Development and Use of Genetic Methods for Assessing Aquatic Environmental Condition and Recruitment Dynamics of Native Stream Fishes on Pacific Islands

Background:

Department of Defense (DoD) activities give rise to military and anthropogenic stressors that can threaten freshwater stream ecosystems on Pacific islands, and DoD personnel need improved stream assessment protocols for watershed management and restoration. Current protocols that rate condition based on measures of native fish species diversity are likely to underestimate impairment because fish assemblages of insular streams are naturally depauperate. Responses to environmental stressors also may be misunderstood since current protocols do not consider ocean-stream connectivity, even though most native stream fishes on Pacific islands are amphidromous (a life history involving both freshwater and marine stages). Genetic assessment protocols are promising alternatives to current approaches because analysis of genetic variation can reveal how environmental stressors affect individuals and populations within spatially explicit frameworks. However, use of genetic assessment protocols for Pacific islands requires identifying the factors responsible for variation in recruitment and dispersal of native amphidromous fishes.

Objective:

The objective of this project is to develop and demonstrate genetic approaches for assessing the condition of Pacific island streams. Researchers first will examine whether local recruitment of native amphidromous fishes draws from mixed immigrant pools due to larval exchange across the Hawaiian archipelago. Results from this study will demonstrate the importance of ocean-stream connectivity. Researchers then will examine patterns of covariance between environmental stressors, population size, and immigration to assess how local recruitment varies according to in-stream conditions and watershed land use.

Process/Technology Description:

In the first study to be conducted under this project, researchers will examine within and among island mitochondrial DNA haplotype frequencies and nuclear microsatellite genotype frequencies in Lentipes concolor and Awaous guamensis. In addition, they will examine otolith microchemistry and compare the genetic profiles of immigrating juveniles to resident adults. The second study will involve assessing genetic variation, otolith microchemistry, and census population size within and among watersheds of forest, mixed agriculture-urban, and military land use. In-stream habitat assessments, analysis of satellite imagery, and nitrogen isotope assays of nutrient loading also will be carried out to develop regression models of genetic diversity, genetic differentiation, population size, and immigration.

Expected Benefits:

The results of these studies will elevate general understanding of oceanic island stream ecosystems, and by characterizing responses of native amphidromous fishes to environmental stressors, this work will help guide DoD conservation of at-risk aquatic species. By also providing powerful new tools for assessing oceanic island stream condition, this research will help DoD identify watershed management strategies in support of sustaining military activity in the Hawaiian Islands and elsewhere in the Pacific. (Anticipated Project Completion - 2012)

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New methods for assessing the aquatic environmental condition of oceanic island streams will be developed from the analysis of genetic variation and otolith microchemistry of native amphidromous fishes across Hawaii.