

Evidence of Large Whale Socio-Sexual Behavior in the New York Bight

Meghan E. Rickard,¹ Kate S. Lomac-MacNair,² Darren S. Ireland,³
Sarah M. Leiter,² Mitchell D. Poster,² and Ann M. Zoidis²

¹*New York Natural Heritage Program, College of Environmental Science and Forestry,
State University of New York, 123 Kings Park Boulevard, Kings Park, NY 11754, USA
E-mail: meghan.rickard@dec.ny.gov*

²*Tetra Tech, Inc., 1999 Harrison Street, Suite 500, Oakland, CA 94612, USA*

³*LGL Ecological Research Associates, Inc., 4103 S. Texas Avenue, Suite 211, Bryan, TX 77802, USA*

Abstract

Large whales, including the endangered sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*), and North Atlantic right whale (*Eubalaena glacialis*), are known to occur in the New York Bight. However, relatively little data exist on social behavior typical of these species in the area. The U.S. Mid-Atlantic has traditionally been considered a large whale migratory corridor with few surveys documenting social dynamics of whale presence in these waters. To better understand the occurrence, distribution, abundance, and behavior of these species for management and conservation planning, monthly line-transect aerial surveys were conducted over a 3-year period from March 2017 to February 2020. During these surveys, three noteworthy socio-sexual behavior events were observed and photographed within groups of sei whales (April 2019), sperm whales (September 2019), and right whales (December 2019). Events included what could be either non-reproductive sexual behavior (socio-sexual behavior) or sexual behavior (copulation) among conspecifics, including mirror pair swimming, lateral and vertical presenting, and belly to belly contact. During all three events, groups were highly active at the surface, frequently and quickly changing speed and direction, and animals were predominantly less than one body length apart from other conspecifics in the group. All species were recorded rolling onto their sides and/or back while at or near the surface. Open mouth display occurred in the North Atlantic right whale event. Though copulation is unlikely to have transpired during the sperm whale event and could not have occurred during the right whale event due to the identification of same-sex individuals, it cannot be ruled out as the impetus for the sei whale event. These observations begin to describe the relative

importance of the New York Bight as more than a migratory corridor and suggest that additional behaviorally focused data collection be incorporated into future surveys.

Key Words: behavior, socio-sexual, mating, sperm whale, *Physeter macrocephalus*, sei whale, *Balaenoptera borealis*, North Atlantic right whale, *Eubalaena glacialis*

Introduction

Large whale socio-sexual behavior and mating events are infrequently observed and documented. This deficit arises from the inherent challenges of conducting research in the marine environment, including distance from shore, availability and visibility of animals at the surface, viewing from one perspective/platform, and incomplete descriptions of when and where most large whales can be found (Lanyon & Burgess, 2014; Schaeff, 2016). Knowledge of large whale behavior, social structure, and mating systems is founded on modern whaling data (Lockyer, 1984; Mann et al., 2000; Schaeff, 2016). Over the past five decades, this information has been enhanced with extensive field data for a number of large whale species, notably humpback whales (*Megaptera novaeangliae*), right whales (*Eubalaena* spp.), and sperm whales (*Physeter macrocephalus*) (Donnelly, 1967; Di Natale & Mangano, 1985; Payne, 1986; Clapham, 1996; Mate et al., 2005; Martin et al., 2008). Some species, however, remain largely elusive, and we must defer to conclusions drawn from whaling data until new data are collected (Prieto et al., 2012; Sears et al., 2013; Geijer et al., 2016; Lomac-MacNair & Smultea, 2016).

The New York Bight (NYB) has long been considered a transitory area for large whales traveling from breeding grounds in the south

to feeding grounds in the north (Kellogg, 1929; Cetacean and Turtle Assessment Program [CETAP], 1982; Sadove & Cardinale, 1993). As such, it has been surveyed less frequently and at a lower spatial resolution than other parts of the U.S. East Coast, resulting in a significant lack of data with which to make informed management decisions (Palka et al., 2017, 2021; Muirhead et al., 2018; National Marine Fisheries Service [NMFS] Northeast Fisheries Science Center [NEFSC] & Southeast Fisheries Science Center [SEFSC], 2021). The NYB is also one of the busiest maritime regions in the United States. With above-average commercial fishing effort (*Mid-Atlantic Ocean Data Portal*, n.d.) and the largest container port on the U.S. East Coast (Strauss-Wieder, 2020), the NYB poses a number of threats to whales, including ship strike, entanglement, noise pollution, and offshore wind energy development (Brown et al., 2019; Stepanuk et al., 2021). Additionally, the greater Gulf of Maine region, also part of the Northwest Atlantic Shelf and intricately connected to the NYB, is among the fastest-warming regions of the global ocean, causing momentous oceanographic change at an unprecedented rate (Pershing et al., 2015; Greene, 2016; Saba et al., 2016; Northeast Fisheries Science Center [NEFSC], 2021). Identifying not just where and when whales are present, but how they are using the area, is essential to successful conservation and management efforts (Palka et al., 2017; New York State Energy Research and Development Authority [NYSERDA], 2021; Quintana-Rizzo et al., 2021).

Behavioral observations, especially those related to critical events like reproduction and foraging, can indicate that a particular area may be biologically significant (Heimlich-Boran, 1988; NMFS Greater Atlantic Regional Fisheries Office [GARFO] & Southeast Regional Office [SERO], 2015; Wray et al., 2021). For example, Biologically Important Areas (BIAs) identify “sites where cetaceans engage in activities at certain times that contribute to an individual’s health and fitness and, ultimately, to the fecundity and survivorship of the population” (Van Parijs, 2015, p. 1; also see LaBrecque et al., 2015). The preservation of such areas, and therefore behaviors, may enable resiliency in a population or species by supporting the existence of behavioral variations, thereby providing more options for adaptation (Brakes & Dall, 2016; Notarbartolo di Sciara et al., 2016). Overall, documenting behavior is of use to scientists and managers for impact analysis and in the decision-making process, and it can help identify data gaps and prioritize future research (Ferguson et al., 2015; Van Parijs, 2015; Van Parijs et al., 2021).

To meet these needs, the New York State Department of Environmental Conservation (NYSDEC) Division of Marine Resources funded aerial surveys conducted by Tetra Tech as part of a 3-year (2017 to 2020) baseline monitoring program focused on six large whale species—humpback whale, sperm whale, fin whale (*Balaenoptera physalus*), blue whale (*Balaenoptera musculus*), sei whale (*Balaenoptera borealis*), and North Atlantic right whale (*Eubalaena glacialis*)—in the NYB (summarized in Zoidis et al., 2021). Herein, we describe observer- and photo-documented interactions and displays of socio-sexual behavior events for three large whale species: sperm whale, sei whale, and North Atlantic right whale. These species are listed as endangered under the U.S. Endangered Species Act and New York State’s Environmental Conservation Law, Part 182. They are also considered High Priority Species of Greatest Conservation Need in New York as designated in the New York State Wildlife Action Plan (New York State Department of Environmental Conservation [NYSDEC], 2015). Observations of socio-sexual behaviors are critical information that will help managers achieve the mandate to prevent further decline and support these populations on the path to recovery.

Sperm Whales

Sperm whale societies dictate the distribution and behavior of individuals in most of their global range, though less is known about sperm whales in the Northwest Atlantic (Whitehead, 2003; Whitehead et al., 2012; Hayes et al., 2020). Here, sperm whales live in single matrilineal and multigenerational groups of approximately eight to ten individuals called units, which consist of adult females, their calves, and juveniles of both sexes (Whitehead et al., 1991; van der Linde & Eriksson, 2019). Compared to the Pacific Ocean, units in the Atlantic occur in smaller groups (e.g., a group is made up of one unit in contrast to the Pacific where a group usually contains at least two to three units) and maintain smaller ranges (Whitehead et al., 2012). Additionally, individual members of a unit in the Atlantic are more likely to be from the same matriline, and calves tend to be more abundant (Whitehead et al., 2012).

North Atlantic units generally tend to inhabit the area below the 40° latitude line, which crosses through the NYB (Leatherwood et al., 1976; Whitehead, 2018). Males seem to leave their unit based on size rather than age, but generally at around age 10 or older they begin to move poleward until they are large enough, typically in their late 20s, to intermittently return to the mid-latitudes to breed (Best, 1979; Mann et al., 2000; Whitehead et al., 2012). Studies show sperm

whale units in the Atlantic are separate from each other both geographically and genetically (Gero, 2007; Engelhaupt, 2009). There is very little social mixing among units even though there is a higher density of aggregations and less vocal differentiation between units than those in the Pacific (Antunes, 2009; Whitehead et al., 2012).

Time and location of mating and migration is not fully understood, though there appears to be a southward winter migration and northward summer migration between Cape Hatteras and Georges Bank (Hamazaki, 2002; Stanistreet et al., 2018). In the NYB, sperm whales are usually found at the shelf break and are thought to be present in the late spring and early summer (Scott & Sadove, 1997; Hayes et al., 2020). However, Zoidis et al. (2021) show that sperm whales occur annually, during all seasons, with their highest abundance in summer.

Sei Whales

In contrast to sperm whales and other odontocetes, baleen whales live mostly solitary lives. Sei whales are the third largest whale species yet one of the most cryptic (Prieto et al., 2012; Horwood, 2018). Stock definitions and population estimates are uncertain at best due to seasonal variations, unpredictable occurrence, and characteristically offshore distribution (Olsen et al., 2009; Hayes et al., 2020). Attributing sightings to the species is not always possible due to the difficulty of distinguishing sei whales from species with similar morphology (e.g., Bryde's whales [*Balaenoptera brydei*] and fin whales; Katona et al., 1983; Jefferson et al., 2008; Prieto et al., 2012). Most of what is known about the natural history and biology of sei whales comes from whaling data and the documentation of "incursion years," when a large number of individuals follow warm water inshore to feed (Kenney & Winn, 1986; Payne et al., 1990; Prieto et al., 2014). While they have been recorded traveling northward from south of Cape Cod along the continental slope in June and July and returning southward in September and October, their presence is considered sporadic; sei whales may consistently use an area one year and be completely absent the next (Mitchell, 1975; Katona et al., 1983; Christensen et al., 1992; Romagosa et al., 2015). Sei whale breeding cycles seem to follow the annual baleen whale migratory scheme of giving birth in warm waters during winter after a 1-year gestation period, though mating and birthing occurrence varies among baleen species, and for sei whales is unknown (Mizroch et al., 1984; Berta et al., 2015).

In the U.S. Mid-Atlantic, sei whales are reliably rare; they are consistently present in small numbers over specific, short periods of time

(CETAP, 1982; Hayes et al., 2020). Sei whales usually appear in the NYB from late May through June, and again in October. However, recent acoustic analysis shows nearly year-round presence in the Mid-Atlantic, a region that has become increasingly important as detections have steadily increased since 2010, especially from March through July (Davis et al., 2020). This was corroborated in a study by Estabrook et al. (2021) where the highest number of acoustic detections occurred between March and June, though there were a few detections throughout the 3-year study at most of the 15 receiver sites across the NYB. In Zoidis et al. (2021), sei whales were seen in April during 2 out of 3 years.

North Atlantic Right Whales

The North Atlantic right whale ("right whale" henceforth) is one of the most critically endangered large whale species on Earth, with an estimated 356 individuals remaining (Pace et al., 2017; Pettis et al., 2021). Though extensive dedicated research and conservation effort have occurred for decades, human-caused mortality (i.e., vessel strike and entanglement) continues to limit the recovery of the species (Corkeron et al., 2018). Right whale habitat stretches from the Southeast U.S. to Canada (Hayes et al., 2021). Until recently, the majority of the population was expected to migrate between southern calving grounds in the winter and northern feeding grounds in the summer (Winn et al., 1986; Zani et al., 2008; Davies et al., 2019; Hayes et al., 2021), though the definitive whereabouts of individuals not giving birth in winter was, and remains, largely unknown (Kraus, 1988; Davis et al., 2017; Gowan et al., 2019). However, right whale distribution has been shifting over the past 10 years, with feeding habitat moving farther north to the Gulf of St. Lawrence and a broad presence of individuals along the entire U.S. East Coast throughout the year (Davis et al., 2017; Meyer-Gutbrod et al., 2021). Partly climate-driven, these changes are connected to a reduction in calving rates and, since 2017, a high mortality rate for the population (Meyer-Gutbrod et al., 2021; Pettis et al., 2021).

Right whale presence within the Mid-Atlantic is likewise not well understood, and the NYB is generally considered a migratory corridor (Knowlton et al., 2002; Firestone et al., 2008). Surveys during the last few decades found right whales in the NYB in all seasons except summer (Muirhead et al., 2018; Zoidis et al., 2021), with sightings of all age classes off the south shore of Long Island, and sometimes within Long Island Sound and other inlets and bays, from March through June (Sadove & Cardinale, 1993; Marine

Science Services, 2021). Davis et al. (2017) found that right whales have transitioned to spending more time in the Mid-Atlantic year-round since 2011. Despite consistent documentation of right whale presence off New York, data are too sparse to draw clear conclusions about right whale use of the NYB.

North Atlantic right whales produce offspring in multi-year intervals (Schaeff, 2016) which have increased during the recent years of population decline as the species contends with shifting prey distribution and long-term stress due to entanglement (Kraus et al., 2001; van der Hoop et al., 2017; Davies et al., 2019; Hayes et al., 2021; Meyer-Gutbrod et al., 2021; Pettis et al., 2021). Calves are typically born from December through March, but where and when mating occurs is still unknown (Kraus et al., 1986a). As such, the presumed breeding season is November through January, and the central Gulf of Maine has been identified as a possible mating ground (Kraus et al., 1986a; Cole et al., 2013). Conception may occur in Surface Active Groups (SAGs), defined as temporary associations of two or more animals in close proximity (< 1 body length [BL]) engaged in frequent physical contact and/or coordination of movement at the surface (Kraus & Hatch, 2001; Parks et al., 2007). Overall, SAGs serve social functions (e.g., play and strengthening bonds), so while not all SAGs indicate courtship, some nonconceptive SAGs may still play a role in reproduction even outside the breeding season (Kraus & Hatch, 2001; Parks et al., 2007; Mesnick & Ralls, 2018).

Methods

Methods are described in detail in Zoidis et al. (2021). Monthly aerial surveys ($n = 36$) were conducted from March 2017 through February 2020 along 15 parallel transect lines spaced 16.7 km apart. Survey design followed line-transect distance sampling methods with a minimum of 14 days between surveys (Buckland et al., 2001). The total area surveyed was 43,449 km², and the total transect length was approximately 2,514 km (Figure 1).

Surveys were flown using a small high-wing, twin-engine, six-seat aircraft (Partenavia P68-C) with bubble windows. Flights were conducted at a target altitude of approximately 305 m and groundspeed of 100 to 110 kts when the Beaufort Sea State (BSS) was 5 or lower. Two observers, one on each side of the aircraft, searched for whales out to approximately 3 km from the transect line. Sighting and environmental data were collected using *Mysticetus*TM software. Data collection included location and time of the sighting; species (to the lowest taxonomic level

possible); number of individuals, group size, and/or group composition; number of calves; and a detailed description of behavior state whenever possible (Table 1).

To document large whale sightings, the aircraft broke off the transect line to begin circling effort while maintaining target altitude. A Canon EOS 7D still camera with a Canon EF 100-400 mm f/4.5-5.6L IS USM lens was used to take photographs, and a video recorder mounted in the belly window ran continuously while the plane was in the air. All sightings of North Atlantic right whales were reported to the National Oceanic and Atmospheric Administration Right Whale Sighting Advisory System (NOAA Fisheries, n.d.) upon landing, and all photographs of right whales were sent to researchers at the New England Aquarium, curators of the *North Atlantic Right Whale Catalog*, for contribution and possible matches to existing individually identified whales (Kraus et al., 1986b; New England Aquarium, 2019).

Results

Sperm Whale Event

On 10 September 2019 at 1757 h, a group of five sperm whales was sighted 155 km from shore at the edge of the 1,000 m isobath in water 992 m deep. The group, which appeared to include similarly sized adults, was circled for focal observation for 11 min. Individuals made short, shallow dives while moving among the group, changed directions, and traveled at the surface. Soon after circling began, all five individuals formed a tight group (< 1 BL dispersal). An individual positioned vertically in the water column was approached by another individual (hereafter referred to by using individual identifiers specific to this sighting only). One individual (“A3,” identified by the scarring on the tail stock) was subsurface ventral side up within the tight group. After approximately 1 min, three individuals positioned themselves facing one direction, one individual faced the opposite direction, and the fifth individual faced perpendicular to the others. The three similarly facing individuals continued to swim in the same direction while the other two individuals, approximately 2 BLs away, also turned to swim in the same general direction.

Within the subgroup of three, one individual (“A1”) initiated a shallow dive from behind another individual (“A2”), swam underneath A2 while turned on its left side, and appeared to rub against A2 (Figure 2). The contact between A1 and A2 lasted for 39 s. Once back at the surface, A1 changed direction, moving away from A2 and A3.

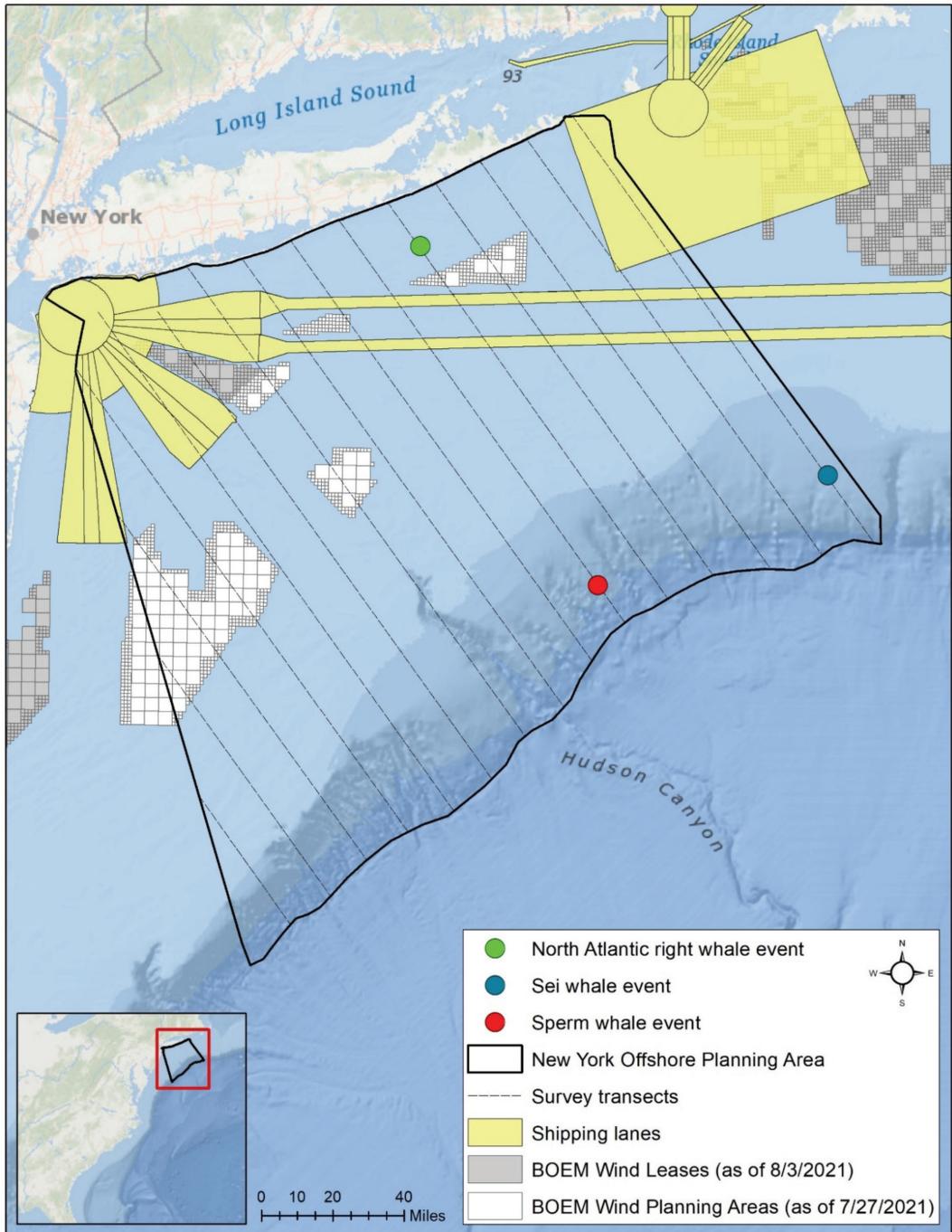


Figure 1. New York Bight survey area and event locations. The North Atlantic right whale (*Eubalaena glacialis*) event was observed between two individuals (#4540, a 6-y-old female, and #4120, an 8-y-old female) on 12 December 2019 at 1410 h; the sei whale (*Balaenoptera borealis*) event was observed among six individuals on 11 April 2019 at 1412 h; and the sperm whale (*Physeter macrocephalus*) event was observed among five individuals on 10 September 2019 at 1757 h. Shipping lanes and offshore wind areas included for reference of current and emerging human activity.

Table 1. Behavior state definitions used in the current study, originally described by Zoidis et al. (2021)

Behavior state	Definition
Rest/slow travel	> 50% of group exhibiting little or no forward movement (< 1 km/h), remaining at the surface in the same location or drifting/traveling slowly with no wake.
Travel	> 50% of group swimming with an obvious consistent orientation and speed; no surface activity. Medium travel = 1 to 3 km/h; no white water. Fast travel \geq 3 km/h with white water.
Mill	> 50% of group swimming with no obvious consistent orientation (non-directional), characterized by asynchronous headings, circling, changes in speed, and no surface activity.
Probable foraging	> 50% of group apparently searching for prey; the process of finding, catching, and eating food. Probable foraging captures foraging (e.g., bubble-net feeding or lunge feeding visible).
Surface active	> 50% of group occurrence of behavior on the water surface that creates a conspicuous splash (includes all head, tail, pectoral fin, and leaping behavior events).
Surface active – mill	> 50% of group while milling; occurrence of behavior on the water surface that creates a conspicuous splash (includes all head, tail, pectoral fin, and leaping behavior events).
Surface active – travel	> 50% of group while traveling; occurrence of behavior on the water surface that creates a conspicuous splash (includes all head, tail, pectoral fin, and leaping behavior events).
Unknown	Not able to determine behavior state (animals out of sight, too far to determine, on a dive, etc.).
Other	Described in observer notes.

**Figure 2.** Body contact sequence during sperm whale event. Individual A1 (far right animal) dove from behind A2 (middle animal), rolled to the left, and rubbed against A2 for 39 s. (Photo credit: Darren Ireland, TT-NYSDEC)

Subsequently, A2 and A3 also changed direction to follow A1, and all three individuals swam toward one of the individuals from the initial group of five that remained approximately 10 to 15 BLs away.

Sei Whale Event

On 11 April 2019 at 1412 h, a group of six sei whales were sighted in the southeast corner of the NYB survey area exhibiting presumed socio-sexual behaviors. The group was 151 km from shore in water 381 m deep and was circled for 10 min and 40 s. All individuals appeared to be of the same size and age class.

Four of the whales were oriented close together, approximately 0.25 to 5 BL dispersal. The two other whales remained approximately 10 to 15 BLs away from the core group of four traveling in the

same direction. The group of four swam closely together, changed direction and speed frequently, and rolled onto their side or back in unison, known as mirror pair swimming (Hill et al., 2015), while at or near the surface (Figures 3 & 4).

Initially, the group appeared to be traveling at a moderate pace in the same direction with 0.5 to 2 BL dispersal. The individuals would occasionally come closer together (0 to 0.5 BL) during the observation period, increase speed, and sometimes turn rapidly. The group would then separate to a slightly greater dispersal while moving at a more moderate speed. Individuals continuously turned on their side for an interval of close to 1 min. The whales cycled through these periods of activity where several individuals interacted in bursts while close together, then upon separating 2 to 3 BLs, returned to moderate travel.



Figure 3. Rolling sequence observed during sei whale event (*Photo credit:* Darren Ireland, TT-NYSDEC)



Figure 4. Mirror pair swimming (two subsurface individuals on the far right) and surfacing of fourth individual (left of the pair) during sei whale event (*Photo credit:* Darren Ireland, TT-NYSDEC)

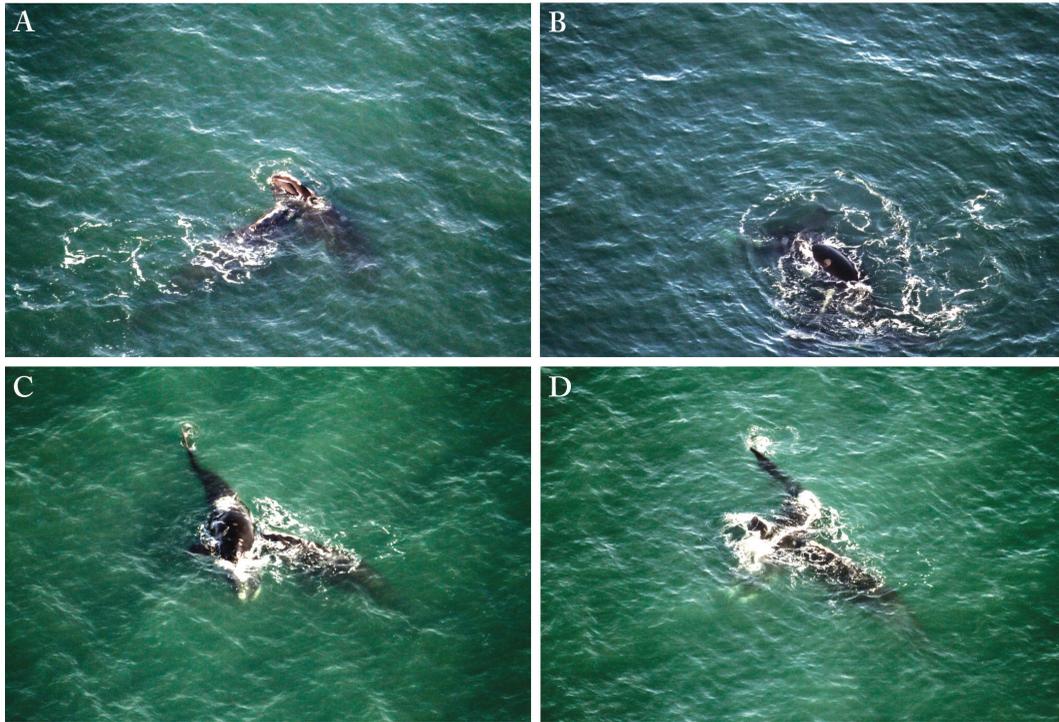


Figure 5. Two North Atlantic right whales (#4540 and #4120) exhibiting head-to-head contact (A), arching (B), head-to-body contact (B & C), and rolling (C & D) (Photo credit: Sarah Leiter, TT-NYSDEC)

North Atlantic Right Whale Event

On 12 December 2019 at 1410 h, a pair of North Atlantic right whales was sighted approximately 18.5 km south of Long Island in 37 m of water. Initially, only one whale was sighted. Upon circling for focal observation, a second individual surfaced 2 to 3 BLs from the first individual. Both individuals were similar in size and appeared to be adults. The New England Aquarium identified one individual as #4540 (referred to here as “R1”), a 6-year-old female, and the other individual as #4120 (referred to here as “R2”), an 8-year-old female (aged at the time of the sighting). Both whales remained at or near the surface for most of the sighting and only occasionally swam below the surface. The individuals stayed within 3 BLs for the duration of the observed event.

The sighting was classified as surface active – mill and included a variety of different behaviors. One individual (R2) was observed vertically in the water column with mouth open and baleen exposed. This open mouth behavior was only seen during vertical positioning but was not photographed. During vertical positioning, the two individuals were oriented perpendicularly head-to-head. Body contact was observed several times in multiple places: belly-to-belly contact

while rolling with pectoral fins out of the water, head-to-body contact, and head-to-head contact (Figure 5). Arching with flukes out of the water by one of the whales was also observed. R2 spent more time beneath the surface and positioned belly-to-belly with R1.

Discussion

The sightings described herein are, to our knowledge, the first documented socio-sexual behavior in the NYB for all three species. Social interactions among whales may be generally categorized as sexual, socio-sexual, or play, distinguished by the conceptive (sexual) or nonconceptive (socio-sexual, play) nature of the behavior (Connor et al., 2000; Furuichi et al., 2014; Hill et al., 2015, 2017). Potentially conceptive behavior is based on the age-sex classes and reproductive states of the individuals involved (Mann et al., 2000). Socio-sexual (nonconceptive) behaviors may or may not include copulation and genital investigation or stimulation, can happen between any age-sex class combinations at any time, and may be used to foster relationships and/or communicate (Lockyer, 1984; Connor et al., 2000; Hill et al., 2015, 2017). Socio-sexual behavior can also vary

widely among cetacean species (Martin et al., 2008). There is evidence that play, including socio-sexual behavior, has a major role in physical, cognitive, social, and emotional development of cetaceans (Thomas & Taber, 1984; Zoidis et al., 2014; Hill et al., 2017). Socio-sexual behavior that is nonconceptive may mediate social relationships or serve a communicative function, and practice in mating may contribute significantly to female reproductive success (Mann et al., 2000; Schaeff, 2016).

Sperm Whale Event

Compared to other sperm whale sightings from this survey where individuals were primarily observed resting or traveling slowly at the surface, the group described herein was engaged in active behavior. The rapid movements, changes in direction, and proximity of individuals, including the belly-to-belly location of body contact between individuals A1 and A2, is suggestive of mating and courtship behavior (Donnelly, 1967; Lomac-MacNair et al., 2016). However, the event observed was brief, and we did not document an extruded penis on either individual, nor was there an obvious size difference between the two individuals. These factors imply that the event was nonconceptive in nature and may have been between same-sex individuals. Penis extrusion is the strongest sign of behavior having a sexual component (Würsig & Clark, 1993), though penis extrusion can happen in a variety of contexts, including lone individuals (Bagemihl, 1999; Pack et al., 2002). In addition, sperm whales are the most sexually dimorphic cetacean; males are one and a half times larger and three times heavier than females, making it easier to identify when potential mating activity is occurring between males and females (Mann et al., 2000; Gero et al., 2014; Schaeff, 2016). Interestingly, it has been noted that adult male sperm whales arrive off the coast of New England in August (Leatherwood et al., 1976); and that off New York, large males are regularly sighted in waters less than 300 m deep (Whitehead, 2018). Though it is not undeniably clear from the photos that the instigating animal (A1) was an adult male, the referenced observations of adult male sperm whales in New York, and particularly the apparent overlap in time, underline the potential for such an event.

Sperm whales have been documented spending about one quarter of their time at or near the surface, which peaks in some parts of the world in the afternoon over several hours (Whitehead & Weilgart, 1991). Our observation, which occurred in the afternoon, anecdotally supports this pattern. Characteristic surface behavior of sperm whales can include a variety of actions, including

clustering and resting, with an emphasis on maintaining body contact, or more active behavior such as breaches and rolling (Whitehead, 1999, 2018). Based on the behaviors observed during this study, the NYB may be an area where these periods of socio-sexual behavior, referred to as a “high level of sociality,” occur (Whitehead & Weilgart, 1991, p. 291). Some sperm whale units in the Atlantic are known to have high resighting rates in some areas, suggesting that the location is preferred habitat (Gero et al., 2014). The typical home range for females is about 2,000 km²; however, if food is abundant, they remain within a range of 10 to 20 km² (Gero et al., 2014; Whitehead, 2018). Consequently, the increased length of time spent in one area may result in greater anthropogenic impact to a unit. Gero et al. (2014) described the behavior and social structure of sperm whale units in the Eastern Caribbean and suggest there be a management focus on the female units in a population due to their regional philopatry.

Sei Whale Event

The observation of the sei whale group engaged in socio-sexual behavior may be the first ever recorded. In contrast to sperm whales and other odontocetes, sexual dimorphism is either absent in baleen whales or females are slightly larger (Schaeff, 2016). For example, the smallest and largest recorded lengths at sexual maturity in sei whales are essentially equivalent between the sexes (Best & Lockyer, 2002). Without the ability to visually identify the sex of the individuals in the sei whale event, we cannot rule out that the socio-sexual behavior observed was not sexual (i.e., conceptive) in nature.

Sei whales are usually observed alone or in groups of two to five individuals and can also occur in larger groups that are typically associated with foraging (Leatherwood et al., 1976). Schilling et al. (1992) described an incursion event in the Gulf of Maine during the summer of 1986 where milling—defined as at least three individuals socializing with one another while moving in random directions, rolling, and staying at the surface for over 10 min—was witnessed four times, and social behavior occurred in groups of up to six individuals. A whaling report from the North Pacific suggests that, based on the sexual condition of harvested sei whales, sexually mature individuals tend to form groups of two or more whales (Nemoto, 1964). During our observation, the six sei whales were not associated with foraging and/or a prey patch, though it is possible that before and/or after the time of our sighting the context of the observed behavior may have changed. Alves et al. (2010) reported Bryde’s whale behavior on a feeding ground, specifically dive synchrony in

the context of associative behavior between two individuals, demonstrating potential traits that may also occur in sei whales. This behavioral description which occurred in a stable association between two Bryde's whales corresponds to the event we describe, which additionally featured mirror pair swim.

North Atlantic Right Whale Event

The North Atlantic right whale event aligns with findings from previous studies regarding time of year, age, number of individuals, and sex/same sex elements of SAGs. Year-round occurrence of SAGs, and specifically all-juvenile SAGs, is common (Parks et al., 2007; Mesnick & Ralls, 2018). Parks et al. (2007) found that significantly more groups of all juveniles occurred from December to February. The study also found that all-female SAG occurrence peaked in January. These findings correspond to our December SAG sighting and may also be reflective of the breeding cycle timeframe in which conception occurs between November and January (Cole et al., 2013). To succeed in reproducing, it makes sense that this practice behavior would sometimes occur at the same time as real mating activities (Parks et al., 2007).

The average group size of an all-female SAG is reportedly 2.2 whales (Parks et al., 2007). Same-sex interactions among right whales, including socio-sexual behavior within SAGs, have been previously documented (Kraus & Hatch, 2001; D'Agostino et al., 2017). Furthermore, females engage in SAG behavior more as juveniles than as adults (Parks et al., 2007). Female North Atlantic right whales become first-time mothers, and are therefore considered adults, at around age 9 (Hamilton et al., 1998; Kraus & Hatch, 2001). The right whales in the event reported herein were known to be 6 and 8 years old at the time of observation (i.e., juveniles). Therefore, it is not surprising that, as a sighting of two individuals, as well as two juveniles, the two animals in the SAG we report here were both female.

To comment on the location of the SAG sighting is more difficult. In Parks et al. (2007), the Mid-Atlantic region was not included in the analysis, which focused on the Southeastern U.S., Cape Cod Bay, and the Bay of Fundy. The lack of surveys, and therefore sightings data and behavioral observations, in the Mid-Atlantic limits the ability to compare the prevalence of SAGs and their elements within the area as well as across regions. Additionally, spatial components of SAG occurrence, such as distance from shore, were not investigated in the study. Revisiting the Parks et al. study to include recent data and the Mid-Atlantic region may add to our understanding of the species' recent distributional shifts.

The SAG components discussed above, all supported by the details of our event, suggest that this observation was of same-sex juvenile right whales practicing mating behavior(s), which may be an essential developmental stage (Kraus & Hatch, 2001). Parks et al. (2007) note that the prolonged juvenile period for right whales "may be important for learning about their physical and social environment and developing specific motor skills prior to attempting reproduction" (p. 883), indicating that the species practices mating behavior to increase the likelihood of success during an actual mating event (Best et al., 2003). However, as previously noted, practice is only one of the potential reasons why the two individuals would engage in such behavior. Given the breadth of social functions a SAG may serve, play and social bonding may also have been present in this event.

To the best of our knowledge, the open mouth behavior displayed by #4540 has not yet been published for North Atlantic right whales, though several anecdotal reports exist (Marine Science Services, 2021; M. Baumgartner, pers. comm., 28 September 2021). In bowhead whales (*Balaena mysticetus*), the behavior has been associated with rock rubbing (e.g., removing dead skin in warm shallow water; Fortune et al., 2017). The authors suggest that by opening their mouths and letting cooler water in, whales can dissipate heat, which is essential after so much activity (rock rubbing, in the case of bowheads, or participating in a SAG in the case of these two right whales). The observed behavior could also have been strictly social given that the event occurred in December when surface waters are significantly cooling down and since the individual was more or less stationary and not actively passing water over the oral rete (M. Baumgartner, pers. comm., 28 September 2021).

The possibility that the NYB provides more habitat function than a migratory area for large whales has been documented for other species—for example, humpback whales (Brown et al., 2017; King et al., 2021) and fin whales (Lomac-MacNair et al., 2022). The NYB's role as a foraging ground is more easily documented than the subtleties of cetacean socio-sexual behavior, which are more complex than what can be inferred through snapshots in time, such as observations typically made during aerial surveys (Mann et al., 2000). Associations between and/or among individuals are too dynamic for brief sampling periods to capture, and scientists are limited by the constraints of conducting research in the marine environment (Mann et al., 2000). There is also the possibility that large whales and other species will react adversely to the presence

of researchers, either by vessel or aircraft, and change their behavior to one of distress and/or defense (Smultea et al., 2008). Nevertheless, visual surveys can, and do, provide evidence of behaviors that are part of the natural history of species and, perhaps most importantly, can help identify geographic areas of significance which can focus conservation efforts (Lanyon & Burgess, 2014; Noren & Hauser, 2016). These results also reinforce the need for continuous data collection on large whales in the NYB (Cole et al. 2013; Meyer-Gutbrod et al., 2018).

Conclusion

Herein, we confirm that large whale species engage in behaviors beyond travel in the NYB, and further, that there is a possibility that some endangered whale species may use its waters to mate or practice mating behavior. These data on socio-sexual behavior can, and should, be applied to conservation strategies, especially in the face of emerging offshore wind energy development and unceasing climate change effects in this region (Meyer-Gutbrod et al., 2015, 2021; Cusano et al., 2019). If the occurrence of a specific behavior that is part of the ontogeny of a marine mammal species and contributes to an individual's overall reproductive success is limited or prevented, the individual's ability to successfully navigate mating activity in adulthood could likewise be affected. The occurrence of these behaviors, which can be critical in the life history of endangered species, should be identified, described, and protected (Hill et al., 2015).

The behavioral events described herein provide new and important insights into the socio-sexual behavior of some large whale species while they are present in the NYB. The overarching study by Zoidis et al. (2021) confirmed the presence of six large whale species here, and the behavioral events recorded begin to address the "why" of their occurrence. Of the utmost importance, the right whale event sheds some light on how the critically endangered species is currently using the NYB amid significant oceanographic and distributional changes. For sperm whales, of which the North Atlantic population is less well understood, and the North Atlantic sei whale population even less so, these events signal the need for species-specific considerations in management as well as marine spatial planning as anthropogenic activity in the NYB continues to increase.

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