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

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Economic value of spinner dolphins in Hawaii

Dolphin stock	Annual Revenue (USD)	Over lifetime
Oahu	$58,000,000	$3,360,000
Hawaii Island	$44,000,000	$1,100,000 - $1,600,000

Wiener *et al*. In review. *Frontiers in Marine Science*.

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)

Background/context

2005: NOAA published an Advanced Notice of Proposed Rulemaking aimed at reducing impacts by implementing time-area closures in spinner dolphin resting bays.

2010: NOAA initiated research to inform preferred management approach of implementing time-area closures.

Murdoch UNIVERSITY

CETACEAN RESEARCH UNIT

Duke UNIVERSITY

- Research by:

- Funded by:

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

Abundance of Hawaii Island spinner dolphins

Study area: Kona Coast, Island of Hawaii (leeward side)

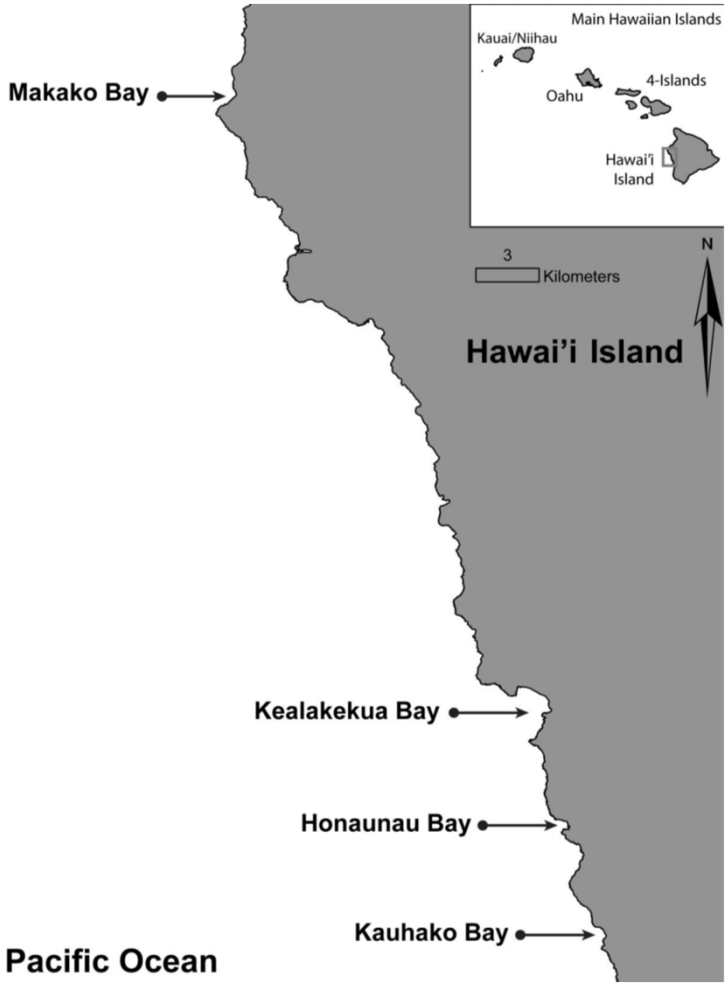
- Makako Bay
- Kealakekua Bay
- Honaunau Bay
- Kauhako Bay

Known as important resting bays for spinner dolphins

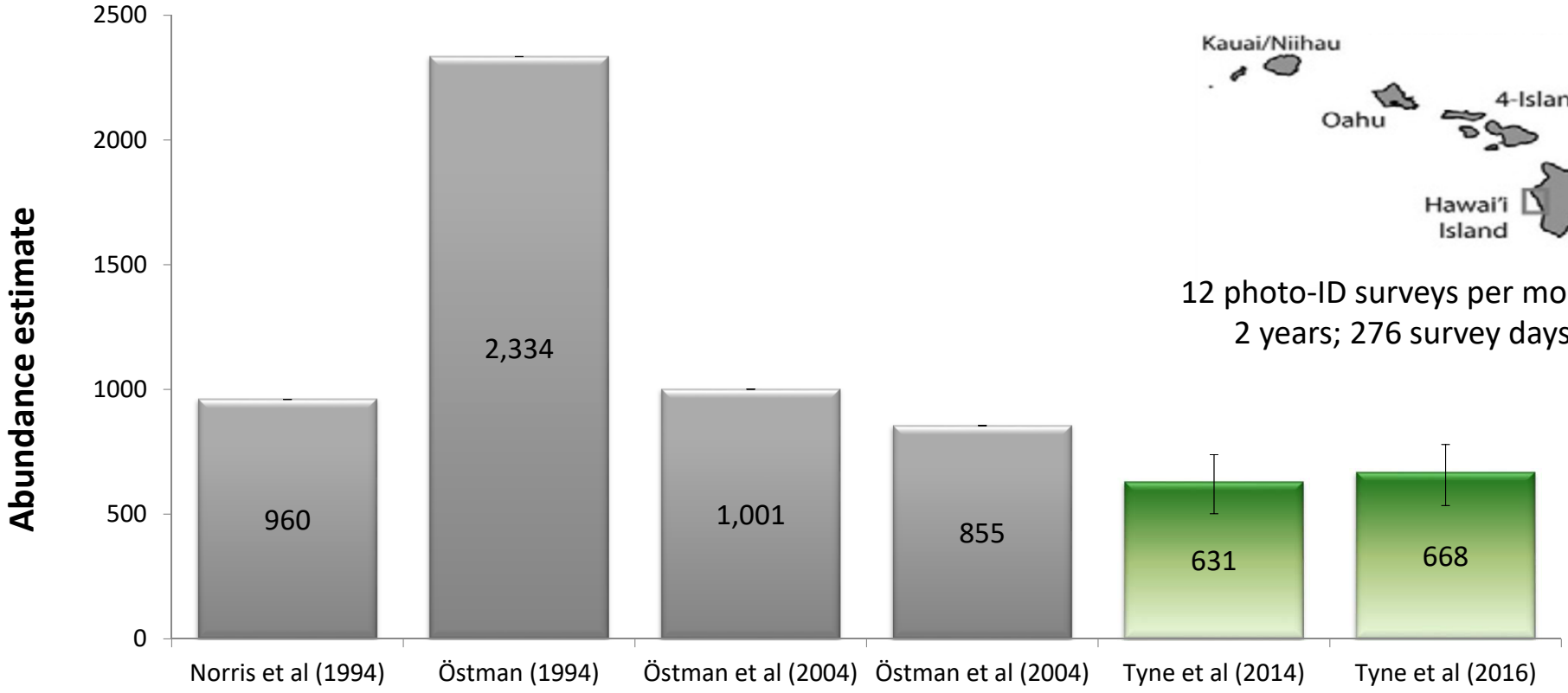
(Thorne *et al*. 2012. PLoS One)

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



12 photo-ID surveys per month;
2 years; 276 survey days

Tyne *et al*. 2014 PLoS ONE

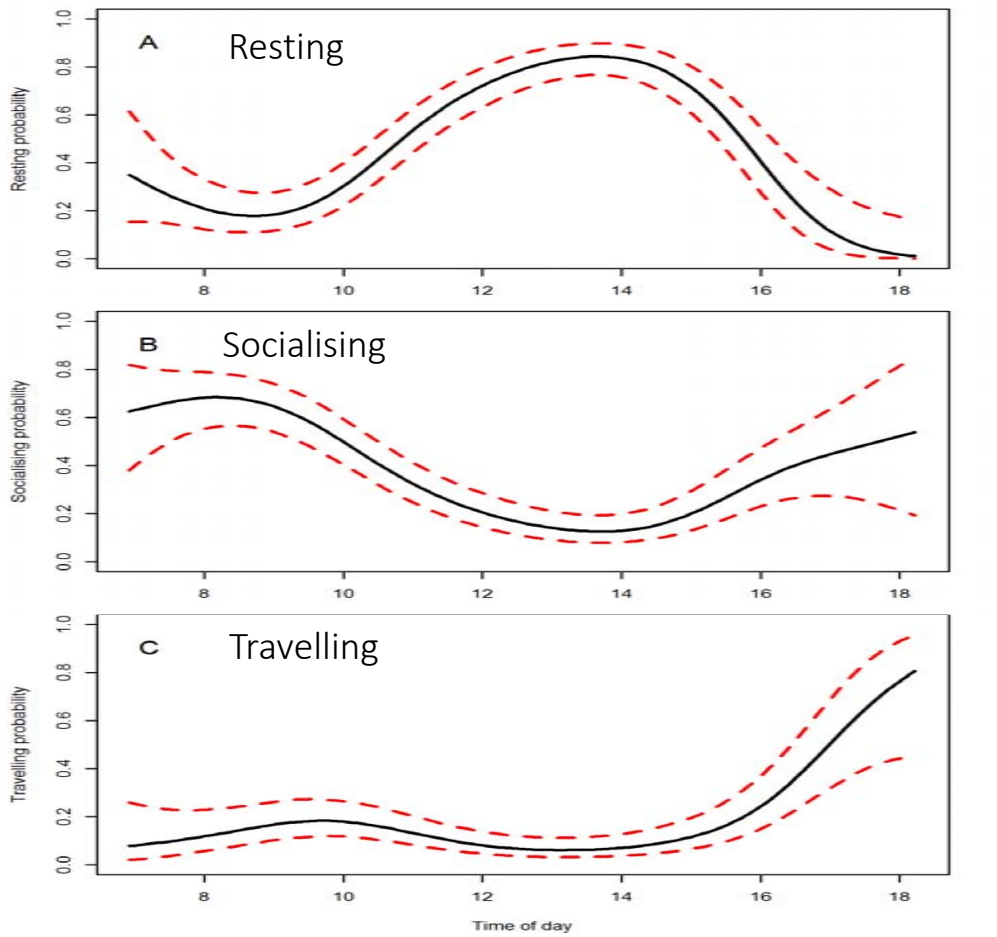
Tyne *et al*. 2016 Biological Conservation

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

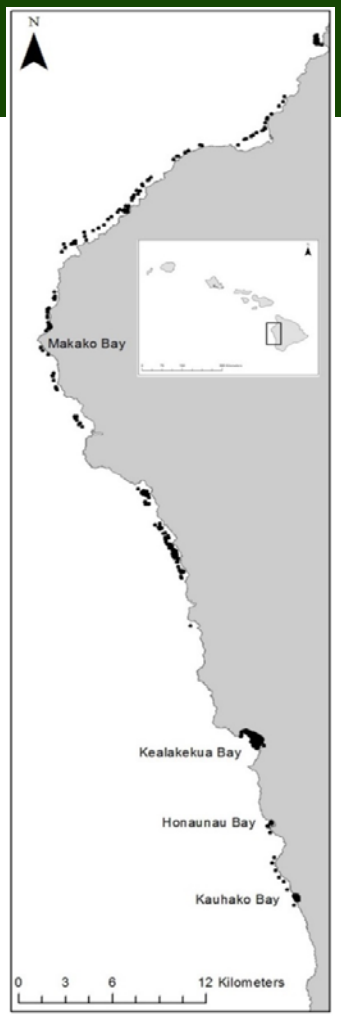
Dolphin activity throughout the day in bays



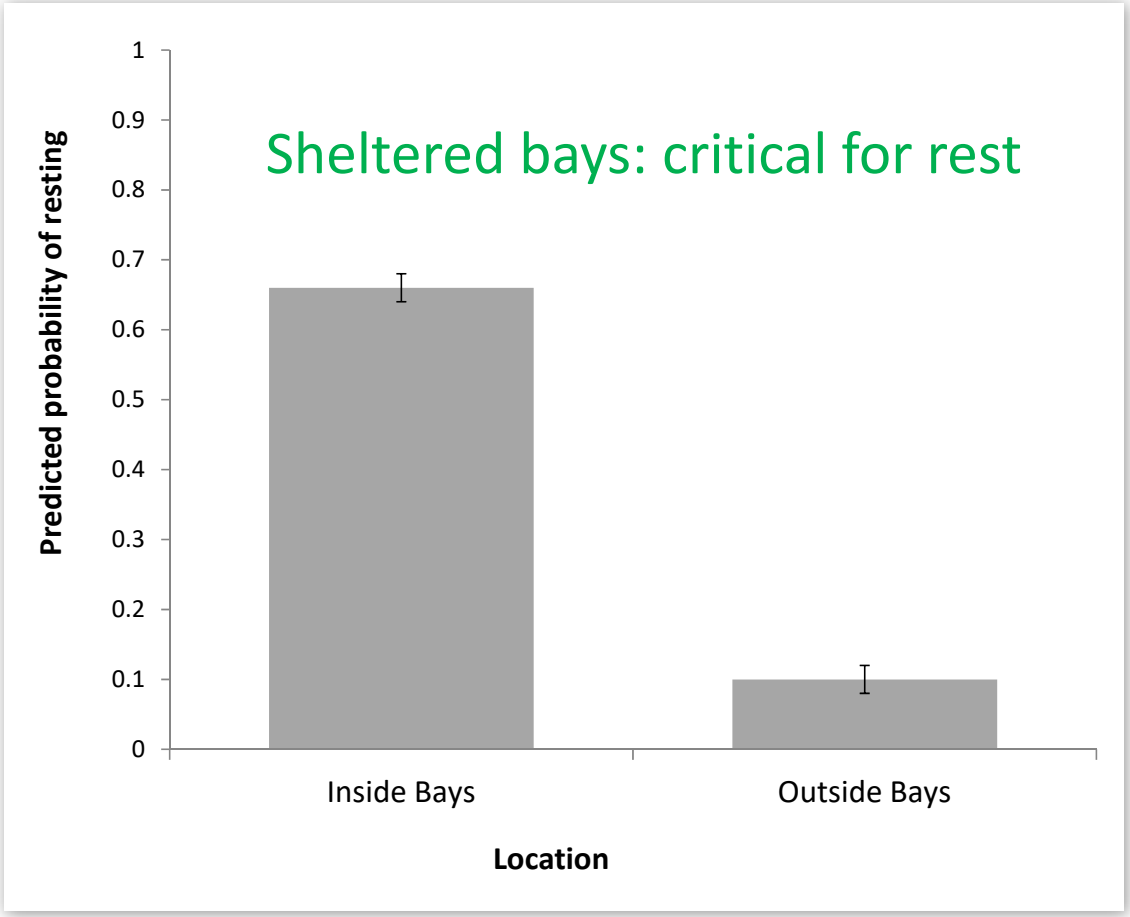
- Corroborate Norris *et al*.'s earlier work (from the late 1970s to the early 1980s)
- Quantified the constrained spinner dolphin activity throughout the day

Tyne *et al*. 2017 Royal Society Open Science

The importance of resting habitat



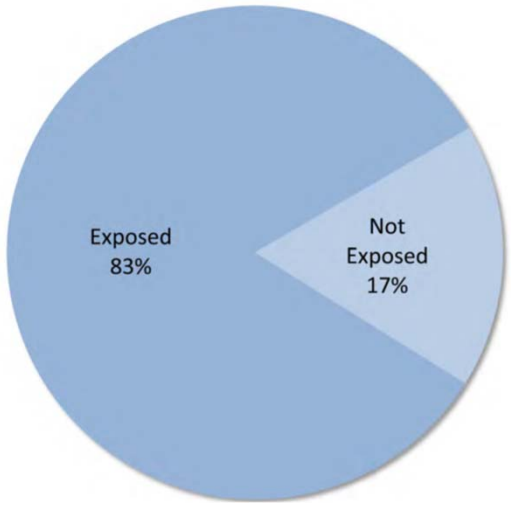
105 behavioural focal follows; 428 hrs



Tyne *et al.* 2015. Journal of Applied Ecology

Highest exposure ever recorded of any cetacean species

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



- 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

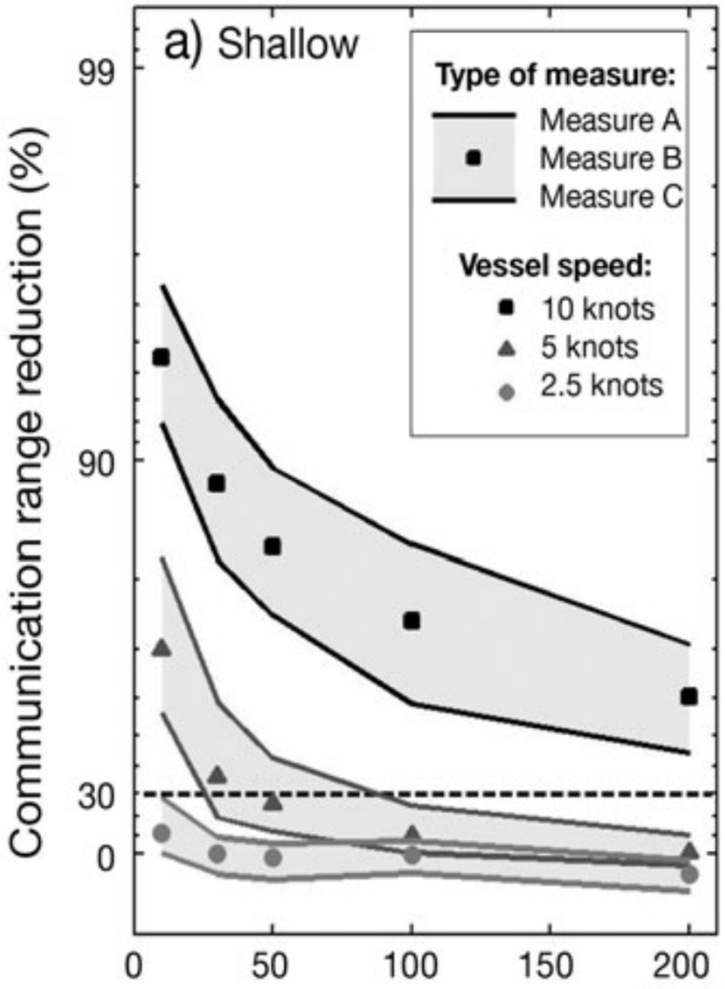
The 50-yard no approach rule is a start …. however….

Management actions needs to be <u>context-specific</u>

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

Communication range reduction and sound propagation



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."

Jensen et al. 2009. MEPS

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

2017: Designated as Important Marine Mammal Areas (IMMAs)

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]

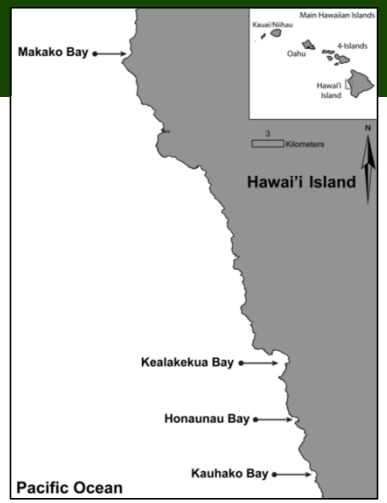
This is not a radical suggestion

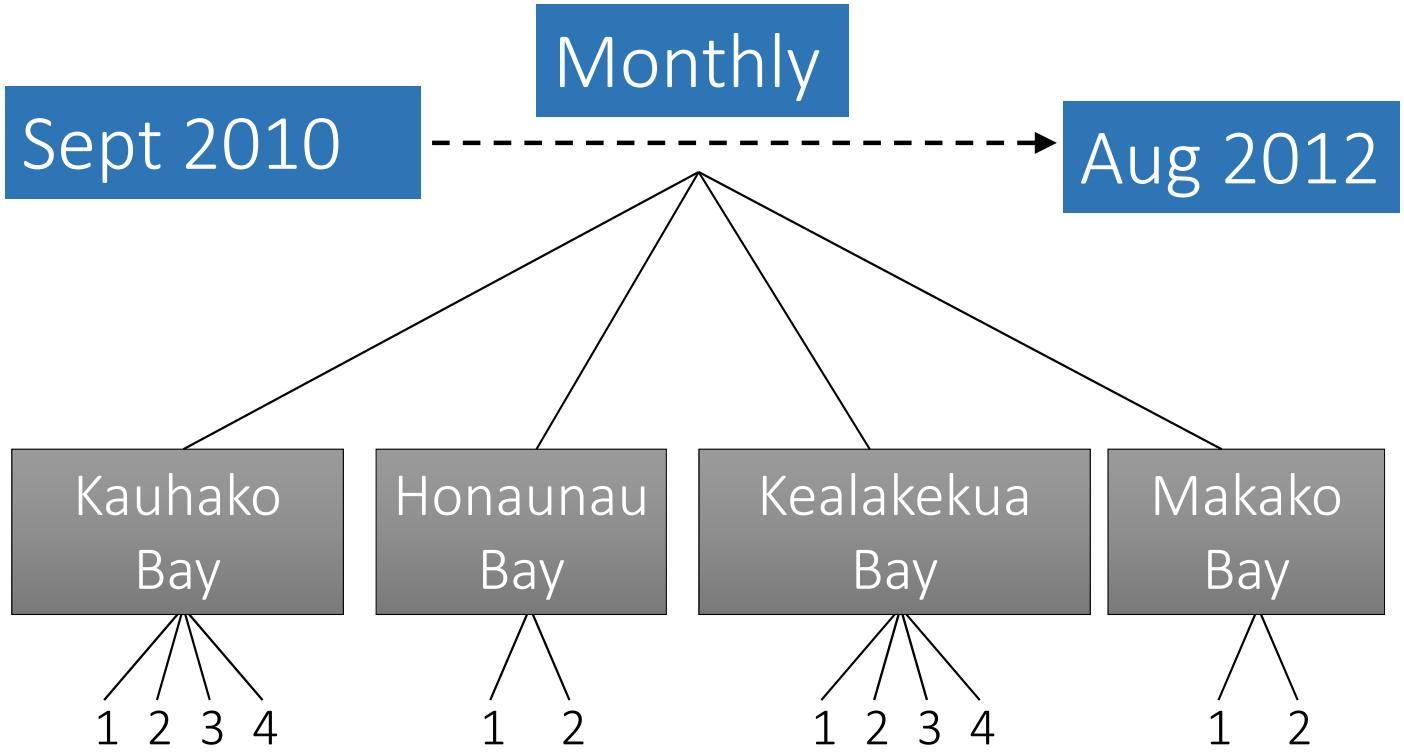
- Time-area closures were the preferred approach until relatively recent
- Areas are not large…. The size of a few football fields…
- Recent state and international initiatives provides favorable support
- It would be easy to evaluate compliance and also to enforce

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

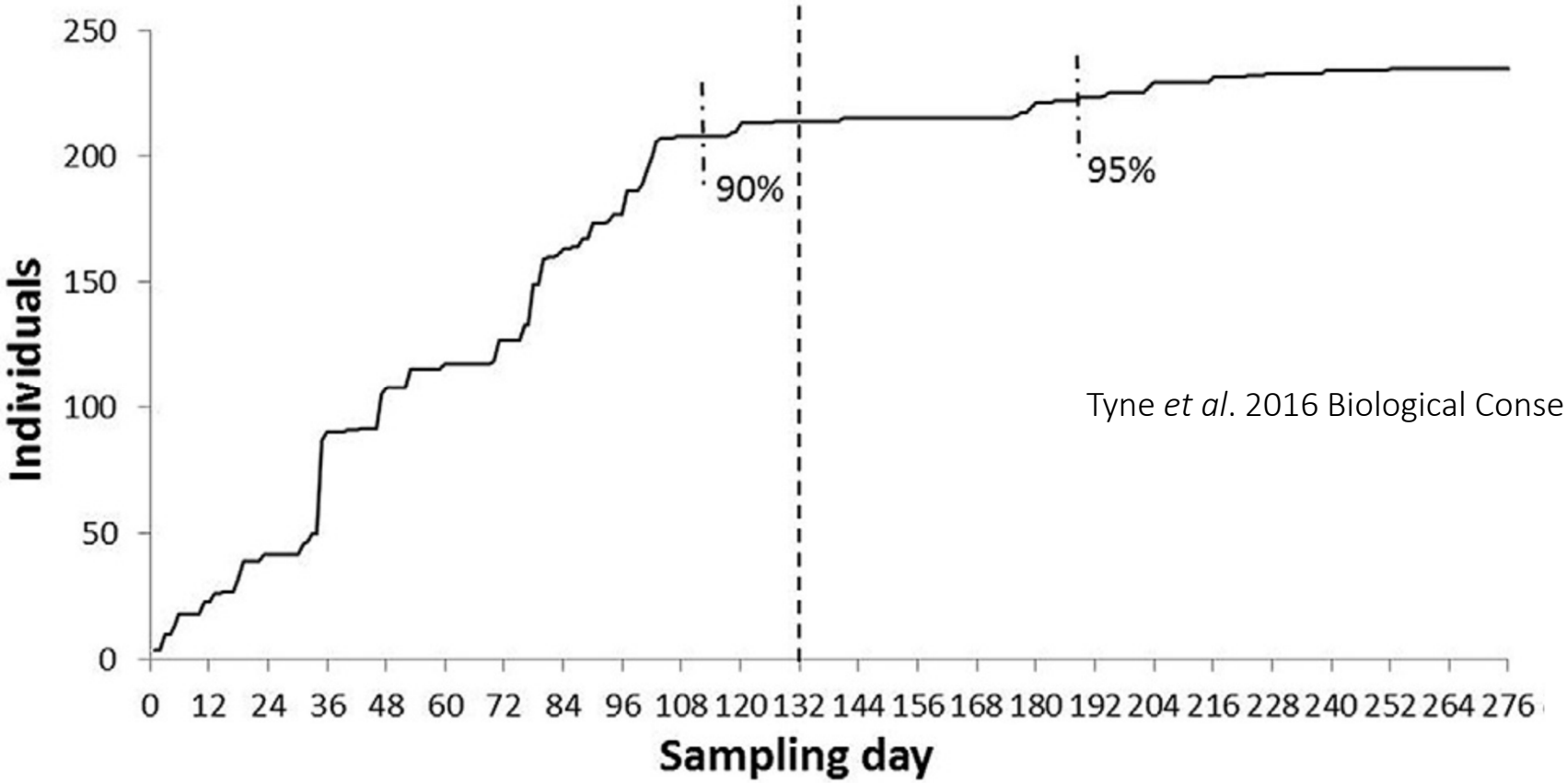
Photo-ID sampling design





12 days per month for
24 consecutive months

Cumulative discovery curve: Years 1 + 2

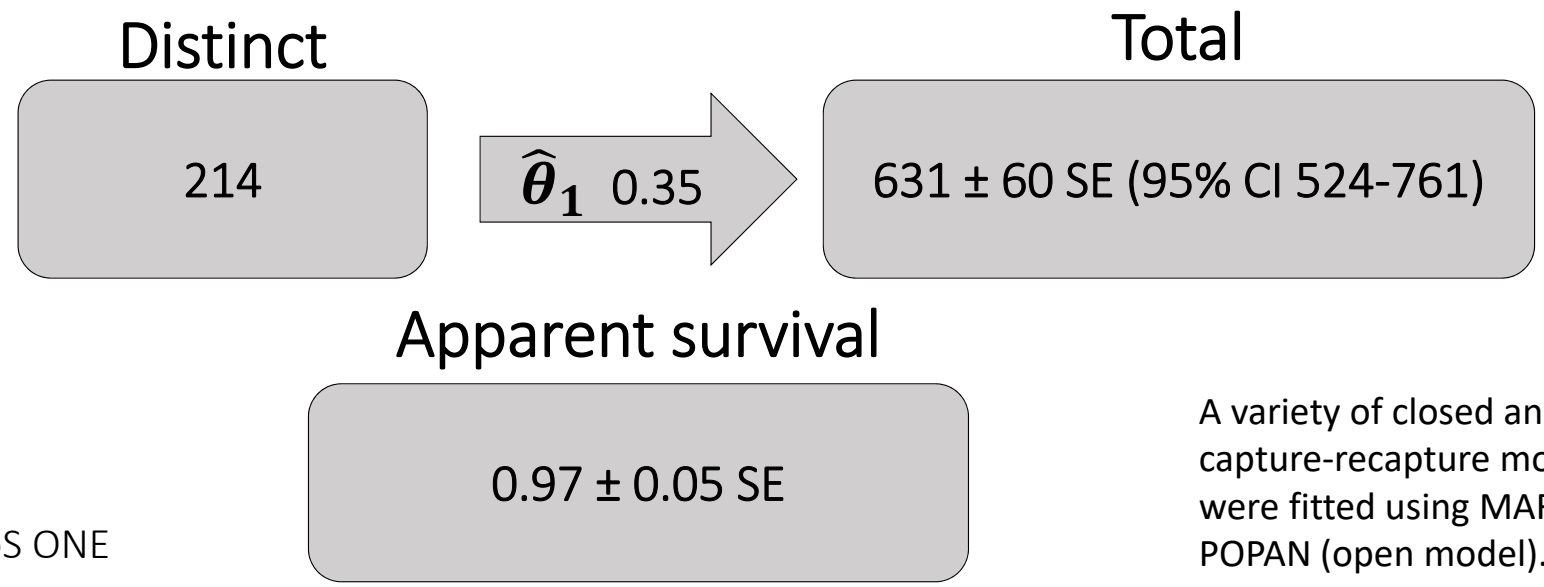


Tyne *et al*. 2016 Biological Conservation

276 photographic-identification survey days (September 2010 to August 2012).

Total (distinct) abundance and survival estimates

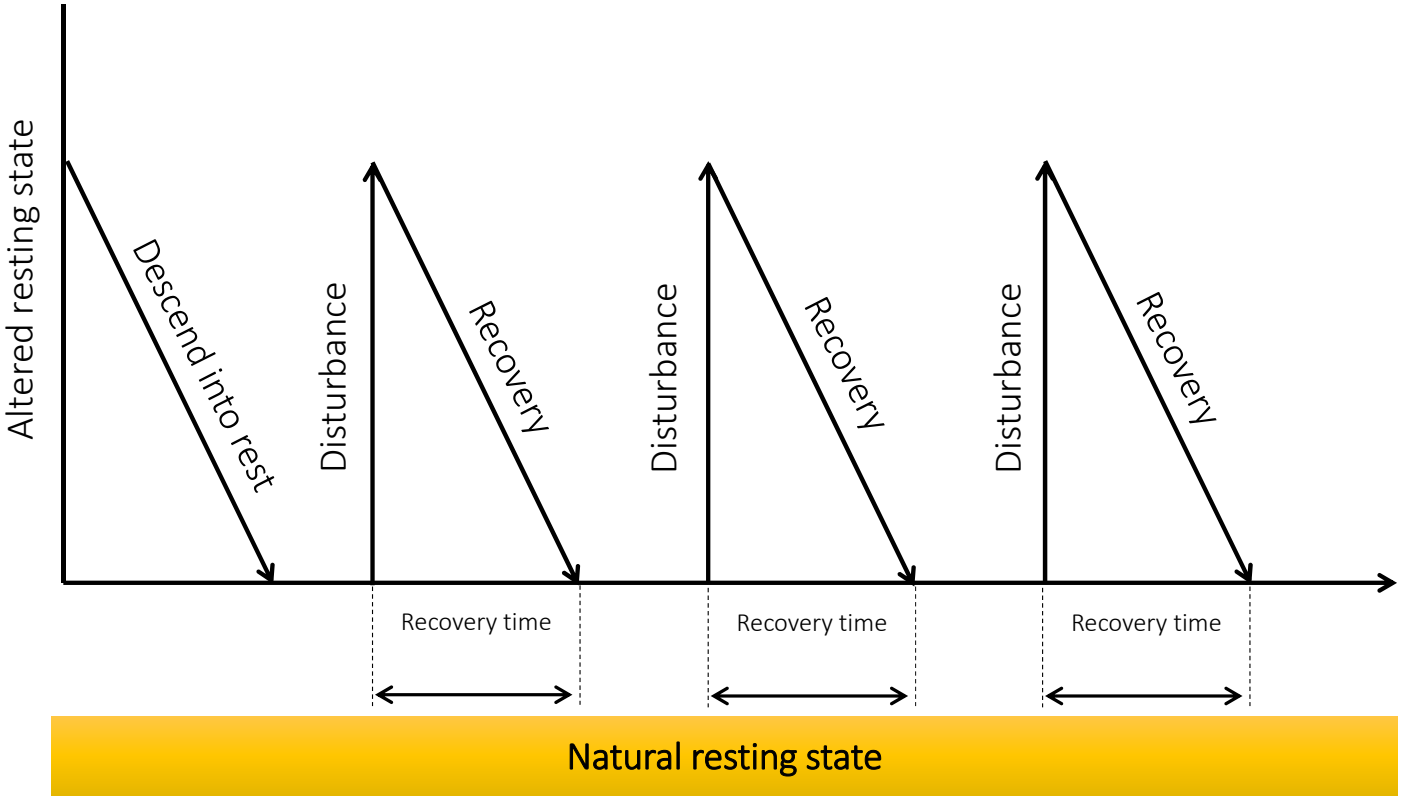
- Independent mark rates
  - $\hat{\theta}_1$ = 0.35 ± 0.02 SE
  - $\hat{\theta}_2$ = 0.36 ± 0.03 SE
  - Z-test (*p*=0.68)



Tyne *et al*. 2014 PLoS ONE

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

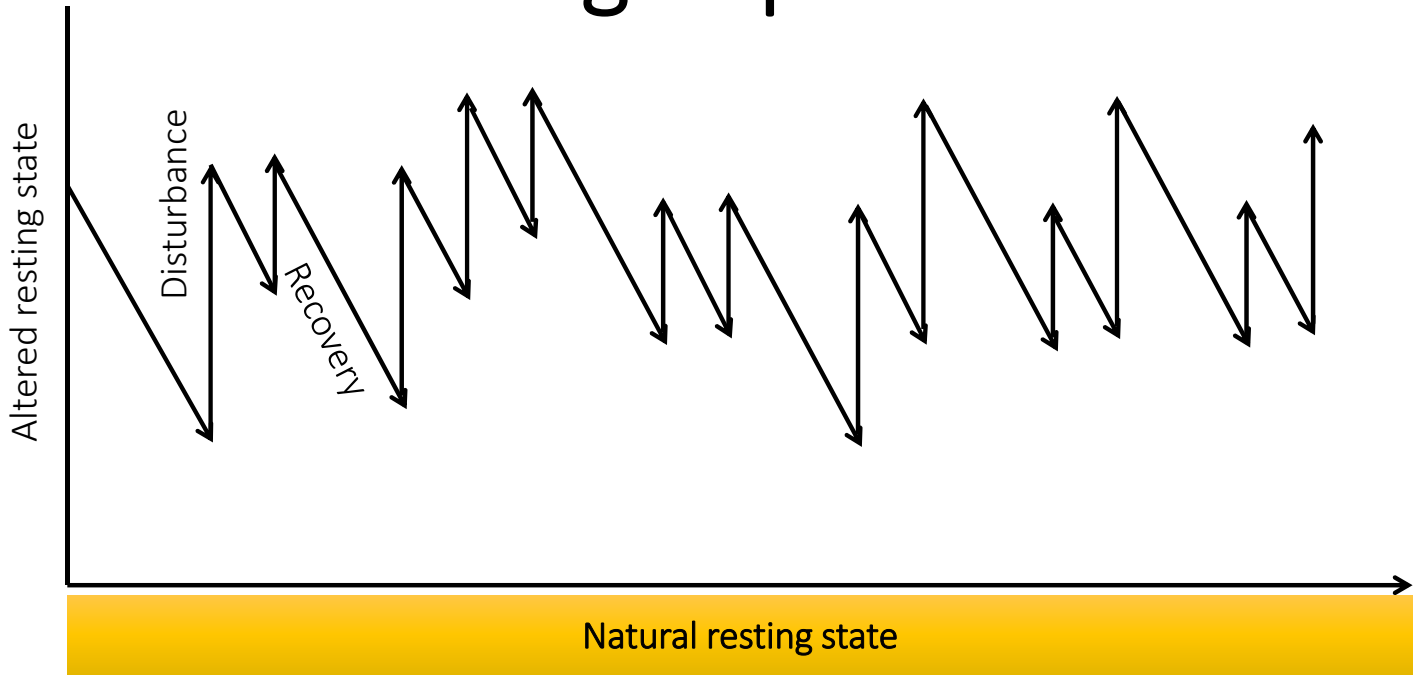
Resting



- 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