A Brief Note on the Interpretation of Studies of Impacts of Whale Watching on Life History Parameters: A Consideration of the Importance of Habitat

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Introduction

The effect of whale watching on whales is a subject of much discussion and study as the industry increases both within and between locations throughout the world. Exposure to repeated close approaches has been thought to affect whales by causing changes in behavior by modifying dive times, swimming behavior, and possibly displacing important activities such as feeding behavior (e.g. Corkeron 1995; Williams et al. 2002; Scehidat et al. 2004). Ultimately, such disturbance, if repeated beyond a particular threshold, may result in effects on an individual's life history parameters, including the ability to survive and/or reproduce (Bejder 2005; Lusseau, 2005; Bejder et al. 2006; IWC, 2007), although studies on long term effects of whale watch exposure remain limited.

Results and Discussion

In the past year, Weinrich and Corbelli (2009) published an analysis of the effects of whale watching on female humpback whale (*Megaptera novaeangliae*) calving frequency and calf survival on their feeding grounds in the southern Gulf of Maine. They used a 30-year database on whale watch exposure to individual females and their post-weaning calves to conclude that there was no evidence that levels of exposure affected female calving intervals and/or subsequent calf survival.

While Weinrich and Corbelli (2009) based their conclusions on a number of analyses, one of their findings suggested the possibility of confounding variables. In a breakpoint regression analysis of cumulative whale watch exposure to the lifetime calving rate of individual females, after approximately 1,650 minutes (or 27.5 hours) there was a significant positive correlation between variables (Figure 1). Further, in multivariate analyses of individual calving events (e.g. logistic regressions), several positive relationships were found between exposure and reproductive parameters. Exposure of females to whale watch vessels during the putative gestation year was the best predictor of whether they returned with a calf, and exposure of one-year old independent whales to whale watch boats was the most significant predictor of survival to year two (Table 1). Based on these analyses, one might conclude that whale watch exposure was beneficial to an individual's survival and inclusive fitness. Certainly, there was nothing to suggest negative effects of whale watch exposure.

However, the purpose of this note is to interject a precaution in the interpretation of such results. Whale watch exposure is, in this (and almost every) case, a function of the amount of time an individual spends in the study area (in this case primarily Stellwagen Bank). Previous work has shown the importance of Stellwagen to humpback whales as a feeding ground (Clapham et al. 1993; Weinrich et al. 1997), especially for mothers with calves (Robbins 2001, Robbins et al. 2007). Further, the post-weaning survival of humpback calves in this population has been closely tied to the availability of sand lance (*Ammodytes* spp.), an annually variable and important prey in the study area (Weinrich et al. 1997; Weinrich 1998; Rosenbaum et al. 2002; Robbins 2007).

In effect, then, the "whale watch exposure" variable in a case such as this is really a proxy for the amount of time that a whale is spending in a key and important habitat. The more time the animal spends there, the more likely it is to be successful in whatever portion of its life history it undertakes in that area. In effect, instead of saying that there is a positive correlation between boat exposure and fitness parameters, a more correct statement would relate to the effect of the whale's habitat use patterns on its fitness parameters.

If this is correct, then, it is possible that a deleterious whale watch effect may be hidden in what appears to be a positive relationship between exposure and a life history parameter. In our case, the relationship between exposure and the parameters examined may be, in fact, showing a weaker positive trend then would exist in the absence of whale watch exposure. However, because there is a positive relationship at all, the tendency would be to dismiss the effects as either absent or inconsequential.

Without a true control of individuals who spend a considerable amount of time in a whale watch area without being exposed to approaches, it is difficult to tease these variables apart. Obtaining such true control data may be difficult, as close approaches are required for the necessary individual identification data. However, in at least one case (bottlenose dolphins in Shark Bay), the short-term approach for identification from a research vessel has been shown to have a lesser effect than whale watching, suggesting that this is not impossible (Bejder et al. 2006).

The implications of such confounding variables goes beyond whale watch impact studies, extending to other studies of a variety of human intrusion into a whale's environment (e.g. shipping noise). I would suggest that understanding the importance of the habitat to an individual is an integral aspect of experimental design and interpretation of data on exposure effects, and the possibility of negative effects should not be dismissed merely because of a lack of negative relationships between exposure and other measured variable.

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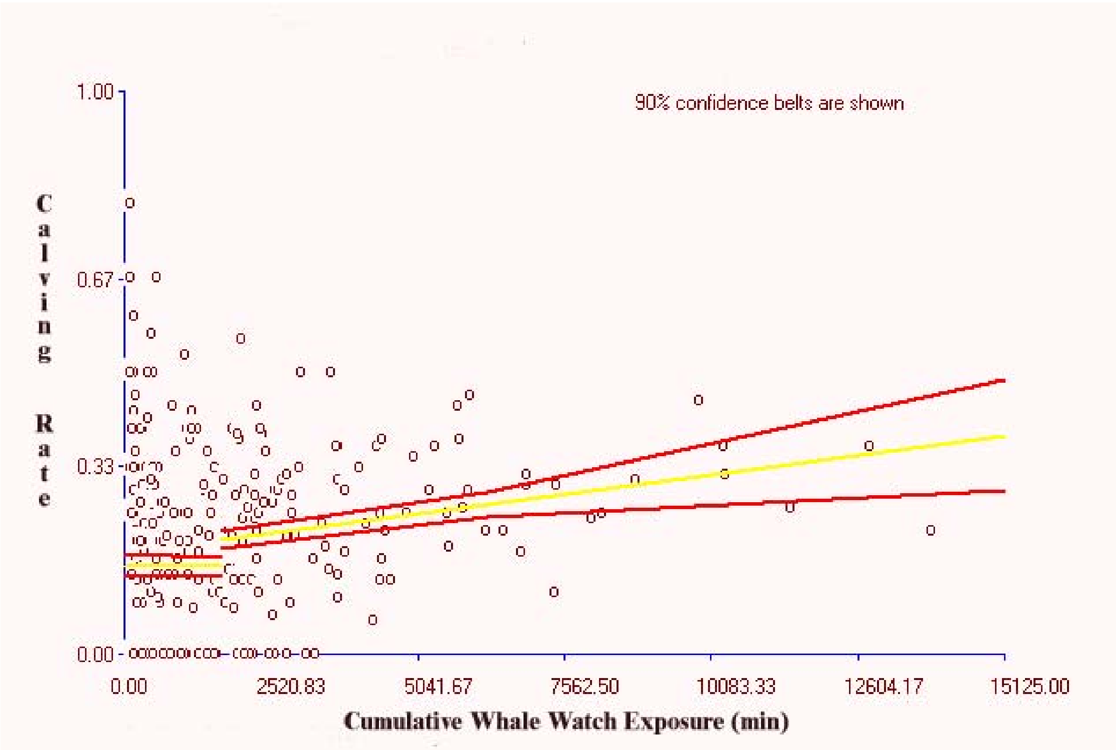

Figure 1: Breakpoint regression analysis between the total exposure time to whale watching vessels (in minutes) and the number of calves per reproductive year for female humpback whales in the Gulf of Maine (from Weinrich and Corbelli 2009).

	Variable	B	S.E.(B)	Wald χ2	p	Exp(B)
♀ sighted w calf or not (n=520)	Exposure Year-1	0.001	0.000	9.204	0.002	1.001
(% categorized correctly = 59.8)	Sand Lance Year -1	0.001	0.001	0.461	0.497	1.001
	Constant	-0.638	0.132	23.305	0.000	0.528
Calf Survival to 1 (n=365)						
(% categorized correctly = 63.8)	Exposure Pregnancy	0.000	0.000	1.667	0.197	1.000
	WW Trips - Pregnancy	0.001	0.001	5.017	0.025	1.001
	Mean Sand Lance - Pregnancy	0.007	0.002	9.564	0.002	1.007
	Constant	-0.843	0.444	3.606	0.058	0.430
Calf Survival to 2 (n=365)						
(% categorized correctly = 66.3)	Exposure Pregnancy	0.001	0.000	3.269	0.071	1.001
	WW Trips - Pregnancy	0.001	0.001	1.277	0.259	1.001
	Mean Sand Lance - Pregnancy	0.005	0.002	5.407	0.02	1.005
	Exposure - First Year Alone	0.003	0.001	13.968	0.000	1.003
	Constant	-1.041	0.455	5.233	0.022	0.353

Table 1. Results of logistic regressions for predictions of whether a female had a calf, whether a calf survived to age 1, and whether it survived to age 2 for the full data set. Degrees of freedom for all comparisons was 1. Details on the variables used in the model may be found in Weinrich et al. (2009).