

Directions for Future Research in Hawaiian Streams and Estuaries: Results of Group Discussion at the Closing of the Symposium on Hawaiian Streams and Estuaries 26 & 27 April 2005 in Hilo, Hawai'i

LORI K. BENSON McRAE

*Department of Biology, University of Tampa, 401 W. Kennedy Blvd., Tampa, Florida 33606-1490 USA;
email: lbenson@ut.edu*

MARK G. McRAE

*Louisiana State University, Museum of Natural Science, 119 Foster Hall, Baton Rouge, Louisiana 70803 USA;
email: mmcrae@paws.lsu.edu*

Introduction

On 26 and 27 April 2005, a Symposium on Hawaiian Streams and Estuaries was sponsored by the Division of Aquatic Resources (Department of Land and Natural Resources, State of Hawaii) and the United States Fish and Wildlife Service Sport Fish Restoration Program. This Symposium (co-organized by the Louisiana State University Museum of Natural Science) had several goals. These included bringing together researchers who had been working in Hawaiian streams and estuaries, as well as biologists who study similar systems in other parts of the World. This forum allowed updates and reports on research projects and facilitated collaboration between these scientists. Other goals included educating local people on the status of freshwater and estuarine organisms and describing the nature and scope of research on aquatic plants and animals. In addition to talks by experts, the conference incorporated presentations by local naturalists and students and thus provided unique opportunities for the scientists to learn from residents whose lives and livelihood have been associated with streams and estuaries for many generations. These latter presentations provided historical and cultural perspectives that otherwise would have been missing from the conference. Finally, symposium participants were charged with providing ideas and directions for future research on Hawaiian streams and estuaries, and a discussion section was scheduled at the end of the symposium. This final discussion section was moderated by M.G. McRae and recorded by L.K. Benson McRae. Participants were provided with a list of possible research directions and talking points as a springboard for discussion. These initial ideas and directions were co-authored by J.M. Fitzsimons & M.G. McRae from LSU and by R.T. Nishimoto & G.R. Higashi of the Hawaii Division of Aquatic Resources. The list below includes these items as well as additional future directions provided by conference participants.

Directions for Future Research in Hawaiian Streams and Estuaries

1. Hawaiian Stream Surveys:

- a. Increase frequency of statewide surveys of streams, especially at the lower elevations where data are limited.
- b. Continue building the GIS-correlated stream database and make it web accessible to potential stream users and researchers.
- c. Improve the integrity of spatial models of Hawaiian streams and native stream fish habitats.
- d. Establish flow requirements for streams and estuaries in Hawai'i.
- e. Maintain early life history studies of amphidromous fishes in the context of identifying source and sink populations of adults.
- f. Investigate the ecological importance of flash floods.

2. Synthesize all information that has been compiled by different agencies and research groups pertaining to hydrologic models.
3. Continue studies on Hawaiian stream organisms.
 - a. Complete life history studies for the principal species of fishes and aquatic invertebrates.
 - b. Develop a field identification key for nonindigenous species reported for Hawaiian streams.
 - c. Continue studies contrasting the two species of *Kuhlia* as a background for management recommendations.
 - d. Support studies on the distribution, systematics, ecology, and behavior of damselflies, dipterans, and other invertebrates whose life cycles are tied to streams and estuaries.
 - e. Continue to explore the use of aquatic insects as indicator species for aquatic environments.
 - f. Pursue studies of freshwater and euryhaline algae and other aquatic plants to identify their significance in community composition and structure in streams and estuaries.
 - g. Expand investigations of the genetics of stream/estuarine organisms and the use of naturally occurring stable isotopes to amplify details of the marine ecology of amphidromous fishes and invertebrates.
 - h. Determine the role of anatomy and biomechanical capabilities of stream and estuarine species in maintaining faunal composition and the distribution of plants and animals in stream/estuarine ecosystems.
 - i. Extend surveys to determine *Lentipes* distributions.
 - j. Investigate the role of increased stream temperatures on goby climbing effectiveness.
 - k. Perform additional diet research on understudied species of gobies, and expand *Sicyopterus* feeding studies to contrast preference vs. availability of algae.
 - l. Accumulate information on traditional use and knowledge of native gobies by Hawaiians.
4. Support research on invasive aquatic species.
 - a. Develop procedures for removing alien aquatic species and assess their effectiveness.
 - b. Establish a program to educate the public about alien species and set up a hotline for reporting.
 - c. Develop creative volunteer programs to assist with alien control.
 - d. Assess the impact of nonindigenous species on native fishes, crustaceans, and mollusks, especially at the stream mouths where the interaction between amphidromous native stream animals and coastal recreational fish species are temporally sympatric.
 - e. Apply stock enhancement technology to analyze the impact of alien mullet (*Valamugil*) on native mullet (*Mugil*).
 - f. Determine if movements of native amphidromous and coastal species are transmitting parasites into pristine native habitats.
 - g. Assess parasite implications of the continued import of established exotics.
 - h. Evaluate links of parasite introductions with the aquarium trade. Determine whether the import of poeciliids should be banned.
 - i. Investigate the pathology of parasites over time on the reproductive success, etc. of native stream organisms.
 - j. Study the effects of exotics on native insects.
5. Extend research into larger watershed scale studies, with emphasis on the links between terrestrial/freshwater species.
 - a. Explore the biological links between terrestrial vegetation and aquatic plants and animals.
 - b. Ascertain the influence of terrestrial inputs on water chemistry in stream watersheds and the implications for coastal marine fisheries.
 - c. Determine the effects of exotic trees, ungulates, etc. on stream quality.
 - d. Study the role of nutrient input from woody debris and riparian vegetation in streams and estuaries.
 - e. Institutionalize the PABITRA methodology for stream assessment studies. (PABITRA = Pacific-Asia Biological Transect Network; <http://www.botany.hawaii.edu/pabitra/>)

- f. Investigate the role of forested/nonforested habitats in cloud formation, rainfall, and water flow in streams.
 - g. Study how vegetation, agriculture, and land use changes affect groundwater discharge.
 - h. Develop predictive models about the correlation between water quality and cover.
 - i. Revisit zoning/land use planning issues regarding building and development near streams and rivers and determine whether the currently mandated buffer zone is being enforced and is adequate.
 - j. Expand *ahupua'a* research to studies of management plans— learn from past management approaches used by traditional Hawaiian cultures.
6. Extend toxicology research to address effects of contaminants on native fish fauna.
 - a. Broaden contaminant studies to include water quality issues with other native biota.
 - b. Determine how toxins in the marine environment affect growth and survival of amphidromous larvae and investigate the subsequent implications for population sizes of adults.
 7. Establish and coordinate restoration efforts.
 - a. Develop procedures for restoring streams, estuaries, and anchialine ponds.
 - b. Initiate a program of replacing exotics with native forest/riparian vegetation.
 - c. Encourage aquaculture of native species.
 - d. Restore goby populations to harvestable levels.
 - e. Examine natural vs. original vs. pristine conditions for developing attainable restoration goals.
 - f. Determine historic flow regimes and determine how they are linked to the presence/absence of stream animals.
 - g. Facilitate better public involvement in management and restoration.
 8. Investigate the response of native stream animals to climate and other environmental changes.
 9. Determine priority catchments for biodiversity conservation in the Hawaiian Islands.
 10. Prepare formal reports that summarize past studies on the biology, conservation, and management of native Hawaiian stream fishes and other aquatic animals.
 11. Periodically organize symposia and publish the proceedings to set directions for future projects.
 12. Develop partnerships with professionals on other Pacific Islands facing similar threats to stream habitats.
 13. Strengthen public education regarding the significance of streams and estuaries in the Hawaiian Islands.

Closing Remarks

In summary, there was a general consensus that better communication and cooperation between research groups, universities, and government agencies needs to exist. This conference led to numerous discussions and brainstorming sessions that hopefully will facilitate a continuation of these dialogues; conference organizers were reminded to provide everyone involved with a list of participants and contact information. It was noted that another potential venue for this type of meeting would be in an aquatic session of the Hawai'i Conservation Conference, hosted by the Hawai'i Conservation Alliance and held each summer in Honolulu. In addition, conference attendees were reminded of the responsibility they have to report research findings and recommendations to the appropriate management organizations. Researchers also were encouraged to facilitate building a common website for reporting research findings, listing government documents and scientific publications, and describing upcoming projects. Finally, educational activities and continued participation of local students of all ages were regarded as being of utmost importance, with the hope that future conferences on the state's streams and estuaries will showcase more research being done in Hawai'i by Hawaiians.

