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NOAA FISHERIES SERVICE

Estuary Habitat

How Levees & Tide Gates in Estuarine Wetlands Affect Pacific Salmon & Steelhead

An estuary is a semi-enclosed coastal body of water where freshwater rivers meet the sea. Estuaries provide an important transition zone for salmon and steelhead as they move from freshwater habitat to life in saltwater. Healthy, functioning estuaries provide productive feeding areas and serve as a refuge from predators for young salmon. Some Chinook salmon, for instance, spend days and even weeks in the same estuarine wetland channel as they undergo physiological changes; and in Puget Sound, some Chinook spend several years in estuarine waters as they grow to maturity. In the Pacific Northwest, examples of estuaries include Puget Sound, the lower Columbia River, and semi-enclosed bays along the coasts of Oregon and Washington.

However, estuarine wetlands and small bays along their shores have been filled, cleared, diked, and drained to meet the development needs of the Pacific Northwest. The use of levees and tide gates enables farmers and coastal communities to convert estuarine wetlands into productive agricultural lands, and flood-prone lands into urban zones. While these same structures protect the altered landscape from free flowing waters, they also undermine the ecological health of the estuary and the salmon and steelhead that depend on it.

What Science Tells Us About Levees & Tide Gates and Their Impact on Salmon

Levees are elevated banks that keep low-lying lands from being flooded during high tides or periods of high river discharge. Tide gates are structures used to control the daily flow of water into and out of the estuarine areas protected by the levee. By hindering the movement of tidal waters at mouths of channels and wetlands, these artificial structures have a number of ecological effects. These include:

- Impairing passage of fish during each tide;
- Controlling upland flooding;
- Changing the velocity, turbulence, and pattern of freshwater discharge;
- Allowing backwaters to become warmer; and
- Creating upstream sedimentation because the lack of a two-way flushing cycle slows the natural transport of sediments from reaching the estuary, or funnels sediments past the flooplain and tidal wetland, creating a sediment starved system.

Functioning estuarine habitat provides juvenile salmon with productive feeding sites, refuge from predators, and a transition zone for gradual acclimation to saltwater. In many estuaries, however, the diverse habitats and complex food webs they support are compromised. Levees and tide gates limit habitat connectivity, impair fish passage (particularly to side channels and tributaries), and may impact the riparian trees and shrubs that provide cover and insect prey to juvenile salmon. Levees and tide gates also can result in fewer zones of mixed fresh

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and salt water, which are critical for salmon and steelhead as they transition from freshwater to saltwater. In addition, the lack of access to side channels and tributaries can result in smaller juveniles being flushed downstream into higher salinity waters, potentially causing increased stress on young fish. The reduction in quantity and quality of estuarine habitat can limit foraging success, limit growth, make salmon susceptible to higher rates of predation, and inhibit downstream and upstream migration.

Best Practices for Protecting Estuaries

Levees and tide gates can be designed and operated to provide important benefits to local communities and economies, while reducing the severity of adverse effects on fish. This is particularly important because several species of salmon and steelhead that depend on estuaries are threatened with extinction and protected by the Endangered Species Act. The best approach to protecting our estuaries is to not install levees and tide gates unless absolutely necessary. If these measures are necessary, please consider the following best practices:

Levee Vegetation: Trees and shrubs will naturally establish and grow on the faces of levees. Typically, a one-lane gravel road is maintained on the crest of a levee to provide access to tide gates and allow for levee repairs. Specific sites with known erosion potential may also need to be kept clear of trees, but ecological function is best met by encouraging dense, natural re-vegetation of native varieties of trees and shrubs, particularly waterward of levees. Vegetated areas above the intertidal zone provide important habitat functions, including decreased bank erosion and increased bank stability.

Levee Setbacks: Because each levee is a structure that eliminates functional intertidal and floodplain habitats, the best ecological condition for an estuary is met by "setting back" as much of a levee as possible—moving it away from lands that can flood from tides or high flows of rivers and streams. In addition to covering some area of intertidal and floodplain habitats, levees are designed to control the flow of tidal waters in ways that favor human use, and are not aligned necessarily with protecting or restoring rearing habitats for salmon. However, there are benefits to moving or setting levees further back from the banks. These include increased flood storage capacity, increased area and function of tidal wetlands and riparian habitats, and reduced upstream flooding and bank erosion. As a result, levee setbacks are a vital component of any estuary conservation plan.

Tide Gate Retrofits: Tide gates that limit free passage of juvenile salmon into and out of tidal channels can be modified to become less of a barrier. Replacing traditional tide gates with gates that close more gradually and stay open longer provide greater fish passage opportunity. When sized appropriately, they can also slow drawdown rates, which can reduce fish strandings. Modifying tide gate operations is also a simple practice that provides benefits. During seasons with no flooding, gates can be left open to provide free tidal exchange and fish passage.

For More Information

If you would like to learn more about how levees and tide gates affect estuarine habitat and the fish that depend on it, or if you would like to implement best management practices into your projects, please consider the following sources:

Marine and Estuarine Shoreline Modification Issues produced by the Washington Department of Fish and Wildlife. Available at: http://wdfw.wa.gov/publications/00054/

The Puget Sound Nearshore Ecosystem Restoration Project — background documents, including preliminary designs, for candidate restoration actions throughout Puget Sound can be found at: http://www.pugetsoundnearshore.org/technical_papers/cdr/Everett%20Marshland%20FINAL%20CDR%20with%20Intro.pdf

Skagit Delta Tidegates and Fish Initiative provides an example of how to comprehensively manage tide gates to help restore salmon habitats. Available at: http://wdfw.wa.gov/licensing/sepa/2008/08002_agreement.pdf

Biological and Physical Effects of "Fish-Friendly" Tide Gates available at: http://www.skagitcoop.org/documents/EB2673_Greene%20et%20al_2012.pdf