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Short Note

Low Prevalence of Visual Impairment in a Coastal Population of Gray Seals (*Halichoerus grypus*) in the Gulf of St. Lawrence, Canada

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Visual impairment is common in captive pinnipeds (Sweeney, 1974; Ridgway et al., 1975; Stoskopf et al., 1983; Greenwood, 1985; Colitz et al., 2010a, 2010b), but its prevalence in the wild is currently unclear due to the limited number of published studies and inconsistent information in the relevant literature (e.g., Griner, 1983; Filer et al., 2003). Visual impairment is a broad category that includes pathological, parasitological, traumatic, or congenital conditions (e.g., Aguirre, 2004; Dailey et al., 2005). Although the prevalence of specific conditions affecting pinniped vision (e.g., *Leptospira pomona* infection) may be under-reported, partly due to the difficulties of field diagnosis methods, general conditions (e.g., opacities, lesions, etc.) are reported most often (Stoskopf et al., 1985; Gerber et al., 1993; Aguirre, 2004). What is clear is that visual impairment reported in wild pinnipeds is usually associated with the cornea, anterior chamber, iris, and lens (e.g., Smith et al., 1977; Stoskopf et al., 1985; Schoon & Schoon, 1992; Baker et al., 1998). However, this prevalence is likely because these are the most conspicuous structures to observers.

Herein, we present results from a series of in-water marine mammal surveys that included an investigation of the prevalence of visual impairment in a coastal population of western North Atlantic gray seals (*Halichoerus grypus*). We included behavioral information from individuals with discernible eye problems and then showed results from a literature survey to compare the prevalence in our study area to those in published studies of pinniped species, including gray seals, around the world. A total of 23 surveys were conducted from 21 June to 9 August 2011, and they

all were in the Mingan Archipelago of the Gulf of St. Lawrence, Canada. Depending on weather and sea conditions, most surveys consisted of four 12-km boat transects that were intermittent with focal follows when one or more gray seals were encountered. Observations were conducted with the naked eye, 7 × 50 binoculars, and digital SLR cameras (12.1-megapixel) with telephoto lenses (300 and 600 mm). The total survey effort was 202.1 h with a mean of 8.8 h/d.

Survey results estimated 200 to 300 individual gray seals in the archipelago throughout the summer, with highest abundances per survey effort in three areas near identified haul-out locations (Figure 1A-C). However, difficulties with identifying and marking individuals likely resulted in some repeated observations. Throughout our surveys, only one gray seal with a conspicuous visual impairment was observed, indicating a conservative prevalence of 1 of 200 (0.5%) gray seals in the area.

The impaired gray seal was a bull that was encountered on 22 July 2011 near 50° 09' 46.7" N, 63° 53' 49.2" W in approximately 35 m of water (Figure 1). Its left eye exhibited a condition resembling endophthalmitis (inflammation of the internal coats of the eye; Figure 2). The principal cause of endophthalmitis is penetration of the eye, usually the cornea, by a sharp foreign body that can introduce bacteria into the anterior chamber, lens, and vitreous as well as the cornea. Other causes include various endogenous systemic infections. Typically, the entire eye becomes affected, often filled with pus, and the cornea turns completely opaque (Samuelson & Brooks, 2011) such as seen in the impaired gray seal we observed.

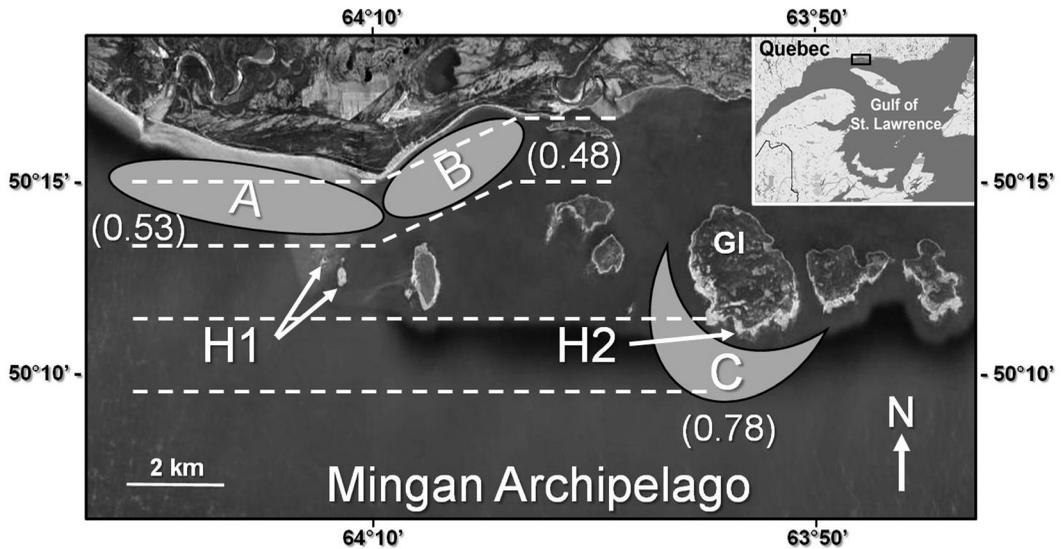


Figure 1. Map of study area (see open rectangle on inset map for a geographic reference) in Quebec, Canada (modified from *Google Earth*, Version 6.1). H1: gray seal haul-out areas on Île de la Maison (House Island; left) and Île du Wreck (Wreck Island; right); H2: La Chaîne de Roches (Chain of Rocks) haul-out area on Grande Île (Big Island; GI), the location near where the impaired animal was encountered. A through C indicate locations of highest gray seal abundance throughout the summer of 2011. Parenthetical values indicate estimated number of gray seals encountered per hour of effort in areas A through C. Dashed lines indicate the four 12-km transect lines used for the surveys.

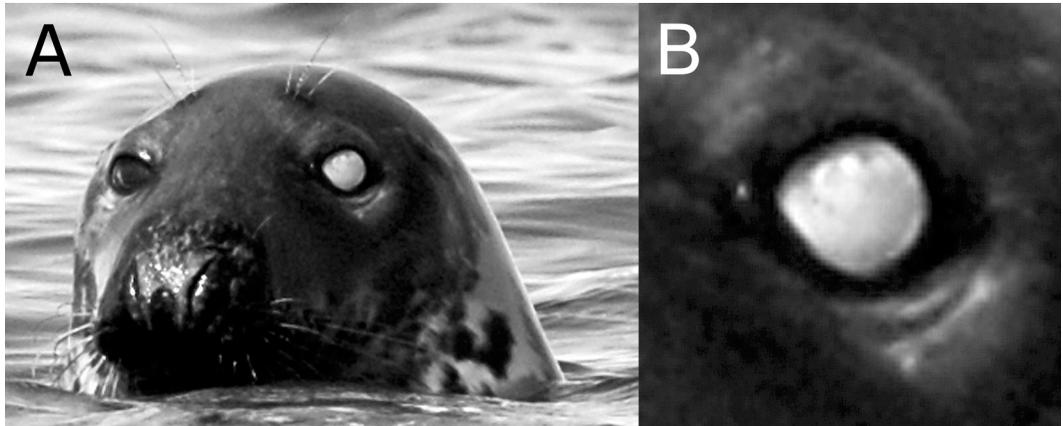


Figure 2. Photograph of a bull gray seal with visual impairment of its left eye from a condition resembling endophthalmitis (A), including a close-up (B)

A second adult male without a visual impairment was within 100 to 300 m of the first gray seal throughout our 46-min observation period. Both bulls were likely part of the herd of approximately 50 gray seals that were 2.3 km away within the shallow Baie aux Loups Marins (Gray Seal Bay) along the south shore of Grande Île (Big Island; Figure 1). Approximately 25 gray seals were hauled out at La Chaîne de Roches (Chain of Rocks; H2 in Figure 1) within the bay, and the other 25 were in adjacent shallow water (< 10 m).

Both gray seals were vigilant at the surface and watched us for 10 to 30 s at least once before each dive. The visually impaired gray seal initially remained beyond 250 m of our 4.3-m boat, but eventually he approached to within 75 m.

Published information on the prevalence of visual impairment in the three taxonomic families of pinnipeds in the wild is limited. The existing literature currently encompasses nine species that collectively show 185 of 4,244 (4.3%) individuals with any type of visual impairment

Table 1. Low prevalence of visual impairment (% VI = [sum N^{VI} / sum N] × 100 = 4.3%) reported from 16 studies of nine different species of pinnipeds in the wild; studies with small sample sizes (N < 5) were not included. When considered independently, the gray seal % VI was 1.6%, which is relatively similar to the 0.5% prevalence in our study area.

Species	N	N ^{VI}	References
<i>Callorhinus ursinus</i>	1,716	79	Stoskopf et al., 1985
	150	3	Smith et al., 1977
<i>Zalophus californianus</i>	765	4	Gerber et al., 1993
<i>Monachus schauinslandi</i>	158	21	Aguirre, 2004
<i>Arctocephalus tropicalis</i>	12	1	Veloze et al., 2009
<i>Mirounga leonina</i>	170	3	Tierney, 1977
<i>Hydrurga leptonyx</i>	59	7	Gray et al., 2009
<i>Leptonychotes weddellii</i>	295	14	Yochem et al., 2009
	498	28	McFarlane, 2009
<i>Phoca vitulina</i>	44	21	Schoon & Schoon, 1992
<i>Halichoerus grypus</i>	36	0	Baker, 1987
	33	0	Baker et al., 1998
	20	0	Baker et al., 1998
	50	2	Baker et al., 1998
	38	1	Baker et al., 1998
	200	1	Kot et al., this study
Sum	4,244	185	
% VI		4.3	

(Table 1), although this differs widely among specific reports. Among otariids, 4 of 765 (0.5%) California sea lions (*Zalophus californianus*) had some form of visual impairment (Gerber et al., 1993). Likewise, 79 of 1,716 (4.6%) Northern fur seals (*Callorhinus ursinus*) were reported with eye lesions (Stoskopf et al., 1985). An earlier account of northern fur seals showed 3 of 150 (2%) pups with a bacterial infection (*Leptospira pomona*), causing dilated and congested vessels of the iris, and hemorrhaging in the anterior chamber of the eye (Smith et al., 1977). A report of subantarctic fur seals (*Arctocephalus tropicalis*) showed 1 of 12 (8%) individuals with protruding eyes and an infected conjunctiva (Veloze et al., 2009). Finally, a study of juvenile Galapagos sea lions (*Zalophus wollebaeki*) showed individuals with conjunctivae that held up to 47 parasitic eye flukes (*Philophthalmus zalophi*; Dailey et al., 2005).

Among phocids, multiple reports of Weddell seals (*Leptonychotes weddellii*) showed 14 of 295 (4.7%) seals and 28 of 498 (5.6%) seals with leukomas (corneal opacities), punctured globes, mucopurulent discharges, and purulent conjunctivitis (McFarlane, 2009; Yochem et al., 2009). One study of gray seals showed no visual impairment in 36 individuals (Baker, 1987). Another showed none in 33 young pups (< 16 wks) and 20 juveniles, but 2 of 50 (4%) older pups (> 16 wks) with panophthalmitis (inflammation of the entire eye) and 1 of 38 (2.6%) adults with corneal ulcerations (Baker et al., 1998). Hawaiian monk seals (*Monachus schauinslandi*) have been reported

with 21 of 158 (13%) individuals with ocular discharge, “puffy eyes,” diffuse maculae and nebulas, and leukomas (Aguirre, 2004).

Other reports of phocid visual impairment include anecdotes of successfully foraging blind ring seals (*Phoca hispida saimensis*; Hyvärinen, 1989), a harp seal with bilateral cataracts (Erlacher-Reid et al., 2011), and a female Northern elephant seal (*Mirounga angustirostris*) with a punctured eye likely caused by male mating aggression (Le Boeuf & Mesnick, 1991). A similar account of aggression in Southern elephant seals (*M. leonina*) reported 3 of 170 (1.7%) individuals with white opacities, lacerated corneas, and inflamed nictitating membranes (Tierney, 1977). One report showed 7 of 59 (11.8%) leopard seals (*Hydrurga leptonyx*) with discharges and conjunctivitis (Gray et al., 2009). An unusual case of Lake Baikal seals (*Pusa sibirica*) with ophthalmitis was reported in individuals with a morbillivirus infection similar to canine distemper virus (CDV) (Grachev et al., 1989). The highest reported prevalence of visual impairment in any pinniped species in our literature survey was 21 of 44 (48%) harbor seals (*Phoca vitulina*); bilateral lenticular lesions, lenticular malformations, and cataracts were identified, yet final conclusions about their causes could not be determined (Schoon & Schoon, 1992).

Reliable estimates of the prevalence of visual impairment in wild walrus (*Odobenus rosmarus*) are not currently possible due to a paucity of published reports. However, one investigation of 17 carcasses noted some individuals with prolapsed

eyes (Garlich-Miller et al., 2011), although *post-mortem* changes cannot be ruled out. Another report generalized that walrus eye loss can develop from dento-alveolar abscesses resulting from advanced tusk wear (Cornell & Antrim, 1987).

In summary, our study provides evidence that gray seals in the Mingan Archipelago within the Gulf of St. Lawrence, Canada, have a low prevalence of visual impairment. This is consistent with results from our literature survey that showed a similarly low prevalence in nine other pinniped species from around the world. When considered independently, the gray seal literature indicated a low prevalence of 1.6%, which is relatively similar to the low prevalence in our study area. Collectively, this study adds to the few published records of North Atlantic gray seals with ocular problems and provides information supporting a low prevalence of visual impairment in wild pinnipeds.

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