Assessing anthropogenic impacts on Hawaiian reef fish assemblages along regional-scale human population gradients

Ivor Williams
Bill Walsh, Kosta Stamoulis
Bob Schroeder, Ben Richards
Alan Friedlander

Hawaii Cooperative Fishery Research Unit & DAR
DAR
NOAA-CRED
NOAA-NOS
Starting Position

- MHI Reef fish populations are depleted
- Lack of consensus on cause(s)

<table>
<thead>
<tr>
<th>THREAT</th>
<th>AVERAGE SCORE (0-10)</th>
<th>% THINKING THREAT A “10”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollution from Land</td>
<td>8.9</td>
<td>62%</td>
</tr>
<tr>
<td>Overfishing</td>
<td>7.9</td>
<td>40%</td>
</tr>
<tr>
<td>Coastal Development</td>
<td>7.9</td>
<td>39%</td>
</tr>
<tr>
<td>Disease</td>
<td>7.8</td>
<td>39%</td>
</tr>
<tr>
<td>Alien Marine Species</td>
<td>7.6</td>
<td>41%</td>
</tr>
<tr>
<td>Nearshore Recreation</td>
<td>5.9</td>
<td>14%</td>
</tr>
</tbody>
</table>

Telephone survey of 1600 Households.

Hamnett, M., M. Lui, and D. Johnson. 2006. Fishing, ocean recreation, and threats to Hawaii’s coral reefs: Social Science Research Institute, University of Hawaii at Manoa
Data Sources

- NOAA/DAR MHI RAMP cruises 2005-6
- ArcGIS for population density & shoreline accessibility

Data per site:
- Fish & benthic survey
- Human population resident w/in 15 km
- Shoreline accessibility (1-3)

Site Pooling:
- 18 locations
- 2 ‘Inaccessible’

89 survey sites
# Study Locations

<table>
<thead>
<tr>
<th>Location</th>
<th>N</th>
<th>Human Population within 15 km</th>
<th>Distance to nearest boat ramp (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INACCESSIBLE LOCATIONS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hamakua</td>
<td>4</td>
<td>4,823</td>
<td>23.9</td>
</tr>
<tr>
<td>NE Maui</td>
<td>5</td>
<td>24,898</td>
<td>8.0</td>
</tr>
<tr>
<td><strong>ACCESSIBLE &amp; REMOTE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volcano</td>
<td>3</td>
<td>39</td>
<td>32.6</td>
</tr>
<tr>
<td>Niihau-Lehua</td>
<td>10</td>
<td>94</td>
<td>48.8</td>
</tr>
<tr>
<td><strong>ACCESSIBLE &amp; POPULOUS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molokai</td>
<td>4</td>
<td>938</td>
<td>13.0</td>
</tr>
<tr>
<td>South Maui</td>
<td>5</td>
<td>1,086</td>
<td>24.2</td>
</tr>
<tr>
<td>SW Hawaii</td>
<td>5</td>
<td>1,340</td>
<td>14.3</td>
</tr>
<tr>
<td>Maui-Hana</td>
<td>4</td>
<td>1,544</td>
<td>3.1</td>
</tr>
<tr>
<td>Kauai-NW</td>
<td>4</td>
<td>1,804</td>
<td>16.3</td>
</tr>
<tr>
<td>South Hawaii</td>
<td>4</td>
<td>1,987</td>
<td>4.2</td>
</tr>
<tr>
<td>Lanai</td>
<td>6</td>
<td>3,159</td>
<td>7.1</td>
</tr>
<tr>
<td>North Kohala</td>
<td>5</td>
<td>5,463</td>
<td>27.9</td>
</tr>
<tr>
<td>Puna</td>
<td>4</td>
<td>8,974</td>
<td>9.0</td>
</tr>
<tr>
<td>Kauai Main</td>
<td>6</td>
<td>15,822</td>
<td>4.4</td>
</tr>
<tr>
<td>Leeward Maui</td>
<td>5</td>
<td>24,570</td>
<td>5.1</td>
</tr>
<tr>
<td>NW Oahu</td>
<td>8</td>
<td>28,700</td>
<td>8.9</td>
</tr>
<tr>
<td>Hilo</td>
<td>4</td>
<td>45,251</td>
<td>12.1</td>
</tr>
<tr>
<td>Windward Oahu</td>
<td>3</td>
<td>66,504</td>
<td>8.0</td>
</tr>
</tbody>
</table>
Fish Biomass By Location

INACCESS.

ACCESSIBLE

Fish biomass (g m⁻²)

Increasing human population

Hamakua, NE Maui, Volcano, Niihau-Lehua, Molokai, SW Hawaii, South Maui, Maui-Hana, NW Kauai, South Hawaii, Lanai, Nth Kohala, Puna, Kuai - Main, Leeward Maui, NW Oahu, Hilo, Windward Oahu

- Apex predator
- Zooplanktivore
- Secondary consumer
- Primary consumer
Fish Biomass v Human Population

All Fishes

Biomass (g m\(^{-2}\))

Mean Human population within 15 km of survey sites

\(R_s = -0.68, p = 0.004\)

INACCESSIBLE
ACCESSIBLE
Distinguishing Impacts of Fishing and Habitat Degradation

- Fishing: Impacts **Target Taxa**
- Habitat Degradation: Impacts **Target & Non-Target Taxa**

**Target Taxa**

1. Target APEX
2. Large Parrotfish
3. Large Wrasse
4. Trgt Surgeon
5. Red Fish
6. Goatfish

**Non-Target Taxa**

1. Sm Wrasse
2. Sm Surgeons Damsels
3. Hawkfish
4. Triggers
5. Butterflyfish
6. Benth

Photos: Kosta Stamoulis, John Coney, UH
Target Fish

(a) Large Parrotfish
\[ R_s = -0.60, p = 0.01 \]

(b) Large Wrasse
\[ R_s = -0.35, p = 0.18 \]

(c) Target Surgeonfish
\[ R_s = -0.49, p = 0.06 \]

(d) Goatfish
\[ R_s = -0.34, p = 0.20 \]

(e) Redfish
\[ R_s = -0.73, p = 0.001 \]

(f) Targeted Apex Predators
\[ R_s = -0.71, p = 0.002 \]

Mean Human Population within 15 km of survey sites
Non-Target Fish

(a) Non-target Wrasse

\[ R_s = -0.03, p = 0.92 \]

(b) Non-target Surgeonfish

\[ R_s = -0.08, p = 0.77 \]

(c) Hawkfish

\[ R_s = -0.31, p = 0.24 \]

(d) Triggerfish (excl. planktivores)

\[ R_s = 0.39, p = 0.14 \]

(e) Corallivorous Butterflyfish

\[ R_s = -0.28, p = 0.14 \]

(f) Benthic Damselfish

\[ R_s = -0.28, p = 0.28 \]

Mean Human Population within 15 km of survey sites
Bottom Line ...

Mean Human population within 15 km of survey sites

**Target Fish**

\[ R_s = -0.64, \ p = 0.008 \]

**Non-target Fish**

\[ R_s = -0.24, \ p = 0.42 \]
State of Oahu Reefs

• Total Fish Biomass: 28% of ‘Remote’ and ‘Inaccessible’

• Target Fish Groups: 23% of RI
  - Target Surgeons: 34%
  - Apex Predators: 10%
  - Goatfish: 16%
  - Large Wrasse: 6%
  - Red Fish: 2%
  - Parrotfish: 3%

• Breeding Stock of Target Fishes
  - ‘Prime Spawner’ Bio: 2%

• Loss of Key Grazers
Parrotfish Biomass v Macroalgal Cover

Source: MHI shallow water surveys Hawaii DAR 2006-7
Conclusions

1) Clear evidence of MHI-wide fishing impacts

2) No indication of increasing anthropogenic habitat or environmental degradation at MHI-wide scale
   .. but ...

Survey locations did not include the worst areas in MHI

Very heavily populated parts of MHI are likely both overfished & suffering from habitat degradation

3) Quite large parts of MHI still in fairly good condition
Acknowledgements:

**Marine Surveys:** Greta Aeby, Bernardo Varga-Angel, Brian Zgliczynski, Craig Musburger, Darla White, Jeff Eble, Jason Leonard, Jill Zamzow, Steve Cotton, Paul Murakawa, and Tony Montgomery on cruises in 2005 and 2006 aboard NOAA Ships OSCAR ELTON SETTE and HI’IALAKAI.

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**Photos:** Kosta Stamoulis, John Coney, UH MOPS QUEST CD

**MHI Fish Assemblage v Human Population Study:**

In press *Environmental Conservation*  
ivor@hawaii.edu