Title:

Marine subsidy contributions to steelhead diet

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Nearly half of US West Coast estuaries form seasonally closing lagoons that are created by the formation of a sandbar across estuarine mouths during low flow summer periods. In California these bar built lagoons are situated in areas where steelhead populations are threatened or endangered. These seasonal lagoon habitats may be primarily freshwater, however large ocean swell events breach the sandbar and deposit seawater and marine detritus in the form of kelp into the lagoon habitat. Depending upon stream flow, saline water quickly dissipates as it is leached through the sandbar back to the ocean, however large amounts of marine detritus remain in the lagoon to contribute marine derived nutrients to an otherwise oligotrophic system. Additionally, as the lowest point of catchment in a watershed, lagoons may accumulate and concentrate terrestrial and freshwater nutrients. These lagoons are highly productive habitats that have a mixture of both marine and terrestrial nutrients. In Scott Creek, a small California watershed, steelhead rearing in the lagoon experience higher growth rates and obtain a larger size at ocean entry; correlated with a higher marine survival than fish reared exclusively in the upper watershed. Enhanced growth of steelhead rearing in the lagoon appears to result from a suite of abundant invertebrate prey (e.g., gammaridae, isopoda) not present in the upper watershed. We used stable isotope compositions of fish and invertebrates collected in the lagoon and upper watershed in a SIAR two source mixing model to estimate the relative percent contribution of marine and terrestrial subsidies to the diet of lagoon reared juvenile steelhead. Analysis indicate that a majority of steelhead diets are dominated by invertebrates from the lower lagoon, enriched with marine derived carbon and nitrogen. These data suggest that the increased growth of lagoon reared juvenile steelhead are due the presence of marine subsidies that are absent in the upper watershed. The productivity of these ecosystems are dependent on these small lagoon nursery habitats that trap and accumulate marine subsidies, which in turn contribute to steelhead population productivity. Changes to the timing of formation and duration of these lagoon habitats may alter the usability and productivity of lagoon estuaries and the benefits received by steelhead rearing in these habitats.