

CHAPTER 5

FRESHWATER AND ANCHIALINE CONSERVATION NEEDS

Hawaii's freshwater ecosystems consist of hundreds of streams, four natural lakes, and many man-made reservoirs and ditches. Stream types are diverse; there are perennial (flowing year-round), intermittent (flowing only at certain times of the year), blackwater, and underground streams. However, relatively few native freshwater species occur in Hawai'i.

Hawai'i also has unique anchialine pond habitats that will be considered in this chapter because their biology and management is more closely tied to single islands and land ownership concerns than is the case for marine ecosystems that were considered in Chapter 4.

OVERVIEW

Hydrology

Hawaiian watersheds differ from continental watersheds in that they are generally short and steep, and they have small drainage basins and minimal channel storage of water. They can rise or fall rapidly depending on rainfall with pulses of water called freshets moving quickly downstream. They are thus considered to be "flashy" and flash-flooding is a common threat to animals and nearby human residents in some areas. Hawai'i has large numbers of both perennial and intermittent stream sections on the main islands because the islands tend to have lots of rainfall on their windward sides, but much less rainfall on leeward sides. Perennial streams or stream sections flow year-round. Perennial streams are found only on the wetter areas of Kaua'i, O'ahu, Moloka'i, Maui, and the island of Hawai'i. Intermittent streams or sections do not flow all year round. Intermittent streams are found on all islands. Many streams only have certain sections that are perennial, often in the upper sections, while lower down the stream bed dries out seasonally or the stream flows underground through lava tubes or other geological spaces. The majority of the streams however are continuous, that is they flow consistently from origin to the ocean.

Streams in Hawai'i vary somewhat by island. Lower sections of streams on older, more weathered islands such as Kaua'i tend to be wider and relatively slower moving, when there are no heavy rainfalls; while streams on younger islands such as the island of Hawai'i are faster moving with narrower channels. However, many streams on all the main islands end in terminal waterfalls because of the presence of large sea cliffs, even on Kaua'i. Non-terminal waterfalls in upstream areas are characteristic of many streams as well. Stream habitats vary from pristine stream reaches in forested habitats that have riparian cover, heterogeneous substrate (boulders, stones), and runs, riffles, and pools to stream reaches in urban areas that often have concrete bottoms and wider channels. Thus, stream sections in urban areas have slower moving water and higher temperatures. Of the four natural lakes in Hawai'i one is intermittent and one is an alpine lake.

The following paragraph summarizes the stream types and features on the main islands. Ni‘ihau has no perennial streams but has Halulu Lake, a natural freshwater lake covering approximately 74 hectares (182 acres), and Halāli‘i Lake, an intermittent lake covering approximately 340 hectares (841 acres). Kaua‘i has 61 perennial streams, 45 of which are continuous. Wailua and Hanalei streams have the largest discharges, 200 and 140 million gallons per day (mgd), respectively. O‘ahu has 57 perennial streams, 29 of which are continuous. Kahana and Waikele streams have the largest discharges, 35 and 27 mgd, respectively. Moloka‘i has 36 perennial streams, 16 of which are continuous. Wailau-Pulena and Pelekunu streams have the largest discharges, 27 and 25 mgd, respectively. There are no perennial streams or natural lakes on Lāna‘i. Maui has 90 perennial streams, 56 of which are continuous. Waihe‘e and ‘Īao streams have the largest discharges - 60 and 43 mgd respectively. Other major streams on Maui include Palikea (the second largest perennial stream in the State), Kalialinui-waialae gulch (the State’s second longest stream), and Honokohau stream (the longest stream channel in west Maui). Kanahā Pond, historically a natural freshwater lake, is approximately one meter (three feet) in depth and 16 hectares (41 acres) in size and is located wholly within the Kahului Airport boundary area. There are no perennial streams or natural lakes on Kaho‘olawe. The island of Hawai‘i has 132 perennial streams, 70 of which are continuous. Wailuku River has the largest discharge at 250 mgd. Waiākea Pond is a natural freshwater lake that is over 2.3 meters (seven feet) deep and 11 hectares (27 acres) in area, and Lake Waiau, at 4,300 meters (13,020 feet), is the only alpine lake in the State. There are no large freshwater habitats in the Northwestern Hawaiian Islands, but small ponds and seeps and the hypersaline lake on Laysan island are important to terrestrial wildlife.

Anchialine ponds are found in geologically young lava fields and only occur on O‘ahu, Maui and the island of Hawai‘i, with an artificial pond on Kaho‘olawe. The lava in these areas has fissures that connect the ponds to the ocean. The subterranean water system reaches the surface through natural or man-made connections and where the salinity of seawater intrudes to at least some degree. Thus these ponds are always close to the sea and have varying salinity levels and tidal influence. Most ponds are less than 100 square meters in size and less than 1.5 meters in depth. Anchialine ponds are home to numerous animals. Anchialine pond shrimp are found in the water column and on the substrate of anchialine ponds as well as in the interstitial spaces that are part of the system linking the pond’s water to oceanic influences. Amphipods, ostracods, snails, worms, and various fishes can also be found in the pools. Eight species of anchialine shrimps are hypogeal, which means they live in subterranean aquatic habitats in the water that occurs in cracks and slits between rocks. Six of these species are candidates for listing under the Endangered Species Act. It is not clear whether anchialine ponds are necessary for the survival of any of the eight shrimp species, as one shrimp has also been found in the open ocean, and many species have been found in artificially created ponds, some many miles from the nearest naturally formed pond. However, the importance of the little-understood hypogeal system is clear, and the anchialine ponds may greatly increase the amount of energy in the hypogeal systems because of the access to photosynthetic organisms in the pools. Anchialine ponds are also home to eleven species of amphipods, two of which have also been found in the open ocean. Little is known about their biology or ecology. One snail species is also often commonly found in anchialine ponds and other estuarine habitats. Many other marine species can be occasionally found in anchialine ponds.

Climate

The windward side of the high islands of Hawai‘i have orographic rain, which is due to the trade winds that blow across the eastern Pacific Ocean. Some areas can receive over ten meters (400 inches) of rainfall annually, while rainfall amounts above 250 centimeters (100 inches) are not uncommon. Areas on the leeward side of islands behind the mountain peaks are in the rain shadow of these peaks and can receive less than 40 centimeters (15 inches) of rainfall annually. All of this rain feeds Hawai‘i’s major streams and also recharges groundwater storage that is the source of many springs in the State.

Water Use

Agricultural, industrial and residential development on the islands has resulted in various patterns and structures to move or retain water for human uses in the islands. The following paragraph summarizes the number of streams (and percentage of total perennial streams) on each island that are partially or entirely diverted for human use as well as the most recent number of streams that have been declared impaired under the U. S. Environmental Protection Agency (EPA) standards under the Clean Water Act. Kaua‘i has 25 diverted streams (41 %) and 12 have altered channels. Kaua‘i has 11 impaired streams under the EPA standards. The Wailua canal system is the largest man-made stream system. Waita Reservoir is a significant man-made lake that is seven meters (23 feet) deep and 171 hectares (424 acres) in size. Oahu has 31 diverted streams (54 %) and 31 have altered channels. O‘ahu has 34 impaired streams under EPA standards. The largest altered stream is Waikele, and the Waiāhole Ditch system is the largest man-made stream system. Wahiawā Reservoir (including Lake Wilson) and Nu‘uanu Reservoir are significant freshwater lakes on the island. Moloka‘i has one stream (Kamalo) that has an altered channel. The Waikolu canal in the northeast is the largest man-made stream system at five mgd. Kualapu‘u Reservoir is a significant man-made lake at 15 meters (50 feet) deep and 40 hectares (100 acres) in area. Maui has 57 diverted streams (63 %) and seven have altered channels. Maui has the highest diversion of natural stream flow volume in the State. ‘Īao is the largest altered stream. The East Maui canal system in Central Maui is the largest man-made stream system in the state at 164 million gallons per day. Maui has ten impaired streams under EPA standards. The island of Hawai‘i has 74 diverted streams (56 %) and four have altered channels. The largest altered stream is Wailoa. The Lower Hāmākua Ditch system in Kohala is the largest man-made stream system at 32 mgd. The island of Hawai‘i has 15 impaired streams under EPA standards.

Human Landscape

Urbanization, agricultural development, and population increases throughout Hawai‘i have led to stream habitat alterations such as channelizations, dams, and diversions. These alterations can cause increased water temperatures, decreased or increased water flow rates, and decreased water flows, which prevent o‘opu and invertebrate larvae from reaching the ocean; thus, reducing their ability to survive. Dams and some diversions can prevent migration of adults up or downstream.

Pollution of streams comes from both point and non-point sources such as industries and government, as well as from generalized runoff of fertilizers, pesticides, industrial and home chemicals, etc. Although agricultural sector non-point source (NPS) pollution is decreasing, development is increasing, resulting in increased residential and commercial non-point source

pollution and sedimentation in streams. U.S. Clean Water Act standards first addressed point source pollution many years ago and more recently have instituted more stringent NPS regulations.

Excessive harvest of freshwater fauna, such as hihiwai, may have also led to their decline. Introduction of non-native freshwater fauna for fishing purposes or accidentally as unwanted aquarium pets, etc also has negatively impacted freshwater organisms through direct predation or competition for food or shelter.

SPECIES AND HABITATS OF IMPORTANCE

All freshwater streams are important, especially because of their unique characteristics and species assemblages. Because there are so few and such small naturally occurring lakes there are no freshwater organisms specially adapted to living only in those systems. Continuous perennial streams are the most important habitat to Hawaii's native freshwater fauna because these species depend on the ocean for part of their larval life stage and would not survive without this connection to the sea. Thus discontinuous or intermittent streams are only suitable for temporary residence or for invertebrates that do not require the ocean for part of their life cycle. Intermittent stream fauna thus primarily consists of oligochaete worms, several crustaceans, and algae.

Appendix B provides information on the freshwater Species of Greatest Conservation Need (SGCN), with more specific taxa information found in Chapter 7. Species include the four freshwater endemic gobies and eleotrid and one indigenous goby, and 35 freshwater invertebrate species including the federally endangered Newcomb's snail, other molluscs, shrimps, rotifers, a sponge, and a worm.

SUMMARY OF KEY THREATS TO SPECIES AND HABITATS

Many general threats to native wildlife and habitats are discussed in Chapter 3 (Statewide Conservation Needs). Threats that are more acute or specific to the freshwater environment are listed below.

- Stream diversions, dams, channelizations, and road impacts (islands affected: Kaua'i, O'ahu, Maui, and Hawai'i);
- Insufficient in-stream flows to insure the biological integrity of many stream systems (islands affected: Kaua'i, O'ahu, Maui, and Hawai'i);
- Development of formerly undeveloped areas and increased urbanization leading to loss and degradation of freshwater habitat (e.g., sedimentation from development near stream corridors) (islands affected: Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i);
- Land-based sources of pollution (islands affected: all);
- Increased stream sediment load resulting from forestry and pasture agriculture (island affected: Maui and Hawai'i);
- Introduced freshwater fishes and invertebrates have adverse effects on native stream species (islands affected: Kaua'i, O'ahu, Maui, and Hawai'i);
- Entry of new aquatic invasive species into the State (islands affected: all);

- Human impacts on anchialine ponds including filling, development, introduced fishes and shrimps, potential overharvesting, (islands affected: O‘ahu, Maui, Kaho‘olawe and Hawai‘i);
- Excessive harvesting for fishes and invertebrates for consumption, shell leis, retail sale (islands affected: all);
- Lack of zoning and other protections for highly impacted middle reaches of streams;
- Human uses in streams including tourism and trampling;
- Populations of ungulates that eat, trample, or uproot plants, degrading habitat, contributing to soil erosion, and impairing stream quality (islands affected: all).

FRESHWATER STRATEGIES

In addition to the seven statewide conservation objectives in Chapter 3 (Statewide Conservation Needs) (main bullet below), specific strategies for freshwater species and habitats include the following (sub-bullet):

- Maintain, protect, manage, and restore native species and habitats in sufficient quantity and quality to allow native species to thrive.
 - Support existing conservation management and implement future needs as identified below in ‘Management Needs’ section;
 - Decrease number of stream diversions and channelized streams;
 - Work with Commission on Water Resource Management to ensure net increase in number of streams with biological integrity and Instream Flow Standards sufficient to sustain viable native fish and invertebrate populations;
 - Protect remaining anchialine ponds from loss, disturbance, development, and invasives;
 - Develop plans to respond to natural disasters and climate change;
 - Determine need for expanded riparian buffer zones;
 - Assess affect of roads on freshwater ecosystems in Hawai‘i;
 - Increase active management in, or acquisition of, extremely rare or threatened aquatic habitats (e.g., middle sections of streams) on all islands.
- Combat invasive species through a three-tiered approach combining prevention and interdiction, early detection and rapid response, and ongoing control or eradication.
 - Continue research on effective management methods and tools for introduced predatory fishes and invertebrates in freshwater and anchialine systems;
 - Increase inspection and implement other “prevention” measures to identify and prevent high-risk invasive species and disease;
 - Review and revise existing screening procedures for the introduction of non-native plants and animals to move from a prohibition on specific listed taxa to a general prohibition on introduction except for identified taxa;
 - Work with pet industry to increase knowledge of the threat and compliance with rules;
 - Decrease in the overall number of streams, lakes and anchialine ponds negatively impacted by invasive species.
- Develop and implement programs to obtain, manage, and disseminate information needed to guide conservation management and recovery programs.
 - Improve dissemination of research and data regarding aquatic populations and

- habitat condition;
 - Identify priorities for research and monitoring to document distribution, abundance, population trends, limiting factors, demography, and behavior of freshwater species in order to guide conservation management and recovery programs;
 - Develop a stream GAP analysis program that quantifies stream habitats and organisms and adjacent land uses and management;
 - Continue to conduct surveys and inventories for freshwater fishes and invertebrates and improve efforts to make surveys more systematic and comprehensive.
- Strengthen existing and create new partnerships and cooperative efforts.
 - Establish new partnerships with private landowners, non-traditional partners, and with community groups to share information and facilitate implementation of identified conservation actions;
 - Increase the scope of community involvement in local conservation efforts by identifying areas for community based management (e.g., West Hawai'i Regional Fisheries Management Council);
 - Formalize partnerships with military agencies to manage areas (including State land) for habitat conservation where freshwater species occur;
 - Support ongoing and future projects to deal with non-point source pollution;
 - Support community based management of freshwater habitats on Moloka'i and look to expand to other islands;
- Expand and strengthen outreach and education to improve understanding of our native wildlife resources among the people of Hawai'i.
 - Maintain existing outreach and educational programs for freshwater species;
 - Increase public understanding of native wildlife by developing and implementing a strategic and comprehensive conservation education program (particularly for Hawaii's lesser known species) that would include public awareness campaigns and working with potential partners (e.g., Department of Education and non-governmental organizations);
 - Provide lawmakers and citizens with the information necessary to effectively legislate and provide funding for the conservation of native species and their habitats;
 - Collaborate to increase compliance with existing laws through outreach and educational programs and support for increased enforcement capacity;
 - Improve conservation education of visitors and the tourism industry on the appropriate use of natural areas, particularly sensitive habitats.
- Support policy changes aimed at improving and protecting freshwater species and habitats.
 - Increase conservation enforcement efforts on all State-owned land and waters through increased funding for trained enforcement officers;
 - Organize an interagency working group to develop vision and policy analysis for stream conservation actions;
 - Evaluate current management of State lands and waters and identify priority areas for changes in current use (e.g., unencumbered State lands of conservation quality or restoration potential);

- Review and revise existing rules and regulations dealing with extractive uses of aquatic animals, plants, and terrestrial snails;
- Administer and award State Wildlife Grant funds through a joint partnership of DOFAW and DAR;
- Improve integration of policies to address linkages between terrestrial, freshwater, and marine habitats and their shared conservation threats and needs.
- Enhance funding opportunities to implement needed conservation actions.
 - Organize an interagency and stakeholder task force to examine and implement market-based conservation funding solutions, including review of recreational gear taxes, visitor taxes, airport landing fees, new or expanded license or user fees, and targeted tax breaks for conservation activities;
 - Support lobbying efforts to increase Federal funds to states and to change the formula used to allocate Federal funds to reflect the conservation realities of each State;
 - Secure permanent dedicated funding for native wildlife conservation education and outreach;
 - Secure additional funding dedicated to recovery priorities for listed species.

MANAGEMENT NEEDS

Current Areas Managed for Species and/or Habitats

The following section addresses the current management actions and future needs of freshwater SGCN species. All managed areas listed below include streams in their boundaries; however, no area actively manages to protect and conserve freshwater fauna. The discussion of future management needs is highlighted within each currently managed area. Size and owner/manager of each area is listed first, then species and habitats within the area, current management, and future needs are listed in separate sections. The section proceeds from the northernmost main island to the south.

Kauaʻi

Hono o Na Pali Natural Area Reserve (3,150 acres), DOFAW

Species: ʻOʻopu (freshwater fishes), freshwater invertebrates.

Habitats: Streams.

Current Management: Management plan exists. Ungulate control through public hunting year-round, invasive weed species removal, monitoring.

Future Needs: Update management plan. Increased ungulate (particularly goat) control, increased invasive weed monitoring and control, baseline survey work in Waiahuakua stream, aquatic wildlife management, better integrate terrestrial and freshwater wildlife needs.

Kauaʻi Watershed Alliance (142,000 acres), Public-Private Partnership

Species: Oʻopu, freshwater invertebrates.

Habitats: Streams.

Current Management: Management plan exists. Planned management includes fencing, ungulate control, weed control, monitoring (ungulate activity, weed distribution, vegetation cover, stream turbidity).

Future Needs: Adequate funding to implement management plan, aquatic wildlife management, better integrate terrestrial and freshwater wildlife needs.

O‘ahu

Ko‘olau Mountain Watershed Partnership (97,760 acres), Public-Private Partnership

Species: O‘opu, freshwater invertebrates.

Habitats: Streams.

Current Management: Management plan exists. Fencing, ungulate control, invasive weed control.

Future needs: Funding to implement management plan, fencing, ungulate control, invasive weed control, outplanting, aquatic wildlife management, better integrate terrestrial and freshwater wildlife needs.

Kawai Nui and Hāmākua Marsh Complex (850 acres), DOFAW

Species: ‘O‘opu, ‘ōpae kala‘ole (shrimp).

Habitats: Non-stream wetlands.

Current Management: Hydrologic studies, habitat restoration including invasive plant removal and native wetland planting.

Future Needs: Continue existing management, secure adequate funding to support expanded management, increased invasive weed removal, habitat restoration, educational opportunities, aquatic wildlife management, better integrate terrestrial and freshwater wildlife needs.

James Campbell NWR (222 acres), USFWS

Species: Anchialine pond fauna.

Habitats: Anchialine ponds.

Current Management: Habitat restoration, predator control, weed control, monitoring.

Future Needs: Continue existing management. Increase anchialine protections.

Moloka‘i

Kalaupapa National Historic Park (10,779 acres, in addition 2 offshore islets), NPS

Species: ‘O‘opu, native shrimp.

Habitats: Streams.

Current Management: Management plan exists.

Future Needs: Continue existing management, aquatic wildlife management, better integrate terrestrial and freshwater wildlife needs.

Pelekunu Preserve (5,714 acres), TNC

Species: ‘O‘opu, freshwater invertebrates.

Habitats: Streams.

Current Management: Management plan exists. Ungulate control, invasive plant monitoring and control, natural resource and water quality monitoring.

Future Needs: Continue existing management.

Maui

East Maui Watershed Partnership (100,000 acres), Public-Private Partnership

Species: O‘opu, freshwater invertebrates.

Habitats: Streams.

Current Management: Management plan exists. Monitoring for stream and water quality, continue fencing across East Maui, ungulate control, invasive weed control, education and outreach.

Future Needs: Secure funding to implement management plan. Expand management into other native-dominated forests within the partnership boundaries (e.g., Makawao Forest Reserve), aquatic wildlife management, better integrate terrestrial and freshwater wildlife needs.

West Maui Mountains Watershed Partnership (52,940 acres), Public-Private Partnership

Species: ‘O‘opu, freshwater invertebrates.

Habitats: Streams.

Current Management: Management plan exists. Fencing, ungulate control, reduction of invasive alien weeds.

Future Needs: Secure funding to implement management plan. Identification of areas in need of active management and/or fencing to protect quality native forests and streams, expand management into other native-dominated forests within the partnership boundaries (e.g., West Maui Forest Reserve), aquatic wildlife management, better integrate terrestrial and freshwater wildlife needs.

West Maui NARS (6,702 acres-3 parcels), DOFAW

Species: ‘O‘opu, freshwater invertebrates.

Habitats: Streams.

Current Management: Management plans exist. Fencing, ungulate control, resource monitoring, non-native plant control, public education, and volunteer recruitment.

Future Needs: Continue existing management, aquatic wildlife management, better integrate terrestrial and freshwater wildlife needs.

‘Āhihi Kīna‘u NAR (2,045 acres including marine), DOFAW

Species: Anchialine pond fauna, marine organisms.

Habitats: Anchialine ponds, marine systems.

Current Management: Management plan exists. Resource monitoring (particularly for any illegal takings), rangers hired for enforcement and education, public education and sign postings, restricting certain areas from public over use. Fencing of anchialine pools has been proposed but not implemented.

Future Needs: Management of human activity, monitoring, education, and outreach.

Pu‘u Kukui Preserve (8,661 acres), Maui Land and Pineapple, Inc.

Species: ‘O‘opu, freshwater invertebrates.

Habitats: Streams.

Current Management: Management plan exists. Fencing, ungulate removal, small mammal and non-native invertebrate control.

Future Needs: Continue existing management, aquatic wildlife management, better integrate terrestrial and freshwater wildlife needs.

Hawai'i

Hawai'i Volcanoes National Park (323,431 acres), NPS

Species: Anchialine pond fauna.

Habitats: Anchialine ponds.

Current Management: Management plan exists. Fencing and ungulate control, habitat restoration, eradication of priority non-native plants, propagation and outplanting of native plant species, monitoring, education. One-time inventory for anchialine pond fauna. Monitoring protocols are under development.

Future Needs: Continue existing management. Expand protection for anchialine pond fauna.

Kaloko-Honokohau National Historic Park (1,161 acres), NPS

Species: Anchialine pond fauna.

Habitats: Anchialine ponds.

Current Management: Management plan exists. Protection of anchialine habitats.

Future Needs: Continue existing management. Expand protection for anchialine pond fauna.

Manukā NAR (25,550 acres), DOFAW

Species: Anchialine pond fauna.

Habitats: Anchialine ponds.

Current Management: Management plan exists. Removal of feral pigs and goats, invasive non-native plant (e.g., fountain grass) control, fencing around rare communities, monitoring.

Future Needs: Continue existing management. Expand protection for anchialine pond fauna.

Potential for Enhanced Conservation Management

In addition to maintaining and enhancing existing conservation actions in managed areas, additional efforts are likely needed for the long-term conservation of native freshwater species. The Division of Aquatic Resources feels freshwater aquatic resources are in need of internal and external policy analysis and visioning. DAR also believes that the needs of freshwater species have not been fully integrated with the management that is occurring in watersheds throughout the State that are managed by DOFAW or are part of watershed partnerships. The Comprehensive Wildlife Conservation Strategy details many potential future conservation actions in wetlands that are considered important to DOFAW's management of birds and terrestrial invertebrates and may also contain important habitat for freshwater species. In addition, other areas may need special protection for freshwater organisms, fishing regulations may need to be modified to adapt to current threats, and the rules and policies of other state and federal agencies (e.g., DOFAW, DOH, DOCARE, the Water Commission) may need to be altered to meet the needs of freshwater organisms or their habitats. On all islands, the middle

reaches of streams are often in need of conservation management. DAR hopes that a comprehensive visioning and policy analysis process that involves these partners as well as the public is necessary to successful freshwater wildlife management in the future.

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