Ruth Sundermeyer has put together some research on the breaching of lagoons and estuaries. Bill Kier would like to acknowledge her good work on this topic as he continues an attempt to find anything published on fish rescue.

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## California Coastal Lagoons
## Effects of Artificial Sandbar Breaching

In many of California's rivers, a sandbar forms across the mouth of the river in the dry season when storm action is weak and river flow is low. This sandbar ponds water, causing the water level in the coastal lagoon to rise. To prevent local property flooding, the sandbar may be artificially breached. Artificial breaching may also be conducted to let migrating steelhead or salmon pass in the fall or spring. Artificial breaching may sometimes help fish passage (juvenile and adult steelhead or salmon), but may also have adverse effects on water quality and fish habitat. To understand how artificial breaching may affect your local lagoon, it helps to understand some basic estuarine/lagoon processes.

Although a sandbar can be open or closed at any time of the year, in most of our small coastal lagoons it usually forms in the spring or summer and may remain closed until the onset of the rainy season, when it would probably breach naturally. When the sandbar is open, the estuary is open to tidal mixing. This tidal influence may extend some distance up into the river, depending on the amount of river flow and the strength of the tide. When the sandbar forms across the mouth of a river, it ponds water and forms a lagoon. Sandbar formation is primarily influenced by offshore conditions and sand availability, but may also be influenced by river flow.

When the sandbar closes the river mouth, the lagoon and river are no longer open to tidal flushing. Saltwater can be trapped in the lagoon. Because salt water is denser than fresh water, it forms a layer under the fresh water from the river (stratification). This saltwater lens traps heat, dissolved oxygen becomes depleted in the saline layer and anoxic conditions can form.

This process was intensively studied in smaller central California coastal lagoons, in Pescadero, San Gregorio, Waddell and Pomponio creeks, north of Santa Cruz (Smith 1990). In these systems, the saltwater lens eventually seeps out through the sandbar, and the resulting freshwater conditions provide excellent rearing habitat for steelhead. The rate of conversion to a freshwater system depends on the amount of salt water impounded when the sandbar forms and on the amount of inflow to the system. Inflow from the river both dilutes the saltwater and causes higher water levels that can increase the rate of seepage through the sandbar. If the sandbar is breached, salt water flows in again. Then, when the sandbar reforms, salinity stratification results in a decrease in water quality and the cycle of freshening must start over. Flows in many of these central California coastal creeks are not augmented (like they are in the Russian River) and upstream water diversion can substantially reduce flow to the lagoon. If the sandbar is breached during low flows in the dry season, the rate of conversion to a fresh water system can be very slow, and may not even occur again in that season.

If one of these central California estuaries (sandbar-open conditions) remains open, good water quality can be maintained with tidal mixing or high river flows. In a lagoon (sandbar-closed), good water quality develops when the system is converted to freshwater, which results in lower water temperatures and higher bottom dissolved oxygen levels. Infrequent breaching,

especially during the low-flow summer months, results in salinity stratification, higher water temperatures and low dissolved oxygen.

Some California estuaries and lagoons have been shown to provide excellent rearing habitat for steelhead or chinook (Smith 1990, Larson 1987, Anderson 1995, 1998, 1999). In the small Central California Coast lagoons studied by Smith (1990) it has been shown that food rich estuaries/lagoons can contribute substantially to juvenile steelhead growth, and lagoon reared fish are a disproportionately larger percentage of the returning adults than fish that rear in the tributaries. Steelhead that leave the river at a larger size are more likely than smaller fish to return as adults. McKeon (1985) determined that in Redwood Creek, estuary reared juvenile chinook grew to a larger size than river reared fish.

Smith (1990) documented excellent juvenile steelhead survival and growth when the lagoons were closed and converted to fresh water. Growth was good when these estuarine systems were open to full tidal mixing. However, during the long transition periods to freshwater (with poor water quality), steelhead growth was poor. If inflow in the spring was high enough, a lagoon could convert rapidly to fresh water, but summertime breaching of sandbars severely degraded habitat quality and quantity, and food availability.

Juvenile steelhead and salmon use estuaries and lagoons to physiologically acclimate to saltwater conditions before they migrate to the ocean. If juvenile or adult fish are to pass through the system, the sandbar must be open. If the sandbar is breached too early in the fall, juvenile fish may be flushed out of the lagoon prematurely, and early adult spawners may be attracted into the river while river water conditions are too shallow or warm, before winter rains have restored adequate river passage conditions.

Not all estuaries are alike. Some estuaries/lagoons have substantial inflow in the summer, others have none, and the amount of flow varies between drought and above-average rainfall years. How an artificial breaching program affects fish and their habitat in a particular estuarine system depends on several factors. One is timing and flow. If an artificial breach occurs while spring flows are still high, the sandbar may reform while there is still enough flow in the river to freshen the lagoon. If an artificial breach occurs in the fall or winter when rainfall is causing a substantial rise in river flow, the breach may occur close to the time that a natural breach would have occurred. However, frequent breaching combined with low river flow may degrade fish habitat.

Another factor is whether juvenile steelhead or salmon are able to utilize the estuarine system. If spawning habitat is a long distance upstream, or if the river or lower portions of spawning tributaries dry back early in the spring, juvenile fish are not likely to be able to get to the lagoon for rearing. In that case, an artificial breaching program may affect fish passage, but not rearing habitat. If upstream water diversions cause lower river flows in the spring, when juvenile fish are migrating to the ocean, there may be an advantage to breaching the sandbar to provide juvenile fish passage out of the lagoon. However, if spawning habitat is nearby and the fish have access, a lagoon may be an important part of the summer rearing habitat in that system. In this case, an ill-timed breach may substantially degrade valuable rearing habitat.

Sandbar breaching programs are often conducted by local or county agencies to prevent flooding of local property. Some of these programs are under review for their effects on ESA listed fish species. Private individuals may also artificially breach a sandbar to protect their property, and these undocumented artificial breaches may have adverse effects on lagoon habitat.

What can you, as a concerned citizen, do? Become informed on how your local estuarine system works and what it takes to protect aquatic habitat. Because formal artificial breaching programs are under review, biological opinions and CEQA documents are being developed for many of these programs. Researchers have studied some local estuaries, and reports are available. By educating yourself and others, you can participate in efforts to revive and preserve our coastal lagoons.

Literature Cited

Anderson, D.G. 1999. Redwood Creek Estuary Annual Monitoring Report. Redwood National and State Parks, Division of Resource Management and Science, Fish and Wildlife Branch. Orick, California.

Anderson, D.G. 1998. Redwood Creek Estuary Annual Monitoring Report. Redwood National and State Parks, Division of Resource Management and Science, Fish and Wildlife Branch. Orick, California.

Anderson, D.G. 1995. Biological supplement to Redwood National and State Parks U.S. Army Corps of Engineers application: Coho salmon utilization of the Redwood Creek Estuary. Research and Management Division, Redwood National and State Parks. Orick, California.

Larson, J.P. 1987. Utilization of the Redwood Creek Estuary, Humboldt County, California, by juvenile salmonids. M.S. Thesis, Humboldt State University, Arcata, California. 79pp.

McKeon, J.F. 1985. Downstream migration, growth, and condition of juvenile fall chinook salmon in Redwood Creek, Humbolt County, California. M.S. Thesis. Humboldt State University, Arcata, California. 90 pp.

Smith, J.J. 1990. The effects of sandbar formation and inflows on aquatic habitat and fish utilization in Pescadero, San Gregorio, Waddell and Pomponio creek estuary/lagoon systems, 1985-1989. Prepared under Interagency Agreement 84-04-324, between Trustees for California State University and the California Department of Parks and Recreation.