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Neither Toy nor Tool:
Grass-wearing Behavior among Free-Ranging Bottlenose Dolphins in Western Florida

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Play and tool use are controversial in part because both have been challenging to define. Play behavior continues to elude specific definition but is currently recognized as a legitimate behavioral classification, especially when it involves handling objects (toys), although play does not require object handling. In contrast, animal tool use requires object handling that also meets criteria of purposeful and conditional handling in a specific context to achieve a goal. This report describes a form of object handling, grass-wearing behavior, exhibited by free-ranging bottlenose dolphins in St. Petersburg, Florida, to see if play or tool-use-like behavior explains it. During 9,551 sightings of 311 dolphins across eight years of study (January 2006–December 2013), $N = 79$ dolphins were observed with one or more blades of grass splayed across the dorsal fin 190 times. Grass-wearing was unrelated to activities conducted in seagrass meadows, age-sex class, or adult female reproductive phase. Grass wearing was primarily related to changes in group composition (fusion events). It occurred in larger groups that were significantly more likely to be socializing in affiliative, explicitly sexual and playful contexts with only one observation during conflict, although grass wearing also occurred during travel, forage/feeding, and resting though infrequently. The behavior was partly explained by play and tool-use-like behavior but is more consistent with dolphins self-decorating with grass as a stimulus enhancement in greeting or bids for attention.

Play and tool use are both controversial in part because both behaviors have been challenging to define. Play behavior continues to elude specific definition but is generally recognized as a legitimate behavioral classification (Paulos, Trone, & Kuczaj, 2010), especially when an activity involves handling objects as toys (Kuczaj, Makecha, Trone, Paulos, & Ramos, 2006). Play is a diverse set of behaviors that arose independently in diverse species from invertebrates to reptiles, birds and mammals (Burghardt, 2005). Although play seems to occur without an obvious purpose, play has many purported beneficial functions (Bekoff & Allen, 1998; Kuczaj et al., 2006; Paulos et al., 2010). Play provides a non-threatening context where animals acquire knowledge about others' physical strength and agility while practicing and perfecting their own (Bekoff & Byers, 1981). Play may teach animals about their social and physical environment (Kuczaj & Highfill, 2005), help them to develop problem-solving skills (Kuczaj et al., 2006), and help them to cultivate important social relationships (Connor, Wells, Mann, & Read, 2000).

Paulos et al.'s (2010) review of play from captive and wild studies of cetaceans identified three types of play: locomotor play, social play, and object play. Locomotor play includes aerial behaviors, erratic swimming, stranding, and surfing. Social play includes two or more individuals engaging in any activities noted as play. Playing dolphins often establish and switch roles (Kuczaj & Highfill, 2005), such as alternating between releasing and chasing a feather (Brown & Norris, 1956; Tavolga, 1966). Cetaceans can play alone, also known as self-directed or solitary play (Bel'kovich, Ivanova, Kozarovitsky, Novikova, & Kharitonov, 1991). One form of solitary play is parallel play, when an individual plays nearby other individuals without

playing directly with them (Parten, 1932). Parallel play occurs in species as diverse as cetaceans (Kuczaj et al., 2006) and monkeys (Weaver & de Waal, 2003). Different types of play can occur in combination as solitary (e.g., solitary locomotor play: a dolphin calf experimenting with postures) or social play.

Object play involves interaction with physical items. Captive and free-ranging bottlenose dolphins, (*Tursiops truncatus*) are known for carrying, wearing and creatively interacting with a range of objects. Paulos et al. (2010) identified four types of cetacean object play. One type of object play occurs with objects that dolphins manufacture themselves, such as bubble rings (Gewalt, 1989; Marten, Shariff, Psarakos, & White, 1996; McCowan, Marino, Vance, Walke, & Reiss, 2000). Another type is play with members of other species, such as poking other species housed in the same pool (Tavolga, 1966). Object play with man-made objects occurs among captive dolphins provided with balls, Frisbees, and other toys. Captive cetaceans treat nearly any object they find like toys (Bel'kovich, Krushinskaya, & Gurevich, 1970; Caldwell & Caldwell, 1972; Paulos et al., 2010; Tavolga, 1966; Tayler & Saayman, 1973). Captive dolphin handle flexible objects like rope and scarves the way free-ranging dolphins handle seaweed: mouthing it, tossing it, or towing it on fins (Paulos et al., 2010).

In their landmark study of play as a form of cultural transmission in captive bottlenose dolphins, Kuczaj et al. (2006) studied object play with every item available to the dolphins, even accidently available, and empirically demonstrated that dolphins have impressive innovative abilities. Altogether, the dolphins generated 270 different novel behaviors. However, most were due to calves, which generated 220 of the novel behaviors and 163 of which were mimicked, mostly by other calves. Both calves and adults were most likely to mimic novel behaviors first produced by calves rather than by adults.

The final type of object play occurs when free-ranging dolphins interact with naturally occurring objects and is of direct interest to this study. Natural object play occurs in a variety of species at sea, and ranges from bowhead whales (*Balaena mysticetus*) playing with logs in the Beaufort Sea (Würsig, Dorsey, Richardson, & Wells, 1989) to dolphin interaction with seaweed. Free-ranging dolphins carry seaweed or kelp across the melon, pectoral fins, and flukes, frequently transferring it to different parts of the body (bottlenose dolphins: Bloom, 1991; Würsig & Würsig, 1979; dusky dolphins (*Lagenothynchus obscurus*): Würsig & Würsig, 1980; Hector's dolphins (*Cephalorhynchis hectori*): Slooten, 1994; rough-toothed dolphins (*Steno bredanensis):* Kuczaj & Yeater, 2007; spotted dolphins (*Stenella frontalis*): Miles & Herzing, 2003; tucuxi (*Sotalia fluviatilis*): Spinelli, Nascimento, & Yamamoto, 2002).

Not all interaction with naturally occurring objects implies play. Adult male Amazon River dolphins (boto, *Inia geoffrensis*) handle plants and balls of mud in the context of courtship that is frequently aggressive, suggesting that it is a potential male sociosexual display rather than play (Martin, da Silva, & Rothery, 2008). Too little is known about this behavior to classify it as other than tool-use-like behavior (Mann & Patterson, 2013). Dolphins carry sponges (Mann & Patterson, 2013; Parra, 2007; Smolker, Richards, Connor, Mann, & Berggren, 1997) and shells (Allen, Bejder, & Krützen, 2010) during foraging. This behavior is not considered play but cetacean tool use (Mann & Patterson, 2013).

Animal Tool Use

Object handling is essential to animal tool use. Beck (1980) defined social tool use as handling objects to manipulate or influence another individual. St. Amant and Horton (2008) defined informational tool use as object handling that changes a message to attempt to influence the subsequent social interaction, such as a courting chimpanzee brandishing a stick. Bentley-Condit and Smith (2010) and Shumaker, Walkup, Beck, and

Burghardt (2011) defined animal tool use as the external employment of an unattached and manipulable attached environmental object to more efficiently alter the form, position, or condition of another object, organism, or the user itself, when the user holds and directly manipulates the tool prior to or during use, and is responsible for the proper and effective orientation of the tool. After reviewing object handling among free-ranging aquatic animals, Mann and Patterson (2013) proposed to modify Shumaker et al.'s (2011) definition by adding the criterion of *conditional* to emphasize that, in order to qualify as tool use, an animal must use an object purposely and conditionally in a specific context to achieve a goal. Aquatic animal tool use is rare because it is difficult to observe, limited by the physical and ecological constraints of marine environments, objects are less accessible, and there is less need compared to terrestrial species (Mann & Patterson, 2013). The conditional criterion eliminates nests, shelters (Borgia, 1995), and objects that animals carry or wear unless conditionally manipulated in appropriate contexts, such as protection or camouflage. This relegates many object handling behaviors among aquatic animals, including seaweed play among young dolphins (Mann & Smuts, 1999), to tool-use-like behavior pending further study (Patterson & Mann, 2015).

Object Handling in John's Pass

When object handling behavior is considered loosely as any interaction with objects, free-ranging dolphins occurring around John's Pass (a tidal inlet connecting the Intracoastal Waterway and the Gulf of Mexico on the west side of St. Petersburg, Florida) exhibit a suite of object handling behaviors (Weaver, 2012). These include man-made objects (e.g., an adult male wearing a discarded sunglass lens propped against his melon) and natural objects (e.g., an adult female rubbing a catfish along shells to remove its spines). Other object handling is opportunistic, such as mothers pushing their dead calf's corpse ($n = 8$ mothers), spitting water ($n = 2$ observations), carrying seaweed ($n = 4$ observations), and poking manatees and cormorants. The most common are various patterns of tossing and carrying fish, eels, mangrove seedpods, carrying whelk egg cases, and wearing grass.

Grass-wearing is defined as one or more blades of grass splayed across the leading edge of the dorsal fin (see Figure 1). It could be construed as accidental except that dolphins will forcibly remove unwanted grass by shuddering and diving, which suggests that they are aware of grass on their bodies and choose to remove it or wear it. Moreover, vortices created at the leading edge of dorsal fins by swimming will immediately rip off anything that lodges there (Fish, Pugliese, Timm, Rittmaster, & Böttger, 2011). We also observed a dolphin deliberately donning grass during an observation of reciprocal self-decoration (date 4/24/2011, Weaver, 2011). As an adult female actively copulated with three males, a fourth male self-decorated by splaying a whelk egg case across his dorsal fin (see inset on Figure 1a) and approached the female directly. She immediately dove and resurfaced wearing a large wad of grass (see Figure 1a). The decorated dolphins submerged, obscuring their subsequent transaction from view. However, working backwards from the birth of her subsequent calf, the female was pregnant within three weeks of this observation.

The female's deliberate response raised many questions: whether grass-wearing is typically deliberate, limited to sociosexual contexts as in Amazon River dolphins (boto, Martin et al., 2008), or accidental from proximity to seagrass meadows. The aim of this report of grass-wearing behavior among John's Pass dolphins is to describe the contexts of grass-wearing in detail and discuss the insights they provide into the behavior's probable function as random, social object handling, tool-use-like behavior, or something else.
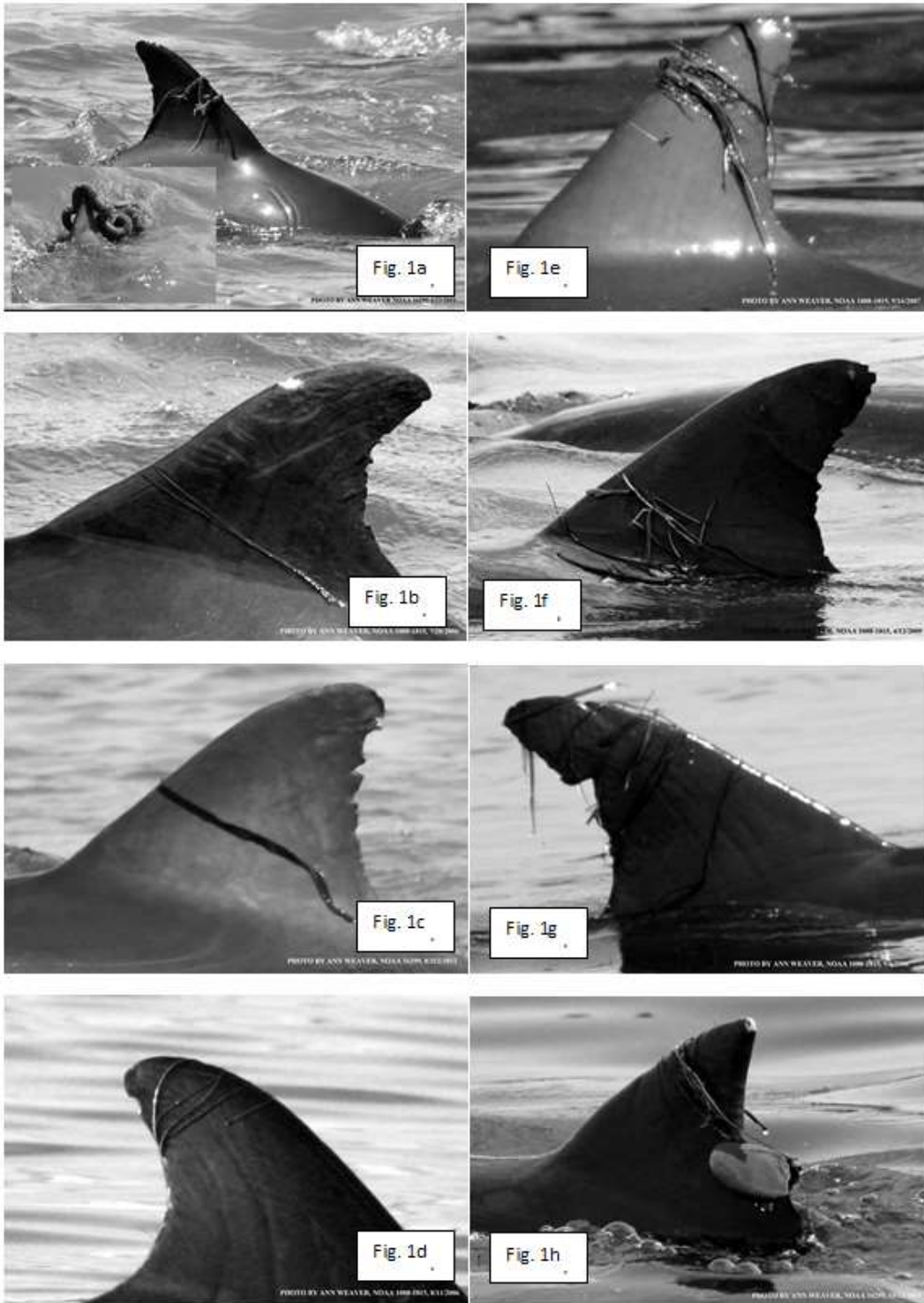
Figure 1. **Grass-wearing behavior among John's Pass bottlenose dolphins.**

Method

Study Area and Boat Surveys

The study area (see Figure 2) is a narrow 15-km stretch of the continuous Boca Ciega Bay Intracoastal Waterway (ICW) estuary that spans John's Pass, a tidal inlet that connects the ICW and the Gulf of Mexico on the west coast of the St. Petersburg peninsula in Florida. Water depth averages 1-3 m deep except in John's Pass, which is 6-12 m deep. The sea floor is a patchwork of hard-packed sand, muddy sand, oyster bars, and continuous and patchy seagrass beds. John's Pass dolphins are part of the Tampa Bay stock (Fulling, Mullin, & Hubard, 2007; Hubard & Schwartz, 2002). No data exist on them outside of the current study (Weaver, 2015). Data collection began in June 2005 under NOAA GA permits 1088-1815, 16299 and 16299-2. As of 2016, the dolphins constitute a semi-closed community, $N = 357$ identified dolphins (Weaver, 2015).

Figure 2. **Map of the John's Pass study area with locations of grass-wearing observations by dolphin gender.**

The study area was surveyed 2-3 times a week by small boat (6-m Proline, 115 hp Yamaha outboard) starting within two hrs of dawn in calm seas ($\leq$ Beaufort 3). A complete survey (incomplete surveys are aborted by bad weather) starts at John's Pass (27.782083 N, 82.781831 W), continues to the north end of the study area (27.830753 N, 82.829525 W), retraces the route half way but continues east of John's Pass tidal deltas to the southern end of the study area (27.738156 N, 82.766681 W), and ends at John's Pass. This report only includes complete surveys. Two observers watch for dolphins (Weaver, 2015). Between 1 to 17 dolphin groups (1 to 52 dolphins per group) are encountered or sighted during surveys ($M = 12$ dolphins/survey). A sighting was any visual encounter with a

dolphin. When dolphins are not sighted (3% of all surveys, Weaver, 2015), it takes two hours to survey the study area but up to eight hours when dolphins are sighted (97% of all surveys).

The survey route is a transect line between channel markers. Dolphins were initially approached to 18 m (three boat lengths) to identify current behavioral state (described in section on definitions of behavioral states). Subsequent observations were typically made from a distance of 7-10 m or less. An observation period lasted a minimum of 15 min (or was excluded from analysis). When behavioral state did not change in 15 min, the observation was ended and the survey continued. When behavioral state or group composition changed, additional 15-min periods were added. When a group fissioned, we followed the subgroup with the least recent data or the most socially active individuals. Social behavior and processes are central to this study. Socializing dolphins were observed until they stopped socializing.

Data Collection Procedure

AW collected all photographic and behavioral data. Dolphins were individually recognized by dorsal fin patterns; no dolphin was artificially marked. Sightings were documented with photo-identification, a noninvasive mark-recapture technique (Hammond, Mizroch, & Donovan, 1990; Würsig & Würsig, 1977). Marks are recognizable patterns. Recaptures are photos of recognizable patterns. Photographic effort was continuous during sightings with Canon EOS 20D and 50D high-speed digital cameras with a 70-300 mm zoom lens, later sorted by eye and quality (Urian, Hohn, & Hansen, 1999) and dated, labeled and stored by survey. Approximately 86,000 ID photos of 311 identified dolphins were saved during the time covered in this report. Grass-wearing dolphins can be viewed by ID number in the NOAA OBIS Seamap Gulf of Mexico Dolphin Identification System (NOAA, n.d.).

A dolphin group was defined as all visible dolphins acting in a coordinated manner. During the eight years covered in this report, $N = 4,095$ dolphin groups were observed. Each group was documented by date, location (GPS), group size and age-sex composition (adult male, adult female, adult of unknown sex, dependent calf and dolphin of unknown age and sex). Adult males were large dolphins with erections or for which genital pictures were obtained. Adult females were large dolphins seen repeatedly with the same calf or for which genital pictures were obtained. Calves were smaller dolphins in steady company with a larger dolphin, its presumed mother.

Grass-Wearing Behavior

Grass wearing is defined as one or more blades of grass splayed across the leading edge of the dorsal fin (see Figure 1). This definition excludes plant material carried by mouth, pectoral or fluke fins, on multiple body parts, used in release-recapture play, traded between dolphins, or forcibly removed from the body. The Florida Fish and Wildlife Conservation Commission (FWC, *n.d.*) maps seagrasses in the Boca Ciega estuary (which includes the John's Pass study area) every 5-10 yrs. The most recent FWC map (2008, see Figure 2) shows that grasses occur in continuous areas (seagrass meadows) and patchy areas primarily along the eastern shoreline. Dolphins wear three local grass species (see Figure 1). Turtle grass (*Thalassia testudinum*) has flat broad blades easily distinguished from round narrow blades of manatee grass (*Syringodium filiforme*) and shoal grass (*Halodule wrightii*), which are difficult to distinguish from each other from photos (Paul Carlson, FWC, personal communication, October, 2014).

Photos of grass-wearing dolphins (see Figure 1) were categorized by species and number of blades (turtle grass, manatee/shoal grass, both turtle and manatee/shoal grass, indeterminate). Figure 2 shows the location and sex of grass-wearing dolphins on the most recent seagrass map of the study area in conjunction with continuous or patchy seagrasses (species cannot be distinguished from aerial photography, Paul Carlson, FWC, personal communication, October, 2014). Paul Carlson calculated the distances in meters between the location of each grass-wearing dolphin and the nearest sea grass meadows with Arc mapping software.

Definitions of Behavioral States

Behavior data were the duration of an observation period that a focal dolphin spent in four behavioral states: socializing, traveling, forage/feeding, and rest. Each state was identified by characteristic features (e.g., formation, distance between dolphins, etc.), defining behavior units (Müeller, Boutiere, Weaver, & Candelon, 1998) and the following definitions. *Socializing* was defined as physical contact between individual dolphins (e.g., pec touching, fluke petting; Müeller et al., 1998) and persistent following at close proximity (i.e., following dolphin's face is at the leading dolphins' flukes). The context of social behavior was classed as conflict or affiliative. *Conflict* was defined as per Weaver (2003). Affiliative states were classed as playful or explicitly sexual. *Playful* contexts involved social and solitary locomotor and object play (Kuczaj et al., 2006). Social play was further defined as active, (usually) enduring behavior with frequent physical contact (e.g., chasing, nudging, poking and rolling over each other) performed with loose, relaxed body tonus. *Explicitly sexual contexts* involved erections, repeated insertion attempts, and intromissions. Because playful,

affiliative, and sexual interactions occur along a continuum, social interaction that did not meet defined criteria for play or sex was default coded as affiliative. *Affiliative contexts* were characterized by (usually) protracted interactions that involved combinations of the following behaviors (Müeller et al., 1998): lateral or inverted rafting, lateral lurches, inverted submergences, head-to-genital contact, ventral/ventral swimming, mount attempts (arched dive directly over another dolphin), sustained spyhops at nearby dolphins, leaning, genital flushing, pushing a rafting dolphin, rolling, double spyhops, and tailslapping (against or in the immediate proximity of another dolphin). *Traveling* was directional movement at speeds greater than 2 mph without evidence of socializing or foraging. *Forage/feeding* was characterized by lone or dispersed dolphins showing steep dives, extended submergences, and unpredictability of next surfacing location. Many observations included chasing prey, fish tossing, and marine birds such as pelicans, terns, and osprey feeding nearby. *Resting* was steady but very slow directional travel at speeds ≤ 2 mph without socializing or foraging.

Group composition changes via fission (dispersion) and fusion (convergence) were noted. Fusion was defined as a change in group composition by new dolphins joining an existing group that subsequently met the definition of a group. Near-fusion behavior was defined as a change in group composition by dolphins that approached other dolphins to within 18 m (three boat lengths) that did not subsequently met the definition of a group. In the grass-wearing context, fusions were smooth convergences rather than animated convergences that follow notable events (e.g., conflicts, separating interventions to protect calves from rough interaction, interactions with sharks, etc.). Fission was defined as a change in group composition by the departure of one or more dolphins further than 18 m that no longer met the definition of a group.

Data were collected on the duration of behavioral states during focal follows across the length of observation periods (Mann, 1999) for all dolphins in groups of five or less; in groups of six or more dolphins, five randomly selected adults were identified for focal sample data collection.

Definitions of Female Reproductive Phase

Adult females were coded by current reproductive phase. *Pregnancy* is the 1-yr period calculated backwards from the birth of a calf. If the newborn had outgrown its fetal folds by the first time it was seen, seven weeks were added to the estimated calf birth window and the previous year's conception window (based on 97 recorded births to date). The *focused mothering* phase is the first 2-yr period of a calf's life or as long as it survived within this period; this is the time when the mother is steadily accompanied by her dependent calf ≤ 2-yrs-old. The *technically available phase* starts upon the death of a calf or when a surviving calf is 2-yrs-old. It implies technical availability for mating activity (rather than receptivity per se) and is defined as adult females not steadily accompanied by a dependent calf ≤ 2-yrs-old and not pregnant. Based on 72 births among 31 resident females (chosen because resident females have been seen the most often), the estimated interval between consecutive births is 3-4 yrs, $M = 42.42$ months, $SD = 19.72$, $Mdn = 37$, bimodal = 36, 48, *minimum–maximum* = 13-84 months between consecutive births. Allowing for a year-long pregnancy, the technically available phase is estimated to last an average of 2-3 yrs.

Data Analyses

This report refers to the 79 dolphins observed wearing grass from January 2006-December 2013. The sighting list of the 4,095 groups encountered during this time was used to generate a sighting history for each grass-wearing dolphin. Grass-wearing rates were generated by dividing the total number of grass-wearing observations by the total number of observations exhibiting each behavioral state and, for adult females, each reproductive phase. This controlled for frequencies of behavior in the population, although our aim was not to compare grass-wearing to non-grass-wearing frequencies because grass-wearing was rare (2% of the time; see the Results section) and significant differences between them inevitable.

Data were screened for normality, linearity, homoscedasticity, and outliers (Hair, Black, Babin, Anderson, & Tatham, 2010). The decision to include outliers was made before analysis took place (Warner, 2013) because they represent actual behavior. The data did not show any substantial or systematic departures from statistical normality. Significance was set at $\alpha = .05$. Analysis was done with SPSS v 23 software. A *t* test was used to compare group size between groups with and without grass-wearing dolphins; effect size was Glass's delta (Δ) using variability from groups without grass-wearing dolphins as the baseline denominator. Repeated measure ANOVA tests were used to compare grass-wearing rates across behavioral states, age-sex classes and female reproductive phases, using partial η^2 (η_p^2) effect size statistics.

Results

The study area (see Figure 2) was surveyed 965 times from January 2006-December 2013 (n = 99-150 surveys/year for eight yrs). During this time, a total of N = 9,551 dolphins were sighted. Of these, 190 sightings (2% of 9,551 sightings) involved dolphins wearing grass. A total of 79 different dolphins wore grass. The average number of overall sightings of the grass-wearing dolphins was over 100 times each, M = 121 total sightings/grass-wearing dolphin, SD = 96, Mdn = 95, $minimum$ = 5 (dolphin #182), $maximum$ = 404 sightings (dolphin #178). Grass-wearing was seen approximately two dozen times a year (M = 21.11 grass-wearing observations/year, 8 years, SD = 7.59, $minimum$ = 9, $maximum$ = 34 observations/year). Table 1 shows that a third of the dolphins were seen wearing grass once. Another quarter was observed wearing grass twice. The remaining third were observed wearing grass 3–8 times. Grass-wearing rates correlated significantly with the rates of sighting individual dolphins, $r(77)$ = .50, p < .001. This result held for males, $r(37)$ = .64, p < .001, and for females, $r(36)$ = .41, p < .001.

Table 1

Number of Grass-wearing Observations x Age-sex Class Crosstabulation, N = 79 Dolphins

Number of times seen wearing grass	Age class					
	Adult male	Adult female	Calf male	Calf female	Calf unknown sex	Total
1	13	10	3	3	1	30 (38%)
2	8	6	2	3	0	19 (24%)
3	5	8	1	0	0	14 (18%)
4	1	4	1	0	1	7 (9%)
5	3	1	1	0	0	5 (6%)
6	1	1	0	0	0	2 (2%)
7	0	1	0	0	0	1 (1%)
8	0	1	0	0	0	1 (1%)
Total	31 (39%)	32 (41%)	8 (10%)	6 (8%)	2 (3%)	79 (100%)

The 190 grass-wearing observations were made on 109 different survey days (i.e., multiple dolphins wore grass on some surveys). One dolphin wore grass per group on approximately half of the observations (n = 106, 56%). On the other approximate half of the observations (n = 84, 44%), more than one dolphin in the group wore grass. Of these, pairs of grass-wearing dolphins were the most common (n = 19 different groups, 10% of 190 grass-wearing observations) and wore grass in all behavioral states except foraging.

It was uncommon to see more than two dolphins in the same group wear grass and such observations were striking. Two observations (1% of 190) of 3 grass-wearing dolphins occurred in the contexts of affiliation (three grass-wearing adult males among 10 adult males socializing with five females) and play. There was only 1 observation of 4 dolphins in the same group wearing grass (< 1% of 190); they were the only group members. All four males wore grass once or twice during protracted explicit sex with frequent changes in sexual pairings, showing that grass-wearing behavior is not limited to heterosexual groups.

The 2 observations (1% of 190) of 5 dolphins in the same group wearing grass were also striking. One observation occurred in an affiliative context when four adult females wore grass as they joined an adult male, which then responded by also wearing grass. These five then maintained close proximity while socializing with other dolphins during an unusually protracted convergence of 32 dolphins in total. Three of the four grass-wearing females were pregnant, showing that grass-wearing behavior is not limited to a particular female

reproductive phase. The other observation of five grass-wearing dolphins occurred in an explicitly sexual context of six adult males and one female, characterized by frequent changes in sexual pairings between the female and various males, during which the female wore grass four different times and four of the males each wore grass once.

Finally, there was a very striking observation of 10 dolphins (five adult males, five adult females) that wore grass (< 1% of 190) a total of 12 times as new dolphins joined until the group totaled 30 dolphins. The group was ultimately comprised of twice as many technically available females as adult males, which introduced considerable potential for competition over sociosexual partners. Also notable was that one of the grass-wearing females that wore grass twice was the mother of a 4-day-old calf, which introduced the notion that grass wearing was not limited to competition among mating pairs or obvious availability for recreational sex.

Proximity to Sea Grass Meadows

Figure 2 shows that grass-wearing behavior did not systematically occur in the immediate vicinity of seagrass meadows. Distances between the grass-wearing dolphin and closest seagrass source were substantial (patchy meadows: M = 196.77 m, SD = 141.23, $minimum$ = 24.44, $maximum$ = 562.34; continuous meadows: M = 103.68 m, SD = 69.44, $minimum$ = 0, $maximum$ = 297.32). Only 1 out of the 190 grass-wearing observations occurred over a seagrass meadow. The two next minimum distances were 14 and 32 m, respectively. Grass worn ranged from a single blade (see Figure 1b, 1c) to a large wad (see Figure 1a, 1e, 1f, 1g). Half of the 190 grass-wearing observations involved turtle grass (n = 93, 48%; see Figure 1c). A third involved manatee/shoal grass (n=66, 35%; see Figure 1b, 1d). A few involved a combination of grass species (n = 18, 9%; see Figure 1a, 1e, 1h) or indeterminate species (n = 14, 8%). Dolphins wore two blades on average (turtle grass: M=1.97 blades, SD = 1.55; manatee/shoal grass: M = 1.83, SD = 1.20).

Group Size Differences

Grass-wearing occurred in the presence of other dolphins with four exceptions of lone foraging dolphins. One was a very old male, judging from worn teeth and bleached leading edges of fins. Two were newly weaned males observed from the start of the study. One was a near-term pregnant female. The hypothesis that group size was larger when dolphins wore grass than otherwise was examined two ways. One, a paired t test was used to compare group size between groups with and without grass-wearing dolphins. Groups that included grass-wearing dolphins were significantly larger by up to four dolphins, $t(78)$ = 3.28, p = .002 (grass-wearing: M = 8.94, SD = 6.74 dolphins/group; non-grass-wearing: M = 6.45, SD = 1.14; 95% CI of the difference [1.00, 4.00]. The effect of grass on group size was very large, $Glass's$ Δ = 2.18. Two, grass-wearing frequencies were calculated for categorical group sizes of n = 1 dolphin, n = 2-3 dolphins, n = 4-10 dolphin and n = 11+ dolphins for each dolphin and compared to see if rates increased with group size. Comparisons showed that the likelihood that individuals wore grass increased with group size. The average individual dolphin wore grass 0.87% of the time when alone, 1.81% of the time when in groups of two or three, 4.89% of the time when in groups up to 10 dolphins, and 4.94% of the time when in groups of 11 or more dolphins.

Grass-wearing Rates by Behavioral State and Age-sex Class

A repeated measures ANOVA was run to test the null hypothesis that grass-wearing rates did not differ by behavioral state or in interaction with age-sex class. Repeated measures were rates of grass-wearing during socializing, travel, forage/feed and rest. The between-subjects variable was age-sex class (with 5 levels: adult male, adult female, calf male, calf female and calf of unknown sex). Grass-wearing rates varied significantly by behavioral state, $F(3, 222) = 12.94$, $p < .001$. The effect of behavioral state on grass-wearing was large, $\eta_p^2 = .15$. In contrast, the effect of the Behavioral State x Age-sex Class interaction was non-significant, $F(12, 222) = 1.34$, $p = .201$, $\eta_p^2 = .07$.

Figure 3 shows that grass wearing was significantly more frequent during socializing ($M = 0.26$, $SD=0.20$) than during the other three main behavioral states. Mean rates of grass-wearing in the other states were low but variable (travel: $M = 0.03$, $SD = 0.09$; forage: $M = 0.04$, $SD = 0.15$; and rest: $M = 0.05$, $SD = 0.20$). Planned contrasts showed that the rate of grass-wearing behavior during socializing was significantly higher than rates during travel, $F(1, 74) = 20.82$, $p < .001$, $\eta_p^2 = .22$; forage/feeding, $F(1, 74) = 26.54$, $p < .001$, $\eta_p^2 = .26$); and rest, $F(1, 74) = 10.31$, $p = .002$, $\eta_p^2 = .12$.
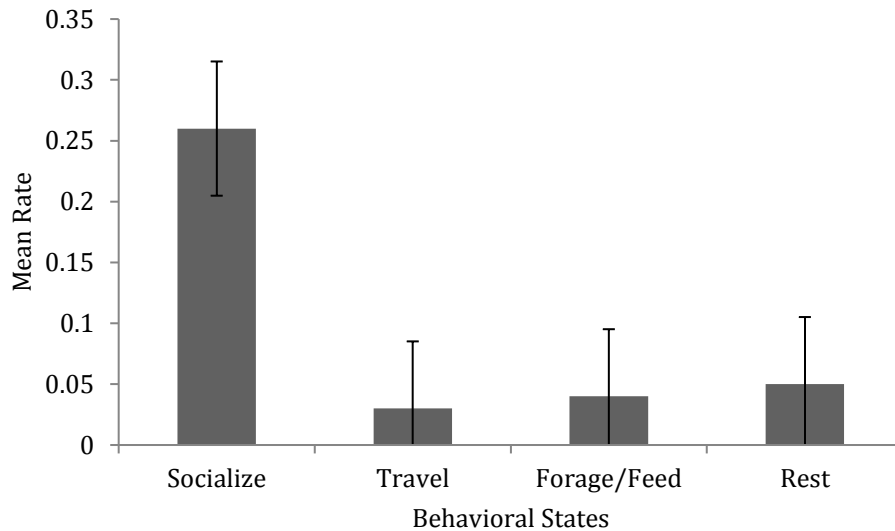

Figure 3. **Mean rates of grass-wearing across four behavioral states (error bars ± 1 *SE*). bars**

Figure 4 shows that 77% of the grass-wearing observations occurred when the grass-wearing dolphin was engaged in social behavior (in descending order: 40% affiliative socializing, $n = 76$ observations; 24% explicitly sexual, $n = 46$ observations; 12% play, $n = 22$ observations; < 1% conflict, $n = 1$ observation). Another 11% occurred when the grass-wearing dolphin was traveling ($n = 21$ observations) or forage/feeding (9%, $n = 18$ observations). The remainder occurred when the grass-wearing dolphin was resting (3%, $n = 7$ observations).

Figure 4 also illustrates the number of grass-wearing observations by fusion events (no fusion, yes fusion, near-fusion). A third did not involve changes in group composition (no fusion $n = 58$, 30%) whereas 70% of the grass-wearing observations involved fusion events ($n = 105$ observations, 55% of 190) or near-fusion events ($n = 28$ observations, 15%). Fusion events characterized 87% of the grass-wearing observations during affiliative socializing ($n = 66$ out of 76 affiliative observations, i.e., 10 times more likely to occur than when fusions did not occur). Fusions were slightly less common during explicit sex ($n = 18$, 39% of 46 sex observations) than when fusions did not occur ($n = 23$ observations, 50% of 46). Fusions were equally likely to occur as not occur during play ($n = 11$, 50% of 22 play observations). In contrast, near-fusion events were more common than no fusion or fusion events during travel ($n = 9$, 43% of 21 travel observations) and forage/feeding ($n = 9$, 50% of 18 feeding observations). Grass-wearing during rest was infrequent, and roughly equal occurrences involved no fusion, fusion and near-fusion events.
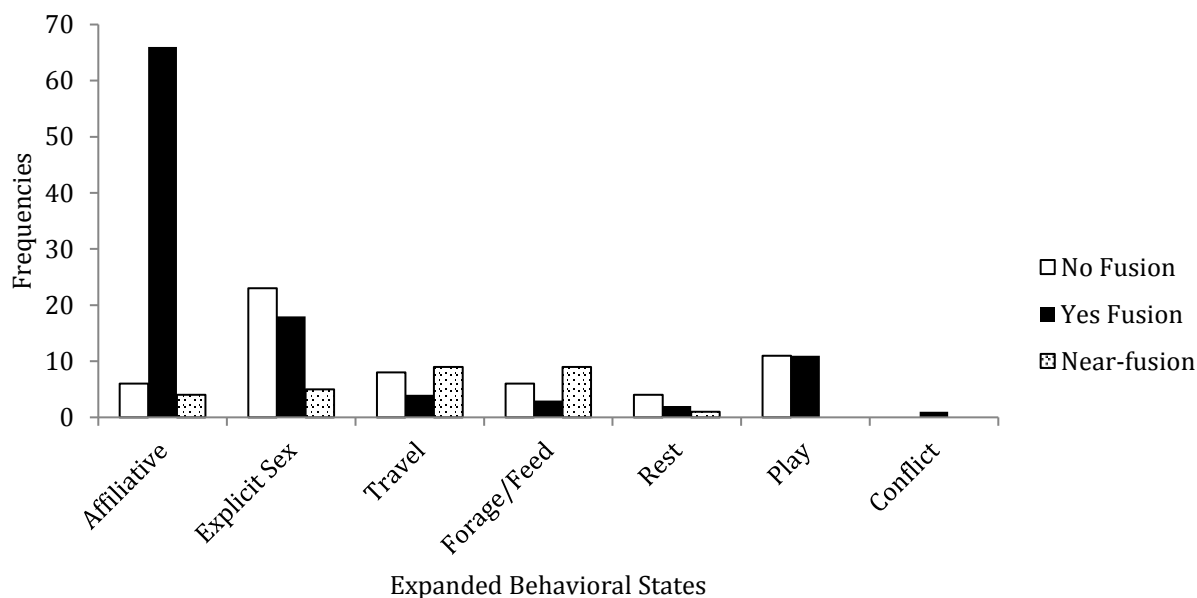

Figure 4. **Distribution of grass-wearing occurrences by fusion event.**

Play was included with social behavior (see Figure 3) and occurred 22 times. Only one of these involved parallel play, when a 6-month-old male calf wore grass during solitary locomotor play near his foraging mother (date: 12/24/2011). The other 21 observations involved social play. Of these, group sizes ranged from 3 to 12 dolphins except for two observations that involved two dolphins. One was the male calf in parallel play and the other involved two adult males that played in a wad of floating grass.

Grass-wearing Rates by Adult Female Reproductive Phase

A repeated measures ANOVA was run to compare grass-wearing rates across adult female reproductive phase. The repeated measures were grass-wearing rates across three reproductive phases (pregnancy, focused mothering and technically available) for each grass-wearing female. Grass-wearing rates

did not vary significantly by phase, $F(2, 48) = 0.13$, $p = .89$. When rounded, rates were the same: pregnancy, $M = 0.02$, $SD = 0.03$, focused mothering, $M = 0.02$, $SD = 0.04$, and technically available, $M = 0.02$, $SD = 0.03$ (see Figure 5).
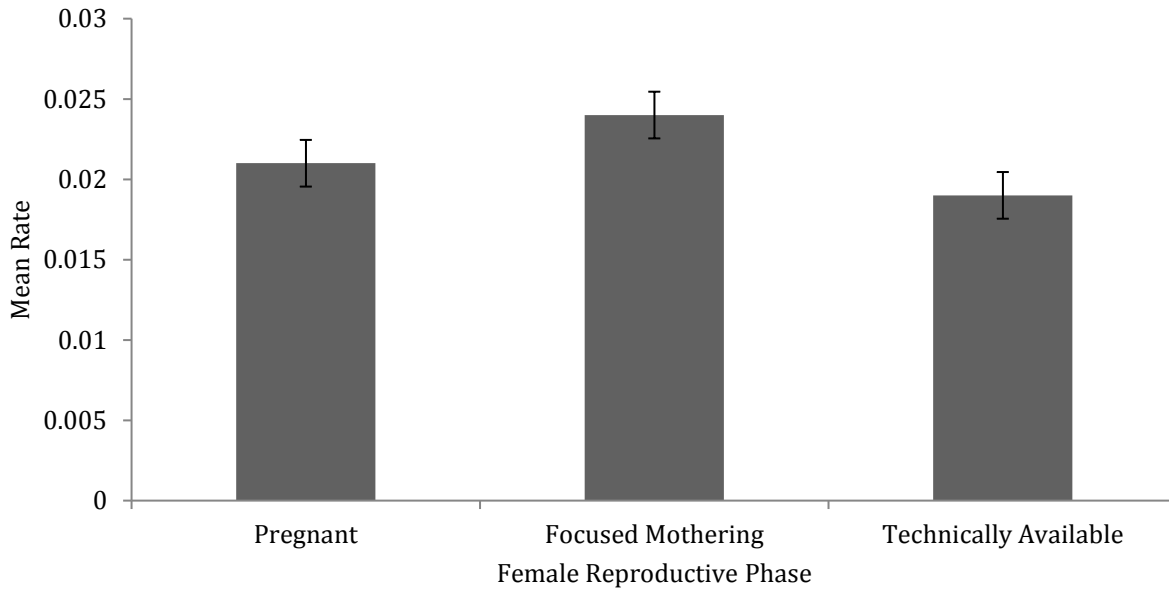

Figure 5. **Grass-wearing rates across adult female reproductive phases (error bars ± 1 *SE*).**

Discussion

Results revealed that grass-wearing behavior has the following characteristics, which do not establish the behavior's function but are suggestive. The behavior occurred rarely but steadily over the 8-yr study period. The behavior was observed in 79 different dolphins, two-thirds of which were observed wearing grass up to eight different times. Grass-wearing events varied in expression from a single blade to a large wad of grass worn during one to several consecutive breathing surfaces (i.e., staying on during submergences). This lack of stereotypy is similar to plant and clay object use among courting male boto (Martin et al., 2008). Grass-wearing occurred over 100 m from the nearest seagrass meadow, suggesting that it is not a random consequence of activities in proximity to it. Rates of grass-wearing behavior did not differ by age-sex classes and do not therefore appear to have an age-sex bias, unlike courting male boto (Martin et al., 2008). Adult females wore grass in all three reproductive phases, suggesting that the behavior was not limited to social receptivity associated with estrus. Finally, grass wearing occurred in larger than average social groups, similar to plant and clay object use among courting male boto (Martin et al., 2008). Unlike boto (Martin et al., 2008), dolphins wore grass in all four main behavioral states although significantly more often while socializing. Finally, unlike boto (Martin et al., 2008), only one observation of grass wearing was seen during conflict. Grass-wearing is not explained as a likely sociosexual male courtship display.

Grass-wearing behavior was only partly explained as play. Play accounted for just 12% of the grass-wearing observations, half of which involved calves, and half adults. All but one instance involved social play,

consistent with grass as a toy. Captive dolphins will treat any object in their pool as toys (Paulos et al., 2010). Most references to cetacean object play with seaweed and flexible man-made materials report that toys are typically carried in the mouth or other body parts, and/or passed around various parts of the body as well as between playmates (Kuczaj et al., 2006; Paulos et al., 2010). However, grass-wearing dolphins did not treat the grass that they wore as if it was a toy, such as is seen during cooperative play (Kuczaj & Highfill, 2005). The grass-wearing definition excluded handling plant material in any way but splayed, although grass-wearing dolphins also handled plant material on two occasions. Nor did grass-wearing dolphins appear to mimic each other, which is also common during play (Kuczaj et al., 2006), insofar as only two grass-wearing observations during play suggested possible mimicry (4/29/2012, 5/12/2012). In both, an adult male wore grass and then the male calf he was playing with wore grass. A further distinction is that Kuczaj et al.'s (2006) landmark study of the role of play in cultural transmission revealed that dolphins usually mimic the play behavior of another calf rather than that of an adult. Grass wearing by more than one dolphin in the same group occurred half of the time, primarily by two dolphins. These observations contra-indicate play and mimicry because grass wearing by one dolphin was not immediately followed by grass wearing in a second dolphin shortly after observing it, nor was it repeated frequently, as occurs during play, and most of these observations did not contain other play characteristics. The lack of immediacy and repetition introduces the possibility that grass-wearing dolphins were reacting to the same triggering environmental stimuli, such as the social setting created by the new group, rather than mimicking per se.

Similarly, grass-wearing behavior was only partly explained as tool-use-like behavior. Mann and Patterson (2013) defined aquatic animal tool use as an animal using an object conditionally and purposely in a specific context to achieve a goal. This currently relegates many types of aquatic animal object handling to tool-use-like behavior, including objects worn to protect or camouflage the body, which grass on the dorsal fin seems unlikely to achieve, and probable sociosexual behavior among male boto. Moreover, grass wearing only meets some of the criteria for tool-use behavior. First, it is probably purposeful because dolphins will forcibly remove stuck grass on occasion and vortices require effort to keep the grass on. Second, the general context is social. The specific context is fusion. True tool use among cetaceans, such as dolphins sponging and otters using rock hammers and anvils, is solitary. However, depending on interpretation, grass is either not manipulated at all or manipulated passively (simply splayed across the dorsal fin), and its purported goal is not concrete compared to using a sponge to protect the rostrum from stinging spines or a rock to smash open an abalone.

Grass wearing is also apparently unrelated to conflict, which further distinguishes it from the probable sociosexual displays with plant materials among male boto (Martin et al., 2008). Conflict among John's Pass dolphins is generally rare (Weaver, 2014), making it unlikely that grass wearing evolved to accrue some advantage as a type of "waving the white flag of surrender" behavior to offset high levels of conflict. However, intense conflict (Weaver, 2003) in this area mainly occurs among dolphins unfamiliar with each other (Weaver, 2014), raising questions about the role of familiarity of group members when grass wearing occurs.

Finally, grass wearing was not explained as accidental from activities conducted in seagrass meadows. However, a limitation is the unknown role of some environmental component because data are not available on availability of floating seagrasses; these data are needed to rule out this explanation of grass-wearing.

Instead, based on the contexts in which grass wearing occurred the most frequently, that is, during fusion and near-fusion events, it can be argued that grass wearing has social meaning because dolphins wear grass when forming a new group whose members then socialize. During fusion events observed in this study, either a new group member wore grass as it converged on an existing group or a dolphin in the existing group wore grass as new group members joined it. A fusion event changes the social environment by increasing any

existing competition for attention from group members or by introducing ambiguity about the nature of ensuring interaction that may benefit from communication that clarifies the intentions of the new dolphin(s).

Fusion itself is common. But wearing grass during fusion is rare and therefore novel. Dolphins are selective about whom they observe (Bender, Herzing, & Bjorklund, 2009; Kuczaj et al., 2006). They pay particular attention to novelty (Kuczaj et al., 2006; Kuczaj, Yeater, & Highfill, 2012). Free-ranging spotted dolphin mothers use fish to capture their calves' attention during foraging lessons (Bender et al., 2009). Bottlenose dolphins (Kuczaj et al., 2012) and killer whales (Kuczaj & Walker, 2006) modify their own behavior to keep it interesting. As novel behavior, we propose that grass wearing is a form of object handling where wearing grass is familiar but novel (i.e., is moderately discrepant) and potentially functions as stimulus enhancement (an observation that leads to increased interest in an environmental element; Kuczaj et al., 2012). The creation of a new dolphin group increases potential competition for social partners. As a novelty, grass wearing may attract the attention of conspecifics or increase their interest in the grass-wearing dolphin. This tentative conclusion is based on the following evidence.

Fusion Events

Over three-quarters of the grass-wearing observations involved fusion or near-fusion events. Fusions involved all manner of group composition changes. Common instances included fusions with adult males that were herding one or more technically available females (e.g., 6/30/2006, 3/17/2007, 6/22/2008, 7/17/2009) and socializing following the convergence of either a female or a male into a socializing group of males and females (e.g., 7/19/2006, 6/15/2007, 5/15/2010). Another common instance was fusion of one or more dolphins with a nursery group comprised on mothers and very young calves (e.g., 12/20/2009, 4/13/2013), an adult female converging with two or more adult males (e.g., 11/6/2010), or an adult male either converging on a mother-calf pair (e.g., 10/19/2013) or a group of females (e.g., 5/12/2012). This behavior is consistent with grass as a stimulus enhancement used in greeting.

Near-fusion Events

Near-fusion events were defined conservatively in the current study. They are a form of "separately together" behavior akin to parallel play insofar as dolphins wore grass in the vicinity of other dolphins but did not clearly join them. Fifteen percent of the grass-wearing observations fit this definition. Near-fusion events mostly occurred when the grass-wearing dolphin was traveling and foraging or feeding. Instances during travel included meandering in the vicinity of socializing dolphins (e.g., 5/3/2006, 12/12/210, 7/31/2011, 9/20/2013) or of courting dolphins (e.g., 7/23/2006, 5/6/2011, 12/12/2011, 8/31/2012, 7/11/2013). Other instances involved adult females without calves that wore grass near playing calves (e.g., 7/7/2006, 10/14/2007, 8/3/2008, 12/20/2009). Several involved a male or female wearing grass in the vicinity of foraging dolphins (e.g., 5/3/2006, 5/19/2006, 5/28/2006, 9/16/2007, 7/31/2011). During forage/feeding, two near-fusion event patterns were a mother dolphin wearing grass while foraging near her calf playing with other calves (e.g., 7/19/2006, 10/14/2007) or other adults (e.g., 12/24/2010, 8/31/2012). Another pattern was grass wearing when approaching but not converging with other foraging dolphins (e.g., 5/19/2006, 5/28/2006, 9/16/2007, 7/17/2009, 7/4/2012). A few episodes involved dolphins playing with a calf that was then retrieved by its mother (fission); one of the playing dolphins then wore grass and followed the mother briefly (7/28/2006, 7/12/2012). These observations are consistent with grass as a stimulus enhancement in the context of either greeting or bids for attention.

Non-fusion Events

A portion of the grass-wearing observations did not involve fusion or near-fusion events because the composition of the dolphin group did not change. These observations are consistent with grass as a stimulus enhancement as bids for attention.

Most of these grass-wearing observations occurred in explicitly sexual contexts. The majority (97%) of dolphins that wore grass during sexual exchange were adults, with slightly more males than females. These observations included four male homosexual groups (11/10/2006, 6/25/2008, 9/8/2013, 10/13/2013). The rest involved both male and female sexual partners (e.g., six observations involved one female and multiple males 10/28/2007, 7/18/2010, 12/12/2010, 4/23/2011, 10/20/2013; including a pregnant female that wore grass and had sex with males 10/30/2010). The 46 grass-wearing sex observations occurred in 29 groups, that is, more than one grass-wearing dolphin was in the group (six groups involved 2 to 5 grass-wearing dolphins). Thus, more than one dolphin responded to whatever triggered grass wearing. Whereas it may be that sex is a form of play, which would make bottlenose dolphins a species that continues to play at extraordinarily high rates throughout life, the alternative is to suggest that play and sociosexual activities occur on a continuum that requires more study. Instead, it seems more reasonable to propose that sexual interaction, versus generic affiliative interaction, changes the social dynamic by intensifying the competition over social partners. Intensified competition is consistent with a potential role for grass as a stimulus enhancement serving as bids for attention.

The greatest limitation of this field study is that fusion events are limited to those that can be observed at the surface from a small boat with a running outboard engine. The running engine means that we cannot hear dolphin vocalizations at sea. The possible role of vocalizations in fission-fusion events among John's Pass dolphins is currently unknown. It is currently unclear if and how often different dolphin groups contact each other acoustically when spatially distributed in ways that do not meet our definition of a dolphin group, and the extent to which grass wearing may occur in response to acoustic contact with other individuals before fusion events or physical contact takes place visibly at the surface. Fusion events may be acoustically mediated and occasionally enhanced with grass.

Why evolve an object handling behavior as a greeting or bid for attention when a body posture or vocalization would suffice? For that matter, why develop such extensive bubble play (Gewalt, 1989; Kuczaj et al., 2012)? John's Pass dolphins exhibit several behaviors that serve as greetings and bids for attention, including body positions that "flash the white belly" at a conspecific and swimming past at very close range (an "interested pass"). Reasons to develop more elaborate behavior are that dolphins are easily bored (Kuczaj et al., 2012), modify their own behavior to keep it interesting (Kuczaj & Walker, 2006), are capable of joint attention (Pack & Herman, 2006) and may plan their behavior when confronted with novel problems (Kuczaj, Gory, & Xitco, 2009). As a form of stimulus enhancement, wearing grass is a novel event that may have more attractive force than standard invitational events that is used selectively as needed.

An element of potential selectivity and further study is to investigate the role, if any, of the relative familiarity among dolphins involved in grass-wearing events. Familiarity can be measured by coefficients of association (COA). A COA x Grass-wearing Behavior analysis can reveal systematic associations if they exist. For example, if grass wearing is more likely among unfamiliar dolphins, grass wearing as stimulus enhancement may augment fusion events by communicating intentions. If grass wearing is more likely among familiar dolphins, grass wearing may be moderately discrepant and serve to augment standard bids for attention in larger groups that present more competition for attention.

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