

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

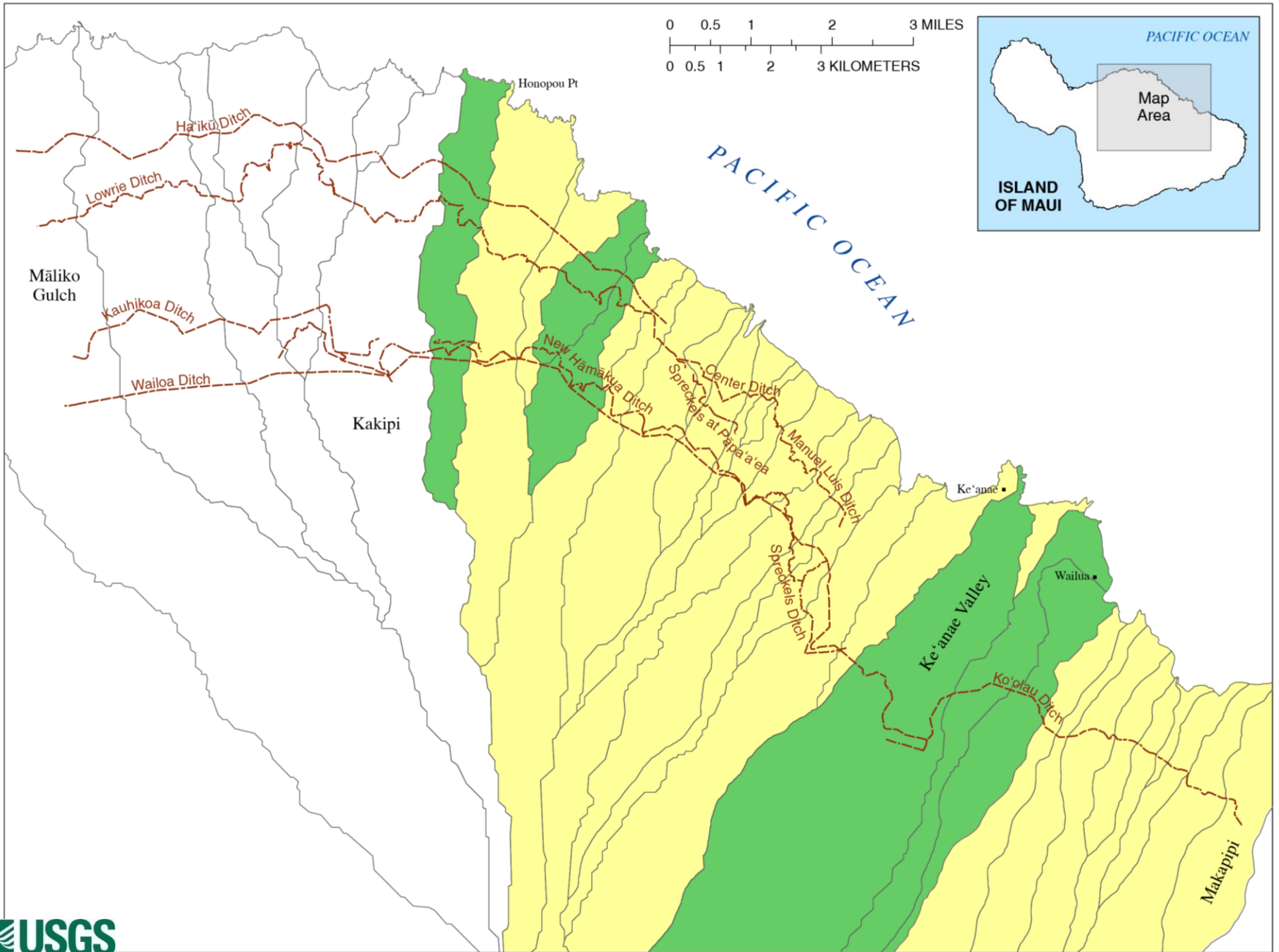


# Instream Uses

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



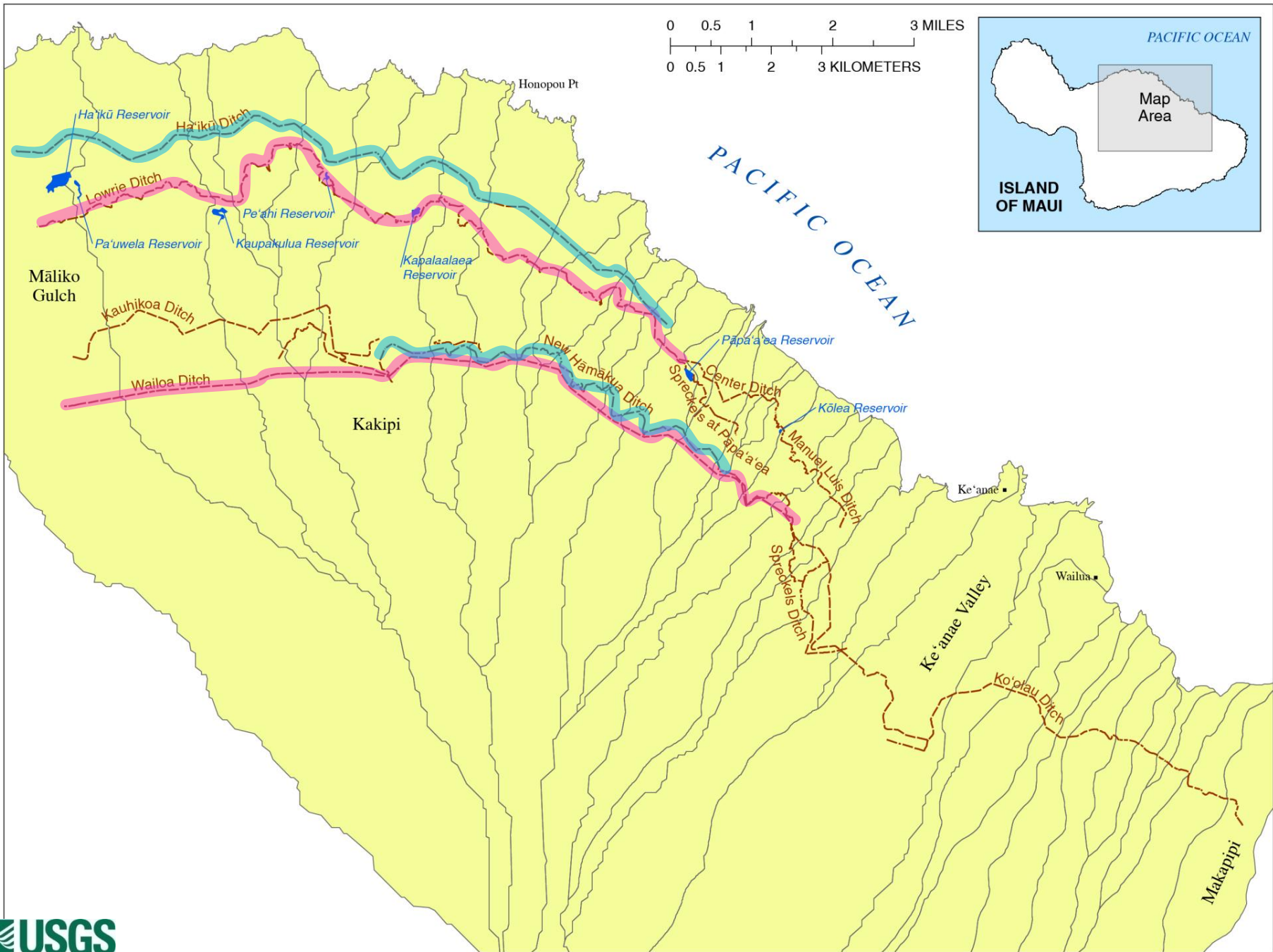
*Taro cultivation*



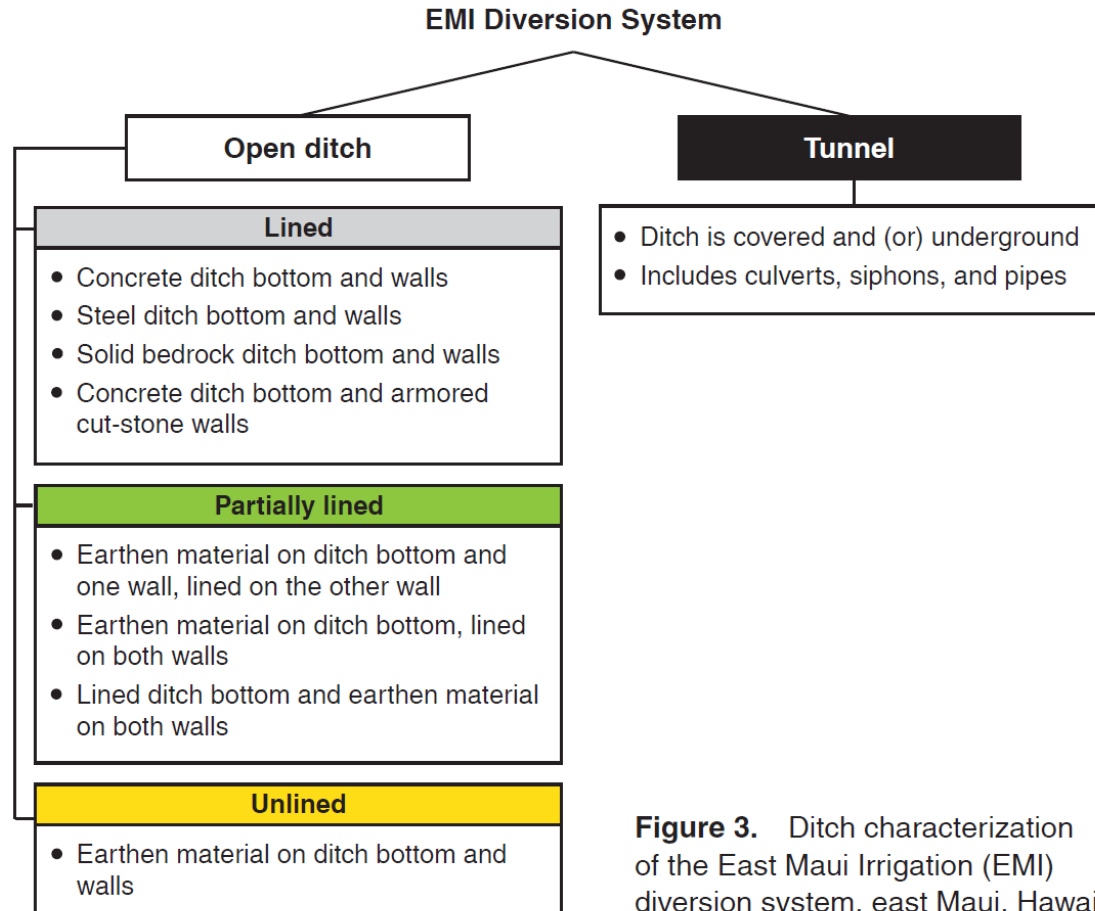


# Objectives

- 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



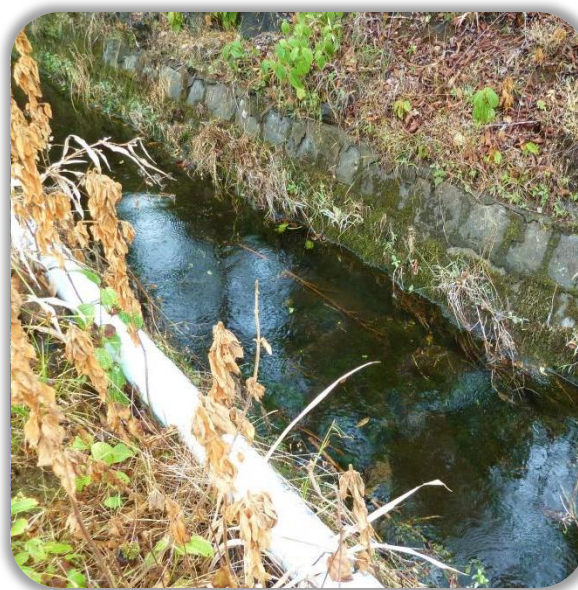
Manuel Luis Ditch,  
typical tunnel



# 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

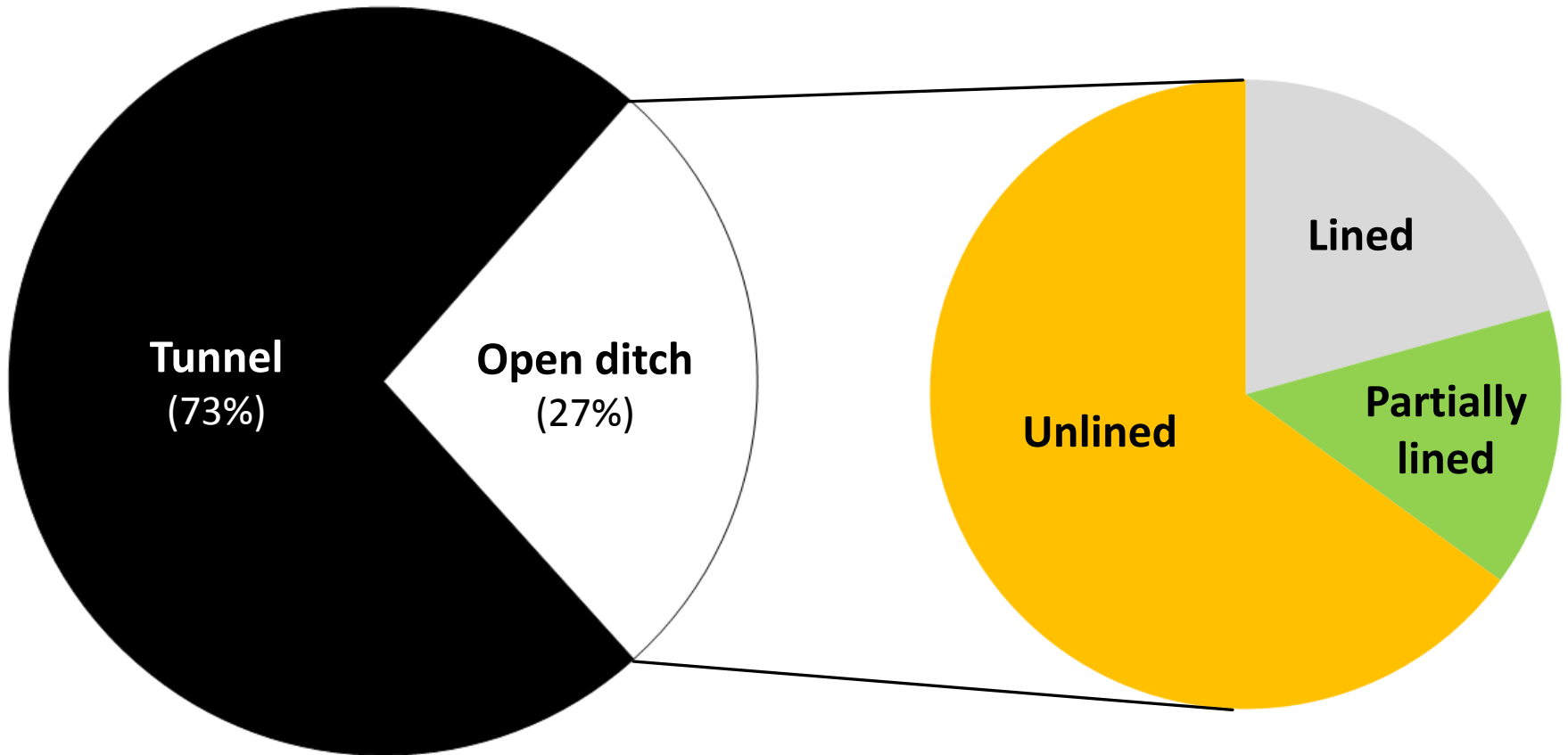


Spreckels Ditch

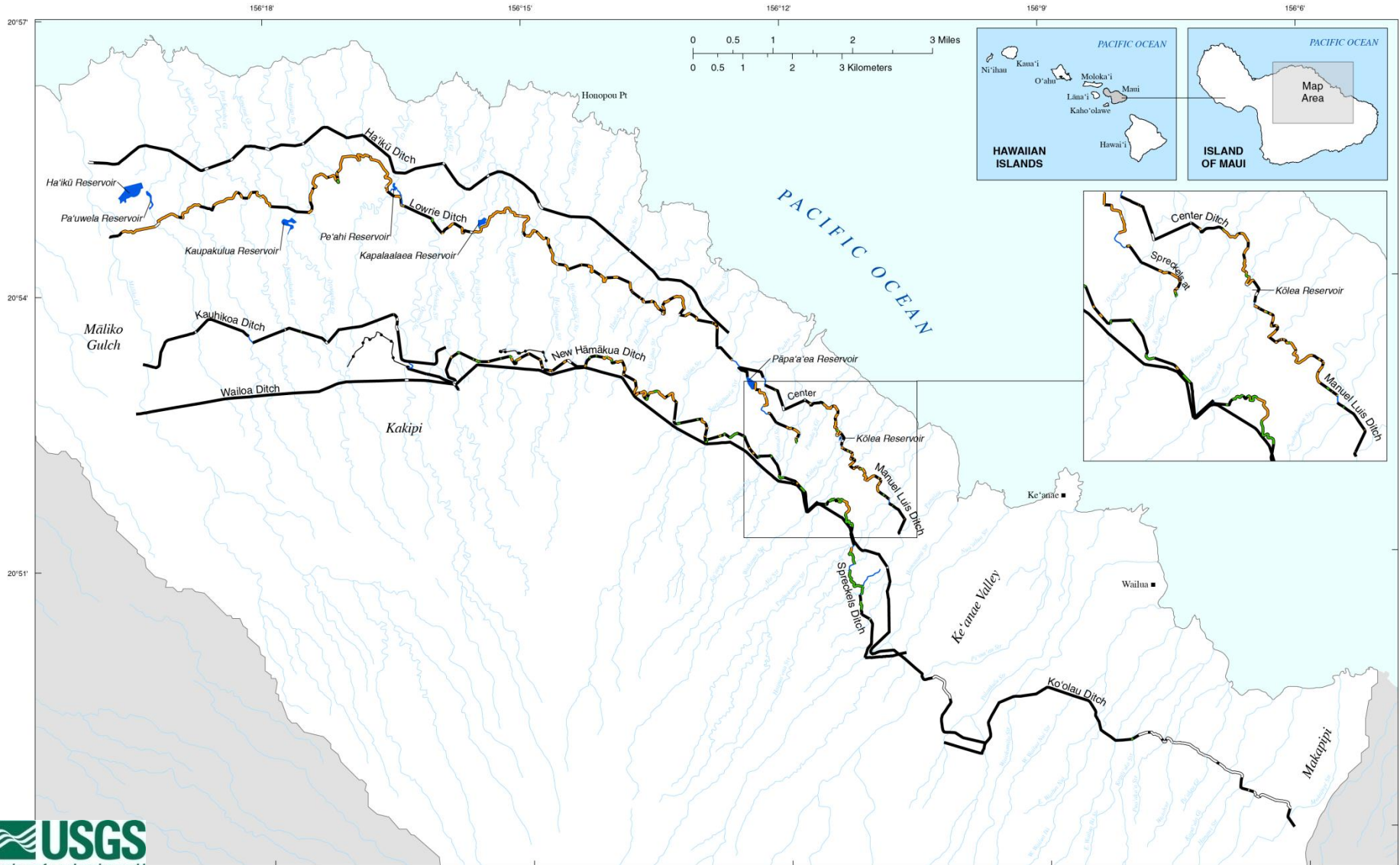


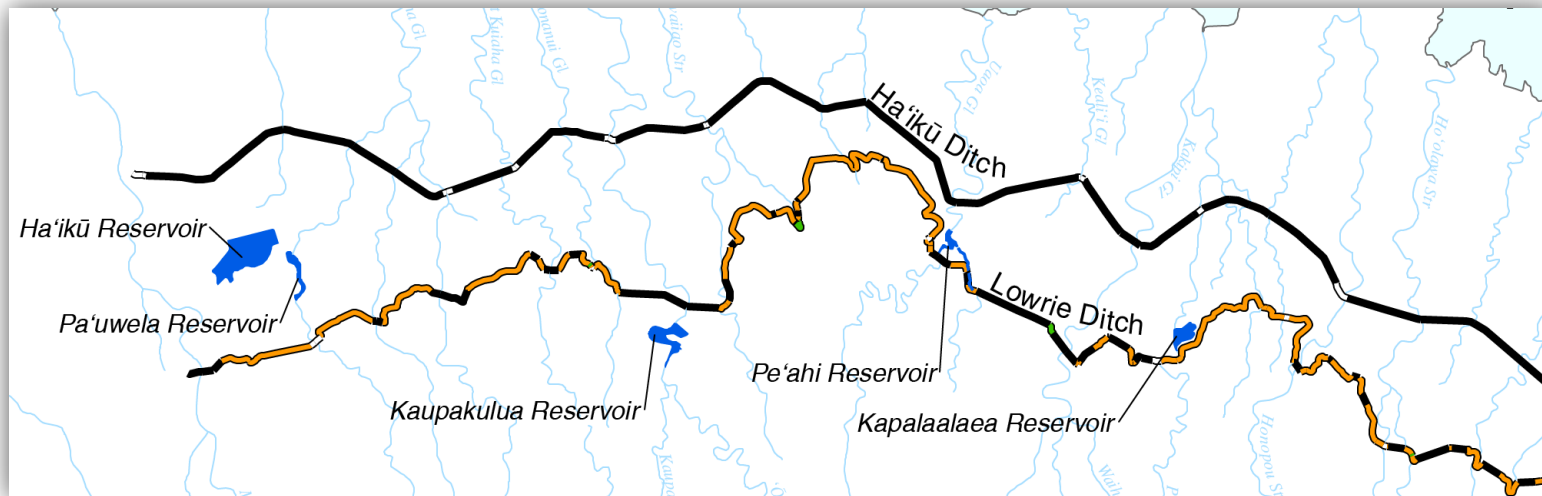
# Ditch Characterization

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.

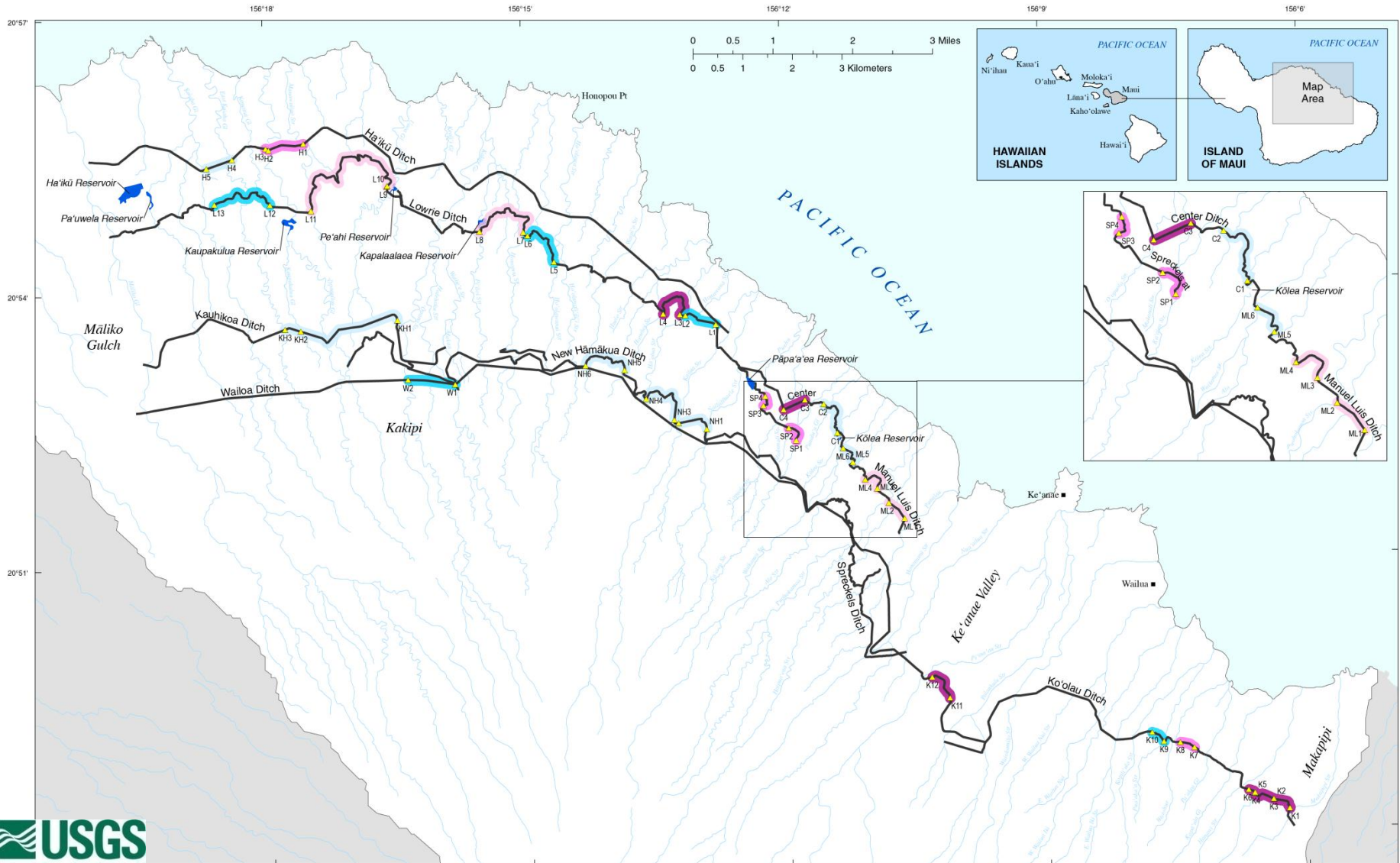
# Seepage Losses and Gains

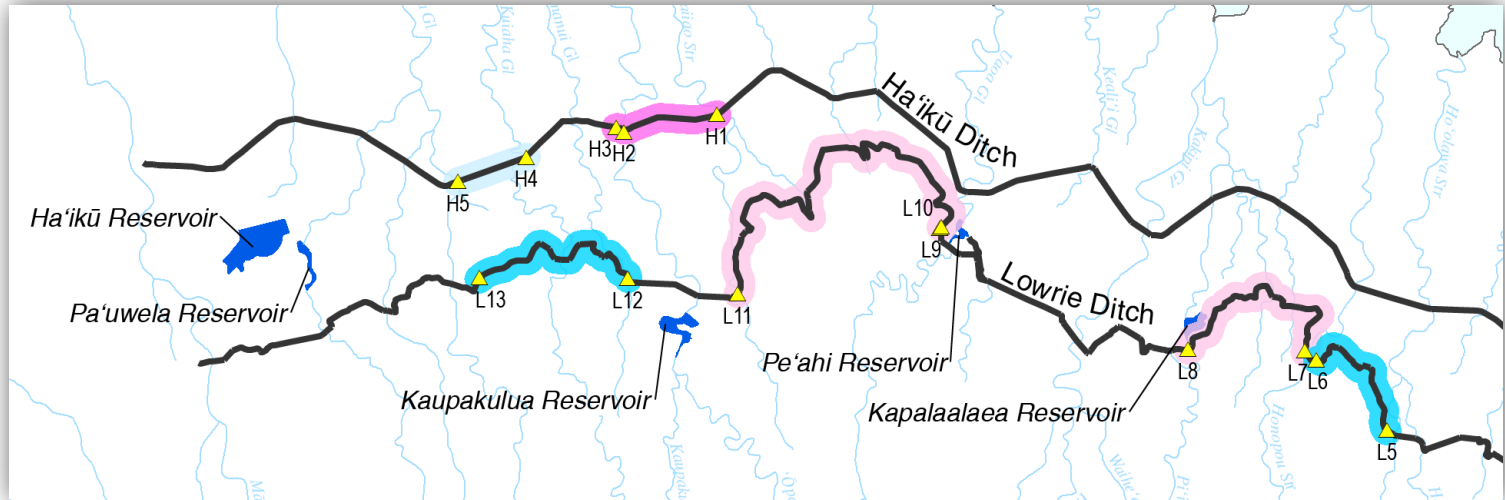
[Mgal/d, million gallons per day]

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