

Combining association and movement analyses of short-finned pilot whales in the Hawaiian Islands: evidence for multiple populations within the Hawaiian Archipelago

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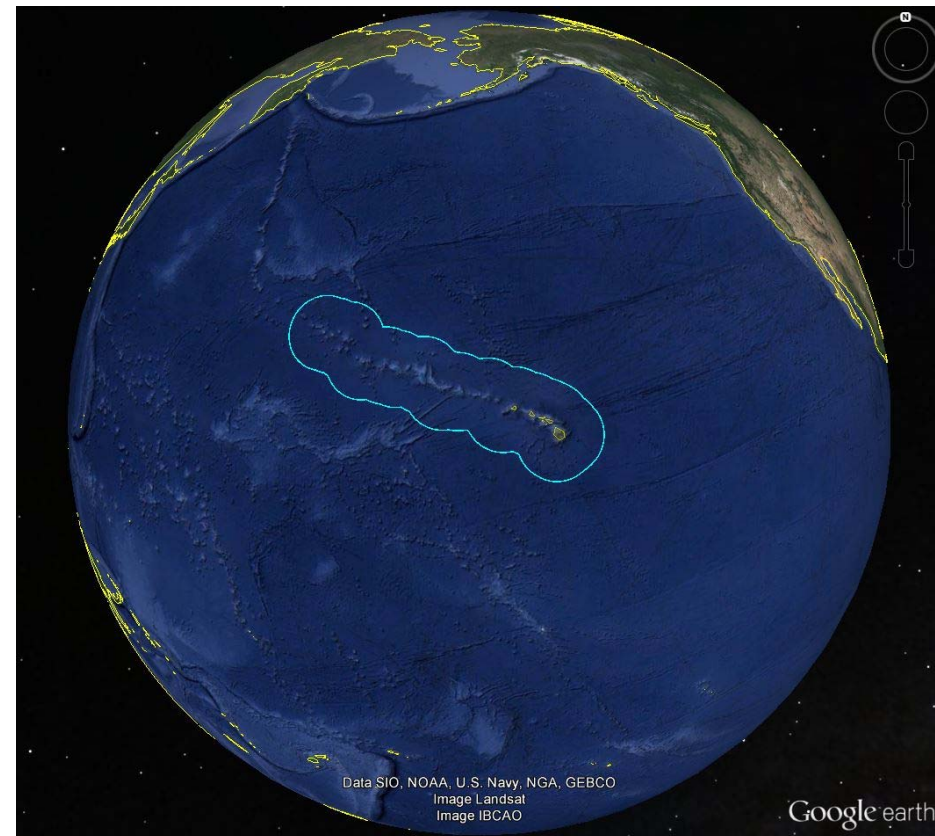


Acknowledgements

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- GIS analyses by Damon Holzer/NWFSC

Short-finned pilot whales in Hawai'i

- Single stock recognized in the EEZ (~2.4 million km²) by National Marine Fisheries Service, with estimated abundance of 12,422 (CV = 0.43) (Bradford et al. 2013)
- Density around main Hawaiian Islands higher than in outer EEZ (Barlow 2006)
- Preliminary genetic results suggest animals around main Hawaiian Islands reproductively isolated from eastern tropical Pacific (Van Cise et al. this conference)



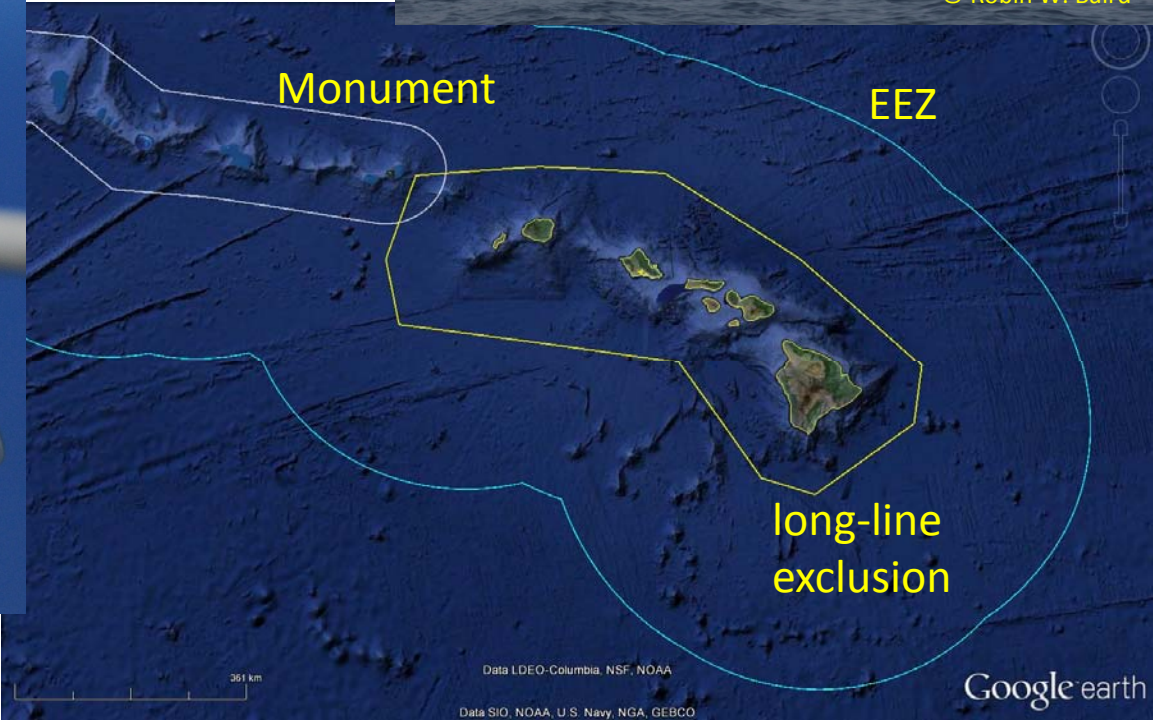
- Anthropogenic interactions around main Hawaiian Islands (fisheries, tourism, Navy training)
- Bycatch in offshore long-line fishery



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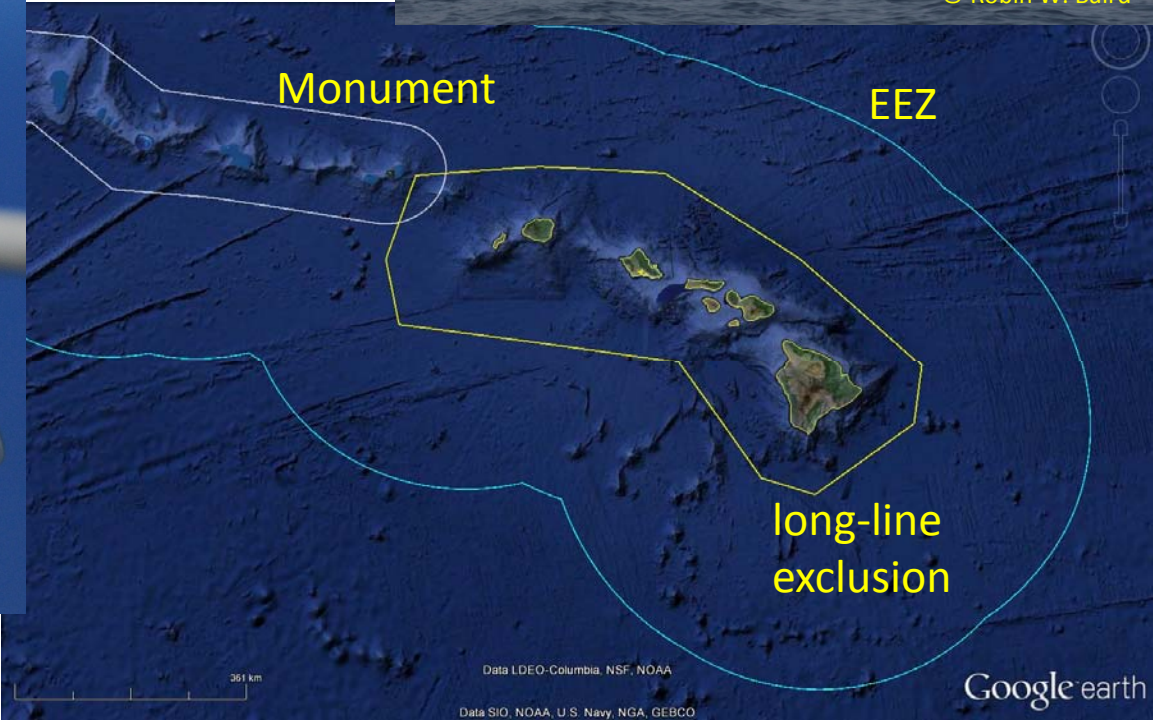
361 km

Data I, DEO, Columbia, NSF, NOAA

Data SIO, NOAA, U.S. Navy, NGA, GEBCO

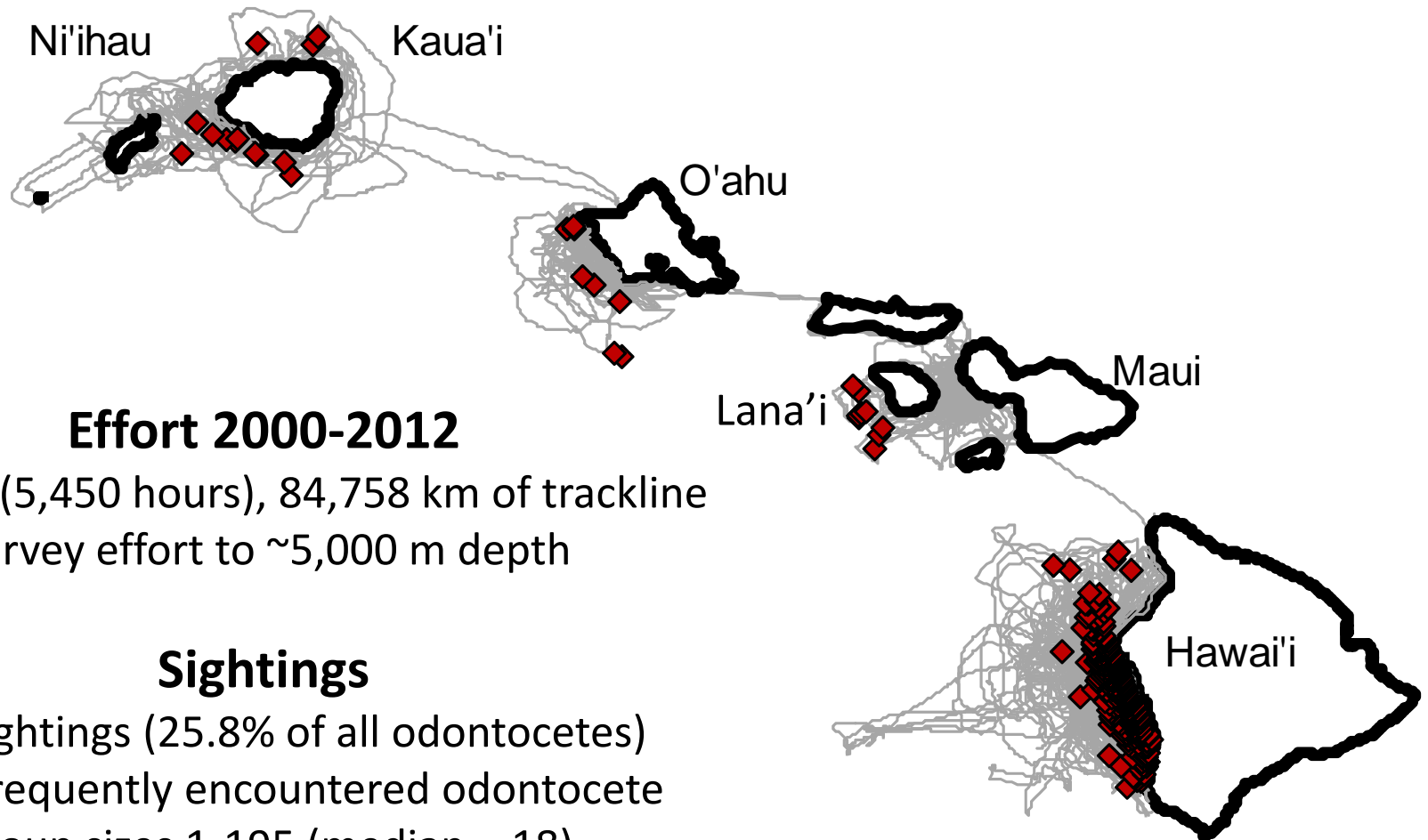
Google earth

Is there one stock that crosses management boundaries or multiple stocks that need to be recognized?



Three sources of information:

Sightings and effort data to assess habitat use



Effort 2000-2012

762 days (5,450 hours), 84,758 km of trackline

Survey effort to ~5,000 m depth

Sightings

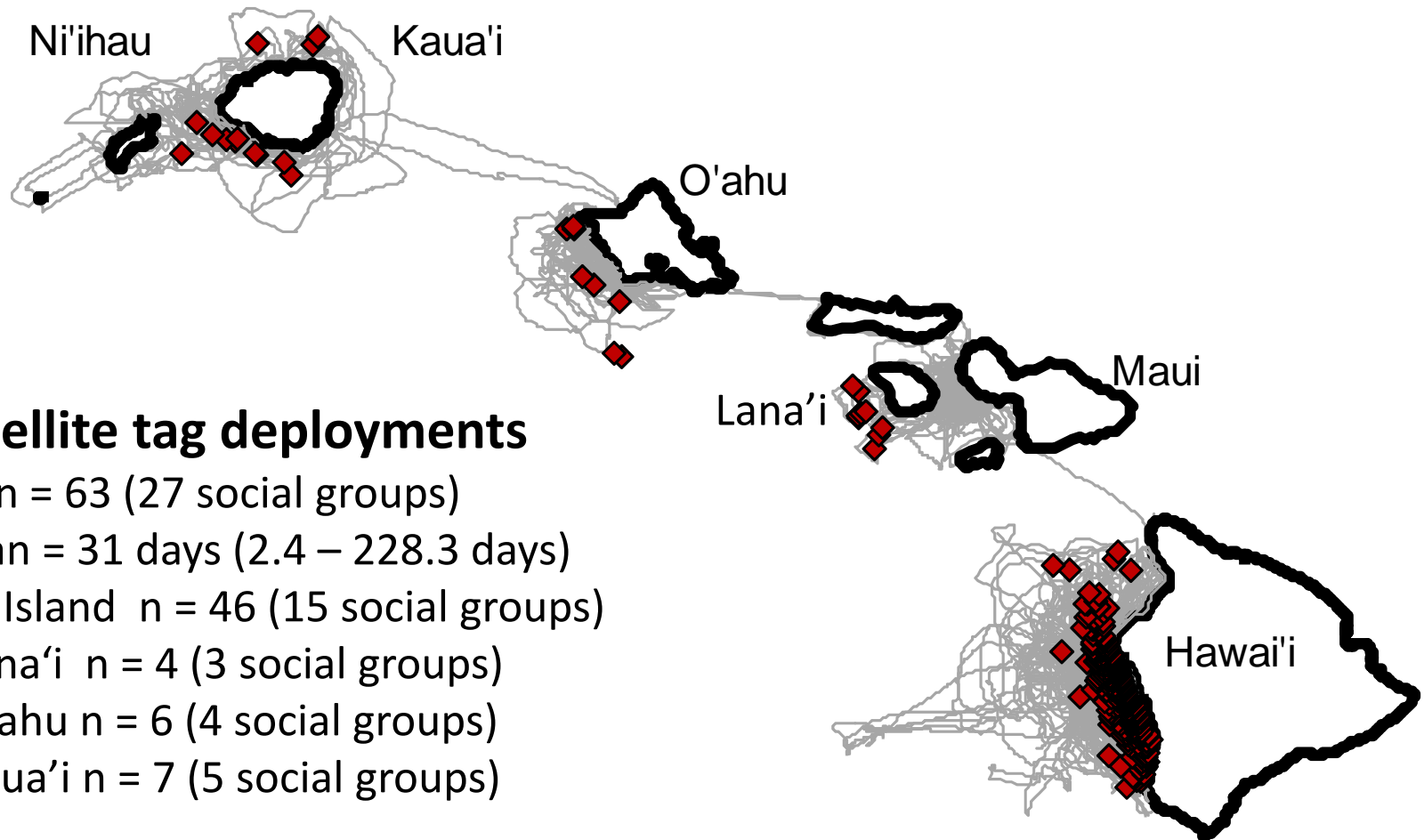
502 sightings (25.8% of all odontocetes)

Most frequently encountered odontocete

Group sizes 1-195 (median = 18)

Three sources of information:

Sightings and effort data to assess habitat use
Satellite tagging to assess movements & habitat use



Satellite tag deployments

n = 63 (27 social groups)

Median = 31 days (2.4 – 228.3 days)

Hawai'i Island n = 46 (15 social groups)

Lāna'i n = 4 (3 social groups)

O'ahu n = 6 (4 social groups)

Kaua'i n = 7 (5 social groups)

Three sources of information:

Sightings and effort data to assess habitat use

Satellite tagging to assess movements & habitat use

Individual photo-identification to assess associations & movements

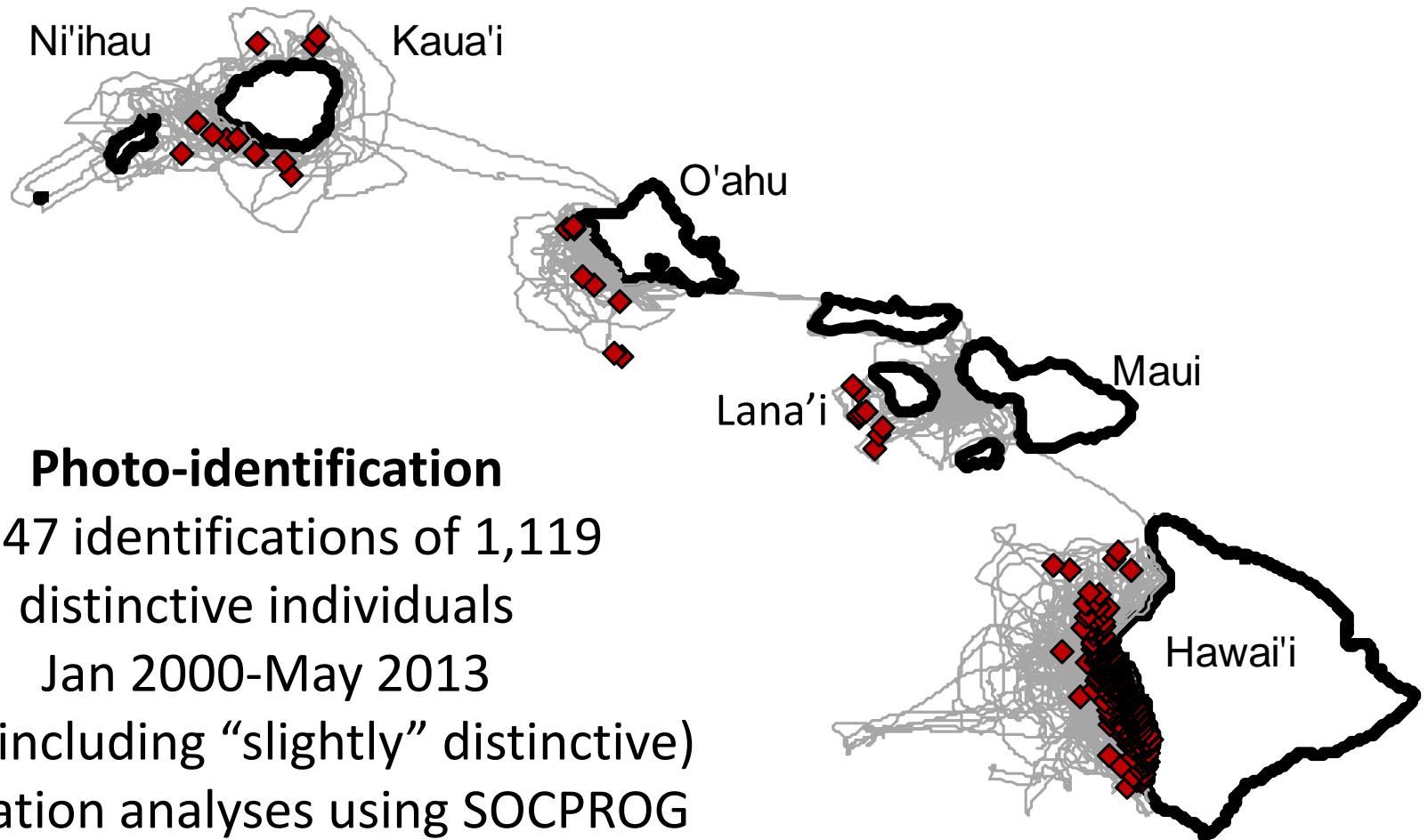


Photo-identification

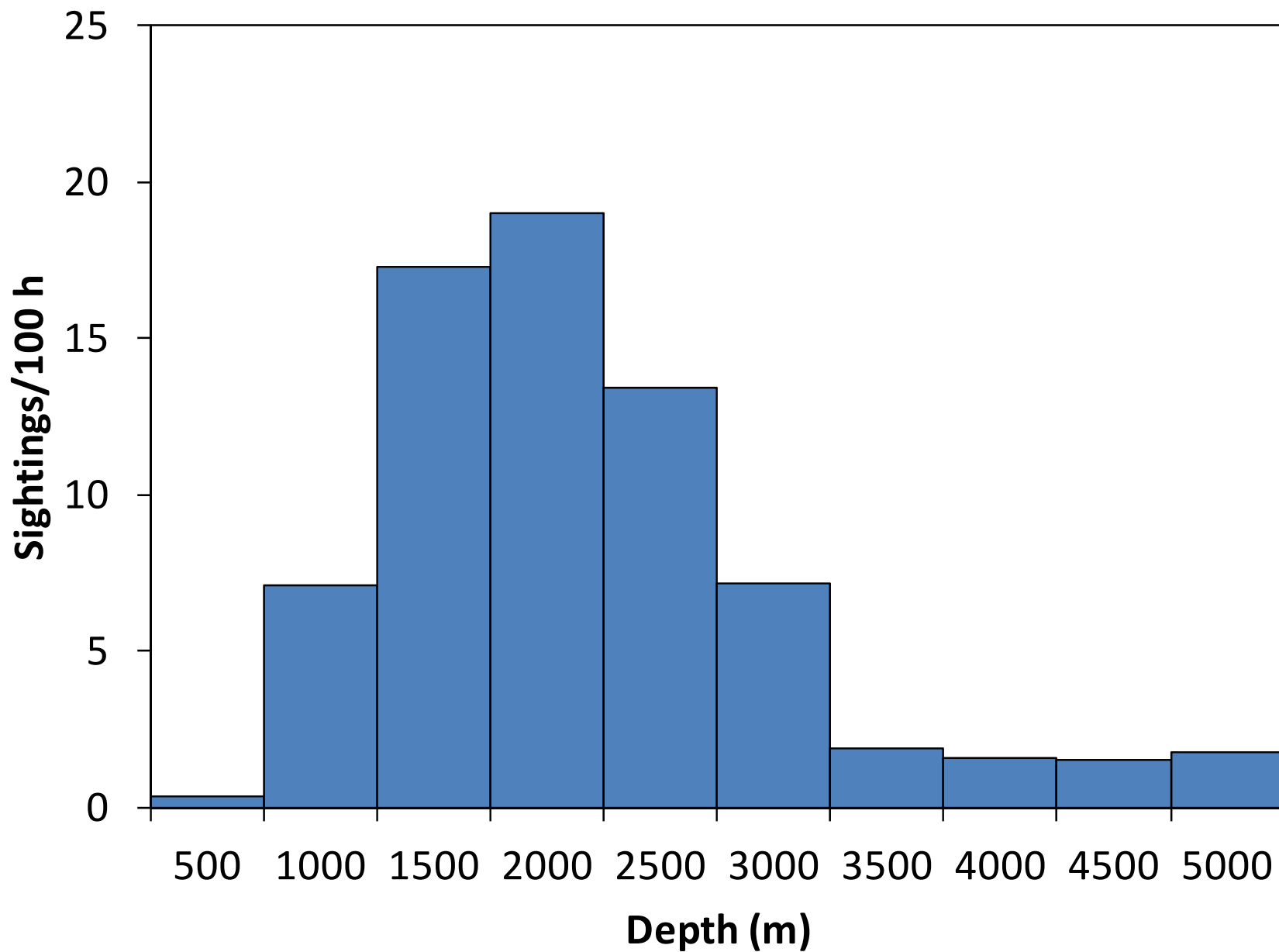
7,947 identifications of 1,119
distinctive individuals

Jan 2000-May 2013

(1,650 including “slightly” distinctive)

Association analyses using SOCPROG

Strongly associated with slope habitats

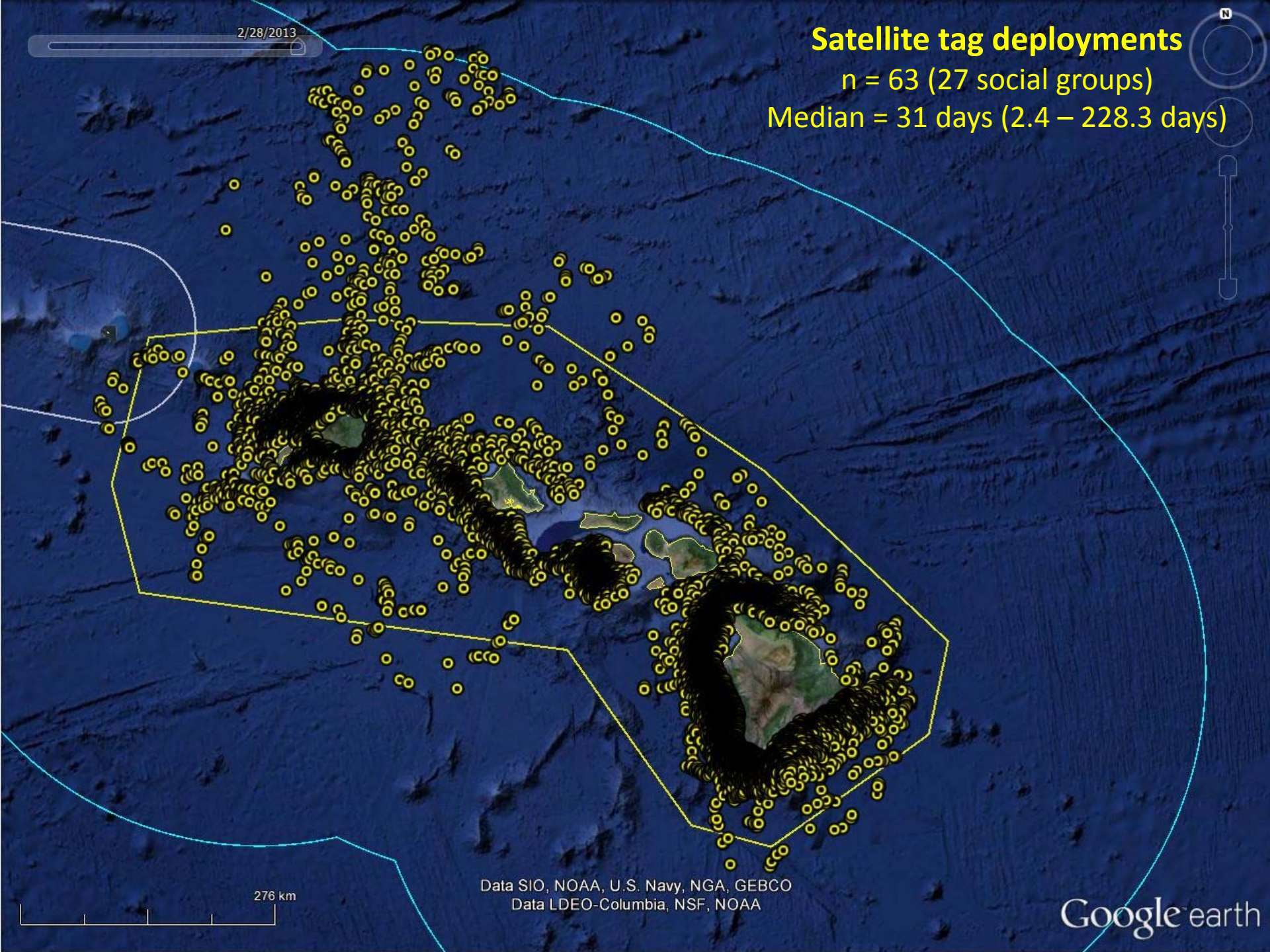


2/28/2013

Satellite tag deployments

n = 63 (27 social groups)

Median = 31 days (2.4 – 228.3 days)



Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data LDEO-Columbia, NSF, NOAA

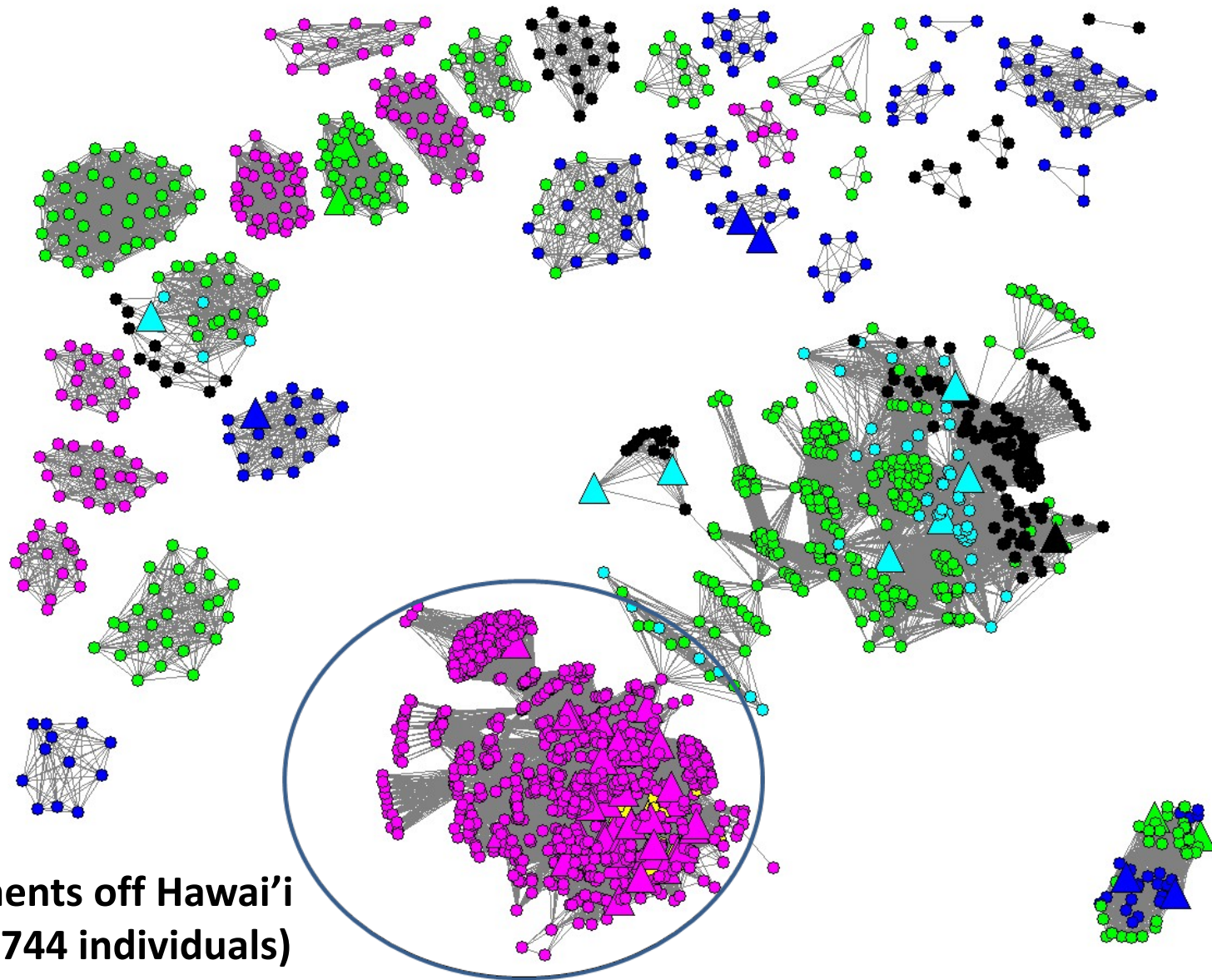
Photo-identification

- Association analyses using SOCPROG
- Network diagrams using NETDRAW
- Identifications and social relationships used to interpret results from satellite tagging



Pilot whales photo-IDd off all the main Hawaiian Islands

- = Lānaʻi or Lānaʻi/Oʻahu
- = Hawaiʻi Island
- = Kauaʻi or Niʻihau
- = Oʻahu
- = Oʻahu and Kauaʻi
- △ = tagged individual



All 46 tag deployments off Hawaiʻi Island associated (744 individuals)

9/14/2012

46 deployments

(43 individuals, 15 social groups)

2.4 – 109.9 days (median = 30.8)

locations = 12,759

GmTag032 (110 days)

tag deployments off Hawai'i Island - 2006-2012

78 km

Data LDEO-Columbia, NSF, NOAA
Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data MBARI

Google earth

2/28/2013

long-line exclusion boundary

Ni'ihau
Kaua'i

O'ahu

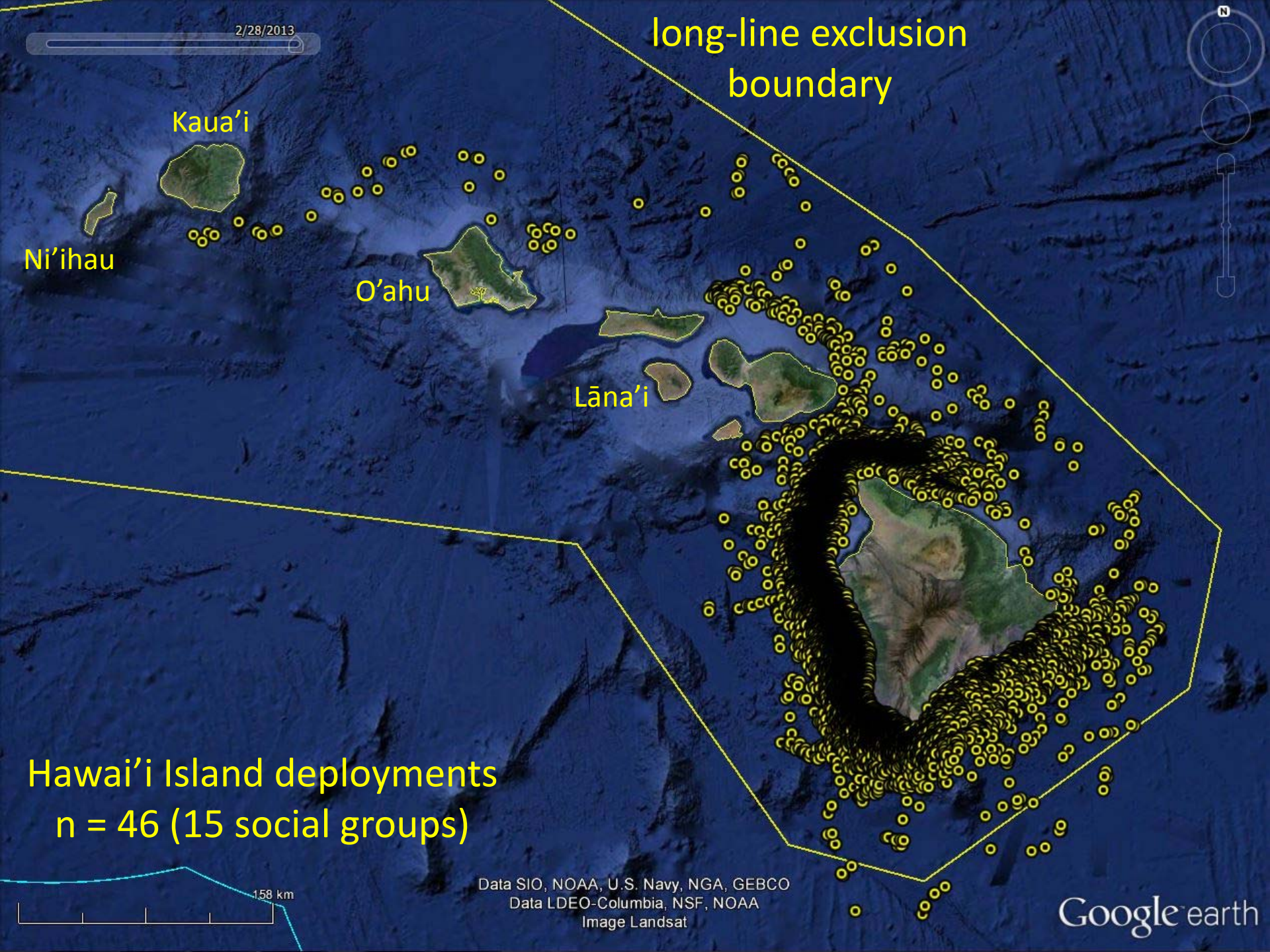
Lāna'i

Hawai'i Island deployments
n = 46 (15 social groups)

158 km

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data LDEO-Columbia, NSF, NOAA
Image Landsat

Google earth



2/28/2013 10 am

long-line exclusion
boundary

Ni'ihau
Kaua'i

O'ahu

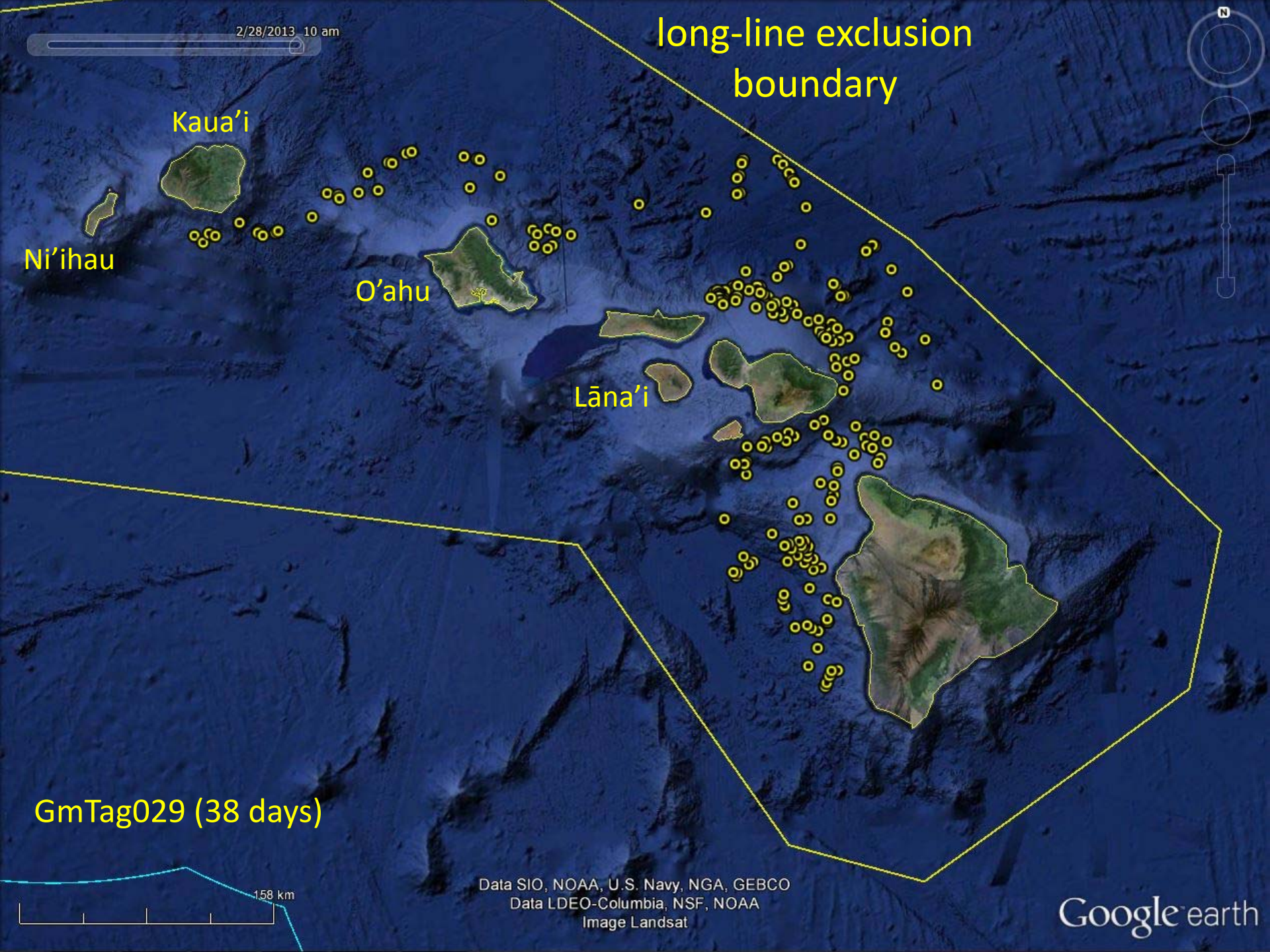
Lāna'i

GmTag029 (38 days)

158 km

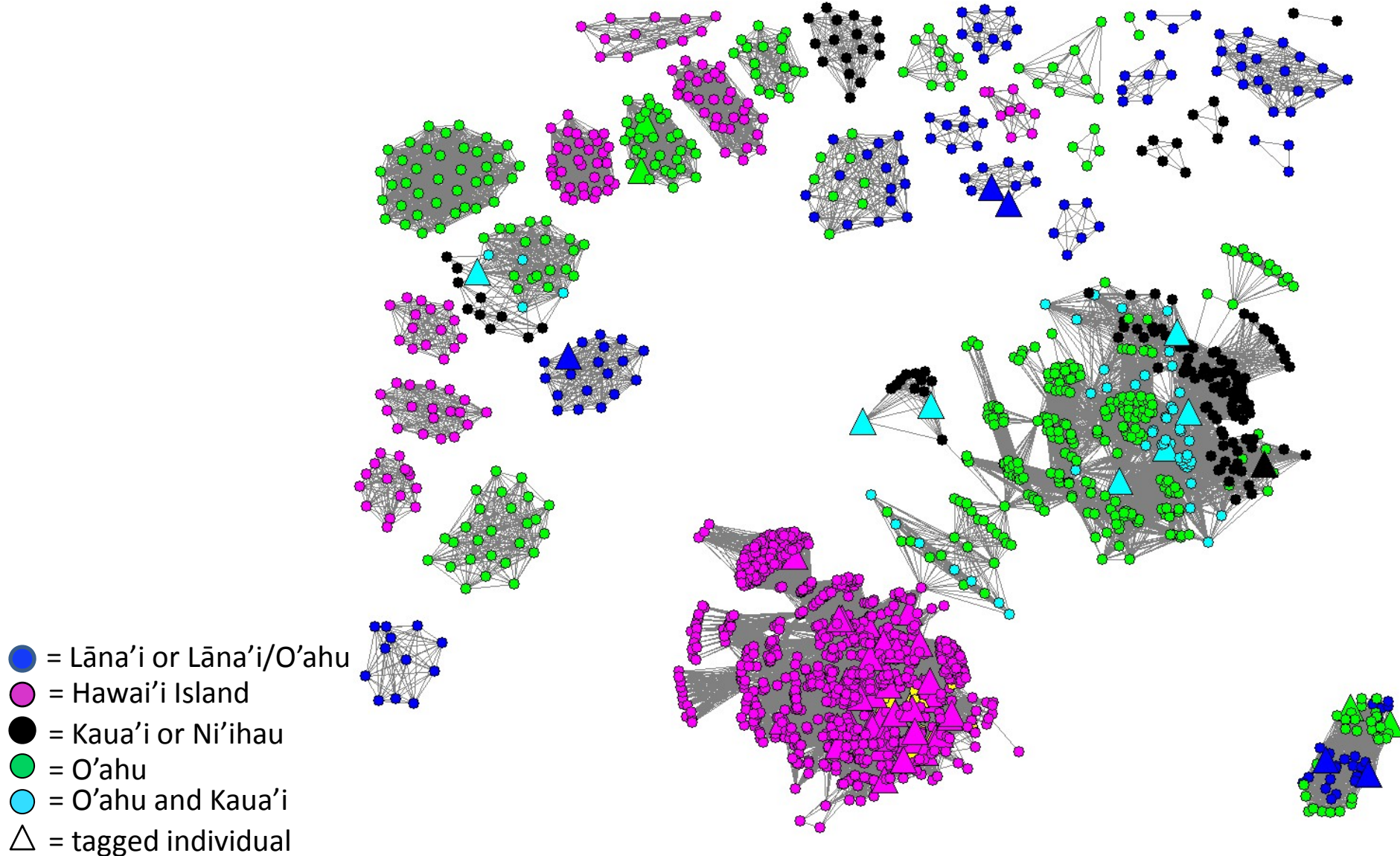
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data LDEO-Columbia, NSF, NOAA
Image Landsat

Google earth



Tag deployments off Kaua'i, O'ahu and Lāna'i

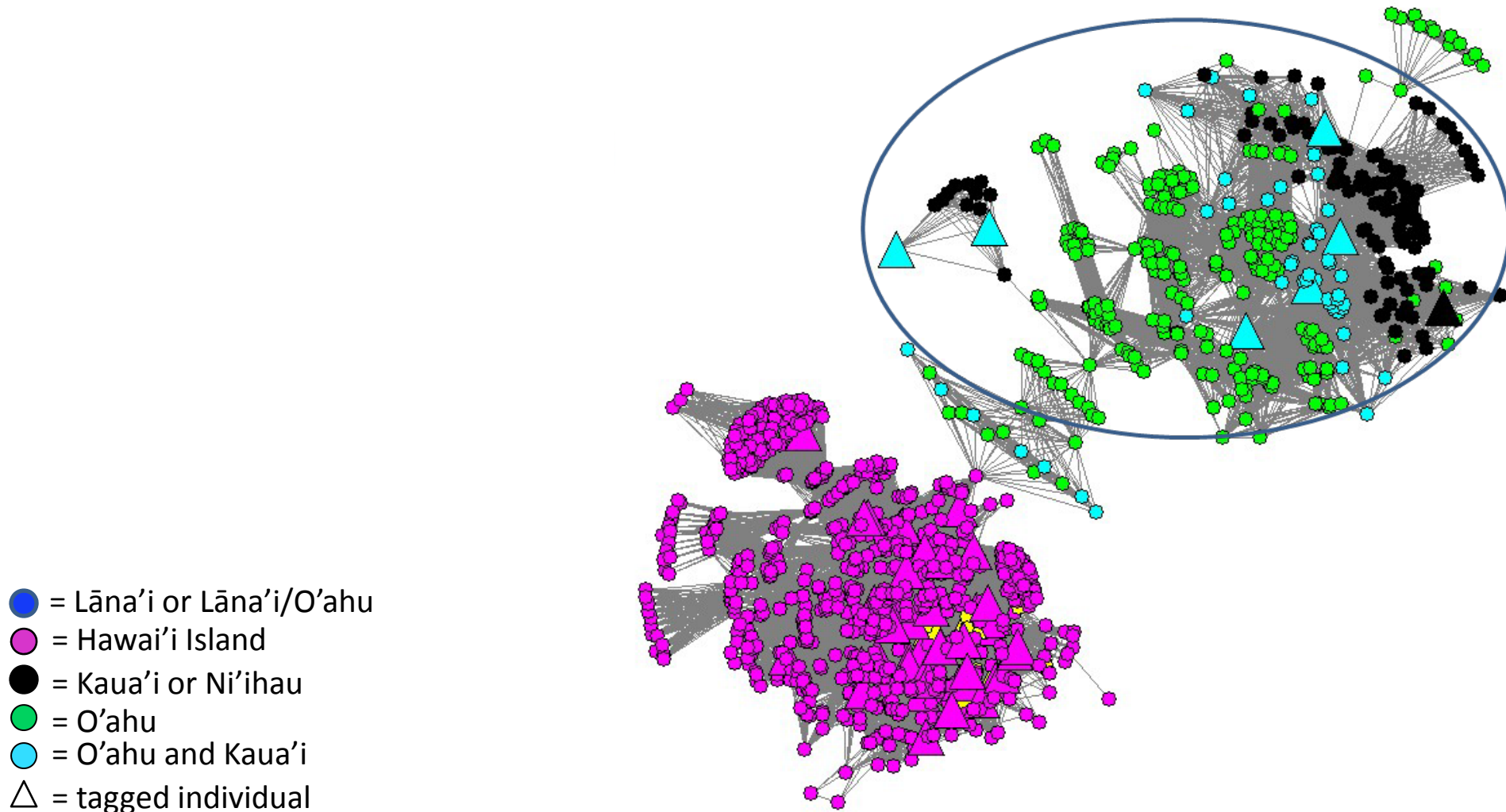
- 7 off Kaua'i (2008, 2011, 2012, 2013) – range 11.7 – 70.3 days (median = 36.8)
 - 6 off O'ahu (2010) – range 9.3 – 228.3 days (median = 55.5)
- 4 off Lāna'i (2012) – range 3.7 – 71.0 days (median = 12.2 days)



Tag deployments off Kaua'i

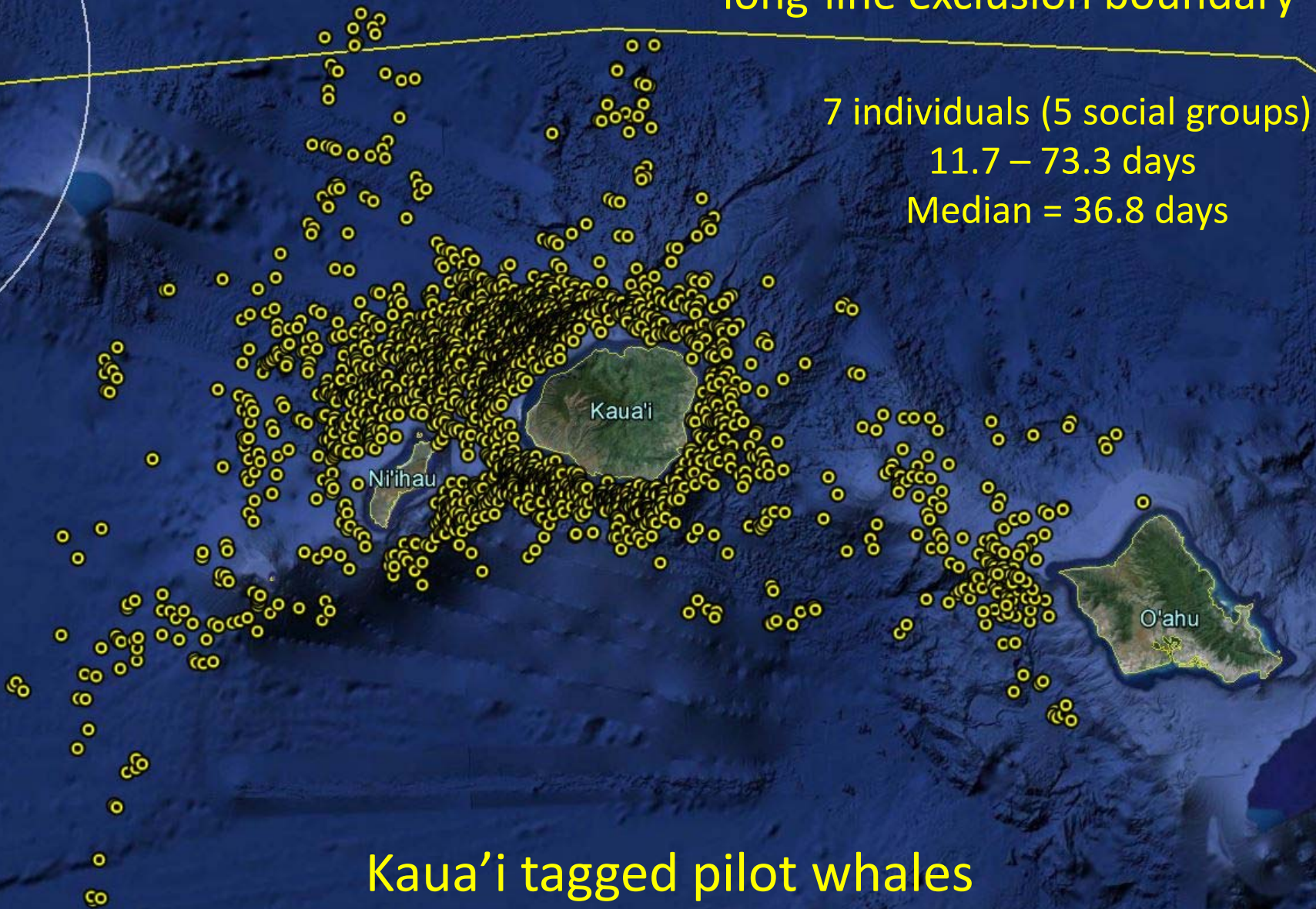
seven (2008, 2011, 2012, 2013) – range 11.7 – 70.3 days (median = 36.8)
five social groups

All linked by association in main cluster with individuals previously documented off O'ahu



long-line exclusion boundary

7 individuals (5 social groups)
11.7 – 73.3 days
Median = 36.8 days

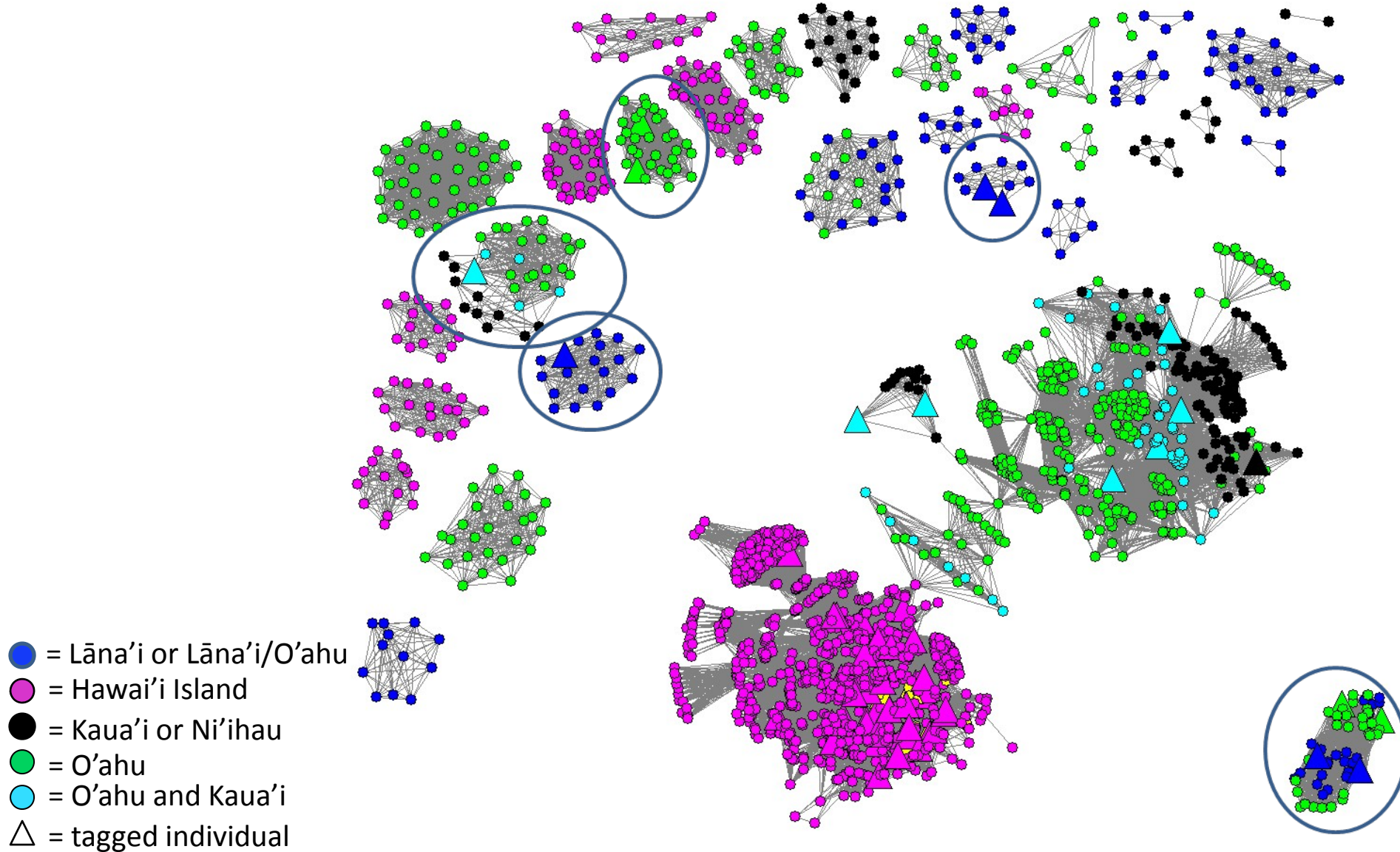


Kaua'i tagged pilot whales

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data LDEO-Columbia, NSF, NOAA
Image Landsat

Tag deployments off O'ahu and Lāna'i

- 6 off O'ahu (2010) – range 9.3 – 228.3 days (median = 55.5)
- 4 off Lāna'i (2012) – range 3.7 – 71.0 days (median = 12.2 days)



Tag deployments off O'ahu and Lāna'i

Six off O'ahu (2010) – range 9.3 – 228.3 days (median = 55.5)

Four off Lāna'i (2012) – range 3.7 – 71.0 days (median = 12.2 days)

Photo-ID re-sightings
between O'ahu and
Kaua'i

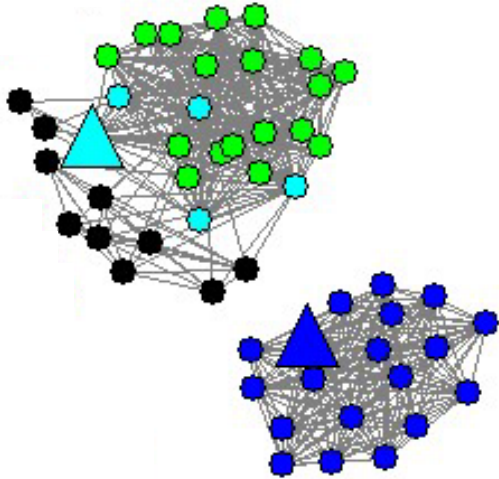


Photo-ID re-sightings between
O'ahu and Lāna'i

- = Lāna'i or Lāna'i/O'ahu
- = Hawai'i Island
- = Kaua'i or Ni'ihau
- = O'ahu
- = O'ahu and Kaua'i
- △ = tagged individual

Tag deployments off O'ahu and Lāna'i

Three off O'ahu (2010) – range 22.8 – 228.3 days (median = 97.5)

Four off Lāna'i (2012) – range 3.7 – 71.0 days (median = 12.2 days)

Photo-ID re-sightings
between O'ahu and
Kaua'i

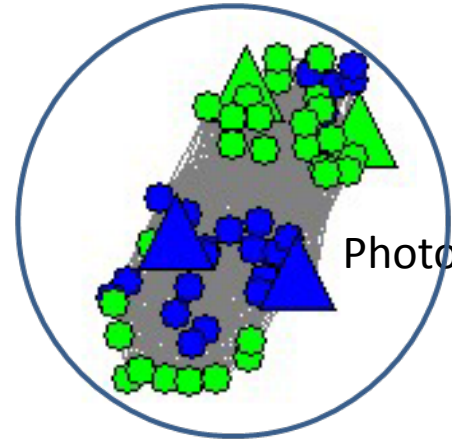
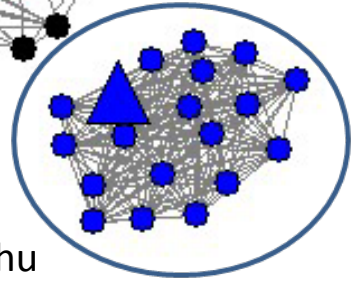
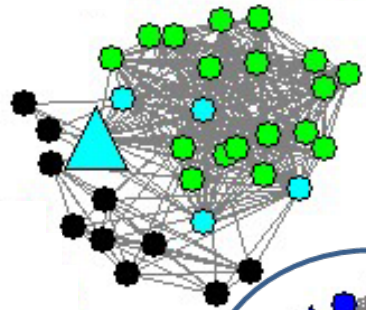


Photo-ID re-sightings between
O'ahu and Lāna'i

- = Lāna'i or Lāna'i/O'ahu
- = Hawai'i Island
- = Kaua'i or Ni'i'hau
- = O'ahu
- = O'ahu and Kaua'i
- △ = tagged individual

2/28/2013 10 am

Lānaʻi tagged pilot whales
4 individuals (3 groups)
3.7 – 71.0 days

O'ahu

Moloka'i

Lana'i

Kaho'olawe

42 km

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data LDEO-Columbia, NSF, NOAA
Image Landsat
Data MBARI

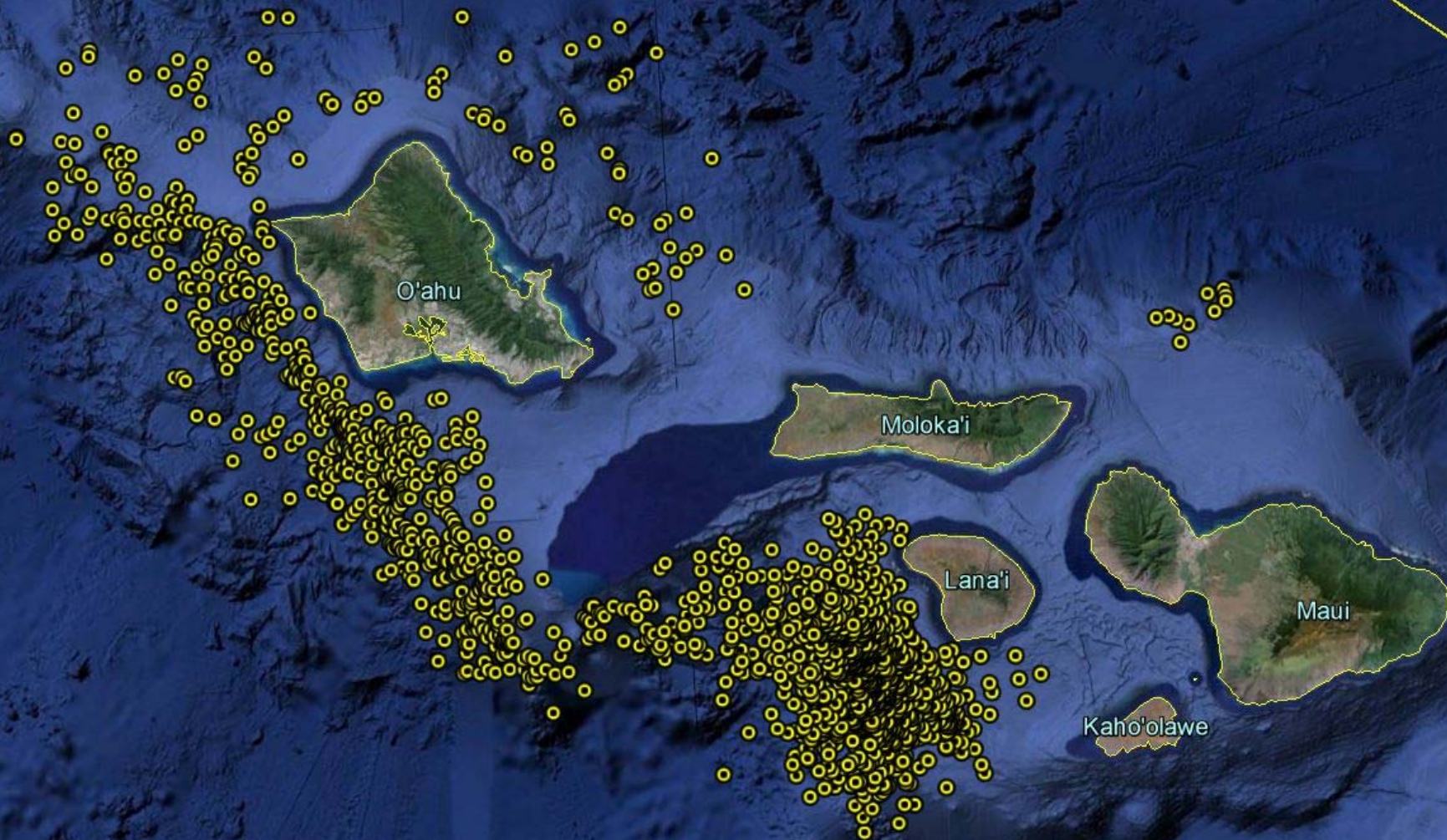
Google earth

2/28/2013

O'ahu tagged pilot whales

3 individuals (2 groups)

22.8 – 228.3 days



Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Data LDEO-Columbia, NSF, NOAA

Image Landsat

Data MBARI

Hawai'ian Islands

Google earth

Conclusions, part 1

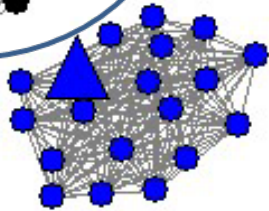
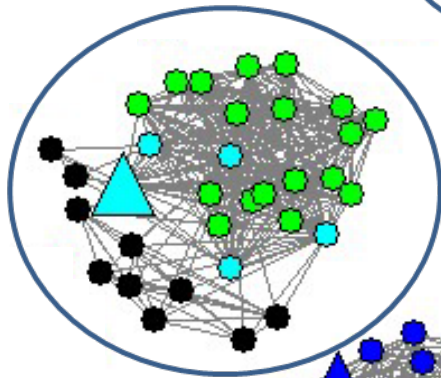
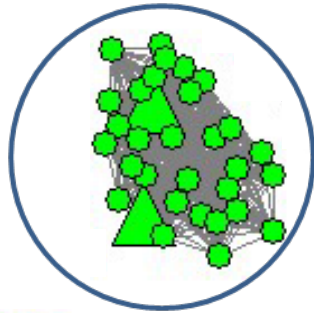
- Sightings & effort island-associated population(s)
- Photo-ID & tag data suggest movements among islands limited, with evidence for more than one island-associated community within the main Hawaiian Islands, small populations sizes, and regular exposure to anthropogenic activities



Tag deployments off O'ahu

Three off O'ahu (2010) – range 9.3 – 58.0 days

Two groups
tagged on same
day ~2 km apart



2/17/2013 9 am

Tagged off O'ahu
October 2010
~2 km apart

Two groups associated
for first 9 days

EEZ

long-line
exclusion
boundary

Niihau

Kauai

O'ahu

Molokai

Lanai

Maui

Kaho'olawe

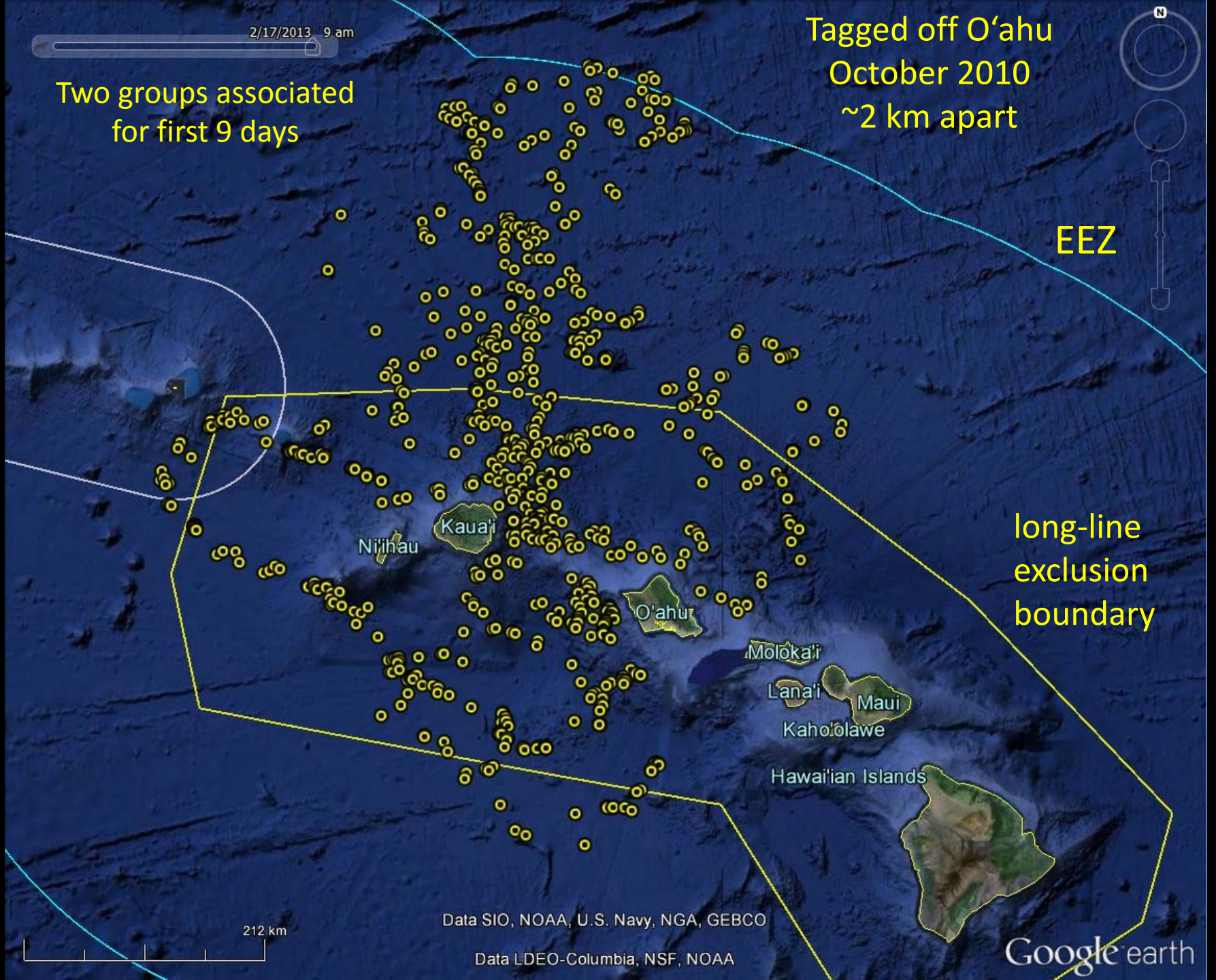
Hawaiian Islands

212 km

Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Data LDEO-Columbia, NSF, NOAA

Google earth



Conclusions, part 2

- tag data suggest the presence of a non island-associated (offshore) population that overlaps with insular population(s), long-line fisheries, and crosses international boundaries
- multiple stocks should be recognized and managed within the Hawaiian EEZ

