QUANTITATIVE BEHAVIORAL STUDY OF BOTTLENOSE DOLPHINS IN SWIM-WITH-THE-DOLPHIN PROGRAMS IN THE UNITED STATES

By Amy Samuels[1,2] and Trevor Spradlin[2]
Assisted by Craig Pelton[3] and Cindy Flaherty[1]

[1] Chicago Zoological Society, Brookfield, IL 60513
[2] Woods Hole Oceanographic Institution, Woods Hole, MA 02543
[3] Florida International University, Miami, FL 33175

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SUMMARY

Behavioral observations of dolphins in Swim-With-The-Dolphin (SWTD) programs were conducted at all SWTD facilities, resulting in 107 observation hours of Swims. We used the same quantitative behavioral sampling technique at each facility to ensure comparable data collection during all Swim programs. All Swim programs or portions of programs were classified into two Swim types, Controlled Swims and Not-Controlled Swims, that were defined on the basis of presence or absence of explicit trainer regulation of dolphin-swimmer interactions.

In comparing dolphin behavior between the two Swim types, we found that high risk activity comprised a substantial proportion of dolphin-swimmer social activity during Not-Controlled Swims. In contrast, high risk activity rarely occurred during Controlled Swims. Comparison of dolphin behavior during Controlled and Not-Controlled Swims at one facility, where the same dolphins and swimmers participated in both Swim types, revealed that direct trainer control was a significant factor in determining the frequency of high risk activity during Swims.

High risk activity included agonistic behavior (aggression and submission), as well as sexual behavior with swimmers which was shown to significantly co-occur with agonistic behavior. Adult women and children were disproportionately involved in swimmer-at-risk activity (aggression/sexual behavior by dolphins; submissive behavior by swimmers), and adult men were disproportionately involved in dolphin-at-risk activity (submissive behavior by dolphins). We could not identify a class of dolphins that was disproportionately involved in high risk activity because few dolphins other than adult females participated in Swims during the study. Thus, adult female dolphins were involved in high risk activity during this study when few males participated in Swims; however, NMFS's records show that it is adult and maturing males that have been implicated in high risk activity leading to serious injury to swimmers.

Behavior of dolphins during Swims was also compared with their own behavior during free time, and this comparison showed that normal free-time dolphin behavior was modified during Swims. During Controlled Swims, trainers effectively eliminated behaviors that put swimmers or dolphins at risk in the Swim context, even though those sexual and agonistic behaviors were a normal component of the dolphins' free-time social repertoire. In contrast, sexual behavior was found to be greatly elevated during one Not-Controlled Swim when compared with the dolphins' normal social repertoire during free time.

Dorsal towing under direct trainer control during Controlled Swims was not associated with any undesirable behavior; however, spontaneous dorsal towing during one Not-Controlled Swim was found to significantly co-occur with agonistic behavior.

Dolphins at one facility did not freely and voluntarily enter the designated refuge area even during their free time; thus, it could not be concluded that that refuge area provided adequate sanctuary from swimmers during Swims. Effectiveness of refuge areas at some other facilities may have been reduced because trainers recalled dolphins from the refuge during Swims.

INTRODUCTION

Swim-With-the-Dolphin (SWTD) programs allow members of the public to enter a pool with one or more captive dolphins for recreational swimming. The National Marine Fisheries Service (NMFS) first authorized use of bottlenose dolphins (*Tursiops truncatus*) in a SWTD program in 1985 and three additional programs were authorized in 1987-88. SWTD programs are presently limited to the original four facilities that operate under experimental and provisional public display permits, pending determination by NMFS whether these programs adversely affect the health and well-being of dolphins. The present study of behavior and social interactions of SWTD dolphins comprises one component of the NMFS evaluation of these programs.

A review of SWTD programs by NMFS was summarized in a 1990 report, "Final Environmental Impact Statement on the Use of Marine Mammals in SWTD Programs" (herein, referred to as FEIS). This report stated that there were insufficient data to make definitive conclusions about effects of Swim programs on dolphin behavior: specifically, whether SWTD dolphins exhibited aggression, aberrant behavior, or behavioral signs of stress. The present behavioral study was designed to quantify the frequencies of such behavior and to evaluate and refine the "Recommended Special Conditions" relevant to behavioral issues (FEIS 1990, pp.74-75).

A protocol for the present behavioral study was developed from recommendations made by marine mammal experts who were convened by the Marine Mammal Commission in 1990 to design evaluation procedures for SWTD programs (Wells and Montgomery 1990). The protocol was refined based on recommendations made by representatives of the four SWTD programs who attended a 1992 NMFS workshop to discuss the present behavioral study. An important outcome of this workshop was that researchers and SWTD operators were able to reach consensus on behaviors-of-concern in the Swim program context. The protocol was further refined during a pilot study to ensure that the same sampling techniques, the same rules for recording behavioral interactions, and the same behavioral definitions were used in data collection at all four SWTD facilities.

Specific goals of the SWTD behavioral study included:
(1) to identify a basis for comparison among diverse Swim program types;
(2) to identify and quantify the frequency of specific dolphin behavioral interactions that occur in the Swim context;
(3) to compare behavioral profiles of SWTD dolphins during Swims with their own behavior during free time;
(4) to identify and quantify the frequency of Swim activities that pose potential risk to dolphins or swimmers;
(5) to identify classes of dolphins or swimmers that may be more susceptible to risk;
(6) to evaluate suitability of refuge types based on usage patterns.

Although evaluation of long-term effects of Swim participation on dolphin behavior was not within the scope of this study (see "Scope," below), short-term effects could be evaluated by

designating SWTD dolphins as their own controls and comparing the behavior of SWTD dolphins during Swims with their "normal" behavioral profiles during free time. In addition, the protocol was designed to facilitate identification of associations between classes of behavior and classes of dolphin, types of Swim, *etc.* to suggest modifications that would better ensure the safety and well-being of SWTD dolphins.

METHODS

Pilot Study: A pilot study was conducted from August 1992 to March 1993 to develop guidelines for the formal study, specifically to (a) identify a basis for comparison among SWTD programs; (b) develop a protocol for behavioral sampling that provided unbiased records of dolphin behavior for each SWTD facility and for each Swim type; (c) design an observation schedule that ensured adequate sample sizes at each facility; and (d) refine the list of behaviors-of-interest that was furnished by SWTD operators at the July 1992 workshop. The pilot study included one month of observer training in behavioral sampling techniques at Brookfield Zoo and two months of behavioral observations at all SWTD facilities. Pilot study data were not comparable from all facilities because the preliminary protocol was modified several times and because observers improved in their abilities to recognize subtle behaviors. Consequently, pilot study data were not included in this report.

Formal Study: The formal study was carried out in two phases during May-June and October-December 1993. During each study phase, observations were conducted at all four SWTD facilities: Dolphins Plus (DP), Key Largo FL; Dolphin Quest (DQ), Waikoloa HI; Dolphin Research Center (DRC), Marathon Shores FL; and Theater of the Sea (TOTS), Islamorada FL. Total number of observation days per facility was prescribed by the number of dolphins participating in Swims and the number of daily Swim observations allowed by the facility's daily schedule (see below).

QUANTITATIVE BEHAVIORAL SAMPLING TECHNIQUES

The quantitative behavioral sampling techniques for this study were adapted from techniques developed in the course of extensive behavioral research on dolphins at Brookfield Zoo (Gifford 1990; Samuels *et al.* 1989, 1990, 1991, 1992) which in turn had been adapted from procedures widely used in behavioral research on terrestrial animals. See Altmann (1974) for definitions of behavioral sampling techniques utilized in this study.

Behavioral sampling was based on a focal-animal sampling scheme in which the activities, associates and social interactions of a single dolphin were the focus of each observation session. The focal-animal sampling scheme was utilized to provide unbiased behavioral profiles of individual SWTD dolphins. These samples were conducted during SWTD dolphins' two primary daytime activities which were (a) Swim sessions with members of the public and (b) free periods in which neither human swimmers nor trainers interacted with dolphins, resulting in 107 h of observations during Swim sessions and 94 h of observations during free time (Table 1). Observations of training sessions and observations of intervals preceding or following Swims

were conducted during the pilot study but were rejected for the formal study because these periods were not comparable across facilities. Observations were not conducted during "therapy" Swim sessions or when trainers worked in the water with dolphins.

Primary behavioral information about the focal dolphin was recorded using instantaneous sampling techniques, *i.e.*, point samples ("points") recorded at 30-sec intervals. During Swims, each point sample contained the following information about the focal dolphin: (a) age/sex class of swimmers within 1m (swimmer classes defined below); (b) identity of dolphins within 1m; (c) behavioral state (states described below); (d) location (within designated refuge area or not); (e) details of social interactions with swimmers or with other dolphins (behavioral interactions described below); and (f) status of swimmers (status conditions described below). During free time when there were no swimmers present, each point sample contained the same information except that proximity to swimmers was omitted and status conditions referenced trainer presence/absence rather than swimmer status.

Status conditions were defined in order to partition point sample data according to general circumstances likely to influence dolphin behavior. During Swims, status conditions referenced (a) swimmer opportunities for interaction with dolphins (*i.e.*, swimmers were separated from dolphins on steps or on the beach; swimmers had access to dolphins on the dock, standing in shallows, or swimming), and (b) presence/absence of direct trainer control of dolphin and swimmer behavior. During free time, status conditions referenced presence/absence of trainers and trainer activities near the dolphins' pool. Status conditions were defined to be mutually-exclusive (Appendix A).

Behavioral states of the focal dolphin were defined to label activities as (a) social *versus* non-social, and (b) under direct trainer control *versus* not under trainer control. All social interactions could be categorized by these two criteria. Behavioral states were defined to be mutually-exclusive (Appendix A).

Social interactions of the focal dolphin were described in detail by recording (a) all behaviors observed, (b) directionality of behaviors, and (c) identities of initiator(s) and recipient(s). In addition, when recording interactions among dolphins during Swims, presence/absence of swimmers within 1m was noted. Interactions were defined as bouts of socializing that were continuous, in which partners (human or dolphin) were within 1m of each other, and in which no change in partners occurred. All behavioral components of social interactions were defined precisely (Appendix A).

Two types of sampling regimes were used to supplement the point sample data.
(a) Continuous (i.e., all occurrence) sampling of social interactions of the focal dolphin was conducted during Swims. (b) *Ad libitum* (i.e., opportunistic) sampling of unusual events and social interactions of non-focal dolphins was conducted during Swims and free time. The same conventions, definitions, and recording rules described for point sample data were used in recording all-occurrence and *ad lib* social interactions.

Difficult observation conditions at all facilities (*e.g.*, murky water, large pool size, and/or extreme surface glare) imposed restrictions on data collection. (a) A single observer was unable to record all information consistently and accurately; thus, all data collection at all four facilities during the formal study was conducted by two observers (T.Spradlin and C.Pelton) who worked together as a team. (b) Murky water at three SWTD facilities (DP, DRC, TOTS) obstructed viewing of dolphin behavior below the surface of the water which may have resulted in incompletely-seen dolphin-swimmer interactions during those Swim types in which movements of swimmers and dolphins were unrestricted (See "Basis for Comparison," below). This was not a problem during those Swim types in which dolphin and swimmer movements were restricted to the surface. (c) Difficult viewing conditions were a greater limitation during free-time observations when dolphins spent less time at the surface and their movements were less predictable. When the focal dolphin was not at the surface at the point sample (indicated by a beeper), observers recorded point sample information if the surfacing occurred within 10s; otherwise, that point sample was recorded as "unknown." In addition, during free-time observations, observers did not record all-occurrence data because difficult observation conditions precluded reliable recording of all social interactions.

SUBJECTS OF SWTD STUDY

The study population of 28 dolphins was composed primarily of adult and maturing females (61%); 21% were adult and maturing males; and 18% were immature (Table 2). All dolphins participating in SWTD programs during the study period were focal subjects of this study, with one exception. An infant at DRC was not a subject of observations because he was the sole infant in the Swim population, and pilot study data indicated that his movements were highly correlated with those of his mother. Adult and maturing males were particularly under-represented during the study because several males listed as participating SWTD dolphins did not participate or participated at low levels in Swims during the study (Table 2).

Selection of a focal subject for each observation session was determined by prior scheduling in order to ensure equal and unbiased coverage of all Swim dolphins. However, we were unable to achieve balanced observation time per Swim dolphin at all facilities (Table 1) because of (a) short- and long-term changes by SWTD managers in the roster of dolphins participating in Swims due to mating, calving, unusual behavior, or other events (Table 2); (b) constraints imposed by daily facility schedules; and (c) constraints imposed by a limited project budget. More balanced per-dolphin observation time was achieved for free-time observations because there were fewer restrictions on dolphin availability and scheduling of observation time.

SWIMMERS PARTICIPATING IN SWIM SESSIONS

Swimmer age/sex classes rather than swimmer identities were used in recording details of dolphin interactions with swimmers. The observers assessed visually the age and sex of all swimmers that participated in Swim sessions observed during this study. Age categories were (a) child (pre-pubescent), (b) teenager (pubescent), (c) adult, and (d) senior (approximately >60 years old).

Swimmers were predominantly adult women at all facilities; the second most common class was

adult men (Table 3). Minimum swimmer age was determined by each facility, and participation of children was allowed only at DP and DRC. There were few senior swimmers at any facility and few teen swimmers at DRC.

Mean number of swimmers per Swim session conformed to the maximum two-swimmers-per-dolphin ratio mandated by NMFS (FEIS, p.74), except during Swim-1 at DQ in which dolphins interacted with only half of the swimmer group at a given time (Table 3).

BASIS FOR COMPARISON OF SWIM PROGRAMS

Swim program formats varied both among and within facilities. Although some variables could not be addressed within the scope of this study, dolphin behavior with swimmers could be compared between Swim types that were defined, not by Swim facility, but by the level of overall trainer control of dolphins and swimmers during Swims. The overall level of trainer control was defined by the presence or absence of explicit trainer regulation of the type and duration of dolphin-swimmer social interactions. On this basis, two Swim types were defined: *Controlled* Swims and *Not-Controlled* Swims. A schematic model of Swim types at each facility is presented in Table 4.

Controlled Swims: Trainers had *direct* control over the movements and interactions of both dolphins and swimmers, *i.e.*, trainers determined when interactions would occur, who interactants would be, what kinds of interactions would occur, and what the duration of interactions would be. For example, trainers would direct 1-2 swimmers and 1-2 dolphins to come together to engage in a specified behavior. Dolphins and swimmers were typically separated when not engaged in trainer-controlled interactions to preclude spontaneous social interactions. In most Controlled Swim formats, dolphins were positively reinforced with fish for performing specific trained behaviors. Controlled Swims included (a) the DRC Swim format, (b) both DQ Swim formats, and (c) the initial portion of the TOTS Swim format.

DQ offered 2 types of Controlled Swims (herein, referred to as Swim-1 and Swim-2) that differed in several ways: (a) swimmer-to-dolphin ratio (see Table 3), (b) the duration of time swimmers were in the water (see Fig.1), and (c) how trainers exerted control. During all of Swim-1 and the first portion of Swim-2, dolphin-swimmer interactions were directed by trainers as described above. In the second portion of Swim-2, trainers did not provide positive food reinforcement for performance of each trained behavior. However, trainers did maintain direct control of dolphin-swimmer interactions by remaining with swimmers in the water, by keeping swimmers together as a small, cohesive group, and by directing dolphin-swimmer interactions. Positive food reinforcement was also provided periodically by a poolside trainer. This portion of DQ's Swim-2 was designated *"Controlled"* (in quotes). Where "Controlled" was not specified in this report, all DQ data were combined and labelled Controlled (no quotes).

Not-Controlled Swims: Facility staff watched over but did not explicitly direct dolphin or swimmer movements or dolphin-swimmer interactions. The Swim participants (dolphins and swimmers), and not the facility staff, were the ones who determined when dolphin-swimmer interactions would occur, what kinds of interactions would occur, and what the duration of

interactions would be. Not-Controlled Swims included: (a) the DP Swim format, and (b) the final portion of the TOTS Swim format.

During Not-Controlled Swims, facility staff exerted control in several ways. During the Not-Controlled portion of the TOTS Swim, dolphins were periodically recalled by a poolside trainer and given positive food reinforcement which was not linked to specific trained behaviors. This was not considered to be a Controlled Swim, however, because trainers did not direct specific dolphin-swimmer interactions. In the DP Swim format, poolside attendants supervised Swims by calling out to swimmers and commenting on swimmer behavior. DP attendants did not direct specific dolphin-swimmer interactions and did not use positive reinforcement to shape dolphin behavior during Swims.

Observations of the TOTS program were especially valuable for comparison of Controlled *versus* Not-Controlled Swims because Swim type varied *within* each Swim session, *i.e.*, the same dolphins participated in Controlled and Not-Controlled Swim types with the same swimmers under supervision of the same training staff in the same pool. Although we could not evaluate the effect of the order in which dolphins experienced the two Swim types, it is likely that differences between Controlled and Not-Controlled portions of the TOTS Swim could be attributed to overall level of trainer control and not to any other feature of the Swim.

For ease of comparison, facilities are listed throughout in the figures and tables in order of overall trainer control: (1) DRC (Controlled); (2) DQ (Controlled and "Controlled"); (3) TOTS (Controlled and Not-controlled); and (4) DP (Not-Controlled).

DATA ANALYSES

Analyses in this report were based on all free-time data and a subset of Swim data collected when swimmers were in the water and had full opportunity to interact with dolphins (herein, referred to as "in-water"). For purposes of analyses, data from "in-water" portions of Swims were combined regardless of swimmer location in the water, *i.e.*, swimmers were swimming (all facilities), holding onto a dock (DRC, TOTS, DP), or standing in shallow water (DQ). Interactions with dolphins also occurred when swimmers were sitting on a dock (DRC, DQ, DP) or, infrequently, when swimmers were standing on steps (TOTS), but these poolside interactions were not included in this report.

All analyses were based on point sample (instantaneous) data unless otherwise stated. Sampling on-an-instant reduced observer subjectivity in defining bouts of behavior (interactions). Point sample data also provided a good estimate of proportion of time spent in specified states. Calculations involving "social time" (or "dolphin-swimmer social time") were based on total number of point samples in which focal dolphins were engaged in social interactions (or, were engaged in social interactions with swimmers).

All-occurrence (continuous) data were used for analyses in which exact counts of interactions were required, *i.e.*, for evaluation of the co-occurrence of agonistic behavior with (a) sexual behavior or (b) dorsal towing (see Results, below). In addition, all-occurrence data were used to

provide a comprehensive listing of behavioral repertoires of Swim dolphins (see Appendix C) because rare, brief interactions were sometimes missed by instantaneous sampling.

Ad libitum (opportunistic) data were considered to be anecdotal and were used only to explain aspects of the quantitative dataset.

To facilitate data tabulation, behavioral data were entered into a database program (Paradox 1992). Analyses were carried out using computerized statistical programs (SAS/STAT 1985; SYSTAT for Windows 1992). Graphs were designed using a computerized graphics program (AXUM 1992). Standard significance levels of $p < 0.05$ were used.

Categorization of Behavioral Interactions

During analysis, social interactions were classified into broad behavioral categories on the basis of key components. Interactions were classified into standard classes of behavior relevant to dolphin-dolphin or dolphin-swimmer interactions (*i.e.*, aggression, submission, sexual, affiliative/neutral). As a conservative measure, we created a fifth category called "abrupt" that included behaviors suggested, but not yet demonstrated, to be aggressive (*e.g.*, slap-water, quick-approach). Behaviors that were included in each class are listed in Table 5. All five classes of interactions were seen during Not-Controlled Swims and free time; all classes except "Sexual" were seen during Controlled Swims.

We defined behavioral classes to be mutually-exclusive; thus, complex interactions were categorized hierarchically using the following scheme.

(a) An interaction that contained any occurrence of aggressive behavior was categorized as "Aggressive."

(b) An interaction that contained any occurrence of submissive behavior and no aggressive behavior was categorized as "Submissive."

(c) An interaction that contained any occurrence of sexual (i.e., active genital contact) behavior but no aggressive or submissive behaviors was categorized as "Sexual."

(d) An interaction that contained any occurrence of abrupt, rapid, or turbulent behaviors but no aggressive, submissive, or sexual behaviors was categorized as "Abrupt."

(e) "Affiliative/Neutral" interactions included all remaining behaviors which were not aggressive, submissive, sexual, or abrupt.

Note that this hierarchical categorization scheme resulted in, for example, interactions classified as "aggressive" that also included submissive and/or sexual components.

The hierarchical categorization scheme described above was used for all analyses except those that evaluated co-occurrence of agonistic behavior with other behaviors. To investigate whether two behavior types co-occurred, we labelled all components of an interaction, rather than classifying the entire interaction on the basis of one behavioral component. For analyses of co-occurrence, behavioral interactions that included, for example, both sexual and aggressive components, were labelled as "sexual" and "aggressive."

Uncontrolled Sources of Variability

A number of notable management changes, occurring between the pilot and the formal study or between phases of the formal study, impeded our efforts to fully interpret some results and/or to carry out more refined analyses, *e.g.*, by season or by individual dolphin. Behavior of SWTD dolphins during the formal study was likely to have been influenced by (a) removals from social groupings at DP, and (b) reproductive events, including births within the Swim group or in adjacent groups at DRC, TOTS and DP; and sexual maturation of one male and first conception by all females at DQ. Important changes were also made in Swim program formats at DQ (phasing-in of Swim-1 format) and at DP (elimination of dorsal towing). In addition, subtle differences in dolphin behavior during TOTS Swims were noticed following the arrival of a new curator although no programmatic changes were instituted. There were also changes in physical environments at DP with on-going construction of pools and refuge areas and at DRC with a temporary pool shift for repairs.

RESULTS

PROFILE OF SWIM SESSIONS

Proportion of Time Swimmers Were in the Water

This report focussed on the behavior and social interactions of dolphins during the portion of Swim sessions when swimmers were in the water and had full opportunity to interact with dolphins. In-water time per Swim differed among Swim programs, constituting 43% to 100% of total Swim session durations (Fig.1; Table 6). In-water time per Swim varied from an average of 11.3 min (DQ Swim-2) to an average of 31 min (DP; DQ Swim-1). Dolphins interacted with swimmers during other portions of Swims (*e.g.*, while sitting on a dock at DQ or DRC) but those poolside interactions were not included in this report.

Proportion of Time Engaged in Trainer-Commanded Behaviors

In-water time was further subdivided into proportion in which focal dolphins were under direct trainer control (referred to as "on-command" or trained behaviors) *versus* not under direct trainer control (referred to as "not-on-command" or spontaneous behaviors) (Fig.1; Table 6).

Controlled Swims: Dolphins were under direct trainer control--*i.e.*, were engaged in on-command, social interactions with swimmers or in non-social, trained behaviors watched by swimmers--between 60% (DQ Swim-2) and 97% (DRC) of in-water time.

Not-Controlled Swims: TOTS dolphins were under direct trainer control--*i.e.*, were engaged in non-social, trained behaviors--during 11% of in-water time in the Not-Controlled portion of the Swim. Trained behaviors in the Not-Controlled context consisted primarily of "stationing at the dock" and never included on-command, social interactions with swimmers. Dolphins at DP were never under direct attendant control, *i.e.*, they were never engaged in on-command, social interactions with swimmers or in non-social, trained behaviors.

Proportion of Time Engaged in Social Activities
In-water time was also subdivided into proportion in which focal dolphins were engaged in social *versus* non-social activities (Fig.1; Table 6).

Controlled Swims: Dolphins were engaged in trainer-controlled social interactions with swimmers for an average of 2.85 min per TOTS Controlled portion of Swim to an average of 10.2 min per DQ Swim-1. Trainer-controlled social time constituted 23% to 33% of in-water time. Spontaneous social interactions with swimmers that were not under trainer control were rare (0-2% in-water time). Social interactions with other dolphins (which were never under trainer control) were also rare (0-4% in-water time).

Not-Controlled Swims: Dolphins were engaged in spontaneous social interactions with swimmers for an average of 2.9 min per TOTS Not-Controlled portion of Swim and for an average of 4.9 min per DP Swim, which constituted 24% and 16% of in-water time at TOTS and DP, respectively. DP dolphins engaged in social interactions with other dolphins during 34% of in-water time. TOTS dolphins rarely interacted with each other. As stated above, during Not-Controlled Swims, social interactions with swimmers were never under direct trainer control.

CLASSIFICATION OF SOCIAL INTERACTIONS BY RISK POTENTIAL

High Risk Interactions
Agonistic interactions, those involving aggression and/or submission, clearly posed potential risk for interactants. Aggressive behavior is characterized by threats and forceful attempts to inflict harm on another. Submissive behavior is a common response to aggression and is characterized by withdrawal or escape which typically serves to inhibit attack.

Sexual behavior was also included in the "High Risk" category, subsequent to the finding that at DP (the only facility where sexual behavior was observed during Swims) there was a significant linear co-occurrence of sexual and agonistic interactions between dolphins and swimmers: the number of agonistic interactions increased with the number of sexual interactions per 3-min intervals of observations (Mantel-Haenszel Chi-square = 53.9, df = 6, $p < 0.001$; N = 636 interactions during 406 3-min intervals; Fig.2). This analysis was based on all-occurrence data from study phase 2; thus, sexual behavior was evaluated in absence of a potential confound "dorsal towing" (see "Dorsal Towing," below).

High risk activity during Swims included agonistic or sexual interactions by dolphins with swimmers or among dolphins near swimmers. High risk activity was a striking component of social time during Not-Controlled Swims at both DP and TOTS, comprising 20.5% of all social time at DP and 9% of all social time at TOTS (Fig.3a; Table 7). In contrast, high risk activity comprised less than 1% of all social time during Controlled Swims at DRC, DQ, and TOTS (Fig.3a; Table 7).

The previous calculation substantially under-estimated the proportion of dolphin-swimmer social time that was high risk at DP, which was the only Swim program in which dolphin-dolphin

socializing was more frequent than dolphin-swimmer socializing. When these data were re-analyzed to exclude dolphin-dolphin interactions, high risk activity at DP comprised 61% of dolphin-swimmer social time (Fig.3b; Table 7). In other Swim programs, exclusion of dolphin-dolphin interactions had insignificant effects because dolphins in these programs rarely socialized with each other during Swims. High risk activity comprised $\leq$1% of dolphin-swimmer social time in Controlled Swims at DRC, DQ and TOTS, and 9% of dolphin-swimmer social time in Not-Controlled Swim at TOTS (Fig.3b; Table 7).

Who was At Risk: Dolphins or Swimmers?

High risk activity comprised a notable portion of social time during both Not-Controlled Swims; however, high risk activity at DP and TOTS differed with respect to which types of behavior predominated and which partner (dolphin or swimmer) was at risk. At DP, aggressive and sexual interactions comprised 98.2% of high risk activity, and all aggressive and sexual behaviors were performed by dolphins and directed towards swimmers. In contrast, during the Not-Controlled portion of the TOTS Swim, submissive interactions comprised 100% of high risk activity, and all submissive interactions consisted of dolphins behaving submissively in response to swimmer actions that were not overtly aggressive. Thus, high risk activity was predominantly swimmer-at-risk at DP and dolphin-at-risk at TOTS.

Predominance of swimmer-at-risk interactions at DP *versus* dolphin-at-risk interactions at TOTS may have been the result of different instructions given to swimmers at these two Not-Controlled Swims: DP swimmers were instructed to remain passive and allow dolphins to initiate and determine types of interactions; whereas, TOTS swimmers were permitted to approach, follow, and initiate social interactions with dolphins.

During Controlled Swims, the small proportion of dolphin-swimmer social time that was high risk was predominantly dolphin submission in response to non-aggressive swimmer actions (88% of high risk activity).

Which Swimmers were Involved in High Risk Interactions?

Classes of swimmers involved in swimmer-at-risk interactions (in the form of dolphin aggression or sexual behavior directed to swimmers and/or swimmer submission in response to dolphin actions) could only be evaluated with the sample size available for DP. The distribution of DP swimmers that were involved in swimmer-at-risk interactions differed significantly from the distribution of the entire DP swimmer population (Kolmogorov-Smirnov, 2-sample test, $p < 0.009$). In particular, Figure 4a shows that women and children were involved in swimmer-at-risk interactions disproportionately more often, and men disproportionately less often, than predicted by the distribution of age/sex classes in the entire swimmer population.

Classes of swimmers involved in dolphin-at-risk interactions (in the form of dolphin submission in response to swimmer actions) could be evaluated across all Swim types. The distribution of swimmers that were involved in dolphin-at-risk interactions at all facilities also differed significantly from the distribution of the entire swimmer population (Kolmogorov-Smirnov, 2-sample test, $p < 0.001$). In particular, Figure 4b shows that men were involved in dolphin-at-

risk interactions disproportionately more often, and children and teens disproportionately less often, than predicted by the distribution of age/sex classes of the entire swimmer population.

Which Dolphins were At Risk?

This study did not identify, on the basis of observed behavior, classes of dolphins that were disproportionately involved in high risk interactions. Nearly all dolphins involved in high risk activity during this study were adult females; however, the majority of dolphins participating in Swims during this study were adult females, and consequently the majority of observation hours were of adult females. Specifically, 70% of dolphin-at-risk interactions involved adult female dolphins which corresponded to 69% of Swim observation hours in which the focal was an adult female. All swimmer-at-risk interactions at DP (where 99.5% of all swimmer-at-risk interactions occurred) involved adult female dolphins which corresponded to 94% of Swim observation hours of adult females at DP.

NMFS's records of dolphin participation in Swims since inception of SWTD programs (listed in Appendix B) provided another means for evaluating long-term effects of high risk behavior for dolphins. These records indicated that the removal from SWTD programs of male dolphins, but not females, has occurred in association with serious injury to swimmers. Specifically, there was a significant difference in numbers of male *versus* female dolphins that were (a) removed long-term ($\geq$6 months) following swimmer injury, (b) removed long-term for other reasons, or (c) never removed from Swims (Pearson Chi-square = 7.45, df = 2, $p < 0.024$; N = 39 dolphins; Table 8).

Further inspection identified a distinct age group of males--maturing and young adult males aged 9-16 years--as those dolphins implicated in swimmer injury incidents. Four of the seven maturing and adult males in the SWTD population were reported to injure a swimmer; and three of these males were removed long-term from Swims following the injury report. Serious swimmer injury and subsequent male removal has occurred at three of four SWTD facilities (Table 9).

Long-term removals of females and immatures were associated with, *e.g.*, reproduction, illness, mortality, or replacement of show dolphins. Removals for those reasons could not be shown to be related directly to Swim participation. However, our observations indicated that adult female dolphins did participate in high risk activity during Swims, and NMFS's records did include injury-to-swimmer reports that implicated female dolphins which were not removed from the Swim program subsequent to the reported injury.

Moderate Risk Interactions

"Moderate risk" interactions included abrupt, rough or rapid behavior that was not under direct trainer control and that occurred in interactions between dolphins and swimmers. These interactions were not overtly agonistic but posed potential risk through forceful execution of the behaviors.

Combining moderate with high risk activity substantially changed the risk profile only for TOTS's Not-Controlled Swim, where combined high and moderate risk activity comprised 16% of dolphin-swimmer social time (Fig.5, Table 7). Addition of moderate risk activity did not change risk profiles for other Swim programs: combined high and moderate risk activity comprised $\leq$1% of dolphin-swimmer social time during Controlled Swims at DRC, DQ and TOTS; and 61% of dolphin-swimmer social time during DP's Not-Controlled Swim.

A catalog of all high and moderate risk behaviors observed at least once during Swims (based on all-occurrence data) is provided in Appendix C.

Staff Response to Escalation of High and Moderate Risk Behavior

High and moderate risk activity sometimes escalated to the point that facility staff modified the normal Swim format. This was observed to occur only during Not-Controlled Swims. During the Not-Controlled portion of one Swim at TOTS, when a dolphin repeatedly breached near swimmers (moderate risk behavior), trainers first called a temporary break in the Swim, requesting all swimmers to leave the water, and finally ended the session prematurely. During 11 Swims at DP, attendants modified the normal Swim format in association with agonistic or sexual behavior performed by dolphins to swimmers. On these occasions, DP attendants (a) requested one swimmer to leave the water (temporarily or for the remainder of the Swim), (b) entered the water themselves to escort swimmers to the dock, and/or (c) made abrupt gestures or movements towards dolphins, including throwing objects.

Dorsal Towing

The behavioral interaction in which a human swimmer is towed through the water while holding onto the dorsal fin of a dolphin was singled out as inappropriate behavior for SWTD programs (FEIS, p.74). Dorsal towing conducted under direct trainer control was observed during Controlled Swims at DRC and TOTS; dorsal towing that was not on-command was observed during the Not-Controlled Swim at DP.

During the first phase of this study, DP attendants eliminated spontaneous dorsal towing initiated by dolphins because dolphins were "...bumping the human...too hard..." (T.Hankins letter to NMFS, 2 February 1994). Our results confirmed the observations of DP attendants: there was a significant co-occurrence of dorsal towing and agonistic interactions between dolphins and swimmers (Pearson Chi-square = 167.5, df = 4, $p < 0.001$; N = 314 interactions during 316 3-min intervals from study phase 1 prior to elimination of dorsal towing). Moreover, the number of agonistic interactions increased with the number of towing interactions per 3-min interval of observation time (Fig.6).

Dorsal towing under trainer control during Controlled Swims at DRC and TOTS was not associated with any other type of dolphin-swimmer interaction.

Lower Risk Interactions
A third potential risk level, "Lower Risk," included trained behaviors with swimmers that were abrupt, rough or rapid and that were under direct trainer control. By this definition, "lower risk" activity could occur only during Controlled Swims. Only by addition of lower risk to high and moderate risk activity did risk profiles of Controlled Swims increase to encompass more than 1% of dolphin-swimmer social time (Fig.7; Table 7). Combined high, moderate and lower risk interactions comprised 7% of dolphin-swimmer social time at DQ, 4% at DRC, and 3% at TOTS.

Evaluation of Trainer Control during Controlled Swims
Lower risk activity was not inherently risky but posed potential risk if "mistakes" occurred in trainer control. "Mistakes" could take two forms: incorrect execution of trained behavior, or spontaneous social interaction that occurred outside of trainer supervision.

An assessment of trainer control over dolphin-swimmer interactions during Controlled Swims was based on categorizing each social interaction as (a) a trained behavior performed at trainer request and executed correctly; (b) a trained behavior performed at trainer request but executed incorrectly; or (c) a spontaneous behavior not under trainer control. Because trainer, dolphin, and swimmer competence was not the focus of this study, our appraisal of the execution of trained behaviors relied heavily on trainer commentary and was likely to underestimate trainer disapproval of dolphin (or swimmer) performance.

The proportion of interactions between dolphins and swimmers that were under trainer control and performed correctly was high during all Controlled Swims: 86% at DRC, 93% at DQ, and 96% at TOTS (Fig.8; Table 10). "Mistakes," therefore, occurred during 14% of dolphin-swimmer social time at DRC (predominantly incorrectly-performed trained behaviors); during 7% of dolphin-swimmer social time at DQ (predominantly spontaneous interactions not under trainer control); and during 4% of dolphin-swimmer social time at TOTS (predominantly incorrectly-performed trained behaviors).

Outcomes of "mistakes" were usually not dangerous. For example, "mistakes" typically included: refusals to execute commands; turning abruptly near swimmers at the sound of a trainer's bridge; rapid dorsal towing; performing unrequested trained behaviors. A small proportion of "mistakes" included high risk behavior: 7% at DRC, 8% at DQ.

COMPARISON OF SOCIAL INTERACTIONS DURING SWIMS *versus* FREE TIME
Swim dolphins were also observed during free time when they were not interacting with swimmers or trainers in order to identify possible short-term effects of Swims on dolphin behavior.

Behavioral Profiles
Dolphins socialized with other dolphins during 36%-44% of free time at DRC, DQ and DP; whereas, TOTS dolphins engaged in social interactions during only 10% of free time (Fig.9).

The proportion of time during Swims that dolphins socialized with swimmers was variable, ranging from 16% of in-water time at DP to 34% of in-water time at DQ. Only at DP did dolphins spend an appreciable proportion of time (34%) socializing among themselves during Swims.

Sexual Behavior

Sexual behavior by DP dolphins comprised a much greater proportion of their social time during Swims (17%) than during their free time (4%)(Fig.10a). In contrast, dolphins at DRC, DQ and TOTS never engaged in sexual behavior during Swims even though sexual behavior was a normal part of free-time social repertoires at DRC and TOTS (Fig.10a). At DQ, sexual behavior was rarely recorded during Swims or free time, even though considerable sexual behavior occurred among dolphins when they were not subjects of our observations because they were sequestered in holding pools for mating.

Agonistic Behavior

Dolphins at DRC, DQ and TOTS rarely engaged in agonistic behavior during Controlled Swims even though agonistic behavior was a normal part of their free-time social repertoires (Fig.10b). In contrast, agonistic behavior comprised an equal proportion of the dolphins' social time during Not-Controlled Swims and free time at DP and TOTS (Fig.10b).

The TOTS Swim format provided an opportunity to compare behavior of the same dolphins under all three conditions: Controlled Swims, Not-Controlled Swims, and free time. When expected values were calculated from percentages of high (11%) *versus* not-high-risk (89%) activity during free-time (Table 11), the numbers of points that were high risk (*i.e.*, agonistic only at TOTS) *versus* not-high-risk differed significantly from expected during Controlled Swims (Chi-square = 17.2, df = 1, $p < 0.001$), but not during Not-Controlled Swims (Chi-square = 0.9, df = 1, $p < .50$). Thus, normal free-time behavioral repertoires of dolphins were not modified during Not-Controlled Swims, but agonistic behavior was eliminated from Controlled Swims even though such behavior was a normal component of the dolphins' free-time repertoire.

DO DESIGNATED REFUGES PROVIDE A CHOICE FOR DOLPHINS?

Use of Designated Refuge Areas

All facilities are required by NMFS to provide a designated refuge area that dolphins, but not swimmers, may enter during Swims (FEIS, p.74). At DRC, DQ and TOTS, a large portion of the main pool with unrestricted entry was designated as the refuge area; at DP, one or two enclosed pens with gate entries were designated as refuge areas. Proportion of time spent in refuge areas during Swims and free time at all facilities is shown in Figure 11.

Dolphins rarely entered designated refuge areas during any of the Controlled Swims ($\leq$1% in-water time at DRC, DQ and TOTS) or during the Not-Controlled Swim at DP (<1% of in-water time). In contrast, during the Not-Controlled Swim at TOTS, dolphins entered the refuge area during 10% of in-water time. It must be noted that during Controlled Swims at DRC and TOTS and during the Not-Controlled Swim at TOTS, dolphins were recalled by trainers to their

training stations even when dolphins were in refuge areas, which may have reduced the effectiveness of the refuge area.

Usage of refuge areas during free time was also recorded in order to document whether dolphins freely and voluntarily entered these areas. At DRC, DQ and TOTS, dolphins frequently entered the designated refuge areas during their free time (22% to 51% of free time) but DP dolphins did not (<2% of free time). In fact, one dolphin at DP was never observed to enter the refuge pens; a second dolphin entered a refuge pen only once. Because DP dolphins were not observed to freely and voluntarily enter the designated refuge area during their free time, it cannot be assumed that the designated refuge area provided adequate sanctuary from swimmers during Swims.

Use of "Effective Refuge"
During Controlled Swims, dolphins could be afforded an additional safeguard from contact initiated by swimmers because swimmers were sequestered away from dolphins and were not allowed to approach dolphins without trainer permission. Thus, during Controlled Swims, dolphins could avoid interaction with swimmers and be in "effective refuge" merely by staying away. Use of "effective refuge" (*i.e.*, when dolphins were simultaneously outside of swimmer reach (>1m) and not engaged in trained behaviors commanded by trainers) was higher in each Controlled Swim (Fig.12) than was use of designated refuge areas (Fig.11). Use of "effective refuge" was particularly notable at DQ (15% of in-water time) where "effective refuge" was more highly sanctioned by trainers than was the designated refuge area and where trainers typically did not recall dolphins that strayed.

Because swimmers were not sequestered and could approach dolphins during Not-Controlled Swims, designated refuge areas were the only choice of sanctuary from swimmers during Not-Controlled Swims.

CONCLUSIONS

HIGH RISK BEHAVIOR DURING SWIMS

1. Social interactions that posed high risk to dolphins or swimmers--*i.e.*, agonistic or sexual behavior--occurred at notable rates only during Not-Controlled Swims. High risk activities comprised 61% of dolphin-swimmer social time during DP's Not-Controlled Swim and 9% of dolphin-swimmer social time during the Not-Controlled portion of TOTS's Swim. In contrast, high risk interactions occurred rarely (<1%) during Controlled Swims at DQ, DRC and TOTS.

2. Comparison of Controlled and Not-Controlled Swims at TOTS--where the same dolphins participated in both Swim types with the same swimmers under supervision of the same training staff--were especially valuable in revealing that direct trainer control was a significant factor in determining the frequency of high risk activity during Swims.

3. High risk activity took two forms: activity in which swimmers were at risk (predominantly dolphins were aggressive and/or sexual to swimmers) or activity in which dolphins were at risk (predominantly swimmers' actions elicited submissive responses from dolphins). High risk activity was principally swimmer-at-risk during DP's Not-Controlled Swim, and dolphin-at-risk during TOTS's Not-Controlled Swim. This contrast may have resulted from the different instructions that were given to swimmers for these two Not-Controlled Swims.

4. Sexual behavior between dolphins and swimmers was determined to be a high risk activity because dolphin-swimmer sexual behavior significantly co-occurred with agonistic behavior. Sexual behavior between dolphins and swimmers was observed only during the Not-Controlled Swim at DP.

5. Submissive behavior was determined to be a high risk activity because submission is commonly elicited by aggression and therefore part of an agonistic complex of behaviors; and submissive behavior typically indicates subordinate status in a relationship. A growing literature on the two-way interaction between agonistic behavior and endocrine/biochemical activity (see *e.g.*, Huntington and Turner 1987) suggests that effects of behaving submissively may be greater than indicated by behavioral outcomes of interactions. In this study, it was surprising to find that human swimmers, which were smaller, less-mobile, and presumably less threatening than dolphins, could and did elicit submissive responses from dolphins.

6. High rates of sexual behavior during the Not-Controlled Swim at DP could not be explained by the dolphins' normal behavioral repertoire: sexual behavior of DP dolphins comprised a significantly greater proportion of their social time during Swims than during fee time.

7. High risk activity was rare during Controlled Swims even though agonistic and sexual behaviors were a normal component of socializing among those dolphins during free time. During Controlled Swims, trainers were effective in eliminating those behaviors that might put swimmers or dolphins at risk in the Swim context.

8. Injurious consequences of high risk behavior were not observed during our study; however, we did observe escalation of high risk behavior to the point that Swim sessions were terminated early for one or more swimmers. These events were observed to occur only during Not-Controlled Swims at DP and TOTS.

9. Reports received by NMFS demonstrated that high risk behavior has escalated to the point of serious injury to swimmers, and that dolphins have been removed from Swim programs as a result of these incidents. High risk behavior can, therefore, be said to have long-term effects on some dolphins, and those effects may be detrimental if adequate management plans do not exist for housing dolphins that are rejected from Swim programs.

10. Dolphins that have been implicated in serious injury to swimmers and subsequently removed from Swim programs were exclusively maturing and young adult males.

11. Although it was male dolphins that were implicated in high risk activity resulting in swimmer injuries, during our study when few males participated in Swims, we observed that adult female dolphins were involved in high risk activity.

12. Classes of swimmers that were disproportionately involved in swimmer-at-risk interactions were women and children. The class of swimmers that was disproportionately involved in dolphin-at-risk interactions was adult men.

13. It was not possible to monitor underwater dolphin behavior at those Swim programs in which the water was murky and swimmers were not restricted to remain at the surface, *i.e.*, during Not-Controlled Swims at TOTS and DP. Thus, dolphin-swimmer interactions may have been imperfectly monitored by study observers (and presumably by facility staff as well) in the very situations that exhibited notable rates of high risk activity.

OTHER BEHAVIORS

14. Observations by DP staff that dolphins were excessively forceful in dorsal towing interactions with swimmers resulted in the elimination of this behavior by DP during the course of our study. Our results confirmed those observations: we found that dorsal towing of swimmers by dolphins during Not-Controlled Swims at DP significantly co-occurred with agonistic behavior. In contrast, dorsal towing under direct trainer control at DRC and TOTS was not associated with any undesirable behavior.

USE OF REFUGE AREAS

15. DP dolphins rarely entered designated refuge areas during Swims or during free time. Because DP dolphins were not observed to freely and voluntarily enter the designated refuge area during their free time, it cannot be assumed that the designated refuge area provided adequate sanctuary from swimmers during Swims. We could not identify which feature of the DP designated refuge area was associated with avoidance by dolphins because the DP refuge differed from refuges at other facilities in several respects: (a) smaller size, (b) enclosed space, (c) restricted entry via narrow gates, (d) changeable location, and (e) changeable shape and construction.

16. Use of designated refuge areas during Swims was notable only during the Not-Controlled portion of the TOTS Swim. This finding may indicate that dolphins did not seek to avoid Swim activities; however, during Controlled Swims at DRC and TOTS and during the Not-Controlled Swim at TOTS, dolphins were recalled from refuge areas by trainers. These actions by trainers may have reduced the effectiveness of the refuge area.

17. During Controlled Swims in which swimmer movements were restricted by trainers, dolphins could create an "effective refuge" during Swims simply by moving away from swimmers. "Effective refuge" was especially utilized by dolphins at DQ where trainers did not recall dolphins that strayed.

18. The changing daily roster of dolphin participants in Swims at DQ and DRC was, in part, a

response by facility managers to dolphins that appeared temporarily uninterested in Swim participation. At DQ and DFC, trainers selected which dolphins would participate in each Swim, thus providing periodic respites from Swims for some dolphins. At TOTS and DP, daily rosters of Swim dolphins were not modified and all current Swim dolphins participated in all Swims.

SCOPE OF THE SWTD BEHAVIORAL STUDY

It was not within the scope of this study to evaluate SWTD issues discussed in the FEIS that were not related to dolphin behavior. In particular, this study did not investigate (a) physical features of Swim facilities; (b) dolphin physical well-being or physiological correlates of Swim participation; (c) trainer expertise; (d) educational programs; or (e) in-water "therapy" sessions with dolphins.

Results of this study cannot be used to evaluate long-term effects of Swim participation on dolphin behavior. To properly evaluate long-term effects of Swims on dolphin behavior, one would want to compare data provided in this study with comparable quantitative baseline data on behavior of non-SWTD dolphins that are matched for age, sex, reproductive status, and history, and living in zoo or aquarium environments and in the wild. However, a quantitative, normative database for dolphin behavior does not yet exist because studies of cetacean behavior have primarily employed qualitative methodologies. Another way to evaluate long-term effects of Swims on dolphin behavior would be to conduct long-term monitoring of dolphin behavior prior to, at the onset of, and after several years' participation in Swim programs. Due to logistical and budgetary constraints, it was not possible to carry out the long-term study that would be necessary to evaluate whether there are long-term effects on dolphin behavior from participation in SWTD programs.

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TABLES

Table 1. **Observations conducted per observation type per dolphin per facility.**

Facility	Total Days	Total Hours	Total Dolphins	SWIMS			FREE TIME		
				Total #Sessions	Total #Hours	Median Hrs/ Dolphin	Total #Sessions	Total #Hours	Median Hrs/ Dolphin
DRC	33	42.5	5-6	58	17.1	2.95[1]	54	25.3	4.05
DQ	22	59.4	6	74	35.1	6.1[2]	76	24.3	4.6
TOTS	10	24	2	24	12.2	6.15[3]	24	11.8	5.9
DP	28	75.1	6-8	76	42.7	6.1[4]	71	32.4	4.65
Total	///	201	///	232	107.1	///	225	93.8	///

[1] DRC: range = 1.4 - 4.2 h per dolphin; variation due to unequal dolphin participation in Swims, removal of 1 dolphin from Swims during second study phase, and restrictions on daily number of Swim observations due to facility schedule.
[2] DQ: range = 4.1 - 6.5 h per dolphin; variation due to unequal dolphin participation in Swims and restricted length of observation periods.
[3] TOTS: range = 6 - 6.2 h per dolphin.
[4] DP: range = 2.7 - 6.4 h per dolphin; variation due to removal of 2 dolphins from Swims during second study phase.

Table 2: **Dolphins in SWTD Programs.**
All dolphins participating in Swims were subjects of this study[1]. Discrepancies (indicated in parentheses) between numbers of dolphins listed in SWTD programs and numbers observed during this study are explained in footnotes.

Facility	SWTD DOLPHINS Listed in 1993 Quarterly Reports (# dolphins observed in this study during study phases 1-2)			
	Total Dolphins	Adult & Maturing ♂♂	Adult & Maturing ♀♀	All Immatures
DRC	7	-	2 (1-2[2])	5 (4[1,3])
DQ	6	2 (1-2[3])	4	-
TOTS	3	2 (1[4])	1	-
DP	12	2 (0-1[3,4])	10 (6-7[2,3,4])	-
TOTAL In SWTD Population	28	6	17	5
TOTAL Observed in this study	≤22	3-4	12-14	4

[1] The sole dependent calf in the SWTD population was not observed in this study.
[2] Part-time participation in Swims during this study due to temporary removals for calving: 1 DRC adult female, 1 DP adult female.
[3] Part-time participation in Swims during this study due to temporary removals for other management reasons (*e.g.*, mating behavior, unspecified): 2 DRC immature females, 1 DQ adult male, 1 DP adult male, 2 DP adult females.
[4] No participation in Swims during this study due to long-term removals for other management reasons (*e.g.*, mating, behavior, unspecified): 1 TOTS adult male, 1 DP adult female, 1 DP adult male.

Table 3. **Swimmers participating during SWTD Behavioral Study.**

	Dolphins per Swim	Total Swimmers	Mean Swimmers per Swim	Adult ♂	Adult ♀	Teen ♂	Teen ♀	All Children	All Seniors
DRC	1-2[1]	204	3.5	28%	62%	0%	2%	5%	2.5%
DQ/Swim-1	2	249	7.8	21%	46%	10%	22%	<.5%	<.5%
DQ/Swim-2	2-4	197	4.7	31%	61%	1.5%	5%	1.5%	0%
TOTS	2	92	3.8	31.5%	47%	6.5%	12%	2%	1%
DP	8	167	8.8	41%	50%	2%	3%	4%	0%
	6	258	7.2	34%	53.5%	1%	2%	8.5%	<.5%
	4	115	5.5	23%	34%	10%	17%	15%	1%

[1] Number of dolphins per trainer per dock. DRC typically offered several simultaneous Swim sessions at different docks in the same pool; we focussed on one dock per Swim for our observations.

Table 4: **Basis for comparison among Swim Programs.**

	SWIM TYPE	TRAINER DIRECTION of INTERACTION TYPE	TRAINER DIRECTION of DOLPHIN & SWIMMER MOVEMENTS	POSITIVE (FOOD) REINFORCEMENT
DRC	**CONTROLLED**	Yes	Yes	Yes, For specific behaviors
DQ	Swim-1 **CONTROLLED**	Yes	Yes	Yes, For specific behaviors
	Swim-2 Part 1: **CONTROLLED**	Yes	Yes	Yes, For specific behaviors
	Swim-2 Part 2: **"CONTROLLED"**	Yes	Yes	Yes, Not linked to specific behaviors
TOTS	Part 1: **CONTROLLED**	Yes	Yes	Yes, For specific behaviors
	Part 2: **NOT CONTROLLED**	No	No	Yes, Not linked to specific behaviors
DP	**NOT CONTROLLED**	No	No	No

Table 5: **Categorization of behavioral interactions.**
Categorization is hierarchical: an interaction is included within a category if it contains one or more behavioral elements of that category and no components of categories higher on the list.

CATEGORY	BEHAVIORS Performed by dolphins or swimmers
AGGRESSIVE	bite; hit; ram; body-slam; forceful push (*e.g.*, into structure, away from dock, underwater); chase; open-mouth threat; head-jerk threat; jawclap threat
SUBMISSIVE	flee; flinch; scream.
SEXUAL	mount; thrust; genital insertion; erection; repetitive genital rubbing; beak-to-genital-propulsion.
ABRUPT	abrupt-turn; rapid circling; white-water; quick-approach; quick-swim; porpoise; leap; breach; slap-water; grab; any spontaneous behavior performed abruptly. any trained behavior performed abruptly.
NEUTRAL/ AFFILIATIVE	all gentle touching; rub; reach; hold; push; rest-together; swim-together; all other trained behaviors

Table 6. **Profile of Swim Sessions.**

		DRC	DQ		TOTS		DP
		Control	Swim-1 Control	Swim-2 Control	Control	Not-Control	Not-Control
Time Swimmers are in water	Total # points	1755	1970	940	600	593	4302
	mean min per Swim	15.15	31	11.3	12.5	12.4	31
	% total Swim	86%	100%	43%	67%	100%	92%
Total Time under trainer control	mean min per Swim	14.9	25.6	6.8	11.6	1.3	NA
	% in-water time	97%	83%	60%	93%	11%	
Trainer-controlled Social Time w/ Swimmers	mean min per Swim	3.6	10.2	3.4	2.85	NA	NA
	% in-water time	23%	33%	30%	23%		
Spontaneous Social Time w/ Swimmers	mean min per Swim	<1	<1	<1	<1	2.9	4.9
	% in-water time	0.9%	1.9%	1.6%	0.2%	24%	16%
Spontaneous Social Time w/ Dolphins	mean min per Swim	<1	<1	<1	<1	<1	10.5
	% in-water time	0.3%	1.5%	3.9%	0.3%	1.8%	34%

Table 7: **Percentage of time that dolphins were engaged in high, moderate, and lower risk interactions during Swims.**

		DRC	DQ		TOTS		DP
		Control	Control	"Control"	Control	Not-Control	Not-Control
ALL SOCIAL POINTS: Dolphin/dolphin and Dolphin/Swimmer	**Social Points**	427	929	121	139	151	2143
	% High Risk	0.9%	0.4%	0.8%	0%	8.6%	20.5%
	% Moderate Risk	0%	0.1%	0%	0%	6.0%	1.0%
	% Lower Risk	3.3%	7.1%	3.3%	2.9%	NA	NA
DOLPHIN/SWIMMER SOCIAL POINTS Only	**Social Points**	424	884	100	137	140	686
	% High Risk	0.9%	0.45%	1%	0%	9.3%	60.6%
	% Moderate Risk	0%	0.1%	0%	0%	6.4%	0.6%
	% Lower Risk	3.3%	7.5%	3%	2.9%	NA	NA

Table 8. **Status of Swim Dolphins since Inception of SWTD programs.**
Long-term removal was defined as an absence from Swim participation of at least a 6- month duration.

	# SWTD Dolphins	
	♂♂ (N = 12)	♀♀ (N = 27)
No long-term removal	6	16
Long-term removal following injury to swimmer	3	0
Other long-term removal	3	11

Table 9. **Status of adult and adolescent males participating in SWTD Programs since 1990.**

	♂♂	Swim Status			Reproductive Status
		In Swims	Longterm Removal	Reported Injury to swimmer	Age / Maturity
DQ	Hobi	X			8 / mature[1]
	Lono	X			8 / immature[1]
DP	Fonzi		X	X	14 / mature[2]
	LilBit	X		X	15 / mature[1]
DRC	Natua		X	X	16 / unknown[2]
TOTS	Buttons	X			21 / unknown[1]
	Stormy		X	X	9 / mature[2]

Age (in years) and sexual maturity are presented:
[1] at the time of the study for males participating in Swims during the study.
[2] at the time of removal from Swims for males not participating in Swims during the study.

Table 10: **Trainer control of dolphin-swimmer social interactions during Controlled Swims.**

	DRC	DQ		TOTS
	Control	Control	"Control"	Control
Total # Dolphin-Swimmer Social Points	424	884	100	137
% On-command & Performed Correctly	86%	94%	91%	96%
% On-command & Performed Incorrectly	10%	1%	2%	4%
% Spontaneous	4%	5%	7%	<1%

Table 11: **Comparison of High Risk Activity during Free Time with Controlled and Not-Controlled Swims at Theater of the Sea.**

# Points	CONTROLLED SWIM		NOT-CONTROLLED SWIM	
	Observed	Expected[1]	Observed	Expected[1]
High Risk	0	15.3	13	16.6
Not High Risk	139	123.7	138	134.4
Total	139	///	151	///

[1] Expected values based on free-time observations (see text for explanation).

FIGURE CAPTIONS

Figure 1: **Profile of Swims: Dolphin activities when swimmers were "in-water"**
Descriptive profile of the average amount of in-water time per Swim that dolphins spent in social activities with swimmers or dolphins, stratified by whether activities were on-command or not-on-command.

Figure 2: **Co-occurrence of Sexual and Agonistic Behavior in Interactions between Dolphins and Swimmers at Dolphins Plus.**
Observation sessions were partitioned into 3-min intervals, and each interval was categorized by the number of sexual and agonistic interactions of the focal dolphin with swimmers. Cells in the 3x4 matrix represented the number of 3-min intervals in which 0, 1, or 2+ agonistic interactions and 0, 1, 2, or 3+ sexual interactions occurred. Each bar represented the deviation from the expected value (expressed as a Z score) for each cell.

Figure 3: **High Risk Interactions during Swims.**
The proportion of all social time (Fig.3a) or dolphin-swimmer social time (Fig.3b) that dolphins were engaged in high risk activity during Controlled *versus* Not-Controlled Swims.

Figure 4: **Classes of Swimmers Involved in At-Risk Interactions.**
The distribution of swimmer age/sex classes that were involved in swimmer-at-risk activity at DP compared with the overall distribution of DP swimmers (Fig.4a) or that were involved in dolphin-at-risk activity at all facilities compared with overall distribution of swimmers at all facilities (Fig.4b).

Figure 5: **High and Moderate Risk Interactions during Swims.**
The proportion of dolphin-swimmer social time that dolphins were involved in high or moderate risk activity during Controlled *versus* Not-Controlled Swims.

Figure 6: **Co-occurrence of Dorsal Towing and Agonistic Behavior in Interactions between Dolphins and Swimmers at Dolphins Plus.**
Observation sessions were partitioned into 3-min intervals, and each interval was categorized by the number of towing and agonistic interactions of the focal dolphin with swimmers. Cells in the 3x3 matrix represented the number of 3-min intervals in which 0, 1-2, or 3+ towing interactions and 0, 1-2, or 3+ agonistic interactions occurred. Each bar represented the deviation from the expected value (expressed as a Z score) for each cell.

Figure 7: **High, Moderate and Lower Risk Interactions during Swims.**
The proportion of dolphin-swimmer social time that dolphins were involved in high, moderate or lower risk activity during Controlled *versus* Not-Controlled Swims.

Figure 8: **Trainer Control of Social Interactions between Dolphins and Swimmers during Controlled Swims.**
The proportion of dolphin-swimmer social time during Controlled Swims in which dolphins were under trainer control or in which "mistakes" occurred.

Figure 9: **Social Interactions of Dolphins during Swims *versus* Free Time.**
The proportion of free time *versus* in-water time during Swims that dolphins were engaged in social activities.

Figure 10: **Behavior of Dolphins during Swims *versus* Free Time.**
The proportion of social time that was sexual (Fig.10a) and agonistic (Fig.10b), comparing Swims with free time. Note that values for TOTS free time were repeated for comparison of the Controlled and Not-Controlled portions of the TOTS Swim.

Figure 11: **Use of Designated Refuge by Dolphins during Swims *versus* Free Time.**
The proportion of free time *versus* in-water time during Swims that dolphins spent in designated refuge areas, comparing refuge types that were within the main pool *versus* in a separate pen.

Figure 12: **Use of "Effective Refuge" by Dolphins during Controlled Swims.**
The proportion of in-water time during Controlled Swims that dolphins were simultaneously outside of swimmer reach (> 1m) and not engaged in trained behaviors commanded by trainers.

Fig.1

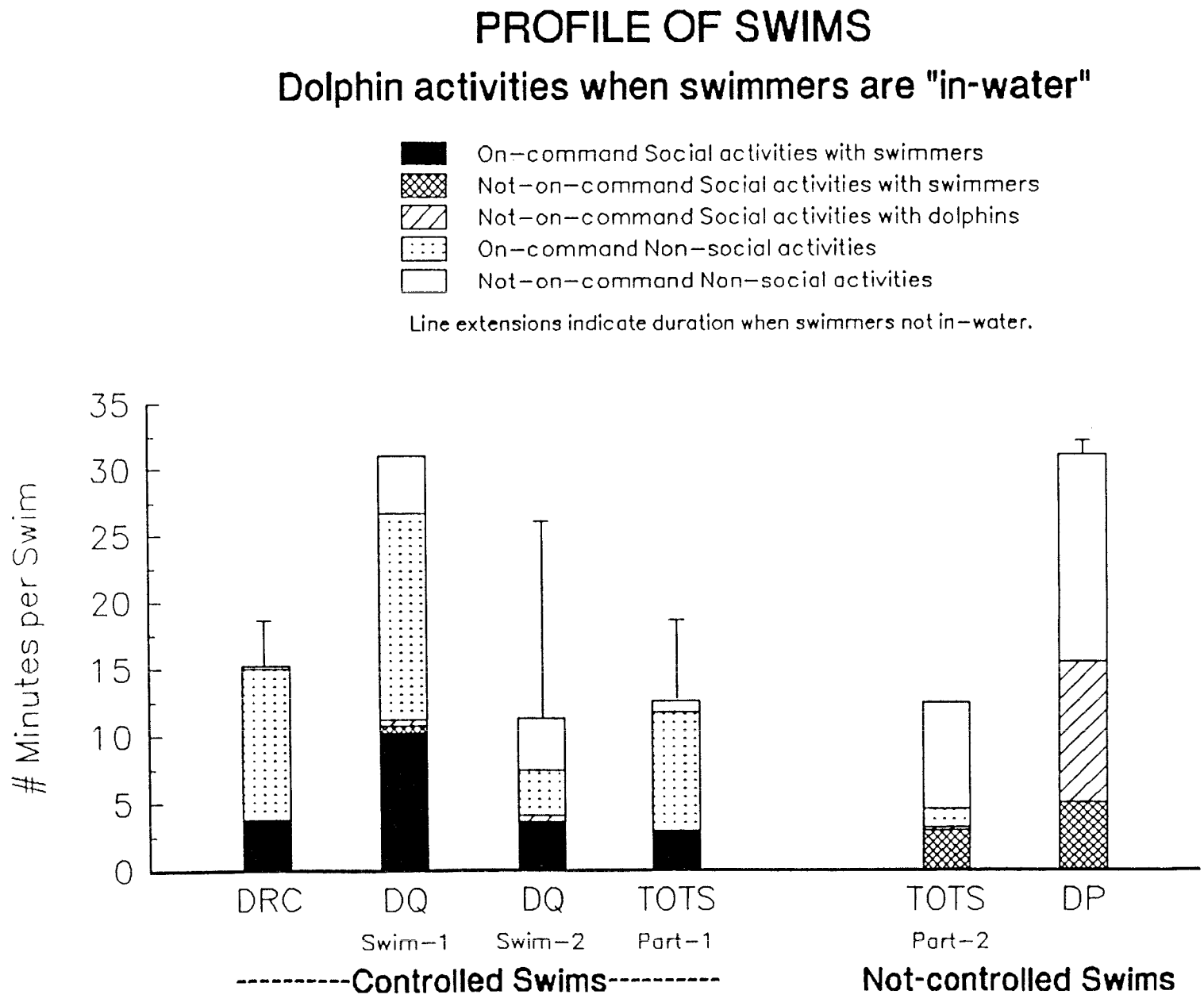

PROFILE OF SWIMS
Dolphin activities when swimmers are "in-water"
On-command Social activities with swimmers
Not-on-command Social activities with swimmers
Not-on-command Social activities with dolphins
On-command Non-social activities
Not-on-command Non-social activities
Line extensions indicate duration when swimmers not in-water.
Minutes per Swim
35
30
25
20
15
10
5
0
DRC
DQ
Swim-1
DQ
Swim-2
TOTS
Part-1
TOTS
Part-2
DP
----------Controlled Swims----------
Not-controlled Swims

Fig.2

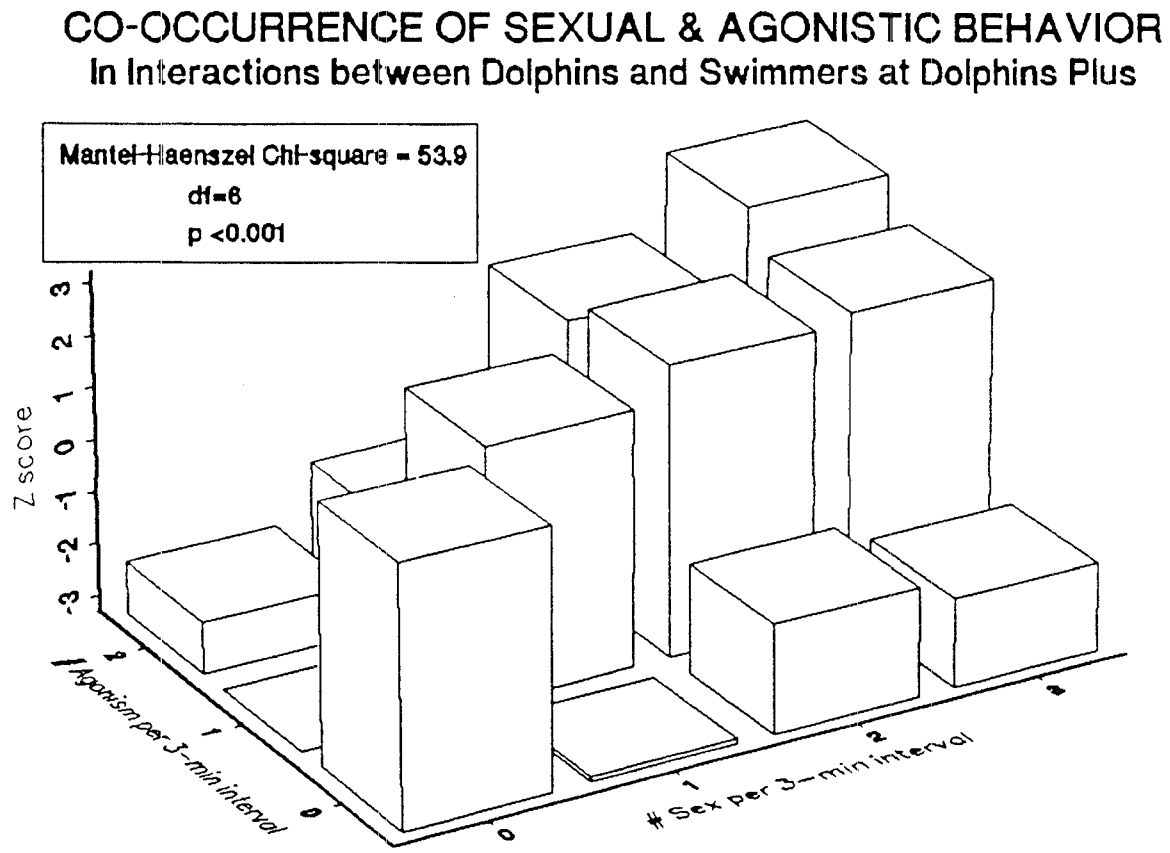

CO-OCCURRENCE OF SEXUAL & AGONISTIC BEHAVIOR
In Interactions between Dolphins and Swimmers at Dolphins Plus
Mantel-Haenszel Chi-square = 53.9
df=6
p <0.001
Z score
-3
-2
-1
0
1
2
3
Agonism per 3-min interval
0
1
2
3
Sex per 3-min interval
0
1
2
3

Fig.3a

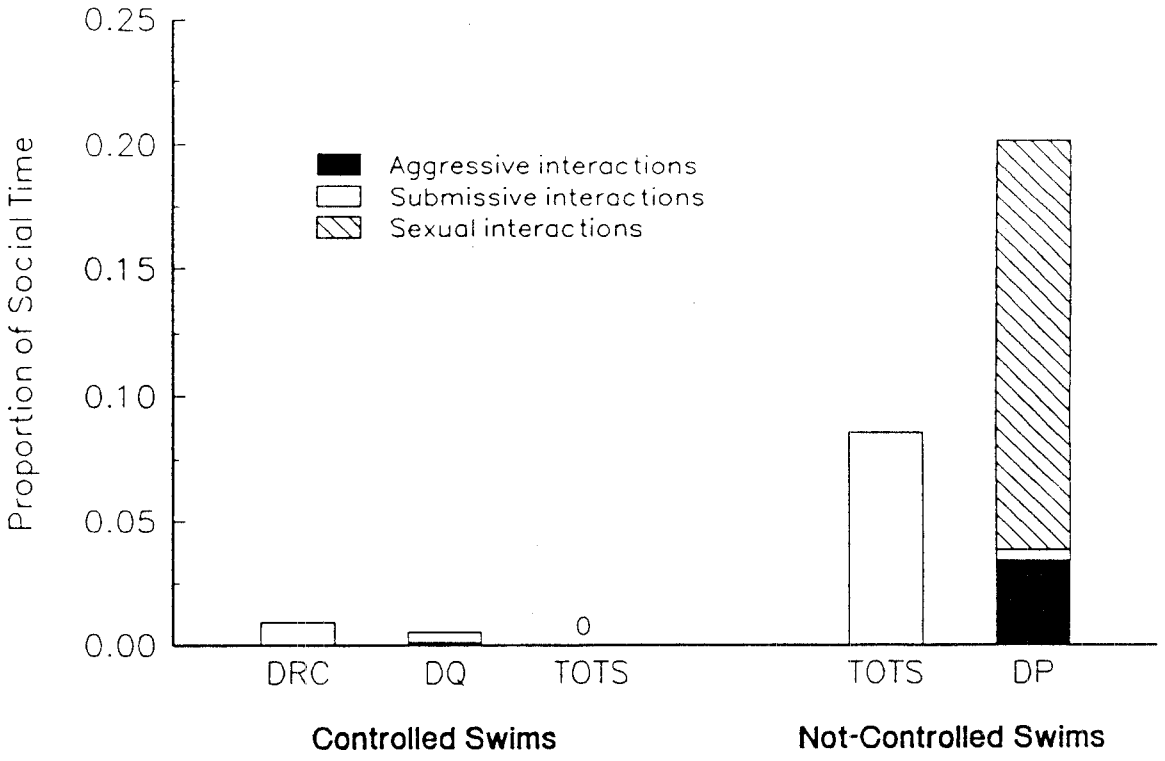

HIGH RISK INTERACTIONS DURING SWIMS
Dolphin/Swimmer or Dolphin/Dolphin near Swimmer
Proportion of Social Time
0.25
0.20
0.15
0.10
0.05
0.00
Aggressive interactions
Submissive interactions
Sexual interactions
0
DRC
DQ
TOTS
TOTS
DP
Controlled Swims
Not-Controlled Swims

Fig.3b

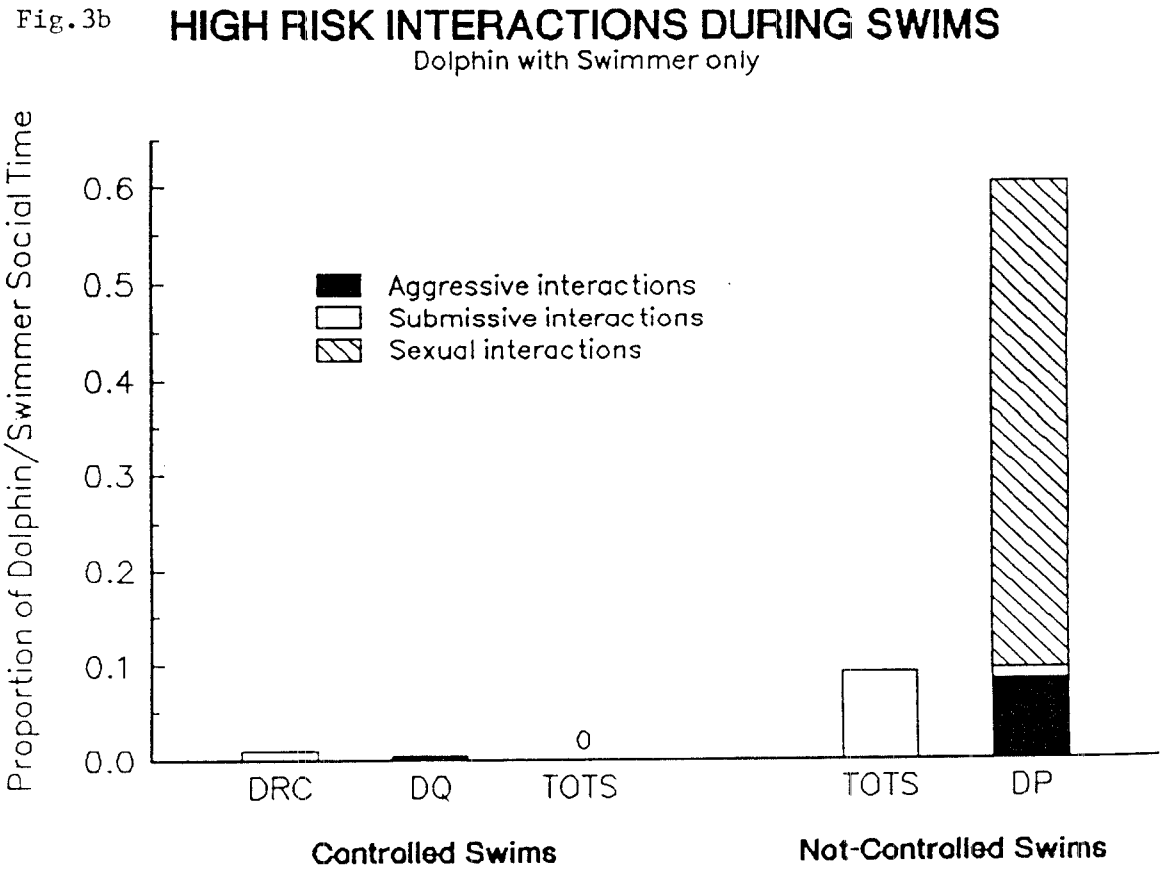

HIGH RISK INTERACTIONS DURING SWIMS
Dolphin with Swimmer only
Proportion of Dolphin/Swimmer Social Time
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Aggressive interactions
Submissive interactions
Sexual interactions
0
DRC
DQ
TOTS
TOTS
DP
Controlled Swims
Not-Controlled Swims

Fig.4a

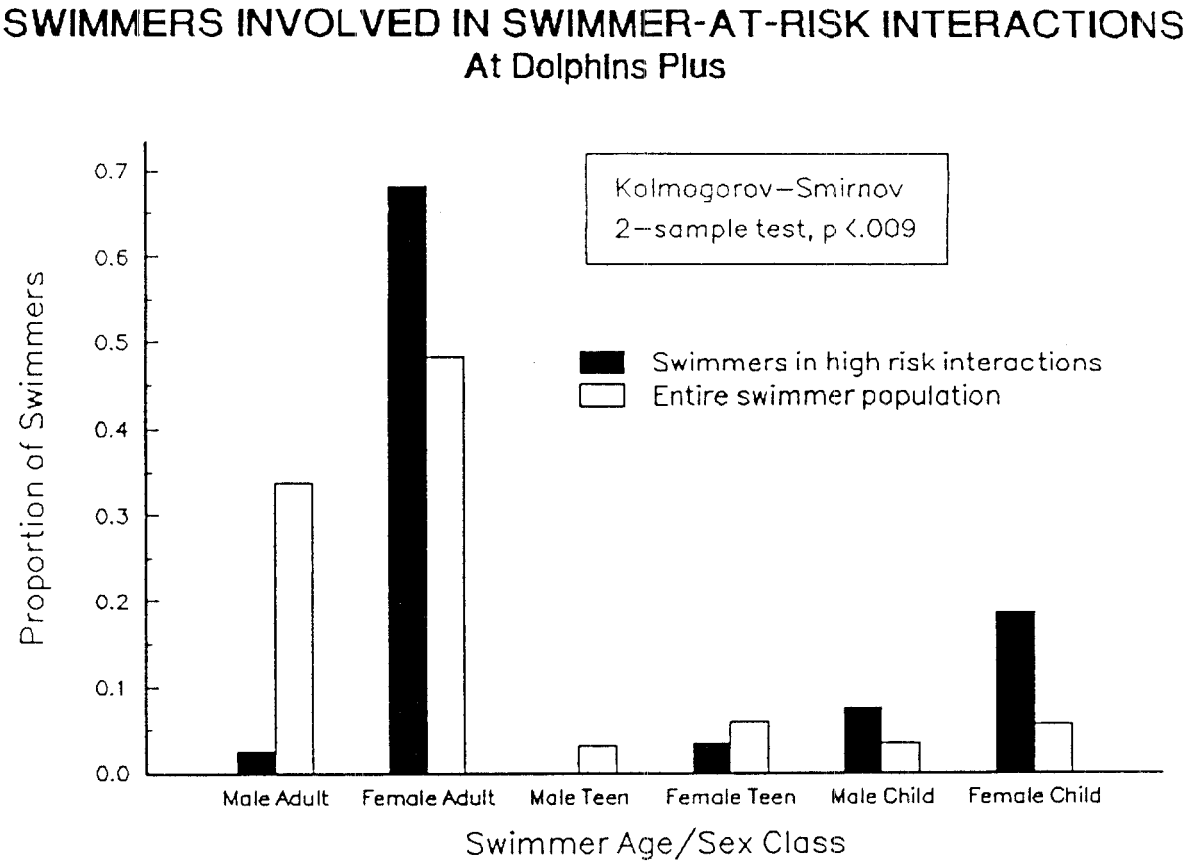

SWIMMERS INVOLVED IN SWIMMER-AT-RISK INTERACTIONS
At Dolphins Plus
Kolmogorov–Smirnov
2–sample test, p <.009
Swimmers in high risk interactions
Entire swimmer population
Proportion of Swimmers
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Male Adult
Female Adult
Male Teen
Female Teen
Male Child
Female Child
Swimmer Age/Sex Class

Fig.4b

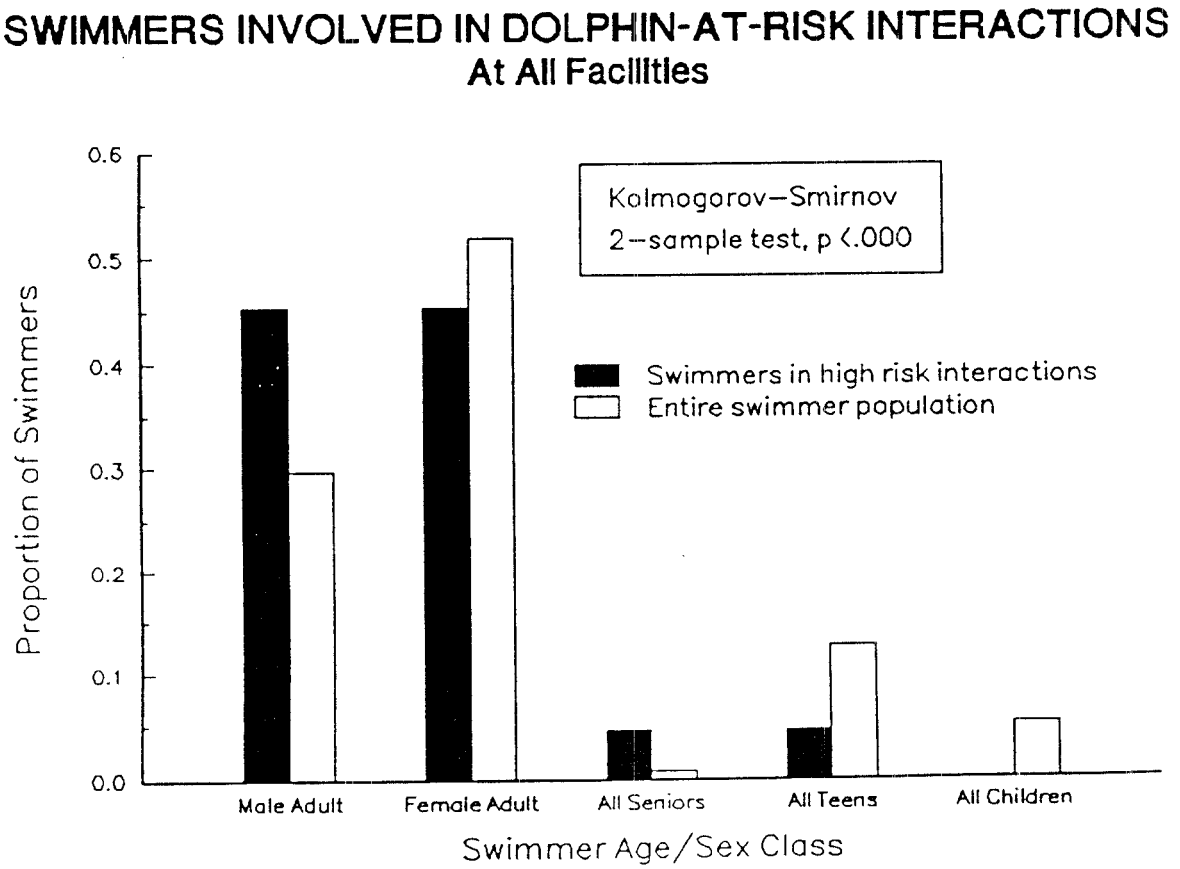

SWIMMERS INVOLVED IN DOLPHIN-AT-RISK INTERACTIONS
At All Facilities
Kolmogorov–Smirnov
2–sample test, p <.000
Swimmers in high risk interactions
Entire swimmer population
Proportion of Swimmers
0.0
0.1
0.2
0.3
0.4
0.5
0.6
Male Adult
Female Adult
All Seniors
All Teens
All Children
Swimmer Age/Sex Class

Fig.5

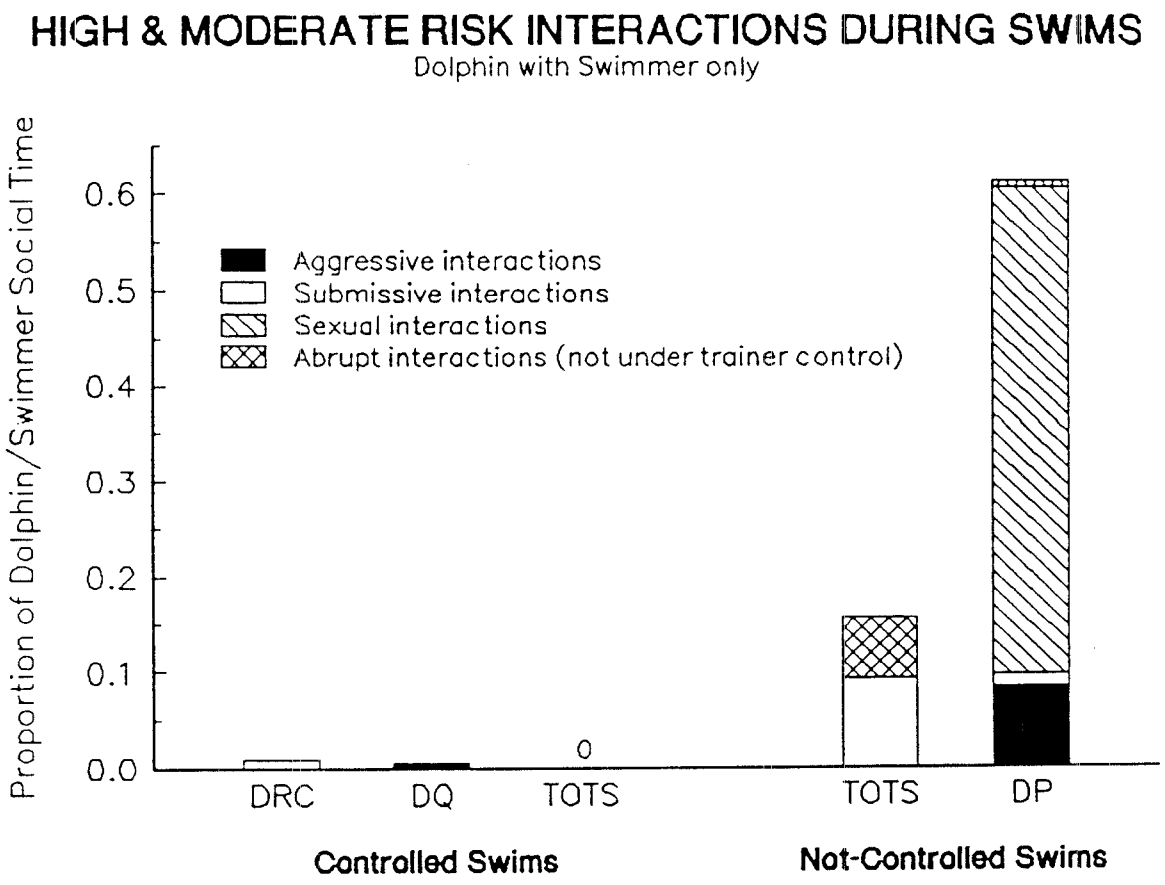

HIGH & MODERATE RISK INTERACTIONS DURING SWIMS
Dolphin with Swimmer only
Proportion of Dolphin/Swimmer Social Time
0.0
0.1
0.2
0.3
0.4
0.5
0.6
Aggressive interactions
Submissive interactions
Sexual interactions
Abrupt interactions (not under trainer control)
0
DRC
DQ
TOTS
TOTS
DP
Controlled Swims
Not-Controlled Swims

Fig.6

CO-OCCURRENCE OF DORSAL TOWING & AGONISTIC BEHAVIOR

In Interactions between Dolphins and Swimmers at Dolphins Plus

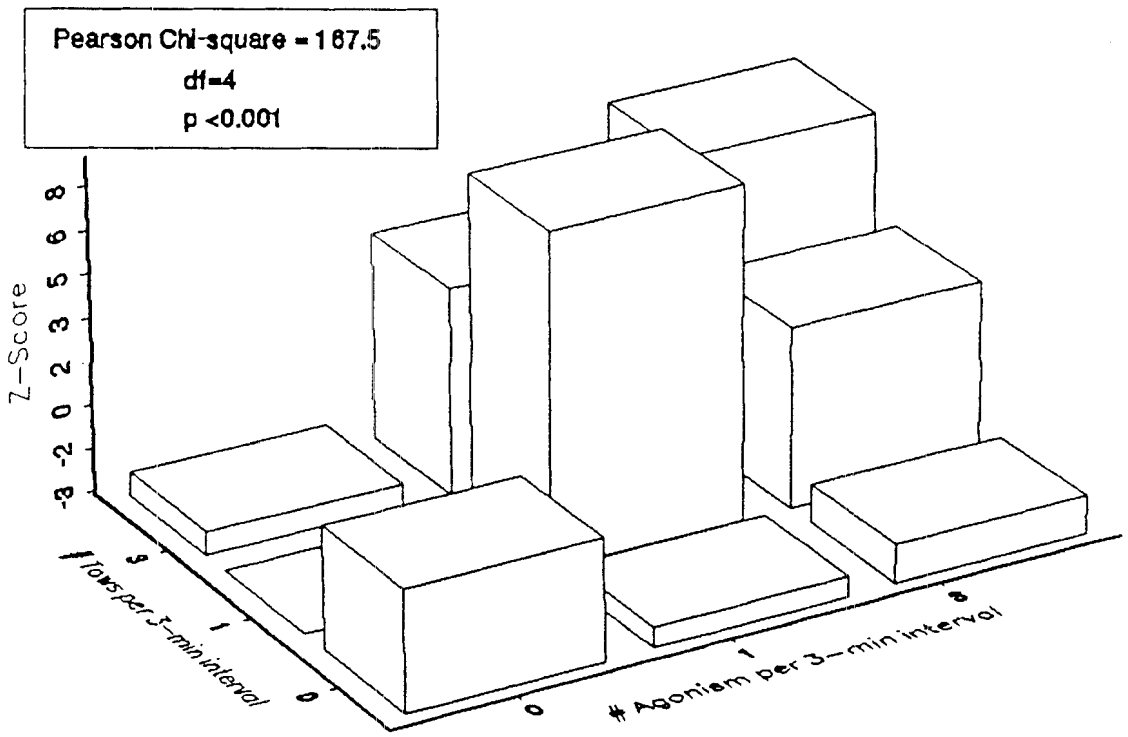


Fig.7

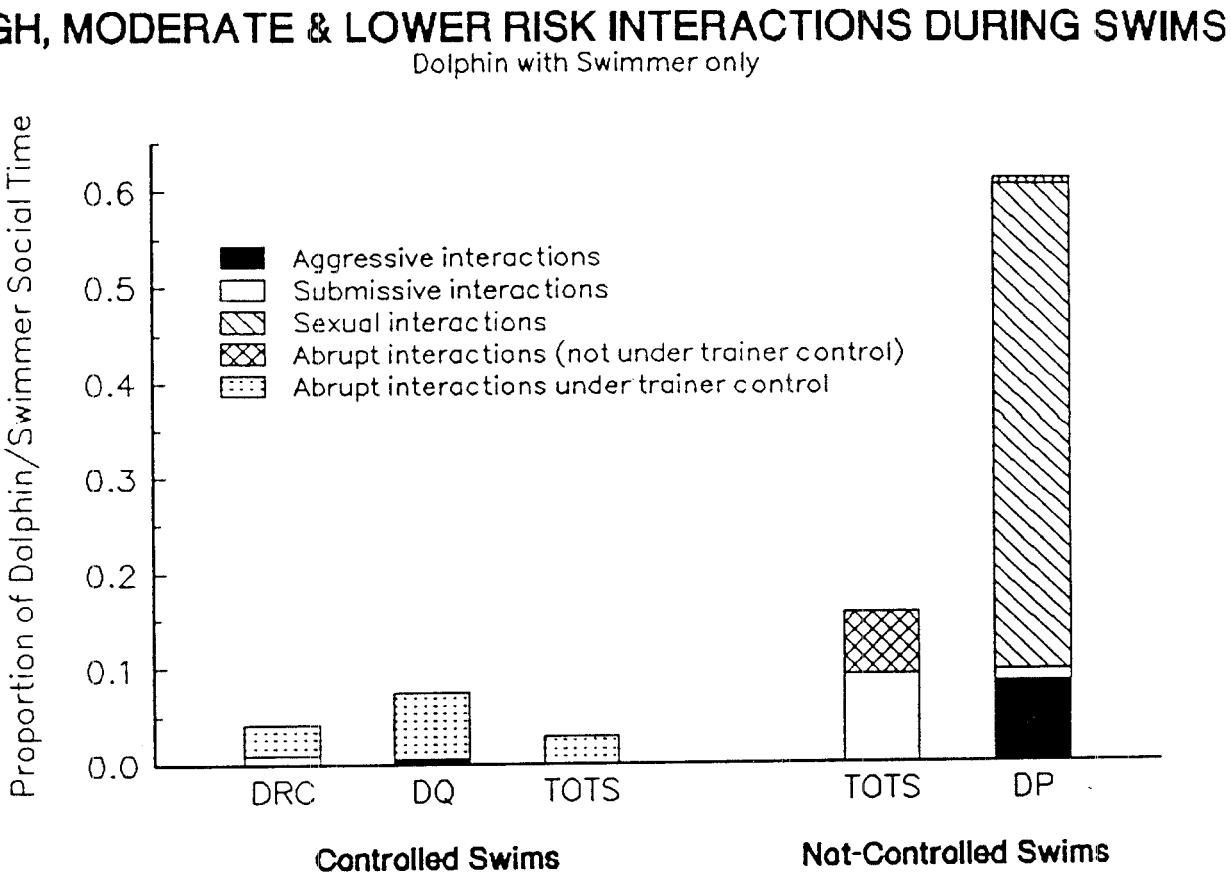

HIGH, MODERATE & LOWER RISK INTERACTIONS DURING SWIMS
Dolphin with Swimmer only
Proportion of Dolphin/Swimmer Social Time
0.0
0.1
0.2
0.3
0.4
0.5
0.6
Aggressive interactions
Submissive interactions
Sexual interactions
Abrupt interactions (not under trainer control)
Abrupt interactions under trainer control
DRC
DQ
TOTS
TOTS
DP
Controlled Swims
Not-Controlled Swims

Fig.8

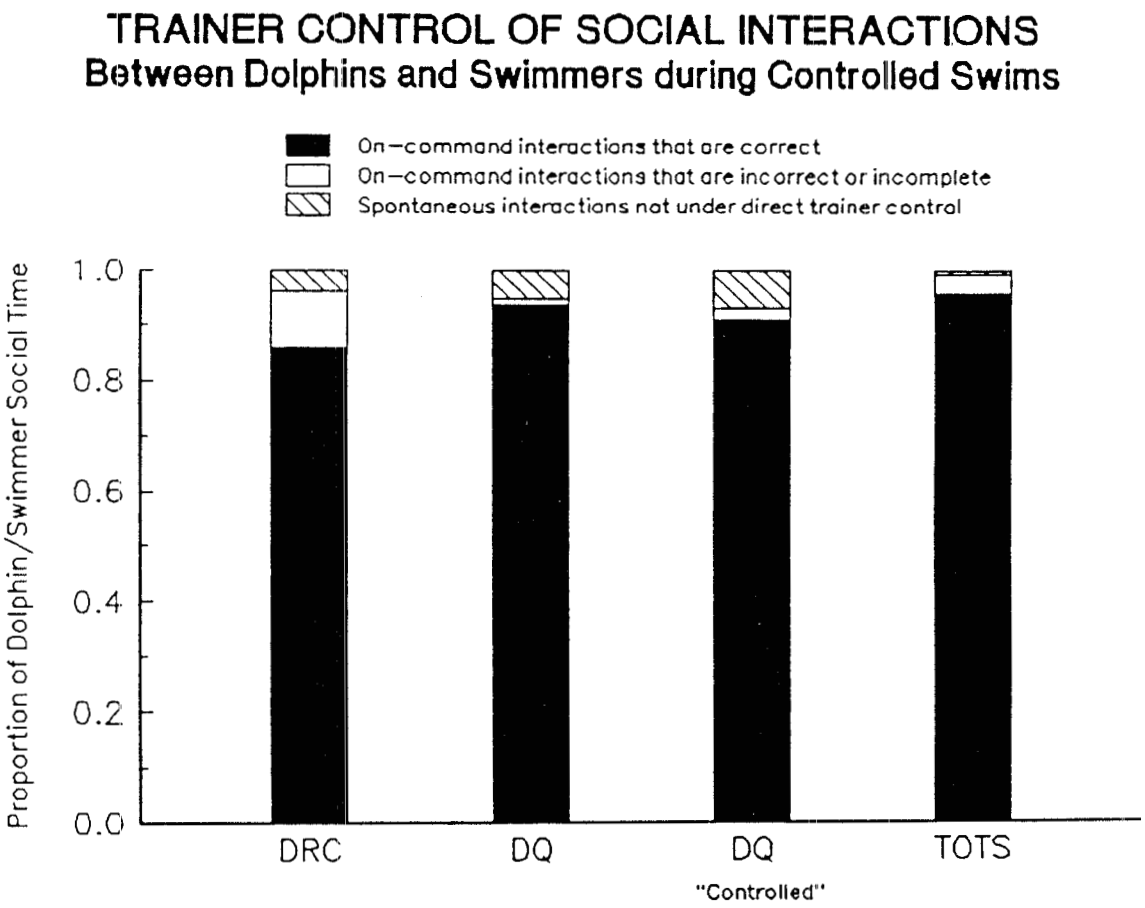

TRAINER CONTROL OF SOCIAL INTERACTIONS
Between Dolphins and Swimmers during Controlled Swims
On—command interactions that are correct
On—command interactions that are incorrect or incomplete
Spontaneous interactions not under direct trainer control
Proportion of Dolphin/Swimmer Social Time
1.0
0.8
0.6
0.4
0.2
0.0
DRC
DQ
DQ
TOTS
"Controlled"

Fig.9

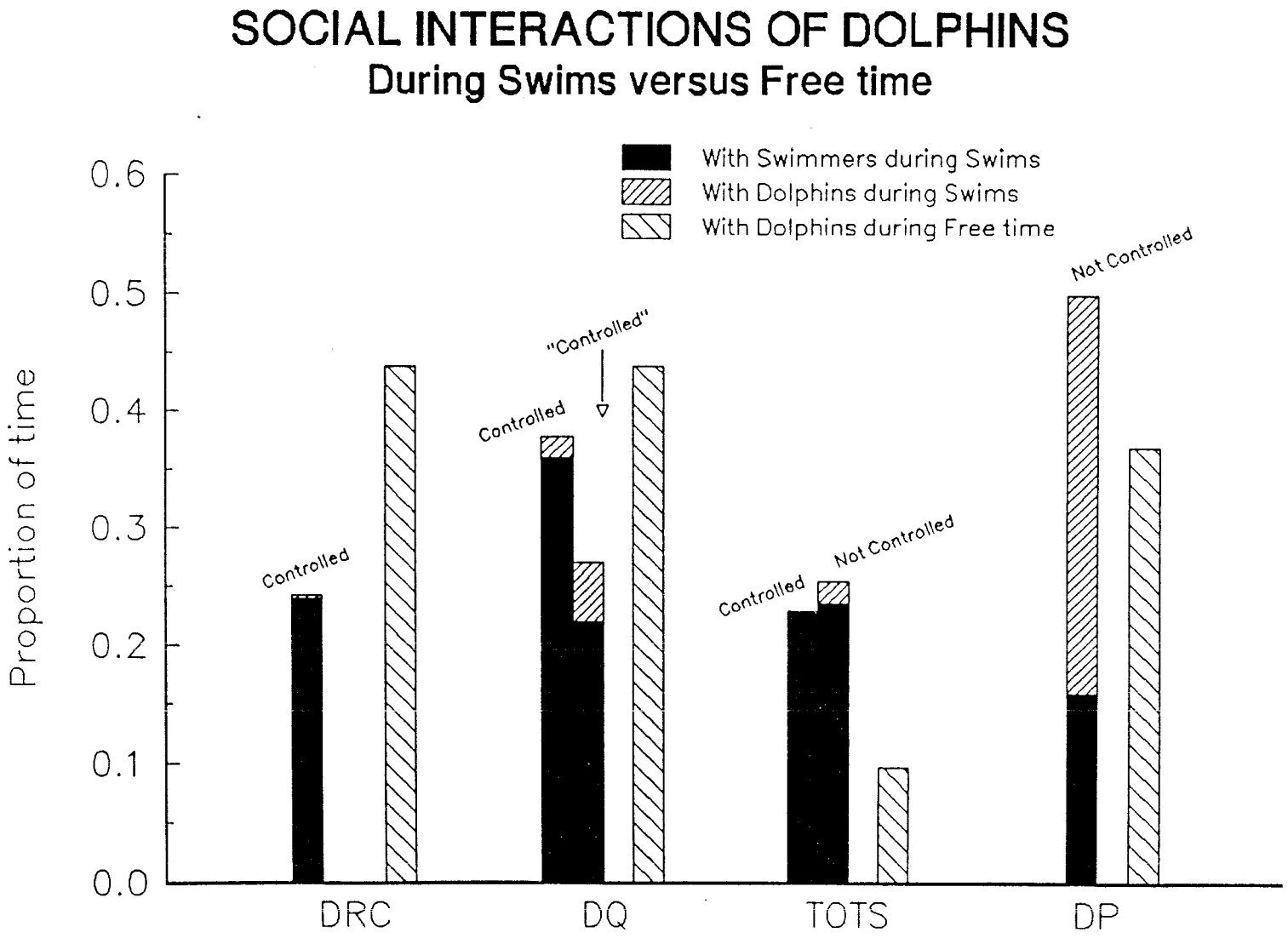

SOCIAL INTERACTIONS OF DOLPHINS
During Swims versus Free time
With Swimmers during Swims
With Dolphins during Swims
With Dolphins during Free time
Proportion of time
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Controlled
"Controlled"
Controlled
Not Controlled
Controlled
Not Controlled
DRC
DQ
TOTS
DP

Fig. 10a

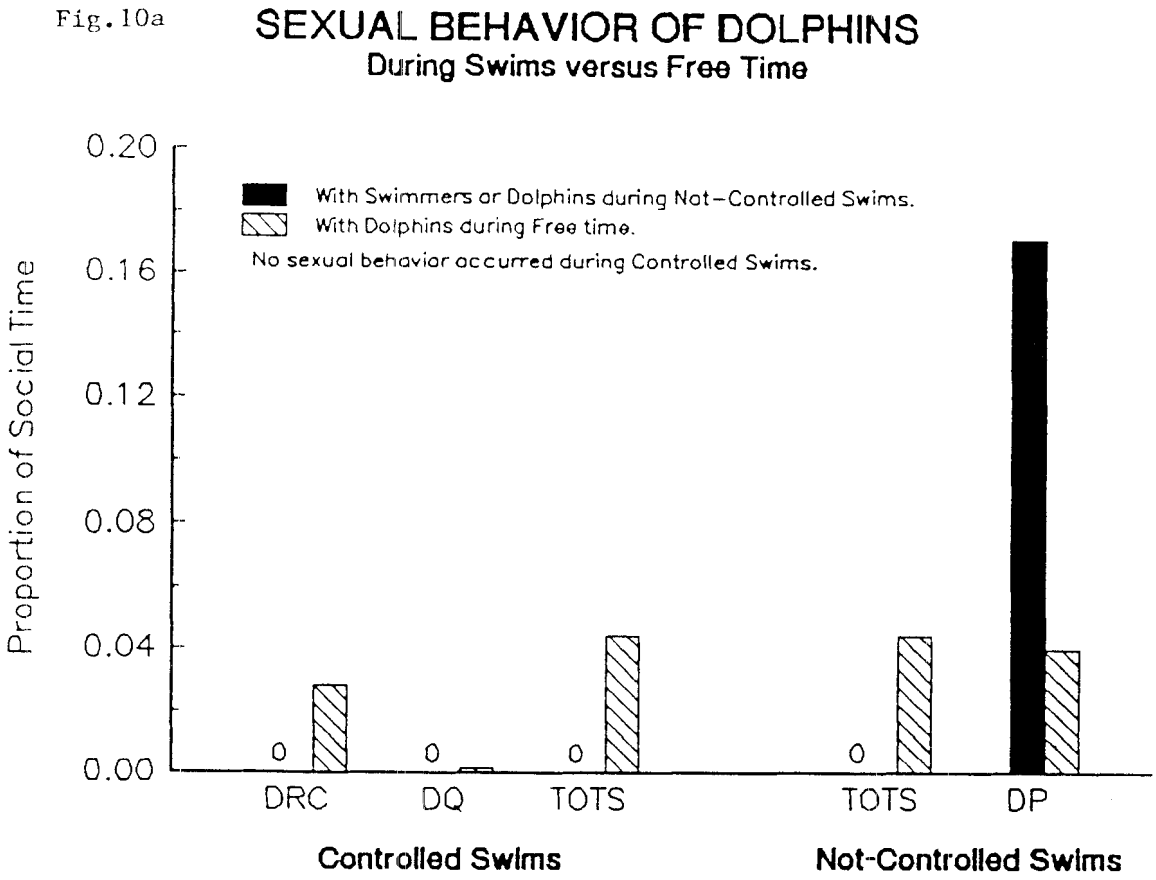


Fig. 10b

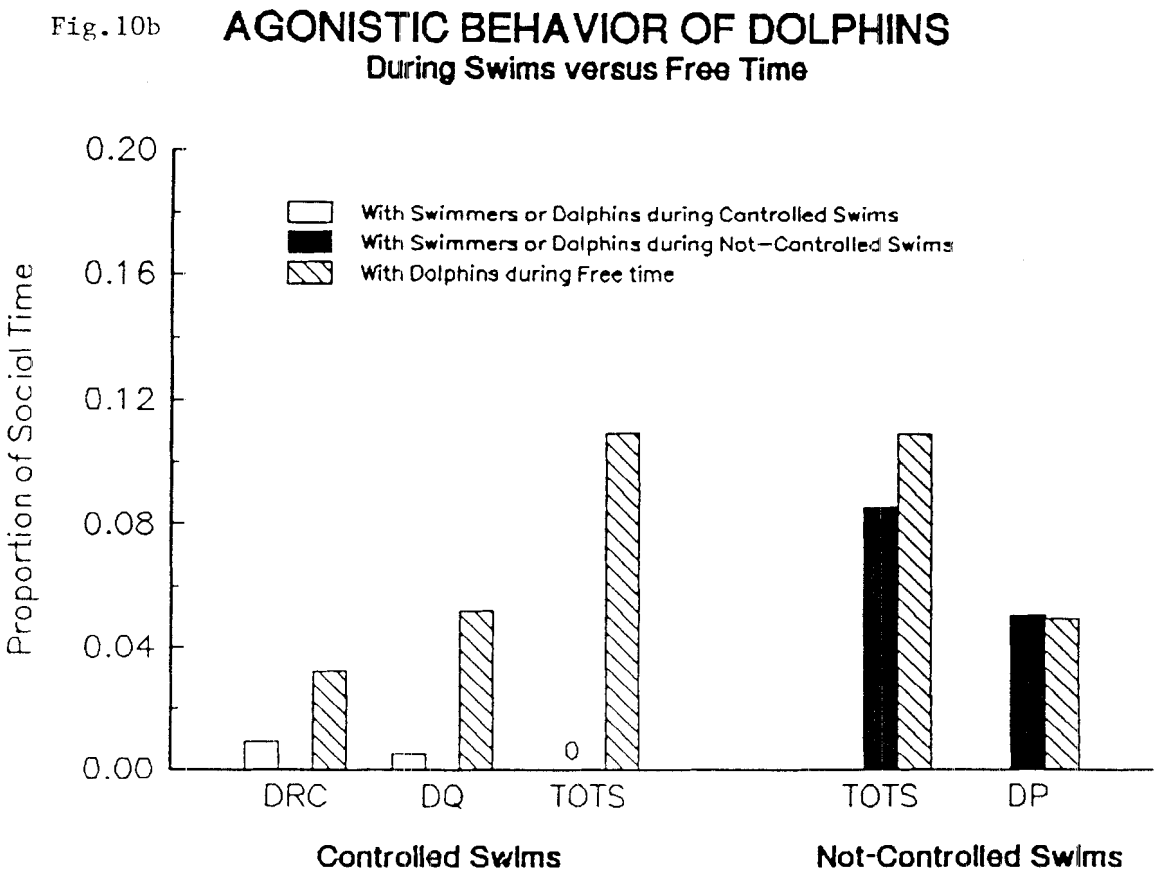


Fig.11

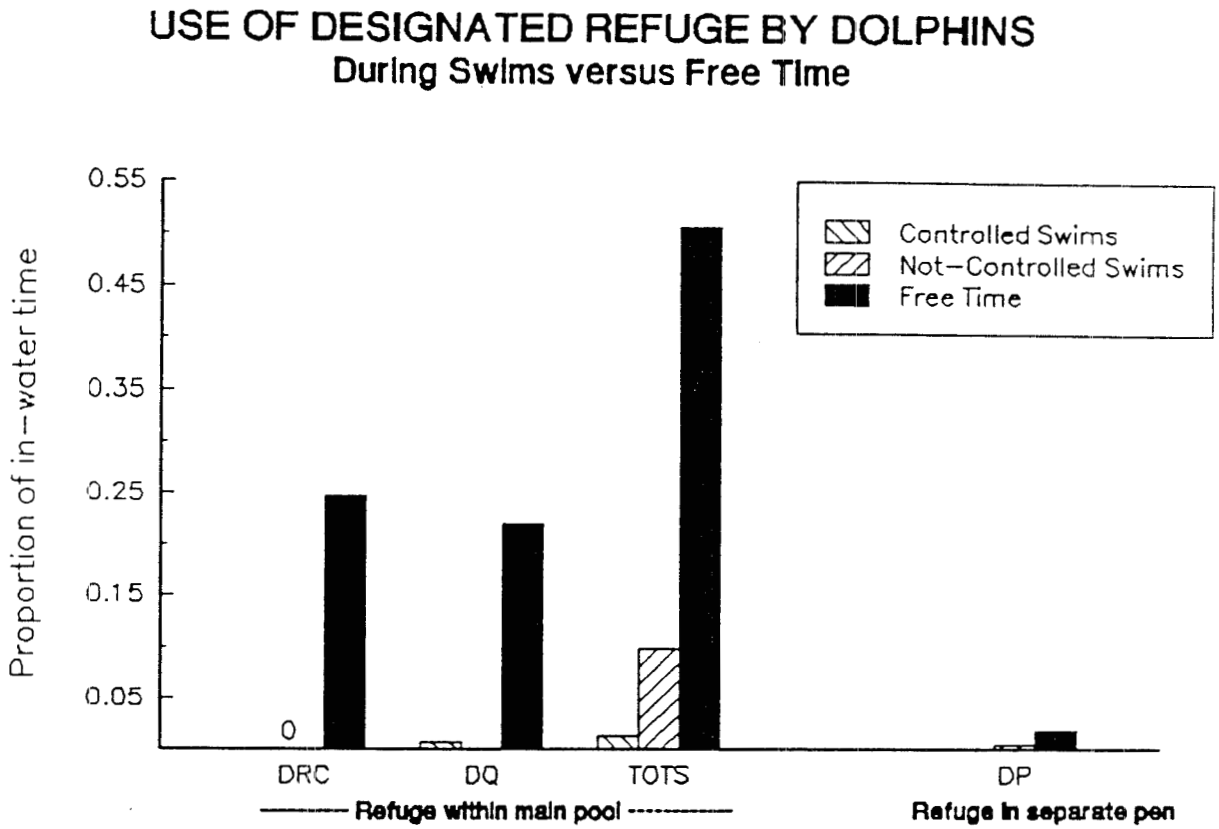
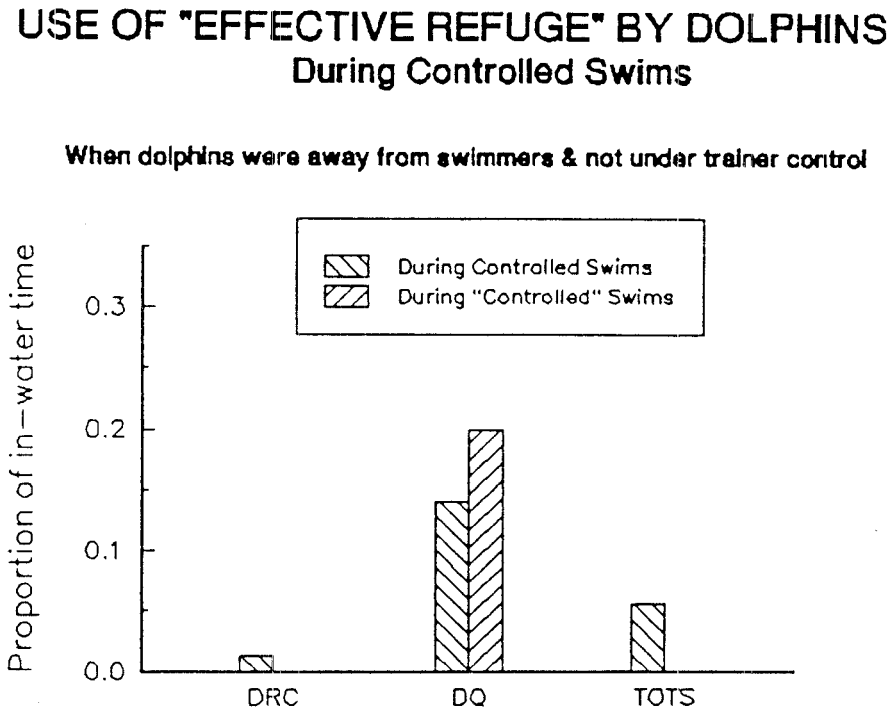

USE OF DESIGNATED REFUGE BY DOLPHINS
During Swims versus Free Time
Proportion of in-water time
0.55
0.45
0.35
0.25
0.15
0.05
0
Controlled Swims
Not-Controlled Swims
Free Time
DRC
DQ
TOTS
DP
Refuge within main pool
Refuge in separate pen

Fig. 12


USE OF "EFFECTIVE REFUGE" BY DOLPHINS
During Controlled Swims
When dolphins were away from swimmers & not under trainer control
Proportion of in-water time
0.0
0.1
0.2
0.3
During Controlled Swims
During "Controlled" Swims
DRC
DQ
TOTS

APPENDICES

Appendix A: **Definitions**

I. STATUS CONDITIONS

A. **SWIM SESSIONS**: Swim observations began when swimmers had the first opportunity to interact with dolphins; observations ended with the last interaction opportunity. Status conditions during Swims referenced swimmer opportunities for interaction with dolphins, and presence/absence of direct trainer control of dolphin and swimmer interactions. Status conditions that were recorded during the study but were not included in this report (*e.g.*, swimmers on dock, beach or steps) are not listed below. Controlled and Not-Controlled Swims defined in the text.

Status	*Definition*
Swim/Controlled	Controlled Swim: swimmers fully immersed in water, hanging onto dock or free-swimming.
Swim/Not-Controlled	Not-Controlled Swim: swimmers fully immersed in water, hanging on dock or free-swimming.
Shallow/Controlled	Controlled Swim: swimmers in shallow water, not fully immersed (only at DQ).
Break	Not specific to a Swim type. Any unscheduled divergence from normal Swim format, e.g., premature swimmer departure from water in association with swimmer or dolphin behavior; temporary or premature removal of all swimmers from water; unusual trainer assistance to swimmers. [Details recorded by observers.]

B. **FREE SESSIONS**: Observations of free time could begin whenever swimmers were unable to interact with dolphins or were not present, and/or trainers were not feeding or training dolphins. Observations of free time ended when swimmers arrived for a Swim session and/or when trainers arrived at poolside with fish.

No Trainers	No trainers or swimmers present near dolphins' pool.
Trainers Present	Trainers pass by or work around dolphins' pool but are not feeding dolphins; may be brief interactions without food rewards. May include briefing of swimmers by trainers prior to the Swim.

II. BEHAVIORAL STATES

All social activities are defined to occur when interactants are within 1m of each other. Specific behaviors are listed in Part III.

A. On-Command Social Activities

Behavioral State	*Definition*
Command/Social	Dolphin is requested by trainer to perform specific trained behavior involving contact or close proximity with swimmer.
Command/Social/Mistake	Dolphin is requested by trainer to perform specific trained behavior involving contact or close proximity with swimmer; but requested behavior is not performed or is performed incorrectly or incompletely. [Details recorded by observers.]

B. On-Command Non-Social Activities

Behavioral State	*Definition*
At Station	Dolphin is stationed at a location designated by trainer and is not performing any other trained behavior.
Command/Non-social	Dolphin is requested by trainer to perform a specific trained behavior that does not involve contact or close proximity with swimmers.
Command/Non-Social/Mistake	Dolphin is requested by trainer to perform a specific trained behavior that does not involve contact or close proximity with swimmers; but requested behavior is not performed or is performed incorrectly or incompletely. [Details recorded by observers.]

C. Not-on-Command Social Activities

Behavioral State	*Definition*
Rest Together	Dolphin is spontaneously floating, hovering or lying on bottom with one or more others for $\geq$5s.
Swim Together	Dolphin is spontaneously engaged in coordinated swimming with one or more others for $\geq$5s.
Other Social	Dolphin is engaged in any spontaneous in-contact or close proximity social interaction.

D. Not-on-Command Non-Social Activities

Behavioral State	*Definition*
Rest	Dolphin is spontaneously at rest for $\geq$5s; not resting with any other individual; not under trainer control.
Solo Swim	Dolphin's swimming pattern is not directed by trainer nor coordinated with that of any other individual.

III. SOCIAL INTERACTIONS

All social interactions are defined to occur when interactants are within 1m of each other.

A. SPONTANEOUS SOCIAL BEHAVIORS (*i.e.*, not under trainer control)

Behavior	*Definition*
Abrupt	Rapid and turbulent movement in contact with or near another; "abrupt" modifies another behavior (*e.g.*, Push-Abrupt, Rub-Abrupt).
Abrupt Turn	Rapid and turbulent initiation of travel or change in direction.
Bite	Abrupt contact with another using teeth.
Body Slam	Abrupt and forceful contact with another using side of body.
Bow Ride	Swim in pressure wave created by swimmer(s) moving quickly through the water.
Breach	Leap partly out of water and re-enter with part of body slapping on surface.
Chase	Rapid and persistent pursuit of another for $\geq$5s.
Chuff	$\geq$2 sharp exhalations at surface by dolphin.
Circling	Repeated rapid and turbulent surfacings by dolphin(s) in same location.
Dorsal Tow	Dolphin pulls swimmer through water as swimmer holds onto dorsal fin.
Erection	Erect penis.
Flee	Abrupt and immediate departure to $\geq$1m away in response to another's action or presence. Includes: beaching, breaching, leaping, or moving to another pool or refuge area.
Flinch	Abrupt and immediate cringing, body retraction, or turning away from another in response to another's action or presence.
Forceful Push	Abrupt and powerful jostling or shoving of another (*e.g.*, underwater or into/away from fence, dock, *etc.*).
Genital Insertion	Dolphin or swimmer appendage (*e.g.*, dorsal fin, flipper, swim-fin) is inserted into dolphin's genital slit.
Hit	Abrupt and forceful contact with another using hands or peduncle/flukes.
Hold	Swimmer hangs onto or cradles dolphin using hands for >5s.

Jaw Clap	Abrupt and forceful closing of mouth (usually with loud sound) directed to another.
Leap	Jump entirely out of water with smooth re-entry.
Mount	Drape ventrum over another, usually with genital-to-genital orientation and contact.
Object Interaction	Dolphin manipulates, investigates, and/or responds to inanimate object in presence of or in conjunction with another. Includes swimming through hoop, over tarp, over rope.
Porpoise	Repeated rapid leaping.
Push	Propulsion of another through water using hands or rostrum/head.
Quick Approach	Rapid and turbulent movement to within 1m of another.
Quick Swim	Rapid and turbulent travel; "quick swim" may modify other behaviors (*e.g.*, dorsal tow-quick swim, push-quick swim).
Ram	Abrupt and forceful contact with another using rostrum or head.
Reach	Extension of appendage towards another without contact.
Rest Together	Float, hover, or rest on bottom with one or more others for $\geq$5s.
Rub	Prolonged or repeated gentle contact with movement against another's body, using appendage or side of body.
Scream	Swimmer emits cry of protest or fear (*e.g.*, shriek, exclaim "OW!") in response to action by dolphin.
Slap Water	Abrupt and forceful hitting of water surface with any body part.
Snout-to-Body	Dolphin touches rostrum to another (or orients rostrum to within 0.5m of another).
Swim Together	Coordinated swimming with one or more others for $\geq$5s.
Threat	Abrupt vertical head movement (head-jerk threat) and/or wide open mouth (open-mouth threat) directed to another.
Thrust	Abrupt genital movement towards another usually with contact and usually with genital-to-genital orientation.
White Water	Abrupt, rapid and turbulent interaction of two or more individuals in which details are obscured by splashing. Usually includes circling, hitting, *etc.*

B. SOCIAL BEHAVIORS UNDER TRAINER CONTROL

Certain behaviors defined as "Spontaneous Social Behaviors" also occur under trainer control:

- Abrupt Turn
- Bow Ride
- Dorsal Tow
- Hold
- Leap, Porpoise
- Object Interactions: swim through hoop, leap over pole
- Push: rostrum to foot, hands to tail
- Quick Swim
- Reach
- Rest or Swim Together
- Rub
- Snout-to-body
- Slap Water

Other behaviors occur only under trainer control:

Behavior	*Definition*
Blowhole Med	Dolphin rests calmly as swimmer approximates medical behavior by placing hand under rostrum, holding cup over blowhole, and tapping head as signal for dolphin to exhale.
Bob	Dolphin and swimmer bounce vertically with heads above water.
Bubbles	Dolphin and swimmer blow bubbles at each other with heads partially submerged.
Feed	Swimmer holds fish for dolphin to take by mouth.
Flip Over	Swimmer rolls dolphin's body overhead while swimmer ducks underwater.
Gift	Dolphin retrieves/finds object (*e.g.*, ring, seaweed) and gives calmly to swimmer.
Head Stand	Dolphin and swimmer submerge vertically with flukes/legs above water.
Kiss	Specific form of "Snout-to-Body" in which dolphin's rostrum touches swimmer's face.
Mouth Med	Dolphin rests calmly as swimmer assists in medical behavior by holding chin-rest for open-mouth exam of dolphin by trainer.
Push Down	Swimmer pushes dolphin to rest on bottom.
Raspberry	Swimmer makes "Bronx Cheer" with mouth to dolphin's ventrum or back.
Rock	Dolphin and swimmer shake side to side while vertical with heads above water.
Roll Swim	Swim-Together in which swimmer and dolphin roll on horizontal axis side by side.
Spit	Dolphin tosses water at swimmer with abrupt head movement, mouth may be open or closed.
Splash	Dolphin splashes water at swimmer, with one or both pectoral fins, while vertical or lying on side.
Twirl	Dolphin and swimmer twirl 360 degrees while vertical with heads above water.

Appendix B. Dolphins that have participated in the SWTD programs since the inception of the programs (based on the best information available in NMFS records). Long-term removals are those in which a dolphin was removed for at least two consecutive quarters.

Sex	FACILITY			
	DRC	DQ	TOTS	DP
♀	Theresa Tursi Merina Aleta SANTINI* **Annessa** **Aphrodite** **Little Bit** *Omega** *Captiva* *Bee*	Kona Leilani Pele Shaka	Kona **Bubbles** [although Jeannie is listed as having been a potential participant, there is no record of her having been in a swim session]	Spunky Dreamer Samantha Nicky Jessica Isla Sarah **Dinghy** **Genie** **Squirt**
	AJ* Talon* ***Natua***	Hobi Lono *Yoichi** *Kai**	Buttons **Stormy** *Sonny**	Lil' Bit **Fonzi**

* - immature (less than 5-yrs old)
Bold - long-term removals from swim sessions for animals not yet returned
SMALL CAPS - long-term removal in the past that is now participating in swims
Italics - deaths. **Bold italics** - removed from swims and later died

	Sex	NUMBER OF DOLPHINS AT EACH FACILITY (n=39)			
		DRC	DQ	TOTS	DP
Total	♀	11	4	2	10
	♂	3	4	3	2
Removed	♀	7	0	1	3
	♂	1	2	2	1

	Sex	AGE CLASS OF DOLPHINS REMOVED (n=17)			
		DRC	DQ	TOTS	DP
Adult/ Maturing	♀	5	0	1	3
	♂	1	0	1	1
Immature	♀	2	0	0	0
	♂	0	2	1	0

Appendix C: **Catalog of all high risk interactions between dolphins and swimmers.** Based on all-occurrence data. Contexts given when known. Behavioral categories occurring <1% of social time are marked with an asterisk.

1. **Dolphin Research Center: Controlled Swim**

	By Dolphin	By Swimmer
AGGRESSIVE*	• mouth-open threat during rapid-approach for tow • hit during abrupt-turn @ sound of bridge	
SUBMISSIVE*	• flinch in response to rub blowhole, other rub, "kiss", reach • flee in response to hold rostrum	• flinch in response to "kiss", abrupt-turn @ sound of bridge
SEXUAL*		
ABRUPT	• abrupt-turn @ sound of bridge • quick-approach when late to join other dolphin for tow • rapid dorsal tow	• grab dorsal (for tow)

2. **Dolphin Quest: Controlled Swim**

	By Dolphin	By Swimmer
AGGRESSIVE*	• hit @ abrupt-turn, in response to hold tail • jawclap	hit due to swimmer clumsiness
SUBMISSIVE*	• flinch in response to hold tail, rub blowhole or head, other rub, reach	• "ow!" in response to hit
SEXUAL*		
ABRUPT*	• abrupt-turn @ sound of bridge • quick-approach • abrupt-spit trained behavior initiated by swimmer without trainer supervision	• abrupt-rub • abrupt face-to-rostrum trained behavior performed abruptly

3a. **Theater of the Sea: Controlled Swim**

	By Dolphin	By Swimmer
AGGRESSIVE*	• hit	
SUBMISSIVE*	• flinch in response to rub, reach	• flinch in response to abrupt-turn
SEXUAL*		
ABRUPT*	• quick-swim	

3b. **Theater of the Sea: Not-Controlled Swim**

	By Dolphin	By Swimmer
AGGRESSIVE*	• hit in response to rub or context unknown • mouth-open threat in response to reach or context unknown • ram in response to rub head	• chase • body-slam or ram due to swimmer clumsiness • hit (to dorsal fin) due to swimmer clumsiness
SUBMISSIVE	• flinch in response to chase, quick-approach, rub tail, other rub, reach, or context unknown • flee (including flee into refuge) in response to chase, quick-approach, abrupt-turn, slap-water, rub tail, reach	• flinch in response to mouth-open threat
SEXUAL*		
ABRUPT	• abrupt-turn @ sound of bridge, in response to reach or rub, or context unknown • breach • rapid-circling • quick-swim @ sound of bridge or context unknown • quick-approach • head-slaps	• quick approach in order to reach or rub • abrupt-turn context unknown

4. **Dolphins Plus: Not-Controlled Swim**

	By Dolphin	By Swimmer
AGGRESSIVE	• bite • hit • body-slam • ram • mouth-open threat • jawclap threat • head-jerk threat • forceful push (into fence,dock, etc; away from fence, dock, etc; underwater) all of above often in context of sexual behavior or dorsal towing; twice in response to being cornered or chased	• chase • hit
SUBMISSIVE*	• flinch in response to reach or context unknown • flee in response to quick-approach	• scream, shriek, "ow!" in response to mouth-open threat, ram, mount & thrust, rub, or context unknown • flinch in response to mouth-open threat, mount & thrust, rostrum-to-face, genital-inspection, rostrum-to-body, rub
SEXUAL	• mount • thrust • genital insertion • repeated genital-rubbing • "beak-to-genital" propulsion all of above often seen in conjunction, and in context of agonistic behavior	
ABRUPT	• quick-approach • quick-swim • tail-slap • abrupt-rub	• quick-approach