

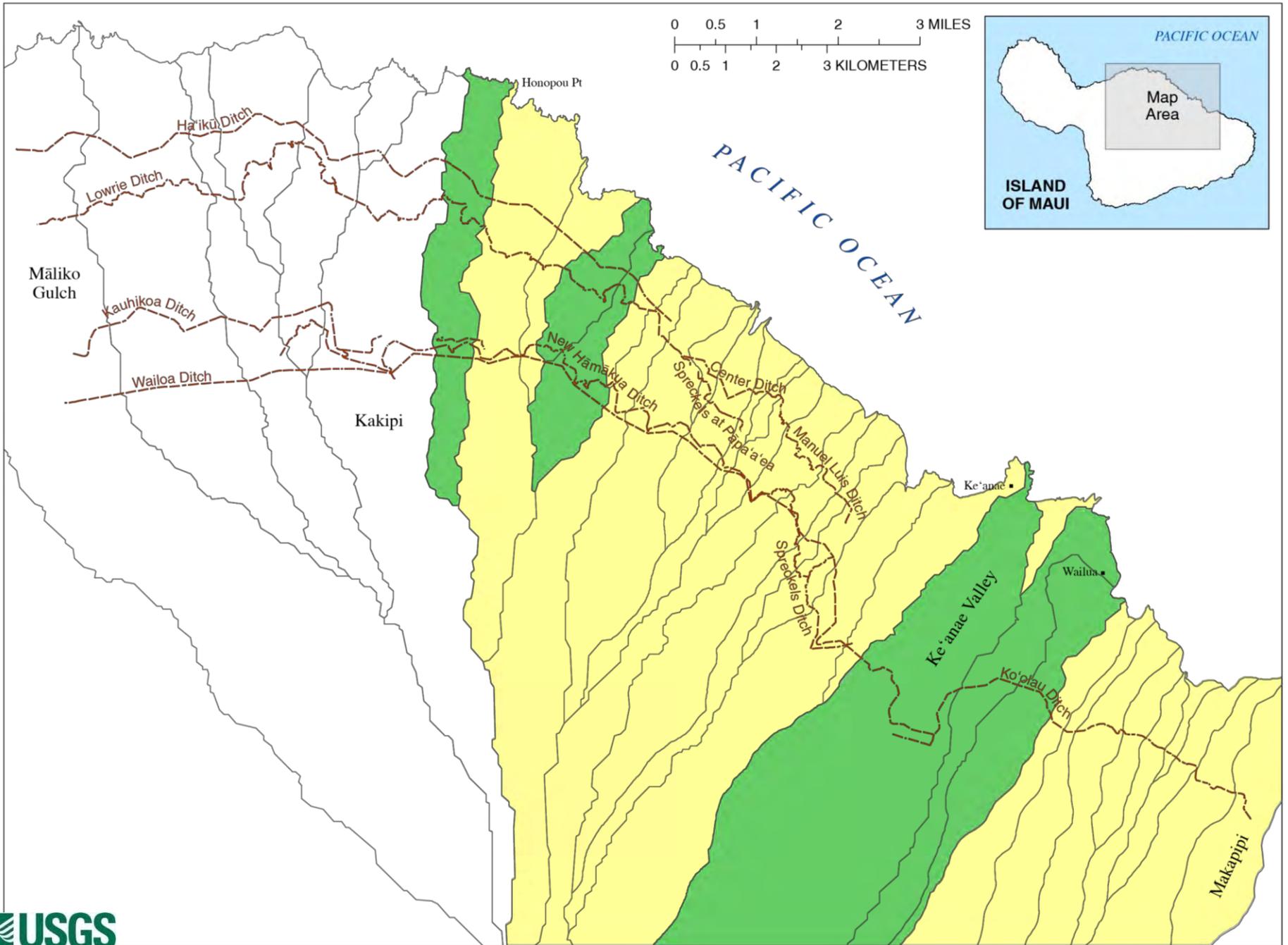
Measurements of Seepage Losses and Gains, East Maui Irrigation Diversion System, Maui, Hawaii



Instream Uses

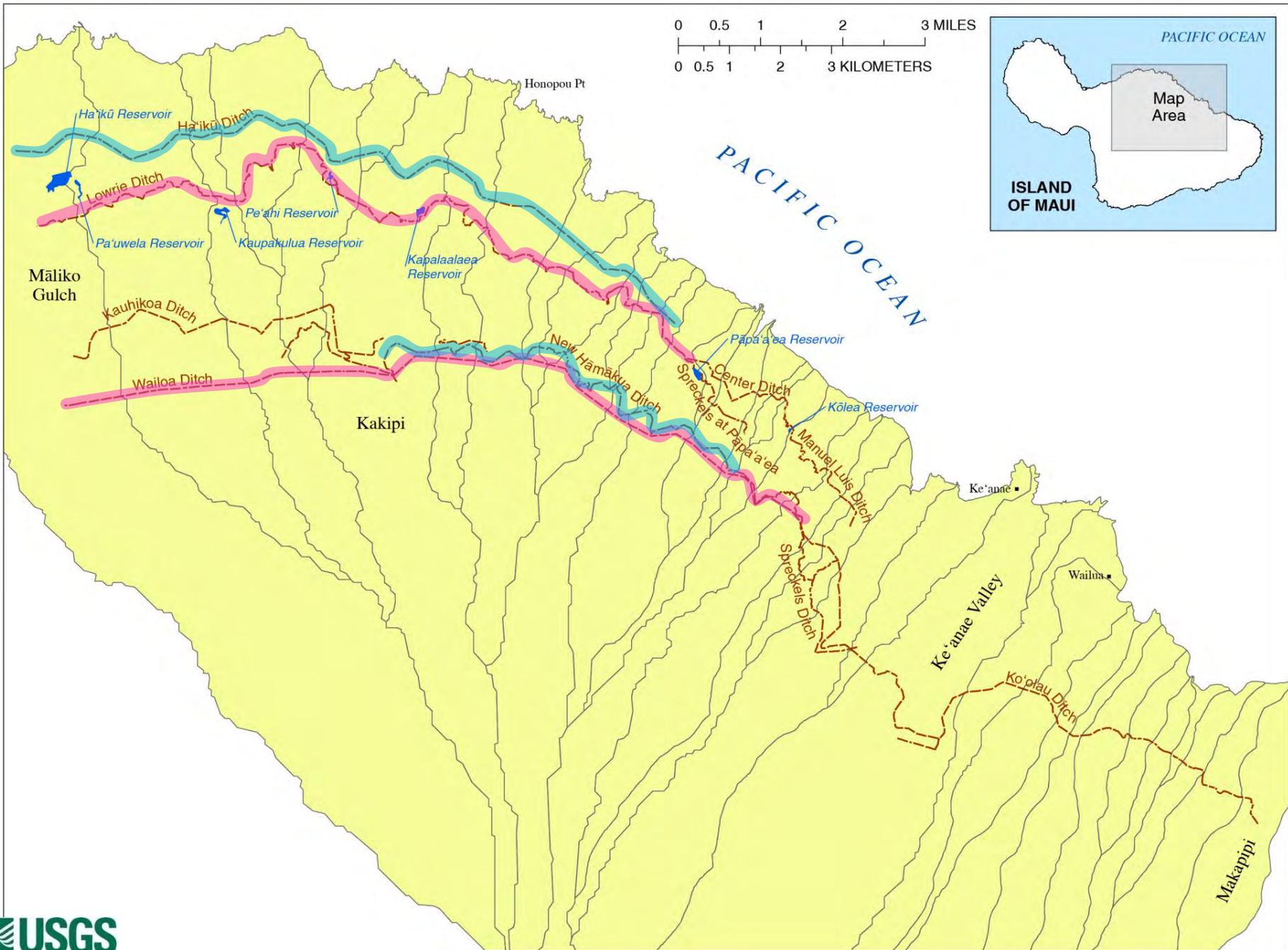
- Traditional Hawaiian rights
- Conveyance of water supplies
- Fish and wildlife habitat
- Ecosystem maintenance
- Recreation
- Aesthetics
- Water quality





Objectives

- Document locations of tunnel and open-ditch sections
- Determine seepage losses and gains along selected reaches



Ditch Characterization

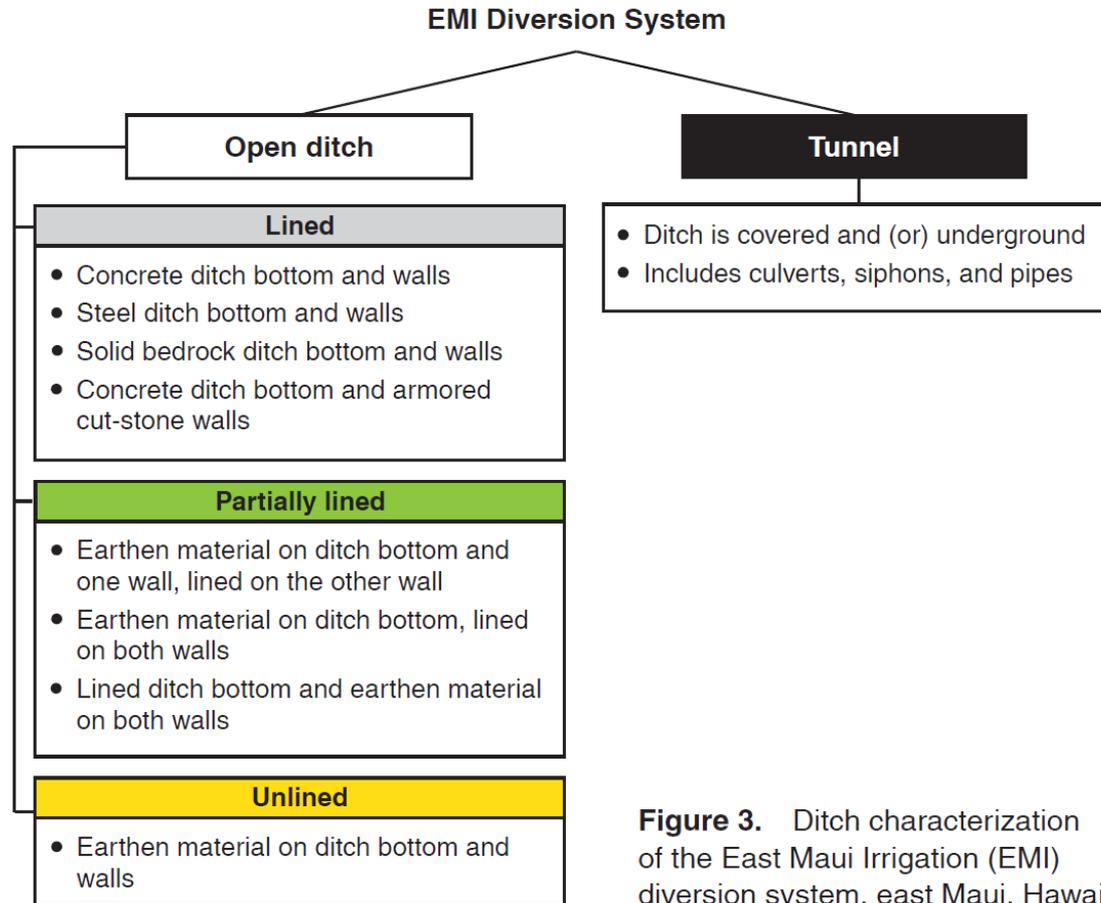


Figure 3. Ditch characterization of the East Maui Irrigation (EMI) diversion system, east Maui, Hawai'i.

Tunnel



Lowrie Ditch,
pipe section of the ditch



Manuel Luis Ditch,
typical tunnel

Lined Open Ditch



Lowrie Ditch,
stainless-steel flume



Koolau Ditch,
armored cut stone



Haiku Ditch,
concrete flume

Unlined Open Ditch



Lowrie Ditch,
earthen walls and bottom



Spreckels Ditch,
earthen material on right wall
and stacked rocks on left wall

Partially Lined Open Ditch



Lowrie Ditch,
concrete on right wall (repaired)
and earthen material on left wall

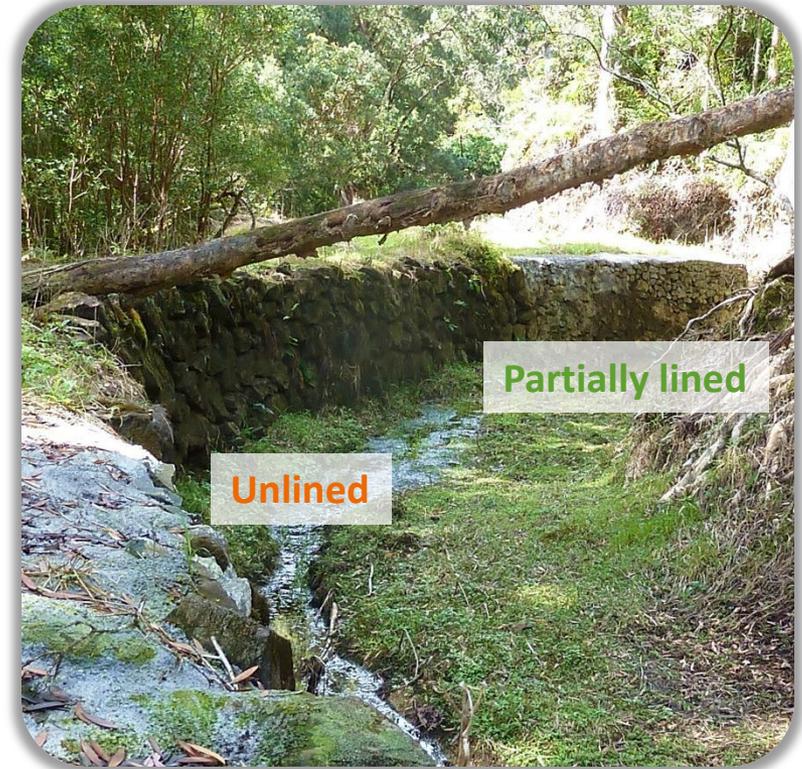


Center Ditch,
stacked rocks on right wall
and bedrock on left wall

Ditch Characterization



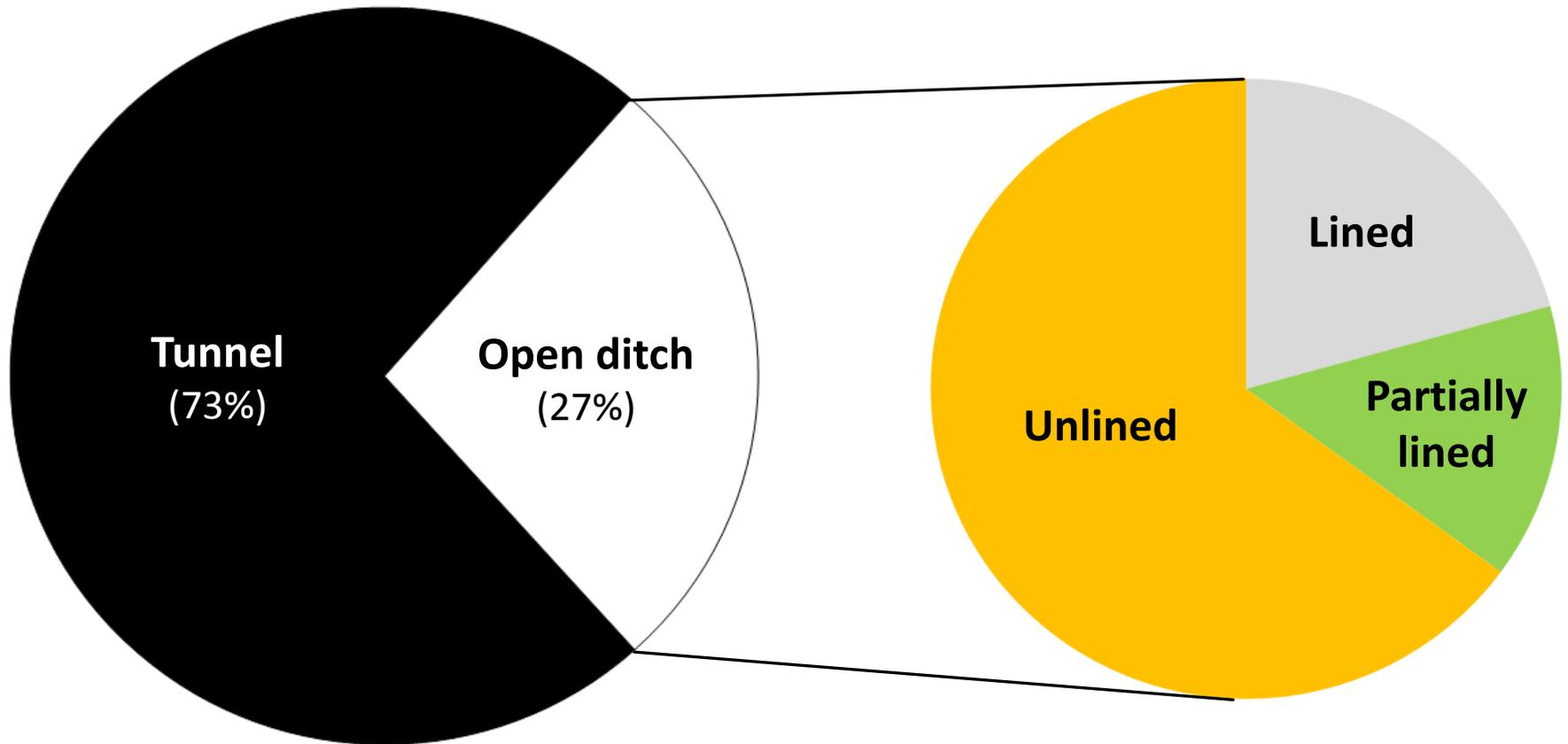
Lowrie Ditch



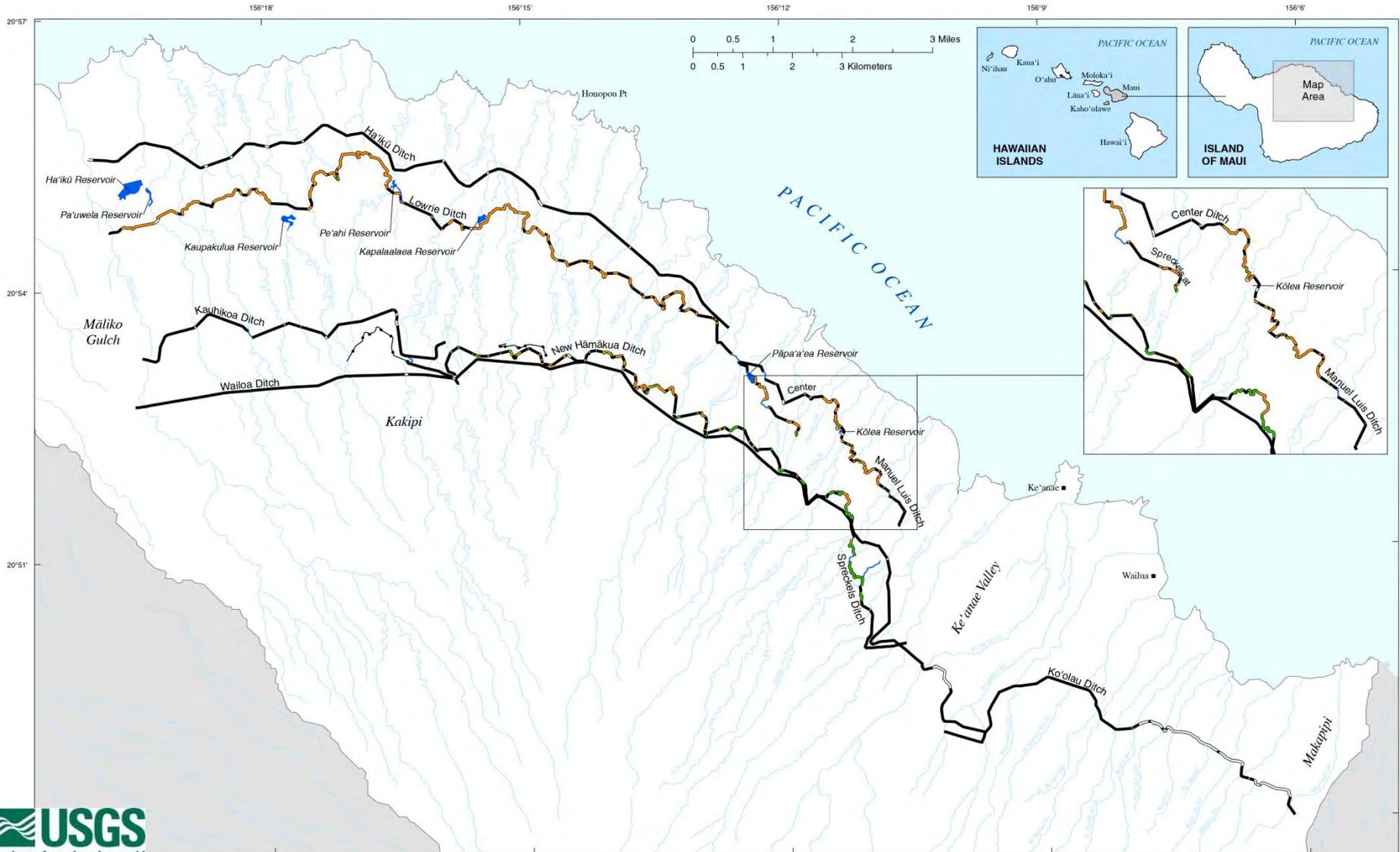
Spreckels Ditch

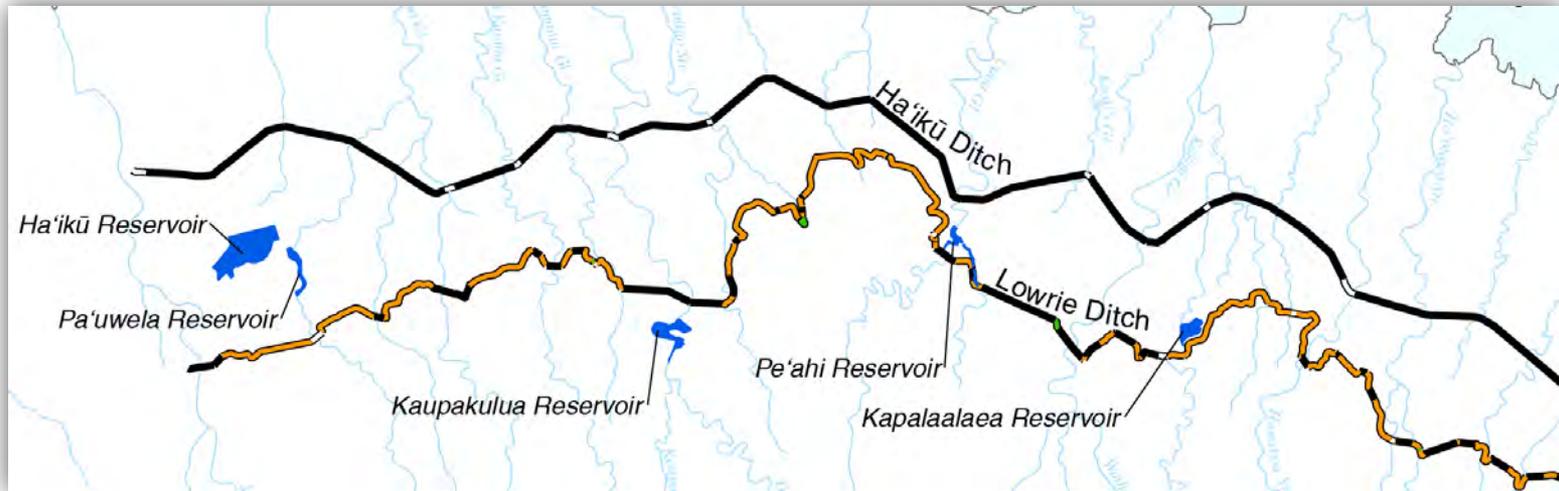
Ditch Characterization

63 miles of the EMI system were characterized



Ditch Characterization





EXPLANATION

EMI diversion ditch characteristics

-  Tunnel
-  Open ditch, lined
-  Open ditch, partially lined
-  Open ditch, unlined
-  Stream conveyance
-  Abandoned

Seepage Losses and Gains

Measurement reaches are:

- ❑ Representative of ditch characteristics
- ❑ As long as possible
- ❑ Minimal or no diversion inflows and outflows

**Finding a measurement
section can be difficult...**



**New Hamakua Ditch,
a short opening**



Wailoa Ditch at Halehaku Flume

...and we measure where we can

Seepage Losses and Gains

[Mgal/d, million gallons per day]

Range of ditch flows, in Mgal/d	Seepage losses and gains, in Mgal/d	Seepage losses and gains, in percentage of ditch flow
> 19	-0.39 to 2	-1.6% to 4%
9.7 to 19	-0.26 to 1.4	-3.7% to 11 %
1.3 to 5.2	-0.78 to 0.17	-20% to 8%
0 to 1.3	-0.13 to 0.21	-71% to 41%

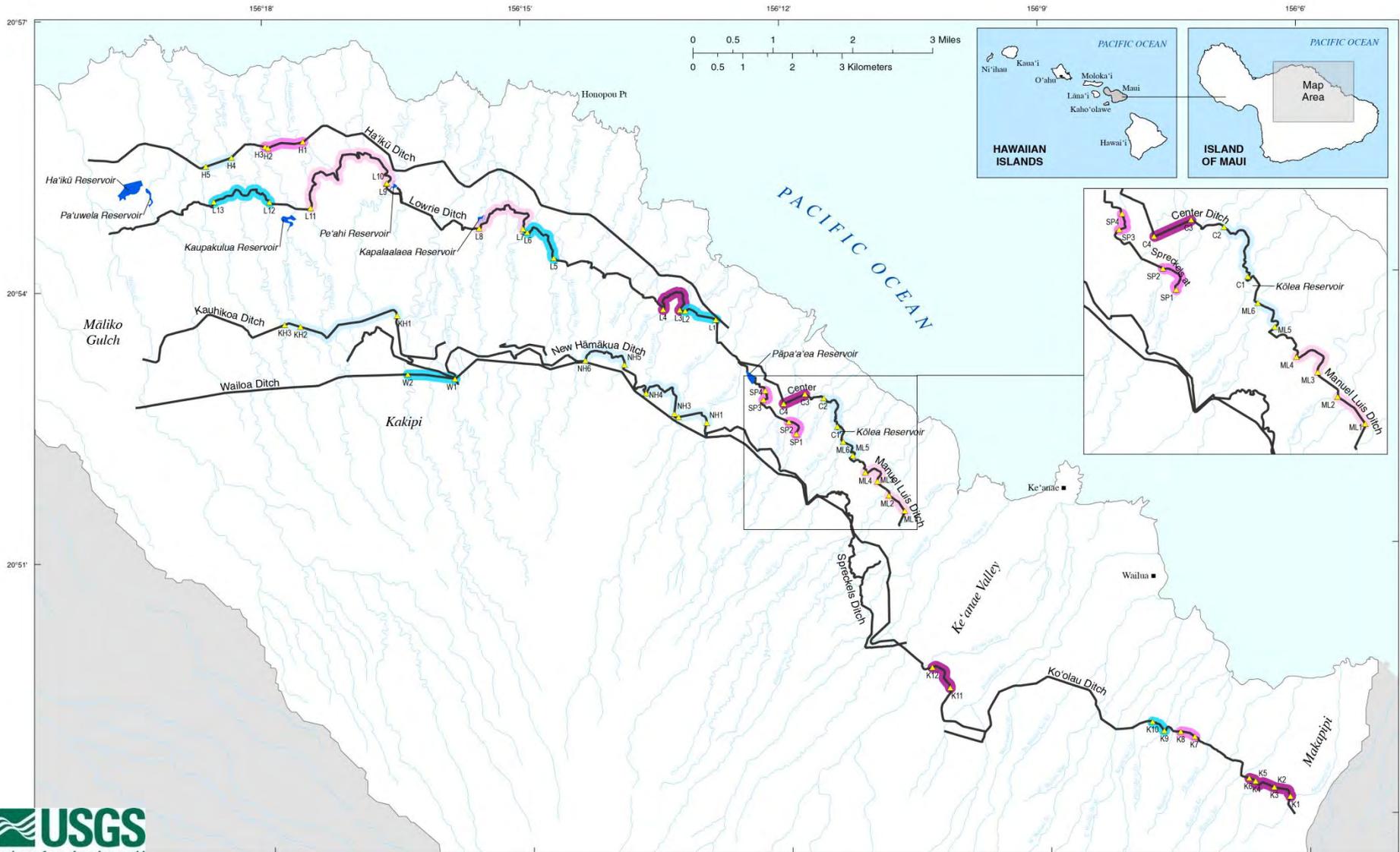
Measurement reach lengths range from 0.15 to 2.23 miles.

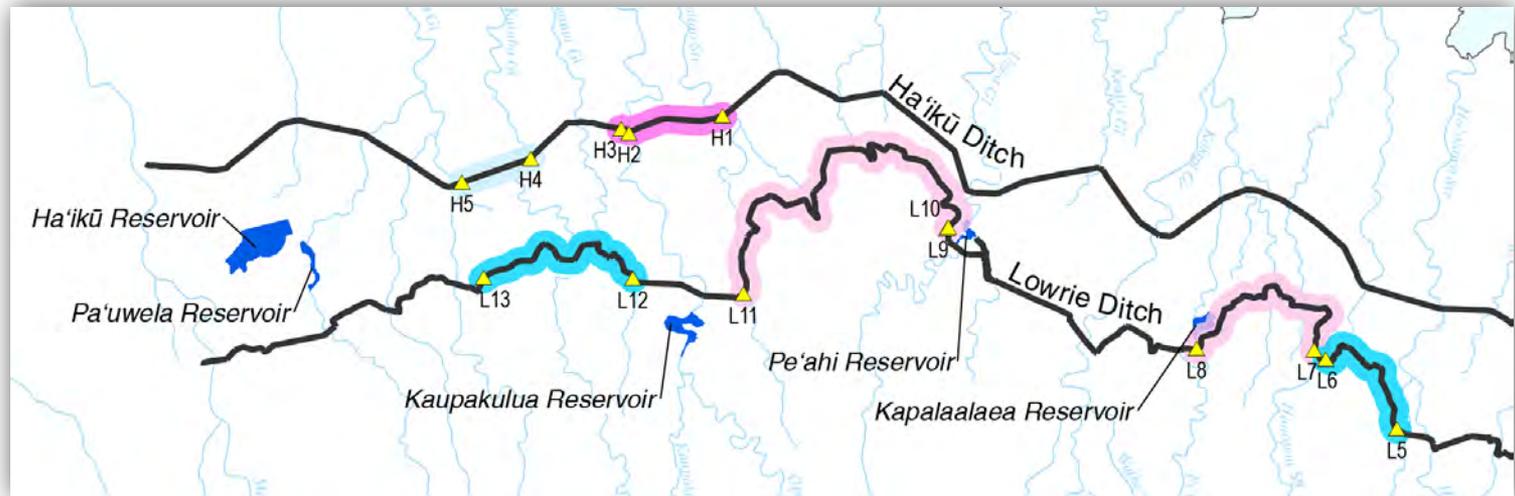
Seepage Losses and Gains

[Mgal/d, million gallons per day]

Ditch system	Total seepage losses, in Mgal/d	Total seepage gains, in Mgal/d	Percentage of ditch length surveyed
Koolau / Wailoa	-1.6	2.4	10%
Manuel Luis / Center / Lowrie	-1.5	3.2	48%

Seepage Losses and Gains





EXPLANATION

▲ K1 Seepage-run station and station identifier

Seepage rates –
in million gallons per day per mile

Gains

- > 0.97
- > 0.01 to ≤ 0.32

Losses

- > 0.65
- > 0.32 to ≤ 1.65
- > 0.01 to ≤ 0.32

Mahalo!

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Reconnaissance survey with Chiu, East Maui Irrigation System