Written Testimony of Shari Witmore (NOAA Fisheries Fish Biologist)

*Professional Background*

My name is Shari Witmore. I have been working as a professional fish biologist with NOAA Fisheries since September 2008. My position is specific to the Klamath Watershed. Prior to my work with NOAA Fisheries, I spent years as a fisheries technician, employed by the US Forest Service, Oregon Department of Fish and Wildlife, and Oregon State University as described in my CV (exhibit 2). In addition to my professional experience as a fish biologist, I also have a Bachelor of Science Degree in Fisheries and Wildlife Science and a Master's of Science Degree in Fisheries Science. My Master's thesis project involved the study of Endangered Species Act (ESA) listed coho salmon using Stanshaw Pond in the Mid Klamath watershed and is described in detail in my thesis paper (exhibit 3).

*Salmonid Life History in the Klamath River Watershed*

Salmon and steelhead are an anadromous species meaning that they are born in fresh water, migrate to the ocean to mature, return to the freshwater streams where they were born to reproduce by spawning, and then finally die after reproduction is complete. Some steelhead (kelts) can migrate back to the ocean after spawning and return to spawn in freshwater streams during subsequent years.

Coho salmon typically exhibit a three year life cycle, spending approximately 18 months in freshwater and 18 months in saltwater (Gilbert 1912) adults migrate and spawn in small streams that flow directly into the ocean, or tributaries and headwater creeks of larger rivers (Sandercock 1991). In larger river systems like the Klamath River, adult coho salmon have a broad period of freshwater entry spanning from August until December (Leidy and Leidy 1984). Adults migrate upstream to spawning grounds with spawning typically occurring November through December. Fry emerge from the gravel in the spring, approximately 3 to 4 months after spawning. Juvenile rearing usually occurs in tributary streams with a gradient of 3 percent or less, although they may move up to streams of 4 percent or 5 percent gradient. Juveniles may spend 1 to 2 years rearing in freshwater (Bell and Duffy 2007), or emigrate to an estuary shortly after emerging from spawning gravels (Tschaplinski 1988). Preferred temperature ranges for juvenile coho salmon rearing have been reported from 11.4 - 14.6 ºC (Beschta et al 1987, Brett 1952) with lethal temperatures occurring at 25.8 ºC (Beschta et al 1987) and cessation of growth at a temperature of 20.3 ºC (Reiser and Bjornn 1979, Brett 1952). Juvenile coho salmon may redistribute in the spring as natal stream temperatures rise. They will seek out thermal refugia in cold water tributaries and in the mainstem river adjacent to the cold water tributary input where they can rear during the summer and fall (BOR 2007). With the onset of fall rains, coho salmon juveniles are also known to redistribute into non-natal rearing streams, lakes, or ponds, where they overwinter in slow water or velocity refuge (Peterson 1982). Emigration of smolt from streams to the estuary and ocean generally takes place from March through May.

In a review of the effects of water temperature on coho salmon in the Shasta River, Stenhouse et al. (2012) found that water temperatures exceeding 20.3 °C have detrimental effects to rearing coho salmon. In the Shasta River, Chesney et al. (2009) found that juvenile coho salmon avoid habitats when water temperatures in the spring begin to approach 18 °C to 20 °C at which point fry and juvenile coho salmon migrate to cold water refugia habitats often associated with cold water spring sources. Water temperatures commonly exceed 20 °C throughout the majority of the mainstem Klamath River in late spring and summer. Over summering habitat within this reach is currently limited to areas of cold water created and maintained by cold water from tributaries. Diversion of cold water sources for irrigation purposes reduces the amount of cold water available instream that would otherwise be available to improve habitat conditions for juvenile coho salmon.

Chinook Salmon have a similar life cycle to coho salmon as described above. Chinook salmon are similarly anadromous, born in fresh water, migrate to the ocean to mature, and die after spawning in natal freshwater habitat. However, Chinook salmon will return to freshwater to spawn when they are 3 to 8 years old (Healey 1991). Runs (fall vs. spring) are designated on the basis of adult migration timing; however, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime and flow characteristics of their spawning site, and actual time of spawning (Myers *et al.* 1998). Chinook salmon generally spawn in waters with moderate gradient and gravel and cobble substrates. Eggs are deposited within the gravel where incubation, hatching, and subsequent emergence take place. The upper preferred water temperature for spawning adult Chinook salmon is 14 $^{o}$C (Reiser and Bjornn 1979). The length of time required for eggs to develop and hatch is dependent on water temperature, and quite variable. After emergence, juvenile Chinook salmon in the Klamath basin typically outmigrate during the spring, entering the estuary before they are a year old. In some instances, juveniles will over-summer in freshwater before entering the ocean when they are one year old. These over-summering Chinook juveniles need cooler water for survival, and use thermal refugia in the mainstem Klamath and in the tributaries (Strange 2011, BOR 2007).

Steelhead Trout have a highly variable life cycle, spending different amounts of time rearing in fresh water, maturing in salt water, and spawning sometimes more than once in natal streams. Juveniles live in freshwater from 1 to 4 years (usually 2 years in the California ESUs), then smolt and migrate to the ocean in March and April (Barnhart 1986). While juvenile steelhead trout can tolerate higher water temperatures than coho salmon, steelhead also benefit from cold water refuia in the mainstem and tributaries of the Klamath basin. Juvenile steelhead trout have been observed in these thermal refugial locations throughout the Klamath basin (Brewitt 2014, Strange 2011, BOR 2007). Smolts and spawned adults (called kelts) migrate through estuaries, spending little time rearing. Survival of migrating smolts is size-dependent, with larger and older fish having higher survival rates (Holtby et al 1990).

*SONCC Coho Salmon Critical Habitat*

Critical habitat for the SONCC coho salmon ESU was designated in 1999 under the ESA, and includes all accessible waterways, substrate, and adjacent riparian zones between Cape Blanco, Oregon, and Punta Gorda, California (64 FR 24049; May 5, 1999). SONCC coho salmon ESU critical habitat is separated into five essential habitat types of the species' life cycle. The five essential habitat types include: (1) juvenile summer and winter rearing areas; (2) juvenile migration corridors; (3) areas for growth and development to adulthood; (4) adult migration corridors; and (5) spawning areas. Essential habitats 1 and 5 are often located in small headwater streams and side channels, while essential habitats 2 and 4 include these tributaries as well as mainstem reaches and estuarine zones. Growth and development to adulthood (essential habitat 3) occurs primarily in near-and offshore marine waters, although final maturation takes place in freshwater tributaries when the adults return to spawn. Within these areas, essential features of coho salmon critical habitat include adequate: (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, and (10) safe passage conditions (64 FR 24049; May 5, 1999).

The condition of SONCC coho salmon critical habitat at the ESU scale, specifically its ability to provide for the species' conservation, has been degraded from conditions known to support viable salmonid populations that contribute to survival and recovery of the species. Some factors degrading the critical habitat and depressing coho salmon populations include: intensive timber harvesting, agricultural and mining activities, urbanization, stream channelization, dams, wetland loss, and water withdrawals for irrigation. SONCC coho salmon are dependent upon low gradient habitats for winter rearing, and will express diversity by overwintering in low-gradient, off-channel and estuarine habitats when they are available.

Key limiting stressors for the ESU include lack of floodplain and channel structure, stream channelization, altered hydrologic function—the amount of water in streams and rivers is insufficient for coho and salmon needs (NMFS 2014). The final recovery plan (NMFS 2014) identified increased water temperature as one of the most widespread (and greatest) stresses in the SONCC coho salmon ESU. The 2016 status review for SONCC coho salmon described lack of water for summer rearing juveniles as worsening since the previous status review and that this is a primary factor inhibiting the recovery of the ESU (NMFS 2016).

*Coho Salmon in the Klamath River Watershed*

Coho salmon are the only ESA listed species in the Klamath Basin. Southern Oregon Northern California Coastal (SONCC) coho salmon are described as a specific Evolutionarily Significant Unit (ESU) and the SONCC Coho Salmon Recovery Plan (NOAA Fisheries 2014,) provides information about the status and recovery strategy of the ESU. Within the Klamath Basin, there are nine populations of coho salmon as defined in the SONCC coho salmon recovery plan. These are Lower Klamath River, Middle Klamath River, Salmon River, Upper Klamath River, Scott River, Shasta River, Upper Trinity River, Lower Trinity River, and South Fork Trinity River. Because the Klamath Basin includes interior populations, individuals from the upstream most reaches of the basin are affected by conditions in the mainstem and tributaries as they migrate downstream (juveniles) and when they return as adults – migrating upstream. The Trinity River populations are not affected by conditions in the Mid Klamath River since the Trinity River confluence is downstream. For example, a fish spawned in the Shasta River, which is at high risk of extinction, will be subject to conditions in the Middle Klamath River when it migrates out to the sea as a smolt. This dynamic, of fish experiencing conditions in regions other than their natal watershed, is particularly important for the coho salmon of the Klamath Basin since these fish have complex movement patterns. The interior watersheds such as Shasta River, Scott River, Upper Klamath River, and the Mid Klamath River experience hotter temperatures and low instream flows, which can become lethal to juvenile coho salmon.

Therefore, juvenile coho salmon often redistribute in the spring and summer as temperatures rise and flows drop. They migrate downstream and seek thermal refugia in tributaries throughout the Klamath Basin. Juvenile coho salmon often migrate a second time during a fall redistribution event. During the fall they seek out slow water refugia such as off channel ponds and tributaries with lower velocity than the mainstem. For example, while conducting my thesis research, I found that juvenile coho salmon could occupy at least 4 different tributaries during their fresh water rearing period, showing a complex and exploratory movement strategy. Additionally, I found that juvenile coho salmon could display a diurnal movement pattern where they migrate each evening from a tributary or off channel pond into a larger water body such as the mainstem Klamath River to presumably take advantage of diverse food resources. Exhibit 3, my thesis document, describes these movement patterns in detail as documented during my research in the Klamath Basin.

*Stanshaw Creek*

Stanshaw Creek is a high gradient tributary to the Klamath River that forms a cold water pond on the floodplain of the Klamath River during the summer low flow season. I included this pond habitat in my thesis research during 2012 and 2013. The pond provides excellent habitat for juvenile salmonids with cold water temperatures, significant cover and overhanging vegetation, and still water for velocity refuge. During the winter the pond can become inundated by high flows in the mainstem, but maintains a deep and slow water habitat that provides velocity refuge from the mainstem. Coho salmon rarely spawn in Stanshaw Creek, but the pond is used extensively by juvenile salmonids for over summer and winter rearing. Fishes that rear in this location have typically migrated from other locations in the basin and could represent fish from many populations upstream. The SONCC Coho Salmon Recovery Plan (NMFS 21014) specifically identifies Stanshaw Creek as a critical rearing habitat for juvenile coho salmon during the summer and describes water diversions there as a threat to coho salmon.

In the spring and summer fish key in on the cold water entering the Klamath River and they move into the pond where they find refugia through the summer. The connection of the pond to the mainstem Klamath River, particularly in the spring (May-July) is important when juvenile fish are actively redistributing and seeking out the cold water refugia. At a certain point in the summer, the mainstem Klamath River reaches lethal temperatures and fish can no longer use it for migration. At this point we do not see fish entering Stanshaw Creek. However, fish would continue to benefit from a connection to the mainstem since we have observed fish migrating daily into the mainstem for feeding opportunities. However, the most critical aspect of the pond habitat will be the maintenance of cold water and sufficient depths to support the fish that are already rearing there. During the summer of 2012, the maximum recorded Mean Weekly Average Temperature (MWAT) was 16°C. At this temperature, I observed fish in a relatively robust and healthy condition with an average summer growth rate of 0.004 gram/gram/day. Connection from the pond to the mainstem Klamath is again critical in the fall when juvenile coho salmon may redistribute to find different winter rearing habitat. Some juvenile coho salmon may choose to overwinter in the pond and would rely on a spring (March-June) connection to the mainstem to outmigrate as smolt when they are one year old.

In summary, coho salmon in the Klamath Basin have evolved to be highly migratory and exploratory in their movement patterns. Because so many natal streams become inhospitable during parts of the freshwater rearing period, fish are forced to seek out suitable habitat. Of the ten study sites in the Mid Klamath watershed that were part of my research project, all ten sites had non-natal juvenile salmonids including steelhead trout, Chinook salmon, and coho salmon. Finding these refugia habitats is critical for the survival of juvenile salmonids from all across the basin. The existence of refugial habitats is a limiting factor for most coho salmon populations as described in the SONCC coho salmon recovery plan and Stanshaw Creek represents a very critical habitat for the survival of coho salmon in the Klamath Basin.

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