Development of an acoustic method for assessment of bottomfish biomass and spatiotemporal distribution in Hawaii

Réka Domokos¹, Amy Comer²

¹Ecosystems and Oceanography Division
Pacific Islands Fisheries Science Center, NOAA
²Joint Institute of Marine and Atmospheric Research,
University of Hawaii
Background

• Bottomfish heavily targeted by local commercial fisheries (Main Hawaiian Islands – MHI – archipelago)

• Part of an ambitious intercalibration project
  ➢ Active acoustics
  ➢ Fishing (experimental and commercial)
  ➢ Botcam (baited stereo-video camera)
## The Deep 7

### Onaga, ula ula kale
- **Local name**: Onaga, ula ula kale
- **Common name**: Scarlet or red snapper
- **Scientific name**: *Ehu luna*
- **Size**: up to 30 pounds and 3 ft long
- **Ave. size at first maturity**: 26.5-28.5 inches
- **Spawning**: June—November
- **Body color** usually brilliant red
- **Caudal fin** ends in slender points and tips may be red or black but not white
- **Small, visible teeth**

### Opakapaka
- **Local name**: Opakapaka
- **Common name**: Pink snapper, looks brown/brownish
- **Scientific name**: *Opakapaka*
- **Size**: up to 20 pounds and 2.5 ft long
- **Ave. size at first maturity**: 20.3 inches
- **Spawning**: June—December
- **Iris** is yellow in color
- **Caudal fin** has orange edge
- **Line drawn through top of upper jaw** goes below the eye
- **Pectoral fin** is yellow or brownish in color

### Kalekale
- **Local name**: Kalekale
- **Common name**: Von Siebold’s snapper, looks brown/brownish
- **Scientific name**: *Pristipomoides siewoldii*
- **Size**: up to 6 pounds, more commonly 1 - 4 lbs, and up to 1 ft long
- **Ave. size at first maturity**: 11.5 inches
- **Commonly mis-identified as opakapaka**
- **Iris** is amber or orange/red in color
- **Line drawn through top of upper jaw** goes through the mid-point of the eye
- **Pectoral fin** is orange/red in color

### Hapapuu
- **Local name**: Hapapuu
- **Common name**: Hawaiian Grasper
- **Scientific name**: *Epinephelus quinque*
- **Size**: up to 3, 3 ft long
- **Ave. size at first maturity**: 22.5-24.5 inches
- **Spawning**: April—June
- **Endemic to Hawaii**
- **Color and spot patterns vary**
- **Large mouth**

### Lehi
- **Local name**: Lehi
- **Common name**: Reddish snapperfish
- **Scientific name**: *Opapaua ravenous*
- **Size**: to 20 lbs, usually 3-12 lbs and up to 3 ft long
- **Caught while fishing for opakapaka**
- **Dorsal fin** with yellowish bearder
- **Fins and iris reddish brown in color**

### Gindai
- **Local name**: Gindai
- **Common name**: Flower snapper, Bridal snapper
- **Scientific name**: *Pristipomoides zonatus*
- **Size**: up to 6 lbs, usually 1-4 lbs and up to 1 ft long
- **Color**: Red with yellow barn/bars
- **Top lobe of caudal fin** yellow saddle-shaped bars
- **Body color is orange/red**
- **Bottom lobe of caudal fin** is yellow in color

### Ehu, ula ula
- **Local name**: Ehu, ula ula
- **Common name**: Red snapper
- **Scientific name**: *Ehu carbonaria*
- **Size**: up to 12-15 pounds, more commonly in the 1-6 pound range, and up to 2 ft long
- **Ave. size at first maturity**: 11 inches
- **Body color more orange than scarlet**
- **Tail fin lobes** are short without filaments
- **Mosch is large with big teeth**

Additional notes:
- **Lower lobe of the caudal and pelvic fins** are tipped white

Illustrations by Lea Hata © Division of Aquatic Resources
Background

• Bottomfish heavily targeted by local commercial fisheries (Main Hawaiian Islands – MHI – archipelago)

• Part of an ambitions intercalibration project
  ➢ Active acoustics
  ➢ Fishing (experimental and comercial)
  ➢ Botcam (baited stereo-video camera)
NOAA Ship Oscar Elton Sette

2011 February 25 – March 09
NOAA Ship Oscar Elton Sette

2011 February 25 – March 09

• Feb 25-27: Calibration of acoustics instruments
2011 February 25 – March 09

• Feb 25-27: Calibration of acoustics instruments
• Feb 27- Mar 08:
  ➢ Acoustic surveys over predetermined grids
  ➢ Simultaneous botcam and acoustics
  ➢ Simultaneous bottom fishing and acoustics
Study Area

Left Map From Donald Kobayashi
Botcam

- Stereo video camera
- Bait lasting for ~ 6 hrs
  - Fresh and frozen fish, squid, canned tuna, crackers, cut to different sizes
- Deployments for ~ 6 hrs
  - (~10:00-16:00)
Bottom fishing

- Ehu
- Gindai
- Opakapaka
Bottom fishing

Paka

Ehu

Kahala
Acoustic Signature of (mostly) opakapaka

Simultaneous acoustics and Botcam

70 kHz $S_v$ (dB re 1 m$^{-1}$)
Acoustics Process

**In-Situ Transects**

Simultaneous Botcam / EK60 & Fishing / EK60 Operations

**Echograms**

Identify Fish

Identify Fish Schools

Identify Individual Fish
Acoustics Process

**In-Situ Transects**

Simultaneous Botcam / EK60 & Fishing / EK60 Operations

**Echograms**

**Identify Fish Schools**

- *Deep 7* species
  - Opakapaka (pink snapper)
  - Onaga (Ruby Snapper)
  - KaleKale (Smallmouth Pink Snapper)
  - Lehi (Silver Jaw Snapper)
  - Ehu (Red Snapper)
  - Gindai (Flower Snapper)
  - Hapu'u'u (Hawaiian Grouper)

- "Other" Common Bottom fish
  - Sharks (Greeneye & Silky)
  - Kahala & Amberjack
  - Bonito Mackerel

**Identify Individual Fish**

- Mean Sv
- Mean TS
- Mean SL
- Mean FL

**Number of Fish**

**Weight (Kg)**

*Sv* → mean volume backscattering strength of fish school (dB re 1 m⁻¹)

*TS* → Target Strength in dB re 1 m²

*SL* → Standard Length in cm

*FL* → Fork Length in cm
## Conversion of Bottomfish Tracks (TS) to Size and Weight

<table>
<thead>
<tr>
<th>Activity</th>
<th>TS mean from Bottomfish Tracks (dB re 1 m²)</th>
<th>TS SD (dB re 1 m²)</th>
<th>Standard Length (cm)</th>
<th>Fork Length (cm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botcam</td>
<td>-30.43</td>
<td>4.17</td>
<td>57.93</td>
<td>47.10</td>
<td>1.86</td>
</tr>
<tr>
<td>Survey</td>
<td>-33.06</td>
<td>3.94</td>
<td>48.39</td>
<td>39.34</td>
<td>1.52</td>
</tr>
<tr>
<td>All</td>
<td>-32.16</td>
<td>4.12</td>
<td>52.87</td>
<td>42.68</td>
<td>1.69</td>
</tr>
</tbody>
</table>

1Foote (1998)
Conversion of Bottomfish Tracks (TS) to Size and Weight

<table>
<thead>
<tr>
<th>Activity</th>
<th>TS mean from Bottomfish Tracks (dB re 1 m²)</th>
<th>TS SD (dB re 1 m²)</th>
<th>Standard Length (cm)</th>
<th>Fork Length (cm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botcam</td>
<td>-30.43</td>
<td>4.17</td>
<td>57.93</td>
<td>47.10</td>
<td>1.86</td>
</tr>
<tr>
<td>Survey</td>
<td>-33.06</td>
<td>3.94</td>
<td>48.39</td>
<td>39.34</td>
<td>1.52</td>
</tr>
<tr>
<td>All</td>
<td>-32.16</td>
<td>4.12</td>
<td>52.87</td>
<td>42.68</td>
<td>1.69</td>
</tr>
</tbody>
</table>

Use
- mean TS from surveys: -33.06 dB re 1 m²

¹Foote (1998)
**Conversion of Bottomfish Tracks (TS) to Size and Weight**

<table>
<thead>
<tr>
<th>Activity</th>
<th>TS mean from Bottomfish Tracks (dB re 1 m²)</th>
<th>TS SD (dB re 1 m²)</th>
<th>Standard Length (cm)</th>
<th>Fork Length (cm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botcam</td>
<td>-30.43</td>
<td>4.17</td>
<td>57.93</td>
<td>47.10</td>
<td>1.86</td>
</tr>
<tr>
<td>Survey</td>
<td>-33.06</td>
<td>3.94</td>
<td>48.39</td>
<td>39.34</td>
<td>1.52</td>
</tr>
<tr>
<td>All</td>
<td>-32.16</td>
<td>4.12</td>
<td>52.87</td>
<td>42.68</td>
<td>1.69</td>
</tr>
</tbody>
</table>

Use

- mean TS from surveys: -33.06 dB re 1 m²
- general equation for physoclists to convert TS to mean SL: 48.39 cm

¹Foote (1998)
### Conversion of Bottomfish Tracks (TS) to Size and Weight

<table>
<thead>
<tr>
<th>Activity</th>
<th>TS mean from Bottomfish Tracks (dB re 1 m²)</th>
<th>TS SD (dB re 1 m²)</th>
<th>Standard Length (cm)</th>
<th>Fork Length (cm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botcam</td>
<td>-30.43</td>
<td>4.17</td>
<td>57.93</td>
<td>47.10</td>
<td>1.86</td>
</tr>
<tr>
<td>Survey</td>
<td>-33.06</td>
<td>3.94</td>
<td>48.39</td>
<td>39.34</td>
<td>1.52</td>
</tr>
<tr>
<td>All</td>
<td>-32.16</td>
<td>4.12</td>
<td>52.87</td>
<td>42.68</td>
<td>1.69</td>
</tr>
</tbody>
</table>

### Use

- mean TS from surveys: -33.06 dB re 1 m²
- general equation for physoclists to convert TS to mean SL: 48.39 cm
- measurements taken on the Sette using fish caught to convert mean SL to mean FL: 39.54 cm \((FL = SL / 1.23)\)

\(^1\text{Foote (1998)}\)
# Conversion of Bottomfish Tracks (TS) to Size and Weight

<table>
<thead>
<tr>
<th>Activity</th>
<th>TS mean from Bottomfish Tracks (dB re 1 m²)</th>
<th>TS SD (dB re 1 m²)</th>
<th>Standard Length (cm)</th>
<th>Fork Length (cm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botcam</td>
<td>-30.43</td>
<td>4.17</td>
<td>57.93</td>
<td>47.10</td>
<td>1.86</td>
</tr>
<tr>
<td>Survey</td>
<td>-33.06</td>
<td>3.94</td>
<td>48.39</td>
<td>39.34</td>
<td>1.52</td>
</tr>
<tr>
<td>All</td>
<td>-32.16</td>
<td>4.12</td>
<td>52.87</td>
<td>42.68</td>
<td>1.69</td>
</tr>
</tbody>
</table>

## Use

- mean TS from surveys: -33.06 dB re 1 m²
- general equation for physoclists to convert TS to mean SL: 48.39 cm
- measurements taken on the Sette using fish caught to convert mean SL to mean FL: 39.34 cm \((FL = SL / 1.23)\)
- Fishbase.org conversion values of weight \((W)\) for opakapaka with the mean FL in the region of Hawaii: 1.52 kg for a FL = 39.34 cm fish

\(^1\)Foote (1998)
Calculation of total bottomfish biomass

- Use data only from surveys (fish track and school)
- Add individual fish biomass (kg and number of fish) from fish tracks and school biomass (kg and number of fish) per box per hour
- Standardize biomass to 500 x 500 m² (area of each box)
Bottomfish Sizes From Tracks

Mean: -39.34 cm

Calculated Bottomfish Forklengths (cm)
Bottomfish Weight From Tracks

Mean: 1.52 kg
Bottomfish School Volumes

Mean: 3,974 m³
Mean: 8,469 fish
Hourly Bottomfish Biomass in Area D

Total for Area D: 3,509 Tons
(~ 1 fish per 3.5 m²)
Total for Area D: 2,469,387 fish
(~ 1 fish per 3.5 m²)
Total Number for Area D: 3025 schools (~ 1 school per 100 m²)
Mean Number per box: 42 schools
Mean Volume for Area D: 3,974 m³
Totals for Area D

- 3,509 Ton
- 1 fish \( \sim 3.5 \text{ m}^2 \)
- 2,469,387 Fish
- 3,025 Schools (\( \sim 1 \text{ school per } 100 \text{ m}^2 \))
Conclusions

• Fork lengths calculated from acoustics are in range of Botcam visual observations
• Most fish biomass are from schools
• Biomass of bottomfish is 3 orders of magnitude higher from acoustics than from drift CPUE
• Schools occupy areas near bottom but individual fish are occurring throughout the entire water column
• Fish were observed at depths of 100-300 m but most occupied waters ~150 m deep
• Schooling behavior is higher during daytime than nighttime
Future Directions

- Get estimates of Deep 7 relative to other bottomfish
- Calculate biomass per grid from acoustic data
- Compare CPUE per grid with acoustic data
- Compare Botcam visual observations with acoustic data