DECLARATION OF MICHAEL H. KIDO
30 October 2019

In Sierra Club - Plaintiff vs. Board of Land and Natural Resources, Alexander and Baldwin Inc. and East Maui Irrigation Inc., LLC – Defendants (CIVIL NO. 19-1-0019-01 JPC – ENVIRONMENTAL COURT)

I earned a Master's Degree in Zoology from the University of Hawaii (UH) in 1973 and worked as a research biologist for UH from 1990 retiring in November 2015. My primary research focus was in Hawaiian stream ecology, establishing the Hawaii Stream Research Center and Long-term Ecological Ecological Research Site (LTER) in Limahuli Stream (Kauai) in 1996 within UHM's Center for Conservation Research and Training (UH-CCRT). My early research in the 90's focused on the diet ecology of native Hawaiian stream gobiid fishes (*'o'opu*) publishing a series of scientific journal papers that provided previously undocumented spatial-temporal information on the algal – invertebrate assemblage living on the stream bottom being selected as foods by our five native *'o'opu* species. These projects provided a basis for the development of robust methodologies to monitor spatial-temporal changes in population densities of native stream animals as well as the algal-invertebrate availability of their preferred foods in Hawaiian stream environments.

These data led to a better understanding of the natural ecological structure and function of Hawaiian stream environments related to the dynamics of flow variation from "mountain-to-sea". This research resulted in scientific papers quantifying stream monitoring – assessment methodologies in the Hawaii Stream Bioassessment Protocol (1999), the Hawaii Stream Index of Biotic Integrity (HS-IBI) (2012), the Hawaii Watershed Health Index (2012) and application of these monitoring tools in natural and human-impacted streams on Kauai, Oahu, Maui, Molokai and Hawaii islands (2000 – 2019). These methods incorporated a core perspective that pristine (i.e. least human-impacted) Hawaiian streams exhibit inherent high "biological integrity" flowing continuously from "mountain-to-sea" within *ahupua'a* and that native *'o'opu - 'opae* are driven to find species-specific preferred habitat locations along this continuum upon entering a stream as juveniles from the ocean. This "reference condition " of high biological integrity was used as a standard to which the biophysical condition encountered in a Hawaiian stream could be compared. The initial set of "reference streams" selected in 1998 included Hanakapiai (Kauai), Lower Hanawi (Maui) and Wailau (Molokai).

Physicochemical factors that degrade Hawaiian stream environments, moving them away from the reference biophysical condition, either disrupt the continuous flow to the ocean (dams – diversions), modify the natural stream channel (culverts, road-crossings, channelization for flood control, etc.), input chemical pollutants and run-off from impervious surfaces into stream environments or modify natural vegetated lands in the watersheds – riparian zones.

The only comprehensive statewide inventory of streams in Hawaii, published in 1978 (41 years ago)(Timbol and Maciolek 1978), concluded that 53% of perennial streams in Hawaii were impacted by some form of water diversion primarily for agricultural or hydropower development. I have looked at stream diversions statewide and they generally fall into three categories: 1) concreted dam structures that impound water behind them with various designs of grated systems to divert water into ditch networks often used to trap additional water from side-tributaries; 2) cut-off trenches dug in to underlie the stream channel so that flow drops directly in the streambed through a grate into the ditch network and; 3) *taro loi* diversions where a portion of streamflow is directed into *auwai* at strategic natural bends in the channel sometimes with stream rocks loosely piled into walls to direct flow as in traditional systems. Dam structures are designed to take 100% of flow up to some predetermined flood level when the barriers are overtopped. *Taro loi* diversions I've seen never take more than 50% of natural flow with traditional systems as in Waipio Valley (Hawaii) diverting less than 30% with used water always returned to the stream.

The obvious negative ecological impact of hardened across-stream diversion structures (types 1 & 2 above), depending on where they are situated on the continuum, is to cut-off continuous flow from "mountain-to-sea" so that juvenile *'o'opu* and *'opae* returning from the ocean may not be able to reach their preferred *mauka* habitat. Moreover adults moving downstream from *mauka* locations to spawn are ensnared by flow into the ditch systems with no way out. The same fate faces newly hatched larvae trying to reach the ocean from spawning grounds above diversion intakes. In stream systems where such diversion structures were in place for decades (e.g. Anahola-Hanalei-Wailua-Waimea-Wainiha (Kauai); Iao (Maui); Waipio-Wailoa (Hawaii)) populations of native stream animals are depauperate or nearly absent in often perfectly good *mauka* habitat upstream of the diversions.

Some of this biological impairment, depending on the magnitude – duration - location of flow disruption, may be attributed to chronic impacts on natural fluvial processes which are critical to nutrient processing, downstream movement of sediments – substrate and nutrient export into the ocean. Streambed habitat downstream of diversion structures can be severely degraded by excessive soil-sediment-organic matter deposits to the point where little or no natural cobble-boulder substrate is visible which is the case in the lower reaches of the Waimea River on Kauai. Flow reduction below diversion structures also lowers the stream's water level and raises water temperature particularly during extended droughts. I have witnessed large numbers of dead *'o'opu* in dried out stream habitat below the Wainiha River dam during such a drought period. Upstream migrating *'o'opu* will wait in shrinking available pools in habitat below diversions until they succumb to high temperatures and lack of oxygen. Flow reduction in stream habitat below diversion structures also enhances habitat for alien slow-water aquatic species like Poeciliid fishes (e.g. mosquito fish, swordtails, mollies, etc.) which harbor lethal internal parasites that are transferred to *'o'opu* species in locations where they coexist. The biological trajectory of chronic, unmanaged water diversion by

hardened systems and accumulating human-impact is towards increasingly degraded biological integrity in the stream system as a whole characterized first by lowering population densities of native stream animals in their preferred habitat locations along the stream continuum, followed by the absence of sensitive species (i.e. *'o'opu alamo'o* and *'o'opu-nopili*), ending in degraded habitat where alien aquatic species predominate.

While I believe that surface-water diversion from streams in Hawaii is necessary to support human populations it must be done responsibly and adequately justified as to the specific quantity – duration – location of the water withdrawn and for what purpose. When - where we do divert water we should use the best available technologies, minimize waste through active management – monitoring of leakage in the diversion systems and design in routes for stream animals to pass. With climate change upon us we are already seeing rising sea-levels that will soon affect estuaries and low elevation aquifers – reservoirs. Catastrophic rain and drought events are becoming the norm as storms intensify, land temperatures increase and rain-producing trade-wind patterns become more variable. Sustainability of water resources and protection of the long-term health (i.e. biological integrity) of Hawaiian streams from "mountain-to-sea" must be at the core of our decision-making process if society hopes to manage in this coming age of water resources limited by an increasingly unpredictable climate.

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30 October 2019