

## Using tidal landform scaling for habitat restoration planning, design, and monitoring

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Tidal channels are structurally and functionally prominent features in tidal marshes, so their restoration is central to tidal marsh restoration. Consequently, a prominent question in tidal marsh restoration is how many tidal channels can a restoration site support, and thus, how many dike breaches should be made to restore tidal inundation and tidal channels. Allometric analysis of reference tidal marshes in Puget Sound river deltas and the lower Columbia River estuary showed channel outlet count scales with marsh area. Further statistical analysis indicated completed and proposed tidal marsh restoration projects were typically deficient in tidal channel count by 4- to 5-fold compared to reference marshes, with likely impacts to fish access to the restoration sites.

Additionally, the lengths, surface areas, and drainage basin areas of the largest, 2nd-largest, 3rd-largest, etc., up to 15th-largest tidal channels that drain a marsh island, as well as the lengths of the largest through 5th-largest tributaries to the largest and 2nd-largest channels also scaled with marsh area. Regression of the scaling relationship y-intercepts against channel rank for each river delta examined showed that the rate of channel size decrease from one rank to the next was well fit by a power function, with R<sup>2</sup> values approaching 1. These relationships reveal predictable structure in many aspects of tidal channel planforms and allow engineers to design channel excavation in considerable detail. Finally, total channel network length and surface area scale disproportionately with marsh area, indicating disproportionate benefits of restoring one large site versus several smaller sites of equal total area.

These results provide general guidance to improve tidal marsh restoration design and planning, and their application is illustrated in a conceptual design that is the basis for a current restoration project.