ABSTRACT

An abstract of the thesis of Adam McCoy Kennedy for the Master of Science in Environmental Sciences and Resources presented May 8, 2006.

Title: The association between equatorial sea surface temperature gradients and Upper Klamath seasonal streamflow: Trans-Niño Index

This research investigates large-scale climate features affecting inter-annual hydrologic variability of streams flowing into Upper Klamath Lake, Oregon, USA. Upper Klamath Lake (UKL) is an arid, mountainous basin located in the rain shadow east of the crest of the Cascade Mountains in the northwestern United States. It is an important reservoir serving the 910 km^2 Klamath Irrigation Project, established in 1906 by the US Bureau of Reclamation.

Developing accurate early season streamflow prediction models for UKL is difficult because the basin has a high degree of topographic, geologic, and climatologic variability. Furthermore, peak monthly streamflow is occurring earlier, which may be associated with global climate change. In an effort to reduce early season streamflow forecast uncertainty, six large-scale climate indices - the Pacific North American Pattern, Southern Oscillation Index, Pacific Decadal Oscillation (PDO), Multivariate El Niño Southern Oscillation Index, Niño 3.4, and a revised Trans-Niño Index (TNI) - were evaluated

independently for their ability to explain inter-annual variation of the main hydrologic inputs into Upper Klamath Lake.

The TNI, which characterizes the sea surface temperature (SST) gradient between regions Niño 1+2 and Niño 4, was the only index to show significant correlations during the current warm phase of the PDO. During the warm PDO phase (1978-present), the averaged October through December TNI was strongly correlated with the subsequent April through September Williamson River discharge ($r = 0.73$), Sprague River discharge ($r = 0.65$), net inflow to UKL ($r = 0.67$), and moderately correlated with observed Crater Lake 1 April snow water equivalent ($r = 0.51$). Incorporating the TNI variable into operational statistical streamflow prediction models significantly reduces the uncertainty (measured by the standard error) of forecasts issued on the first of December, January, and February by 7%, 9%, and 8.3%, respectively, for the Williamson River and by 9.2%, 7.5%, and 10.4%, respectively, for the Sprague River (p-value < 0.1).

These results suggest that during the current climate regime, SST gradients, as opposed to mean SST or sea-level pressure patterns, explain a significant portion of hydrologic variability observed in the streams flowing into UKL and are useful in real-time hydrologic applications.