Section 8

Cumulative Effects

Under federal guidelines, a biological evaluation must describe and analyze the effects of actions that are cumulative to the primary action. Cumulative effects are impacts on the environment that result from the incremental impact of future actions when added to other past, present, and reasonably foreseeable future actions regardless of which agency or person undertakes the action. For this SBE, 'cumulative effects' are the effects of future local, state or private activities that are reasonably certain to occur within the Seattle action areas (see Figure 1).

Federal actions are not included in the cumulative effects analysis because the effects of those actions would be considered in any future Section 7 consultations. This cumulative effects analysis does not address future work within the Seattle action areas that would be authorized by a federal agency (*e.g.*, work requiring a Corps Section 10 or 404 permit), funded by a federal agency (*e.g.*, projects receiving funding from the Federal Highway Administration, U.S. Department of Housing and Urban Development, *etc.*), or carried out by a federal agency (*e.g.*, Corps' modification of the Hiram M. Chittenden Locks).

Cumulative effects within the seven action areas for this SBE may include impacts from the following:

- Expansion of transportation networks may result in environmental impacts
- Increases in population growth that may result in increases in impervious surfaces, contaminant releases, and pesticide use and subsequent releases
- Along the Puget Sound waterfront, increases in water-based actions, water-based businesses and waterfront businesses (such as barge shipping, fishing, cement production, shipbuilding and repair, marine construction, aircraft manufacturing, sand and gravel operations, and recreational boating) may result in environmental impacts
- Global and regional changes to climate may cause variations in environmental impacts

All these activities, which may have an incremental impact and/or compounding effect when experienced together, may result in impacts to ESA-listed fish and wildlife species. The following are direct and indirect effects resulting from these cumulative actions:

- Increased sedimentation

- Altered hydrology including increased surface water peak flows and reduced groundwater flows
- Increased impervious surface
- Loss or further degradation of functional riparian habitats

These effects may be lessened by the application of updated regulatory regimes that focus on protecting riparian areas, decreasing stormwater runoff, and controlling the harmful effects of erosion and drainage during construction. Seattle's Department of Planning and Development has programs and services that educate and provide technical assistance and incentives to produce long-term, environmentally sustainable benefits to the city. Some of these programs include Greenhouse Gas Assessment; Shoreline Alternative Mitigation Plan; Shoreline Master Program; Stormwater, Grading and Drainage Code; and City Green Building. These and other programs will help improve the environment as well as meet the City's increasing population demands.

As of early 2015, the City of Seattle population estimate of is approximately 662,400 (http://www.seattle.gov/dPd/cityplanning/populationdemographics/default.htm). In the next 20 years, the population is projected to increase about 17.5% or by 98,700 residents (City of Seattle 2005). Population increases may result in changing impervious surfaces through construction of more buildings and paved or concreted surfaces. A related potential impact is the pressure to move the urban growth boundary as a result of increased housing costs. The political will to hold to the urban growth boundary will be important in focusing greater impacts on the City of Seattle rather than sprawl into the rural areas. While holding to the current urban growth boundary will provide better ecological functioning overall, it puts added pressure on the urban areas and requires increased emphasis on the protection of water quality and riparian and aquatic habitat.

Development increases impervious surfaces. Most physical, chemical, and biological characteristics of stream quality were found to degrade with more impervious surfaces (May *et al.* 1996). The effect of increases in impervious surfaces can result in higher peaks in water flow during rains and less infiltration to ground water, resulting in lower groundwater flows to waterbodies during dry periods. It also may increase the quantity of pollutants entering surface waterbodies instead of being filtered by the soils during infiltration. The City of Seattle is already highly urbanized and little new impervious surface can be built. Nonetheless, updated land-use regulations, building standards, and construction regulations help minimize or mitigate adverse impacts to areas critical to ESA-listed species through prohibiting actions or by dictating timing and methods of an action. Increased residential and commercial development also may result in increased use of chemical fertilizers or pesticides, which can enter Puget Sound, Lake Washington, and streams within the seven action areas. Outreach and education programs conducted by local governments and utilities may be effective at minimizing this increase. In addition, the City has an Environmental Action Agenda that includes protection and improvements to surface water quality and Seattle's aquatic habitats.

The action areas along Puget Sound are major urban industrial waterways that support water-based commerce, waterfront businesses and water transportation networks, such as marine container and barge shipping, fishing, rail and highway transportation, concrete production, shipbuilding and repair, marine construction, aircraft manufacturing, sand and gravel operations, and recreational boating, to name a few. The Puget Sound shoreline is continually changing as new waterfront facilities and uses occur. The increased operation of the waterway's facilities may increase the use of the water-based

transportation network and its connection to the land-based transportation network. Puget Sound contains several onshore oil facilities, tanker ports receiving large numbers of tanker and barge trips annually, large industrial developments, tanker and other shipping routes, bypass traffic into southern British Columbia, and other coastal and urban developments. The increase in vessel traffic will increase the potential for water pollution from vessel-related activities (*e.g.*, oil, transmission fluid, gasoline, and diesel fuel spills).

Regulation by agencies, such as the Washington State Department of Ecology (Ecology) and the U.S. Coast Guard, mitigate or minimize adverse effects to water quality, including those caused by vessels operating in Puget Sound. For example, regulations prohibit bilge and sewage discharge and require that any hazardous material spilled (*e.g.*, diesel fuel, gasoline, oil, and transmission fluid) be reported to Ecology and the U.S. Coast Guard.

Lately it has become important to consider global climate change as a possible component of cumulative effects. The City has introduced locally and nationally a Climate Protection Initiative to reduce global warming, improve air quality, and review the rise in sea-level and its potential and effects. Locally, there have been increases in the number of days of warm temperatures in some surface waters, such as in the Ship Canal. In addition, rainfall frequency and intensity may be impacted by global climate change. These changes may carry incremental environmental impacts, such as affecting the timing of salmon migration and survival or reproductive viability. More discussion is provided at the end of this section.

The City of Seattle is taking numerous actions to offset adverse cumulative effects and to benefit the environment. One such action is to promote healthy people and communities by creating healthy livable urban centers and promoting sustainable practices. In addition the Green Seattle Initiative was initiated for restoring the urban forest, increasing open space, and promoting the greening of the 'built environment.' A second action is the Plan to Protect Seattle's Waterways, which is a comprehensive strategy being implemented to reduce overflows and discharge of pollutants from combined sewers and the storm drain system. Other offsetting actions for adverse effects to growth include:

- Increasingly well-informed and targeted regulations
- Educating citizens
- Creating environmentally-friendly areas

Local, state, and federal regulators are striving to develop effective regulations and guidelines to manage the environment. These include Seattle's Environmental Critical Area ordinance, which mitigates for development and the related Seattle Shoreline Master Program. In addition, many agencies and nonprofit groups are educating citizens on topics such as using environmentally-friendly products, planting native vegetation and removing invasive plants, car-pooling, mass transit, biking, walking, and creating and improving fish and wildlife habitats. Environmentally-friendly trends include construction of more natural surface water drainage systems through designs that allow longer surface water contact with the soil and, thus, more infiltration and pollutant soil filtering. Other actions include removal of stream blockages and the restoration of stream, lake, and Puget Sound shorelines to benefit salmon and other riparian and aquatic species. While many of these actions will require permitting with the Corps and, therefore, consultation with the Services, they will help avoid and minimize the cumulative effects of ongoing activities within the Seattle action areas.

Climate Change

There is now widespread consensus within the scientific community that atmospheric temperatures on earth are increasing and that this will continue for at least the next several decades (IPCC 2007, p. 749). There is also consensus within the scientific community that this warming trend will alter current weather patterns and patterns associated with climatic phenomena, including the timing and intensity of extreme global events such as heat-waves, floods, storms, and wet-dry cycles.

Recent observations and modeling for aquatic habitats in the Pacific Northwest suggest that salmonids and other native cold-water species will be negatively affected by ongoing and future climate change. Rieman and McIntyre (1993, p. 8) listed several studies which predicted substantial declines of salmonid stocks in some regions related to long-term climate change. Battin et al. (2007) modeled impacts to salmon in the Snohomish River Basin related to predictions of climate change. They suggest that long-term climate impacts on hydrology would be greatest in the highest elevation basins, although site specific landscape characteristics would determine the magnitude and timing of effects. Streams which acquire much of their flows from snowmelt and rain-on-snow events may be particularly vulnerable to the effects of climate change (Battin et al. 2007, p. 6724). In the Pacific Northwest region, warming air temperatures are predicted to result in receding glaciers, which in time would be expected to seasonally impact turbidity levels, timing and volume of flows, stream temperatures, and species responses to shifting seasonal patterns.

Battin et al. (2007, p. 6720) suggest that salmonid populations in streams affected by climate change may have better spawning success rates for individuals that spawn in lower-elevation sites, especially where restoration efforts result in improved habitat. Higher elevation spawners would be more vulnerable to the impacts of increased peak flows on egg survival. They further note that juvenile salmonids spending less time in freshwater streams before out-migrating to the ocean would be less impacted by the higher temperatures and low flows than juveniles that rear longer in the streams.

Changes in climate have been identified that are occurring now or will occur over the next 50 to 100 years (Glick et al. 2007, p. iii; Mote et al. 2005, p. 4). The predicted changing precipitation patterns are expected to result in more frequent severe weather events and warmer temperatures (Mote et al. 2005, p. 13). Glaciers in the Cascades and Olympics Mountains have been retreating during the past 50-150 years in response to local climate warming. Regional warming can result in reduced winter snowpack, earlier occurrence of peak runoff, and reduced summer flows. If the current climate change models and predictions for Pacific Northwest aquatic habitats are relatively accurate, salmonids in the Puget Sound region are likely to be impacted through at least one or more of the following pathways:

- Changes in distribution of salmonids within a watershed, such as reduced spawning habitat, and/or seasonal thermal blockage in the migratory corridors associated with increased stream temperatures
- Disturbance or displacement of eggs, alevins, juveniles, and adults during winter flooding events
- Short-or long-term changes in habitat and prey species due to stochastic events during winter floods

- Changes in flow/out-migration timing in the spring for salmonids and their prey species
- Increased migration stressors from lower stream flows and high stream temperatures during spawning migrations