LETTER

No evidence of cryptic bycatch causing New Zealand sea lion population decline

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In PNAS, Meyer et al. (1) analyze whether exclusion devices in trawl nets contributed to New Zealand sea lion (NZSL; *Phocarctos hookeri*) population decline at the Auckland Islands. We refute the primary conclusion from their correlative assessment: that annual pup production changes (as a measure of population size) were primarily driven by cryptic bycatch of adults in sub-Antarctic trawl fisheries. We also contest their interpretation that sea lion exclusion devices (SLEDs), used throughout the Auckland Islands squid trawl fishery since 2004, "…can obscure rather than alleviate fishery impacts on marine megafauna" (1).

Meyer et al. (1) compare annual pup estimates with factors that could impact NZSL populations, reporting that when the fisheries interaction rate (IR; NZSL interactions per trawl) was high in one year, the following year's pup count was reduced (replicated in Fig. 1*A*). Sea lions escape from trawls via SLEDs and are likely to survive the encounter, and observed bycatch in the squid trawl fishery has been greatly reduced following SLED implementation (2). Since SLED implementation, NZSL interactions and IRs have been estimated from a model with acknowledged high levels of uncertainty (Fig. 1 *C* and *D*) (3). To account for uncertainty, Meyer et al. (1) undertook a sensitivity analysis using the upper 95% confidence interval (CI) of IR. This increased the magnitude of IR across the time period, but did not account for uncertainty in the direction of change between years, which was what their correlative assessment was actually relating to pup count changes. Moreover, as fishing effort was highly variable across the study period (3), IRs are an inappropriate index of potential annual fisheries-related mortality. Leaving aside high uncertainty in estimates (Fig. 1*D*) and the decline in breeders across the study period, a comparison with total annual NZSL–fishery interactions (accounting for fishing effort changes through time) showed no relationship with changes in pup counts (Fig. 1*B*) (4). Furthermore, any population effects of bycatch on pup production would be confounded with known variation in annual pupping rate (4), which should have much greater influence on annual pup production changes than fisheries-related mortality.

Bycatch of adults is no longer considered the primary impact on NZSLs (5, 6), yet Meyer et al. (1) dismiss more probable causes of population decline (5). The authors (1) discount disease-induced mortality, although other sources quantify the negative population effect of *Klebsiella pneumoniae*-induced pup mortality estimates on subsequent breeder numbers (5, 7). Meyer et al. (1) found no influence of food limitation on NZSLs, whereas other research has identified multiple indicators of nutritional stress at the Auckland Islands, including adverse breeding rates (5). Studies on other pinniped species have also shown that low juvenile survival can drive population declines, even when other factors are influencing adult survival and pupping rate (8).

Encouragingly, pup production at the Auckland Islands has increased in recent years (9), and all other breeding populations are increasing or stable (10). It is essential that efforts focused on understanding key population impacts for NZSLs, including disease, climate, and fisheries influences, are not hampered by studies that downplay known threats to their continued recovery.

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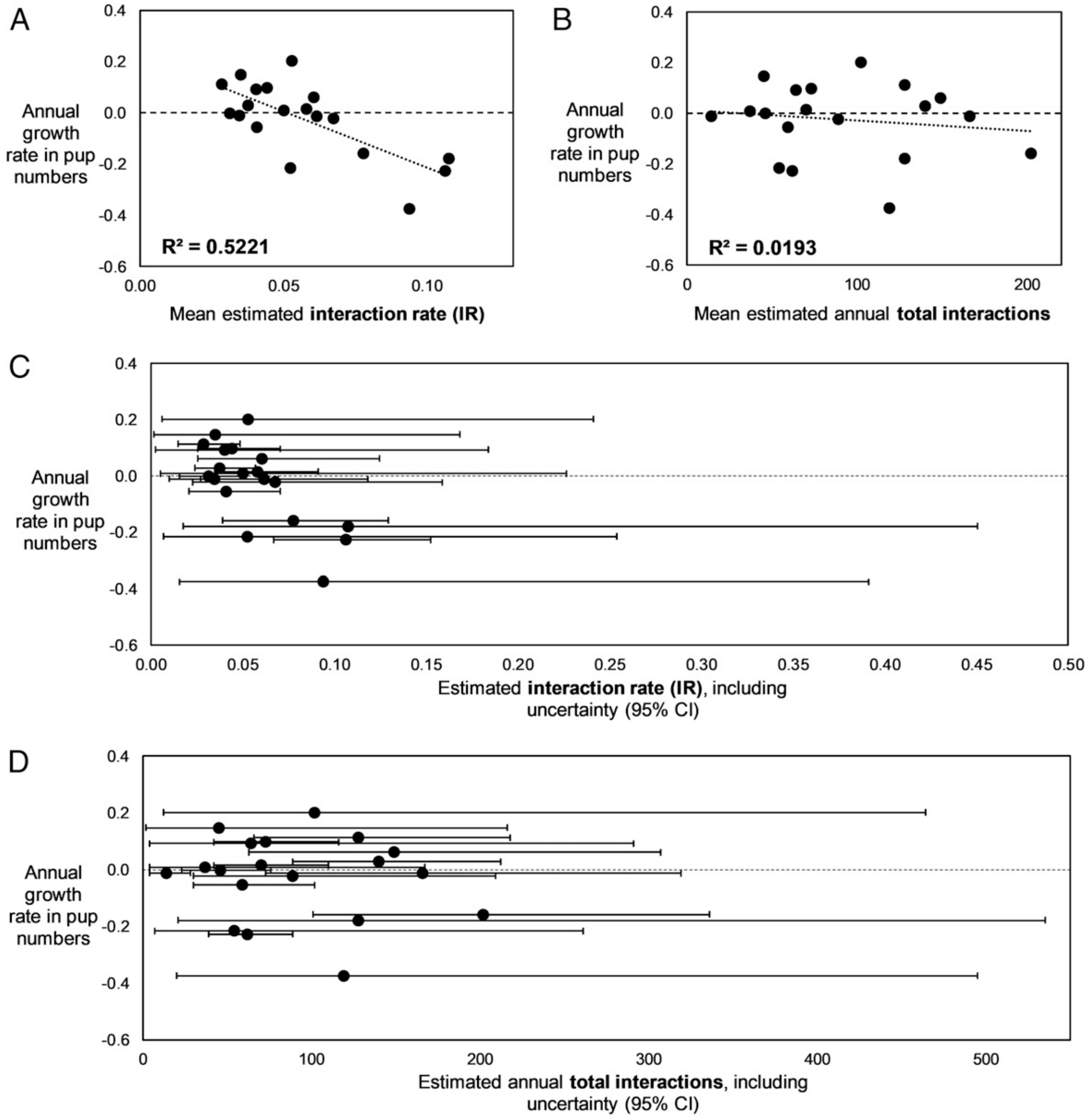

Fig. 1. **From 1996 to 2014, the degree of relationship between the estimated annual growth rate in NZSL pup production at the Auckland Islands and: (*A*) mean estimated NZSL interaction rate with squid trawls; (*B*) mean estimated annual total NZSL interactions; (*C*) estimated NZSL interaction rate showing 95% CI to illustrate the large uncertainty in estimates; and (*D*) estimated annual total NZSL interactions showing 95% CI to illustrate the large uncertainty in estimates (data from refs. 3 and 9).**

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6 Hamilton S, Baker GB (2016) Current bycatch levels in Auckland Islands trawl fisheries unlikely to be driving New Zealand sea lion (*Phocarctos hookeri*) population decline. *Aquat Conserv* 26:121–133.

7 Roe WD, et al. (2015) Septicaemia and meningitis caused by infection of New Zealand sea lion pups with a hypermucoviscous strain of *Klebsiella pneumoniae*. *Vet Microbiol* 176:301–308.

8 Schwarz LK, Goebel ME, Costa DP, Kilpatrick AM (2013) Top-down and bottom-up influences on demographic rates of Antarctic fur seals *Arctocephalus gazella*. *J Anim Ecol* 82:903–911.

9 Childerhouse S, Burns T, French R, Michael S, Muller C (2017) BPM-17-Final Report for CSP Project NZ sea lion ground component 2016-17. Blue Planet Marine, New Zealand. Available at https://www.doc.govt.nz/Documents/conservation/marine-and-coastal/marine-conservation-services/reports/final-report-csp-nz-sea-lion-groun-component-2015-16.pdf. Accessed April 1, 2018.

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