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

EMI Diversion System

- Open ditch
  - Lined
    - Concrete ditch bottom and walls
    - Steel ditch bottom and walls
    - Solid bedrock ditch bottom and walls
    - Concrete ditch bottom and armored cut-stone walls
  - Partially lined
    - Earthen material on ditch bottom and one wall, lined on the other wall
    - Earthen material on ditch bottom, lined on both walls
    - Lined ditch bottom and earthen material on both walls
  - Unlined
    - Earthen material on ditch bottom and walls

- Tunnel
  - Ditch is covered and (or) underground
  - Includes culverts, siphons, and pipes

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
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
- Partially lined
- Unlined

Spreckels Ditch
- Partially lined
- Unlined
Ditch Characterization

63 miles of the EMI system were characterized

- Tunnel (73%)
- Open ditch (27%)
- Lined
- Partially lined
- Unlined
Ditch Characterization
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

[Million gallons per day]

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

Measurement reach lengths range from 0.15 to 2.23 miles.
## Seepage Losses and Gains

[Mgal/d, million gallons per day]

<table>
<thead>
<tr>
<th>Ditch system</th>
<th>Total seepage losses, in Mgal/d</th>
<th>Total seepage gains, in Mgal/d</th>
<th>Percentage of ditch length surveyed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Koolau / Wailoa</td>
<td>-1.6</td>
<td>2.4</td>
<td>10%</td>
</tr>
<tr>
<td>Manuel Luis / Center / Lowrie</td>
<td>-1.5</td>
<td>3.2</td>
<td>48%</td>
</tr>
</tbody>
</table>
Seepage Losses and Gains
Reconnaissance survey with Chiu, East Maui Irrigation System