"Sea-level rise and its impact"

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The NPAFC scientific community is aware of problems related to sea level rise, as predicted by the International Panel on Climate Change (IPCC) – up to 0.69 meters of global sea level rise in this century. Local sea level changes result from a combination of global average sea level and changes in coastal elevation due to local tectonic activity. Global average sea level rose about 20 cm over the past century, with the rate increasing over the past 15 years. The rate of change varied substantially by region and had considerable decadal-scale variability.

Recent projections suggest an increase of 20 to 60 cm over the next century, but do not include a recent information on the dynamics of ice melt. With these data, sea level increase by 2100 is estimated for the Pacific Northwest coast to range from 15 cm to 1.25 m. A higher rise is expected in areas with more rapid coastal subsidence, e.g., in the northern Oregon.

The effect of sea level rise may be experienced differently by Pacific salmon in different habitats throughout the stream network. The main threats are as follows:

- Sea-level rise will submerge existing estuarine habitats, which may or may not be able to rebuild themselves upstream due to topography and human development.
- Rising water level in river watersheds will reduce availability of wetland habitats for juvenile salmon with a long freshwater life phase. In the Pacific Northwest, estimates of potential essential habitat losses include: 65% loss in estuarine beaches, 61% loss of tidal swamp, 52% of brackish marsh will convert to tidal flats, transitional and saltmarsh, up to 44% loss of tidal flats, 25% loss of tidal fresh marsh and 13% loss of inland fresh marsh.
- Flooding of coastal areas will negatively impact water quality in estuaries by increasing of bank erosion. Extra mud and silt settling as well as debris accumulation on estuary floors negatively affect the dwelling conditions for rearing salmon. Sand-bar accumulation may prevent salmon access to spawning grounds in smaller tributaries.
- Higher in the stream system, fish populations may be affected by changes in precipitation timing that alter flow regimes and make existing spawning and rearing habitats inhospitable.
- Changes in estuarine biotopes will lead to declines in forage fish and zooplankton, along with the salmon and other aquatic life that rely on them. Negative consequences of food web alteration with be especially severe for coho salmon that use estuaries as a migration corridor and other salmonid species that rely on extended estuarine rearing.
- Widespread presence and construction of new dikes and floodgates to prevent the infrastructure flooding will restrict estuary expansion and lead to loss of essential salmonid habitat, especially for juvenile Chinook and coho salmon.

The NPAFC scientists study estuary ecosystems and share information on estuarine morphology, hydrological regime and sedimentation processes to estimate their potential resistance to sea-level rise related effects to project environmental and socio-economic impact of sea-level rise. Most recent progress in these studies took place in the Kamchatka Peninsula, Russia and the Pacific Northwest, U.S.A.

Estuaries of the tidal-lagoon type are found the most susceptible to sea-level rise related effects while estuaries of the fjord type are the least susceptible. The greatest variety of environmental conditions are observed in the lagoon-channel estuaries which may include both water channels and basins with different water salinity. The most extreme conditions of fish habitats are found in the lagoon-lacustrine estuaries and the channel estuaries with mouth widening: in the first case, due to the periodic appearance of hydrogen sulfide, and in the second case, due to the stressful tide impacts: regular fluctuations of water level, salinity, temperature, turbidity, speed and direction of water flows, etc. In general, steep river-dominated estuarine systems will have a less pronounced change in habitats due to sea level rise than low gradient ocean-dominated estuary systems. Basins with large estuaries are to receive more influence from sea level rise than those with small estuaries.

Future research efforts will be directed at understanding development on the connection and potential predictability of changes in the timing and intensity of stream hydrology on available spawning habitat under sea-level rise influence, modeling of hydrological and sedimentation processes as well as biogeochemical cycles in estuaries at different water level. Estuarine environmental monitoring will be strengthened, and related research will be expanded to the neighboring areas. Airborne LiDAR survey is becoming an increasingly valuable tool for such monitoring. Monitoring results and scientific findings will have significant implications to estuarine ecosystem management practices involving environmental conditions control for Pacific salmon. Marsh restoration at Salmon River in Oregon, U.S.A. has already been shown to increase the capacity of the salmon river system to store tidal flow and, potentially, sea-level rise.

Literature:

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