Hawaii Island spinner dolphins: Research findings (2010-2018), impacts and implications for management

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## Economic value of spinner dolphins in Hawaii

<table>
<thead>
<tr>
<th>Dolphin stock</th>
<th>Annual Revenue (USD)</th>
<th>Over lifetime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oahu</td>
<td>$58,000,000</td>
<td>$3,360,000</td>
</tr>
<tr>
<td>Hawaii Island</td>
<td>$44,000,000</td>
<td>$1,100,000 - $1,600,000</td>
</tr>
</tbody>
</table>

Spinner dolphins in the Hawaiian archipelago

Distinct stocks (n=6)
(Andrews et al. 2010; Hill et al., 2011)
Evolved specialised behavioural pattern
(Norris et al. 1994, Benoit-Bird et al. 2003; Tyne et al. 2017)

Concerns over possible impacts of human activity (>25 yrs)

2010: NOAA initiated research to inform preferred management approach of implementing time-area closures.
Quantifying the abundance, important habitat and cumulative exposure of the Hawaii Island spinner dolphin stock to human activities

2010-18: Research, community engagement, analyses and publications to inform management (PhD candidates: J. Tyne and H. Heenehan [acoustics])

Aims (leeward-side of Island of Hawaii)

- Estimate population size
- Quantify daily behavioral repertoire
- Quantify the importance of bays to resting dolphins
- Quantify the exposure of spinner dolphins to human activities

Tyne et al. 2014. PLoS ONE
Tyne et al. 2015. Journal of Applied Ecology
Tyne et al. 2016. Biological Conservation
Tyne et al. 2017. Royal Society Open Science
Tyne et al. 2018. Royal Society Open Science
Study area:  Kona Coast, Island of Hawaii (leeward side)
  - Makako Bay
  - Kealakekua Bay
  - Honaunau Bay
  - Kauhako Bay

Known as important resting bays for spinner dolphins


Systematic boat-based photo-id surveys
  - Two-years (276 survey days)
  - Year-round (24 consecutive months)
  - Consistent effort
Highest concerted effort to estimate abundance revealed lowest estimates.

Norris et al (1994)  
Östman (1994)  
Tyne et al (2014)  
Tyne et al (2016)

Abundance estimate

960  
2,334  
1,001  
855  
631  
668

Tyne et al. 2014 PLoS ONE  
Tyne et al. 2016 Biological Conservation

12 photo-ID surveys per month; 2 years; 276 survey days
1. Quantify daily behavioral repertoire
2. Quantify importance of resting bays
3. Quantify exposure to human activities

In addition to monthly photo-id sampling:

• 105 focal follows; 428 hours focal follow data
  • Behavioral time-series data (inside and outside bays)
  • Collected from both land- and vessel-based platforms
  • Included data on human activities
Dolphin activity throughout the day in bays

- Corroborate Norris et al.’s earlier work (from the late 1970s to the early 1980s)
- Quantified the constrained spinner dolphin activity throughout the day

Tyne et al. 2017 Royal Society Open Science
The importance of resting habitat

Sheltered bays: critical for rest

105 behavioural focal follows; 428 hrs

Tyne et al. 2015. Journal of Applied Ecology
### Highest exposure ever recorded of any cetacean species

<table>
<thead>
<tr>
<th>Species</th>
<th>Study; Year</th>
<th>Distance</th>
<th>Proportion of time exposed to human activities %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottlenose dolphin</td>
<td>(Lusseau, 2003); 400 m</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Bottlenose dolphin</td>
<td>(Lusseau, 2004); 400 m</td>
<td>10.8</td>
<td></td>
</tr>
<tr>
<td>Bottlenose dolphin</td>
<td>(Lusseau, 2004); 400 m</td>
<td>12.8</td>
<td></td>
</tr>
<tr>
<td>Bottlenose dolphin</td>
<td>(Lusseau, 2006); 400 m</td>
<td>15.5</td>
<td></td>
</tr>
<tr>
<td>Common dolphin</td>
<td>(Meissner et al., 2015); 300 m</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Hectors dolphin</td>
<td>(Bejder et al., 1999); 200 m</td>
<td>23.6</td>
<td></td>
</tr>
<tr>
<td>Bottlenose dolphin</td>
<td>(Peters et al., 2012); 50 m</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Common dolphin</td>
<td>(Stockin et al., 2008); 300 m</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Killer whale</td>
<td>(Lusseau et al., 2009); 100</td>
<td>28.5</td>
<td></td>
</tr>
<tr>
<td>Dusky dolphin</td>
<td>(Dans et al., 2008); 200 m</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>Killer whale</td>
<td>(Lusseau et al., 2009); 100 m</td>
<td>37.6</td>
<td></td>
</tr>
<tr>
<td>Bottlenose dolphin</td>
<td>(Stensland &amp; Berggren 2007); 50 m</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Dusky dolphin</td>
<td>(Lundquist et al., 2012); 300 m</td>
<td>51.6</td>
<td></td>
</tr>
<tr>
<td>Bottlenose dolphin</td>
<td>(Constantine et al., 2004); 300 m</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>Spinner dolphin</td>
<td>Tyne et al. 2018; 100 m</td>
<td>82.7</td>
<td></td>
</tr>
</tbody>
</table>

- Exposed 83% of the time (<100 m)
- **25% higher than reported for any other cetacean species**
- Avg. time btw exposure events: 9.6 min

Tyne et al., 2018. Royal Society Open Science
Recent change in preferred management option by NOAA

• Up until 2015: NOAAs preferred management approach: time/area closures

• 2016/17: NOAAs preferred management approach has changed to a 50-yard no-approach rule (within 2nm of coast), which was sent out for public comment in 2016.
Summary

• Relatively small stock, genetically distinct
• Constrained behavioural schedule
• Bays critically important resting habitats
• Within resting bays: highest reported rates of any cetacean population to exposure to human activities
• Recent change in preferred management approach by NOAA
The 50-yard no approach rule is a start .... however....

Management actions needs to be **context-specific**

No special protection within critical resting habitat
- equal protection inside and outside bays

The 50-yard rule does not consider vessel noise
- acoustic exposure propagates 100’s-1000’s of yards
Bottlenose dolphins

4-stroke engine

“Gear shifts generate high-level transient sounds (peak–peak source levels of up to 200 dB re 1 μPa) that may be audible over many kms and may disturb close-range animals.”
Current preferred management approach is inadequate to protect spinner dolphins from human activities.

Given that there is time before a rule is implemented, recommend that we revisit protective measures within the important resting bays.
The four Hawaii Island spinner dolphin resting bays have been designated as **IMMAs** by the IUCN Marine Mammal Protected Area Task Force

**IMMA:**

.....“discrete portions of habitat, important to marine mammal species, that have the potential to be delineated and managed for conservation”..

....“consist of areas that may merit place-based protection and/or monitoring”
Governor Ige’s ‘30-by-30 Initiative: “to effectively manage 30% of Hawaii’s nearshore waters by the year 2030” [Introduced in 2016]
This is not a radical suggestion

• Time-area closures were the preferred approach until relatively recent.

• Areas are not large.... The size of a few football fields...

• Recent state and international initiatives provides favorable support.

• It would be easy to evaluate compliance and also to enforce.

Monitoring the efficacy of management actions:
ensure that monitoring regimes can track successes (and failures) of management actions. Be specific on the metrics they need to evaluate.
Mahalo
Photo-ID sampling design

Sept 2010 → Monthly → Aug 2012

Kauhako Bay
1 2 3 4

Honaunau Bay
1 2

Kealakeku Bay
1 2 3 4

Makako Bay
1 2

12 days per month for 24 consecutive months
Cumulative discovery curve: Years 1 + 2

276 photographic-identification survey days (September 2010 to August 2012).
Total (distinct) abundance and survival estimates

- Independent mark rates
  - $\hat{\theta}_1 = 0.35 \pm 0.02$ SE
  - $\hat{\theta}_2 = 0.36 \pm 0.03$ SE
  - Z-test ($p=0.68$)

Tyne et al. 2014 PLoS ONE

A variety of closed and open capture-recapture models were fitted using MARK: POPAN (open model).
Resting

- Milford Sound, New Zealand
- At least 68 min between exposures
  (Lusseau, 2004)
Resting deprivation

- Impair cognitive ability (Cirelli & Tononi, 2008)
- Increase predation risk (Lima & Dill, 1990, Lima et al., 2005)
- Reduced foraging efficiency (Johnston, 2014)
- Mothers and calves particularly vulnerable
- Reduced population viability
Two estimates of mark rate ‘highly distinct individuals (D1)’

Mark Rate 1: \((\hat{\theta}_1)\) groups > 20 dolphins
• Proportion of randomly photographed identifiable dolphins

Mark Rate 2: \((\hat{\theta}_2)\) groups ≤ 20 dolphins
• Knowledge of group size and the number of distinctive individuals in each group