Review of False Killer Whale Biology

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Sources of information on false killer whales in Hawai'i

- Strandings (extremely infrequent, 2 in last 20 years)
- Aerial surveys
- Large-vessel surveys
- Photo-identification (multiple contributors)
- Small-vessel surveys
- Fishery observer program
- Genetic analyses (multiple contributors)
- Tagging studies (satellite, diving)

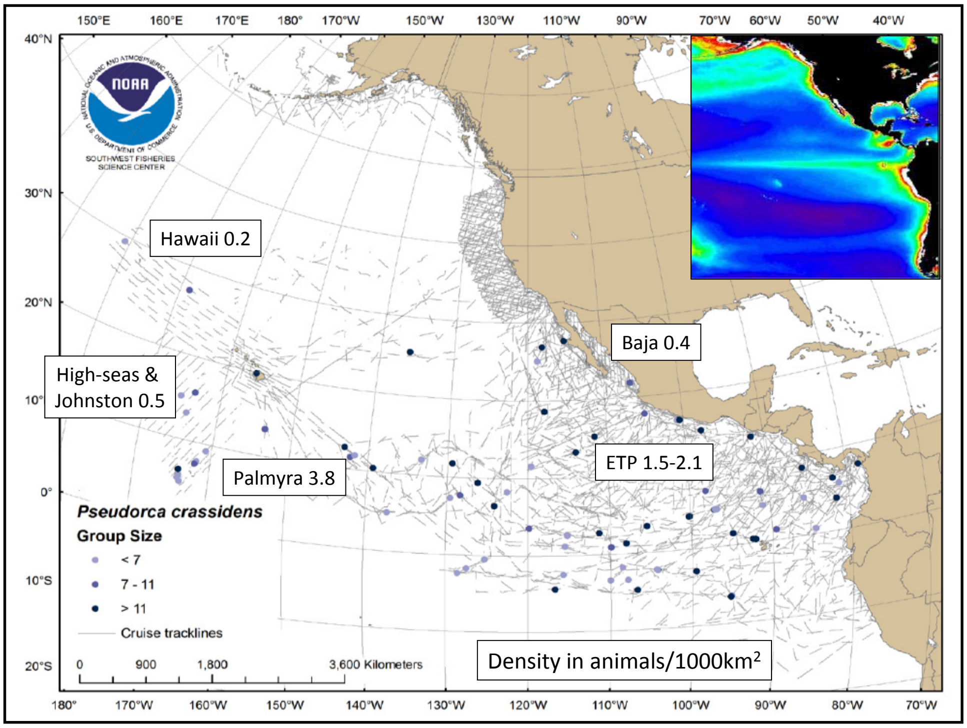
Life History

- Long-lived (50s – 60s)
- Slow to mature (~10-18 years)
- Low calving rate (one every ~6-7 years)
- Females have long post-reproductive period
- Occasionally mass strand (group size mean = 180 (range = 50 – 835, n =14)

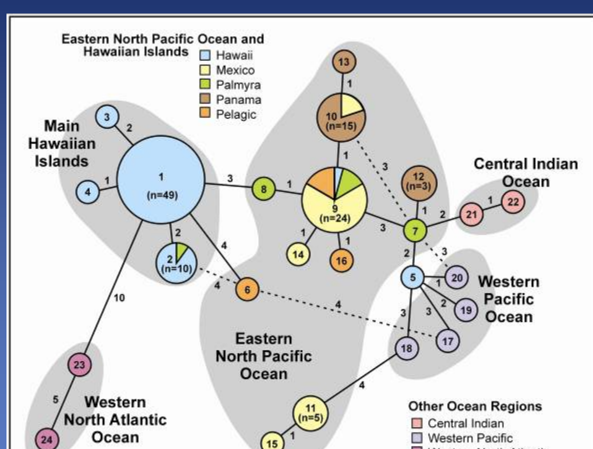
Distribution

- Tropical and warm temperate oceanic waters
- Rare throughout their range

  → lowest cetacean density in Hawaiian waters, among lowest in ETP
- Density decreases in sub-tropics



Population Structure

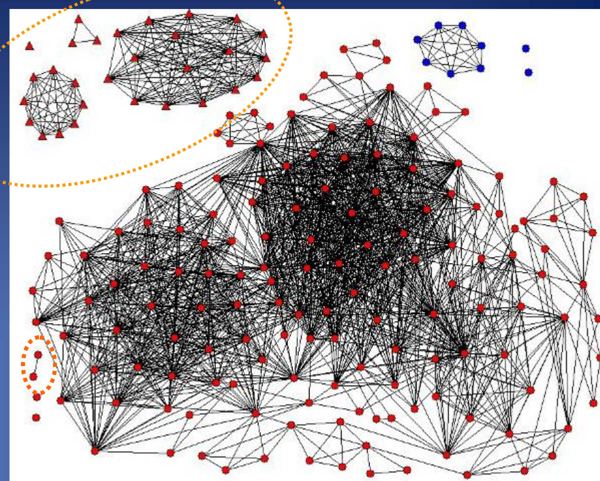


Chivers et al. 2007 CJZ

- Evidence for a insular Hawaiian Islands population
- “Pelagic” population cannot be distinguished from greater eastern Pacific population

Population Structure within Hawaii

42-120 km offshore



Social network diagram
- 1986-May 2009
- Based on 553 IDs

▲ Offshore (pelagic stock)
● O'ahu, 4-islands, Hawai'i (insular stock)
● Kaua'i (unknown stock)

Movement Patterns in Hawai'i

- Individual movements have been assessed using photo-ID and satellite tags
- Individuals move extensively and quickly among islands

Satellite tracks

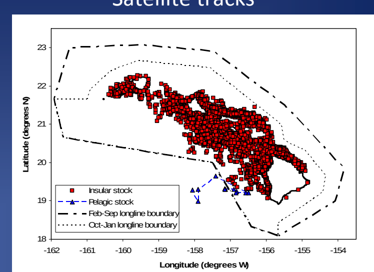
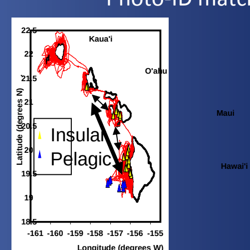


Photo-ID matches



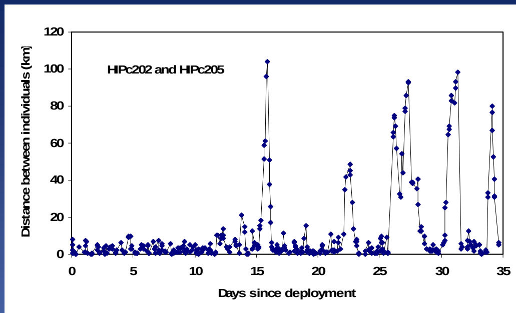
Movements of Hawaiian Animals

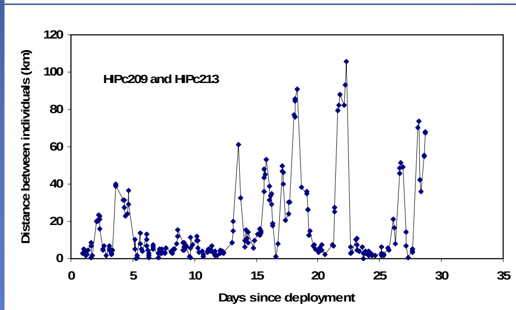
Period tagged	Animals Tagged	Max tag duration (days)	Distance from shore (km) Median (range)	Depth (m) Median (range)	Minimum distance traveled (km)	Maximum distance moved from tagging location (km)
Aug 07	3	32	14.1 (1.6 – 95.9)	597 (46 – 4,833)	2,612	420.1
Jul 08	7	76	20.5 (0.9 – 83.1)	827 (46 – 4,767)	3,010	329.9
Dec 08	1	54	22.7 (2.7 – 87.3)	1,052 (94 – 4,847)	5,653	330.7
Oct 09	5	94	23.2 (0.1 – 112.8)	1,225 (10 – 5,401)	8,058	389.9
Dec 09	4	65+	17.9 (2.2 – 66.8)	716 (91-4,787)	5,290	279.6
Apr 08	1	15	122.8 (62.1 – 210.0)	3,844 (1,474 – 4,747)		

Range/boundary information continuing to come in
5 insular individuals satellite tagged October 2009, 3 in December 2009

All groups move among islands
Movements among islands rapid
Furthest offshore ~110 km

October 2009
10 days of movements 3 individuals
9 days of movements 1 individual
8 days of movements 1 individual





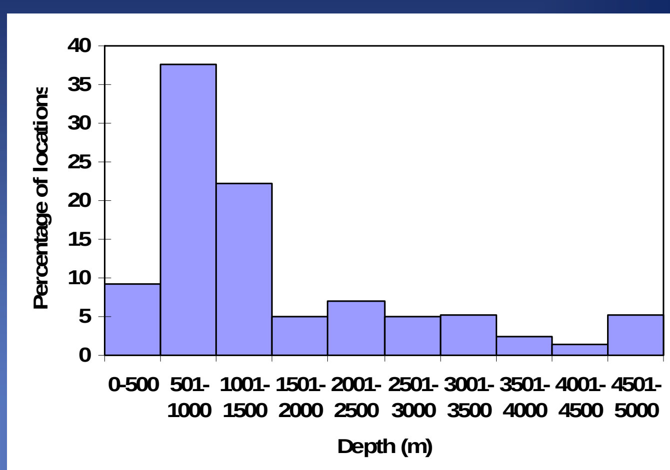
Individuals within groups spread as far as 100+ kilometers and re-join over periods of days

False killer whales are cooperative hunters that share prey and converge on captured prey

Suggests large social networks may connect smaller groups

Habitat

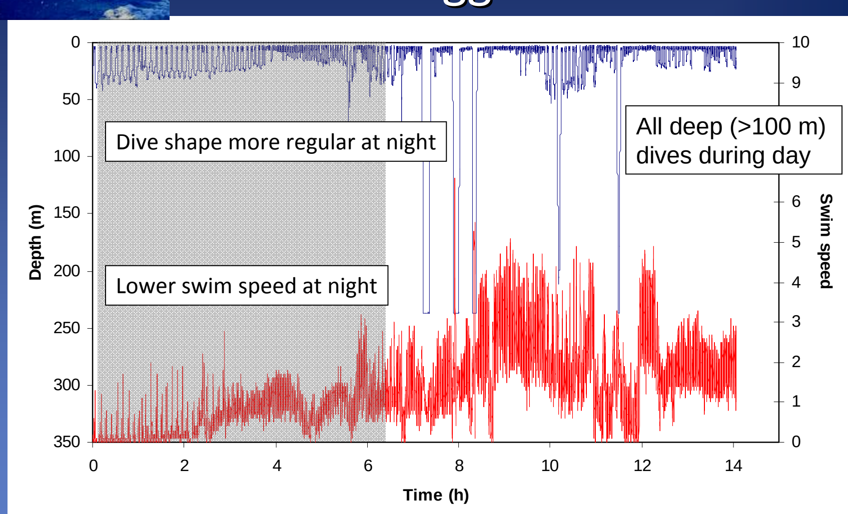
Sighting rates by depth (corrected for effort) indicate extremely broad range of habitats



Foraging Ecology

- Frequently share prey
- Many surface oriented prey
- Prey large
  (= prolonged handling)

Dive Behavior from insular false killer whale tagged October 2004



Observed Prey

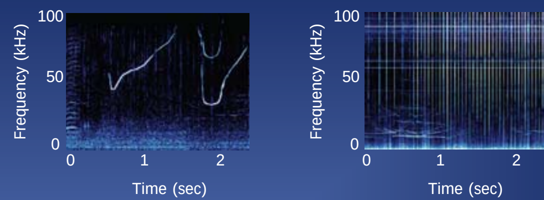
- Prey fish observed in Hawaii
- Taken by insular and pelagic false killer whales
- Frequent prey sharing and prolonged handling

Acoustic Behavior: General Cetacean Acoustics

Why use sound?

- Sound is the most effective means of transmitting or receiving information about the aquatic environment and communicating
- As a result, the sound production system of some cetacean species is highly evolved

Odontocete Vocalization Types



- Whistles: tonal sounds used for communication; social sounds
- Clicks: short-duration broadband impulse sounds
    - Echolocation- clicks capable of "illuminating" objects for foraging, navigation, or communication
    - Burst-pulse- very fast repetition rate clicks such that they sound buzz-like and have a tonal quality

False killer whale acoustics

- Reasonable body of research on false killer whale acoustics
    – Whistles identified and classified from field recordings, can be distinguished from other species
    – Echolocation clicks and capabilities well understood from captive research

Stereotyped Whistles make for Easy Identification

Table 5. Results of 66 terminal node classification tree grown using seven variables (beginning frequency, end frequency, minimum and maximum frequency, duration, number of inflection points, number of steps). Overall correct classification = 53.1%, *n* = 908. Bold-face numbers are percent correct classification scores; others are percentages of whistles classified incorrectly. Numbers in parentheses are Chi-square *P*-values testing whether correct classification is greater than expected by chance.

	Classified as								
Actual species	Bottlenose dolphin	Short-beaked common dolphin	False killer whale	Pantropical spotted dolphin	Long-beaked common dolphin	Short-finned pilot whale	Rough-toothed dolphin	Striped dolphin	Spinner dolphin
Bottlenose dolphin	**60.3** (<0.05)	7.7	0.6	7.1	7.1	0.6	1.3	11.5	3.8
Short-beaked common dolphin	12.5	**28.4** (<0.05)	5.7	5.7	10.2	2.3	8.0	15.9	11.4
False killer whale	0.0	1.4	**88.4** (<0.05)	0.0	0.0	4.3	2.9	1.4	1.4
Pantropical spotted dolphin	10.3	9.3	0.0	**48.5** (<0.05)	12.4	0.0	2.1	12.4	5.2
Long-beaked common dolphin	5.5	5.5	4.1	19.2	**24.7** (<0.2)*	0.0	9.6	20.5	11.0
Short-finned pilot whale	2.0	2.6	11.8	1.3	0.7	**68.0** (<0.05)	7.2	3.3	3.3
Rough-toothed dolphin	2.9	5.9	16.2	0.0	7.4	11.8	**45.6** (<0.05)	4.4	5.9
Striped dolphin	2.2	14.3	1.1	15.4	4.4	1.1	7.7	**40.7** (<0.05)	13.2
Spinner dolphin	7.1	11.6	6.3	8.0	10.7	3.6	7.1	14.3	**31.3** (<0.05)

Oswald et al 2003

Echolocation behavior

- Echolocation clicks have highest energy between 30-60kHz
- Click characters (peak frequency, beam angle, etc.) are dynamic depending on echolocation task & potential masking
- Clicks can discriminate very fine differences between targets in considerable noise
- Exhibit learning in echolocation behavior

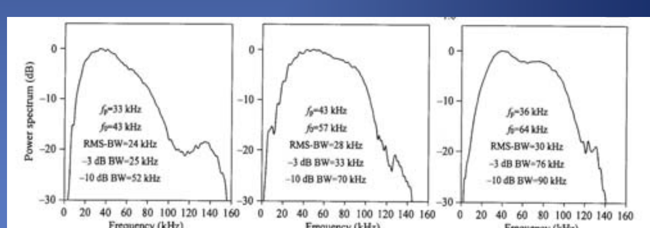


Fig. 4. Dynamics of the sound generator. Three examples (A–C) of on-axis clicks from *Pseudorca* are displayed (top) along with their spectra (bottom). All three clicks consist of one cycle with a short duration. While the f_p values are rather constant, it is seen that the f_0 values and the bandwidth are positively correlated with the source level.

Rendell et al 2004

Target Detection

Table 2. *Estimated detection ranges of different prey items based on detection capabilities of a captive* Pseudorca, *and the source parameters derived in the present study*

Predator	SL (dB re. 1 μPa, pp)	f_0 (kHz)	Noise (dB re. 1 μPa^2 Hz^{-1})	Prey	TS (dB)	Detection range (m)
Pseudorca	220	50	35	Tuna (1 m)	−30[1]	210
Pseudorca	220	50	35	Dolphin (*Tursiops*)	−20[2]	320
Pseudorca	220	50	35	Small squid (20 cm)	−50[3]	80
Grampus	220	75	32	Small squid (20 cm)	−50[3]	85
Grampus	220	75	32	Large squid (80 cm)	−40[3]	130

SL, source level; f_0, centroid frequency; TS, target strength.
It is assumed that detection is limited by ambient noise, and that the receiving system of a *Grampus* performs like that of a *Pseudorca*.
TS for a *Tursiops* may not represent TS for smaller delphinids preyed upon by *Pseudorca*, but it is the only available TS for a dolphin.
[1]Bertrand et al. (1999); [2]Au (1996); [3]Medwin and Clay (1998).

- Echolocation clicks capable of detecting tuna at moderate range (~200m).
- Use echolocation to locate and discriminate target even in clear illuminated waters and at very short distances (<1m)
- In tunas, echolocating off swim bladder and brain case

Questions?