic needs of pre-smolt juvenile salmonids. Energy and fitness requirements necessary to survive the tremendous physiological strain of acclimation to salt water are not supplied through occupation of sub-marginal habitats such as these. As Hall et al. (1997) emphasize-"home range is not necessarily equivalent to habitat." The simple act of finding an animal in a location does not imply that it is using that area as habitat-that the area supports some or all of its needs. It is the support of needs that determines habitat.

Historical Stream Conditions

The heavy winter rains that occur in the area, historically, likely influenced Corvallis' streams. Channel-forming flows likely occurred as a combination of ground-water influence and run-off following saturation of the soils in winter. Groundwater inputs have maintained some baseflow in the summer, although the braided and anastamosed (non-permanent braided channel) nature of the Dixon Creek and Oak Creek channels likely diffused this somewhat. The historical status of Squaw Creek is uncertain, as the stream may not be in its historical channel.

Corvallis stream channels were probably composed of degraded alluvial sediments and thus contained mostly fine sediments. Riparian areas were predominantly oak forests or prairies. The low summer flows and tendency for pooling in the channels likely led to warmer temperatures, despite groundwater influence and shading. The lower reaches could have been anastamosed or braided, depending upon flows, or simply continued meandering.

Present Stream Conditions

As the result of their use as a stormwater transport system, the hydrographs for all creeks have become flashier, with higher highs and lower lows. Base flows are low, due in part to the replacement of soils with impervious surface, and the incision of the creeks combining to reduce considerably the groundwater inputs to the system and surface water-groundwater connectivity. Both these factors likely severed Dixon and Oak Creeks from their groundwater connection in several, if not most reaches. The upper reaches of Oak Creek have suffered little alteration as the result of development, but the same cannot be said for Dixon Creek. Extensive residential development in its upper reaches has severely altered the nature of the stream geomorphology and instream habitat. Long stretches of the streams have been straightened and the habitat considerably simplified. The Dixon Creek channel is straight, with armored banks, and temperatures in the pools may be higher, although that is likely to remain unknown. Oak Creek still maintains a small amount of meander.

Squaw Creek is perhaps the most deceptive stream in the system. It appears to maintain considerable amounts of hydraulic connection with its floodplain and has well-developed riparian zones, with some wetlands. However, the contours of the stream appear to have been formed by a dragline, and there exists no instream habitat, in terms of bank undercuts or riffle-pool complexes.

The habitat-forming processes for Corvallis streams currently consist of the high runoffs during winter, as the result of the impervious surface, and the armored banks that resist erosion and movement of the channel. Large woody debris recruitment no longer occurs. Sediments continue to be fin-textured. Water quality is diminished due to runoff contaminants.

Restoring these streams to historic conditions (pre-1860) would require the following actions:

- Wholesale condemnation of large developed areas along the stream channels to provide room for channel meandering (at least in the lower reaches).
- Re-engineering the channels throughout their entire length (in the lower gradient portions) to restore meanders. This would include laying back the banks to restore hydrologic connectivity.

- Removal of all impervious surface to allow for revegetation of the upper reaches, restoring hydrographs to those more likely seen in historical periods thereby preventing, or slowing, further incision in an effort to restore groundwater-surface water connectivity.
- Replanting of the lower reach oak gallery forests and restoration of historic disturbances in the form of episodic wildfires to maintain them
- Removal sufficient amounts of impervious surface in the lower reaches and replacing it with sufficiently pervious surface to restore historic groundwater levels and provide higher baseflows.
- Provide initial flushing flows to remove concentrations of fine sediments.
- Replacement of all culverts with bridges.
- Addition of large woody debris into Squaw Creek to provide some habitat complexity.
- Complete treatment of all runoff prior to its entering either of the water systems to remove all pollutants.

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