NOAA TECHNICAL MEMORANDUM
NMFS-SEFSC-393

BOTTLENOSE DOLPHIN PHOTO-IDENTIFICATION WORKSHOP:

MARCH 21-22, 1996
CHARLESTON, SOUTH CAROLINA

FINAL REPORT
TO THE
NATIONAL MARINE FISHERIES SERVICE
CHARLESTON LABORATORY

CONTRACT NO. 40EUNF500587

by

KIM W. URIAN and RANDALL S. WELLS

U.S. Department of Commerce
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Bottlenose Dolphin

Photo-Identification

Workshop

21-22 March 1996

Charleston, South Carolina

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NOTICE

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Bottlenose Dolphin Photo-Identification Workshop 21-22 March 1996, Charleston, South Carolina

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Introduction

Since the large scale mortality event of 1987-1988, much attention has been focused on the bottlenose dolphins (*Tursiops truncatus*) inhabiting the waters of the Atlantic seaboard of the United States. As a result of this event, the "coastal migratory stock" of bottlenose dolphins has been designated as "depleted" under the Marine Mammal Protection Act. The defining parameters for this depleted stock are poorly understood, however, and the National Marine Fisheries Service (NMFS), has specified the identification and characterization of bottlenose dolphin stocks in the northeast Atlantic as a priority. In its management role, NMFS needs to be able to evaluate the impact of the mortality event on specific populations of dolphins. As one of the first steps, stock identification requires information on geographical ranging patterns. Resulting hypotheses about stock discreteness can be tested subsequently through genetic analyses. In addition to tagging and telemetry, photographic identification (photo-ID) has proved to be a powerful tool for determining the ranging patterns of individual dolphins.

A number of bottlenose dolphin photo-ID studies are being conducted by laboratories, museums, and independent investigators along the mid-Atlantic coast. All but one of these has been initiated since the large scale mortality event. Preliminary reports indicate that some dolphins have been identified across study sites. Thus, these studies collect data which could be useful in characterizing mid-Atlantic coastal bottlenose dolphin stocks, but to date few of the data are available in peer-reviewed literature (see Appendix 1 for a bibliography). Further, a variety of methods is being used currently to collect and analyze the data.

The NMFS has recognized the needs: 1) to facilitate interactions between the independent investigators to expedite access to information relevant to stock identification and characterization, 2) to validate current methodologies, 3) to evaluate the potential value of standardizing data collection and analysis methods, and 4) to explore the possibility of a central database for dorsal fin identifications. It was also recognized that as the number of dolphins identified increases, improved fin matching, data storage and retrieval systems are needed. A computerized system would allow comparison of data sets, facilitate the use of the photo-ID data as a conservation and management tool, reduce the time invested managing photo-ID catalogs, and provide the potential for interfacing with new technologies such as Geographic Information Systems (GIS). A computerized catalog of photographs and development of image analysis software to enhance matching capabilities will decrease the time required to match photos, yielding significant cost savings and more efficient coordination and dissemination of data.

In response to these needs, NMFS decided to conduct a workshop involving current photo-ID researchers along the Atlantic seaboard to facilitate information and data exchange, to promote standardization of methodology, and to evaluate computer-aided identification analysis, archival, and retrieval systems. NMFS plans to use this information to 1) select appropriate estuarine sites for photo-ID studies and collection of biopsy skin samples for genetic analyses for stock discrimination, and 2) to investigate the possibility of developing a centralized, computerized photo-ID database. It is critical that the photo-ID information on coastal bottlenose dolphins be documented with a high degree of reliability to provide the confidence required for reaching accurate conclusions about stock identification and characterization, and for forming the basis of future field studies relevant to managing the depleted stock.

To these ends, NMFS contracted with the Chicago Zoological Society (CZS) with the general objectives of convening a workshop to establish validated criteria for photo-ID studies, and developing a report on standardizing photo-ID methods. The CZS was selected for this role because of its staff's involvement in the longest-running study of identifiable wild bottlenose dolphins in the world, with experience in addressing many of the concerns of the Atlantic coast researchers, and because of their status as an impartial independent organization operating outside of the Atlantic coast. The CZS staff's tagging and photo-ID efforts since 1970 along the central west coast of Florida have resulted in a catalog of more than 2,240 identifiable dolphins, and a computerized database including more than 11,375 group encounters.

The workshop was convened at the Charleston Laboratory of the National Marine Fisheries Service on March 21-22, 1996, prior to the annual Atlantic Coast Dolphin Conference (see Agenda, Appendix 2). The workshop included one day of discussion amongst researchers from 13 existing Atlantic coast photo-ID projects, as per a list of investigators provided by the NMFS (Appendix 3). The second day included four invited presentations on computer-assisted matching, archiving, retrieval, and data processing. The specific objectives of the workshop included:

1. Summarization of methods and efforts of current photo ID researchers;
2. Validation of field methods;
3. Validation of data collection and handling methods;
4. Standardization of protocols for determining residency;
5. Investigation of current potential for computerized photo-analysis.

These objectives were summarized concisely in the stated goal of the workshop: "To reach a consensus across independent research efforts on the best means to reliably, accurately, and expeditiously identify recognizable bottlenose dolphins from one Atlantic coast research site to the next." Much importance was placed on ensuring that the independent research groups were able to maintain their autonomy, while at the same time trying to establish uniform standards of scientific rigor and quality assurance/quality control (QA/QC) across projects.

The following contract products were identified and compiled as part of this report, with the expectation that they would be disseminated to investigators and other interested parties as a NMFS Technical Memorandum or comparable publication:

1. Bibliography of presentations and publications by Atlantic coast researchers;
2. Summary of questionnaire responses on existing efforts;
3. Recommendations for facilitating comparisons across sites;
4. Summary of available and developing computer technology for photo-ID studies;
5. Summary of photo-ID methodology used by the CZS Sarasota Dolphin Research Program in long-term research on Gulf coast bottlenose dolphins.

Brief Summary of Questionnaires

A questionnaire was developed to characterize the current bottlenose dolphin photo-ID efforts along the Atlantic seaboard. Fifteen questionnaires were sent and thirteen responses were received. A detailed summary of the responses to this questionnaire is presented in Appendix 4. The study areas of the responding researchers are depicted in Appendix 5. Nearly all of the groups indicated that their primary research interest relative to photo-ID was to improve our understanding of migratory connections, movement and distribution patterns of bottlenose dolphins along the Atlantic coast.

The level of effort varied greatly from site to site. The earliest study was initiated in 1985, while the most recently initiated studies began in 1995. The number of days in the field each year ranged from a minimum of three to a maximum of 100. Depending on the presence of dolphins at the site, research was conducted seasonally or year-round. The numbers of identification photographs taken each year ranged from 200 to 12,600. The numbers of dolphins in the identification catalogs of each site ranged from 19 to 1,156. Much of the variability from site to site was attributed to the general lack of funding support for the research. Though a few of the research efforts receive NMFS support, most struggle to secure support from other sources.

Each individual project has developed methods that best suit their specific research interests and study sites, and this is reflected in the differences evident in the summary. A variety of media has been used, including color slides, black and white prints, and video. Some groups have adopted aspects of the methodology of other researchers in regard to data collection, use of terms, and the basics of dorsal fin characterization, but in many cases researchers have modified the methods to suit specific field conditions, research needs and the nature of the dolphins in that area. At some sites the sizes of the photo-ID catalogs and the numbers of photographs taken are substantial, but arrangements for the exchange of data and photos are not formally organized. This underscores the need to encourage cooperation between sites to gain the most from the data collected through the considerable independent efforts of each of the participants.

Results of the Workshop

One of the first, and arguably one of the most significant, suggestions made by the group was for a centralized photo database to facilitate access for comparisons of fins. This database might include copies of the best images available for each dolphin currently identified along the Atlantic coast, along with some very basic data on each image. Presentations made on the second day of the workshop about computerization of matching and database management took on even greater relevance with this early recognition of the value of a centralized system. With the concept of a centralized database in mind, subsequent discussions focused on the appropriate components and formats for data to be included in such a database.

The most fundamental, objective, and important kind of data to be considered is the image of an identifiable dorsal fin. It was decided that the medium of the image was not important as long as a clear, accurate hard copy can be provided for comparisons. Media used currently by the researchers include color and black and white photographic slides and prints, and Hi-8 and Super VHS videotape. Each of these media can be converted into an acceptable hard copy. Of greater importance than the nature of the medium is the quality of the image. The consensus **recommendation** of the group for a preferred image included the following features:

1. The image should be of high quality, clearly focused, showing the entire fin;
2. The fin should be perpendicular to the observer;
3. Fin features should not be obscured by *Xenobalanus*, waves, or other objects.

A basic suite of accompanying data was identified for any image provided for comparisons or for a centralized database, in order to document the image, facilitate meaningful comparisons and conclusions, and guarantee the ability to access the original data and image, if necessary. These data include:

1. Date photograph was taken or video was recorded;
2. Encounter or group sighting number (the consensus **recommended** definitions of these terms appears in Appendix 6);
3. Photographer or contributor name;
4. Location. This includes a general description of the area (Beaufort, NC or Virginia Beach, VA, for example) along with latitude and longitude recorded to the nearest hundredth of a minute when possible. The importance of precise and accurate location data was stressed

relative to the need to summarize sighting locations on charts, or to integrate sighting data with GIS systems, etc.;

5. Film roll and frame number, or video counter number;
6. Individual animal identification code or accession number;
7. Indication of features used to define the animal as a neonate, calf, or female (consensus definitions of these terms appear in Appendix 6);
8. There was general agreement that whomever contributes their own data has ownership of the information and the photograph. It was **recommended** that the accompanying information should include a statement to be signed by the recipient to the effect that images cannot be used without the written consent of the photographers, and that the contributions will be formally acknowledged with all uses of the image.

These basic data from a single encounter of an individual dolphin will facilitate determination of potential matches while not compromising the proprietary data collected by each researcher on resighting histories of that individual, local patterns, etc. In the absence of a centralized database, this standardization of image and data should expedite and add a level of rigor to initial comparisons via mail, for example, and should lead to a more efficient face-to-face meeting to compare original images if desired, and to share resighting data as appropriate. If a centralized database is established, then the image copy and accompanying data would form the basis of the database. It was **recommended** that a data transmission form be developed based on the criteria identified above, and circulated to the workshop participants for comments (Appendix 7).

Desired Features for Centralized Database

Two features of a centralized database were considered highly desirable: 1) the ability to easily store and retrieve image copies and associated data, and 2) the ability for automated matching of dorsal fins. Computerized systems offer the potential for providing these features. Existing systems can accomplish the desired storage and retrieval functions as demonstrated by the computerized manatee identification system (MIPS) described in Appendix 8, but computer-automated fin matching is not yet available. Existing or easily-modified computer systems can facilitate a first-order selection of images for comparisons, but for the immediate future, final confirmation of matches will remain in the human visual domain.

It was generally agreed that the initial database should be composed of copies of the best images of a given individual with the basic accompanying data described above. More detailed sighting information could be provided by agreement between the contributing photographers through interactions once matches were confirmed, thereby maintaining the proprietary nature of the individual researcher's data. It would be desirable for the images to be available through CD-ROM disks that could be distributed among contributing investigators, or via the Internet.

Even at the current level of computer technology, systems exist that could narrow down potential matches. A descriptive database such as the MIPS software for manatee identification (see Appendix 8) could be modified for sorting based on a list of objective codes that describe relatively discrete dolphin dorsal fin features. As one product of this contract, a draft list of fin features that might be used in a coding system to make these comparisons has been compiled from the questionnaire, and circulated to workshop participants for comments (see Appendix 9). The MIPS system offers the additional feature of potentially interfacing with computer-automated fin matching systems currently under development, such as the DARWIN system (see Appendix 10), or GIS systems (see Appendix 11).

Thus, a **priority recommendation** of the workshop was to further investigate the hardware, software, staff, and funds required to establish a centralized, computerized photo-ID database. It was suggested that a group be convened to define the process and estimate costs. Decisions regarding the sources of funding for the development and maintenance of the database, its location, and details regarding access remain to be resolved.

Arrangements for Comparisons of Images Between Sites

A centralized database and a preliminary computer-automated fin matching system may reduce the number of fins to be considered for potential matches, but for the foreseeable future matching decisions will continue to require comparisons by eye. Current systems of visual fin matching are, by necessity, subjective. These matches take on biological meaning only when they are subjected to a set of rigorous scientific standards that allow other scientists to have confidence in their accuracy.

The workshop participants **recommended** the following procedures for matching and quality control:

1. Confirmation of matches across study sites should involve a juried system. A third experienced, unbiased person in addition to the representatives from the two study sites is required to make a unanimous decision about a match.
2. Images must be included whenever documenting a match and whenever a match is made, every effort should be made to involve three people in the judgement.
3. For changes to a centralized catalog, three judges must be used to verify a match.
4. When the results of matches have been submitted for publication, they should be accompanied by copies of the appropriate images, either to be published as figures for documentation, or for use by the reviewers in evaluation of the data and conclusions.

Immediate Applications for a Centralized Database Based upon Rigorous Standards

Much of the workshop discussion centered around the details of the procedures and tools that are used for identifying dolphins along the Atlantic coast. It is important to keep in mind the relative importance of **why** this work needs to be conducted as well as ensuring that the **how** of the work meets necessary standards of scientific rigor. The **priority recommendation** was made to examine the overall residency of bottlenose dolphins up and down the coast. NMFS would like to see expedited efforts directed toward a larger analytical interpretation of images to produce a document that describes in detail the movements and residency patterns of these animals. With this information in hand, responsible management and conservation decisions are possible, and future research can be directed most efficiently and effectively.

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Appendix 2. Workshop Agenda

BOTTLENOSE DOLPHIN PHOTOGRAPHIC IDENTIFICATION WORKSHOP

Thursday, 21 March 1996

08:30-09:00 Welcome and introductions (Pat Fair, Randy Wells)
Statement of goals and objectives

Workshop Goal: *To reach concensus across independent research efforts on the best means to reliably, accurately, and expeditiously identify recognizable bottlenose dolphins from one Atlantic coast research site to the next.*

Workshop objectives:
1. Summarize methods and efforts of current photo-ID researchers.
2. Validation of field methods.
3. Validation of data collection and handling methods.
4. Standardization of protocols for determining residency.
5. Investigate current potential for computerized photo-analysis.

Desired products of the workshop
Report to NMFS and workshop participants, including:
1. Summary of questionnaire responses for ADRC photo-ID studies.
2. Bibliography of ADRC publications/presentations.
3. Results of today's discussions.
4. Recommendations for facilitating comparisons across sites.
5. Summaries from tomorrow's presentations.
6. For reference purposes: Sarasota Dolphin Research Program Field Techniques and Photo-Identification Handbook.

09:00-09:10 Brief summary of findings from questionnaires (Kim Urian)

09:10-10:15 Discussion of methodology for facilitation of comparisons
- a. Definition of preferred photographic image and medium.
- b. Definition of associated data accompanying image.

10:15-10:30 Coffee break

10:30-12:00 Discussion of methodology for facilitation of comparisons
- c. Concensus on definitions of terms:
  1. neonate/young-of-the-year
  2. calf
  3. subadult/juvenile
  4. group/sighting/encounter
  5. female
  6. resident (permanent vs. seasonal, criteria)
- d. Definition of format for associated data accompanying images

12:00-13:30 Lunch (at local eateries, see map)

13:30-15:00 Arrangements for comparisons of photos between sites
1. What factors have limited comparisons to date?
2. What would facilitate or expedite comparisons?
3. Timing.
4. Location.

4. Location.
5. Participants.
6. Materials for consideration.
7. Matching session design
    a. Existing procedures
    b. Recommended procedures for matching, quality control.

15:00-15:15 Coffee break

15:15-17:00 Arrangements for comparisons of photos between sites (continued)
8. Plans for dissemination of results.
9. Identification and sharing of proprietary data.

17:00 Adjourn.

Friday, 22 March 1996:
Presentations on computer-assisted matching and archiving technology.

09:00-09:30 Kenneth Bible: Applications of GIS to studies of bottlenose dolphins.

09:30-10:00 Mike Wesley: FINNS -- Fluke Identification Neural Network System.

10:00-10:30: Cathy Beck, Ron Osborn: MIPS -- Manatee individual photo-identification system.

10:30-11:00: John Stewman, Mark Allen: DARWIN -- Software to identify dolphins in digital images.

11:00-12:00 Discussion, questions, wrap-up.

12:00 Adjourn

14:00 Registration for ACDC

17:00-19:00 ACDC social

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Appendix 3. Workshop Participants

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Appendix 4. SUMMARY OF QUESTIONNAIRE RESPONSES FOR PHOTO-ID WORKSHOP

Abbreviations used in summary:
N/A: not available or applicable
N/R: no response to the question

NJMD:	Rich Mallon-Day, Cape May County Dolphin Survey, Cape May, NJ
VASJ:	Sherman Jones III, Christopher Newport University, Chesapeake Bay, VA
VASB:	Sue Barco, Virginia Marine Science Museum, Virginia Beach, VA
NCAR:	Andy Read, Duke University Marine Lab, Beaufort, NC
NCKR:	Keith Rittmaster, North Carolina Maritime Museum, Beaufort, NC
NCGR:	George Rountree, Cetacean Watch Project, Wilmington, NC
NCAT:	Amanda Truett, Wilmington, NC
NCLS:	Laela Sayigh, University of North Carolina, Wilmington, NC
SCRP:	Ric Petricig, Hilton Head, SC
SCEZ:	Eric Zolman, NMFS, Charleston, SC
GAJS:	John Schacke, Dolphin Project of Georgia, Savannah, GA
FLMC:	Marthajane Caldwell, University of Miami/NMFS, Jacksonville, FL
FLJC:	Joe Contillo, NMFS, Biscayne Bay, FL

Primary research interests: To evaluate the priority of interest, we assigned a point system, i.e., a ranking of **1** = 3 points, **2** = 2 points, **3** = 1 point and summed the number of points to arrive at a number that would reflect the primary research interests of the different research groups.

Distribution patterns & movements:	23
Population estimates:	17
Behavior:	10
Conservation:	8
Life History:	6
Strandings:	2
Acoustics:	2
Population Trends (write-in):	1
Population Genetics:	0
Toxicology:	0
Health and Disease:	0
Physiology:	0
Morphology:	0

PROJECT BACKGROUND:

1. **Primary goals/objectives of research:** *Please refer to Table 1 for summary.*

2. **Do you have a NMFS permit or G.A.?**

Yes:	9	Number of permits = 5
		Number of G.A.s = 3
		Not specified = 1
No:	3	
Pending:	1	

3. **Month/year research was initiated:** *See Table 1 for summary.*

4. **Annual amount put toward your research?**
   # Responses: 7
   Range: $1200-$48,000
   Average: $20,886

5. **Range of study areas:**
Latitude: 41° 00' Longitude: 74° 00' (NJ)
Latitude: 25° 18' Longitude 80° 30' (FL)

6. Size of study area: # Responses: 10
Range: 20-2000 km^2
Average: 354 km^2

7. Platform(s) used:
vessel: 13
shore-based: 4 (in addition to vessel)
aerial: 1 (in addition to vessel)

8. Kind of camera used:

- *Please refer to Appendix 4a for responses from each research group.*
- Some groups use more than one system.

# Responses: 12	
Nikon:	6
Canon:	6
Sigma:	1
Nikkormat EL	1
Canon Hi 8:	1
JVC Super VHS	1
Lens: 75-300 zoom AF	7
200/210:	3
100-500:	2
400:	1
Motordrive:	
Yes:	10
No:	1
N/A:	1
Databack:	
No:	7
Yes:	4
N/R:	1

9. Medium of photographs:

- Some groups use more than one medium.

Color slides:	7
B & W:	6
Video :	6
Color prints:	2

10. Film brand/ASA:

- Some groups use more than one medium.

Kodak 400:	4
Kodachrome 64:	4
Kodachrome 200:	4
Ektachrome 100:	2
Ektachrome 400:	1
Agfa 400:	1
Fuji 400:	1
Fuji 100:	1
Hi-8 tapes	1
JVC cassettes	1

11. No. of photographs taken annually:

	1993:	**1994:**	**1995:**
# Responses:	6	8	10
Range:	500-4000	252-10,000	200-12,600

Average:	1933	3469	3476
Minutes of tape:		360	4100

Average # of photographs taken by each program, 1993-1995:

NJMD:	1767
VASJ:	2500
VASB:	2000
NCAR:	N/A
NCKR:	6000
NCGR:	708
NCLS:	N/A
SCRP:	1233
FLMC:	6426
FLJC:	9000

FIELD DATA:

1. **Duration of typical field season** (month begin/month end):

# Responses:	12
Year-round:	8
May-Aug	2
Feb-Nov	1
Apr-Nov	1

2. **Number of field days in:**

	1993:	**1994:**	**1995:**
# Responses:	8	11	12
Range:	4-100	12-60	3-100
Average:	44	37	36

3. **Survey design:**
- Some groups use a combination of survey designs.

# Responses:	12
Repeated routes:	7
Opportunistic:	7
Systematic transects:	5
High use areas:	1

4. **What field data are collected?**
- *Please refer to enclosed forms sent by participants to compare information collected and formats used.*

5. **How do you determine location?**

# Responses:	13
GPS:	7
Loran:	4
Navigational aids, landmarks <u>only</u>:	3

6. **What type of photograph do you target?**
- Most groups target a combination of photograph types.

# Responses:	13
Sun-side:	11
Right and left sides:	10
Silhouette only:	2
Silhouette:	2
Right side only:	1

7. Is *Xenobalanus* a problem in your study area?

# Responses:	13	
Yes:		8
No:		4
Not yet:		1

8. Average number of person days per month spent both in the field and in the lab?

	Field	Lab
# Responses:	3	3
Range:	5-30	18-30
Average:	17	22

CATALOG:

1. Number of individuals in your catalog? *See Table 1 for summary.*
Based on analysis of data collected over what time period?:
Range: June 85-December 95

2. Catalog composition:

- Some groups use more than one medium.

#Responses:	13	
B&W prints:	5	
Slides:		5
Color prints from slides:		4
Tracings:		4
Digitized images:		3

3. What features do you use to identify individuals? *See Appendix 4b for details.*

#Responses:	13	
Distinctive features on trailing edge:	13	
Coloration patterns; scarring on fin:	5	
Shape of dorsal fin; deformity:		5
Distinctive features on leading edge:	5	
Dorsal ratios:	2	
Evidence of scarring on peduncle:	2	
Prominent, permanent scars:	2	
Rake marks, scratches:		2
Body deformity (i.e., scoliosis):		1
Distinctive *Xenobalanus* w/in a sighting:	1	
Freezebrands:	1	
Lobomycosis.:		1
Occasionally social affiliations:		1
The flukes:		1
Dorsal ridge:	1	
Top Notch:		1

4. Number and definition of feature categories: *See Appendix 4b for details.*
#Responses: 11

Number of feature categories =	1:	2
	4:	2
	5:	1
	6:	3
	7:	1
	12:	2

Definition of feature categories:

Single notch:	4
1 or 2 trailing edge features in up/mid/base third:	1
2+ trailing edge features in up/mid/base third:	1
2-3 notches:	3
2 notches:	1
3 + notches:	1
3-4 notches:	1
4+ notches:	3
5+ notches:	1
Tip features: Tipnick/Top notch Extended tip/tip protrusion:	10
Leading edge:	9
Chopped fins/missing top/tip:	7
Questionable catalog:	5
Coloration/scarring/pigmentation:	4
Defran dorsal ratio:	4
Entire trailing edge:	3
Unique/smooth fin shape:	3
Peduncle notches; dorsal ridge:	3
Fins w/ *Xenobalanus:*	2
Features in upper third:	2
Features in middle third:	2
Features in lower third:	2
Right/Left bend:	2
Body deformity:	1

5. How is the catalog organized?:

- Some groups maintain a variety of catalog organizations, therefore points were assigned, i.e., a ranking of **1** = 3 points, **2** = 2 points, **3** = 1 point, and a sum of points was used to to rank the most commonly used system:

#Responses: 12

feature category:	25
chronologically:	9
by dolphin ID:	8
other: by region:	1
by matches:	1
slides:	1

6. Who in your research group maintains the catalog?

NJMD:	Rich Mallon-Day
VASJ:	Sherman C. Jones III
VASB:	Sue Barco, 2 volunteers
NCAR:	Andy Read/Gail Cannon
NCKR:	Nan Bowles
NCGR:	George Rountree III

NCAT:	Amanda Truett
NCLS:	Laela Sayigh
SCRP:	Ric Petricig
SCEZ:	Eric Zolman
GAJS:	John Schacke
FLMC:	Marthajane Caldwell
FLJC:	Joe Contillo

7. How are original images archived:

- Some groups archive images both by individual and chronologically.

#Responses: 12

chronologically:	10
by individual:	7
other:	2

8. Definition of catalog quality image:

- *See Appendix 4b for specific definitions used by respondents.*

#Responses: 10

Clear focus:	7
Readily identifiable individual, showing distinctive features and entire fin and trailing edge visible:	7
Perpendicular to photographer:	6
High contrast, distinct from background:	3
Fills at least 1/3 of the screen:	1
No definition. Typically has 2+ distinctive fin features likely to show up in the average photo:	1
At least 1 notch or distinct shape/scar:	1

9. How are matches made? What features are used? What sequence of procedures do you follow? *Please see Appendix 4b for responses.*

10. How many people are required to verify a match?

Responses: 11

One person:	5 (*In five study areas a single person manages the photo-ID catalog and is responsible for making and verifying matches).
2 people:	2
3 people:	4
4 people:	1
5 people:	1
N/A:	1

Must a decision be unanimous?

(Some are unanimous by default since one person is responsible for making decisions).

Yes:	5
No:	5
N/A:	1

11. Additions to the catalog: what steps are taken before a fin is added?

- *See Appendix 4b for steps used by respondents.*

12. What happens with a fin that is distinctive but not catalog quality?

- *See Appendix 4b for detailed responses.*

#Responses: 10

Saved/Questionable/Unidentified/Purgatory Catalog:	8
Catalog includes substandard fin image sections:	1
No definition of catalog quality:	1

13. Do you have a system for ranking or grading the quality of your photos or photographic coverage of a sighting? *See Appendix 4b for detailed definitions used by respondents.*

Responses: 12

Yes:	7 *(3 groups grade photo coverage, not photo quality).
No:	5

14. When/How often do you work with other researchers on making and verifying matches?

#Responses: 11

Never:	4
Within study area:	3
Once/year:	3
2-4 times/year:	1
10 days/year:	1
N/A:	2

15. With whom do you compare photos? (Photo-ID and stranding images):

#Responses: 11

NJMD:	ADRC researchers
VASJ:	Not yet
VASB:	*NCKR & NJMD*
NCAR:	N/A
NCKR:	*VASB*, *NJMD*, DUML, *FLJC*, L. Risk (GA '87), *SCEZ*, *SCRP*, *FLMC*, G. Oliver ('78-'80), NMFS NC strandings.
NCGR:	ADRC researchers
NCAT:	N/R
NCLS:	N/A
SCRP:	N/R
SCEZ:	Not yet
GAJS:	ADRC researchers, C. Gubbins, *FLMC*.
FLMC:	*GAJS*
FLJC:	Not yet; once with *NCKR*

16. Do you meet (if so, where?) or compare photos by mail, etc.?

#Responses: 11

NJMD:	Annual ACDC conference
VASJ:	N/A
VASB:	Beaufort, NC, NJ. Not by mail, except for new sightings of confirmed matches.
NCAR:	N/A
NCKR:	Beaufort, NC, Virginia Beach, NJ, & by mail
NCGR:	Annual ACDC conference & mail
NCAT:	N/R
NCLS:	N/A
SCRP:	N/R
SCEZ:	N/A
GAJS:	Annual ACDC conference, Hilton Head, SC, Savannah, GA
FLMC:	Compare tracings, confirm matches by comparing slides
FLJC:	Mail

17. How many joint matches have been made?

#Responses: 11

NJMD:	6 with *(VASB)*
VASJ: 0	
VASB:	8-9 with *(NCKR)* 4 with *(VASJ)* 3 with *(NJMD)*
NCAR:	N/A
NCKR:	7 with other sites
NCGR:	6 with *(NCKR)*
NCAT:	N/R
NCLS:	N/A
SCRP:	N/R
SCEZ:	0
GAJS:	Unknown at present
FLMC:	0
FLJC:	0

18. What arrangements have you made for assigning credit/authorship based on joint matches? *See Appendix 4b for specific arrangements described by respondents.*

# Responses:	10
None:	4
Yes:	3
N/A:	3

19. How do you assign a "name" to each identifiable individual?

- *See Appendix 4b for responses.*

# Responses:	12
Numbers:	8
Name/Letters:	1
N/A:	2

20. Would you recommend a common naming system along the Atlantic seaboard?

# Responses:	11
Yes:	6
Indifferent:	3
No:	2

21. What would you like to get out of a cooperative effort along the Atlantic seaboard?

NJMD:	To get a better idea what the migration looks like.
VASJ:	The efforts of all these hard-working people be rewarded by their collectively resolving the details of movement patterns of the coastal migratory dolphins.
VASB:	A better understanding of the dolphins I work with Apr-Nov, particularly northern and southern migratory limits/ranges.
NCAR:	An understanding of the population structure of *T.t.* sufficient for management and conservation.
NCKR:	Get people jazzed about analyzing and comparing photos. See more matches which may lead to a hypothesis about migratory patterns.
NCGR:	N/R
NCAT:	N/R
NCLS:	An understanding of movement patterns and "stock" discreteness. Already animals tagged in the summer in Beaufort have been seen in Wilmington and VA. suggesting that we may not be dealing with a discrete migratory "stock".
SCRP:	N/R
SCEZ:	Standardize procedures and nomenclature (both in naming systems as well as terminology). Increased communication between efforts.
GAJS:	Data on home range and migration patterns; site fidelity; habitat utilization and differentiation.
FLMC:	Ideally a computerized method for comparing dorsal fin images among areas and willingness to cooperate and standardize methods and dissemination of information.

FLJC: Further define migratory boundaries of transients.

DATABASE:

1. Do you use a computerized database?

# Responses:	11
Yes:	9
No/Future plans:	2

2. Number of entries in photo-ID database as of 31 Dec. 95?

# Responses:	11
0 entries:	4
Range(by sighting):	56-933
Range(by individual):	236-1913

3. How are entries structured?

- Some groups maintain multiple databases, therefore points were assigned, i.e., a ranking of **1** = 3 points, **2** = 2 points, **3** = 1 point, and a sum of points was used to rank the most commonly used database structure:

#Responses:	11
by date:	14
by individual:	10
by sighting:	6
relational:	3
no database :	2

4. Describe hardware and peripherals. *See Appendix 4c for responses.*

- Some groups use more than one type of computer.

# Responses:	10
PC (config. not specified):	2
PC 486:	6
PC 386:	1
PC 586:	1
MacIntosh Quadra	1

5. Software used? Do you recommend this for other researchers?

- *See Appendix 4c for responses.*

		Recommend?	
Software used	**# Users**	**Yes**	**No**
Aldus (?)	1	1	
Corel	2	1	1
DBase III	1		
Excel	6	2	3
Fototouch	1		1
FoxPro	2	2	
Lotus 123	1		
Lotus Approach, 123	1	1	
Mocha	1		
Paintbrush	1	1	
Progress RDBS	1		
Quattro Pro	1		

6. What information is entered and how is it organized?

NJMD: Slides are entered by roll & frame #, each slide is classified with # and species of animals, then individuals are noted.

VASJ:	Not photo-ID; Columns as per data sheets.
VASB:	N/A
NCAR:	All information on sighting sheets. Organized by date, sighting #; each box on data sheet is a field in relational database.
NCKR:	Fin ID, date, general location, catalog for each date, numerically by individual.
NCGR:	N/R
NCAT:	N/R
NCLS:	All information on sighting sheets. Hopefully will ultimately link with digitized fins and signature whistles.
SCRP:	N/R
SCEZ:	Image, date & time, tape counter #, location, name of animal.
GAJS:	Date, time, place, conditions and crew. Database screen looks like data collection form. Each record is individual fin.
FLMC:	Information from sighting data sheets.
FLJC:	Information from Photo-ID project sheets.

7. What is the average time from sighting to entry into database?
Responses: 9
Range: 1 day-26 months
Average: 5 months

8. Can you identify social associations within a sighting?
Responses: 10
Yes: 7
No: 3

9. Do you have the ability to produce maps of sighting locations?
Responses: 12
Computerized:
Yes: 8
No: 4
By hand: 7 *(4 responses were both computerized and by hand)

10. Do you have access to GIS?
Yes: 7
No: 5

DEFINITIONS:

1. Briefly, how are animals characterized?
- *See Appendix 4d for detailed definitions submitted by respondents.*
- Most respondents use a combination of features for these definitions.

neonate:
Responses: 12

Fetal folds:	12
Small size, 50% of presumed mother's length:	8
Awkward head-up surfacing pattern:	7
Dark coloration:	6
Consistently surfacing in "calf position"; associated with adult:	5
Floppy dorsal:	5
Extremely buoyant:	4
Depressed behind skull:	2
Behavior:	1
With known mom of neonate:	1

Assumed to be less that 4 months old:	1
Calf in first calendar year of life:	1

calf:
Responses: 11

Smaller animal (50-75%) length of adult and in close association with a noticeably larger animal in calf position:	9
Small size:	2
Close association with an adult:	2
Includes neonates:	1
Non-neonate:	1
With group containing adults:	1
Assumed to be greater than 4 months old:	1
Do not use calf data unless a known mom is sighted the year following her appearance with a neonate:	1

subadult/juvenile:
Responses: 9

Don't use this category:	7
Behaviorally different from adults:	4
Size; slender & smaller than "adult":	3
Apparently non-dependent:	1
Often larger animals absent:	1
Small groups:	1
Smooth:	1
Usually without *Xenobalanus:*	1

group:
- *Respondent's specific definitions varied, see Appendix 4d*

#Responses: 11

Dolphins exhibiting similar activity in a given area:	8
Dolphins within a certain distance of one another:	3
All dolphins engaged in similar activity:	1
$\geq$3 dolphins, any sex, size, condition:	1
More than one animal:	1
Don't use this term:	1

sighting:
Responses: 10

A photographic encounter with a group of dolphins:	4
All dolphins within visual range:	3
A photographic record of a dolphin:	2
Same as group:	2
One or more animals:	1

2. How do you identify females?
Responses: 11

Association/presence of a small or neonatal calf surfacing consistently with a larger individual:	11
Live capture:	1
Stranding:	1
Observation of genital slit & mammary glands :	1
Observations of nursing:	1
Tentatively, if very pink or swollen belly observed:	1

Guess: 1

3. How do you think "resident" should be defined?

NJMD: N/R

VASJ: Although I believe there is room for a term "temporary resident", "resident" dolphins should spend almost all of their time (≥80%) at a specific geographical location.

VASB: Resident should only refer to individual present in a defined area all year (at least 1 sighting/month?). Possibly, then we could define "seasonal resident" as an individual present a defined portion of the time dolphins are present in an area (1/4 of the time ?)

NCAR: An individual that does not exhibit seasonal and (non-contiguous) shifts in home range.

NCKR: A dolphin photographed in at least 3 of 4 weekly surveys per month over a minimum of a 3 month period beginning and ending on dates photographed.

NCGR: Defining residency for the east coast *T.t.* is not going to be easy. Our definitions and arbitrary borders mean nothing to the dolphin. So little is known about the east coast *T.t.* and its movements. From what little is known, it appears these dolphins travel greater distances than other *T.t.* pops. Personal anecdote. I see dolphins year-round, except in winter when the water temperature drops below 5°C, but this would mean there are no residents if they don't stay year-round. I believe we are starting out with the wrong question or definition. I think we should be working on a definition of home range, then we could work on defining residency. But for what it is worth, I think to call a dolphin a resident, it must be sighted at least every month, with exception of environmental extremes. It must be seen feeding, traveling, resting, playing, in other words, it must be utilizing the habitat for it's living. But without knowing more about the home range and territoriality of these dolphins, I do not see how we can really define residency. The east coast *T.t.* may consider the whole east coast its home range and itself a resident from FL. to NJ.

NCAT: N/R

NCLS: An individual that does not exhibit seasonal and (non-contiguous) shifts in home range.

SCRP: Sighted at least once during each calendar season.

SCEZ: An animal that spends the majority of a defined period of time (i.e. seasonal vs. year-long residents) in a fixed geographic location.

GAJS: Since we survey the whole coast of Georgia, state lines are useful for description of area covered. I think, however, that a better definition would be based on physiographic region, observed home range movement and site preference.

FLMC: A resident is an individual that utilizes the study area at least once every month.

FLJC: Present year-round.

4. Do you use visual confirmations?(i.e., id's made in the field w/o photo-documentation? If so , what are your criteria for verifying ID's? *See Appendix 4d for criteria listed.*

# Responses:	12
No:	8
Yes:	4

Table 1. Summary of research objectives of photo-identification studies of bottlenose dolphins along the Southeastern US coast.

Respondent	Region	Photo-Identification Objectives	Catalog size	Initiated
Rich Mallon-Day *(NJMD)*	Cape May, NJ	N/R	35	Jul '89
Sherman Jones III *(VASJ)*	Chesapeake Bay, VA	The use of Chesapeake Bay by *Tursiops truncatus.* This includes spatial & temporal patterns, behavioral studies, population estimates & association patterns.	123	May '92
Sue Barco *(VASB)*	Virginia Beach, VA	a) To investigate the movement patterns of dolphins in the nearshore waters of VA by: developing sighting patterns of identifiable individuals within a year and from year to year, and investigating factors that may affect dolphin migration, especially water temperature and prey availability. b) to use photo-ID to examine the migration of dolphins along the Atlantic US coast by comparing photo-ID catalogs among research groups.	400	May '89
Andy Read *(NCAR)*	Beaufort, NC	Improve understanding of the ecology and life history of coastal *Tursiops* in NC, including studies of prey, feeding behavior, reproduction & growth, body condition.	31	Jul '95
Keith Rittmaster *(NCKR)*	Beaufort, NC	Use direct counts from boat transects to detect patterns of local habitat utilization and trends in relative density. Use photo-ID to study local individual residency and movement patterns, calving intervals of known females and social affiliations. Express crude birth rates as a % of neonates in the total number of dolphins observed in the summer months. Collaborate with other researchers to see if/where similar patterns do/don't exist, compare photos and relevant data and develop a migration model for coastal dolphins. Stranding response to support the NC MMSN and look for known animals.	1156	Jun '84
George Rountree *(NCGR)*	Wilmington, NC	Behavior patterns Attempt to identify residents and home range How does habitat affect behavior?	75	Oct '91

Table 1. continued.

Respondent	Region	Photo-Identification Objectives	Catalog size	Initiated
Amanda Truitt *(NCAT)*	Wilmington, NC	To increase the efficiency & decrease the problems associated with fin ID within and among sites using computer aided fin ID.	137	Spr. '89
Laela Sayigh *(NCLS)*	Wilmington, NC	Behavior and communication of wild *Tursiops.* It is necessary to obtain data on stock discreteness, movement patterns, residency and social structure before behavioral questions can be addressed. Interested in the potential for using acoustic monitoring as an additional tool in assessing stock structure to supplement photo-ID.	31	Oct '95
Ric Petricig *(SCRP)*	Hilton Head, SC	Describe population size, social structure, movement patterns and range. Residency status and behavior of resident stock.	67	Aug '88
Eric Zolman *(SCEZ)*	Charleston, SC	Residency patterns/relative abundance Develop photo-ID catalog Influence of physical and seasonal variables on habitat use & short range movements Evaluate Hi-8 video for photo-ID purposes	19	Jul '94
John Schacke *(GAJS)*	Savannah, GA	To identify the resident population in the near-shore waters and estuarine system of coastal Georgia. To develop a dorsal fin catalog to document residency, home range movement, immigration/emigration and social behaviors exhibited by that population. To share these data with the professional marine science community and to use them to educate the public at large about the status of and outlook for the bottlenose dolphin population in Georgia coastal waters.	262	Jul '89
Marthajane Caldwell *(FLMC)*	Jacksonville, FL	Identify year-round resident *Tursiops* in Jacksonville study area Identify seasonal residents.... Identify social units and their movements, habitat utilization, behavior patterns	236	Dec '94
Joe Contillo *(FLJC)*	Biscayne Bay, FL	Distinguish transients from residents Define habitat Population dynamics of residents	115	Jun '90

Appendix 4a. Project Background: Responses to questionnaires.

Cameras used:	lens/ motordrive/databack:	Film brand/ASA:	Medium of field photographs: B & W	Color slides	Color prints	Video
NJMD:						
Canon EOS 630	75-300/Y/N	Kodak&Fuji 100		Y		
VASJ:						
Nikkormat EL	100-500,70-210,400/N/N	Kodak TMax 400	Y	few		Y
Canon AE-1		Ektachrome 400				
Canon F-1						
VASB:						
Sigma SA300	80-300/Y/Y	Kodachrome 64		Y		
		Ektachrome 100				
NCAR:						
Nikon 8008	75-300/Y/Y	Kodachrome 64 &200		Y		
Canon 2000						
NCKR:						
Canon AE-1	300 f4/Y/N	Kodak TMax 400	Y			
NCGR:						
Canon AE-1	100-500/Y/N	Kodak/Agfa 400	Y	Y	Y	Y
Sharp Camcorder						
NCAT:						
Canon AE-1	200/Y/N	Kodak/Fuji 200			Y	Y
VC Super VHS video		JVC cassettes				
NCLS:						
Nikon 8008	75-300/Y/Y	Kodachrome 64		Y		
Nikon N-90						
SCRP:						
Nikon F8	80-200 AF/Y/N	Kodachrome 200	Y			Y
SCEZ:						
Canon Hi8 video	N/A	Hi8 ME 120 tapes				Y
GAJS:						
35mm SLR	200/some/some	Kodak/Fuji 400	Y			Y

Appendix 4a. Continued.

Cameras used:	lens/ motordrive/databack:	Film brand/ASA:	Medium of field photographs: B & W	Color slides	Color prints	Video
FLMC:						
Nikon 8008	75-300/Y/Y	Kodak /?ASA	Y			
FLJC:						
Nikon N90	300AF/Y/?	Kodachrome 64 &200		Y		
Nikon F4						

CATALOG:

3. What features do you use to identify individuals?

NJMD:
- Acquired marks on dorsal fin

VASJ:
- 1: trailing edge notches
- 2: other edge imperfections
- 3: coloration patterns visible

VASB:
- trailing and leading edge features, permanent scars (sometimes), body deformity (i.e., scoliosis), unusual fin shape/fin deformity

NCAR:
- distinctive features on leading & trailing edge
- evidence of scarring on fin, peduncle
- shape of dorsal fin

NCKR:
- 1: distinctive notches, tabs, freezebrands.
- 2: prominent scars
- Occasionally social affiliations and distinctive *Xenobalanus* within a sighting

NCGR:
- Dorsal fin; Defran ratio for matches.

NCAT:
- Notches

NCLS:
- Nicks and notches on leading & trailing edge
- fin shape
- evidence of scarring on fin, peduncle

SCRP:
- 1. dorsal trailing edge-long-term
- 2. other dorsal markings-short-term

SCEZ:
- 1: patterns of notches on dorsal fin
- 2: body coloration &/or scarring, fin shape or deformation, in one case, the flukes

GAJS:
- Notches on leading edge, top, trailing edge and dorsal ridge.

FLMC:
- 1: notches
- 2: scratches
- 3: fin shape

FLJC:

- Dorsal fin: leading edge, trailing edge notches, chops, etc.
- Dorsal ratios, scars and rake marks
- Lobomycosis

4. Number and definition of feature categories:

NJMD: No formal categories except Defran ratio.

VASJ :
- Leading edge markings
- Single notch
- 2 notches
- 3 + notches
- Coloration
- *Xenobalanus*

VASB: We are working on this now, it changes as the catalog grows. Right now we have 4 overall categories with 5-10 descriptions in each:
- 1. Tip features: tip missing; 1 tip notch; >1 tip notch/ragged tip; tip protrusion; extended tip; other
- 2. 1 or 2 Trailing edge features: 1 feature @top1/3; 1 feature @mid 1/3; 1 feature @base; 2 features w/ highest @ top 1/3; 2 features w/ highest @ mid 1/3; 2 features w/ highest @ base
- 3. Other: leading edge feature; scarring/pigment; unique fin shape; body deformity
- 4. More than 2 trailing edge features-haven't decided on descriptions
- 5. Questionable catalog: fins that may not have identifiable features.

NCAR&NCLS (may reduce to 9)
- Leading edge
- Missing top/tip
- Tipnick
- Right/Left bend
- Scarring/pigmentation
- Peduncle notch
- Entire trailing edge
- Upper third
- Middle third
- Lower third
- Extended tip
- Purgatory catalog

NCKR.:
- Leading edge catalog
- Top notch catalog
- Tip miss catalog
- 2 Notch catalog
- 3-4 Notch catalog
- 5+ Notch catalog
- IDWTWTWTFBSEC catalog

NCGR: Defran ratio.

NCAT: N/R

SCRP: N/R

SCEZ:
- 1: trailing edge
- 2: leading edge

- 3: apex
- 4: chopped fins
- 5: other
- Within first 2 categories fins are further organized using their dorsal ratios.

GAJS:
- 1: Leading edge notch: notch in leading edge
- 2: Top notch: notch in top of dorsal fin
- 3: Chopped fins
- 4: Single or smooth: single or smooth fins that are unique and distinctive.
- 5: 2-3 notches: fins with 2-3 notches
- 6: 4 or more notches: fins with 4+ notches
- Dorsal ratios within categories.

FLMC:
- 1: Top notch: notch in top of dorsal fin
- 2: Leading edge notch: notch in leading edge
- 3: 2-3 notches: fins with 2-3 notches
- 4: 4 or more notches: fins with 4+ notches
- 5: Single or smooth: single or smooth fins that are unique and distinctive.
- 6: Xeno: fins with multiple *Xenobalanus*.
- Dorsal ratios within categories.

FLJC:
- Scans/Tracings: Novel fins, chops/amputations, leading edge, single notch, 2-3 notches (Defran dorsal ratio), 4+ notches (Defran dorsal ratio), smooth fins (no ratio), unidentified fins (poor photos, etc.). Slides: numerically.

8. Definition of catalog quality image:

NJMD: N/R

VASJ: Perpendicular view, clear focus

VASB: An image showing distinctive features of the fin. The quality of the image varies somewhat with type of feature.

NCAR&NCLS. Readily recognizable; entire fin, from anterior insertion to posterior insertion of dorsal fin, and trailing edge must be visible, the image must be in focus, perpendicular to photographer, and if available, R and L sides.

NCKR: We don't have one. Typically a catalog quality image has 2 or more distinctive fin features likely to show up in the average photo. We don't accept a photo as readily as we used to.

NCGR: Clear outline of fin or distinct markings.

NCAT: N/R

SCRP: N/R

SCEZ: Fin must be clear, perpendicular to camera, distinct from background and fill at least 1/3 of the screen.

GAJS: High quality (determined by assessing the image for clarity, lack of parallax, and high contrast), and have at least one dorsal fin with a distinctive notch pattern.

FLMC: Clear, at least 1 notch or distinct shape/scar, lack of parallax, high contrast

FLJC: Best unmistakably identifiable photo of individual from each day.

9. How are matches made? What features are used? What sequence of procedures do you follow?

NJMD: Since limited in amount of time to devote to this, generally use easily recognizable individuals.

VASJ:
1. Initial examination then choose which catalog chapter
2. Compare to all individuals in that chapter
3. Decide on best match
4. Keep records of "confusing individuals", may be resolved later by additional information.

(5. Am planning on developing method with several "judges"; in past there have been too many transient members of study group).

VASB: We analyze images in a step-down/step-up process. Images are first compared within a sighting, the best images of each individual are compared for the cruise. Once each sighting and cruise is analyzed, all cruises for the season are matched, then the season is compared with the master catalog by separating images into categories and descriptions. To verify matches or add a new individual, images are then compare with progressively broader categories until all fins have been compared.

NCAR&NCLS: Following the DBRI protocol:

A packet of data sheets and corresponding slides for a given boat-day are selected for photo analysis. Each slide is examined using a 15-power lupe eyepiece to find all distinctive dolphins. Slides are sorted by each identifiable individual within a sighting and the best-quality slides of each animal showing the distinctive features of the fin are selected to compare with the photo-ID catalog.

The most prominent feature of the fin is identified and the category that best describes that feature is searched for a potential match. Matches are often made by comparing the slide directly to the print in the catalog. However, with a close match or to distinguish between fins with similar features, the original slide is used for comparison. To verify a match between similar fins, both fins are projected using a slide projector with a zoom lens and traced to line up distinguishing features. When a match is made with a fin in our catalog, all slides are labeled with the dolphin's unique code and the dolphin is scored as a positive identification. The best quality slide is selected and filed in the individual animal's file as a representative sighting slide for that dolphin.

If there is more than one identifiable fin in a slide, arrows indicate which fin corresponds to which code. On the data sheet under the column labeled:

Dolphins Sighted: the dolphin's name is entered.

Code: unique 4-place code is entered

Conf: P is entered to indicate that the identification was confirmed with a photograph.

All slides are put back in the original slide sheets in chronological order.

All information from sighting sheets are entered into the sighting database after photo-analysis is complete.

NCKR: Following fin feature key: Check for resights by comparing each photo with every photo within one (or several) catalog(s). Some matches (or non-matches) are confirmed alone and a list of questions is maintained for verification. Prints are numbered and placed in the catalogs, and resight database is updated. We use overlays of tracings and/or transparency projections when considering difficult matches.

NCGR:. I am the sole researcher, so matches must be unquestionable to be a true match.

NCAT: N/R

SCRP: Position of notch patterns on dorsal.

SCEZ: Defran dorsal ratio & visual comparisons. The dorsal ratio is calculated with Mocha image analysis software. For features used refer to question 3. One surveys' worth of images are analyzed at a time, hard copies are made of each catalog-quality image, the single best image of each individual is saved to the hard drive and to disk. The hard copies (using their dorsal ratios if applicable) are then compared to the images in the appropriate subsection of the catalog. If the individual represents a resight this information is then entered into a resight database. If the animal is not a resight a second hard copy is placed in the catalog within the appropriate dorsal ratio sub-section.

GAJS: Follow Defran et al. 1990. A tracing is made of each fin, all fins are oriented "swimming to the right" to facilitate resighting. A dorsal fin ratio is calculated for all fins with 2 or more notches. Notch patterns (i.e., top, leading, 2 or 3 or 4 or more) determines where the search is started. If a prospective match is located, the subject identification number is used to retrieve all previous negatives of that dolphin. The current negative is compared to all previous sightings using an 8x lupe. The current negative must match all previous negatives before a resight is confirmed. Once a match is verified, the negative, tracing and data sheet are labeled with the appropriate ID #.

FLMC:. Follow Defran et al. 1990; a tracing is made of each fin. The catalog is searched for the image in question. Notch patterns (i.e., top, leading, 2 or 3 or 4 or more) determines where the search is started. If a match cannot be found after 2 thorough searches of the entire catalog, the animal is considered new IF the negative is of high quality. If the negative is of questionable quality it is filed in a "resight later" book. Once every 3-6 months every slide in the catalog is compared to every other slide to confirm that every identified individual is in the catalog only once and that all the slides are in their appropriate place.

FLJC: Leading and trailing notches, dorsal ratio. Slides are sorted and separated within each sighting and then matched to scan/tracing catalog and finally to archived slides.

11. Additions to the catalog: what steps are taken before a fin is added?

NJMD: Assign new ID #

VASJ: 1. A "catalog quality" grade A image is automatically there (*is added).*
2. If multiple photos of lesser quality are taken on 2 different sightings, then fin is added.

VASB: Same process as question #9&#10

NCAR&NCLS: When a match is not found in the first category searched, all other possible categories are searched to account for dolphins that have multiple identifying characteristics. The entire catalog is searched up to 3 times, as well as the "Purgatory catalog", before a new animal is added to the catalog. If we are confident the fin is reliably recognizable, the dolphin is given a unique code that describes the most obvious feature of the fin. The best-quality slide is labeled with the code and catalog category that describes the most prominent feature of the fin. A print is made and added to appropriate category in the print catalog, and the original slide is filed in sequence by individual with the original catalog photographs. The code, name, primary (and secondary) category, location code, date of sighting, mother or calf's code if applicable, roll and frame number is entered on the ID Master List (this is a list of all the fins in the catalog, and the categories in which they belong). If the fin has features that can be classified in two different categories, either a second slide or two copies of the best slide are labeled for the secondary category. A piece of paper is put in the chronological slides to replace the original that lists the dolphin's code, that it's a new fin, and the roll and frame number so that there aren't any gaps in the chronological slides.

NCKR.: If a match is found it goes in the corresponding catalog. If not, it goes in as the next sequential number. Following key, fin is added to appropriate category catalog chronologically.

NCGR:. N/R

NCAT: N/R

SCRP: N/R

SCEZ: Review of appropriate subsection followed by 3 whole catalog reviews.

GAJS: If a tracing cannot be found in its appropriate catalog, then it must be compared to all tracings in the catalog. If a match is not found after 3 complete and thorough searches through each catalog, the dolphin is considered a "new sighting" and the next available ID number is assigned.

FLMC: A fin/slide must be compared to all sightings of an individual before a match is confirmed; this is a self checking mechanism. New fins are added only if 2 complete and thorough searches of the catalog result in no matches.

FLJC: All archival slides of individuals are checked against the possible addition and if new it is assigned a number and scan/tracing is made and dorsal ratio determined.

12. What happens with a fin that is distinctive but not catalog quality?

NJMD: A note is made until a higher quality shot is obtained.

VASJ: See #11; All catalog chapters have substandard fin image sections.

VASB: If it is the only image in the sighing it is kept in a separate catalog, unless 3 people decide to discard it (actually it sits in a file).

NCAR&NCLS: The Purgatory Catalog: It is possible to identify animals in a sighting that are not sufficiently distinctive to make long-term matches, or appear distinctive but are unidentifiable because the entire fin is not visible, or obstructed (by tassel barnacles, for example), photo coverage is incomplete, or photo quality is substandard. Each of these dolphins is classified as an "other..." with some reference to the most distinguishing feature, both on the slide and under the Dolphin Name on the Sighting Sheet. A slash (/) is entered in the code box beside the Dolphin Name and will not be entered in the Sighting database or the Master Code List. Although it is not considered a positive identification, an "other..." dolphin is counted toward revision of the group-size estimates.

In some cases some of the fin markings are visible and slides of these "other" individuals are kept in a separate catalog of "others" (the Purgatory catalog). If this "other" dolphin is sighted in the future with a better photo, it may be possible to go back and identify or match the individual in question.

Fins that lack distinctive markings are considered "clean" but may be used in calculating or adjusting group size estimates. Clean fins cannot be "resighted" but in some cases, may be distinguished from one another within a sighting based on differences in fin shape.

NCKR.: If a match is found it goes in the corresponding catalog. If not, it goes in as the next sequential number. Tough question as we don't have a definition of catalog quality.

NCGR: Saved but not used.

NCAT: N/R

SCRP: N/R

SCEZ: Saved, so presence of animal is verified for residency/migratory determination.

GAJS: N/R

FLMC: The fin is placed in a book and every 3 months we try to resight the fin to the catalog.

FLJC: It is put into the "unidentified" catalog.

13. Do you have a system for ranking or grading the quality of your photos or photographic coverage of a sighting?

VASJ: A: catalog quality
B: good image (matchable) but deficient in angle, extent, contrast
C: fair/poor image with visible markings

VASB: No for photos, yes for coverage.

NCAR&NCLS. A grading system that integrates recognizability, photographic quality, and coverage is used to identify the quality of a given sighting. Each sighting is rated with a Photo Coverage Grade recorded on the sighting sheet after photo-analysis:

Grade-1 - All dolphins in the group were photographed or otherwise positively identified. All the animals in the best field estimate are accounted for as a) confirmed positive identifications; or b) as individuals that can be distinguished within a sighting from a high quality photograph but do not warrant status as a 'marked' dolphin in the catalog.

Grade-2 - There are photographs of some dolphins with distinctive fins that may be in the catalog, but because of the quality of photographs it is not possible to make appropriate comparisons with the catalog and make a match or assign an identification.

Grade-3 - Photographic coverage is known to be incomplete, because all dolphins were not approached for photographs, no photos were taken, film did not turn out, sighting conditions were poor, etc.

NCGR: Nothing written, I grade based on usable/non-usable.

GAJS: Yes. Each photographer and videographer is graded after each survey and receives a written critique. Photographers are give contact sheets to review performance.

FLMC: Photos-no; Yes for photo. coverage: %photographic effort=#identifiable dolphins within a sighting/# of adults counted on boat. This includes ID-able smooth fins-fins that can be IDed within a sighting but not within the catalog.

FLJC: No system for grading quality of photos; Yes for photographic efficiency for each survey: %=# identified within survey/# total adults * 100

18. What arrangements have you made for assigning credit/authorship based on joint matches?

VASB: It's case by case. We have based authorship on time spent matching and writing. I'm not sure merely taking a picture should warrant authorship, but we'll see.

NCKR.: Senior author prepares drafts and has been involved in all aspects of study. Co-authorship would require contribution of a usable photo of significant value to the study with a minimum (yet to be determined) of accompanying data, analysis and approval.

GAJS: Verbal agreements for acknowledgment of photos; joint authorship if material published/publicly presented.

19. How do you assign a "name" to each identifiable individual?

NJMD: I assign one

VASJ: Consecutive number based on chronological time of discovery each year

VASB: When we assign a name it is based on fin features, we haven't named many, they all get numbers.

NCAR: Still deciding between numbers and names; one possibility is assigning numbers that have some meaning with respect to the fin feature categories; e.g., category 1: 1000-1999, category 2: 2000-2999, etc.

NCKR:. Sequentially numbered. Names whimsically.

NCGR: N/R

NCAT: N/R

NCLS: So far have made up a few names that are meaningful to me, but I recognize this is not acceptable and am struggling to come up with a better system. Still deciding between numbers and names; one possibility is assigning numbers that have some meaning with respect to the fin feature categories; e.g., category 1: 1000-1999, category 2: 2000-2999, etc.

SCRP: Numbers.

SCEZ: 3 letters in length, and descriptive.

GAJS: Unique ID number based on survey date, zone where sighting occurred, and survey team.

FLMC: We assign a 3 digit-number to each animal. For dolphins that are distinct enough to be IDed in the field, we give them a name that reminds us of the pattern or the dolphin. Names are easier to remember than numbers.

FLJC: Numbered chronologically

Appendix 4c. DATABASE: Responses to questionnaires submitted for the Photo-ID Workshop.

	Describe hardware:	peripherals:	5. Software used:	recommend?
NJMD:	Laptop 486, Windows based		Progress RDBS	N/R
VASJ:	IBM 486 (x2)	Laser & dot matrix printers	Excel	Y
VASB:	IBM 386 dx with 66mHz 120MB HD	600x600dpi B&W laser printer 14.4 bps fax/modem	Excel Quattro Pro	N N
NCAR:	Gateway 2000 486 MacIntosh Quadra 650	HP printers	FoxPro Excel	Y Y
NCKR:	Gateway 2000 P5-60	HP Laserjet Logitech scanner	Corel Wordperfect Excel Fototouch	N N N N
NCLS:	PC 486	Nikon Cool-scan slide scanner	FoxPro	Y
SCRP:	IBM psi		DBase III, Lotus 123	N/R
SCEZ:	586 computer with 32 megs RAM	Sony 15" monitor Sony EV-C100 Hi 8 VCR Targa & board Video maker Laserprinter	Excel Mocha	N/R
FLMC:	486 DX		Excel 3.0	N
FLJC:	IBM	Deskjet printer Scanner	Lotus 123 Corel Paintbrush Aldus(?)	Y

Appendix 4d. Responses to questionnaires submitted for the Photo-ID Workshop.

DEFINITIONS:

neonate:

NJMD: Fetal folds

VASJ: 1. small 2. awkward motion 3. echelon position 4. fetal markings

VASB: Presence of fetal folds automatically qualifies it; a combination of size (less than 1/2 adult) and behavior (position and proximity to adult and "popping-up") together identify a neonate.

NCAR: Calf in first calendar year of life; recognized by: small size, 50% of presumed mother's length, dark coloration, fetal folds (sometimes), floppy dorsal, head-out surfacing, consistently surfacing in "calf position".

NCKR: Small, next to adult, and any of the 4 following features:
1. extremely buoyant 2. fetal folds present 3. depressed behind skull
4. with known mom of neonate 5. cute 6. Assumed to be less that 4 months old.

NCGR: Fetal folds. This falls inside definition for neonate, but I feel it is the only truly defining feature. Size cannot be used as that will vary with a variety of factors, nutrition just being one.

NCAT: N/R

NCLS: <50% length of adult, dark colored, fetal folds (sometimes), floppy dorsal, head-out surfacing.

SCRP: Fetal folds, color, size, association with adult

SCEZ: Requisite criteria: small animal (>120 cm) with larger animal (at least twice as large); Secondary criteria: 1. fetal folds 2. dorsal floppy 3. post-cranial indentation 4. dark gray/black coloration 5. greater buoyancy ("corking" when surfacing).

GAJS: Presence of one of the following: hyperbuoyancy, fetal folds, or floppy dorsal.

FLMC: Coloration, fetal folds, buoyancy: stereotyped swimming style and awkward head up respiratory pattern.

FLJC: Fetal folds, coloration, floppy dorsal, swimming/surfacing

calf:

NJMD: Small size, in close association with an animal >twice it's size

VASJ: (Includes neonates for us) but also: noticeably smaller than adult with when is swimming in echelon position.

VASB: I have a hard time with this one and generally do not use calf data unless I see a known mom the year following her appearance with a neonate.

NCAR: Smaller unmarked animal that appears next to a noticeably larger animal, and is in calf position, i.e., alongside and slightly behind the presumed mother.

NCKR: Non-neonate, small, with group containing adults. Assumed to be greater than 4 months old.

NCGR: One half the size of the animal it's swimming with

NCAT: N/R

NCLS: 50-75% length of adult, frequent surfacings in "baby position" (close to mom, with head slightly behind dorsal fin of mom).

SCRP: N/R

SCEZ: Not rigorously characterized; smaller animal in closer contact with larger animal.

GAJS: ±1/2 length of average adult

FLMC: Less than 1/2 size of adult, close contact/association with an adult

FLJC: 1/2 size on smaller than mother/adult

subadult/juvenile:

NJMD: N/R

VASJ: Behaviorally only (and I don't try to count them!) Usually: small groups,slender and smaller than "adult", approach boat-lots of activity and "play".

VASB: I do not base any analyses on juvenile counts; I believe they are behaviorally different from adults (more apt to bow-ride, more "playful", etc.), but do not feel confident quantifying their presence.

NCAR: We don't use this category.

NCKR: Apparently non-dependent, smooth, smallish, often larger animals absent, usually without *Xenobalanus*.

NCGR: Too hard to call in the wild.

NCAT: N/R

NCLS: So far we have only used this term for known age animals in Sarasota.

SCRP: N/R

SCEZ: Animals subjectively judged as being small, medium or large.

GAJS: Don't use.

FLMC: N/A

FLJC: Size, behavior, "look"

group:

NJMD: A collection of animals in one area.

VASJ: Don't use this term, but a "sub-group" or "pod" is dolphins in close proximity. Perhaps then the "group" would be all the dolphins in a sighting- I might call it a herd.

VASB:. Individuals within 100 m of one another.

NCAR: As defined by DBRI:"We use the term "sighting" and "group"interchangeably to refer to all dolphins in sight at any given time who are moving in the same general direction, interacting with one another and/or engaged in similar activities. Usually, these animals are within 100m of each other but there will be exceptions. Every time group composition changes = new sighting. Sometimes, particularly with large, dispersed groups this is problematic and the group definition may be arbitrary. Also a problem when groups join & split....

NCKR: A dolphin or assemblage of dolphins gathered together (generally within 10 body lengths of one another).

NCGR: N/R

NCAT: N/R

NCLS: As defined by DBRI:"all dolphins in sight at any given time who are moving in the same general direction, interacting with one another and/or engaged in similar activities. Usually, these animals are within 100m of each other but there will be exceptions".

SCRP: All swimming in same area, direction, generally in 20m radius, same activity.

SCEZ: All animals within 100m of one another and engaged in same or similar activities.

GAJS: $\geq$3 dolphins of any sex, size or condition.

FLMC: All dolphins engaged in same or similar activity.

FLJC:. More than one animal.

sighting:

NJMD: A photographic encounter, a second group would be another sighting.

VASJ: All the dolphins in a (large, visible) geographic area. In large groups I can't even pretend to photograph them all.

VASB: A photographic encounter with a group of dolphins. I also use it to refer to a photographic record of an individual; a resight is another sighting of the same individual.

NCAR: Same as group.

NCKR: (One column on data sheet). A group from which no other dolphins can be seen. Several groups can be in one sighting.

NCGR: N/R

NCAT: N/R

NCLS: Same as group.

SCRP: N/R

SCEZ: Any and all dolphin encounters regardless of duration or quality of video.
RE: photo-ID, a photographic image of an individual.

GAJS: For photo-ID, a sighting ("event" in our parlance) is an approach resulting in film (still or video) taken.

FLMC: All dolphins within visual range.

FLJC: One or more animals.

2. **<u>How do you identify females</u>?**

NJMD: I don't try; except associated with a calf over several sightings.

VASJ: For data, I don't. I presume that the adult with a calf in echelon formation is a female-<u>maybe</u> the mother.

VASB: I guess, based on consistent presence with a neonate.

NCAR: Presence of a small or neonatal calf surfacing consistently with a larger individual.

NCKR: Known from social history (with neonate), live capture, stranding.

NCGR: If genital slit and mammary glands visible, which isn't often. I will tentatively call it a female if it has a very pink or swollen belly. I watch for it to be with an infant that appears to belong to it. I will tentatively call it a female if I see it alone with a neonate or calf, especially if I see what appears to be nursing.

NCAT: N/R

NCLS: By association with calves.

SCRP: Continued presence of neonate.

SCEZ: Rigorously: animals in close association with neonates; in the field, a dolphin believed to be with a calf is considered to be a female.

GAJS: We guess! Only if a penis is in evidence, do we classify a dolphin as male.

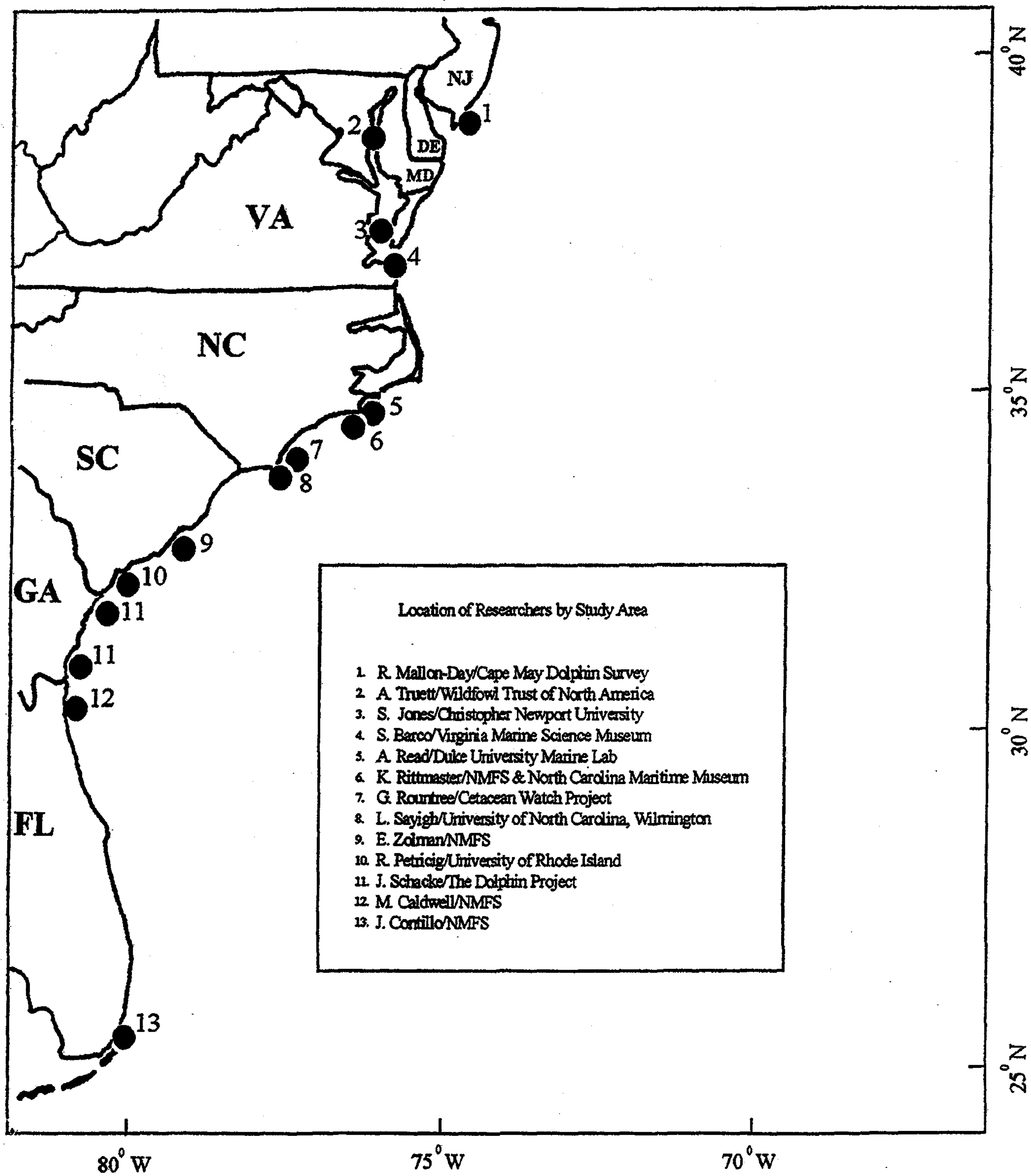
FLMC: Repeated sightings over several weeks of a dolphin with a calf.

FLJC: If there is a calf (in position) present or if criteria are presented-no hard data on M/F is taken, data on sex is put in comments section.

4. **<u>Do you use visual confirmations?(i.e., id's made in the field w/o photo-documentation</u>? <u>If so , what are your criteria for verifying ID's</u>?**

NCGR: Y There are a few dolphins I have seen so many times with very distinct fins. I can ID visually for certain (have compared my ID in field and photos-have always been correct).
SCRP: Y Shape and notch pattern of dorsal.
SCEZ: Y So far, I have been for purposes of establishing residency but not incorporating them (or planning to) for mark-recapture purposes. I have been having misgivings about biasing resight (residency) data with easily recognizable individuals.
FLMC: Y 2 people familiar with the dolphins/fins in question confirm the sighting.

Appendix 5. Location of study areas of NMFS Photo-ID Workshop participants.



Appendix 6. Consensus definitions of commonly-used terms as derived from discussions during the workshop

Neonate - less than 3 months old, with the following features: 1) fetal folds (this feature alone is enough to define a neonate, and/or 2) size is less than 50% of the mother's length. Other features that may contribute to the definition, but can not define a neonate in the absence of other features include: darker coloration than the adult, head-up surfacing pattern, and surfacing in calf position alongside a larger animal presumed to be the mother.

Calf - a small non-neonate, up to 75% of the presumed mother's length, and typically in association with a larger animal presumed to be its mother.

Subadult/Juvenile - this category was considered too vague for field assessments.

Encounter (= Group or Sighting) - all dolphins in sight at any time; an experience or encounter with dolphins during field efforts, usually assigned a serial number for any given field day.

Presumed Female - this category is defined from repeated encounters in which the animal is in association with a calf; one sighting with a calf is not sufficient to call it a presumed female.

Resident - This definition will await findings based on more extensive resighting data than are currently available. For the purposes of the NMFS, it isn't necessary that the animals are immediately identified from the field as residents as long as the appropriate information is provided to facilitate their own interpretation, including: when the dolphin was seen, where it was seen, how many times it was seen, what survey schedule was used to obtain the sightings, and how frequently the animal was seen relative to this schedule.

Appendix 7. Submission Form for Image of Bottlenose Dolphin

To be completed after submission:

Accession code: [ ] Date of Submission: [ ]

CONTRIBUTOR:

Name: ______________________

Affiliation: ______________________ Archive Location: ______________________

Address: ______________________ Phone #: ______________________

____

Contributor comments: ______________________

____

LOCATION (where image was taken):

State: __________ Description of location: ______________________

Latitude: ______ degrees ______ minutes ______ 1/100 minute

Longitude: ______ degrees ______ minutes ______ 1/100 minute

PHOTO DATA:

Date of photo: ____ /____ /____ Encounter #: ______ Reference/Roll & Frame # ______________

day / month / year

DATA ON DOLPHIN

Contributor's Dolphin Identifier: [ ]

Age class (check box and circle method(s) of determination below):

[ ] Adult [ ] Calf [ ] Neonate

Adult: size

Calf : non-neonate characteristics small size (up to 75% of length of presumed mother and associated with presumed mother

Neonate : fetal folds, size (50% of presumed mother's length), darker coloration, head-up surfacing, calf position

Sex (indicate method of determination below): [ ] Male [ ] Female [ ] Unknown

Male based on observation of genital area

Presumed female based on asssociation with calf/neonate in repeated encounters (minimum of 3)

Agreement for collaborative use of image: This image may not be used for purposes other than initial fin matching without the written consent of the contributor- the contributing organization maintains ownership of the image and the accompanying data:

______________________ ______________

Signature of contributor Date

Appendix 8. MIPS: A Computer Assisted Identification System for Manatees

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The photographic documentation of individual Florida manatees (*Trichechus manatus latirostris*) based on unique features (mostly scars acquired from encounters with boats and entanglement in fishing gear) has been a major tool of manatee researchers for nearly 40 years. Early photographic catalogs of manatees quickly outgrew boxes and albums, hand-sorted punched cards, and even a computerized system integrated with images on videodisc. To help manage this growing catalog of individually known manatees, an updated computerized photo CD-based system was developed using Multimedia Toolbook for Windows.

The Manatee Individual Photo-identification System (MIPS) accesses identity information, feature codes, images, and sighting data stored in dBase tables for each individual in the manatee catalog. These tables also store additional data not accessed by MIPS, but available for analyses. The tables contain a variable number of fields, but each has in common a unique identification number for each manatee.

The identity table contains a unique numerical record for each identified manatee, and when available, the manatee's name, sex, date when photo-documentation was complete, date the manatee is considered an adult, and other supplementary identifiers such as tag number or captive ID number, when applicable.

The feature table contains the coded descriptions of all features on all manatees. Features are described by type (e.g. head, flipper, anterior trunk), number, size (small, medium, or large), color (gray or white), and shape (line or blotch). Based on these choices, a character code is created to describe each feature. Feature codes are used to search for matches between cataloged and newly photographed individuals.

The image table identifies, by an ID prefix, each composite sketch, and provides information about each photograph used to document the features of each manatee. Image data accessed by the MIPS includes the date the photograph being viewed was taken, and the slide catalog identifier.

The most extensive table is the sighting table. Every documented sightings of a known manatee is listed in this table, including the sighting date, documentation code, observer, area and specific locality, size class, reproductive or dependency status, as well as other information. These records are the basis for population fecundity and survival analysis studies.

To ensure that a manatee is not cataloged in the MIPS as more than one individual, catalog criteria require that each individual manatee be fully documented photographically and have a permanent (healed) feature that is unique enough to be recognized in future photographs. MIPS images for each manatee consist of photographs, taken from Photo-CDs and compressed as JPEG image files. Images also include composite sketches. hand-drawn from multiple photographs and scanned as bitmap files. Photo-CDs offer the flexibility to inexpensively digitize, archive, and update images as new features are acquired. JPEG compression provides quick access and display of any image in the catalog on a 486/66DX2 personal computer.

By entering one or more feature codes, field locations, or a manatee's identification number of name, the system provides a list of known individuals that possibly match the newly-photographed manatee. For each possible match, information (e.g. name, sex, complete feature list, sighting history) is displayed while the composite sketch and images for each manatee are rapidly perused. If still uncertain about a positive match, any candidate manatees may be retained while additional individuals are selected by other features codes or location qualifiers. Once a match is confirmed, the new sighting record may be added and features updated, if necessary.

To date, 1,027 manatees with nearly 15,000 sighting records and 5,000 images are included in the MIPS. The MIPS is providing efficient access to valuable, long-term data on habitat use, site fidelity, movements, behavior, and reproduction traits, and is the basis for current research on estimation of survival rates. Consistent identification of known individuals each year has yielded the only data for age at first reproduction and interbirth intervals in wild manatees. The MIPS database framework and software is easily adaptable with Multimedia Toolbook, and may be used in other studies where rapid identification of many individual animals is needed.

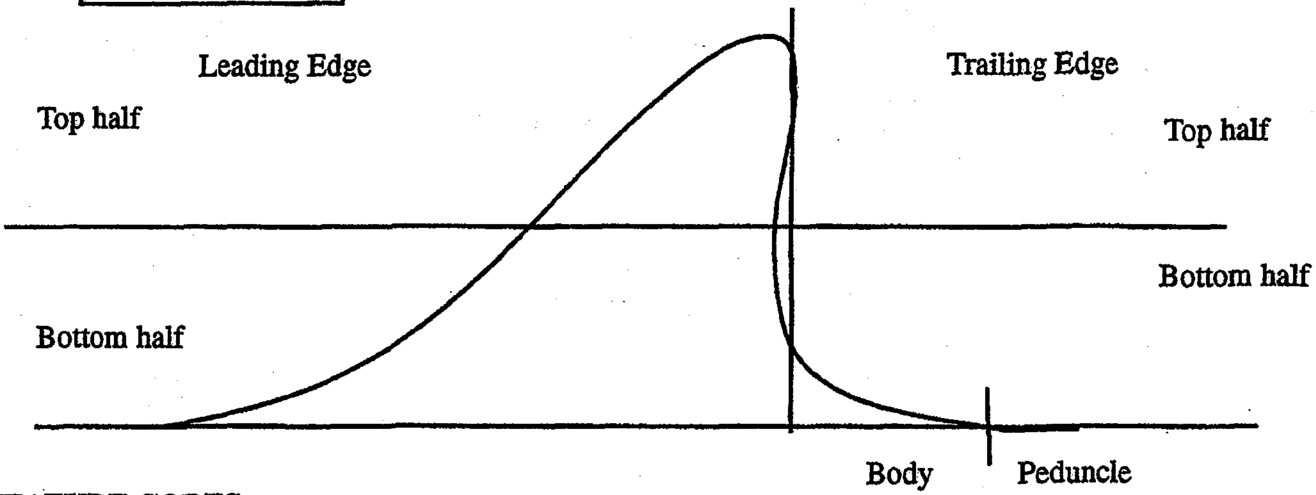
Appendix 9. Trial Coding System for Fin Features

Your Name: ____________

Date: ____________

Dolphin ID ____________

Accession code: ____________



FEATURE CODES

REGION	TYPE	LOC	LEFT/RIGHT FIN	LEFT/RIGHT BODY	SCAR COLOR	SCAR SHAPE	FIN SHAPE	TAG/ BRAND	SIZE
___	___	___	__/__	__/__	___	___	___	___	___
___	___	___	__/__	__/__	___	___	___	___	___
___	___	___	__/__	__/__	___	___	___	___	___
___	___	___	__/__	__/__	___	___	___	___	___
___	___	___	__/__	__/__	___	___	___	___	___
___	___	___	__/__	__/__	___	___	___	___	___

REGION

- L - Leading edge
- T - Trailing edge
- P - Peduncle
- B - Body
- F - Fluke

TYPE

- M - Mutilation (ex/missing part of fin)
- S - Scar
- F - Feature (notch, nick, protrusion)

LOCATION OF FEATURE

- T - Top half
- B- Bottom half
- E - Top & Bottom halves

LEFT/RIGHT SIDE

Fin
- L - Left side
- R - Right side
- U - Not recorded

Body
- L - Left side
- R - Right side
- U - Not recorded

SCAR

COLOR
- W - White
- P - Pink/Red
- Y - Yellow
- L - Lobomycosis/Skin disease

SHAPE
- S - Shark bite
- B - Blotch
- L - Line

FIN SHAPE

- I - Intact, "normal"
- R -Right bend
- L - Left bend
- U - Unique

TAG/BRAND

- F - Freezebrand
- R - Rototag

SIZE OF FEATURE

- L - Large
- M - Medium
- S - Small

Appendix 10. DARWIN: A Computer System to Identify Bottlenose Dolphins From Dorsal Fin Photos

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Introduction

Although it is clear that photo-identification of *Tursiops* can yield a tremendous amount of data regarding dolphin biology, it is problematic in certain ways.

The manual process of photo-analysis is visually fatiguing. Individuals who spend extended periods of time engaged in photo-identification, especially when using an ocular zoom lens, can experience tired eyes and consequently loose their ability to discern fine details in an image. Since photo-analysis is conducted by humans, the interpretation of the image of a fin is subjective. Fatigue and subjectivity can both lead to errors in identification.

Photo-analysis is a time intensive process. Catalogs are often large, and massive numbers of new photos can be acquired annually. One estimate, suggested by Dr. Randall Wells of the Dolphin Biology Research Institute in Sarasota, Florida, is that for every hour spent in the field taking photos, two hours are spent in the lab analyzing them.

Data collected in photo-identification surveys are maintained in various formats such as photos, sighting data sheets, environmental logs, etc. For the scientist it is inconvenient and inefficient to manually cross-reference information which is not organized in a central database. Also, the absence of data and metadata standards makes sharing of data between geographically different surveys difficult.

The DARWIN system has been designed with a Windows-based user interface, which supports the screen display of full size images. The automated identification processes are intended to minimize effects of user subjectivity, and the number of photos viewed in the photo-identification process, thus decreasing visual fatigue. Ideally, the system will allow the researcher to maximize productivity in the lab, by automatically finding matches as, or more, quickly than the human alone.

As ultimately envisioned, the system will integrate all image and textual data into a central database. This will eliminate multiple data sheets and allow researchers to discover meaningful relationships within their information.

The database will be designed with a networked client-server architecture and will be accessible via an Internet connection. The server will maintain the database of textual and image data for each survey group that utilizes the system. The client will facilitate the exchange of information with the server to automatically match images and will provide the interface and the database access routines. If given permission (password access) a researcher could access another group's database in order to expand the search space for matching.

Initially, we identified three types of systems which might be developed to aid in the process of photo-identification. Each would provide varying levels of support for the researcher involved in photo-identification. Also, each would require varying amounts of user interaction.

The first design would be a networked client-server database, which would allow research groups to centrally store their data. The system would facilitate easy exchange of data among different surveys, but would not solve the problems of photo-analysis (fatigue, lack of standards, and subjectivity), and photo-identification would still be done manually.

A second system would provide an on-line expert to aid in the identification process. The expert would guide the user through the process of creating a qualitative description of the fin. The system would require the researcher to systematically describe the fin based on generally accepted terms, or labels, indicating overall fin shape, location and type of damage along the fin edge, and any other characterizing features.

The first DARWIN prototype was developed as this type of system. Initial testing indicated that the system could not produce acceptably reliable identifications because of the subjectivity involved in the characterizing process. Perhaps a system of this type used primarily by a single user would be adequate, but it fails in use by multiple researchers, especially when some are inexperienced.

A third system would automatically identify individual dolphins without user interaction. Such a system would quantitatively describe the fin and match these descriptions automatically. This kind of system would generate objective descriptions, thereby increasing reliability of the matching process.

In designing the DARWIN system, we have concluded that a hybrid of the client-server database with automated fin description and matching routines promises the most comprehensive solution to the varied problems of manual photo-identification. Additionally, we believe that the human user has a role to play, even in this largely automatic process.
Automatically identifying dolphin fins is complicated by ...

- Poorly focused images
- Poor image contrast, especially between the fin and the background
- Variations in lighting conditions
- Blurring of the fin caused by motion of dolphin or camera
- Areas of high intensity glare caused by bright sunlight on wet surfaces
- Orientation of the fin other than perpendicular to the line of sight
- Obscuration of part of the fin by water or other dolphins
- Variation in the overall fin shape due to flexing of the back
- Changes to fin shape and edge damage over time
- Fins that are essentially nondescript

In order to minimize some of these problems, the current DARWIN system makes several assumptions.

All digitization of images occurs outside the DARWIN system.

Images used in the matching process are standardized at approximately 500x500 pixels, grayscale, with the fin height at least 1/2 the image height.

Images are of sufficient quality that they could be used in manual photo-identification.

Essentially what we are trying to accomplish is to mimic or at least duplicate the human ability to recognize individual objects in multiple images. A valuable and useful model of human perception was proposed years ago by David Marr. His model is often used to provide a loose framework for computerized attempts to create vision systems. Marr theorized that visual perception is a bottom-up process, which can be characterized as follows:

-- Image Capture --
Rays of light reflected from a scene are refracted through the lens of the eye and are focused on the retina where photo-receptors are differentially stimulated. The receptors generate electrical impulses which are channeled through the optic nerve and eventually reach the visual (striate) cortex.

-- Raw Primal Sketch --
Marr suggests that special cortical cells, which he called feature detector cells, within the visual architecture are stimulated only by areas in a scene with high intensity gradients. These areas represent edges of objects and shadows and possible boundaries between areas of different texture within the scene. Edges and the region elements they bound are amassed within the early part of the visual process to form a low-level, essentially unprocessed representation of the scene image called the "raw primal sketch."

--Full Primal Sketch--
The unprocessed edges and texture elements are grouped into intuitive aggregations based on Gestalt properties such as similarity, proximity, and colinearity. Similarity of gradient intensity and orientation are key. The resulting "full primal sketch" is an image which contains meaningful, connected boundaries and regions of texture.

-- Features & Recognition --
Meaningful descriptors (features) are extracted from the boundaries and in the full primal sketch. Objects in the scene, which are characterized by these features, can be recognized via an intrinsic matching scheme in the human brain which is optimized by critical knowledge about the objects.

The DARWIN system attempts to parallel these stages in the visual process in a well defined sequence of steps.

Acquire the image. This is done by capturing light from the scene with a camera, then developing the film, and finally digitizing the film image with a scanner and storing it in an image file on disk.

Enhance the image. This is done by the user, who is provided with a small set of standard image enhancing tools. Image sharpening, brightening, darkening, reversal, and contrast enhancement are provided.

Segment the Image. Edge elements are found automatically and are joined into meaningful boundaries.

Feature extraction. The boundary of the fin edge is processed automatically to extract quantitative descriptors, or features, which characterize the fin shape.

Identification. An automatic matching process compares sets of features in order to find the "best" matches to the fin in the scene. The user is asked to verify final identification from a short list of candidates.

The user interface of the PC version of DARWIN has been designed as a stand alone MS-windows application, and is currently being tested. DARWIN is also being implemented on a UNIX platform and will run under X-windows.

The basic file management and image enhancement routines are provided by a commercial image processing library marketed by Catenary Systems. The FILE menu allows the user to browse various directories, load images from disk, save images to disk and exit the program. Disk images can be in any of a number of standard image file formats. GIF, TIFF, BMP and JPEG are supported. Simultaneous display of multiple images is supported.

The IMAGE PREPROCESS menu provides some relatively standard image processing tools useful in improving the appearance of the image. The user can increase or decrease the image brightness, improve the contrast, and flip the image in preparation for later steps in the automatic identification process. The contrast enhancement is quite useful in accentuating the boundary between fin and background. Flipping the image allows a standard orientation (leading edge left) to be used in all later steps.

The last preparatory step before the automatic process takes over is to have the user highlight the region of the image containing the fin edge. We feel this is an appropriate user input. It take only a few seconds, and greatly reduces the complexity of the automatic routines that follow by bounding the image space within which the automatic processes work. The user is given what is essentially a fat cursor and is asked to cover the fin edge in the image by performing a rough trace of it. It is not essential that the trace be very accurate, only that the fin edge is covered by the trace. This area of the image is designated as the FOCUS STRIP.

The automatic process begins with detection of image points (pixels) that are likely to be on edges in the image. Edges are generally defined as areas of rapid change in image intensity over a small distance, and are detectable by examining the intensity gradient at each pixel. Pixels with high gradients are most likely to be on edges, and these edges are likely to be along the boundaries of meaningful regions in the image.

We provide two edge detection operators, the Sobel and the Canny. Both are implemented in such a way that they operate only within the user designated focus strip. This speeds the edge detection process substantially. The two edge detectors both produce indications of edge strength and orientation. Strength is directly related to the magnitude of the image gradient in the neighborhood of the edge pixel and orientation is related to the direction of the greatest gradient change across the edge pixel.

The Sobel and Canny edge detectors differ in the following ways. The Sobel is faster but tends to produce wider, more poorly localized edges. It is also more likely to produce strong edges near noisy image areas such as the wave covered surface of the water. The Canny edge detector works at multiple scales and includes a secondary process which selectively suppresses the edge strength for those edges not found at maximal gradients. This tends to produce fewer spurious edges. Those edges it does find are well localized and thin. The disadvantage of the Canny edge detector is that it is significantly slower. The restriction of processing to the focus strip allows us to use the Canny edge detector without significant delay to the overall process.

The next step is to use the likely edge pixels in order to find the best curve, or contour, that will fit the boundary of the fin in the image. We have chosen to use an active contour (SNAKE) for this. A SNAKE is a connected sequence of points which define a contour in the image. The contour is "active" because an iterative process moves (some say slithers) the contour into the position in the image which minimizes the SNAKE's total energy. The energy of the snake is a weighted sum of internal and external energy measures. The two internal energy measures force the SNAKE to maintain a relatively even spacing of points and to act as a somewhat stiff plate. Essentially, these measures tend to move the SNAKE into a shape that is smooth. The external energy measures are based on characteristics of the image. In particular, the snake is pulled toward areas of the image which are edgy (have steep gradients) and into shape that is perpendicular to the direction of the edge gradient. As the iterative process moves forward the SNAKE points move in the image in order to achieve a lower total SNAKE energy. We have implemented the iterative process in a tiered manner so that initially the contour is fairly stiff, the neighborhood is large, and the external forces are more heavily weighted. This tends to rapidly move the SNAKE into rough correspondence with the fin outline. In later iterations the neighborhood is smaller, and the contour is mad less stiff so that it will better fit small scale details of the fin boundary. In some cases the contrast between fin and background is so poor that the localization of the SNAKE is not adequate. We are implementing a user controlled tool which can be used to move errant SNAKE points into better positions.

It may be possible to use the SNAKE points directly in order to identify the dolphin. We have done some preliminary evaluations of the use of neural networks to identify the individual dolphin from the SNAKE points themselves. A neural network is a parallel computational model which simulates the arrangements of brain cells and their cooperative processing abilities. The network we created took the SNAKE point sequence as inputs and produced outputs indicating the degree to which the network was certain that the points represented a contour from the fin of each dolphin. The output(s) with the highest certainty factor represented the identity (or identities) of the dolphin. We used a supervised learning paradigm, providing a sequence of input contours and correct identities to the network, and allowed it to learn by back-propagation (a process of correcting the strengths of its internal connections to correct for erroneous identifications). We used 4 contours from each of 5 dolphins. From each of these we created additional contours that were translated, scaled and rotated randomly in the image. A total of 400 contours was created. The network was trained on 320 of these and then tested to see if it could recognize the remaining 80. Testing was 100 percent correct. This is promising and work will continue, although this small scale test does not necessarily indicate the approach will scale up to the large problems faced in some photo-identification surveys.

One alternative to using SNAKE points directly is to characterize the contour in some way that captures the important features of its shape and then use some method to match those features. There are a wide variety of possible features that could be used to describe the contour. In many manual photo-identification efforts the biologists use descriptive names (nick, notch, button, etc.) for salient features. We have found significant variations in the way different individuals apply these labels to features, so we have avoided them in our system.

Listed below are several methods we have investigated in order to characterize the shape of the contour. Those which are invariant to or easily corrected for scale, translation and rotation of the contour in the image are the most desirable.

A SIGNATURE of the contour (such as distance from the centroid as a function of angle)

A SKELETON of the contour (essentially a set of branching medial axes derived from the distance of interior points to the fin outline)

A sequence of ARCS of similar curvature (contour is segmented at infection points and each arc is characterized by arc length, average orientation and curvature, and relative position)

A set of SALIENT FEATURES (typically those humans look at most closely, such as regions of high curvature, curve occlusions, etc.)

A SCALE-SPACE representation of the curvature inflection points as a function of spatial scale

We have focused our efforts on the first three characterizations above. Each has been or will be used with a different approach to matching. Essentially, we seek to identify an individual dolphin by finding the best match between the description of the contour in the current image and description(s) of some contour(s) in the database. The quality of the match is evaluated in different ways depending on the approach to matching.

One way of describing the contour is to find its signature. A signature is a one-dimensional function which characterizes the two-dimensional contour. We compute a signature that specifies the distance from the centroid of the fin to the contour fit to its edge as a function of angle. This function is invariant to translation, and can be easily corrected for scale. Two signatures can be matched using a mean squared error measure which is minimized when the two signatures are most closely aligned. The average magnitude of the signature is used to minimize scale variations and an angular correction can be found which brings signatures into the best correspondence. We have some very preliminary results that indicate that the system can match contours of the same dolphin when the entire fin outline is available.

The two major problems related to the use of signatures are 1) missing part of the outline shifts the centroid and significantly alters the signature, and 2) the signature shape changes significantly when the dolphin is not aligned almost perpendicular to the line of sight. To solve the first problem we have implemented a method for the user to designate a best estimate of the point where the leading ad trailing edges join the back. This augments the SNAKE producing an extended contour for use in determining the centroid and produces much more stable signature shape even when moderate obscuration of the leading or trailing edge is present. The error measure is based only on the signature and it is calculated only from the SNAKE, ignoring the user applied extensions. The second problem is solvable by mathematicallycreating a set of characteristic views of the contour. We are implementingprocesses to do this by taking a clean contour from a perpendicular view and creating contours at regularly spaced intervals of angle within +/- 30
degrees of pan and +/- 20 degrees of tilt. This set of contours will represent the various appearances of the dolphin's fin outline and will comprise its representation in the database.

Another method of describing the contour is to compute its skeleton. The skeleton consists of all points in the interior of the fin that do not have some single closest point on the contour. The skeleton resembles the vein patterns in a leaf and extend medially outward from the center of the fin to each protrusion along the contour. The degree of branching is controlled by the shape of the contour and by the scale at which the calculations are done. At a large scale, the skeleton reduces to essentially a medial axis based on gross fin shape. This medial axis can be used to estimate the orientation of the fin and perhaps the degree of flex. When small scale detail is included the skeleton includes numerous branching points which could be used as a cluster of features similar to branch points and terminations in human fingerprint matching. Our work with skeletons it just beginning.

We have routines in place for splitting the SNAKE at inflection points into a series of arcs of similar curvature. Each arc, a convex or concave portion of the fin outline, is characterized by arc length, mean curvature, mean orientation, and position. We plan to develop a matching process based on a constrained search for a correspondence between arcs in the image and similar arcs from a database model. The search can be visualized as a branching tree, where each match of arc to arc is a node. An identification is made only if a sufficient number of arcs can be matched with a low enough error. The matching process could be exhaustive if not constrained. We can apply a variety of unary and binary constraints to the matches, and then continue to extend the matching if and only if the constraints are satisfied. When constraints are not satisfied, the last arc pairing is rejected and the search backs up in the tree and attempts to extend with a different pair. While the search is occurring, global scale, orientation and rotation corrections are hypothesized and refined from the matched image and model arcs. Unary constraints between image and model arcs ensure near equality of 1) arc lengths (appropriately scaled), 2) curvature, and 3) orientation (appropriately rotated). Binary constraints ensure near equality of measures between image arc pairs and matched object arc pairs, including 1) separation distance (appropriately scaled), 2) positions relative to a third reference arc, etc.

Regardless of the method used to automatically match the fin contour or characteristic features extracted from it, the end product of the automated identification process is expected to be a short list of candidates. The user will then be allowed to view contours and/or images of the current dolphin and the potential match in order to verify the final identity. The user is always to be the final arbiter.

Where are we now? MS-windows and Unix/X-windows prototypes exist. They are written in C and are under continuing development. The PC version is nearing completion as a stand-alone application for performing automated photo-identification and has modules in place to perform all capabilities described above, except for matching of skeletons and arc-based descriptions. We are beginning evaluation of the signature based matching routines now. More work will occur this summer on approaches using neural networks and constrained searches.

This project has provided a testbed for numerous undergraduate student experiments related to image processing and computer vision. It is nearing the point that an actual usable application to automatically perform photo-identification seems possible. Additional features such as ability to access a multimedia database from the network are planned, but have not been implemented to any degree. Truly, much has been done, but much challenging work remains.

We will close with a few brief points that seem particularly relevant to any extension of our work or that of others to provide a large scale, centralized archive of data related to *Tursiops* along the coastal US. The biology community studying these marine mammals faces several hard choices.

There is a need for some singe accepted STANDARD set of protocols for images, data, and metadata.

Significant funding will be required to provide LONG-TERM, CONTINUING support for a LARGE archival database.

Mechanism(s) for SELECTIVE ACCESS to data must be established, and the degree to which data is to be shared must be decided.

Those of us attempting to provide automated tools for photo-identification need indications of the LEVEL OF TRUST biologists are willing to put in a technological solution.

Appendix 11. Geographic Information Systems For Research Collaboration

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Purpose

Geographic Information Systems (GIS) have existed in one form or another for over 30 years. Simply put, a GIS is a computer system capable of holding data describing places on the earth's surface. As such, a GIS may be an ideal platform for the researcher. Integrating the file transfer capabilities of the Internet with the analysis tools in GIS creates the potential for a powerful collaboration network.

Background

Fundamentally, the ability to answer spatial questions using different types of data defines GIS. A GIS bridges the gaps between data sources and linkages by using geography as the key link between pieces of data. The questions asked in marine research fall into two categories, spatial and aspatial.

An aspatial question does not require knowledge of a latitude and longitude value to answer. Nor does it require a knowledge of the relation of places on the globe to each other. A spatial question depends on geographic data to answer.

Data may also be linked, or matched, in different ways.

Exact matching occurs when the data is linked by a common field, and linking is simply a matter of establishing a key field common to both files.

More commonly, one dataset will be compiled in greater detail or more frequently than the other data. The grouping of data from smaller areas within a larger area is called hierarchical matching. The collected data from the smaller units make up the totals for the larger area.

When dealing with other types of data, the boundaries of the smaller areas may not match those of the larger area. If you want to determine the most likely water temperature in which to find dolphins, you need to overlay a view of isothermal areas over the population data, and note the combinations for each isothermal area. In such cases, where the boundaries of two data sets do not match, the linkage is referred to as fuzzy matching.

A GIS handles all of these manipulations, because geography is the key link between the data. Why is this important? Suppose you have isothermal areas defined for each month of the year, and population data for the area of interest for each month of the year. You might map the population and isotherms separately, or perhaps develop one valid combination of population versus water temperature for each month. But if there are more than two datasets for the study area, the number of possible combinations rapidly escalates. With dozens of properties (temperature, salinity, currents, etc.) which might be considered in marine research, millions of combinations exist. The current technology holds the promise of allowing the individual scientist to experiment with his data in a GIS, without extensive computer knowledge or database design experience.

What kind of questions can a GIS answer? A well designed system should be able to handle five generic questions involving location, condition, change, patterns, and modeling.

Planning the Project

Investment in GIS once required a six figure investment. Current systems are being fielded for one and even two orders of magnitude less. The bottom line is that the cost of obtaining data far outweighs the cost of hardware and software. Bearing this fact in mind, the construction of a GIS application requires careful consideration of the desired result.

The questions to be answered by a GIS application must be stated clearly in the project planning stages. In developing the system goals, appropriate sources for the data will proceed out of discussions about required content, scale, and accuracy.

After the questions for the system are well defined, the exact project area is defined. In the case of dolphin studies, the project area might be defined as several coastal zones. Administration of cruises in each zone might be divided amongst several researchers, who coordinate dates and locations to maximize the value of the data.

With these criteria defined, it is possible to gather data and develop an application.

Project Data Sources

Most of the plotting information you gather can be loaded real-time into a GIS using current technology. Several manufacturers sell products off-the-shelf to take Global Positioning System (GPS) coordinates, and plot them within a PC based GIS software package. Additional user defined data, such as cruise number, identification coding, and photo identification links can be automatically stored along with the GPS position information, and immediately mapped on the computer screen. These technologies seem particularly applicable to live capture efforts, especially if developed within a roll-on, roll-off platform which is transportable between research teams.

From ashore, population counts can be recorded rapidly to sub-meter accuracy using laser rangefinder binoculars. It is now possible to simply spot the individual of interest from shore, press a button, and record position information. Additional hardware, such as digital writing tablets allow annotation of additional database entries. These data are then downloaded directly into the GIS application producing a digital map, which may have background information superimposed.

Digital photography is in widespread use, and costs of high quality systems are falling rapidly. Several manufacturers offer simple imaging systems which provide nearly the same quality image as traditional photographic products.
A wide variety of remote sensing data may be found on the Internet, and utilized within a GIS to map coastal and ocean water properties.

In the laboratory or office setting, temporal studies using archived dolphin population data may be performed using water temperature data, tidal and current information, and data on feed populations as background maps.

Data Sharing

As a first step in sharing GIS data, or any digital data source, establishing Internet connectivity between all partnering research sites should be accomplished to allow sharing of post-processed data coverages.

Access restrictions to the data can be established to allow secure areas for raw or proprietary information.

Collaborative tools, such as the Virtual Board Room, have been developed at NISE East for one of our Navy sponsors. This collaborative tool was built on the same technology as the many chat rooms currently existing on the Internet.

Sharing data in this fashion provides several built-in benefits. First, the process encourages a standard data collection method. Further, a standard data structure and data layer naming convention can be established. As a result, batch processing algorithms can be developed to merge project zones readily to give a broad coastal view of the collected data. Finally, standard metadata collection methods can be adopted to provide data about the data to each other, and to the public.

The Future

There is a great deal of excitement in the remote sensing world. One meter resolution in satellite data is forthcoming. Soon hyperspectral data encompassing hundreds of bands will overtake multispectral data as the norm. Sonic Detection capabilities continue to advance, and an exciting new breed of unmanned platforms is being developed.

Examples of the unmanned vehicle technology include aerial and underwater versions. A recent article in Mechanical Engineering magazine highlighted the development of the Global Hawk and DarkStar unmanned aerial vehicles (UAVís). Noteworthy among the impressive performance characteristics of these UAVís were their ability to produce high resolution visible and synthetic aperture radar (SAR) images (with one meter resolution in some cases), while cruising at altitudes of greater than 50,000 feet for up to 24 hours of dwell time over the target area. With the capability to map 14,000 square nautical miles per day, UAV technology would be ideal for large scale marine research.

Unmanned underwater vehicles exist today which provide the ability to readily sample ocean bottom material for geophysical and geochemical characteristics faster and more reliably than ever before.

Conclusion

There is a tremendous volume of geographically linked data readily available for your analysis. GIS provides an ideal tool to link remote sensing, traditional databases, and real time data for your analysis. As you develop questions for your ideal information system, consider the data to which you have current access, and consider how GIS might link the various data into an integrated research tool. However, do not limit your thoughts to the information you have used in the past, but consider new data sources which might give you new insight, and how GIS could place them within your grasp.

Appendix 12. The FINNS (Fluke Identification Neural Network System) Process

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Introduction

Nichols Research Corporation has investigated the transfer of technology developed for the Department of Defense to the classification of whales under an Internal Research and Development (or IRAD) program. This program is call Fluke Identification Neural Network System, or FINNS for short.

FINNS exploits the unique patterns on the ventral side of humpback whale flukes to identify individual animals from photographs. The National Marine Fisheries Service is using photo-identification on many species of whales and dolphins to support studies of species distribution, migration patterns, population estimates, survivorship and reproduction rates.

Currently, the process requires a human to match new photographs to a catalogue. This effort is extremely time intensive. FINNS will allow the National Marine Fisheries Service to advance their information technologies and increase the effectiveness of their studies by performing the identification task on a PC.

The FINNS process was envisioned to allow a user to enter a digitized image of a whale and the program would return the four or five top matches from the catalog with a numeric score for the closeness of the match. The user would then make the final choice. FINNS as implemented in the proof-of-principle demonstration requires the user to extract the fluke and normalize the image as described in subsequent charts.

Fluke Extraction from Scene

Once a photograph of a whale has been digitized, the first step performed in the IRAD FINNS is to remove the background leaving only the fluke to be identified. This is performed by manually tracing the outline of the fluke in the photograph as shown on here. Upgrades to FINNS would employ edge detection, neural net pixel classification and model-based vision techniques to automatically excise the fluke from the photograph.

Normalize Fluke

The next step in the FINNS process is to normalize the fluke. Whales are non-cooperative subjects and rarely is the fluke presented in an ideal profile. To ensure a precise digital characterization of the fluke, a normalized image must be developed from the photograph. This is done by de-warping the image. A wire frame of a whale fluke is manually flexed and rotated to match the orientation of the fluke in the photograph. This is accomplished using the controls on the bottom of the screen. When the wire frame matches the photograph, the pixels are projected onto the wire frame which is flattened and rotated to form an ideal, or normalized, image. In the final version of FINNS the wire frame will be adjusted automatically to obtain the best statistical fit to the photograph.

Segment Fluke

Once the fluke image is normalized, the fluke can be segmented allowing the pigmented areas of the fluke as well as unique markings such as rakes and notches to be mapped into specific segments.

In a paper by Hammond, Mizroch, and Donovan, an approach to classifying whales based on the color pattern in 14 segments of a fluke was presented. The approach presented in the paper required a human to determine the shadings in each segment and characterize them to the computer. The computer would search a data base to obtain the possible matches. The proof-of-principle FINNS uses these same features. However, the degree of shading as well as the classification is done by the computer.

Identification Methodology

Once the features have been extracted from a normalized image, they are processed through a neural network classification system. A threshold is used to determine when the features are similar enough to be from the same animal.

Conclusion

NRC has invested its own funds to produce IRAD FINNS as a proof-of-principle demonstration. This was done to show the Department of Commerce and the National Marine Fisheries Service how Department of Defense techniques can advance their Information Technologies.

While the IRAD FINNS shows much promise, work still remains. Obviously the manual steps need to be automated. Investigation of additional classification features such as rakes and notches on the fluke needs to be performed as well as rigorous testing with a large number of images.

Once a successful FINNS program has been completed for humpback whales, the same techniques can be tailored for other species such as orcas, bottlenose dolphins and blue whales.

Appendix 13.

Sarasota Dolphin Research Program

Field Techniques

and

Photo-Identification

Handbook

Prepared by the:
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Field Techniques and Photo-Identification Manual

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Field Effort

Surveys are conducted from 6-7 m outboard-powered boats. Each boat is equipped with a VHF radio, depth sounder, compass, thermometer, and a hand-held GPS. Survey crews range in size from two to six people per boat. Survey routes are selected each day based on predicted weather conditions, tidal state and the status of survey coverage. While searching for dolphin schools, the boats are operated at the slowest possible speed that allows the vessel to plane, typically 33 to 46 km/hr, depending on the vessel. Once schools are encountered, the boat is slowed to match the speed of the dolphins and move parallel to the schools to obtain photographs.

Every dolphin school encountered along a survey route is approached for photographs. We remain with each dolphin school until satisfied we have photographed the dorsal fin of each member of the school, or until conditions preclude complete coverage of the group. A sighting form is recorded for each sighting. The data forms are designed so that one full page (side) is used for each sighting on a given day. We use the term "sighting" interchangeably with the terms "group" (1982-1988), "herd" (≤ 1981), "school", and "pod" to typically refer to all dolphins in sight at any given time who are moving in the same general direction, interacting with one another, and/or engaged in similar activities. Usually, these animals are within 100 m of each other, but there will be exceptions.

Numbers of dolphins are recorded in real time as minimum, maximum, and best point estimates of numbers of total dolphins, **calves** (dolphins ≤ about 80-85% adult size, often swimming alongside an adult), and **young-of-the-year** (as a subset of the number of calves). A **young-of-the-year** is defined as a calf in the first calendar year of life and is recognized by one or more of the following features: (1) small size; 50%-75% of the presumed mother's length, (2) darker coloration than the presumed mother, (3) non-rigid dorsal fin, (4) characteristic head-out surfacing pattern, (5) presence of neonatal vertical stripes, (6) consistently surfacing in "calf position".

We use Nikon camera systems (FE, F3, 2020, 8008) with 70-300 mm zoom-telephoto lenses, motor drives, and data backs that imprint the date and time on each image. Kodachrome 64 color slide film is used; the fine grain of this film provides excellent clarity for resolution of fin features. Color film also allows evaluation of the age of some wounds and fin features, and identify the presence of *Xenobalanus* on the dolphin.

Definition of survey effort:

Survey effort is measured in several ways. One measure is the count of the number of boat days, scored when a boat leaves the dock to search for dolphins, during a specific time period or in a certain area. Another measure is the number of field hours spent on-effort searching for dolphin, exclusive of time spent with dolphins. The most descriptive measure of effort is calculated as the number of linear kilometers surveyed by boat. This is measured using a digital plan measure calibrated for kilometers, following the daily boat track that is sketched on copies of nautical charts at the end of each boat day. This enables us to monitor the amount of coverage in different parts of the study area.

Ideally, surveys should have two components: an intensive effort to photograph and identify dolphins (at the potential expense of not following a rigorous survey route or sampling design), and an effort to cover the whole area in a period of time with repeatable survey routes. The first component allows the development of the photo-ID catalog so that sufficient numbers of marked dolphins are identified to estimate abundance precisely, while the second component would provide a standardized effort each year so that annual comparisons can be made.

Dolphin Biology Research Institute
Sighting Form

Photo Grade:

Field Hours ________ to ________

Effort S O C

Platform ________

Date & initial when complete:
Photo-analysis:
Data entry:

Date: __/__/__

Sighting No:

Recorder/Observers ________

Time: ____ to ____

Location ________ LOC

Latitude ___ ___ ___ Longitude ___ ___ ___

Swim Speed

Conditions ________ COND ____ B.S.

Depth ____ ft. Water Temp: ____ °F Tide: IN 1 OUT 2 HI 3 LOW 4 Salinity: ____ 00/000

Heading: Initial ____ General ____

Activity: Mill 1 Feed 2 Prob. Feed 3 Travel 4 Play 5 Rest 6 Leap Tailslap Chuff 7 Social 8 w/Boat 9 Other 0

FIELD ESTIMATES	MIN	MAX	BEST	PHOTO ANALYSIS: Pos IDs	Min not IDed	Max not IDed	Revised MIN	Revised MAX	Final BEST
TOTAL DOLPHINS									
TOTAL CALVES									
YOUNG OF YEAR									

Comments:

Associated Organisms:

Dolphins Sighted: ID confirmation: P= photograph V= visual O = other (explain)

Name	Code	Conf.	Name	Code	Conf.	Name	Code	Conf.

Photos: (roll: frame->frame) ________

Tape: (tape: counter) ________

Sighting Form Use

These data forms are designed to work with a FoxBase program on our Macintosh computer. The blanks on this data form are used as a series of prompts to ensure that data are collected consistently from one sighting to the next.

- Please, neat and legible handwriting is a must!
- Avoid abbreviations and shorthand that are difficult to interpret during data entry.

Field Hours: This is recorded as the time that the boat left the dock and the time it returned, in 24-hour time. Also record the time "off effort", for example, when stopping for fuel, or ferry trips when no systematic effort is being made to search for dolphins. This is entered on the first page <u>only</u>.

Date: This is entered on **each** page. The date is entered as DAY/MONTH (first three letters)/YEAR, for example 01/JAN/95.

Effort: This describes the intended effort for the day and the field effort occurring when the dolphins were sighted. **S**= Survey, **O**=Behavioral Observations, and opportunistic or land-based sightings, and **C**=Capture/Release. The appropriate initial should be circled on each page. If the Behavioral Observation involves a focal animal follow, write an **F** next to the O, ("OF").

Highlights: Record any significant occurrences for that boat day at the top of the first page, for example, "First sighting of FB17 with a YOY".

Sighting No.: This is entered serially for the day. When more than one boat is in use on a given day, each boat has a pre-assigned set of sighting numbers. If only one boat is in use, start at 1. Each boat uses the following sighting numbers:

Mini Mako	1-20
Makila	21-40
Fandango	41-60
Naia	61-80
Bobmako	81-100
Mote MM Wellcraft	101 +
Private boat/Land-based/Other	201 +

A new sighting sheet is started when the group composition changes, for example if animals join or leave a group. It is important to describe in the comments the time and group composition change that links the two sightings. If the same (identical) group is sighted more than once (i.e., after at least a 15 minute break) during a day, then it is considered a new sighting, and receives the next serial sighting number.

Platform: This refers to the platform from which the dolphins are sighted. The boat name or shore location, etc., is entered here.

Recorder/Observers: The first initial and the full last name of the person responsible for filling out the sighting form is listed first, followed by the first initial and last name of each person on the boat. This is written on the <u>first page only</u>.

Time: The time the dolphins were first sighted and the time they are left or last seen is entered here, in 24 hour time.

Location: The location of the initial sighting should be described as clearly as possible, using aids to navigation, landmarks, bridges, etc.

LOC: This is a 3-letter location code found on laminated master charts.

Latitude and Longitude: These coordinates should be determined from a chart at the end of the day or from a LORAN or GPS and entered as degrees, minutes, and 1/100ths of a minute.

Swim Speed: Some of the depth sounders also present boat speed. If the dolphins are moving steadily in a straight line at the same speed as the boat, then a value (in knots) should be recorded if possible.

Conditions/COND and Beaufort State/BS: This refers to meteorological and sea state conditions. They are described briefly, then entered as a code in the boxes to the right. The condition codes are given on the attached page. A running log of environmental conditions relative to survey effort (noted at each major change in conditions or significant location) and time off-effort, should be kept on a separate page and is attached to the data sheets at the end of the day.

Depth: Water depth at the location where the dolphins are first sighted is obtained from a depth sounder, a depth pole or from a nautical chart and is given in feet and tenths of feet (taking tidal state into account).

Water Temp: Surface water temperature data (in degrees and tenths of degrees F) are available on some depth sounders, or through the use of a bucket and thermometer.

Tide: Tidal state is circled. In the field, this can be judged from pilings, etc., by the degree of exposure of barnacles and oysters and by the direction and velocity of movement of water past the object.
H = Slack High and L = Slack Low.

Salinity: When a salinometer is available, this value is recorded in parts per thousand.

Heading: We record **Initial** heading as the heading of the dolphins when they are first sighted, and the **General** heading as that of the dolphins over the entire observation period. This is recorded in degrees: North = 360 degrees, Milling (no heading) = 000. In narrow passes, channels, or rivers, "IN" or "OUT" may be more meaningful than a compass heading. When there is no clear general heading, for example, when the dolphins are not milling in a limited area but are frequently changing their heading, indicate variable headings with "VAR".

Activity: Dolphin schools can engage in a variety of activities. The appropriate activities should be circled, and the numbers of the five most prevalent activities should be entered in the box to the right in the order of decreasing level of occurrence.
Mill = non-directional movement, and often occurs in conjunction with other activities.
Feed is recorded whenever a dolphin is observed with a fish in its mouth.
Prob. Feed is recorded when there are indications of feeding, but the feeding can not be confirmed (e.g., active milling by a dolphin with frigate birds diving on it).
Travel is directed movement, including zig-zag movement.
Play involves interactions with objects other than dolphins (e.g., throwing a stingray repeatedly).
Rest involves slow, quiescent activity in the absence of other identifiable activities.
Leap-Tailslap-Chuff includes individual aerial or acrobatic behaviors of any kind. The particular behavior should be described in detail under "Comments".
Social includes all active interactions with other dolphins, including contact, chasing/following, sexual interactions, etc.
W/Boat includes all cases where the dolphins are interacting with a boat, including bowriding, stern wake riding, making figure-8's ahead of the boat, etc. This could be considered a sub category of play, but it should be recorded separately in addition to play.
Other is a catch-all category to accommodate the dolphins' behavioral flexibility.

Field Estimates: These nine values are entered in real time in the field. The number of **TOTAL DOLPHINS** includes all age classes in the sighting. The **MIN**imum estimated number present, the **MAX**imum estimated number present, and the **BEST** estimate, a point estimate, count, or midpoint of a range of estimates, must be entered. The number of **TOTAL CALVES** includes all calves in the sighting, including young-of-the-year. The number of **YOUNG OF YEAR** are all of the calves born within the calendar year. Typically, these will be recognizable as newborns during about the first six months of life. This value will be used in estimates of birth rates.

Photo Analysis: These 18 values will be entered in the lab upon completion of the photographic analyses, and completion of the **Dolphins Sighted** section at the bottom of the page. *Please refer to "Procedures for Photo-Analysis".

Photo Grade: This is filled in for each sighting after photo analysis is completed. This is for a grade of the quality of the photographic coverage of the dolphin group. *Please refer to "Procedures for Photo-Analysis".

Comments: These lines should be used for narrative descriptions of subgroup structure (SG1: FB54, FB15+c, plus 2 others, 15 m S of SG2); SG2: FB51, FB33, FB19+c), behavioral events, sketches of distinctive features of individuals, descriptions of group geometry and spacing, distances and orientations to other groups, numbers of boats present, etc. Descriptions should be concise but complete, and printed clearly. Times (24 hour clock) should be given at the beginning of each entry. Use additional pages as necessary.

Associated Organisms: If other organisms such as frigate birds, sharks, or fish species (e.g., identified between the jaws of a dolphin) seem to play a major role in the activity of the dolphins, they should be noted.

Dolphins Sighted: Dolphins identified in real time in the field should be listed by their **Name** or freeze brand number on the lines. (Please put a cross through any number 0's (Ø) to differentiate them from the letter O). If there can be no question that they were positively identified, then a "V" should be entered under **Conf.** (Confirmation). If the identification is considered probable, but not confirmed, then leave the **Conf.** blank. List calves directly below their mothers. If mothers are known from previous sightings to have calves, make an extra effort to confirm the presence or absence of that calf in the present sighting. The four-place identification **Code** will be entered for each dolphin in the lab, as will **Photographic Confirmations.**

Photos: The photographer, roll and frame numbers are entered here for any photographs taken of the dolphins (even by visitors). They should be entered as Roll#: Beginning Frame # - Ending Frame #. The Roll # includes the photographer's initials, the year, and the serial number of the roll of film the photographer is shooting (e.g., RW-93-135: 12-27). All photographs taken on boats approaching dolphins under National Marine Fisheries Service Scientific Research Permits issued to Dolphin Biology Research Institute are considered to be data. DBRI requests that copies of data photographs be made available for the DBRI chronological files (at DBRI's expense). Photographs of one sighting should be separated from the next by a "blank" photograph of a completed data sheet or sighting map. This provides an unambiguous separation on the film roll, as well as another copy of the data. Whenever possible, databacks should be used to provide an imprint of the date, hour, and minute on each frame. Whenever possible, a separate film log should be kept with the date, time, sighting number, roll number, and details of the subjects of particular frames.

Tape: A record of video or acoustic tapes should be maintained, including the identifying designation of the tape and counter numbers.

Charts: The approximate locations of sightings are indicated on copies of nautical charts. The **Sighting No.** should be circled at the location of the initial sighting, and the track of the dolphins should be traced, with an arrowhead at the end of the track. If the dolphins are milling over a large area, enclose the entire area in the location circle. The boat's route should be traced at the end of the day, preferably with a solid line from a green fine point felt-tip marker (this allows the route to be easily distinguished from dolphin tracks even when photocopied). Parts of the route where sightings were probably missed due to being off-effort or because of poor conditions should be indicated by a dashed line. Each chart should be labeled with the date and the name of the boat.

Data Set: At the end of the day, when the data sheets are complete (e.g., with **Field Hours** completed and **Latitudes** and **Longitudes** added and checked), and the charts are complete (e.g., with boat routes), the package should be 3-hole punched and stapled along the left side with the 1) study area cover sheet depicting the day's boat route first,

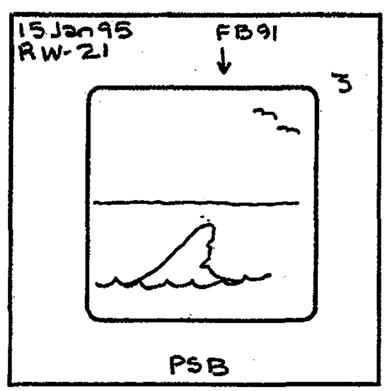
2) the sighting forms, 3) then the environmental log, and 4) finally the charts, folded so that they can be opened easily even when in a binder (without having to open the rings of the binder). The completed original data packages should then be filed in a binder in chronological order maintained in the data vault.

Film Processing: Exposed slide film should be placed in Kodalux mailers. The mailers are returned with the return label attached to the slide box, so the roll number should be clearly indicated on the return label. The return label of the mailer should be labeled as below (unless otherwise directed). Use pre-printed adhesive labels when available.

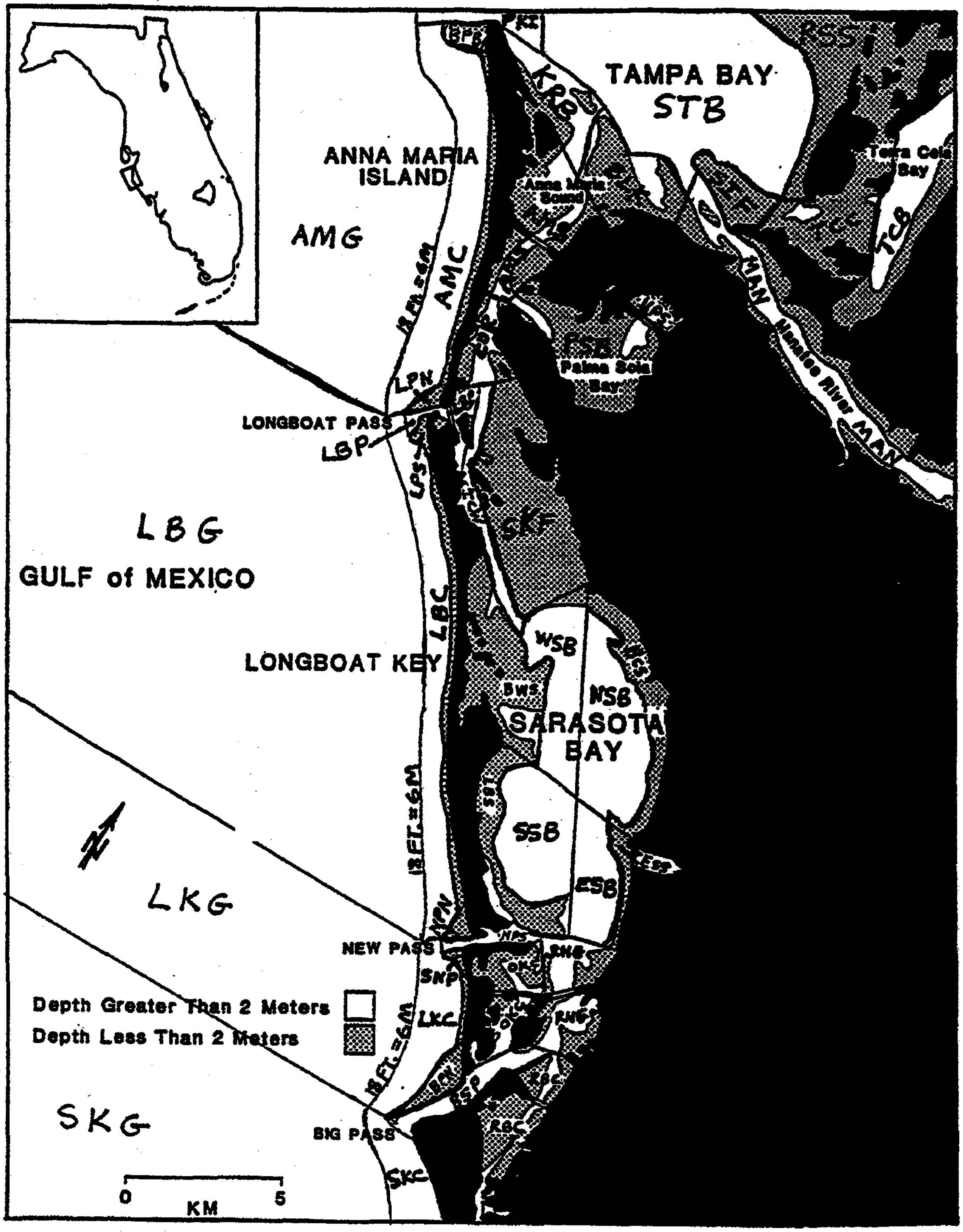
R.S. Wells (Roll #)
Mote Marine Lab, 1600 Thompson Pkwy
Sarasota, FL 34236

Completed mailers should be deposited in the courier bag for eventual delivery to Norton's Camera for shipment to Kodalux. Expect return of the developed slides within about 2-3 weeks.

Slide Labeling: Upon return of the developed slides, the end of each box should be labeled with the roll number. No more than one box of unlabeled slides should be open at any one time. Each slide should be labeled using a black permanent fine-tip marker, with the following information: <u>Date</u> (upper left corner), <u>Roll #</u> (just below Date), Frame # (already printed in the lower right corner), **<u>Sighting #</u>** (above the image in the upper right), and **<u>Location Code</u>** (LOC), just below the image. Space should be left in the upper right corner for **<u>dolphin identifications</u>**. Labeled slides should be placed chronologically in archival quality slide storage pages (from left to right, working down the page). Photographs of the same sighting by different photographers should be grouped together. A new slide page is started for each boat day. This allows us to pull a datasheet packet and slide pages for a boat day for photo-analysis.



Condition Codes:							
SEA STATE		**WEATHER**		**GLARE**		**SIGHTABILITY**	
Wave height 0-0.2m (8 in)	0	Clear or few clouds	0	None	0	Excellent	0
Wave height 0.2-0.4m (8-16 in)	1	Partly cloudy	1	Little, non-interfering	1	Good, unlikely to miss dolphins	1
Wave height 0.4-0.6m (16-24 in)	2	Overcast	2	Some, could interfere	2	Fair, may miss some dolphins	2
Wave height 0.6-0.8m (24-32 in)	3	Rain	3	Much, interfering	3	Poor, probably missing dolphins	3
Wave height 0.8-1.0m (32-40 in)	4	Thunderstorm	4			Not on effort	4
Wave height >1.0 m (>40 in)	5	Fog	5				
Initial or General Heading:							
Use degrees in most cases, "360" = North							
Milling = "000"							
In passes, rivers, use "IN" or "OUT" if degrees are less appropriate							
BEAUFORT SEA STATE							
Wave height (ft)	**B.S.**						
Calm, glassy (0 ft)	0						
Rippled (1 ft)	1						
Small wavelets (1 ft)	2						
Large wavelets, scattered whitecaps (3 ft)	3						
Small waves, many whitecaps (5 ft)	4						
Moderate waves (10 ft)	5						


TAMPA BAY
STB
ANNA MARIA ISLAND
AMG
AMC
LONGBOAT PASS
LBP
LBG
GULF of MEXICO
LBC
LONGBOAT KEY
WSB
NSB
SARASOTA BAY
SSB
ESB
LKG
NEW PASS
SKG
BIG PASS
Depth Greater Than 2 Meters
Depth Less Than 2 Meters
0 KM 5
Palma Sola Bay
Terra Ceia Bay
Anna Maria Sound
Manatee River
MAN
TCB
SKF

Procedures for Photo-analysis

The ability to recognize individuals over time provides opportunities to estimate abundance using mark-resight methods, to evaluate possible cases of immigration, emigration, or transience, to monitor individual female reproductive case histories, to determine the origins of carcasses for mortality estimates, and to examine community structure.

The importance of including only excellent quality images of distinctively marked individuals in the photo-ID catalog minimizes subjectivity in the matching process and reduces the chance of making incorrect identifications or missing them altogether.

I. Initial Sorting

1. Select a packet of data forms and corresponding slides for a boat-day from the chronological slide and data sighting form binders archived in the data vault.
2. Read comments on data forms for field notes, or sketches for clues to identifications.
3. Scan slide sheets for the sighting using an 8 or 15-power lupe eyepiece and pull out all slides that show fins with distinctive characteristics.
   Use extreme care handling original slides.
4. Sort slides by each distinctive individual (in rows or piles) within that sighting. Select the best slide of each individual showing the entire fin to examine all features.

II. Matching

1. Identify the most distinctive feature of the fin and go to the category in the catalog that best describes that feature. Please refer to the fin category drawings and key for more specific descriptions of each category. Search the appropriate category for a potential match.

2. Often a match is made directly by comparing the slide to the print in the catalog. If the fin you are searching for is very similar to one in the catalog but there is some question whether or not it is a match, go to the **original** slide catalog (organized alphabetically by 4-letter code) and pull the original slide for comparison. In close cases, use a slide projector with a zoom lens, to project both fins at the same scale, onto paper and trace them to line up the distinguishing features. To confirm long-term matches or difficult matches, 3 experienced people examine the potential matches and must vote unanimously on the final match.

3. When the fin that you are searching for matches one in the catalog, label **all** the slides of that individual with the dolphin's 4-letter code in the upper right corner of the slide with a red pen. Write both the code and name on the best quality slide of each individual identified; this enables us to quickly locate that animal if we need to go back to that sighting. When the slide used to compare against the catalog is better than the catalog photo, or if is shows a feature not represented in

the catalog photo, (whenever possible we try to show both right and left sides of the fin) put the slide in a slide sheet to be made into a print and added to the catalog. In the chronological slides, replace the slide with a piece of paper that lists the dolphin's code, note that it is a better catalog slide, and include the roll and frame number. If there is more than one identifiable fin in a slide, label all animals with their code and indicate with arrows which fin corresponds to which code.

4. On the data sheet under the column labeled:
   Dolphins Sighted: write out dolphin's name
   Code: enter 4-letter code
   Conf: enter P for the identification being confirmed by a photograph

5. When an animal's identification is confirmed in the field, it is considered "visually confirmed" (denoted by a "V" written in the Conf. column), and it is included in the **POS IDs** under Photo Analysis even though no photos were taken of that animal in the sighting. Visual confirmations should only be made when there is no possibility for error, for example, when a clear freezebrand can be read.

6. When an animal is "visually confirmed" in the field, and there is also a slide of it, label the slide with the animal's code, and put a slash (/) and a **P** for photograph next to the V on the Conf. line.

III. Additions to the Catalog

1. When a match is not found in the first category searched, all other possible categories are searched to account for dolphins that have multiple identifying characteristics. The entire catalog is searched up to 3 times before a new animal is added to the catalog. If no match is found, and the fin is reliably recognizable, the dolphin is given a unique name that describes the most obvious feature of the fin. Select an original 4-letter code (i.e., one not in the ID Master Code List, a list of all animals in our catalogs) that abbreviates the name chosen. Write **new** beside the Dolphin Name to identify the initial sighting of this newly "marked" animal.

2. Label the best quality slide of the new animal with its **Name** and **Code.** On the bottom left of the slide write the name of the category that best describes the main feature of the fin. Put this slide in a separate sheet to be made into a print to add to the catalog. Enter the code, name, primary (and secondary) category, location code, date of sighting, mother or calf's code if applicable, roll and frame number on the Master List. If the fin has features that can be classified in two different categories, either include a second slide or have two copies of the best slide and label it for the secondary category. Put a piece of paper in the chronological slides to replace the original and that lists the dolphin's code, that it's a new fin, and the roll and frame number.

IV. Calves

1. For the purposes of photo-analysis, a calf is considered positively identifiable only if it can be "resighted" because of distinctive features that make it "marked",

independently of the presence its mother. If the calf is identifiable, it is included in the appropriate fin category (entered in the ID Master Code List as 'CALF' for its primary category and the fin category as its secondary category; this facilitates sorting for calves in the Master List).

2. When there is a smaller, unmarked animal that appears in all slides next to a noticeably larger animal and the smaller animal is in "calf position", i.e., alongside and slightly behind the presumed mother, it is assumed to be a calf. Also check the "Comments" section of the data sheet for descriptions of the mother's fin or references to the number of mothers with calves. If the calf is with an identifiable mother, but the calf is not distinctive and could not be "resighted", enter "**O**" for **Other** in the Conf. column and note "**with mom**" to the side. (NOTE: see #5 below for an exception). It helps to put a "c" beside the calf's name to help calculate the total numbers of calves and YOYs present.

3. If a YOY is present in the sighting, from field estimates and slides of a mother with a YOY, note "**mom of YOY**" next to her name and "**YOY**" next to the calf's name under the Dolphins Sighted section on the data form. (A "young-of-the-year" is defined as a calf born within the calendar year). Only if the YOY has distinctive markings can it be entered under TOTAL YOY Pos. IDS (but see #5 below).

4. All calves are identified by a code that refers to its mother's code. This allows us to keep track of females and calves over time. Include 2 letters of the mother's code, a C (for Calf), and, if it is known, a number to indicate the serial position of this calf in its mother's offspring history, (e.g., **MGC2** is the second known calf of **MGMA**).

5. Calves and YOYs of known Sarasota mothers are always counted as Pos. IDs, if there is no question of their presence, even prior to capture and branding.

V. Other Cases

1. In some cases it is possible to identify animals in a sighting that are not sufficiently distinctive to make long-term matches, or appear distinctive but are unidentifiable because the entire fin is not visible or obstructed (by tassel barnacles, for example), or photo coverage is incomplete, or photo quality is substandard. Write in : **NOT VALID ID.s** above the far right column in the "Dolphins Sighted" section to list the animals that cannot be included in the Pos ID's.

2. Each dolphin listed under this heading is labeled in quotation marks as "**other...**" with some reference to its most visible distinguishing feature, both on the slide and under the Dolphin Name. Enter a slash (/) in the code box beside the Dolphin Name. These dolphins will not be entered into the Sighting Database or the ID Master Code List, but are used in calculating and revising our Final Best estimate. In some cases, some of the fin markings are visible and slides of these "other" individuals are kept in the "Purgatory Catalog" to be checked in future sightings along with the main catalog. If this "other" dolphin is confirmed in the future with a better photo, it may be possible to go back and identify or match the individual in question.

3. Fins that lack distinctive features are considered "**clean**" and the slides of that animal are labeled "clean". Clean fins are also included under the **NOT VALID ID.s** column because they cannot be "resighted". This helps in calculating or adjusting the minimum and maximum estimates. However, if there are many clean fins in one sighting and it is impossible to differentiate individual clean fins, it is not necessary to sort and label them.

4. Return all slides to the original slide sheets in chronological order.

VI. Photo-Analysis Numbers

1. After completing identification of all dolphins in the sighting: Calculate the number of <u>**Pos. IDs**</u> from the list of 'Dolphins Sighted", including only identifiable animals, **not** clean calves and YOYs, "others" or "cleans". Enter the number of Pos. IDs for the categories of **Total Dolphins, Total Calves,** and **Young of Year.**

2. Both <u>**Min not IDed**</u> and <u>**Max not IDed**</u> is the **MIN** and **MAX** minus the **Pos IDs**, or the minimum and maximum number of dolphins not identified. These values would include the IDs listed under the **NOT VALID IDs** such as the "others", "cleans", etc. in the count of dolphins. If more animals are identified from slides than were estimated in the field, revise the MIN and MAX to reflect this difference. <u>**Revised MIN**</u> is the sum of the number of **Pos IDs** plus the **Min not IDed.** In most cases it will be the same as the **MIN**, except when the number of **Pos IDs** and exceeds the **MIN.** Similarly, the <u>**Revised MAX**</u> will be the sum of the **Pos IDs** and the **Max not IDed.** It will equal the **MAX** except in those cases where the **Pos IDs** exceed the **MAX.** These two categories will provide the necessary values to do mark-resighting analyses and arrive at a range of population size estimates. The <u>**Final BEST**</u> estimate is the best point estimate, literal count, or midpoint of the **Revised MIN** and **Revised MAX** estimates. This value will be used for most group size analyses. It will be about the same as the **BEST** field estimate except in those cases where **Pos IDs** exceed **MIN, MAX,** or **BEST.**

3. A grading system that integrates recognizability, photographic quality and coverage is used to identify the quality of a given sighting. Each sighting is rated with a **Photo Coverage Grade** that is written in the Photo Grade Box at the top of the page.

- **Grade-1** - All dolphins in the group were photographed or otherwise positively identified. All the animals in the best field estimate are accounted for as (a) confirmed positive identifications; or (b) as individuals that can be distinguished within a sighting from a high quality photograph but do not warrant status as a 'marked' dolphin in the catalog.
- **Grade-2** - There are photographs of some dolphins with distinctive fins that may be in the catalog, but because of the quality of photographs it is not possible to make appropriate comparisons with the catalog and make a match or assign an identification.
- **Grade-3** - Photographic coverage is known to be incomplete, because all dolphins were not approached for photographs, no photos were taken, film did not turn out, sighting conditions were poor, etc.

ID Master List-19 Dec1995

CODE	FB	NAME	SEX	BORN	DIED	CAT 1	CAT 2	LOC	INIT. SIGH	MOM	CALF	Study	B.O.
FB77	FB77	NAT, C71-2	M	74	31-Jul-87			S	1975	FB71		SB	2
FB78	FB78	RIPTORN = SKEWED PEDUNCLE (RIPT)	M	72				NSB	1980			SB	
FB79	FB79	FB79	F	79				S	1985			SB	
FB80	FB80	RT-6	M	73				S	1975			SB	
FB81	FB81	57	F					S	1976			SB	
FB82	FB82	CALF OF FB91, BABY, C91-1, A-6 = (FB50)	M					S	1975	FB91		SB	1
FB83	FB83	JAGGED MAMA (JGMA)	F	50				S	1980			SB	
FB84	FB84	MAMA MIA, 65	F	58				S	1975			SB	
FB85	FB85	CALF OF FB83, C83-2	F	83				S	1984	FB83		SB	2
FB86	FB86	CALF OF FB84, A-7, C84-1	M					S	1975	FB84		SB	1
FB87	FB87	SQUARENOTCH (SQNT)	F	77		MID		BPB	1980			SB	
FB88	FB88	CALF OF FB57, C57-1	M	75				S	1980	FB57		SB	1
FB89	FB89	CLOWN	F	71		LOW		MAN	1981		CCLL	SB	
FB90	FB90	KILLER	F	70				S	1975			SB	
FB91	FB91	GERTIE, RT-10	F					S	1975			SB	
FB92	FB92	CALF OF FB84, LASAGNA, C84-4	M	88				S	1988	FB84		SB	4
FB93	FB93	CALF OF FB35, C35-2 (C352)	F	85				S	1985	FB35		SB	2
FB94	FB94	SPARKS, RT-2	M	70				S	1975			SB	
FB95	FB95	CALF OF FB71, C71-5	F	88				S	1988	FB71		SB	5
FB96	FB96	H (HHHH)=ANTEATER2 (ANT2)	M			SC		NSB	1980			SB/TB	
FB97	FB97	CALF OF FB25, C25-1	F	88				S	1988	FB25		SB	1
FB98	FB98	G (GGGG)	M	53		SC	UP	NSB	1980			SB/TB	
FB99	FB99	TWO NICKS ABOVE A SCOOP (TNAS)	F	87		UP		BHS	1989			SB/TB	
FBLN		FLAG BUTTON LOW NOTCH				ET		TBS	1988			TB	
FBRK		FLAG 'N' BRACKET = "OTHER"				ET		AMG	1990			TB-O	
FCRV		FRENCH CURVE				ENT		BHS	1983			TB-O	
FDLB		FRONT DENT LOW BUCK				LD		CHN	1994			CH	
FEAT		FEATHER				UP		WSB	1990			TB	
FFMA		FOLDED FIN MAMA	F			LB		NTB	1988		FMC1	TB	
FGLS		FRINGE + LOW SCOOP				ENT		STH	1993			TB	
FGMA		FISHGAPE MAMA	F			TN		KIC	1992		FGMC	CH	
FGMC		CALF OF FGMA		92		CALF		KIC	1992	FGMA		CH	
FGNP		FLAG AND MIDNIP				ET		ESB	1991			TB	
FGSF		FLAG-STAFF				ET		HBB	1993			TB	
FH2C		CALF #2 OF FHIS		93		CALF		NEL	1993	FHIS		CH	
FHIC		CALF OF FHIS				CALF		SPS	1991	FHIS		CH	
FHIS		FALCATE HI SCOOP	F			UP		SPS	1991		FHIC,FH2C	CH	
FINK		FINK				LOW		TBN	1993			TB	
FINS		FIN-ISHED				MT		TBN	1993			TB	
FJSR		FATHER JUNIPERO SERRA				MID		LKC	1983			TB	
FLAG		FLAG				ET		STB	1990			TB	
FLAP		FLAP				ET		NTB	1983			TB-O	
FLAX		FLAG X				ET		CHW	1991			CH	
FLBB		FLAG BROAD BASE				ET		OTN	1989			TB	
FLBC		CALF OF FLBT				CALF		TBN	1989	FLBT		TB	
FLBT		FRILLY LOW BUCKTOOTH	F			ENT		TBS	1989		FLBC	TB	

Dorsal Fin Photo-ID Catalog

Dolphin Biology Research Institute maintains a photo-identification catalog of more than 2,200 fins, collected since 1975. Archives are kept at Mote Marine Laboratory. For more information, contact Kim Urian, Data Manager or Randy Wells, Principal Investigator.

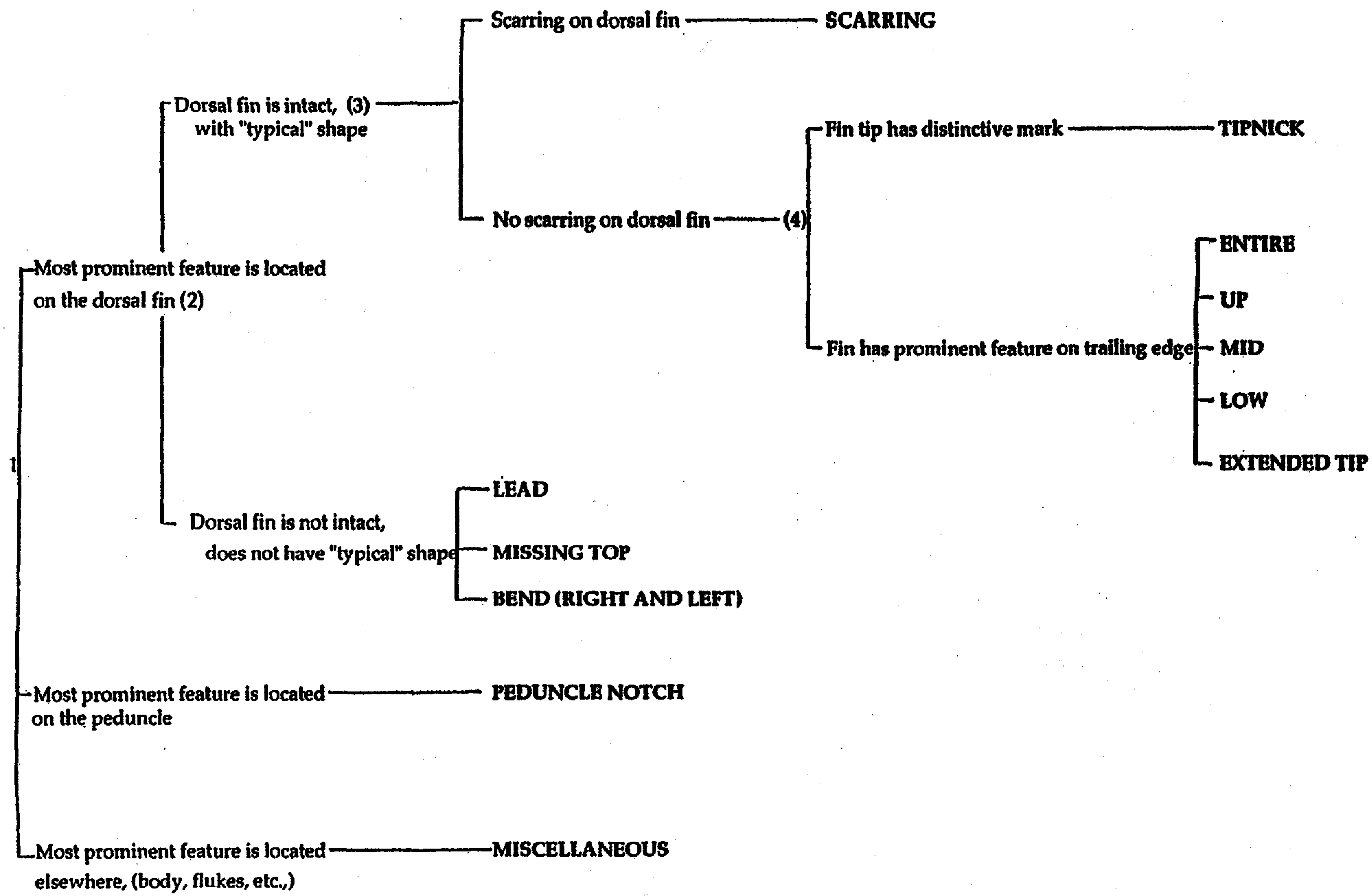
Our photographic catalog is based on exclusive categories that classify individuals with similar features together. The catalog is divided into 13 categories based on: (1) the shape of the fin; (2) distinctive features on the leading edge of the dorsal fin, (3) the division of the trailing edge of the dorsal fin into thirds with each category based on the location of the most prominent feature in each third; (4) evidence of permanent scarring or pigmentation patterns on the fin, peduncle or body. Each category is arranged with the most dramatic fins first to fins with more subtle diagnostic features last. This arrangement facilitates searching since similar fins are grouped together. Each fin is given a unique name that is abbreviated as a 4-place code based on the defining features (nick, notch, flag, knob, scoop, etc.) that best describe the fin.

The primary photo-ID catalog is composed of the most diagnostic and best quality original slides of each animal, filed alphabetically by each individual dolphin's unique four-place code. Prints are made from the original slides and filed in a working catalog used for initial searching for matches. A duplicate catalog of color photocopies of the color prints is maintained off-site as a backup copy. We maintain photo-ID catalogs that represent our different study areas: Sarasota Bay, Charlotte Harbor, Tampa Bay, and the inshore waters of the Gulf of Mexico. All catalogs are ultimately searched before an addition is made to the appropriate catalog.

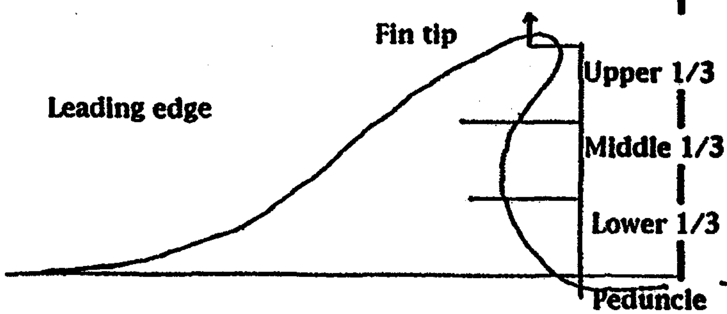
Our Key:	Catalog Category
1. a) The most prominent feature is located on the dorsal fin.......2	
b) The most prominent feature is located on the peduncle	**Peduncle Notch**
c) The most prominent feature is located elsewhere,(body, flukes,)	**Miscellaneous**
2. a) Dorsal fin is intact, with "typical" shape.................................3	
b) Dorsal fin is not intact or does not have "typical" shape: A	
A. Fin has notch,nick or slice on the leading edge	**Lead**
B. Fin is cut off, top or tip of fin is missing	**Missing Top**
C. Fin is canted/bent/curled	**Left/Right Bend**
3. a) Dorsal fin has scarring, pigmentation pattern, healed wound	**Scarring**
b) Dorsal fin does not have scarring..4	
4. a) Tip of dorsal fin has distinctive mark	**Tipnick**
b) Fin has prominent feature on trailing edge below the tip: A	
A. equally distinctive features in up/mid/low third of fin	**Entire**
B. distinctive features in upper third of fin	**Up**
C. distinctive features in middle third of fin	**Mid**
D. distinctive features in lower third of fin	**Low**
E. Extended tip: the fin tip extends past trailing edge	**ET**

*NOTE: Fins place in the 'Peduncle' and 'Scarring' categories are also placed in secondary categories based on distinctive features on the fin in case the peduncle notch or scarring is obscured in subsequent photographs. If there are equally distinctive features in more than one third of the trailing edge of the fin, the location of the lowest feature takes precedence over the higher feature.

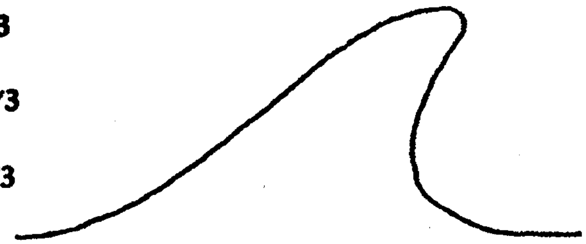
DBRI DORSAL FIN PHOTO-ID CATALOG CATEGORIES



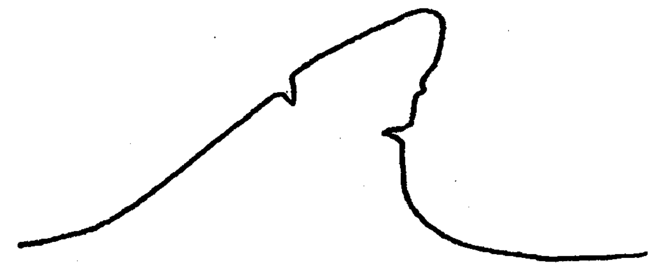
DBRI CATALOG CATEGORIES:
Each category of the catalog is based on:
*division of the trailing edge of the dorsal fin into thirds
*distinctive features on the leading edge of the fin from the anterior insertion to the fin tip
*distinctive feature on the peduncle



Fin with "Typical", intact shape
* no distinctive characteristics
* not identifiable

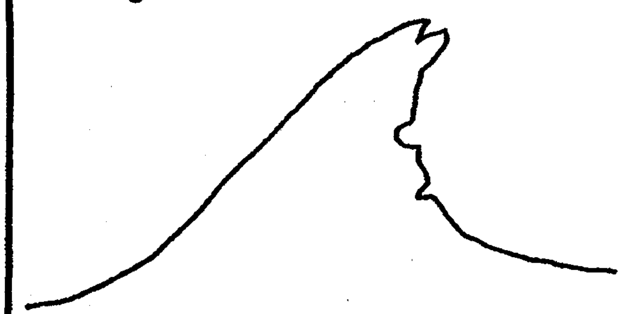


Category: LEAD (LD)
* leading edge of fin has distinctive notch, nick or slice
* LD is ranked above all other categories: fins with distinctive features on the leading edge are placed in LD regardless of other features

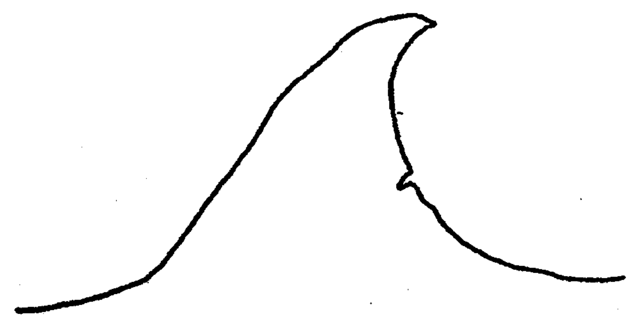


Category: MISSING TOP/TIP (MT)
* missing a large portion of the fin tip
* tip of fin is missing
* MT is ranked above all other categories except LD; even if there are other features, the MT takes precedence over all other categories

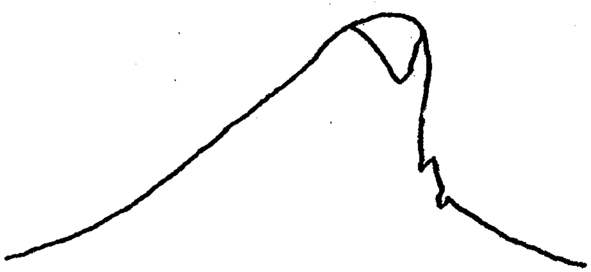
Category: TIPNICK (TN)
* tip of fin has nick, notch or scoop
* TN is ranked above all other categories except LD & MT
*TN takes precedence over all other trailing edge features



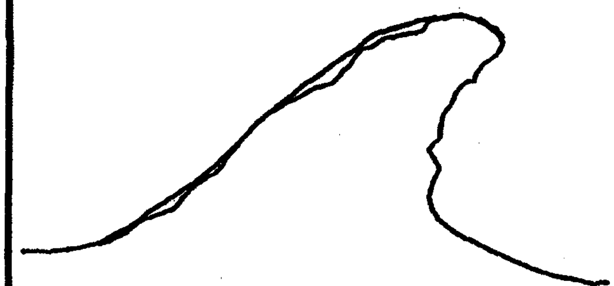
Category: RIGHT BEND (RB)
* fin canted or bent noticeably to the right



Category: LEFT BEND (LB)
* fin canted or bent noticeably to the left

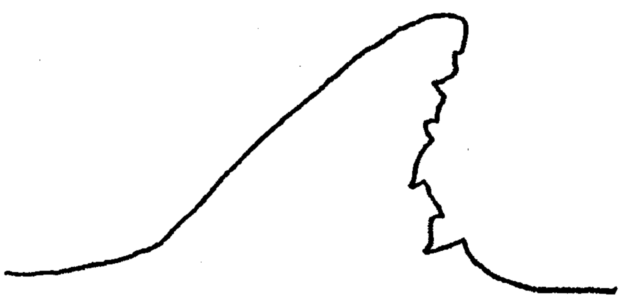


Category: COLOR/SCARRING (SC)
* most distinctive feature of fin is permanent scarring or color
* an individual classified in this category must also be placed in a secondary catalog based on features of the fin in case the scarring is not visible.



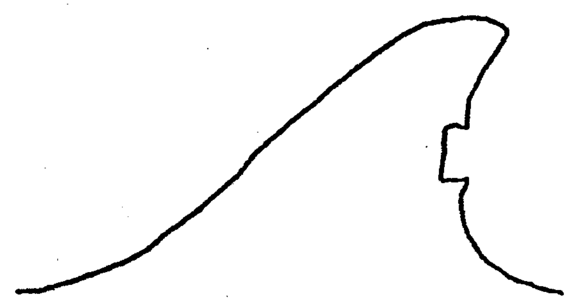
Category: PEDUNCLE NOTCH (PED)
* most distinctive feature is on the peduncle
* an individual classified in this category must also be placed in a secondary catalog based on features of the fin in case the peduncle notch is obscured.

Category: ENTIRE (ENT)
* each third of the trailing edge has equally distinctive features

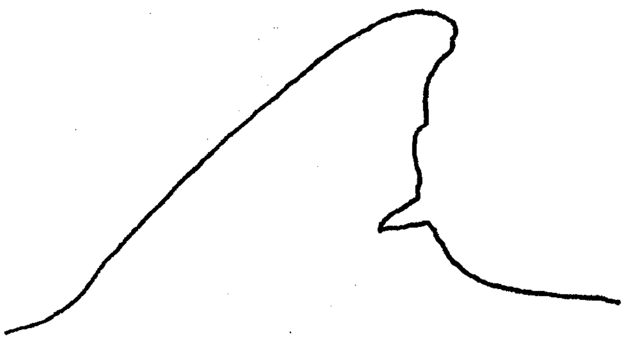


Category: UPPER THIRD (UP)
* upper third has most distinctive feature
*When there are equally distinctive features in more than one third of the trailing edge, the location of the lowest feature takes precedence over the higher feature.

Category: MIDDLE THIRD (MID)
*middle third has most distinctive feature

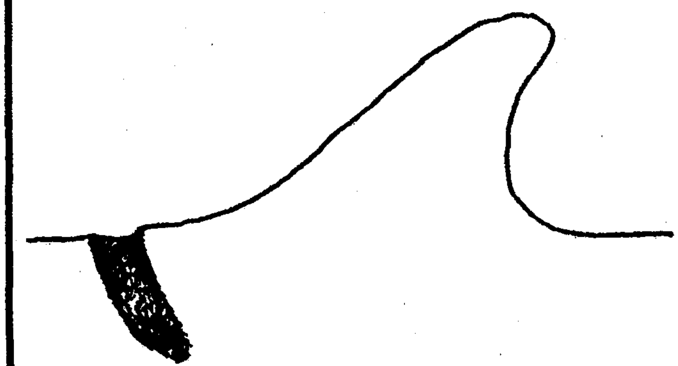


Category: LOWER THIRD (LOW)
* lower third has most distinctive feature



Category: EXTENDED TIP (ET)
* tip of fin extends past remainder of trailing edge

Category: MISCELLANEOUS
* the most prominent feature is located elsewhere, the body, flukes, back, etc.



DESCRIPTIVE DEFINITIONS

Notch: a V-shaped, angular or jagged indentation
Nick: a small notch or groove
Slice: a deep, straight notch
Scoop: a rounded or smooth indentation
Scallops: series of scoops
Bucktooth: a square projection on trailing edge of fin
Tab: a projection or flap on trailing edge of fin
Button: a small protuberance on trailing edge edge of fin
Chomp: large part of fin missing with ragged edge; included in MT category
Hack: missing large portion of fin top/tip with a clean/straight edge or margin;in MT category
Lobe: fin noticeably pinched on both leading and trailing edge: included in LD category
Flag: included in ET category: square fin edges
Knob: included in ET category: rounded fin tip

Database Management

Data from the sighting forms and results from photo-analysis are entered into a computerized database. The database currently includes 10,547 sighting records from Sarasota Bay, Tampa Bay, Charlotte Harbor and the inshore Gulf waters from 1975 to 1994. We use the FoxBase+/Mac Version 1.1 relational database management system containing dBase programming language that permits us to write specific programs to manipulate the database. Coefficients of associations are calculated using a program with the sighting database. Atlas Mapmaker software for the MacIntosh is used in conjunction with FoxBase offering the capability of plotting any information from our sighting database such as group size, a specific activity, sightings of individual animals or pairs of animals using hand-digitized maps of each of our study areas. Data from the sighting database is often imported into other software packages. We use Excel and Statview for MacIntosh for a variety of analyses, such as generating abundance estimates.

A Macintosh IIsi computer is used for data entry and a Macintosh Centris 650, and Quadra 650 computers are used primarily for data manipulations. A Syquest 88MB external hard drive and cartridges are used for backing up our databases and transferring updated versions to our various computers.

The *DBRI DATABASE LOGBOOK* : This is a used to maintain records on the status of our sighting database and for guidelines and instructions when working with the database. It includes the **Data Entry Checklists** by year.

- The **Data Entry Checklist** is kept current; it lists the status of the database:
  (1) "Photo-Analysis Complete": checked off only when the photo-analysis has been completed, i.e., all numbers and dolphin ID codes have been filled in on the sighting sheet,

  (2) "Data Entry Partial": checked off when all data are entered except what is referred to under the column labeled "Comments"; on occasion, all data are entered except for identifications that need to be verified, and therefore are not entered, and are listed in this "Comments" column,

  (3) "Data Entry Complete": checked off when all the fields in the database have been entered, and

  (4) "Data Entry Double-Checked": checked off only when all data entry is checked against the original datasheets and edited; when this column is checked we should never have to go back to original data sheets (except to refer to the narrative comments) and know that what is entered is as accurate as is humanly possible.

The Steps:

1. Field data are collected as per **SDRP Sighting Form Use.**

- Sighting sheets checked for accuracy and completeness and Lats &Longs checked before being filed in chronological sighting sheet binders.

2. Photo-analysis is completed, as per **SDRP Procedures for Photo-Analysis.**
- All blanks on the sighting data sheets are completely filled in, ID codes verified, Master code list updated, photo-analysis numbers are checked to add up correctly.
- The "Photo-Analysis Complete" column is checked off in the box on the top of the sighting form page and on the **Data Entry Checklist**. (This helps us identify the gaps and needs for photo-analysis).

3. Data entry on disk:
- It is mandatory to use two people to enter data on a floppy disk. One person reads from the data sheet and the other person enters the data; both checking each other and reaching consensus when judging discrepancies, poor handwriting, etc.
- The box on the top of each sighting form is filled in with date, initials and the Data Entry disk # when entry is completed. The column labeled "Data Entry Complete" on the **Data Entry Checklist** is also checked off when all data for that boat day has been entered completely.

4. Data Checking and Editing: After a "chunk" of data is entered on disk, it is double-checked against the original datasheets for accuracy. It is then appended to the main database.

5. Database Backups: The data manager maintains ***at least*** 3 dated backups of the newly revised database on our Syquest cartridges that are stored off-site and in the fire-safe vault (these are the "Golden Copies").
- Backups of all databases and DBRI's hard drives are conducted at least once a month on designated syquest cartridges; more frequently during work on major projects, and bouts of data entry and editing.

SDRP's Guidelines for Access to and use of its Databases

This protocol is designed to maintain the integrity of SDRP databases and research data and ensure appropriate distribution and use of the data. As the project has grown, it has become necessary to develop a higher level of coordination and standardized procedures for using and releasing data. Adherence to these guidelines is also important for quality control because: a) SDRP must control access to and use of its research products and b) the user must have confidence in the way the data were collected, used, edited, and when appropriate, analyzed.

An outline and an agreement to provide updates should be included in the request to the PI to ensure appropriate use of the data. All requests to access SDRP data, databases, or analyses should have a brief hard copy summary of the request, including the purpose the research, the expected extent of the data needs, the time frame, the research products, and security arrangements for the computer files and any data summaries. The summary can be brief, but it should be written so that, the PI can send it to the other SDRP PI's for their information or approval. The summary will be maintained at SDRP as documentation for each use of the SDRP data.

Dolphin Biology Research Institute
Sighting Form

Photo Grade: 1

Field Hours Ø838 to 17:15

Effort (S) O C

Platform Mini Mako

Date & initial when complete:
Photo-analysis: 5/9/95 - KAU
Data entry: 14 Jun 95 - KB+SS

Date: 16/Jan/95

Sighting No: 3

Recorder/Observers S. Hofmann, R. Wells, K. Hull, K. Urian

Time: 1351 to 1415

Location Fork of channels - Palma Sola Bay

LOC PSB

Latitude 27 29 ØØ Longitude 82 4Ø ØØ

Swim Speed 999

Conditions calm, 0.0-0.2m chop, clear, some glare to west, light SW breeze, excellent

COND Ø626 B.S. Ø

Depth 4.5 ft. Water Temp: 75.Ø °F Tide: IN 1 OUT (2) HI 3 LOW 4 Salinity: 999 °°/ooo

Heading: Initial Ø9Ø General VAR

Activity: Mill (1) Feed 2 Prob. Feed 3 Travel 4 Play 5 Rest 6 Leap Tailslap Chuff 7 Social (8) w/Boat (9) Other 0

819

	FIELD ESTIMATES MIN	MAX	BEST	PHOTO ANALYSIS Pos IDs	Min not IDed	Max not IDed	Revised MIN	Revised MAX	Final BEST
TOTAL DOLPHINS	8	12	1Ø	10	4	4	14	14	14
TOTAL CALVES	3	5	4	1	2	4	3	5	4
YOUNG OF YEAR	1	1	1	0	1	1	1	1	1

Comments: initially sighted subgroup of moms & calves
14:00 - joined with socializing subgroup - lots of socializing!
- calves approached boat, surfacing independently
- YOY of 49LA tight with mom
- few clean fins

Associated Organisms:

Dolphins Sighted: ID confirmation: P= photograph V= visual O = other (explain)

Name	Code	Conf.	Name	Code	Conf.	Name (Not Valid ID Names)	Code	Conf.
FB91	FB91	V/P	Claw	CLAW	P	"clean"		
Killer	FB90	V/P	Sawblade	SBLD	P	"other tiny low nick"		
'92 calf of Killer	F122	V/P c						
Elf	ELFF	P						
White-tip Mama	WTMA	P						
calf of WTMA	WTMC	O/P → with mom						
49 Look-alike	49LA	P						
yoy of 49LA	49LC	O/P → with mom						
Nick Jagger	NKJG	P						
Sliced Fin	SLIC	P						

Photos: (roll: frame->frame) RW(95) 21: 1 → end RW(95) 22: 1 → 15 (data sheet)

Tape: (tape: counter)

1995 DATA ENTRY CHECKLIST

DATE	BOAT	AREA	EFFORT	#SIGHTS	PHOTO-ANAL COMPLETE	Initials &Date	DATA ENTRY PARTIAL	Initials &Date	DATA ENTRY COMPLETE	Initials &Date	DATABASE CHECKED	Initials &Date	COMMENTS
1-Jan-95	HK	SB	O	1	✓	KM 5/5/95			✓	KB-H 6/10/95	✓	SS+TM 6-20-95	
10-Jan-95	MM	GS	S	4	✓	KM 5/5/95			✓	KB-H 6-10-95	✓	SS+TM 6-20-95	
11-Jan-95	MM	GS	S	6	✓	KM 5/5/95			✓	KB-H 6-10-95	✓	SS+TM 6-20-95	
12-Jan-95	MM	GS	S	6	✓	KM 5/5/95			✓	KB-H 6-10-95	✓	SS+TM 6-20-95	
13-Jan-95	MM	GS	S	2	✓	KM 5/5/95			✓	KB-H 6-10-95	✓	SS+TM 6-20-95	
16-Jan-95	MM	SB	S	4		KM 5/5/95							sight #2: verify TFLG w/ RW.
17-Jan-95	MM	SB	S	4	✓	KM 5/8/95			✓	KB-H 6-10-95	✓	SS+TM 6-20-95	
18-Jan-95	MM	GS	S	6	✓	KM 5/8/95			✓	KB-H 6-10-95	✓	SS+TM 6-20-95	
19-Jan-95	MM	GS	S	4	✓	KM 5/8/95			✓	KB-H 6-10-95	✓	SS+TM 6-20-95	
20-Jan-95	MM	SB	S	1	✓	KM 5/8/95			✓	KB-H 6-10-95	✓	SS+TM 6-20-95	
28-Jan-95	PR	SB	O	1	✓	KM 5/8/95	✓			KB-H 6-10-95			sight #1: check Lat.&Long.
3-Feb-95	LB	SB	O	1	✓	KM 5/7/95			✓	KB-H 6-10-95	✓	SS+TM 6-20-95	
7-Feb-95	MM	SB	S	3	✓	KM 5/7/95			✓	KB-H 6-10-95	✓	SS+TM 6-20-95	
10-Feb-95	MM	SB	S	3	✓	KM 5/7/95			✓	KB-H 6-10-95	✓	SS+TM 6-20-95	
15-Feb-95	MM	GS	S	9	✓	KM 5/7/95			✓	KB-H 6-10-95	✓	SS+TM 6-20-95	
16-Feb-95	MM	GS	S	2	✓	KM 5/7/95			✓	KB-H 6-10-95	✓	SS+TM 6-20-95	
17-Feb-95	MM	STG	S	11	✓	KM 5/7/95			✓	KB-H 6-11-95	✓	SS+TM 6-20-95	
18-Feb-95	MM	SB	S	3	✓	KM 5/10/95			✓	KB-H 6-11-95	✓	SS+TM 6-20-95	
19-Feb-95	HS	SB	O	1	✓	KM 5/9/95			✓	KB-H 6-11-95	✓	SS+TM 6-20-95	
23-Feb-95	PR	SB	O	2	✓	KM 5/10/95			✓	KB-H 6-11-95	✓	SS+TM 6-20-95	
25-Feb-95	MM	CH	O	3									KB-H: to check CH catalog for IDs
26-Feb-95	MM	CH	S	1									
27-Feb-95	PB	SB	O	1	✓	KM 5/10/95			✓	KB-H 6-11-95	✓	SS+TM 6-20-95	
28-Feb-95	MM	TB	S	8									
3-Mar-95	PB	SB	O	2									
14-Mar-95	MM	GS	S	2									
15-Mar-95	MM	GS	S	4									
16-Mar-95	MM	GS	S	9									
17-Mar-95	MM	GS	S	5									
18-Mar-95	LB	SB	O	1									

Example of SDRP Database Structure

DATE	SIGHTNO	PHOTO GRADE	EFFORT	TIME BEGIN	TIME END	LOC CODE	LAT DEG	LAT MIN	LAT SEC	LONG DEG	LONG MIN	LONG SEC
19941206	1	1	S	1143	1157	LBC	27	20	91	82	36	76
19941206	2	1	S	1313	1356	KRB	27	31	89	82	43	6
19941207	1	1	S	1006	1020	BSP	27	18	57	82	33	42
19941207	2	1	S	1104	1121	LBC	27	21	77	82	37	59
19941207	3	1	S	1155	1218	AMG	27	29	7	82	42	73
19941207	4	3	S	1244	1251	KRB	27	31	77	82	42	67
19941207	5	2	S	1312	1341	PSB	27	28	75	82	40	87
19941207	6	1	S	1442	1516	BWS	27	22	83	82	36	59
19941208	1	1	S	1013	1026	LBP	27	26	54	82	41	41
19941208	2	3	S	1122	1146	BLK	27	31	66	82	39	76
19941208	3	2	S	1203	1222	MAN	27	37	71	82	36	37
19941208	4	2	S	1313	1326	TCB	27	32	88	82	35	20
19941208	5	3	S	1341	1351	TCC	27	32	75	82	37	60
19941208	6	1	S	1418	1430	AMS	27	29	38	82	41	85
19941208	7	1	S	1530	1607	BWS	27	23	83	82	36	95
19941209	1	1	S	933	944	ESS	27	22	38	82	34	1
19941209	2	1	S	1000	1005	NSB	27	25	21	82	36	59
19941209	3	1	S	1010	1025	WSB	27	24	89	82	37	25
19941209	4	1	S	1058	1131	PSB	27	28	66	82	40	55
19941209	5	3	S	1221	1233	KRB	27	32	27	82	44	14
19941209	6	1	S	1352	1403	BWS	27	23	21	82	37	40
19941211	501	3	O	1330	1400	OKC	27	19	50	82	34	15
19941212	1	1	S	1025	1036	RBC	27	14	68	82	31	20
19941212	2	1	S	1112	1120	BBB	27	7	84	82	28	19
19941212	3	1	S	1121	1128	BBB	27	7	53	82	28	16
19941212	4	1	S	1239	1257	RBC	27	18	27	82	32	66
19941212	5	1	S	1412	1419	LBP	27	26	87	82	41	7
19941212	6	1	S	1530	1543	NPS	27	19	71	82	35	28
19941213	1	1	S	1134	1153	UPS	27	30	13	82	38	90
19941213	2	1	S	1212	1218	PSB	27	28	78	82	40	87
19941213	3	1	S	1241	1310	ICW	27	25	58	82	39	74
19941214	1	1	S	1008	1022	LBC	27	22	73	82	38	54
19941214	2	1	S	1204	1215	PSB	27	28	76	82	41	5
19941215	1	1	S	1130	1139	PSB	27	29	59	82	38	95
19941215	2	1	S	1145	1148	PSB	27	28	90	82	38	86
19941215	3	1	S	1324	1330	SKF	27	25	59	82	38	41

Example of SDRP Database Structure

SWIM SPEED	COND	DEPTH	TEMP	TIDE	INIT HEAD	GEN HEAD	ACTIVITY	TOTMIN	TOTMAX	TOTBEST	MINCALVES	MAXCALVES	BESTCALVES	MINYOY
999	131	8.6	74	1	160	160	437	2	2	2	0	0	0	0
999	1031	3.2	74	1	60	VAR	2147	7	7	7	3	3	3	1
999	501	6.2	73.5	2	30	30	49	2	2	2	0	0	0	0
999	511	5	73	1	0	320	487	4	4	4	0	0	0	0
999	111	26	73.5	1	325	VAR	317	4	7	5	0	1	0	0
999	201	6.4	73.5	1	245	0	1	4	4	4	1	1	1	0
999	201	9.5	73.5	1	270	OUT	4897	11	13	11	3	3	3	2
999	131	4.8	74	1	340	360	4817	7	9	8	1	1	1	1
999	31	22	72	2	110	VAR	164	4	4	4	0	0	0	0
999	1121	6.8	72.5	2	0	330	487	6	6	6	2	2	2	0
999	11	12.9	74	1	210	80	4987	12	14	12	4	5	4	1
999	21	8.2	74.5	1	90	0	1	2	2	2	0	0	0	0
999	31	6.4	72.5	1	320	270	417	3	3	3	1	1	1	0
999	31	10.4	72.5	1	10	10	4	4	4	4	1	1	1	1
999	31	4.7	75	1	150	VAR	437	7	7	7	2	2	2	0
999	31	5.8	73	2	325	325	43	2	2	2	0	0	0	0
999	31	7.7	74	2	0	0	1	1	1	1	0	0	0	0
999	31	7.4	74	1	200	0	817	3	3	3	0	0	0	0
999	21	2	73	1	0	IN	43197	6	6	6	1	1	1	1
999	111	12.1	74.5	1	300	280	46	4	4	4	0	0	0	0
999	121	3.1	75	1	240	VAR	31	1	1	1	0	0	0	0
999	11	6	99	9	40	999	872	3	3	3	1	1	1	0
999	31	11.1	68	2	340	340	431	1	1	1	0	0	0	0
999	10	10.1	71	2	350	VAR	90	1	1	1	0	0	0	0
999	10	10.9	71	2	350	VAR	910	1	1	1	0	0	0	0
999	11	7.3	70.5	2	345	350	41	3	3	3	0	0	0	0
999	131	4.2	71	4	25	25	49	2	2	2	1	1	1	1
999	131	15.5	72	1	230	230	41	3	3	3	0	0	0	0
999	201	5.6	68.5	2	240	250	43	2	2	2	1	1	1	1
999	201	5.1	67	2	0	VAR	3	1	1	1	0	0	0	0
999	211	11.6	68	2	300	VAR	497	5	7	5	0	0	0	0
999	201	13.7	66	1	0	315	14	2	2	2	0	1	1	0
999	201	12.3	65	3	270	OUT	49	1	1	1	0	0	0	0
999	21	6.5	65.5	1	170	0	1397	2	2	2	1	1	1	1
999	21	5.2	65.5	1	210	0	21	1	1	1	0	0	0	0
999	31	3.9	66	2	300	300	4	1	1	1	0	0	0	0

Example of SDRP Database Structure

MAXYOY	BESTYOY	TOTPOSID	MIN NOT ID	MAX NOT ID	REV MIN	REV MAX	TOT FIN BEST	CALF POS ID	CALF MIN NO ID	CALF MAX NO ID	CAL REV MIN
0	0	2	0	0	2	2	2	0	0	0	0
1	1	7	0	0	7	7	7	3	0	0	3
0	0	1	1	1	2	2	2	0	0	0	0
0	0	4	0	0	4	4	4	0	0	0	0
0	0	4	1	3	5	7	5	0	0	1	0
0	0	3	1	1	4	4	4	1	0	0	1
2	2	10	1	3	11	13	11	3	0	0	3
1	1	8	0	1	8	9	8	1	0	0	1
0	0	4	0	0	4	4	4	0	0	0	0
0	0	2	4	4	6	6	6	0	2	2	2
1	1	5	7	9	12	14	12	0	4	5	4
0	0	1	1	1	2	2	2	0	0	0	0
0	0	1	2	2	3	3	3	0	1	1	1
1	1	4	0	0	4	4	4	1	0	0	1
0	0	7	0	0	7	7	7	2	0	0	2
0	0	2	0	0	2	2	2	0	0	0	0
0	0	1	0	0	1	1	1	0	0	0	0
0	0	3	0	0	3	3	3	0	0	0	0
1	1	6	0	0	6	6	6	1	0	0	1
0	0	3	1	1	4	4	4	0	0	0	0
0	0	1	0	0	1	1	1	0	0	0	0
0	0	2	1	1	3	3	3	1	0	0	1
0	0	1	0	0	1	1	1	0	0	0	0
0	0	1	0	0	1	1	1	0	0	0	0
0	0	1	0	0	1	1	1	0	0	0	0
0	0	3	0	0	3	3	3	0	0	0	0
1	1	2	0	0	2	2	2	1	0	0	1
0	0	3	0	0	3	3	3	0	0	0	0
1	1	2	0	0	2	2	2	1	0	0	1
0	0	1	0	0	1	1	1	0	0	0	0
0	0	5	0	2	5	7	5	0	0	0	0
0	0	2	0	0	2	2	2	1	0	0	1
0	0	1	0	0	1	1	1	0	0	0	0
1	1	2	0	0	2	2	2	1	0	0	1
0	0	1	0	0	1	1	1	0	0	0	0
0	0	1	0	0	1	1	1	0	0	0	0

Example of SDRP Database Structure

CAL REV MAX	CALF FIN BEST	YOYPOSID	YOYMINNOID	YOYMAXNOID	YOYREVMIN	YOYREVMAX	YOY FIN BEST	DOLPH 1	DOLPH 2	DOLPH 3	DOLPH 4
0	0	0	0	0	0	0	0	FB98	FB96		
3	3	1	0	0	1	1	1	FB54	F118	FB10	FB65
0	0	0	0	0	0	0	0	C371			
0	0	0	0	0	0	0	0	FB98	FB96	F175	FB75
1	0	0	0	0	0	0	0	PN10	BBMB	LFLA	LCKL
1	1	0	0	0	0	0	0	FB09	FB63	F138	
3	3	2	0	0	2	2	2	FB65	C652	FB99	C991
1	1	1	0	0	1	1	1	F131	FB34	FB59	C595
0	0	0	0	0	0	0	0	FB33	FB71	FB84	FB29
2	2	0	0	0	0	0	0	F102	CONS	CONC	
5	4	0	1	1	1	1	1	F149	F147	LDMA	LNPF
0	0	0	0	0	0	0	0	BIST			
1	1	0	0	0	0	0	0	LBMA			
1	1	1	0	0	1	1	1	FB99	F155	C991	FB01
2	2	0	0	0	0	0	0	FB03	FB90	FB60	FB54
0	0	0	0	0	0	0	0	FB02	FB24		
0	0	0	0	0	0	0	0	FB34			
0	0	0	0	0	0	0	0	FB06	F108	HITS	
1	1	1	0	0	1	1	1	FB99	C991	FB01	FB03
0	0	0	0	0	0	0	0	FB07	FB11	FB05	
0	0	0	0	0	0	0	0	FB79			
1	1	0	0	0	0	0	0	FB74	F128		
0	0	0	0	0	0	0	0	FANT			
0	0	0	0	0	0	0	0	BEGR			
0	0	0	0	0	0	0	0	MOCH			
0	0	0	0	0	0	0	0	FB43	FB15	FB13	
1	1	1	0	0	1	1	1	FB65	C652		
0	0	0	0	0	0	0	0	FB41	FB43	F108	
1	1	1	0	0	1	1	1	FB99	C991		
0	0	0	0	0	0	0	0	F155			
0	0	0	0	0	0	0	0	FB36	FB38	FB94	FB66
1	1	0	0	0	0	0	0	49LA	49C3		
0	0	0	0	0	0	0	0	FB92			
1	1	1	0	0	1	1	1	FB99	C991		
0	0	0	0	0	0	0	0	F155			
0	0	0	0	0	0	0	0	FB79			

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