State of Hawaii
Department of Land and Natural Resources
DIVISION OF AQUATIC RESOURCES

May 17, 2010

TO: Ken C. Kawahara, Deputy Director-Water
Commission on Water Resources Management

CC: Laura H. Thielen, Chairperson
Department of Land & Natural Resources

FROM: Robert T. Nishimoto, Environmental Program Manager
Division of Aquatic Resources

SUBJECT: Request for stream flow estimates for H_{50} and H_{70} and the Division of Aquatic Resources' position statement on Minimum Habitat Flows

The Division of Aquatic Resources (DAR) is responsible for the protection and management of living aquatic resources in the waters of Hawaii. The DAR realizes that the Commission on Water Resource Management (CWRM) has the responsibility of balancing the current and future value of multiple uses of water when rendering its decisions on specific Instream Flow Standards. By contrast, the DAR's recommendations focus only on the requirements of the native aquatic biota that fall within the scope of our authority, and do not consider additional instream or offstream uses of stream water. This memorandum reflects DAR's position on the recommendations that support restoration of native species habitat, migratory pathways for upstream recruiting individuals and downstream drifting larvae, and overall population structure and health for eight native fish and macroinvertebrate species inhabiting East Maui streams.

On March 11, 2010, the Division of Aquatic Resources met with Native Hawaiian Legal Corporation (NHLC), Commission on Water Resource Management (CWRM), Hawaiian Commercial & Sugar (HC&S), and Maui Department of Water Supply to discuss current data that CWRM has received to date. The DAR presented a spreadsheet of East Maui Stream flow ranks for H_{90} and H_{100} which are the percent of habitat based on the USGS IFIM study for East Maui Streams. It was requested that DAR recalculate the flow ranks for H_{50} and H_{70}. H_{50} and H_{70} were not presented by DAR as DAR staff had already determined that these flow rates for these habitat levels would not support all aspects of the native species life history requirements.

The former administrator to DAR misconstrued DAR's position to the March 11th meeting participants when he stated that DAR could calculate H_{50} and H_{70} flow rates. While DAR has the ability to calculate flows for any habitat level based on the USGS

IFIM study, DAR does not believe that H_{50} or H_{70} reflect viable flow rates for the protection of native aquatic biota.

On May 4, 2010, the DAR was directed by the DLNR administration to provide the H_{70} and H_{50} flow estimates for the DAR recommended streams and these are provide in this document. It is understandable why such a request would be made. Almost by definition, there is an expectation that a linear relationship exists between the amount of habitat and the number of animals. Thus it is tempting to assume that H_{70} is only 20% less habitat then H_{90} and therefore would result in only 20% less animals. Similarly, H_{50} is only 20% less then H_{70} and therefore only an additional 20% less animals. This conclusion IS NOT supported by the DAR.

DAR fully comprehends the rationale, methods, and results of the USGS IFIM study, and thus understands that it considers only a limited portion of the life history requirements of the native species. The USGS IFIM study primarily considered the attributes of water depth, velocity, and substrate, yet did not consider important components like food production or availability, the presence of suitable refuges, pathways for migration, the availability of spawning habitats, flow mediated triggers for reproductive events, or seasonally variable flow rates. The is not intended as a criticism to the quality of the work provided by USGS, only that as USGS states in their report, "These results are intended to be used along with other biological and hydrological information in development, negotiations, or mediated settlements for instream flow requirements." DAR's position is that H_{min} (H_{90}) or 64% of the naturally occurring base flow represents the minimum viable flow expected to provide suitable conditions for growth, reproduction, and recruitment of native stream animals. Flows lower than the minimum habitat flow would serve primarily maintenance flows where the adult animals "survive" until more suitable flows return.

The DAR's recommendations are based on several lines of evidence. First, DAR biologists and technicians spent considerable time and effort surveying habitat and animal populations in these streams. The results of these surveys found that while some areas within the streams do contain native animals, many stream sections had few or no native species. Second, the DAR compared the results of the stream surveys with estimates of expected native species occurrence by utilizing the Hawaiian Stream Habitat Evaluation Procedure (HSHEP) analytic model, with the results for the 19 East Maui streams provided to CWRM staff on November 20, 2009. The results of the HSHEP also suggest that native animals are missing from a number of stream sections where they should naturally exist. Finally, the DAR used available information and the extensive experience of its staff to develop a general life history description of island stream animals and used this in determining the final list of actions needed to support restoration of native species in these 19 streams.

A general consensus among DAR staff and many outside researchers regarding stream flow and native stream animals' life history is that the animals' behavior changes with changes in seasonal stream flow. For adult animals, periods of higher base flow triggers many reproductive events. The animals react to the higher flows to initiate courtship and

spawning. The animals attached the fertilized eggs to the substrate (fish and mollusks) or to their body (crustaceans). After a period of development, the larvae hatch from the eggs and drift downstream. The newly hatched larvae have a short period of time to reach the ocean before dying thus higher flows serve to successfully transport larger numbers of newly hatched larvae from spawning sites further inland. Once the larvae reach the ocean, they spend 3 to 5 months (in most species) developing in ocean waters. When the animals are ready to return to the stream, they usually return in mass in response to high stream flow events. The small animals, averaging ¼ to 1 inch long, move upstream to find suitable adult habitat. The juveniles that find suitable habitat mature into adults. Adults live for multiple years and can spawn multiple times in a single spawning season. There is evidence in Hawaii and in other Pacific islands that native island stream animals' reproduction commences with the beginning of the wet season and recruitment of young animals peaks toward the end of the wet season. As a result of this generalized life history pattern, the creation of an artificial "wet season" with higher base flows in a flow controlled stream may support many of the animals life history requirements.

DAR supports the following positions regarding restoration efforts in East Maui Streams.

As a general position regarding stream diversion and native aquatic animals:

- The removal of stream diversions and the complete restoration of stream flow would be the best possible condition for native aquatic animals. DAR understands that management of the resource is a balance between the needs of the animals and the needs of people thus supports some use of water from East Maui Streams.
- In no case are additional diversions of stream water recommended, although current levels of stream flow diversion may be appropriate on some streams. Flow restoration is only recommended on 8 of the 19 streams under consideration.
- The prioritization of the East Maui Streams is based upon the "biggest bang for the buck" concept, where priority is placed on streams with the greatest potential to increase suitable habitat for native species.
- The restoration of suitable flows to a single stream is more appropriate than the return of inadequate flow to multiples streams. DAR supports the trade-offs on the restoration of a smaller number of streams with sufficient water (see below) over the return of insufficient water (for example at H_{50} or H_{70} levels) to a larger number of streams.
- Restoration of stream flow should reflect the water budget of the individual stream catchment. The use of trans-basin water diversions from ditches to restore stream sections should be avoided where at all possible.
- Co-mingling of stream and ditch flows should be avoided where at all possible to limit the potential spread of invasive aquatic species.
- Restoration of streams should be spread out in a geographic sense. This will provide a greater protection against localized habitat disruptions, a wider benefit to estuarine and nursery habitat for nearshore marine species, and result in more comprehensive ecosystem function across the entire East Maui sector.
- Implementation of a long-term monitoring program to analyze the effect of restored flows to native biota, their health, and all aspects of their life history.

With respect to amount of water flow needed in the stream:

- The goal of returning H_{min} during the wet season and C_{min} during the dry season is considered the minimum viable flow to achieve suitable conditions for native aquatic animals.
- Minimum viable habitat flow (H_{min}) for the maintenance of suitable instream habitat is defined as 64% of Median Base Flow (BFQ_{50})(also defined as H_{90} by USGS studies). DAR expects that these flows will provide suitable conditions for growth, reproduction, and recruitment of native stream animals.
- Minimum viable connectivity flow (C_{min}) for the maintenance of a wetted pathway between the ocean and stream habitats is defined as 20% BFQ_{50}. These flows are expected to allow adult animals to move among habitats and allow recruiting animals to move upstream to suitable habitats. These flows are considered by DAR to be too low to expect suitable long-term growth and reproduction of native stream animals.
- Seasonally adjusted flows, H_{min} during the wet season and C_{min} during the dry season may mimic the natural flow variability observed in Hawaiian streams and support most ecological functions required by the stream animals. Seasonally adjusted flows would also provide maximum water for human use during periods of highest needs in the dry season and provide increased water to the stream animals during the period of lowest demand during the wet season. The increased wet season flows are intended to trigger reproductive events and maximize production of native animals.
- A "share-the-pain" approach in dealing with droughts may be appropriate. When an area is experiencing drought conditions then instream flow requirements may be suspended. The native aquatic animals in Hawaii streams have evolved in a system where droughts and the resultant low flows periodically occur and the animals can repopulate a stream when more favorable conditions return. This is not supportive of the continuous man-made artificial drought conditions currently experienced in many East Maui Streams as a result of stream diversion.

With respect to entrainment of native animals in stream diversions:

- The DAR realizes that complete elimination of entrainment for native stream animals is unlikely, but an avoidance of entrainment at diversion locations is important to maximize populations of native stream animals while minimizing the negative impacts from stream diversions.
- As newly recruiting animals move upstream to adult habitats, they follow the available path of water in the stream. Thus release of water from sluice gates in the immediate vicinity of diversion intakes serves to funnel animals to the intake and results in high rates of entrainment (and ultimately death) of animals migrating upstream. Therefore, water releases should provide a pathway as far away as possible from the point of diversion to minimize entrainment of upstream migrating animals.
- As newly hatched animals travel downstream to the ocean, they passively drift with the stream water. Thus release of water from sluice gates in the immediate vicinity of diversion intakes serves to concentrate animals near the intake and

results in high rates of entrainment (and ultimately death) of animals drifting downstream. Therefore, water releases should provide a pathway as far away as possible from the point of diversion to minimize entrainment of downstream drifting animals.

The following are the flow recommendations for the 8 East Maui Streams (Table 1). The H_{min} and C_{min} flow are provided (highlighted in green) along with the USGS H_{70} (removal of 63% of median base flow for all species less opae and 77% of median base flow for opae) and USGS H_{50} (removal of 83% of median base flow for all species less opae and >99% of median base flow for opae). The DAR recommendations of H_{min} and C_{min} flows represent essential actions that will greatly enhance native species habitat, connectivity, and overall population structure and viability. In no case are additional diversions of stream water recommended.

Note: DAR has seen little evidence in its surveys across the State of Hawaii that substantial (83%) to nearly complete (>99%) removal of base flow from a stream results in only losing 50% of its animals as suggested by the USGS study and thus does not support the designation of these flow amounts as 70 and 50% of available habitat.

Table 1. Various level of flow diversion for East Maui streams.

	Average stream flow below lower most diversion	H_{min}: DAR Recommended minimum habitat flow for wet season (H_{90} from USGS)	USGS H_{70} for all animals less opae (not supported by DAR)	USGS H_{70} for opae (not supported by DAR)	C_{min}: DAR Recommended minimum connectivity flow for dry season	USGS H_{50} for all animals less opae (not supported by DAR)	USGS H_{50} for opae (not supported by DAR)
	Amount of flow (cfs) remaining after diversion of x% of Median Base flow (BFQ_{50})						
Stream	Undiverted BFQ_{50} (cfs)	H_{min}: 36%	H_{70}: 63%	H_{70}: 77%	C_{min}: 80%	H_{50}: 83%	H_{50}: 99%
Waikamoi	6.9	4.4	2.5	1.6	1.4	1.2	0.1
Puohokamoa	10.5	6.7	3.9	2.4	2.1	1.8	0.1
Haipuaena	5.2	3.3	1.9	1.2	1.0	0.9	0.1
W. Wailua Iki	7.0	4.5	2.6	1.6	1.4	1.2	0.1
E. Wailua Iki	7.0	4.5	2.6	1.6	1.4	1.2	0.1
Kopiliula	8.0	5.1	3.0	1.8	1.6	1.4	0.1
Waiohue	6.8	4.3	2.5	1.6	1.4	1.1	0.1
Hanawï	no flow restoration recommended only modification of diversion for passage						

We apologize for any confusion created by the lack of clarity surrounding DAR's position on suitable instream flow requirements to support native aquatic animals. We hope this memorandum clarifies DAR's position on the subject. We understand the developing appropriate instream flow standards is a complex and difficult task and hope we can continue to support CWRM by providing well-reasoned scientific information that supports DAR's mandate to protect and manage the living aquatic resources in the waters of the State of Hawaii.