Modelling the spatial distribution of humpback whales in the Kimberley

KIMBERLEY MARINE RESEARCH PROGRAM NODE

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Background

- ~33,000 humpbacks migrate annually
- Northerly migration (July – August)
- Aggregate Pender Bay, Camden Sound and Frost & Tasmanian Shoal area
- Calving between Lacepedes & Camden Sound
- Whaling caused collapse, listed as vulnerable

Jenner, Jenner and McCabe 2001
Background

Extensive aerial and boat surveys over 3 decades by CWR also industry, govt, tourism, much for EIA for industry

These datasets offer an opportunity to synthesize these data to quantify:

- spatial distributions and critical habitats
- environmental drivers

Combining many years of data allows powerful insights, and a more holistic approach to better inform management

Lyn Irvine
Objectives

Amass all data to develop spatial models of humpback distribution, abundance in the Kimberley

Quantify important habitats

Understand drivers of distribution

Advise on future monitoring of humpbacks, esp in the Lalong-Garram/Camden Sound MP

Centre for Whale Research
<table>
<thead>
<tr>
<th>Platform</th>
<th>Year</th>
<th>Sample days</th>
<th>Total whales</th>
<th>Survey program</th>
<th>Months covered</th>
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Methods

Density surface modelling (distance sampling coupled with gam) to predict density (counts/abundance)
- Accounts for detectability
- Accounts for effort (length of transects/segments)

Species distribution model (Maxent)
- Presence/absence data to predict probability of occurrence/habitat suitability

Set of environmental predictors
- Depth, slope, rugosity, SST
- Modelled groups with calves separately
- Modelled months separately and combined
### Density model

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<th>ΔAICc</th>
<th>ΔBIC</th>
<th>wAICc</th>
<th>wBIC</th>
<th>%De</th>
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![Graph showing number of whales over date and depth](image1.png)

![Map showing density distribution](image2.png)

[Western Australian Marine Science Institution logo]
Seasonal model predictions

August

Sept/Oct
Movement behaviour

Similar hotspots to density model

Whales almost always in resident mode (not migrating)

8/23 northbound whales tracked from NW Cape were still transmitting on arrival in the Kimberley and only 4 went to Camden Sound

2/6 northbound whales in 2006 (tagged at JPP) went to Camden Sound
Presence/absence model

Distance to coast most influential predictor of habitat suitability

Distance to coast (km)

Probability of presence

All groups

Groups with calves
Spatial predictions of habitat suitability

All whale groups

Groups with calves
Binary scale of habitat suitability

All whale groups

Groups with calves

Combined

All output raster pixels with predicted probabilities above the maximum kappa threshold = statistically suitable habitats

- Unsuitable habitat
- Suitable habitat
- Calving/nursing habitats
Future monitoring

How to monitor humpbacks in the future?

Very high resolution satellites (Digital Globe) –
  - Worldview-2 = 50 cm
  - Worldview-3 = 30 cm

Accessed archive of Worldview-2

Tasked WV3, 425 km2 early to mid August, 2016 Lalang-Garram / Camden Sound MP
32 whales, including 8 calves on Aug 06, 2016 and 25 whales including 6 calves on Aug 12, 2016

- Costs more than 10 x the cost of boat surveys and ~50 x cost of aerial surveys
- But benefits: image can be obtained in an instant and can be archived
- Analysis time is a fraction of that required for traditional surveys
- Only cost effective for small areas like Pender Bay or Camden Sound
- Aerial surveys required for abundance estimate over whole distribution
Key outputs considerations and implications

Have quantified the spatial and temporal abundance and habitat suitability of humpback whales in the Kimberley

Abundance was highest in Pender Bay across the entire season, with Camden Sound only important in August

Whales in Pender Bay have only the limited protections provided by the designation of the area as a multiple use zone within the Kimberley CMR

Calving/nursing areas are closer to shore and smaller in spatial extent

Calving areas extend southwards along the Dampier Peninsula, rather than being confined to the Camden Sound area

No systematic surveys of the entire Kimberley area used by humpbacks since 2007 - now crucial that a monitoring program be implemented
Acknowledgments

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• Data providers: CWR, Richard Costin, Inpex and Woodside
• Curt and Micheline Jenner and Lyn Irvine for photos
• Ben Radford and Rebecca Fisher for assistance with modelling