Feathered Oceanographers: Seabirds as Bio-Indicators

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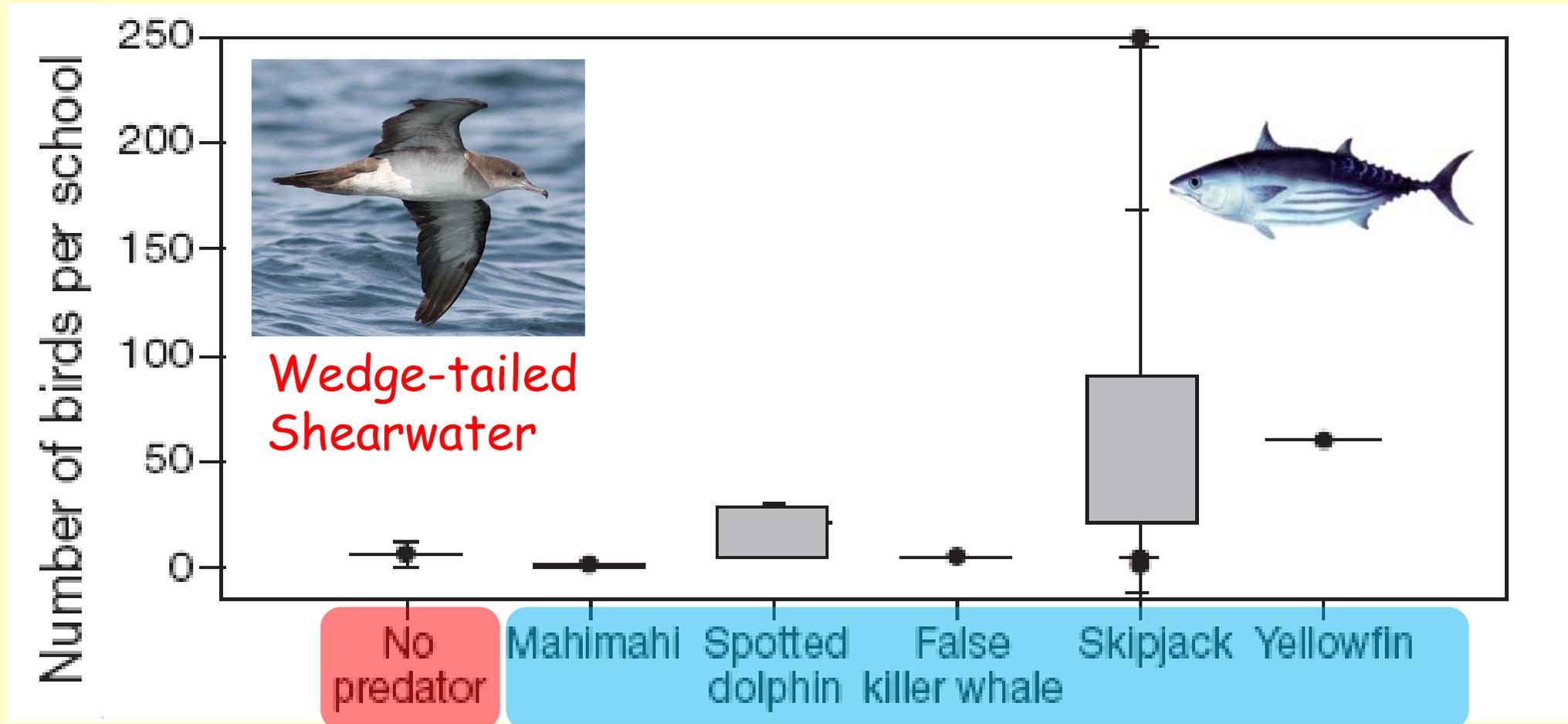
Seabird – Tuna Associations Around O'ahu
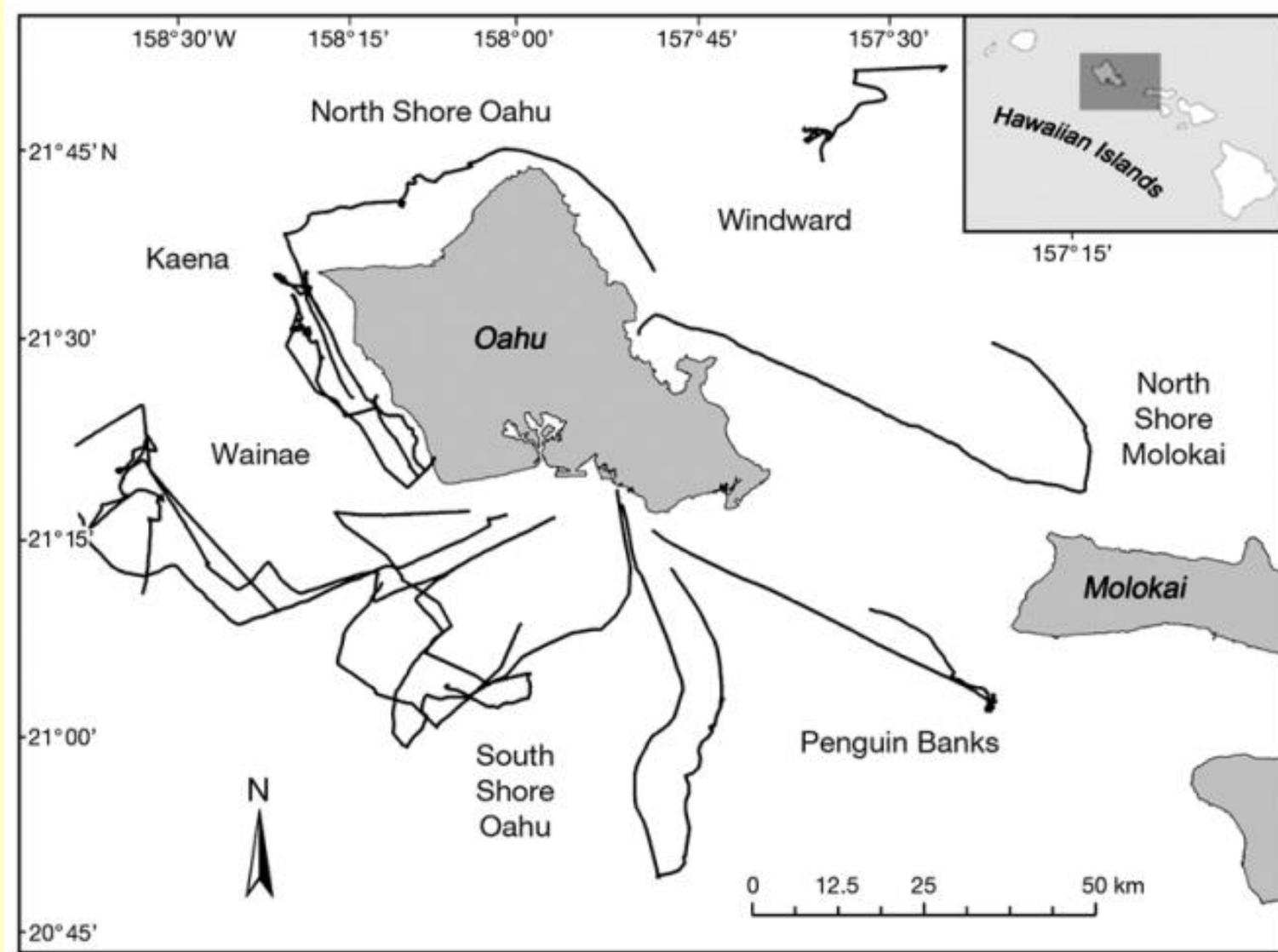
Survey Platform: Fishing vessels (comm. & rec.)

62 seabird feeding observations

97 % with Tunas & Dolphins

(Hebshi et al., 2008)

Species-Specific Associations

Wedge-tailed Shearwater Significantly Associated with Skipjack

(Hebshi et al., 2008)
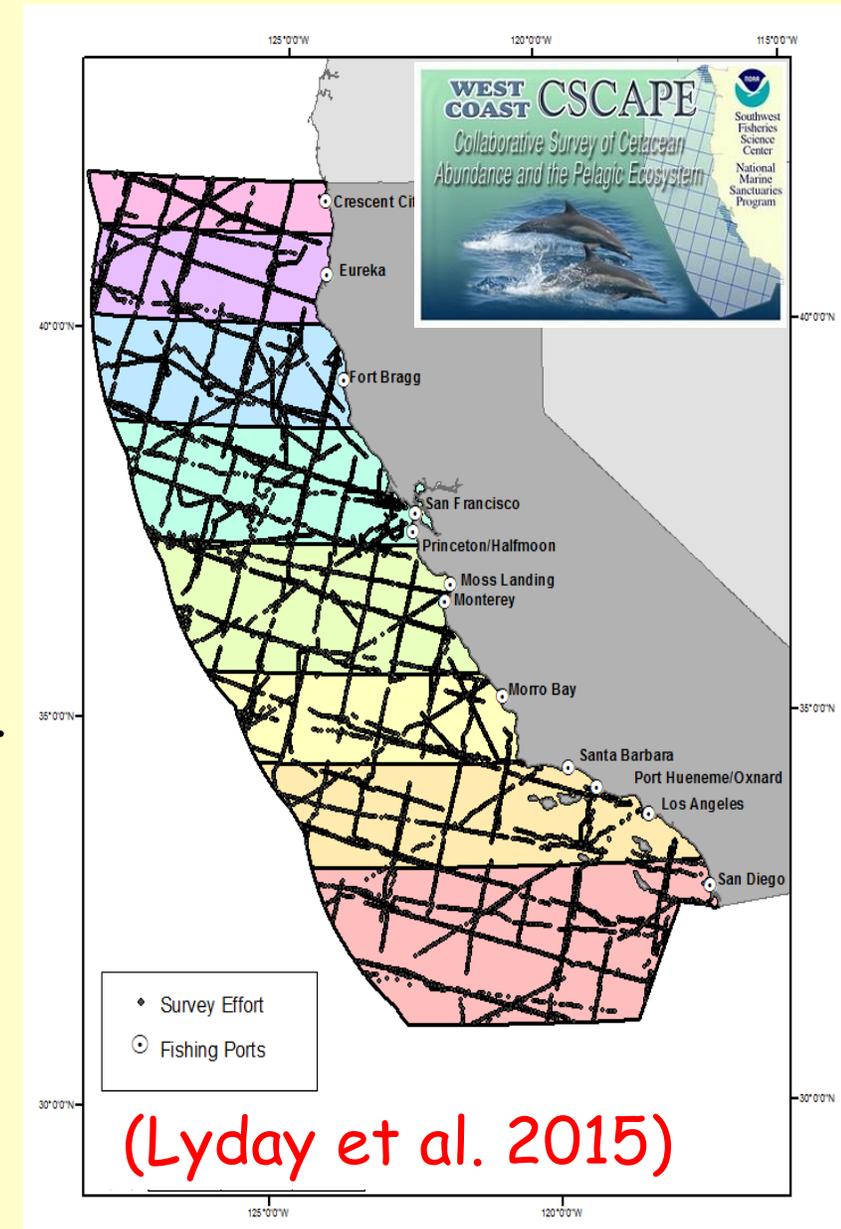
Take-Home #1: Ecological Associations

Shearwaters and Small Tunas Forage Together

Shearwaters Predict California Fishery Catches

• Commercial Catch:
    4 summers (96, 01, 05, 08)
    13 fish / squid species

• Fishery Catch = function of:
                    (latitude) +
                    (MEI) + (PDO) + (NPGO) +
                    (Shearwater Metrics)

• Shearwater Metrics: 6 species
        Density (# birds / km^2)
        Behavior (% feeding)

(Lyday et al. 2015)

Best Fishery Models Including Shearwater Metrics

- Abundance:

Catch	Shearwater Variable	# Predictors	r^2
MARKET SQUID	Sooty Shearwater Density	5	0.33

- Behavior:

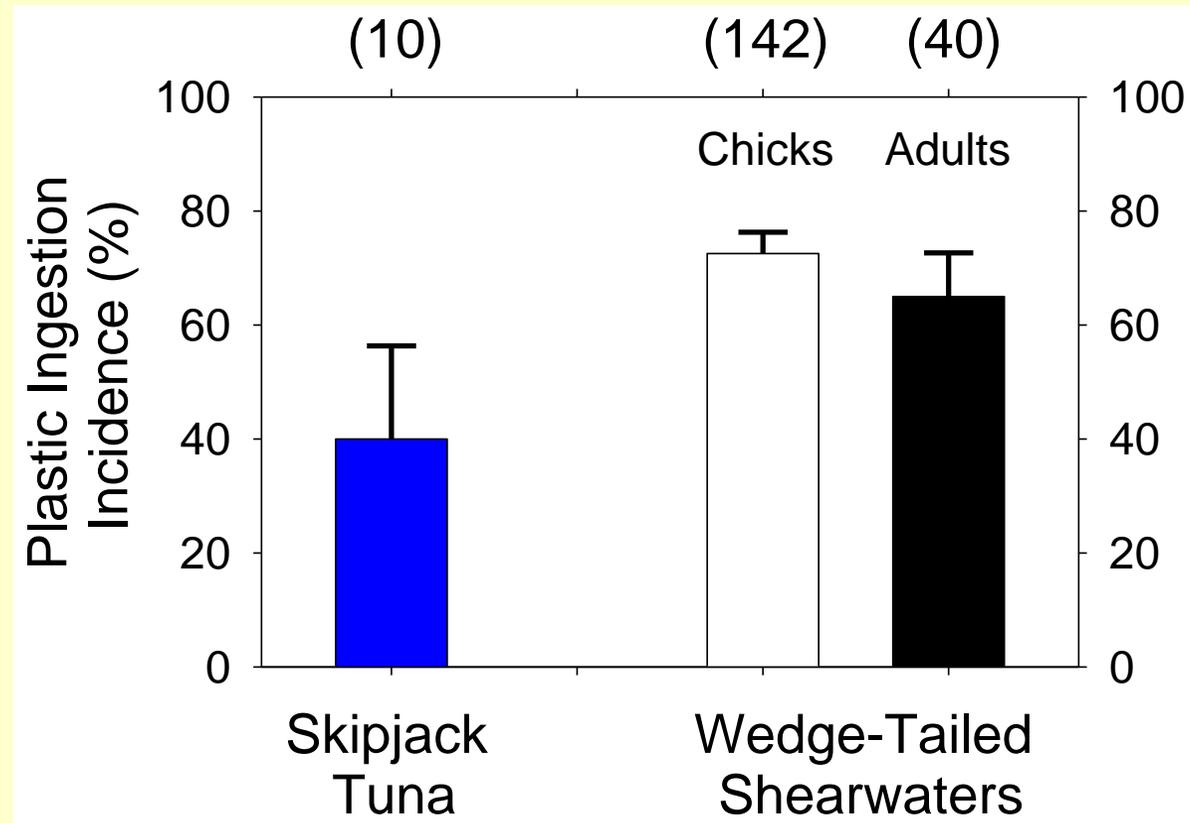| Fishery	Shearwater Variable	# Predictors	r^2
MAHI-MAHI	Black-vented Shearwater Feeding	1	0.75

(Lyday et al. 2015)

Take-Home #2: Shearwaters & Fisheries Covariation

Fishery Independent Metrics: Abundance and Behavior

So What ?

Shearwaters & Tunas Share Same Food Web

Way Forward:
Integrated Seabird / Fishery Management

Sophie Webb

References

Lyday, S.E., Ballance, L.T., Field, D.B.,
& Hyrenbach, K.D. 2015.
Shearwaters as Ecosystem Indicators:
Towards Fishery-Independent Metrics of Fish
Abundance in the California Current.
Journal of Marine Systems 146: 109–120.

(Link)

Hebshi, A.J., Duffy, D.C.,
& Hyrenbach, K.D. 2008.
Associations between seabirds and
subsurface predators around O'ahu, Hawaii.
Aquatic Biology 4: 89-98.

(Link)

Script

In tropical regions throughout the world, commercial and recreational fishers use seabirds to find tuna and mahi-mahi. My talk focuses on how seabirds can inform our understanding of these predatory fishes and the fisheries that target them.

Around the island of Oahu, observations during daily fishing trips onboard commercial and recreational fishing boats revealed the importance of these associations, where 97% of 62 seabird feeding events were associated with subsurface predators: involving predatory fishes and dolphins

The wedge-tailed shearwater was the numerically dominant species, accounting for 75% of all seabirds in mixed-species feeding events. While wedgies sometimes fed without tunas and dolphins, they associated with 5 subsurface predators. However, they were only associated beyond what would be expected by chance with one species: the skipjack tuna. Occasionally, they aggregated in vast flocks, of up to 250 shearwaters.

The first take-home is that seabirds often associate with subsurface predators. In this case, a shallow-diving shearwater was associated with a small tuna species. Next, we will examine if we can use these tuna – seabird associations to learn about fisheries, by studying the shearwaters.

Let's go to California, where our goal was to predict monthly fishery catches of 13 fish and squid species, using data from summer NOAA CSAPE cruises, which survey the marine ecosystem – including seabirds – within the 200 mile EEZ. Our approach was to predict fishery catches as a function of three drivers: latitude, large-scale oceanographic indices (el Niño, pacific decadal oscillation, and the north pacific gyre oscillation) and data from concurrent at-sea surveys of 6 shearwater species. In particular, we used the density (number of birds per km square) and their behavior (the proportion of birds feeding).

The best abundance model: predicted catches of marked squid, using the abundance of the sooty shearwater – a transequatorial migrant and summer visitor of the California Current – as the top variable.   Altogether, this model used 5 variables and explained one third of squid catches. If you think this is pretty good, check out the best model including shearwater behavior. This model predicted Mahi-mahi catches using a single variable: the proportion of foraging black-vented shearwaters, and explained three quarters of the variability in the catch.

This result leads us to the second lesson: shearwaters and fishery catches vary together, and this covariability provides new metrics, involving shearwater abundance and behavior, to monitor the fisheries.

But why am I talking about predicting fishery catches at a conservation conference?   Well, if shearwaters and tunas are sharing the same food webs… they are susceptible to the same threats from pollution and climate change. In fact, if you look in the stomachs of skipjack tuna and wedge-tailed shearwaters around O'ahu, you see that they are both affected by plastic ingestion: 40% in the tuna and a higher rate in the shearwaters: 65 % in adults and 72% in chicks.

So, the final take-home from my talk is the need for integrated management of seabirds and tuna fisheries in tropical oceans, going beyond bycatch and addressing their ecological links and shared threats from anthropogenic pollution and climate impacts.