

Surface-water availability during low-flow conditions

Case study in Lahaina District, west Maui and
Hawaii statewide application

Chui Ling Cheng, U.S. Geological Survey



Kahoma Valley, Maui



Kapaloa Stream, Maui

WATER AVAILABILITY

- Cultural use
- Agricultural use
- Municipal use



From Real Time Farms,
<http://www.realtim farms.com>, Jan 2013

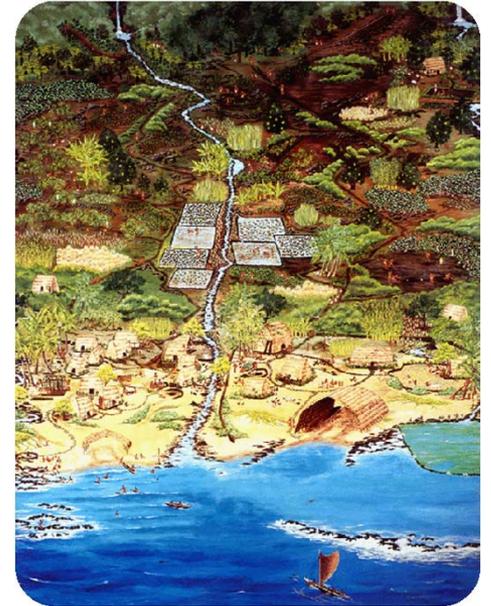
WATER QUALITY

- TMDL
- Drinking water



WATERSHED

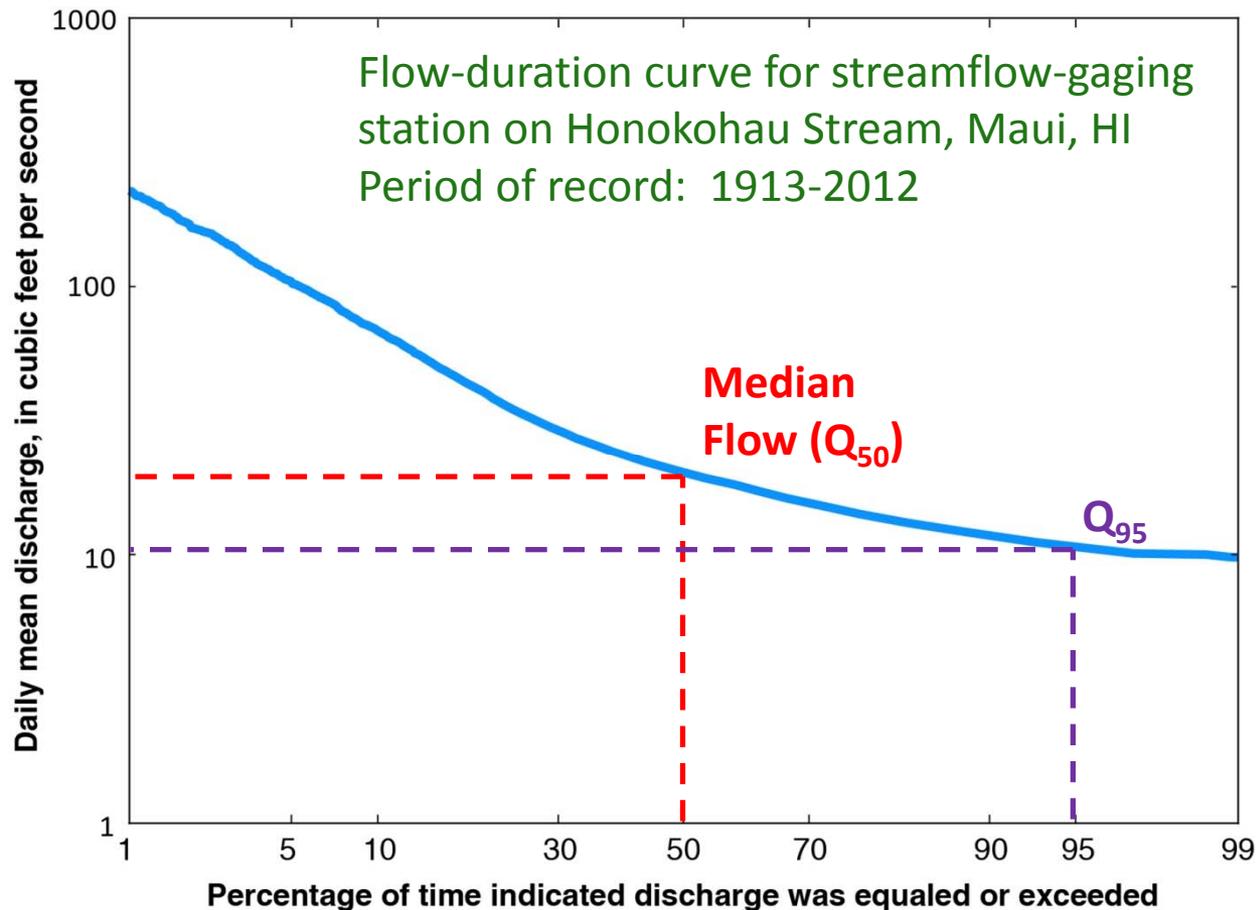
- GW discharge
- Aquatic life



From Native Books Hawaii,
www.nativebookshawaii.com, Jan 2013

Surface-water availability

Water availability is oftentimes characterized with duration discharges

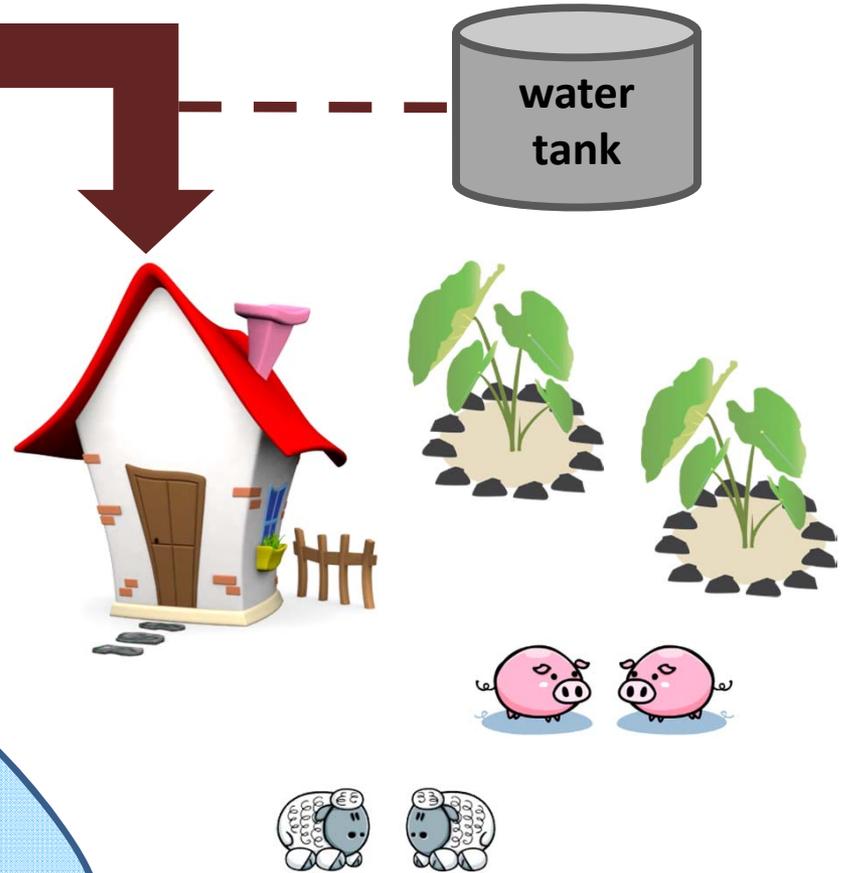
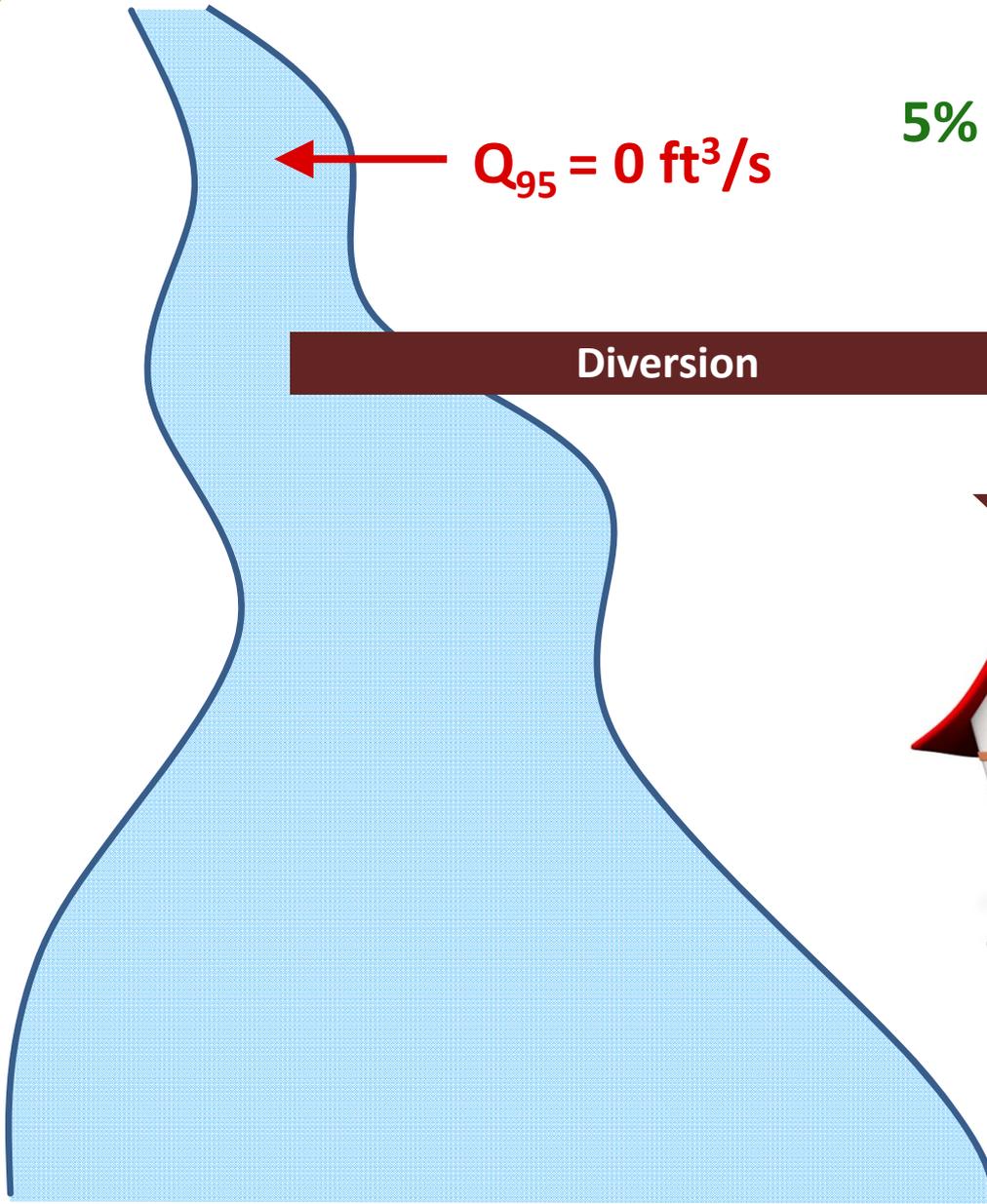


$Q_{95} = 0 \text{ ft}^3/\text{s}$

5% of the time, you are not going to have water

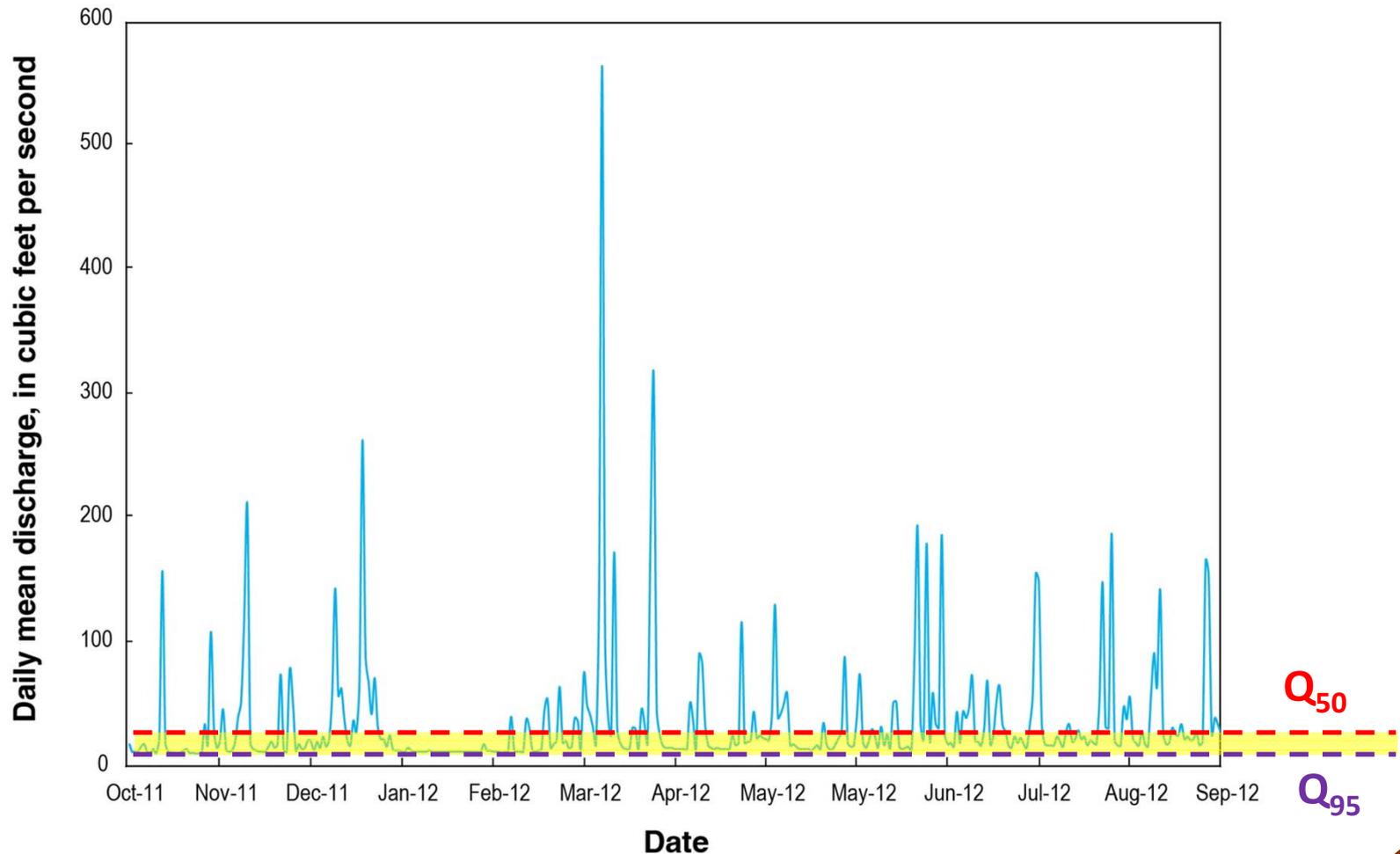
Diversion

water tank



Low-flow statistics

Hydrograph of stream-gaging station on Honokohau Stream, Maui, HI



Sites used to compute low-flow statistics

CONTINUOUS-RECORD

Provides continuous-record of discharge at a particular location



Wailua River, Kauai

PARTIAL-RECORD

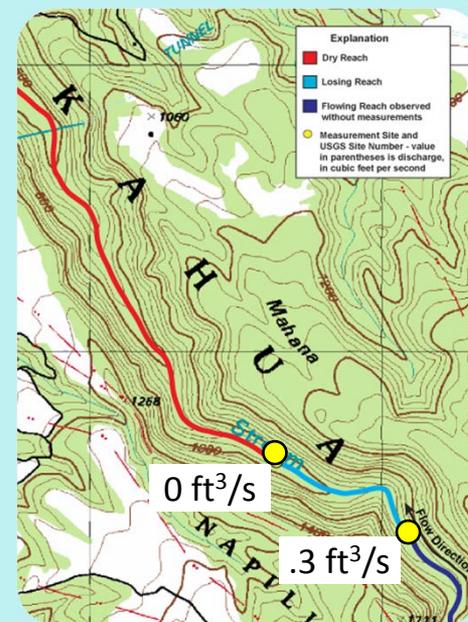
Discharge measurement made repeatedly at a particular location during low-flow periods



Ukumehame Gulch, Maui

SEEPAGE RUN

Discharge measurements made at several locations along a stream



Honokahua Stream, Maui

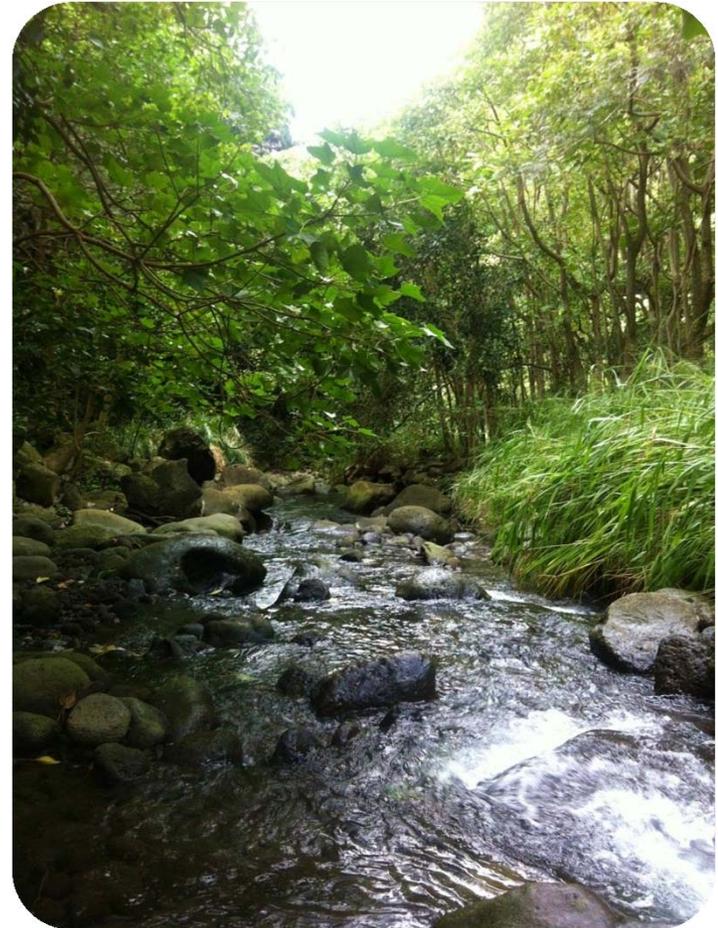
Case study: Lahaina District, Maui

Cooperator

State of Hawaii, Commission on Water Resource Management

Objective

Determine how much water is available, under natural low-flow conditions, on the main streams in the Lahaina District of west Maui.



Kanaha Stream, Maui

Instream flow standard (IFS)

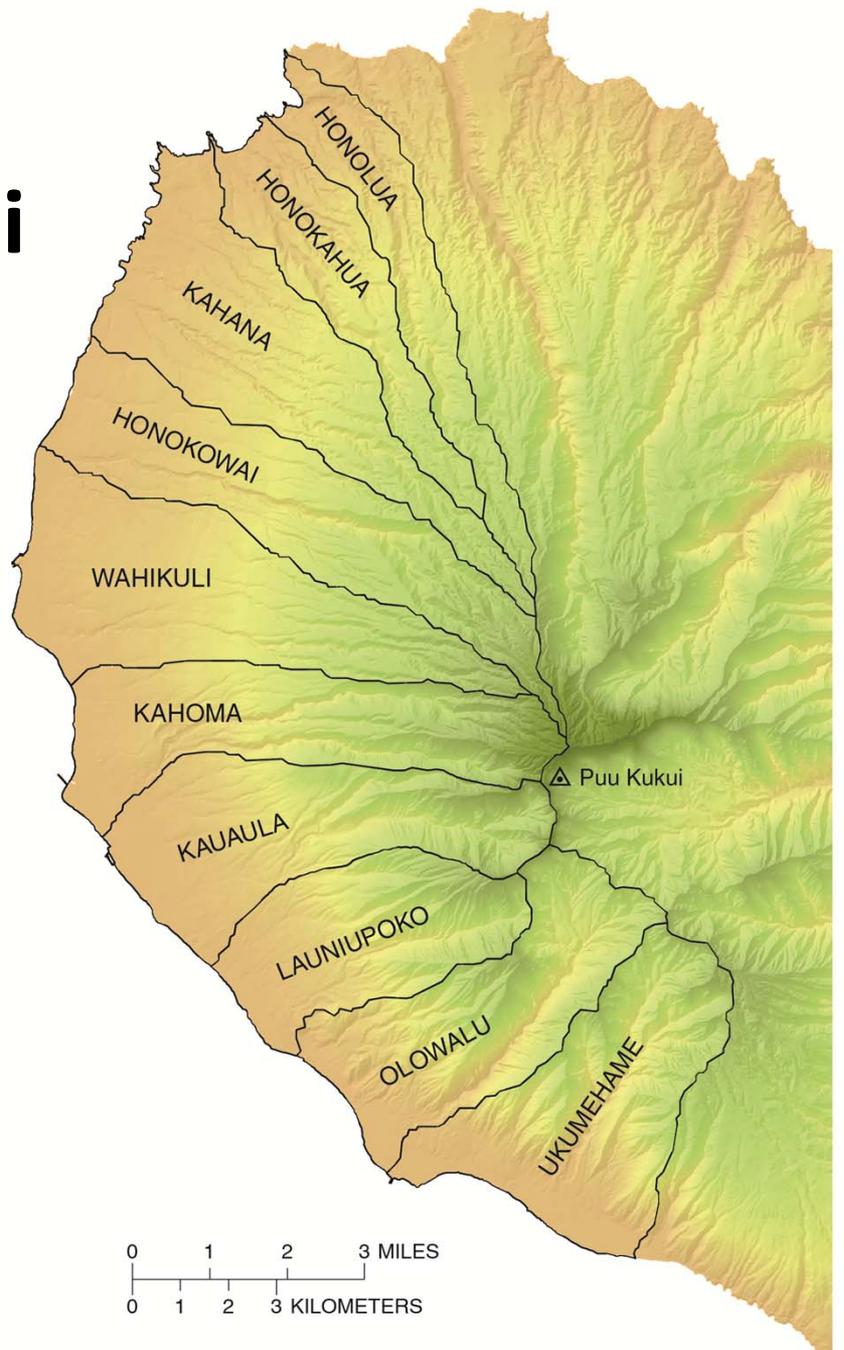
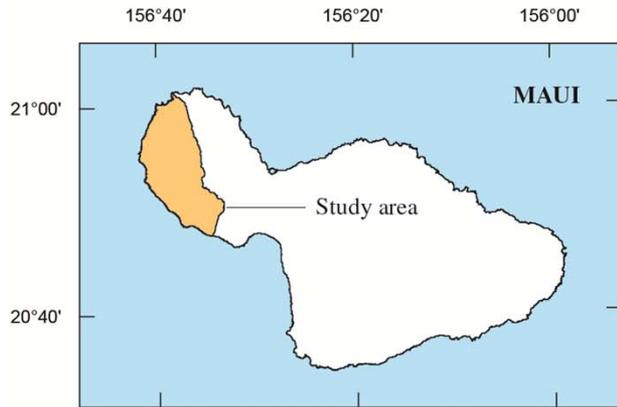
Describe the flows necessary to protect the public interests in a stream

Considers existing and potential water developments, and the economic effect of restricting such use

Beneficial instream uses

- Traditional Hawaiian rights
- Conveyance of water supplies
- Fish and wildlife habitat
- Ecosystem maintenance
- Recreation
- Aesthetics
- Water quality

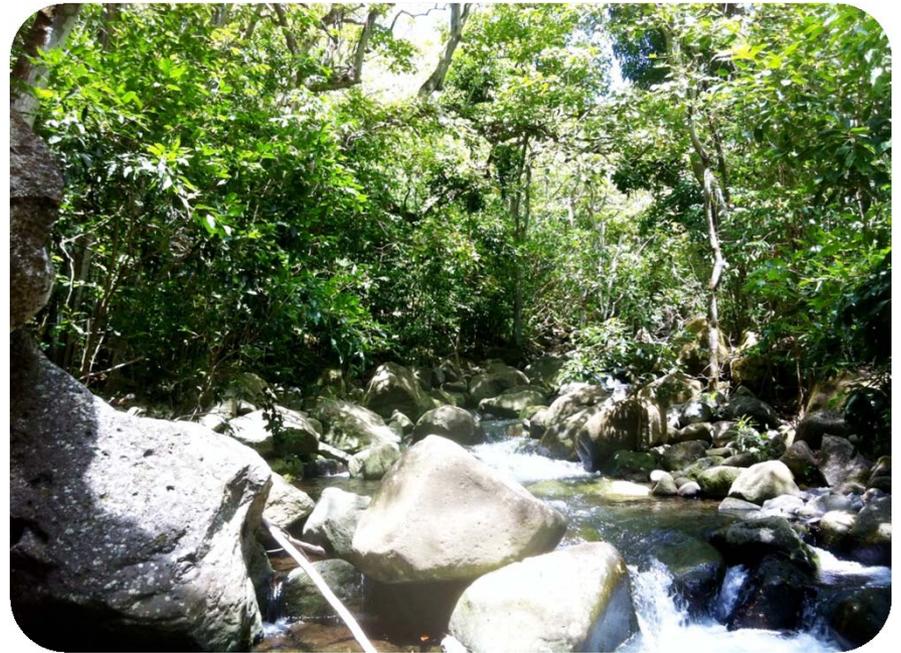
Study area: Lahaina District, Maui



Study objectives

How much flow is in the stream above the diversions?

How streamflow varies along the stream?



Upper Kahoma Stream, Maui



Study approach

Step 1: Collect data

Establish low-flow partial-record sites and measure discharge during independent low-flow periods



Step 2: Select index station

Correlate concurrent daily mean discharges at continuous-record station and measured discharges at low-flow partial-record stations



Step 3: Compute low-flow characteristics

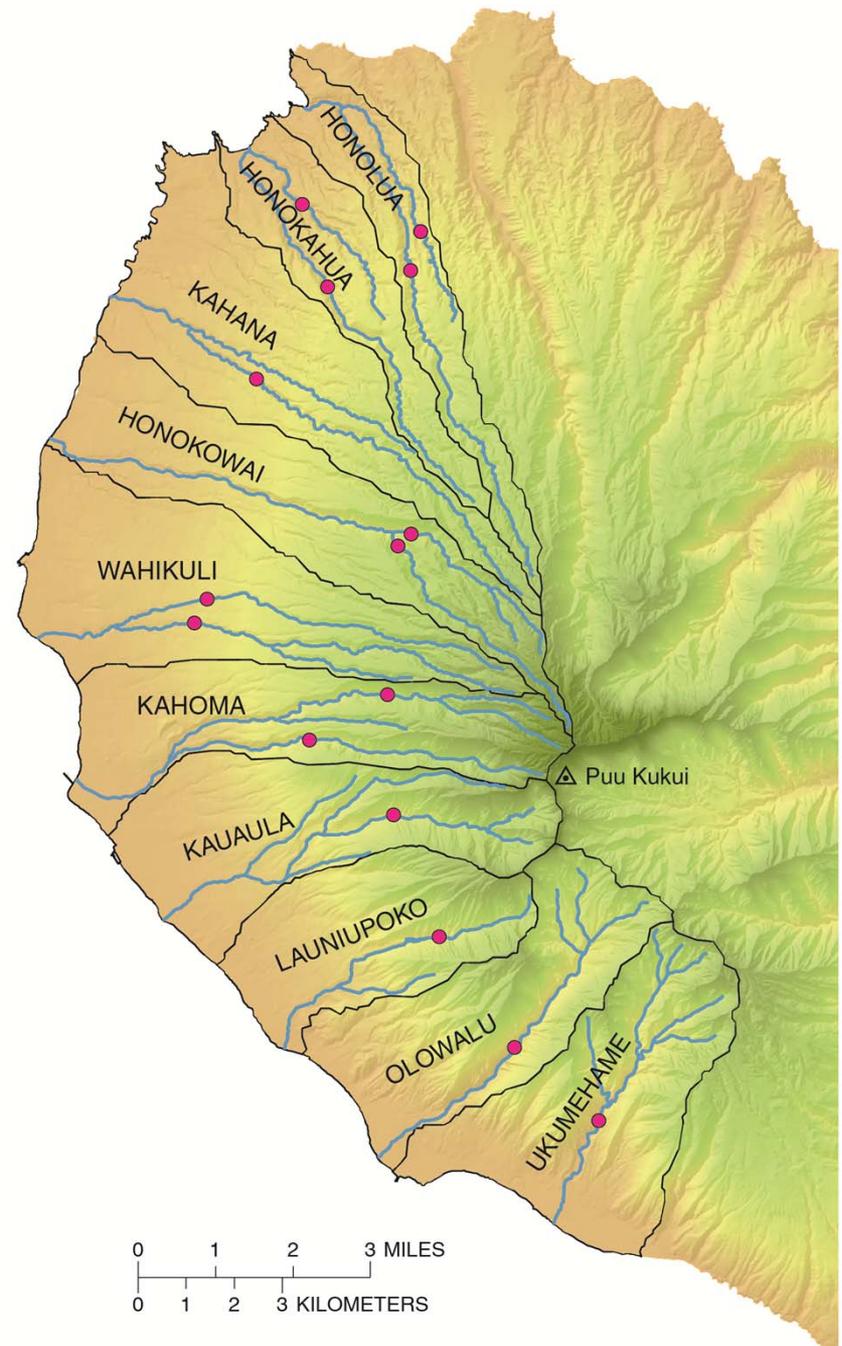
Estimate duration discharges at low-flow partial-record stations using streamflow data from index station

Collect Data

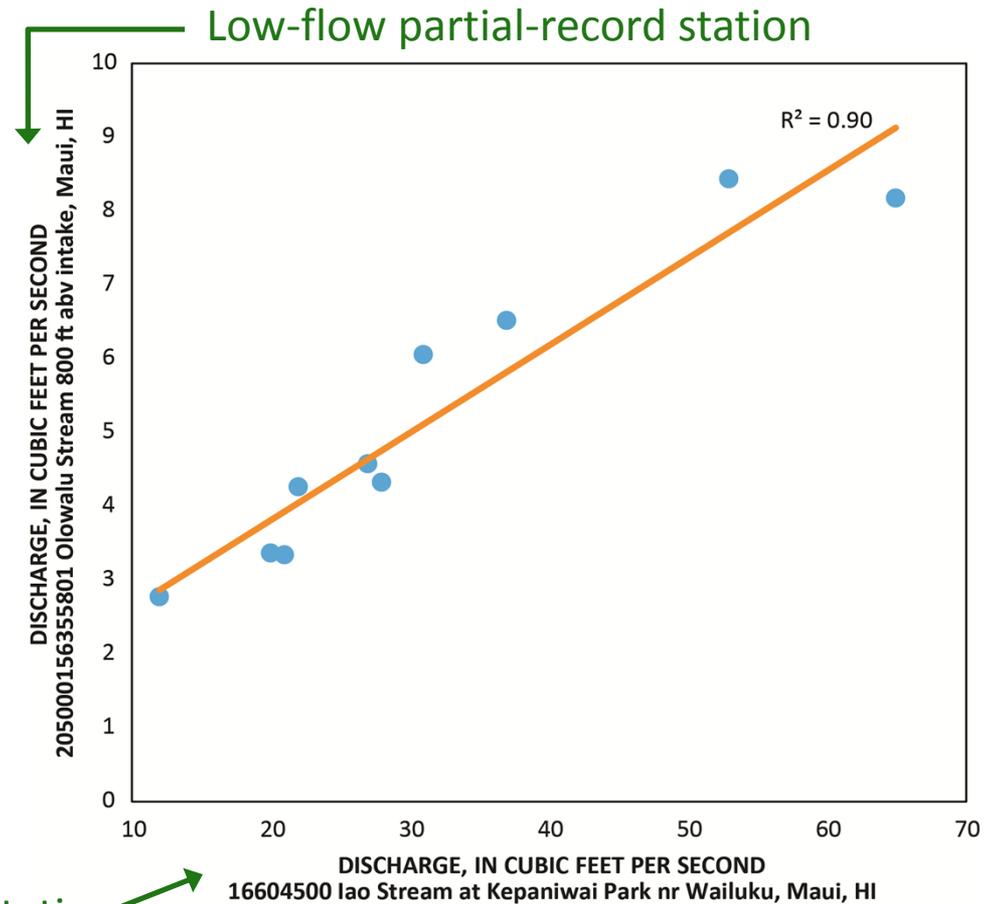
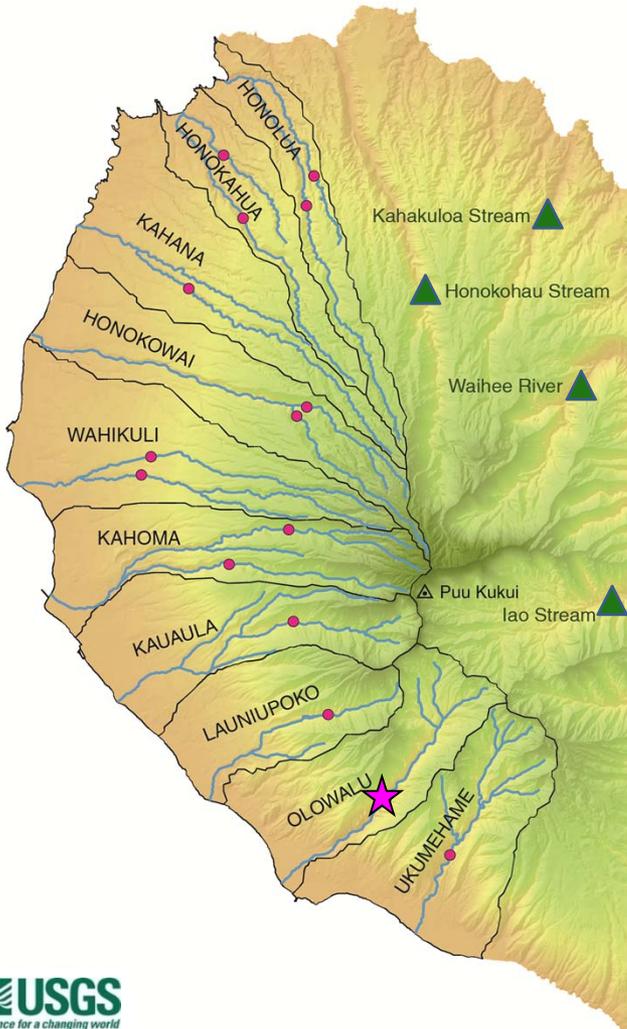
Established 15 low-flow partial-record sites

Measurement sites are mainly upstream from diversions

Measure flow during low-flow periods



Select index station



Index station

Compute low-flow characteristics

INPUT

Duration
discharge at
the index
station

Statistical relation

$$Y_i = m_y + \frac{s_y}{s_x} (x_i - m_x)$$

X = Index station

Y = Partial-record site

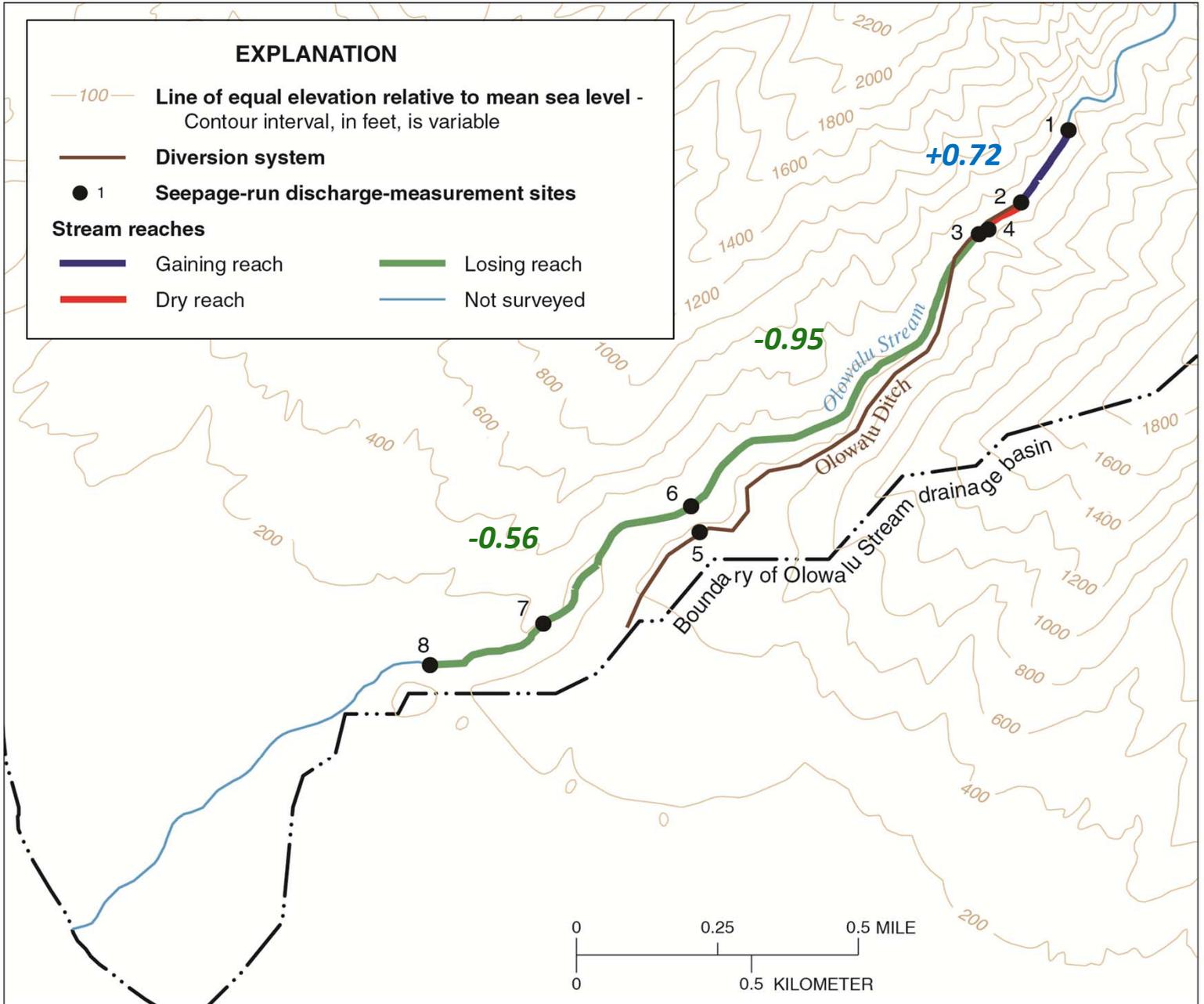
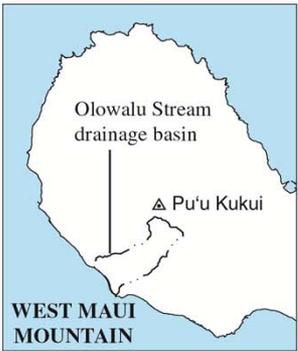
m = Mean

s = Standard deviation

OUTPUT

Duration
discharge
at partial-
record site

Equation from: Hirsch, R.M., 1982, A comparison of four streamflow record extension techniques: *Water Resources Research*, v. 18, no. 4, p. 1081–1088.

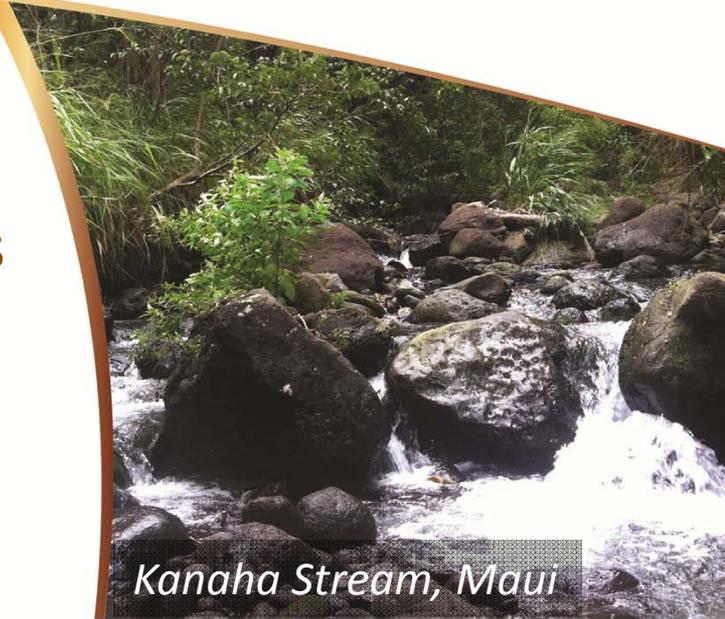


Lahaina study, preliminary results:

- Low flows in most streams correlate well with Honokohau Stream (index station)
- Honokahua Stream, Kahana Stream, and Wahikuli Gulch remain dry more than 50% of the time
- Majority of the streams generally lose flow downstream from diversions

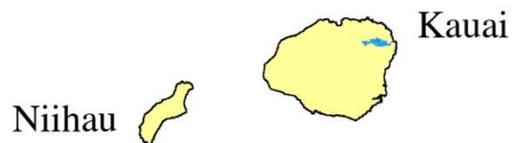
Study results can help with:

- Establishing instream flow standards
- Quantifying water availability for downstream use
- Prioritizing areas for further study



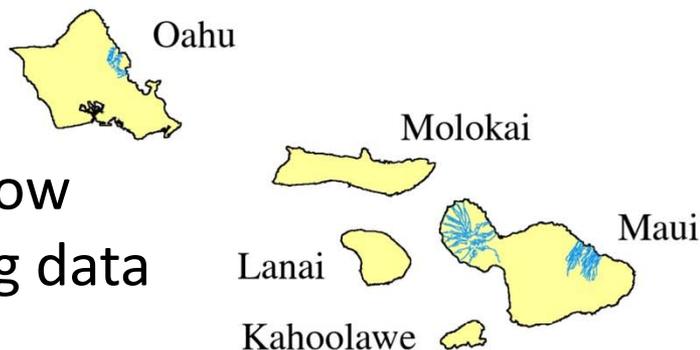
Kanaha Stream, Maui

Hawaii statewide application



Phase 1

Provide estimates of natural low flows for streams with existing data at gaged sites, and

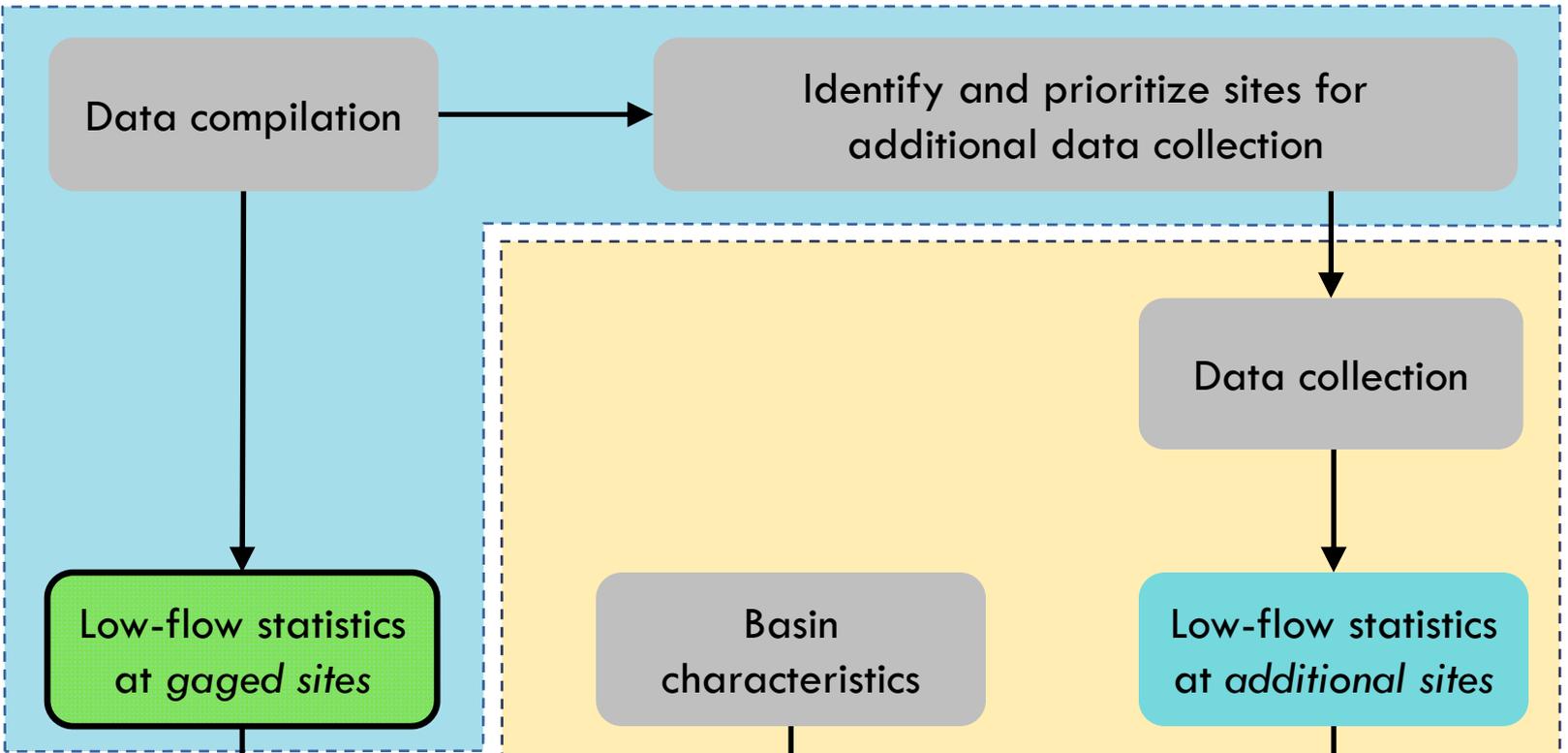


Phase 2

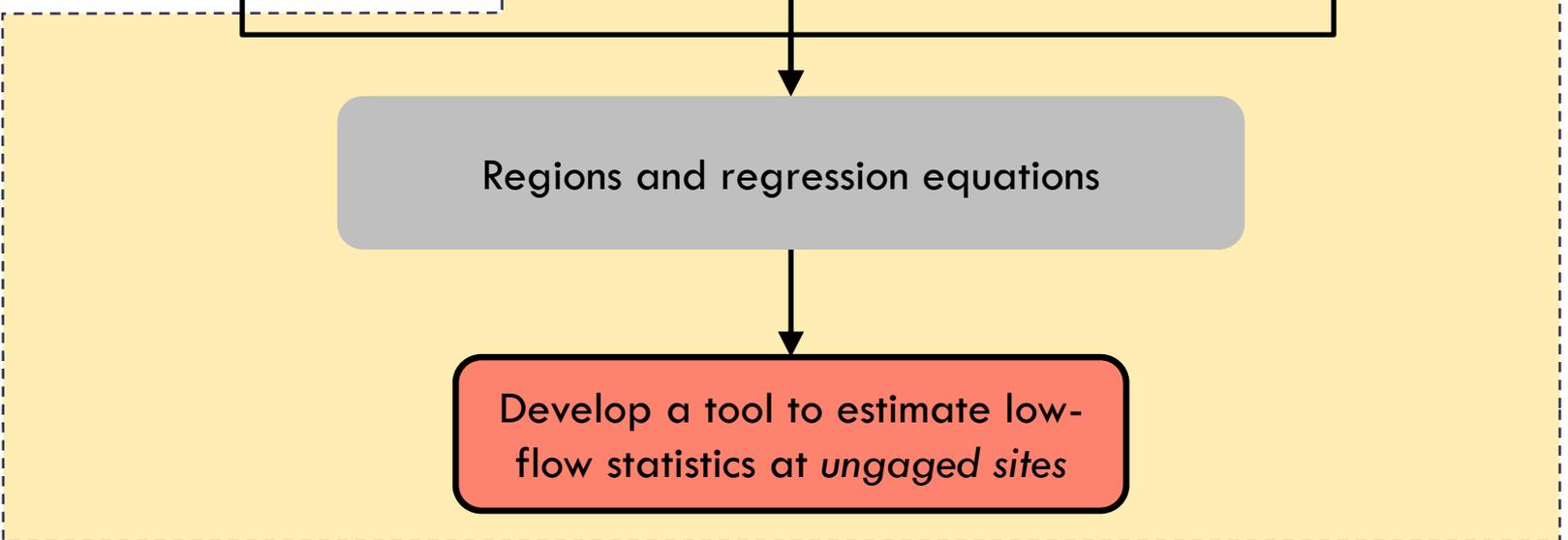
Develop a tool to estimate natural streamflow under low-flow conditions at ungaged sites.



PHASE 1



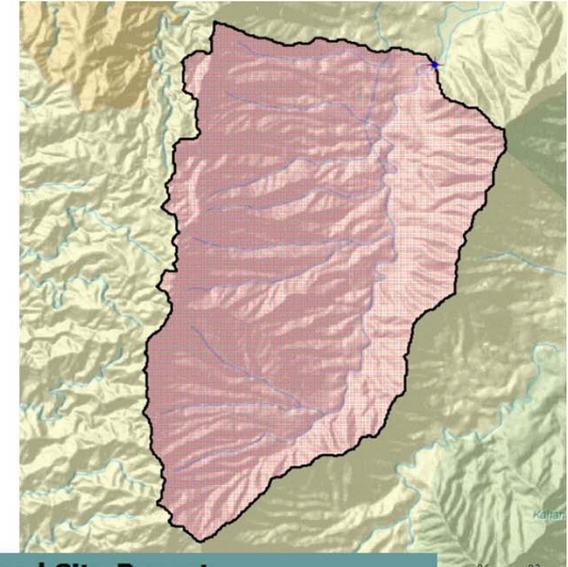
PHASE 2



StreamStats

StreamStats is a web-based GIS database that computes basin and streamflow characteristics.

As part of this study, a new tool within StreamStats will be developed for estimating natural low-flow availability at ungaged sites in Hawai'i.



Streamstats Ungaged Site Report

Date: Mon Jan 28 2013 11:10:01 Mountain Standard Time
 Site Location: Hawaii
 OLD HAWAIIAN DATUM Latitude: 21.5688 (21 34 08)
 OLD HAWAIIAN DATUM Longitude: -157.8974 (-157 53 51)
 NAD83 Latitude: 21.5656 (21 33 56)
 NAD83 Longitude: -157.8946 (-157 53 41)
 Drainage Area: 4.3 mi2
 Percent Urban: 3.28 %
 Percent Impervious: 0.35 %

Peak-Flows Basin Characteristics

100% Peak Region 4 2010 5035 Oahu windward (4.3 mi2)			
Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	4.3	0.04	5.44

Peak-Flows Streamflow Statistics

Statistic	Flow (ft ³ /s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	1750	63			
PK5	3300	51			
PK10	4560	47			
PK25	6350	46			
PK50	7830	46			
PK100	9370	48			
PK500	13400	54			

Summary

Importance of low flows

Low-flow information is critical in the planning and management of our limited surface-water resources.

Low-flow analysis

Method used in the Lahaina study helps expand the geographic coverage of low-flow information.

Regionalizing low flows

This method can be used to estimate low flows at ungaged sites.

StreamStats

This web-based program produces low-flow estimates that meet the varying needs of different agencies.

Status of statewide study

Budget and timeline

	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20
Phase 1		Funded at \$350,000*						
Phase 2				Unfunded, est. budget \$2,000,000*				

*USGS cost shares 50%

Phase 1 funding agencies:

- Commission on Water Resource Management
- Department of Hawaiian Home Lands
- Office of Hawaiian Affairs

Potential cooperating agencies:

- Department of Agriculture
- Department of Health
- DLNR, Division of Forestry and Wildlife
- DLNR, Land Division
- Honolulu Dept. of Planning and Permitting
- Honolulu Board of Water Supply
- Maui County Department of Water Supply
- U.S. Army Corps of Engineers

streamstats.usgs.gov

hi.water.usgs.gov

QUESTIONS

ccheng@usgs.gov