Pacific Islands Fisheries Science Center

Pacific Islands Photo-Identification Network Workshop Report

Edited by

Marie Chapla, David Johnston, and Kim Urian

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Edited by

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INTRODUCTION

The Pacific Islands Photo-Identification Network (PIPIN) was initiated by a U.S. Marine Mammal Commission (MMC) grant to the cetacean research program at the Pacific Islands Fisheries Science Center (PIFSC) in Honolulu. The funding is directed to support a collaborative photo-identification (photo-ID) catalog that will integrate the efforts of various researchers conducting photo-ID studies on spinner dolphins (*Stenella longirostris*), and other species, in the waters of the Pacific Islands Region (PIR).

The PIPIN Workshop was convened to bring together spinner dolphin researchers from around the Hawaiian Islands to begin developing the network and begin creating the photo-identification database. Potential workshop participants were invited based on their known involvement in spinner dolphin research and photo-identification. Additional invitations were based on suggestions from these potential workshop participants. A questionnaire (Appendix A) that canvassed potential contributors about their research, photo-ID techniques, and existing spinner dolphin catalogs (if applicable) was attached to the invitations. Although responses were received from 15 research groups (Table 1), prior commitments prevented some invitees from attending the workshop. Questionnaire responses were compiled and presented as part of an information packet (Appendix B) distributed to workshop participants. Responses to the question, “Are you interested in participating in a community-based photo-ID project?" were overwhelmingly positive, and responders listed their desired outcomes of the project (Table 2). Tables 3–9 show summaries of additional questionnaire responses.

The PIPIN Workshop was held during 11-12 December 2006 at the Honolulu offices of the Hawaiian Islands Humpback Whale National Marine Sanctuary/ Northwest Hawaiian Islands National Monument. The workshop (see agenda in Appendix C) was attended by local researchers from 12 organizations, including the Hawai‘i Marine Mammal Consortium; the Hawai‘i Association for Marine Education and Research; the Dolphin Institute; the Hawai‘i Wildlife Fund; the Kaho‘olawe Island Reserve Commission; the Hawaiian Islands Humpback Whale National Marine Sanctuary; the Status of Populations, Levels of Abundance, and Status of Humpbacks (SPLASH) project; Oceanwide Science Institute; Kula Nai‘a Foundation; the Pacific Scientific Review Group, Hawai‘i Institute of Marine Biology and representatives from the Hawai‘i Department of Land and Natural Resources; NOAA Pacific Islands Regional Office (PIRO); PIFSC; and MMC (Table 10). In addition, attendees Kim Urian and Dr. Andrew Read (Duke University) shared their insights and experience as curator of, and contributor to (respectively), the Mid-Atlantic Bottlenose Dolphin Catalog (MABDC), a similar project on the U.S. east coast.

The goals of the workshop were to (1) discuss research and management priorities for spinner dolphins in Hawai‘i, (2) present examples of established collaborative photo catalogs (MABDC and SPLASH) and photo-identification tools (database/catalog organization software), (3) provide a venue for researchers to explore the idea of developing and contributing to a collaborative catalog project, (4) canvas local research stakeholders on how best to approach such a project, and (5) develop a steering committee or working group to move the process forward.

BACKGROUND

Spinner dolphins, present throughout the PIR, are frequently found in island- and atoll-associated populations (Norris and Dohl, 1980; Norris et al., 1994; Poole, 1995). Currently, we know little about the abundance and stock structure of spinner dolphins in the Hawaiian Islands. The most recent estimate of spinner dolphin abundance in Hawaii (3,351 individuals) comes from a 2002 line-transect survey carried out in U.S. Exclusive Economic Zone (EEZ) waters around the Hawaiian Islands by the NOAA Ships *David Star Jordan* and *McArthur* (Barlow, 2006). The most intensively studied population of spinner dolphins, for which published data exist, is located around the Island of Hawai‘i. Würsig and his colleagues (1994b) concluded that the local population was open and that certain individuals moved regularly in and out of different areas. Certain recognizable individuals, though, consistently used particular areas around the island for resting (Würsig et al., 1994b).

Spinner dolphins hunt cooperatively in offshore waters at night as the deep scattering layer of shrimps, fishes, and squids migrates upward and inshore (Norris et al., 1994; Benoit-Bird and Au, 2003; Benoit-Bird et al., 2001). During the day, the dolphins move into shallow coastal waters to rest and socialize (Norris and Dohl, 1980; Würsig et al., 1994a). The areas used most frequently for resting are wind protected, typically < 50 m in depth, and have sandy bottoms – presumably to aid in the detection of predators (Norris and Dohl, 1980; Norris et al., 1994). In many cases, these resting areas coincide with human recreational areas. Studies suggest that interactions between humans and spinner dolphins may have a significant effect on the resting behavior of spinner dolphins (Würsig, 1996; Driscoll-Lind and Östman-Lind,1999; Courbis, 2004; Danil et al., 2005; Timmel, 2005).

RESEARCH NEEDS

The National Marine Fisheries Service (NMFS) and the MMC have recognized conservation concerns regarding spinner dolphins in Hawaiian waters and a need for better data on dolphin stock structure, abundance, and demography. The spinner dolphins’ diurnal pattern of behavior is of particular importance because it results in dolphins predictably entering coastal areas frequently used by humans. This predictable use of coastal habitat puts the

dolphins at risk of adverse impacts from eco-tourism activities. Other potential threats to spinner dolphins include natural processes like predation and emergent diseases, and human-caused threats including marine debris, noise pollution, and fisheries interactions.

Knowledge of spinner dolphin stock structure is important for informed management. Genetic data from spinner dolphins in the main Hawaiian Islands (MHI) suggest that limited genetic exchange is occurring among dolphins associated with different islands and island groups (Andrews et al., 2006; Baird et al., 2005b; Galver, 2002). In addition, Andrews et al. (2006) found limited gene flow among the islands and atolls in the Northwestern Hawaiian Islands (NWHI). These genetic data provide an evolutionary perspective on the stock structure of spinner dolphins in Hawaiʻi. The use of photo-ID techniques to improve understanding of this structure will be extremely useful in determining the best way to manage threats to this species on ecological time scales. For example, if each island supports a separate, "resident" population (little movement between islands or atolls) it is important that management decisions reflect this level of population structure.

Long-term photo-identification studies are an excellent tool to gain insight into habitat use, movements, and life history of spinner dolphin populations in Hawaiʻi and elsewhere in the PIR (Mann, 2000). For example, a photo-ID study at Midway Atoll demonstrated the "first documentation of inter-atoll movement of spinner dolphins in the Northwest Hawaiian Archipelago" (Rickards et al., 2001). Previous research found a resident and closed population of spinner dolphins inhabiting the nearshore waters of Midway (Karczmarski, et al., 1998). In 1999, a second distinct group of spinner dolphins was observed in the Midway Atoll lagoon (Rickards et al., 2001). Individuals from this group had been previously photographed at Kure Atoll (Rickards et al., 2001). A third group of spinner dolphins was observed at Midway in 2001 and photographs indicated that at least one of the dolphins had previously been documented at Pearl and Hermes Reef (Rickards et al., 2001). Interactions among groups were limited, with most interactions occurring between the second and third groups (Rickards et al., 2001). Although spinner dolphins may be observed using the same areas, local populations may be behaviorally isolated, as suggested by the limited gene flow observed by Andrews et al. (2006).

Understanding patterns of habitat use by individual spinner dolphins is essential for determining the types and locations of important habitat (e.g., resting areas) and should be the focus of research to identify effective protection measures. A study on Oʻahu revealed areas of high use by spinner dolphins along the west coast of the island (Lammers, 2004) and similar studies, dating from the 1980s to the present, provide similar findings for the Kona coast of the Island of Hawaiʻi. In addition, Lammers (2004) noted that spinner dolphins "consistently exhibited a strong affinity for the 10-fathom isobath." Studies in the NWHI demonstrated that groups of dolphins followed both natural and man-made depth contours inside the atolls (Karczmarski et al., 1998; Rickards et al., 2001).

A long-term collaborative photo-ID database will provide important information for management decisions and provide significant research opportunities for cetacean researchers

in Hawai‘i. A community-based collaborative database offers many benefits to spinner dolphin research and conservation. A centralized database provides researchers an opportunity to collaborate on specific research projects. Through collaboration, researchers can address questions like:

- What is the abundance of spinner dolphins in Hawai‘i?
- Are spinner dolphin populations isolated to individual islands?
- How do individuals use their habitat? Are there differences from one island to the next?
- Does habitat use change over time?
- Is reproductive success different from one island to the next?
- Are survival rates different from one island to the next?

In addition, a collaborative catalog provides a fund-raising focus and a tool to educate the public on conservation issues surrounding spinner dolphins in the PIR.

OTHER COLLABORATIVE CATALOGS

The Mid-Atlantic Bottlenose Dolphin Catalog (MABDC) and Structure of Populations, Levels of Abundance, and Status of Humpbacks (SPLASH) catalog are examples of successful collaborative catalogs that may provide PIPIN with insight. The MABDC was developed in 1997 to examine the population structure of bottlenose dolphins (*Tursiops truncatus*) along the western North Atlantic coast to determine if a single coastal migratory stock exists from New Jersey to central Florida (Urian et al., 1999). Twenty-three researchers from 15 different sites contribute to the catalog. Currently, there are approximately 4,000 dolphins identified in the catalog. Results demonstrate that the patterns of dolphin movements are complex with a high rate of exchange among the northern sites and less movement among southern sites.

SPLASH is an international collaborative project that was started in 2004 to understand the population structure of humpback whales (*Megaptera novaeangliae)* in the North Pacific by using photo-ID and genetic sampling. The study area encompasses the humpbacks' summer feeding areas as well as their winter breeding areas, including Hawai‘i. In Hawai‘i alone, eight different research groups contribute to the photo catalog. A status report at the beginning of 2007 indicated that 2,962 individuals had been identified and 2,032 biopsies had been collected in Hawai‘i.

During the PIPIN workshop Kim Urian (MABDC) and Allan Ligon (SPLASH) presented information on the background and organization of their respective catalogs.

The following key requirements were noted with regard to the collection, processing, and organization of photo-ID catalog data:

- A strict protocol is required to ensure consistent data collection;
- Photos must be graded for quality (e.g., only 50% of photographs were accepted from contributing catalogs);
- A clearly defined consent form should be developed and signed by contributors of data and images;
- Digital photographs are essential;
- Database software is critical;
- An online database would be useful;
- Computer-assisted matching programs help with the labor-intensive search for potential matches.

PHOTO-IDENTIFICATION SOFTWARE TOOLS

Two important components of maximizing the efficiency of a collaborative catalog are (database) organizational software and image manipulation and matching tools. Curators of collaborative catalogs typically rely on relational databases that store information, such as sighting and environmental data (as well as data associated with catalog images), in addition to an image viewer or matching tool. Certain customized database programs combine these tools to some extent and can allow researchers to assign user-defined attributes to facilitate the matching process.

During the workshop, participants from different research groups demonstrated the software they use for their own photo-ID catalogs, including FinScan (Kim Urian, Duke University), FinBase (Mark Deakos, HAMER), and ThumbsPlus (Susan Rickards, HMMC). In addition, Kim Urian demonstrated a prototype, Web-based photo-ID catalog that would be a portal within the Ocean Biogeographic Information System – Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP).

FinScan is a computer-assisted matching system developed by Dr. Gil Hillman and colleagues at the University of Texas Medical Branch and Texas A&M University. This software program matches images based on a metric description of the features or notches on the trailing edge of the dorsal fin and uses a matching algorithm to rank the most similar fin. The user makes the final decision after reviewing the ranked images (Araabi et al., 2000). The metrical approach used by the FinScan software program minimizes subjectivity introduced by assigning attributes or fin features to categorize fins and search for matches. The FinScan program uses a Microsoft Access database to store the fin contour data.

FinBase, a customized Microsoft Access database developed by NOAA's National Centers for Coastal Ocean Science (NCCOS), stores and manages textual and numerical data from photo-identification surveys and performs tasks associated with image management and analysis. The user assigns specific attributes (e.g., chop, apex, lower fin notch, peduncle scar/notch) to the record of a specific fin image. The catalog can be sorted so that images with the most similar attributes to the current image/fin are located at the beginning of the sorted catalog, thereby reducing the time spent analyzing images that are unlikely to match the current image. FinBase offers several customized forms for entering photo-ID sighting data (e.g., environmental, individual associations, survey details). In addition, a GIS mapping tool allows the user to plot sighting locations. FinBase is not photo-editing software and requires other software such as ACDSee to prepare photos for entry into the database. FinBase is a free software program that presently offers technical support.

ThumbsPlus is a customizable image editor and database created by Cerious Software, Inc. Photographs can be edited (e.g., cropped, adjusted for contrast and color, etc.), and user-defined fields can be assigned to each photograph or groups of photographs. The photographs can then be sorted based on a query of specific user-defined fields. A batch-processing function allows the user to edit details (e.g., file name, EXIF & IPTC data, picture size, etc.) of multiple photographs at the same time. Database information is stored using Microsoft Access. At the time of the workshop, the professional version of ThumbsPlus version 7 retailed for $89.95 for a single user. Network licenses were also available for $95 per user. ThumbsPlus presently offers a WebClient version 1.0, which is a web-based interface that hosts ThumbsPlus database content and allows access to users over the internet. Users can connect from computers using Windows, Mac, or Linux operating systems. At the time of the workshop, the base price for the WebClient server was $199, and each user connection license cost $49.95.

OBIS-SEAMAP is a web-based, multifunction information system designed to provide data from the Census of Marine Life to scientists, managers, and educators (http://seamap.env.duke.edu). OBIS-SEAMAP was developed by Dr. Pat Halpin and Dr. Andy Read from Duke University. The database, which currently includes more than one million observations, continues to grow. It allows the interactive display, query, and analysis of digital archives of data on the distribution and abundance of marine mammals, birds, and sea turtles as well as environmental data. Many contributors provide photo-ID data to OBIS-SEAMAP, but the system is currently unable to depict an individual animal’s records. Kim Urian has been working with the OBIS-SEAMAP programmers to develop a Web-based interface that allows photo-ID researchers to upload their photos and sighting information and browse those of other contributors. Potential matches could also be reviewed and verified on the Web site. Contributors could also use the common features of the OBIS-SEAMAP Web site such as mapping dolphin sightings on Google Earth or overlaying sighting data with environmental data. This site is still under development, but the contributors to PIPIN could test the system as it is being developed.

PROJECT ISSUES AND APPROACHES

Guidelines for Data Contributed to PIPIN

The Marine Mammal Protection Act (MMPA) prohibits the “take” of marine mammals and defines "take" as “to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal" (16 U.S.C. 1362 § 3(13)). NMFS’ implementing regulations expand on that definition and define “take” as including the “negligent or intentional operation of aircraft or vessel, or the doing of any other negligent or intentional act which results in disturbing or molesting a marine mammal” (50 CFR 216.3). Under the MMPA, photography that has the potential to disturb wild marine mammals is considered “Level B Harassment,” defined as "any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild" (16 U.S.C. 1362 § 3(18) and 50 CFR 216.3). Level B harassment is allowed under a "General Authorization" permit for *bona fide* scientific research being conducted on marine mammals not listed under the Endangered Species Act.

Workshop participants raised concerns about the potential for tour boat operators disturbing spinner dolphins, intentionally or accidentally, when they collect photographs of them. Although one goal of PIPIN is to foster a community-based, grass roots network of photo collectors and contributors, PIPIN also emphasizes responsible wildlife viewing by the public and does not want to encourage the unauthorized harassment of dolphins. Participants pointed out that tour boat operators have the advantage of being on the water year-round and have the ability to collect important seasonal data. In addition, the exclusion of data based on its source may be detrimental to the project, both in terms of data and community support, and should not be done without careful consideration. Workshop participants agreed that no data resulting from the unauthorized harassment of spinner dolphins would be accepted for use in the catalog database. Possible permit requirements will be addressed by the steering committee.

Role of NMFS

NMFS has stock assessment mandates for cetaceans in the PIR, requiring efforts to assess stock structure and abundance for each species inhabiting waters within the U.S. EEZ. Currently, at least 23 species of cetaceans inhabit the PIR. NMFS is actively building collaborations within the region to conduct and support research necessary for stock assessment, because resources available within the PIR are limited (Reeves et al., 2007). To this end, PIFSC has supported (largely through the addition of start-up funding provided by the MMC) the development of the PIPIN project with the initial goal of assessing the abundance and stock structure of spinner dolphins in the Hawaiian Islands. However, it is the expectation that PIPIN will evolve into a community-based network, directed and managed by the

community of local researchers interested in the science and conservation of spinner dolphins in Hawai‘i. NMFS will continue to be a strong contributor to the catalog but will not serve as the long-term manager.

PIPIN RESEARCH PRIORITIES

Workshop participants agreed on the following draft list of research priorities designed to meet the objectives of the PIFSC and PIPIN:

- Stock structure and abundance estimates for each stock (considering both inshore/offshore populations as well as island-associated populations);
- Movements on ecological time scales and potential effects of human disturbance;
- Vital rates (e.g., calving, survival);
- Entanglement and fishery interaction issues (i.e., scarring rates);
- Individual habitat usage patterns;
- Use of passive acoustics to determine presence of dolphins in areas that are hard to survey visually;
- Identification of control areas (not subject to human activities) to provide baseline data for management;
- Investigation of dolphin association patterns between individuals (e.g., male coalitions, mom/calf associations in resting areas);
- Rates of occurrence and persistence of scars from cookie cutter sharks and presence of remoras.

MAXIMIZING THE USE OF EXISTING DATA

Several research groups indicated they have spinner dolphin identification photographs that have not been analyzed or processed (e.g., cropped, adjusted for contrast and brightness). Researchers were asked to provide an inventory of their archived photo-ID data and images that they are willing to contribute to PIPIN. The need to focus on mining existing data or to initiate new data collection will be determined as each research priority is addressed by the steering committee.

POTENTIAL SOURCES OF FUNDING

The need for future funding support for spinner dolphin photo-ID research was discussed during the workshop. Participants offered suggestions for several potential sources, which included:

- Environmental Grantmaking Foundations: Directory
- University of Hawai‘i Sea Grant College Program
- David and Lucile Packard Foundation
- License plate funds (e.g., in the case of Florida manatee/protect wild dolphins license plates, a portion of the profit is donated to research)
- PADI small grants
- Marine Mammal Commission
- National Science Foundation
- Marine tour operators fund (i.e., a proportion of the profit from each ticket would be donated to research)
- Patagonia’s Oceans as Wilderness Campaign
- National Fish and Wildlife Foundation

STEERING COMMITTEE

Workshop participants reached consensus on the formation of a steering committee made up of all interested participants. The designation of individual duties will be determined at the first steering committee meeting. The following topics will be discussed by the steering committee as a whole:

- Identification of the order of research priorities
- Current funding priorities
- Protocol for data collection and submission to the catalog
- Permit requirements for contribution of data and images to PIPIN
- Development of a consent form for submission of images and data to PIPIN
- Database software and structure
- Establishing efficient exchange of information/data
- Future sources of funding to support PIPIN

WEB SITE

A PIPIN Web site (http://pipin.org/community) was created to provide background information on spinner dolphins (e.g., distribution, biology, ecology, and potential threats),

photo-identification techniques and exemplar photos, information regarding the workshop, current popular news articles about spinner dolphin conservation issues, and links to other Web sites. A photo gallery was created for the posting of spinner photographs of particular interest to contributors. Primarily, however, the Web site was created to provide a central location for communication among network participants.

CONCLUSION

The workshop was a successful beginning to what we hope will be productive and long-term collaborations by participating organizations and individuals. A collaborative approach is necessary for conducting and integrating the biological research needed to support management and conservation of spinner dolphins in a funding-limited environment. It was agreed that our next step would be to organize a meeting of the steering committee to determine the short-term and long-term goals or objectives of PIPIN. Once research priorities are identified, we can focus on developing projects that will meet the goals of the committee.

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REFERENCES

Andrews, K. R., L. Karczmarski, L., W. W. L. Au, S. H. Rickards, C. A. Vanderlip, and R. J. Toonen.
2006. Patterns of genetic diversity of the Hawaiian spinner dolphin (*Stenella longirostris*). Atoll Res. Bull. 543:65-73.

Araabi, B. N., N. Kehtarnavaz, T. McKinney, G. Hillman, and B. Würsig.
2000. A string matching computer-assisted system for dolphin photo-identification. Ann. Biomed. Eng. 28:1269-1279.

Baird, R.W., D. J. McSweeney, D. L. Webster, A. M. Gorgone, and A. D. Ligon.
2003. Studies of odontocete population structure in Hawaiian waters: results of a survey through the Main Hawaiian Islands in May and June 2003. National Oceanic and Atmospheric Administration Report No. AB133F-02-CN-0106.

Baird, R.W., A. M. Gorgone, D. L. Webster, D. J. McSweeney, J. W. Durban, A. D. Ligon, D. R. Salden, and M. H. Deakos.
2005a. False killer whales around the Main Hawaiian Islands: an assessment of the inter-island movements and population size using individual photo-identification. Pacific Islands Fisheries Science Center Report No. JJ133F04SE0120.

Baird, R.W., D. L. Webster, and D. J. McSweeney.
2005b. Biases and data limitations of odontocete cetacean sighting data from small-boat surveys around the main Hawaiian Islands. Cascadia Research Collective Report N62742-05-P-1880.

Barlow, J.
2006. Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. Mar. Mamm. Sci. 22(2):446-464.

Benoit-Bird, K.J. and W. W. L. Au.
2003. Prey dynamics affect foraging by a pelagic predator (*Stenella longirostris*) over a range of spatial and temporal scales. Behav. Ecol. Sociobiol. 53:364-373.

Benoit-Bird, K. J., W. W. L. Au, R. E. Brainard, and M. O. Lammers.
2001. Diel horizontal migration of the Hawaiian mesopelagic boundary community observed acoustically. Mar. Ecol. Prog. Ser. 217:1-14.

Courbis, S. S.
2004. Behavior of Hawaiian spinner dolphins (*Stenella longirostris*) in response to vessels/swimmers. M.A. thesis. San Francisco State University.

Danil, K., D. Maldini, and K. Marten.
2005. Patterns of use of Maku‘a beach, O‘ahu, Hawai‘i, by spinner dolphins (*Stenella longirostris*) and potential effects of swimmers on their behavior. Aqua. Mamm. 31(4):403-412.

Driscoll-Lind, A. and J. Östman-Lind.
1999. Harassment of Hawaiian spinner dolphins by the general public. Mar. Mam. Prot. Assoc. Bull. 17:8-9.

Friday, N., T. D. Smith, P. T. Stevick, and J. Allen.
2000. Measurement and individual distinctiveness for the photographic identification of humpback whales, *Megaptera novaeangliae*. Mar. Mamm. Sci. 16(2):355-374.

Galver, L.
2002. The molecular ecology of spinner dolphins, *Stenella longirostris*: genetic diversity and population structure. PhD Thesis, Scripps Institute of Oceanography, San Diego, California.

Karczmarski, L., B. Würsig, and B. Winning.
1998. Socio-ecology and population biology of spinner dolphins, *Stenella longirostris,* in Midway Atoll, Northwest Hawaiian Chain, Central Pacific. Unpublished report to U.S. Fish and Wildlife Service and National Marine Fisheries Service. 41pp.

Karczmarski, L., B. Würsig, G. Gailey, K. W. Larson, and C. Vanderlip.
2005. Spinner dolphins in a remote Hawaiian atoll: Social grouping and population structure. Behav. Ecol. 16(4):675-685.

Lammers, M. O.
2004. Occurrence and behavior of Hawaiian spinner dolphins (*Stenella longirostris*) along O‘ahu’s leeward and south shores. Aqua. Mamm. 30(2):237-250.

Mann, J.
2000. Unraveling the dynamics of social life: long-term studies and observational methods. In: Mann, J., Connor, R.C., Tyack, P.L., Whitehead, H. (eds.). Cetacean Societies: Field Studies of Dolphins and Whales. University of Chicago Press, Chicago.

Marten, K., S. and Psarakos.
1999. Long-term site fidelity and possible long-term associations of wild spinner dolphins (*Stenella longirostris*) seen off O‘ahu, Hawai‘i. Mar. Mam. Sci. 15(4):1329-1336.

Norris, K. S., and T. P. Dohl.
1980. Behavior of the Hawaiian spinner dolphin, *Stenella longirostris*. Fish. Bull. 77:821-849.

Norris, K.S., B. Würsig, R. S. Wells, and M. Würsig.
1994. The Hawaiian Spinner Dolphin. University of California Press, Berkley.

Östman-Lind, J., A. D. Driscoll-Lind, and S. H. Rickards.
2004. Delphinid abundance, distribution and habitat use of the western coast of the island of Hawai‘i. Southwest Fisheries Science Center Administrative Report No. LJ-04-02C.

Poole, M. M.
1995. Aspects of the behavioral ecology of spinner dolphins (*Stenella longirostris*) in the nearshore waters of Mo‘orea, French Polynesia. PhD Dissertation, University of California, Santa Cruz.

Reeves, R. R., A. J. Read, and D. W. Johnston.
2007. Report on the Workshop on Research Needs for the Conservation and Management of Cetaceans in the Pacific Islands Region, Honolulu, HI; June 22-24, 2005, pp. 50.

Rickards, S. H., C. Vanderlip, and G. Oliver.
2001. Spinner dolphins (*Stenella longirostris*) of Midway Atoll, Northwest Hawaiian Archipelago: February-November 2001. Year-end report for National Marine Fisheries Service and U.S. Fish and Wildlife Service. 41 pp.

Timmel, G. B.
2005. Effects of human traffic on the movement patterns of Hawaiian spinner dolphins, *Stenella longirostris,* in Kealakekua Bay, Hawai‘i. MS Thesis, San Francisco State University.

Urian, K. W., A. A. Hohn, and L. J. Hansen.
1999. Status of the Photo-identification catalog of coastal bottlenose dolphins of the western North Atlantic: report of a workshop of catalog contributors. U.S. Dep. Commer., NOAA Tech. Memo. NOAA-TM-NMFS-SEFSC-425.

Würsig, B.
1996. Swim-with-dolphin activities in nature: Weighing the pros and cons. Whalewatcher. 30(1):11-15.

Würsig, B., R. S. Wells, K. S. Norris, and M. Würsig.
1994a. A spinner dolphin's day. In: K. S. Norris, B. Würsig, R. S. Wells, and M. Würsig (eds.), The Hawaiian Spinner Dolphin, University of California Press, Berkley, pp. 65-102.

Würsig, B., R. S. Wells, M. Würsig, and K. S. Norris.
1994b. Population structure. In: K. S. Norris, B. Würsig, R. S. Wells, and M. Würsig, (eds.), The Hawaiian Spinner Dolphin, University of California Press, Berkley, pp. 122-140.

Table 1.--Codes for research groups and individual representatives that responded to the PIPIN questionnaire.

CRC_RB	Cascadia Research Collective_Robin Baird
DI_AP	Dolphin Institute_Adam Pack
HAMER_MD	Hawai‘i Association for Marine Education and Research_Mark Deakos
HIHWNMS_DM	Hawaiian Islands Humpback Whale National Marine Sanctuary_David Mattila
HIMB_KA	Hawai‘i Institute of Marine Biology_Kim Andrews
HMMC_SR	Hawai‘i Marine Mammal Consortium_Susan Rickards
HPU_KW	Hawai‘i Pacific University_Kristi West
HWF_CK	Hawai‘i Wildlife Fund_Cheryl King
KIRC_CK	Kaho‘olawe Island Reserve Commission_Cheryl King
KN_JOL	Kula Nai‘a_Jan Ostman-Lind
LK & SR	Leszek Karczmarski & Susan Rickards
OSI_ML	Oceanwide Science Institute_Marc Lammers
PIFSC_DJ & MC	Pacific Islands Fisheries Science Center_Dave Johnston & Marie Chapla
SPLASH_AL	Structure of Populations, Levels of Abundance, and Status of Humpbacks_Allan Ligon
WDF_TC	Wild Dolphin Foundation_Tori Cullins

Table 2.--A summarized list (not prioritized) of desired outcomes for a collaborative photo-ID network in the Hawaiian Archipelago as expressed by research groups that responded to the PIPIN questionnaire.

What would you like to get out of a collaborative effort throughout the Hawaiian Islands?
Better information for management
Peaceful and fruitful collaborations
Determine if spinners are moving between islands
Matching of dead cetaceans (mortality rates)
Population size estimate
Habitat use/needs (changes over time?)
Better understanding of social behavior
Better understanding of threats to spinners
Opportunities for students/staff
More reliable funding
Information about other research groups’ goals & activities
Community outreach & education about conservation issues surrounding spinner dolphins

Table 3.--Primary research interests of participants that responded to the questionnaire. See Table 1 for research group codes. N/A = not applicable.

Research Group	Primary Research Interests	Initiation of Research	Annual Funding
CRC_RB	Cetacean population assessment, stock structure, ecology, behavior	February 2000	~$100,000
DI_AP	Humpback whales, odontocetes including spinner, bottlenose, and spotted dolphins.	Humpbacks: 1975 Odontocetes: 2005	Field research = $40,000 Data analysis = $10,000
HAMER_MD	Marine mammal population trends, home ranges, habitat needs, and threats; public education	Spinner IDs: 2003 HAMER: 2004	Variable
HIHWNMS_DM	Humpback population biology & human impacts	January 2002	$0-$250,000 (excluding salaries)
HIMB_KA	Population genetics of Hawaiian spinner dolphins	2001	~$7,000
HMMC_SR	Seasonal distribution and behavior of cetaceans off the west coast of the Island of Hawai‘i	HMMC: Jan. 2001 (some members: 1989)	~$10,000-$20,000
HPU_KW	Cetacean strandings; bottlenose dolphin nutrition and physiology	2006	$10,000-$100,000
HWF_CK	Human usage/impacts on the terrestrial and aquatic resources of Keoneo‘i‘o	~1999	Variable
KIRC_CK	All animal resources within Kaho‘olawe Island Reserve	1990's	Variable
KN_JOL	Spinner dolphin organization, social behavior, acoustics and long-term movement patterns	June 1989	N/A
LK & SR	Spinner dolphin population parameters, ecology, social structure; behavior and habitat; socio-genetics; population genetics; foraging ecology; acoustics; evolutionary effects of geographic and social insularity; population processes and trends	February 1998	Variable ($18,000+)
OSI_ML	Marine bioacoustics	July 1996	Variable
PIFSC_DJ&MC	Spinner dolphin abundance, stock structure, and vital rates	January 2006	Variable
SPLASH_AL	Odontocete diving behavior and population assessment	December 2003	N/A
WDF_TC	Spinner dolphin photo-id and impacts from tourism	1999	~$30,000

Table 4.--Study areas, fields seasons, and number of spinner dolphin photos taken per season. See Table 1 for research group codes. N/A = not applicable; N/R = no response.

Research Group	Study Area	Field Season	# Spinner Photos/Season
CRC_RB	Main Hawaiian Islands, with primary effort off Big Island	Variable; spread out over 11 mos. to capture seasonal variability	Average since 2003 of 1,223/year (maximum of 3,874 in 2005)
DI_AP	Whale work primarily off west Maui in the ‘Au‘au, Palilolo, and Kalohi Channels; spinner dolphin work concentrated along the Leeward coast of O‘ahu.	Humpbacks: Dec 20 – April 20 Spinner dolphins: May 1– Dec 1	100-200
HAMER_MD	Maui waters (‘Au‘au Channel) extending north to Moloka‘i, south to Kaho‘olawe, and up to 20 miles west of Lana‘i; also leeward sides of Kaua‘i (Kekaha)	Variable	Variable
HIHWNMS_DM	Focus on Main Hawaiian Islands and American Samoa	Hawai‘i: Dec – May American Samoa: Sept – Oct	20-500
HIMB_KA	The Hawaiian Archipelago	Photo-Id: Smmer 2002; Summer 2003	1,000 from O‘ahu (2002); 100 from Maui (2003)
HMMC_SR	Northwest coast of the Island of Hawai‘i	Jan – March	Variable; 500 (2006)
HPU_KW	Main Hawaiian Islands	Year-round	N/A
HWF_CK	Keoneo‘i‘o (La Perouse Bay) and Ahihi-Kina‘u Natural Area Reserve (Maui)	Year-round	N/R
KIRC_CK	Kaho‘olawe Island Reserve (KIR)	Year-round	< 100
KN_JOL	West side of the Island of Hawai‘i; occasionally Lana‘i –South coast	Variable	Variable
LK & SR	Kure Atoll and Midway Atoll (annual) Pearl & Hermes Reef and French Frigate Shoals (opportunistic)	June – Sept (last 5 yrs.)	~35,000-40,000
OSI_ML	South and west shores of O‘ahu for spinner dolphins; entire Pacific region for nearshore acoustics	Variable	Very few
PIFSC_DJ&MC	Pacific Islands Region (PIR)	Variable; summer in NWHI & winter in American Samoa	> 2,000
SPLASH_AL	Main Hawaiian Islands	Dec – April	~200-500
WDF_TC	Wai‘anae coastline (O‘ahu)	Year-round	30,000

Table 5.--Summary of existing spinner dolphin photo-ID catalogs including number of individual dolphins identified. See Table 1 for research group codes. N/A = not available.

Research Group	# Individuals	Time Frame	Location
CRC_RB	N/A	2000-2001	Four Islands region
DI_AP	50-75	2005-2006; incidental: 1998 to date	O‘ahu leeward coast
HAMER_MD	~150	2004-2006	See Table 4
HMMC_SR	> 60	March 2003-March 2006	Hawai‘i NW coast
KN_JOL	700-800	1989-2003	Hawai‘i west coast
LK & SR	369	1998-2006	Kure, Midway, Pearl & Hermes, French Frigate Shoals
PIFSC_DJ&MC	> 40	2003-2006	American Samoa
WDF_TC	~1,000	2003-2006	O‘ahu Wai‘anae coast

Table 6.--Summary of responses to selected questions from the "project background" section of the PIPIN questionnaire. There were a total of 15 responses (see Table 1). For some questions individuals gave multiple responses.

NMFS Permit	**# of Responses**
Yes	9
No	6
Research Platform	**# of Responses**
Vessel	13
Shore	5
Aerial	1
Underwater	2
Media	**# of Responses**
Slides	4
Digital	12
Video	4
Print	1
Camera	**# of Responses**
Canon 1D Mark II	1
Canon 10D	3
Canon 20D	5
Canon D30	1
Canon D60	2
Canon ELAN7	1
Nikon D100	1
Nikon D300	1
Olympus C700	1
Lens	**# of Responses**
Canon 75-300 mm	2
Canon 100-300 mm	6
Canon 100-400 mm	4
Nikon 80-200 mm	1
Nikkor 70-300 mm	1
Sigma 100-300 mm	1

Table 7.--Summary of responses to selected questions from the "field data" section of the PIPIN questionnaire. There were a total of 15 responses (see Table 1). For some questions individuals gave multiple responses. N/A = not applicable; N/R = no response. * See Appendix D for data sheets.

Survey Design	**# of Responses**
Opportunistic	5
Systematic surveys	3
Non-systematic surveys	4
High-use areas	6
Carcass collection	1
Variable	2
Determination of Sighting Location	**# of Responses**
GPS	13
Location description	5
Photograph Target	**# of Responses**
Left/Right sides of dorsal fin	12
Body scars	6
Flukes	4
Tailstocks	4
Sighting Data Collected*	**# of Responses**
Date/Time	13
GPS location	13
Species	5
# individuals (min/max/best)	13
# calves/neonates	12
Behavior	12
Photographer/Camera/Frames	6
Environmental	4
Vessel/Captain/Observers	4
Other	3
N/A or N/R	2

Table 8.--Summary of responses to selected questions from the "catalog & database" section of the PIPIN questionnaire. There were a total of 15 responses (see Table 1). N/A = not applicable; N/R = no response.

Operating System	**# of Responses**
Windows only	6
Mac only	2
Windows & Mac	5
N/A or N/R	2
Access to GIS	**# of Responses**
Yes	11
No	3
N/R	1

Table 9.--Summary of responses to selected questions from the “catalog & database” section of the PIPIN questionnaire. Responses are summarized for eight research groups with spinner dolphin catalogs (see Table 4). Individuals gave multiple responses for some questions.

Features to Identify Individuals	**# of Responses**
Dorsal fin notches	8
Dorsal fin shape	8
Body scars	7
Coloration	2
Individual "Naming" System	**# of Responses**
Arbitrary number	1
FinBase alias	1
Chronological/sequential number	3
Prominent feature location	2
Finscan assigned number	1
Catalog Organization	**# of Responses**
Chronological	1
Prominent feature	3
Numeric ID	2
Alpha-numeric ID	2
Catalog/Database Software	**# of Responses**
ACDSee	4
Access	5
Excel	3
Filemaker Pro	1
Photoshop	2
Thumbsplus	2
FinBase	1
FinScan	1
Fin Matching	**# of Responses**
Manual	7
Automated	1
Photo quality grading	**# of Responses**
Yes	4
No	4

Table 10.--PIPIN workshop participants.

Participants	**Affiliations**
Andrews, Kim	Hawai‘i Institute of Marine Biology
Baker, Jason	Pacific Islands Fisheries Science Center
Bernard, Hannah	Pacific Scientific Review Group
Chapla, Marie	Pacific Islands Fisheries Science Center
Cullins, Tori	Wild Dolphin Foundation
Deakos, Mark	Hawai‘i Association for Marine Education and Research
Johnston, Dave	Pacific Islands Fisheries Science Center
King, Cheryl	Hawai‘i Wildlife Fund
Lammers, Marc	Oceanwide Science Institute
Lefors, Jayne	Pacific Islands Regional Office
Ligon, Allan	Hawaiian Islands Humpback Whale National Marine Sanctuary
Lopez, Jessie	Pacific Islands Fisheries Science Center
Lowry, Lloyd	Marine Mammal Commission
McCue, Laura	The Dolphin Institute
Metz, Jen	Pacific Islands Regional Office
Milette, Aliza	The Dolphin Institute
Östman-Lind, Jan	Kula Nai‘a
Pack, Adam	The Dolphin Institute
Read, Andy	Duke University
Rickards, Susan	Hawai‘i Marine Mammal Consortium
Urian, Kim	Duke University
VanAtta, Lisa	Pacific Islands Regional Office
Vanderlip, Cynthia	Hawai‘i Department of Land and Natural Resources
West, Kristi	Hawai‘i Pacific University
Yates, Chris	Pacific Islands Regional Office
Yuen, Michelle	Pacific Islands Regional Office

Appendix A: PIPIN Questionnaire

Project Background

1. What are your primary research interests?
2. When was your research initiated (month/year)?
3. Do you have a NMFS permit? If so, what permit do you work under?
4. How much money do you put toward your research annually?
5. What is the range of your study area?
6. If spinner dolphins are **not** the focus of your research do you regularly/opportunistically encounter spinner dolphins?
7. Do you photograph spinner dolphins during an opportunistic sighting?
8. What platforms do you use (vessel/shore-based/aerial)?
9. What type of camera/lens do you use?
10. What type of media (slides/digital/video/print) do you use?
11. How many photos do you take each year/field season?
12. How many photos of spinner dolphins do you take each year/field season?

Field Data

1. When is your field season?
2. What is the duration of your field season (days/year)?
3. What is the design of your survey (systematic transects/high-use areas/opportunistic/etc.)?
4. What data do you collect during an encounter (please submit a copy of your data sheet if you would like)?
5. How do you determine location of sightings?
6. What type of photograph do you target (right &/or left sides/silhouette/sun-side)?
7. What is the average number of person days per month spent in both the lab and the field?

Catalog and database

1. Do you currently have a catalog of spinner dolphins?
2. If yes, how large is your catalog (# of distinct individuals)?
3. What time period does your catalog encompass?
4. What features do you use to identify individuals?
5. How is your catalog organized (prominent feature/chronological/dolphin ID/etc.)?
6. What software do you use for the organization of your photos/database information?
7. What type of operating system do you use (Windows/Mac/Unix)?
8. Do you use or have access to GIS?
9. What is the average time from sighting to entry into database?
10. What steps are taken before a fin is added to the catalog?
11. Do you have a system for ranking or grading the quality of your photos?
12. What happens with a fin that is distinctive but not catalog quality?
13. How do you assign a “name” to each identifiable individual?
14. How do you match fins (manual/automatic)?

15. What features are used for matching?
16. How many people are required to verify a match? Must a decision be unanimous?
17. With whom do you compare your photos? If anyone, how do you compare photos?
18. What arrangements have you made for assigning credit/authorship based on joint matches?
19. Are you interested in participating in a community-based photo ID project?
20. What would you like to get out of a cooperative effort throughout the Hawaiian Islands?
21. Would you recommend a common naming system for the Hawaiian Islands?

Appendix B: PIPIN Workshop Packet Materials

- Agenda
- Questionnaire compiled responses
- Collaborative catalog
    - MABDC overview
    - MABDC workshop report: Urian et al., 1999
    - SPLASH information sheet
    - SPLASH progress report 2004
    - Prototype consent form for photo contribution
- Photo-ID techniques
    - Protocol for MABDC
    - Sarasota Dolphin Research Program field techniques & photo-ID handbook
    - SPLASH data sheet instructions & procedures (Hawaii region)
    - Photo-ID data sheets (see appendix D)
        - SPLASH
        - Northwestern Hawaiian Islands Spinner Dolphin Research Project
        - Cascadia Research Collective
        - Florida State University
        - Hawai‘i Institute of Marine Biology
- Background Papers (see References for complete bibliographic information)
    - Andrews et al., 2006
    - Barlow, 2006
    - Baird et al., 2003
    - Baird et al., 2005a
    - Baird et al., 2005b
    - Friday et al., 2000
    - Karczmarski et al., 2005
    - Lammers, 2004
    - Marten and Psarakos, 1999
    - Östman-Lind et al., 2004
    - Rickards et al., 2001
- Potential Funding Sources
    - National Science Foundation Grants
        - Biological research collections
        - Research coordination networks in biological sciences
        - Biological databases and informatics
    - David and Lucile Packard Foundation
    - Patagonia: Oceans as wilderness
    - National Fish and Wildlife Foundation
        - General matching grants program
        - National Whale Conservation Fund

Appendix C: PIPIN Workshop Agenda (December 11–12, 2006)

Day 1: 9:00 am – 4:00 pm

Welcome and Intro./Background	*9:00-10:50*
• Needs for collaborative catalog_Dave Johnston	9:00
• MABDC_Kim Urian	9:30
• SPLASH_Allan Ligon	9:45
• Role of scientists/tour operators_Dave Johnston	10:00
• Questionnaire review_Marie Chapla	10:30
• Coffee break	10:45

Software/database discussion	*10:50-1:00*
• FinScan demo_Kim Urian	10:50
• FinBase demo_Mark Deakos	11:10
• Thumbsplus demo_ Susan Rickards	11:30
• OBIS Seamap_ Kim Urian	11:50

Lunch *12:15-1:00*

Data collection and organization *1:00-3:00*

- Data to include w/ photos
- File naming system
- Photo quality
- Individual "naming" system
- Consent of photo use (form)
- Photo submission
- Matching process
- Posting pictures on PIPIN website
- Organization within database (by island, etc)

Needs discussion *3:00-4:00*

- Unmined data
- Missing data—areas not surveyed
- Funding needs and opportunities
- Steering committee
- Sources of future funding

Day 2: 12:00 pm – 4:00 pm

Research Talks	*12:00-1:00*
• Surveys for odontocetes in American Samoa_Dave Johnston	12:00
• Occurrence and behavior of Hawaiian spinner dolphins along O‘ahu's leeward and south shores_Marc Lammers	12:20
• Spinner dolphins in the Northwestern Hawaiian Islands_Susan Rickards	12:40

Items Revisited *1:00-4:00*

- Steering committee
- Sources of funding