

# THE NATIVE STREAM FISHES OF HAWAII



**Konrad Schmidt**

St. Paul, MN

ssminnow@usfamily.net

Several years ago at the University of Minnesota a poster about Hawaii's native freshwater fishes caught my eye. I was astonished to learn that for a tropical zone the indigenous freshwater ichthyofauna (traditionally and collectively known as 'o'opu) is incredibly rich in uniqueness, but very poor in species diversity, comprising only four gobies and one sleeper. Four of the five are endemic to Hawaii. However, recent research suggests the 'o'opu nākea of Hawaii is a distinct species from the Pacific River Goby, and is, therefore, also endemic. In addition to these fishes, there are only two native euryhaline species that venture from the ocean into the lower and slower reaches of streams not far above their mouths: Hawaiian Flagtail (*Kuhlia sandvicensis*) and Striped Mullet (*Mugil cephalus*). The cause of this depauperate assemblage is attributed to the isolation of the Hawaiian archipelago and the great depths of the Pacific Ocean.

The "uniqueness" of these species is due not only to the high degree of endemism, but also includes their habitat, life cycle, and evolutionary adaptations. Hawaii's watersheds are typically short and small. The healthiest fish populations generally inhabit perennial streams located on the windward (northeast) side of islands which are drenched with 100-300 inches of rainfall annually. Frequent and turbid flash floods, called freshets, occur on a regular basis; between events, however, stream visibility can exceed 30 feet. On the leeward, drier sides, populations do persist in some intermittent streams at higher elevations even though lower reaches may be dry for months or years. These dynamic streams are continually and naturally in a state of recovery. This constant state of flux would be widely viewed as impacted watersheds on the U. S. mainland where stable streams and adherence to minimum flow standards are the optimal goals. In con-



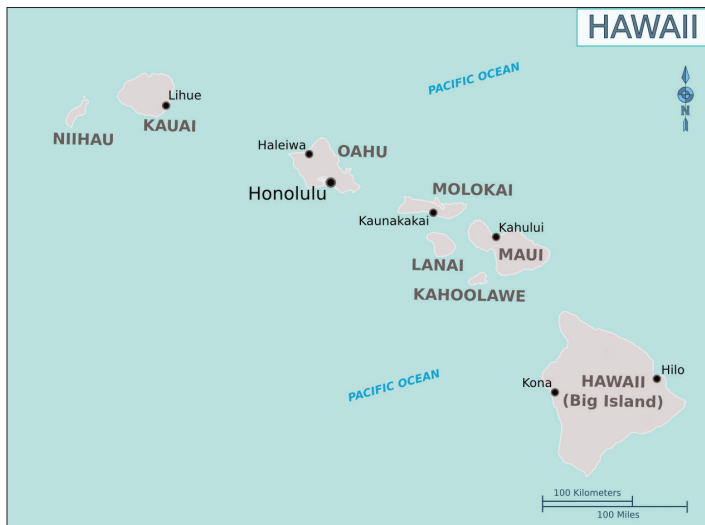
Hawaiian Flagtail: adult (top) and juveniles (bottom).

Striped Mullet: adult (top) and juveniles (bottom)

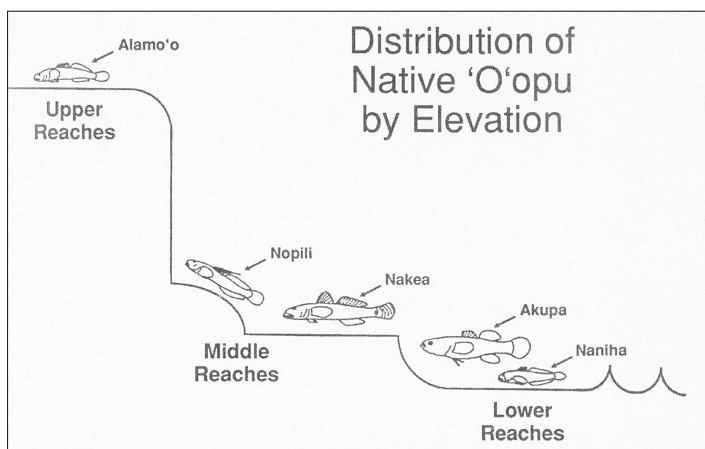
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trast, the native fishes in Hawaiian stream communities not only survive major and chronic flooding but have adapted and are actually dependent on these freshets for their existence. The gobies and sleeper share a life cycle of amphidromy where adults live and breed in freshwater streams, but hatching larvae drift out to sea and remain there for several months feeding on ocean plankton. When freshet plumes spread into the ocean, chemical cues lead larvae back to stream mouths. Unlike salmon, however, they do not necessarily return to the same streams where they were born.

Three of the four gobies are peerless in fish feats, utilizing a specialized pelvic fin that acts as a suction cup and allows them to scale the sheer bedrock of waterfalls. The larvae of Hiukole Goby are the kings in this arena, climbing falls of more than 400 feet and accessing streams as high as 3300 feet above sea level. Instead of full-frontal assaults, fighting both high velocity water *and* gravity, goby larvae attack the flow-free, wet flanks of falls. During the long climbs, they must occasionally visit tiny side rivulets to “catch their breath.” Hiukole and Pacific River gobies climb using an undulating advance consisting of rapid bursts of flapping of their caudal and pectoral fins. This travel mode is 30 times faster than the



The distribution of 'o'opu is generally restricted to major islands of the Hawaiian Chain.



Nopoli Rockclimbing Goby, which ascends by doing “chin-ups” with its specialized mouth. Streams with short estuaries and gentle gradients in their lower reaches are likely to have all five species, while the Hiukole Goby is often absent in streams with long estuaries. Streams with waterfalls exceeding 50 feet that drop to ocean beaches will usually only have Hiukole and Nopoli Rockclimbing gobies.

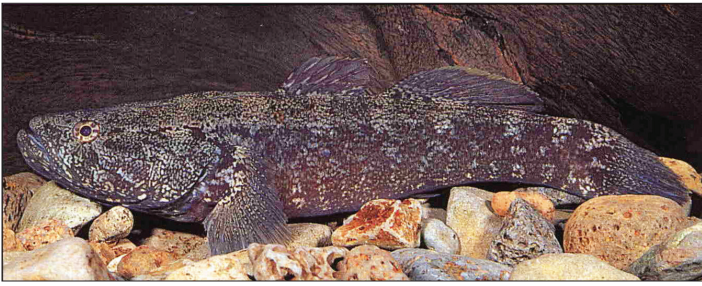
Impacts on these fishes and streams have come from several fronts. Historically, sugar cane production diverted streams for irrigation and cut the connection with the ocean required for the fishes' life cycles. Current threats include the establishment of more than 50 introduced fishes (e.g., cichlids, livebearers, trout, catfish, sunfish, and killifish) from sport stocking and aquarium releases. These species compete with, prey upon, and infest the native fish fauna with introduced parasites and diseases. However, the primary threats today are stream channelization, riparian destruction, ground and surface water pumping, and pollution resulting from ever-increasing human population and urbanization. This is most apparent on the island of Oahu, home to 85% of the state's population. In 1900, the Hawaiian Islands had a population of 150,000, but this had swelled to 1.4 million by 2010. There is also growing concern about how climate change will affect precipitation patterns feeding streams. Rising ocean temperatures can also alter the currents that carry developing larvae, prolonging the drift period and increasing their metabolism, while the availability and abundance of food may wane.

Based on electrofishing surveys from 1980, the Hiukole Goby was reviewed for federal status in 1989 as an endangered species on the islands of Oahu, Maui, and Hawaii, and as a threatened species on Kauai and Molokai. However, as with the benthic darters of North America, there has since been a revelation that electrofishing is far from the most effective sampling method. Follow-up snorkeling surveys, which pushed farther inland and surveyed many more streams than the 1980 study, found the species had a much wider distribution than previously known and it was never federally listed. Nevertheless, concerns remain for the long-term survival of all five species. The Nature Serve Explorer website ranks the Nopoli Rockclimbing Goby as imperiled and the rest as vulnerable.

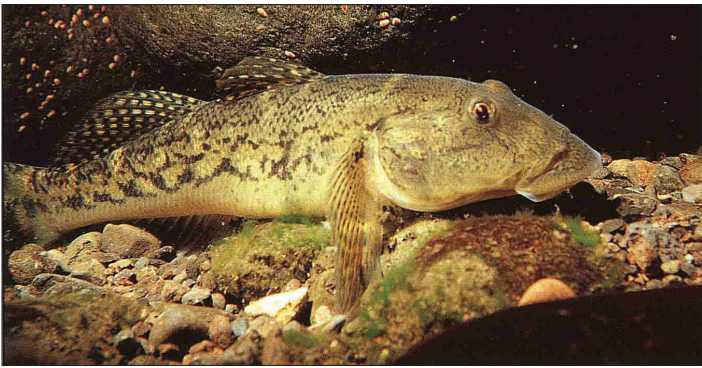
Each of the five species exhibits its own unique and fascinating attributes, as will be seen in the following species profiles:

### AKUPA SLEEPER

Akupa Sleeper (*Eleotris sandwicensis*), or 'o'opu 'akupa, adults have brown to black bodies, can grow to 13 inches, and lack the sucker on the pelvic fins found on the species' goby associates. Juveniles under an inch in length have a jet-



black upper body and lighter flanks and belly. The sleeper is a gluttonous predator of fish and invertebrates. There is one account of a 12-incher choking on a Pacific River Goby almost the same size. Recent research, however, has revealed a dietary shift to exotic snails as a preferred food. The species occurs on all the major islands, but is abundant on Oahu in both natural and altered streams where it is often associated with Naniha Gobies. Sleepers cannot climb falls and are restricted to the lower reaches of streams and estuaries. Early Hawaiians highly prized the species for its tasty white meat and anglers today also use it as bait.



**PACIFIC RIVER GOBY**

The Pacific River Goby (*Awaous guamensis?* *Awaous stamineus?*), is called ‘o’opu nākea in Hawaiian. Because the jury decision of “splitters and lumpers” is still out, the Pacific River Goby name will be used here instead of ‘o’opu nākea for the Hawaiian form which may eventually be classified as a distinct and separate species. This is the largest of the gobies, growing to 14 inches. Its mouth is huge in relation to the rest of its body: a human fist will fit inside the mouth of a large fish. The body is mottled brown to gray, with a white belly. The dorsal and caudal fins have vertical dark and light stripes, and the base of the caudal fin has a dark patch. The Pacific River Goby is omnivorous, its diet consisting of algae

and invertebrates. The species inhabits all the major islands in the lower to middle reaches of streams, where it burrows into the substrate with only its eyes exposed. This goby is a fair climber that can scale falls of up to 65 feet and inhabits streams up to 1,150 feet above sea level. Spawning occurs during the rainy season from August through November. Freshets trigger a downstream migration to the last riffles above stream mouths where males (of all the gobies) guard the nests. Fry hatch in about a day without eyes, digestive tract or gills, all of which develop within five days. The larvae drift on ocean currents feeding on plankton for five to six months before returning to a stream between December and July. The fish is considered a delicacy and populations in the Hanalei and Waimea rivers on the island of Kauai still support an important recreational fishery. Gobies steamed in ti leaves once provided a feast solely reserved for Hawaii’s former royalty. Commoners who dared to also indulge risked betrayal by the telltale aroma from cooking the meal.

**HIUKOLE GOBY**

The Hiukole Goby (*Lentipes concolor*) is known in Hawaiian as ‘o’opu ‘alamo’o, ‘o’opu hi’u kole, ‘o’opu nu ‘ukole, and ‘o’opu hi’u ‘ula. Adults grow to about six inches. Males and females are strikingly sexually dimorphic, which led early biologists to consider them separate species. Nuptial males



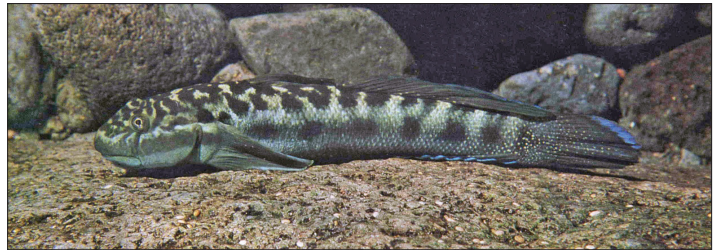
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Nuptial males (top, center) and female (bottom).

are two-tone. The front half of the body is velvety black and the back is reddish-orange. The dorsal fin is brilliant white. Females are olive to brown. Both sexes have bright blue eyes. Their diet is omnivorous, but the young eat more plant material while adults prefer more animal matter. The species is fairly common in the middle to upper reaches of streams on the windward sides of Hawaii, Kauai, Maui, and Molokai, but rare on Oahu. Only post-larvae and juveniles migrate upstream. They are the supreme climbers among fish, holding the world record for scaling Hi'ilawe Falls in the Waipio Valley, the highest in Hawaii with a vertical drop of 1,200 feet. There are also accounts of the species being found in the air conditioning ducts of tall buildings in Honolulu, apparently gaining access through pipes from the sea. Adults occur at the widest range of altitudes among the Hawaiian gobies, but are most often found at elevations from 160 – 1,600 feet. Spawning occurs from late fall through early spring. Eggs hatch in two to three days, and larvae drift out to sea to feed on plankton, returning to streams from February through May. Early Hawaiians of Maui and Molokai often captured this goby for food using what sounds like a primitive minnow trap. Gourds were hollowed out and baited with crushed 'ōpaekala'ole (an endemic shrimp) and suspended in streams using a stout pole. The fish were dried and salted. On the other islands, however, the fish was considered bad luck and discarded because its lizard-like appearance was associated with deities that would cause harm if disturbed.

niles and females are mottled brown to gray-green. Juveniles at lower elevations may also exhibit red fin edges. Nuptial males have blue and red dorsal fins and bodies ranging in color from turquoise to brilliant blue to black with two white racing stripes along the flanks. Both sexes turn very dark when disturbed. Larvae drifting in ocean currents are omnivorous with terminal mouths; 48 hours after returning to a stream, however, mouths permanently transform to a subterminal position and the fish switch to a herbivorous diet. The subterminal mouth serves two functions: to scrape algae off rocks and to climb waterfalls. Nopoli defend feeding patches, visible as areas grazed free of algae. The species is abundant on all the major islands except Oahu, where it is rare. Where the goby does occur on Oahu, its presence is an indicator of good water quality, and of the likely presence of Hiukole Gobies farther upstream. The Nopoli can climb falls up to 100 feet high and occupy streams more than 1,100 feet in elevation, but prefers riffles and runs in the middle reaches of streams. It is also occasionally found in lower reaches just above stream mouths. Spawning occurs from August to March and eggs hatch in one to two days. Larvae spend about five months at sea. Early Hawaiians fa-



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Nopoli Rockclimbing Goby. Bottom: Gobies climbing.



Hi'ilawe Falls in the Waipio Valley. Height: 1,450 feet (sheer drop: 1,201 feet).

### NOPOLI ROCKCLIMBING GOBY

The adult Nopoli Rockclimbing Goby (*Sicyopterus stimpsoni*), called 'ō'opu nōpili in Hawaiian, reaches a maximum size of about seven inches and the species varies greatly in appearance throughout the life cycle. The first dorsal fin in mature males overlaps with the second when relaxed. Juve-

vored Nopoli as food and a symbol of good luck. Priests also utilized it for love magic sorcery. Until the 1950s, communities would create a partial stream diversion to reduce water volume and use native plants to drug the gobies. Both sexes were harvested, but gravid females were the most highly prized. Bundles of fish looking like old bananas would be hung on porch rafters to dry.

### NANIHA GOBY



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Nuptial male (top) and female (bottom)

The smallest of the Hawaiian natives, reaching a maximum size of four to five inches, is the Naniha Goby (*Stenogobius hawaiiensis*), also known as 'o'opu naniha. Nuptial males and females exhibit 9 to 11 vertical black bars on the flanks, dorsal fin margins become red and the black eye bar dramatically darkens. Males also develop a dusky flush to their throats and lower jaws. Naniha is an omnivore that feeds on algae and invertebrates by thrusting its snout into soft sediments. A streambed dimpled with tiny craters indicates recent feeding. A poor climber, it is restricted to the lowest reaches of streams and brackish areas near stream mouths where it is a common associate of the Akupa Sleeper. Spawning occurs year-round; eggs hatch in about a day. Fry lack eyes, gills, and digestive tract, but these develop within five days. Larvae spend approximately 135 days adrift before returning to streams. "Naniha" translates to "avoidance," but the original meaning relative to the goby is not known. One guess is early Hawaiians rarely utilized this species as a food source.

After researching this article, I have now added the first item to my bucket list. I will someday swim with the 'o'opu in their crystal clear streams and paradise setting. Perhaps this will also serve as a teaser for a future NANFA convention...the more the merrier.

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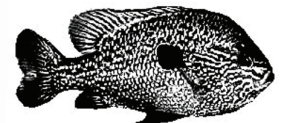
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Clockwise, from top left: Nopoli Rockclimbing Goby (*Sicyopterus stimpsoni*) (Photo courtesy of Hawaii Fish Habitat Partnership), Hiukole Goby (*Lentipes concolor*) (Photo by Cory Yap), and Naniha Goby (*Stenogobius hawaiiensis*) (Photo by Marj Awai).