Aquatic Mammals 2018, *44*(3), 244-249, DOI 10.1578/AM.44.3.2018.244

Short Note

In Situ Observations of Pinnipeds in New York City, 2011-2017

Kevin L. Woo[1,2] and Kristy L. Biolsi[2,3]

[1]*SUNY Empire State College, Division of Science, Mathematics & Technology, Department of Natural Sciences, Metropolitan Location, 325 Hudson Street, Fifth Floor, New York, NY 10013-1005, USA*
E-mail: Kevin.Woo@esc.edu
[2]*St. Francis College, Psychology Department, 180 Remsen Street, Brooklyn Heights, NY 11201, USA*
[3]*Center for the Study of Pinniped Ecology & Cognition (C-SPEC), St. Francis College, 180 Remsen Street, Brooklyn Heights, NY 11201, USA*

The urbanization of cities has drastically altered the way in which species interact with their environment. Some species have managed to adapt well to habitat modification (McIntyre et al., 2001; Bonier et al., 2007), and some can even thrive in urban areas because of their tolerance for local ecological shifts (Shochat et al., 2006). For instance, non-native and invasive species that exhibit generalist characteristics and are therefore free from the constraints that regulate natural populations thrive during disturbance and habitat modification (McKinney & Lockwood, 1999). In contrast, the homogenization of urban ecosystems may influence the ability for some species to cope with anthropogenic changes (McKinney, 2002, 2006), causing a rapid decrease in population or local extinction (e.g., invertebrates: Fattorini, 2011; mammals: Davidson et al., 2009; and birds: Devictor et al., 2007).

Top predators are of particular interest in studying ecosystems of any kind. As such, marine mammals may serve as a sentinel species and, therefore, are an important group to study in relation to climate change, water quality, and other anthropogenic effects. They access busy commercial ports around the world and must contend with the challenges of acoustic noise and boat traffic from commercial shipping (Moore & Clarke, 2002; Kent et al., 2012), recreational boating (Buckingham et al., 1999; Graham & Cooke, 2008), ecotourism (Wilke et al., 2005; Allen et al., 2007), dredging (Pirotta et al., 2013), and local commercial fishing (Lewison et al., 2004), as well as increased pollution (Parsons, 1998). It is likely that the interaction of all these anthropogenic activities contributes to the decline of local populations such as in the case of the Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) in Western Australia (Ansmann et al., 2013).

In even smaller and more geographically isolated populations, the effects of potentially harmful anthropogenic activities can contribute to a steady and critical decline, as in the case of the vaquita (*Phocoena sinus*) whose current total population has been estimated to be approximately 30 individuals (Taylor et al., 2016; Jaramillo-Legorreta et al., 2017), or to the extinction of an entire species such as the baiji (*Lipotes vexillifer*), which is now considered to be functionally extinct from its habitat of the Yangtze River in China (Turvey et al., 2007). However, population recovery may occur, but it often varies greatly depending on a number of interacting factors such as the intensity of the threat, genetic diversity, and longevity and persistence of negative events (Lotze et al., 2011).

Historically, harbor seals (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) were commonly observed around the waterways of New York City; however, local populations sharply disappeared at the start of the 1900s (Burrows & Wallace, 1998; Sanderson, 2013). Some have suggested that the local extinction of pinnipeds during this period is correlated with the rapid industrialization in New York City and, subsequently, the increase of pollution in the surrounding waterways (Sanderson, 2013). It is known that increased pollution negatively affects the population and quality of local prey (Fabricius, 2005). Such factors have been observed to decrease harbor seal populations in other locations such as in the Gulf of Alaska (Pitcher, 1990; Frost et al., 1999). Although pinnipeds are consistently sighted at haul-out locations during the wintering months in waterways immediately outside the New York City vicinity, such as Long Island and New Jersey, reports of pinnipeds within New York City itself remained absent for nearly 100 years (Sanderson, 2013). In the last two decades, anecdotal sightings of their presence in areas such as Gateway National Park, Jamaica Bay, and the lower Hudson River (Woo & Biolsi, 2017) have prompted a more systematic approach for monitoring their return to this former habitat. To date, most such observations were casual and never formally documented.

Herein, the *in situ* observations of pinnipeds in the waterways of New York City are reported. Harbor seals are the most common pinniped found along the coastal areas in New York City, but grey seals are also present. This report is the first systematic documentation of consistent local populations in the most populous city in the United States.

A survey was created in 2011 to identify possible haul-out locations for pinnipeds along the foreshores of New York City. The majority of the respondents were the general public from Brooklyn, New York, and they reported a number of local sightings across the five boroughs—Manhattan, Brooklyn, Queens, Bronx, and Staten Island. For preliminary observations, land-based naturalistic field observations were conducted at these locations to verify reliable haul-out locations. The responses on the surveys indicated that pinnipeds were seen at many locations within the five boroughs; however, only one land-based location was reliable: Orchard Beach/Pelham Bay in the Bronx (Michalak et al., 2017; see Figure 1).

In addition to the land-based observations, a partnership with the New York City Audubon Society was formed to conduct boat-based observations that started in January 2013. Here, observations were conducted on populations that were observable on and around two man-made islands in close proximity to each other in the lower Hudson River harbor: (1) Hoffman Island and (2) Swinburne Island (see Figure 1; from hereon referred to as Hoffman/Swinburne Islands).

Each year, pinnipeds haul out at coastal locations around the tri-state area (e.g., New York, New Jersey, and Connecticut) during mid-autumn to mid-spring. This was consistent with observations reported by others along coastal New Jersey (Terhune, 1985) and Connecticut (Payne & Selzer, 1989). The field season, therefore, was defined as the beginning of October to the end of April. Formal observations were conducted from October 2011 to April 2017.

Observations from land began at the field sites approximately 1 h before peak low tide and continued when possible for approximately 1 h following peak low tide. At Orchard Beach, a series of exposed rocks named Middle Reef (40° 52' 17.4324" N, 73° 46' 14.6388" W) were identified during low tide, which appeared 700 m into Pelham Bay from the land-based site. The seals were found to haul out on Middle Reef during low tide.

The boat-based observations were conducted in conjunction with the New York City Audubon Society, which runs boat tours from January through March each year; thus, the observation period was opportunistic and based on the Audubon Society's tour schedule. This meant that boat-based observations occurred at the same time of day for each observation period regardless of tidal stage. Animals were only observed for 30 min during each trip due to the constraints of the tour operator's schedule. Since Hoffman/Swinburne Islands (40° 33' 56.9232" N, 74° 3' 0.0468" W) were artificial, man-made constructions composed of primarily large boulders, the underwater topography became relatively shallow during low tide, and the rocky substrate could potentially damage the vessel. Therefore, during high tide, we were able to reduce our distance to the island (~25 m); however, at peak low tides (when seals seem to prefer to haul out in larger numbers due to more landmass exposure), the boat was only able to approach the islands at 350 m.

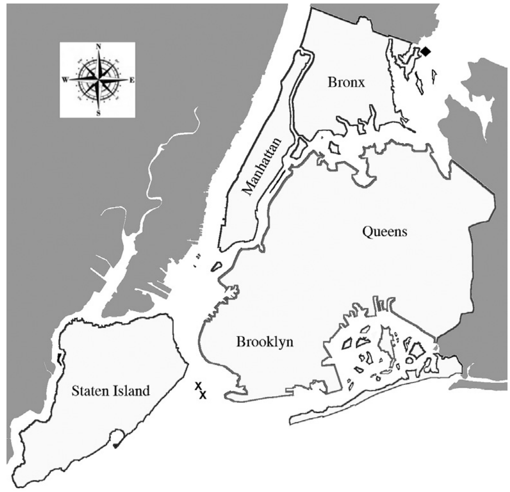

Figure 1. Locations of field sites in New York City between 2011 and 2017: (1) Orchard Beach (◆) and (2) Hoffman (north) and Swinburne (south) Islands (×)

During each observation (i.e., land- and boat-based), the number of seals that were both hauled out and visible at the surface of the water was recorded. Environmental data consisting of temperature, wind direction, wind speed, percentage of cloud cover, the observer's distance from haul-out site, Beaufort sea scale, and number of vessels in the immediate vicinity were also recorded. The field surveys were conducted using naturalistic observations only.

To observe the seals, 20-60 × 60 mm spotting scopes (Barska Blackhawk Spotter Model #AD11284; Barska, Pomona, CA, USA), mounted on generic aluminum tripods, were used. In the most recent field seasons (2015 to 2017), a combination of two systems was used: (1) a MeoPro 80 HD spotting scope (80 mm lens with a 20x-60x integrated eyepiece; Meopta® USA Inc., Hauppauge, NY, USA)

Figure 2. Photograph of pinnipeds hauled out on Swinburne Island with the urban landscape of Coney Island, Brooklyn, in the background

with an iPhone 5 (Apple Inc., Cupertino, CA, USA) and/or Samsung Galaxy S4 (Samsung Electronics Co., Suwon, South Korea) for digi-scoping, and (2) a Nikon D5000 digital single lens reflex camera (12.3 MP; Nikon USA, Melville, NY, USA) with a Tamron SP A011 150-600 mm telephoto lens (Tamron USA, Inc., Commack, NY, USA). For each observation period, photographs (.jpgs) of our field sites were captured, and downloaded onto an Apple Mac-Mini (3.0 GHz dual-core Intel Core i7 processor; Apple Inc.). With the use of both digital systems, panoramic photographs of our field sites were taken to more accurately count the number of individuals upon subsequent review (see Figure 2).

To analyze the demographic data, the total number of seals at each location was first collapsed to acquire the average (± SD) number of individuals per site. Secondly, the average (± SD) number of individuals that were observed was subsequently calculated for each field season. After recording the cumulative sums across all seasons for both locations, the averages (± SD) between Orchard Beach and Hoffman/Swinburne Islands were compared using an independent samples *t* test. Two independent one-way analysis of variances (ANOVA) were employed to compare the changes between each field season for Orchard Beach, and then for Hoffman/Swinburne Islands. IBM *SPSS Statistics for Mac*, Version 22.0 (IBM Corporation, Armonk, NY, USA) software was used to analyze the data.

Between 2011 and 2017, 77 observation sessions were conducted and a total number of 614 seals were observed, the majority of which were identified as harbor seals (n = 604) (grey seals, n = 10). For Orchard Beach, a total of 232 seals (harbor seals, n = 230; grey seals, n = 2) were observed, which was an average of 4.02 (± 4.77) seals per visit. For Hoffman/Swinburne Islands, a total of 382 seals (harbor seals, n = 374; grey seals, n = 8) were observed, yielding an average of 18.82 (± 13.62) seals per visit (see Figure 3). In comparing average annual observed populations, Hoffman/Swinburne Islands were found to have significantly more individuals per observation period ($t(77) = -5.86$; $p < 0.05$).

Over the course of the field seasons, relatively stable annual population counts were recorded for both locations (see Figure 4). When the results were compared at Orchard Beach across field seasons, no significant differences were found ($F_{5,51}$

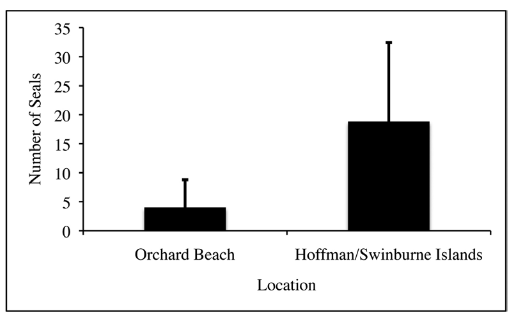

Figure 3. Average number of pinnipeds observed at Orchard Beach and Hoffman/Swinburne Islands per sampling period between 2011 and 2017, with Hoffman/Swinburne Islands showing significantly more individuals than Orchard Beach

= 1.07; $p = 0.39$). Similarly, results for Hoffman/Swinburne Islands also yielded no significant differences between number of individuals between field seasons ($F_{4,17} = 0.39$; $p = 0.81$).

The results demonstrate that pinnipeds are reliably present in the New York City area across wintering months, and their numbers have remained consistent across the documented field seasons. This work is important as it is the first systematic documentation of pinnipeds in the urban environment of New York City.

Understanding the demographics of large marine predators, such as these marine mammals, is important as they have long been identified as bioindicators of ecosystem health (Tanabe, 2002). For example, Blasius & Goodmanlowe (2008) measured the concentrations of dichlorodiphenyltrichloroethane (DDT) and polychlorinated biphenyls (PCBs) found in deceased California sea lions (*Zalophus californianus*), Pacific harbor seals (*P. vitulina richardii*), and northern elephant seals (*Mirounga angustirostris*) from the Southern California Bight and found that concentrations across tissue samples yielded higher concentrations than levels that would cause negative health effects. Evidence, such as that provided by Blasius & Goodmanlowe, indicates that marine mammals can provide reliable and important data for an ecosystem profile of a highly industrialized area. This connection between overall ecosystem health and marine mammal health and abundance may also be demonstrated here with seals in New York City waterways. From the decline and subsequent absence in the New York City waterways of marine mammal species, such as harbor and grey seals, until their relatively recent resurgence, the marine ecosystem experienced a significant collapse of invertebrate species such as bivalves and several species of gastropods (Franz, 1982). This local extinction was likely correlated with increased levels of pollution (Waldman, 2012), particularly oil from 1870 to 1900 (Hurley, 1994), as well as depleted dissolved oxygen levels measured at 0 to 20% saturation for two decades across the marine ecosystem (Franz, 1982). Continuing to examine these top predators, as well as further research on pollutant concentration in their tissues, will allow for a more comprehensive understanding of such a complex urban ecosystem.

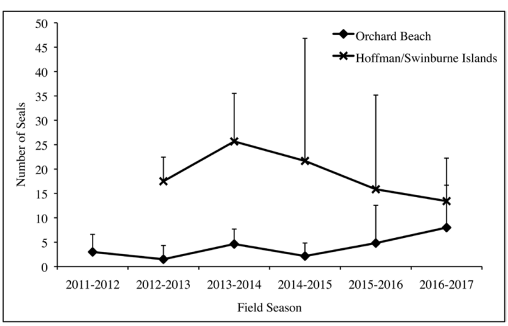

Figure 4. Observed population trends of pinnipeds at Orchard Beach (♦) and Hoffman/Swinburne Islands (×) between 2011 and 2017

Some fairly recent findings suggest that industrial metals, such as mercury, still exist in the marine substrate within the New York-New Jersey Bight, but toxic concentration levels are steadily receding (Balcom et al., 2008). As the health of the New York City marine ecosystem displays improvement, other indicator species, such as eastern oysters (*Crassostrea virginica*), have also been found to have successfully repopulated the local marine ecosystem after artificial reintroduction (Hoellein & Zarnoch, 2014). As mesopredators, it is likely that the reliance on local prey suggests the quality of the food can support pinnipeds for reoccurring seasons. The benefit of a potentially favorable habitat needs to be weighed against the continuing risk factors that drove previous populations to decline. However, it is important to monitor the threshold for the trade-off between benefits and risks that would further elucidate how seals manage to cope with these short- and long-term anthropogenic challenges over time.

The return of seals to New York City documented herein is a clear example of local fauna reclaiming previous habitat. Although busy harbors like New York City's will continue to be used for both commercial and industrial purposes in the foreseeable future, the consistent presence of pinnipeds suggests a likely positive change in their habitat and elucidates the challenges that accompany interactions with anthropogenic activity. For example, pinnipeds will need to continue to negotiate challenges such as persistent toxicity in food sources (Blasius & Goodmanlowe, 2008) and the environment (Balcom et al., 2008), boat traffic that can cause physical harm (Aipanjiguly et al., 2003), and motorized noise that can lead to distress (Erbe, 2002). Due to the relatively rapid urbanization of many areas in the U.S. and the increase in the number of people choosing to reside and work in cities rather than commute to cities from the suburbs, understanding the urban ecosystem is increasingly important (Lambert, 2012; Frizell, 2014; U.S. Census Bureau, 2017). What was once considered a non-natural environment is becoming a large percentage of the global ecosystem. The interactions between flora and fauna in urban settings must be better documented to understand the influence of anthropogenic factors on this environment and vice versa.

Acknowledgments

We are thankful to the two anonymous reviewers for their comments and suggestions on the manuscript. We would also like to thank our former and current research students: Afia Azaah, Jennifer Magee, Kelly Michalak, Wendy Ochoa, Catherine Payne, Hilda Posada, Jeannette Raymond, and Brian Restrepo. C-SPEC would like to thank the New York City Audubon Society, the Riverhead Foundation, the National Oceanic and Atmospheric Administration (NOAA), and the New York State Department of Environmental Conservation. We would also like to thank John Rowden (National Audubon Society), Raul Manzano (ESC), Jennifer Lancaster (SFC), Timothy Houlihan (SFC), and Paul Sieswerda (Gotham Whale). The St. Francis College Institutional Animal Care and Use Committee approved our research protocol (14-001/14-002). This research was supported by funding from SUNY Empire State College and St. Francis College.

Literature Cited

Aipanjiguly, S., Jacobson, S. K., & Flamm, R. (2003). Conserving manatees: Knowledge, attitudes, and intentions of boaters in Tampa Bay, Florida. *Conservation Biology*, *17*(4), 1098-1105. https://doi.org/10.1046/j.1523-1739.2003.01452.x

Allen, S., Smith, H., Waples, K., & Harcourt, R. (2007). The voluntary code of conduct for dolphin watching in Port Stephens, Australia: Is self-regulation an effective management tool? *Journal of Cetacean Research and Management*, *9*(2), 159-166.

Ansmann, I. C., Lanyon, J. M., Seddon, J. M., & Parra, G. J. (2013). Monitoring dolphins in an urban marine system: Total and effective population size estimates of Indo-Pacific bottlenose dolphins in Moreton Bay, Australia. *PLOS ONE*, *8*(6), e65239. https://doi.org/10.1371/journal.pone.0065239

Balcom, P. H., Hammerschmidt, C. R., Fitzgerald, W. F., Lamborg, C. H., & O'Connor, J. S. (2008). Seasonal distributions and cycling of mercury and methylmercury in the waters of New York/New Jersey Harbor Estuary. *Marine Chemistry*, *109*(1), 1-17. https://doi.org/10.1016/j.marchem.2007.09.005

Blasius, M. E., & Goodmanlowe, G. D. (2008). Contaminants still high in top-level carnivores in the Southern California Bight: Levels of DDT and PCBs in resident and transient pinnipeds. *Marine Pollution Bulletin*, *56*(12), 1973-1982. https://doi.org/10.1016/j.marpolbul.2008.08.011

Bonier, F., Martin, P. R., & Wingfield, J. C. (2007). Urban birds have broader environmental tolerance. *Biology Letters*, *3*(6), 670-673. https://doi.org/10.1098/rsbl.2007.0349

Buckingham, C. A., Lefebvre, L. W., Schaefer, J. M., & Kochman, H. I. (1999). Manatee response to boating activity in a thermal refuge. *Wildlife Society Bulletin*, *27*(2), 514-522.

Burrows, E. G., & Wallace, M. (1998). *Gotham: A history of New York City to 1898*. New York: Oxford University Press.

Davidson, A. D., Hamilton, M. J., Boyer, A. G., Brown, J. H., & Ceballos, G. (2009). Multiple ecological pathways to extinction in mammals. *Proceedings of the National Academy of Sciences*, *106*(26), 10702-10705. https://doi.org/10.1073/pnas.0901956106

Devictor, V., Julliard, R., Couvet, D., Lee, A., & Jiguet, F. (2007). Functional homogenization effect of urbanization on bird communities. *Conservation Biology*, *21*(3), 741-751. https://doi.org/10.1111/j.1523-1739.2007.00671.x

Erbe, C. (2002). Underwater noise of whale-watching boats and potential effects on killer whales (*Orcinus orca*), based on an acoustic impact model. *Marine Mammal Science*, *18*(2), 394-418. https://doi.org/10.1111/j.1748-7692.2002.tb01045.x

Fabricius, K. E. (2005). Effects of terrestrial runoff on the ecology of corals and coral reefs: Review and synthesis. *Marine Pollution Bulletin*, *50*(2), 125-146. https://doi.org/10.1016/j.marpolbul.2004.11.028

Fattorini, S. (2011). Insect extinction by urbanization: A long term study in Rome. *Biological Conservation*, *144*(1), 370-375. https://doi.org/10.1016/j.biocon.2010.09.014

Franz, D. R. (1982). An historical perspective on mollusks in Lower New York harbor, with emphasis on oysters. In G. F. Mayer (Ed.), *Ecological stress and the New York Bight: Science and management* (pp. 181-197). Columbia, SC: Estuarine Research Federation.

Frizell, S. (2014, April 25). The new American dream is living in a city, not owning a house in the suburbs. *Time*. Retrieved from http://time.com/72281/american-housing

Frost, K. J., Lowry, L. F., & Ver Hoef, J. M. (1999). Monitoring the trend of harbor seals in Prince William Sound, Alaska, after the Exxon Valdez oil spill. *Marine Mammal Science*, *15*(2), 494-506. https://doi.org/10.1111/j.1748-7692.1999.tb00815.x

Graham, A. L., & Cooke, S. J. (2008). The effects of noise disturbance from various recreational boating activities common to inland waters on the cardiac physiology of a freshwater fish, the largemouth bass (*Micropterus salmoides*). *Aquatic Conservation: Marine and Freshwater Ecosystems*, *18*(7), 1315-1324. https://doi.org/10.1002/aqc.941

Hoellein, T. J., & Zarnoch, C. B. (2014). Effect of eastern oysters (*Crassostrea virginica*) on sediment carbon and nitrogen dynamics in an urban estuary. *Ecological Applications*, *24*(2), 271-286. https://doi.org/10.1890/12-1798.1

Hurley, A. (1994). Creating ecological wastelands: Oil pollution in New York City, 1870-1900. *Journal of Urban History*, *20*(3), 340-364.

Jaramillo-Legorreta, A., Cardenas-Hinojosa, G., Nieto-Garcia, E., Rojas-Bracho, L., Ver Hoef, J., Moore, J., . . . Taylor, B. (2017). Passive acoustic monitoring of the decline of

Mexico's critically endangered vaquita. *Conservation Biology*, *31*(1), 183-191. https://doi.org/10.1111/cobi.12789

Kent, C. S., McCauley, R. D., Parnum, I. M., & Gavrilov, A. N. (2012). Underwater noise sources in Fremantle inner harbour: Dolphins, pile driving and traffic. *Proceedings of the Acoustical Society of Australia, Fremantle*, 1-7.

Lambert, L. (2012, March 26). More Americans move to cities in the past decade – Census. *Bond News*. Retrieved from www.reuters.com/article/usa-cities-population-idUSL2E8EQ5AJ20120326

Lewison, R. L., Crowder, L. B., Read, A. J., & Freeman, S. A. (2004). Understanding impacts of fisheries bycatch on marine megafauna. *Trends in Ecology & Evolution*, *19*(11), 598-604. https://doi.org/10.1016/j.tree.2004.09.004

Lotze, H. K., Coll, M., Magera, A. M., Ward-Paige, C., & Airoldi, L. (2011). Recovery of marine animal populations and ecosystems. *Trends in Ecology & Evolution*, *26*(11), 595-605. https://doi.org/10.1016/j.tree.2011.07.008

McIntyre, N. E., Rango, J., Fagan, W. F., & Faeth, S. H. (2001). Ground arthropod community structure in a heterogeneous urban environment. *Landscape and Urban Planning*, *52*(4), 257-274. https://doi.org/10.1016/S0169-2046(00)00122-5

McKinney, M. L. (2002). Urbanization, biodiversity, and conservation: The impacts of urbanization on native species are poorly studied, but educating a highly urbanized human population about these impacts can greatly improve species conservation in all ecosystems. *BioScience*, *52*(10), 883-890. https://doi.org/10.1641/0006-3568(2002)052[0883:UBAC]2.0.CO;2

McKinney, M. L. (2006). Urbanization as a major cause of biotic homogenization. *Biological Conservation*, *127*(3), 247-260. https://doi.org/10.1016/j.biocon.2005.09.005

McKinney, M. L., & Lockwood, J. L. (1999). Biotic homogenization: A few winners replacing many losers in the next mass extinction. *Trends in Ecology & Evolution*, *14*(11), 450-453. https://doi.org/10.1016/S0169-5347(99)01679-1

Michalak, K., Azaah, A., Woo, K. L., & Biolsi, K. L. (2017). *Seals and the city: Pinnipeds are returning to urban waterways*. SUNY Undergraduate Research Conference (SURC), Suffolk Community College, Selden, New York.

Moore, S., & Clarke, J. T. (2002). Potential impact of offshore human activities on gray whales (*Eschrichtius robustus*). *Journal of Cetacean Research and Management*, *4*(1), 19-25.

Parsons, E. C. M. (1998). Trace metal pollution in Hong Kong: Implications for the health of Hong Kong's Indo-Pacific hump-backed dolphins (*Sousa chinensis*). *Science of the Total Environment*, *214*(1), 175-184. https://doi.org/10.1016/S0048-9697(98)00063-1

Payne, P. M., & Selzer, L. A. (1989). The distribution, abundance and selected prey of the harbor seal, *Phoca vitulina concolor*, in southern New England. *Marine Mammal Science*, *5*(2), 173-192. https://doi.org/10.1111/j.1748-7692.1989.tb00331.x

Pirotta, E., Laesser, B. E., Hardaker, A., Riddoch, N., Marcoux, M., & Lusseau, D. (2013). Dredging displaces bottlenose dolphins from an urbanised foraging patch. *Marine Pollution Bulletin*, *74*(1), 396-402. https://doi.org/10.1016/j.marpolbul.2013.06.020

Pitcher, K. W. (1990). Major decline in number of harbor seals, *Phoca vitulina richardsi*, on Tugidak Island, Gulf of Alaska. *Marine Mammal Science*, *6*(2), 121-134. https://doi.org/10.1111/j.1748-7692.1990.tb00234.x

Sanderson, E. W. (2013). *Mannahatta: A natural history of New York City*. New York: Abrams.

Shochat, E., Warren, P. S., Faeth, S. H., McIntyre, N. E., & Hope, D. (2006). From patterns to emerging processes in mechanistic urban ecology. *Trends in Ecology & Evolution*, *21*(4), 186-191. https://doi.org/10.1016/j.tree.2005.11.019

Tanabe, S. (2002). Contamination and toxic effects of persistent endocrine disrupters in marine mammals and birds. *Marine Pollution Bulletin*, *45*(1), 69-77. https://doi.org/10.1016/S0025-326X(02)00175-3

Taylor, B. L., Rojas-Bracho, L., Moore, J., Jaramillo-Legorreta, A., Ver Hoef, J. M., Cardenas-Hinojosa, G., . . . Hammond, P. (2016). Extinction is imminent for Mexico's endemic porpoise unless fishery bycatch is eliminated. *Conservation Letters*, 1-8. https://doi.org/10.1111/conl.12331

Terhune, J. M. (1985). Scanning behavior of harbor seals on haul-out sites. *Journal of Mammalogy*, *66*(2), 392-395.

Turvey, S. T., Pitman, R. L., Taylor, B. L., Barlow, J., Akamatsu, T., Barrett, L. A., . . . Wang, D. (2007). First human-caused extinction of a cetacean species? *Biology Letters*, *3*(5), 537-540. https://doi.org/10.1098/rsbl.2007.0292

U.S. Census Bureau. (2017). *Cities and town population total tables: 2010-2015*. Retrieved from https://www.census.gov/data/tables/2015/demo/popest/total-cities-and-towns.html

Waldman, J. (2012). *Heartbeats in the muck: The history, sea life, and environment of New York harbor*. New York: Oxford University Press.

Wilke, M., Bossley, M., & Doak, W. (2005). Managing human interactions with solitary dolphins. *Aquatic Mammals*, *31*(4), 427-433. https://doi.org/10.1578/AM.31.4.2005.427

Woo, K. L., & Biolsi, K. L. (2017). Increasing STEM education through marine mammal research in an urban environment. *All About Mentoring*, *50*, 43-48.