

Longitudinal comparisons of digital photography of marine mammals from aircraft and shore

Janet Biondi^{1,2}, Mari A. Smultea^{1,3}, Cathy E. Bacon^{1,4}, Glenn Gailey³, Olga Sychenko³, Bernd Würsig³, Silvia Bonizzoni^{3,5}, Giovanni Bearzi^{3,5}

¹ Smultea Environmental Sciences (SES), P.O. Box 256, Preston, WA 98050; ² Biondi Arts, 37 Old Long Pond Rd., Brewster, MA 02631 ; ³ Marine Mammal Behavioral Ecology Group, Marine Biology Department, Texas A&M University at Galveston, Pelican Island, Galveston, TX 77553; ⁴ Marine Science Department, Texas A&M University at Galveston, Pelican Island, Galveston, TX 77553; ⁵ Dolphin Biology & Conservation, Collebaldo via Cupa 40, 06066 Piegara, Italy



ABSTRACT

Rapid progress and affordability of photographic technology with increasing improvements in image resolution have facilitated advancements in efficiency and alternative approaches in data collection for marine mammals. We report these recent improvements by comparing marine mammal photographs taken during 2008-2013 aerial surveys of 16 marine mammal species in the Southern California Bight, shore-based studies of bottlenose dolphins (*Tursiops truncatus*) in Galveston Bay, Texas (2011-2013), and gray whales (*Eschrichtius robustus*) off Sakhalin Island, Russia (2004-2010). Various Canon and Nikon high-definition cameras ranging from 8.2-36.3 MP resolution and 70-1600 mm lenses with image stabilization were used during the studies. Results of these photographic comparisons demonstrate the evolution of digital photography advancements with the successful capture of individuals, as well as detailed information for behavioral ecology studies. For example, (1) individual identification of marine mammal species from aircraft not previously reported (Risso's dolphins (*Grampus griseus*), killer whales (*Orcinus orca*), and blue and fin whales (*Balaenoptera musculus* and *B. physalus*)), (2) shore-based individual identification of bottlenose dolphins up to 400 m and of gray whales up to 2 km from shore, (3) instantaneous differentiation/confirmation of short-beaked vs. long-beaked common dolphins (*Delphinus delphis* and *D. capensis*) from 1,500-ft altitude with a 36 megapixel (MP) camera, (4) reduced proportion of "unidentified" dolphin and whale species, and (5) potential tracking of the behavior, social associations and durations, and relative position within the group of some individually identified delphinids and other species not previously studied in this manner. High-definition digital photography reduces costs and acquisition/processing time from earlier "tried and true" analog photography. This facilitates, advances, and compliments the efficacy of data collection for population and behavioral ecology studies on marine mammals, most recently allowing capture of individual identification images at distances of up to 2 km away.



Resight of photo-ID'd Blue whale, S California.

- Photographed from a small circling plane from 232-274 m altitude on 24 July 2013 at 12:55 (Top) and at 13:49 (Bottom).
- The black circle denotes a divot scar used to photo-identify (ID) this individual on three different occasions between dives on the same day within 1 hr of each other.
- Photo-ID was critical to confirm that focal behavior follows were done on the same individual when other blue whales entered the area.
- Photos taken with a Nikon D800 HD 36.3 MP still camera with a 80-400 mm internally stabilized lens.

Photos by D. Steckler under NMFS permit 14451.

SOUTHERN CALIFORNIA BIGHT – Aerial Photos



Photos by J. Biondi and B. Würsig under NMFS permit 15369.

Risso's Dolphin



- Photographed from a small circling plane from 313 m altitude on 29 July 2013 at 13:55 (Top Left), 241 m altitude on 17 November 2008 at 15:55 (Bottom), and 477 m altitude on 26 March 2013 at 13:23 (Top Right).

- Individual Risso's dolphins have been photo-identified within one focal/photo session from the aircraft with the same camera as the blue whale (left photos). However, we have not yet cross-compared Risso's photos across days.



- (Left) Long-beaked common dolphin photographed from circling plane at 271 m altitude on July 25, 2013 by B. Würsig under NMFS permit 15369.

- (Right) Short-beaked common dolphin photographed from circling plane at 277 m altitude on May 26, 2013 by D. Steckler under NMFS permit 15369.

- Both photos made with a Nikon D800 HD 36.3 megapixel still camera with a 80-400 mm internally stabilized lens. Species were identified in the field.



SAKHALIN ISLAND, RUSSIA – Shore-based Photo-ID

From July – September 2004-2009, shore-based photo-identification (ID) methods were employed on western gray whales off northeastern Sakhalin Island, Russia. This was part of a behavioral monitoring program that covered 66 km of coastline in part of the nearshore feeding grounds of this species.

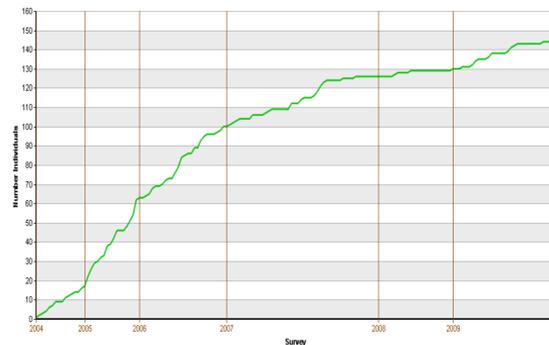
- A Nikon D1x with a 100-400 mm Nikon lens was used in 2004 as a feasibility study.
- Based on this success, to supplement ongoing vessel based photo-ID efforts, additional equipment (Nikon D2x and larger lenses Sigma 300-800 mm APO F5.6 EX DG, with a 2x extender) was incorporated.
- The improved camera equipment significantly increased the number of individuals photographically captured. This larger lens facilitated photo-ID of individuals from shore at distances of ~0.2 to 1.5 km away.
- All photographs were captured in RAW format and processed with specialized photo-identification software, DISCOVERY.
- There was one shore-based photo-ID team in 2004-2005 and two shore-based photo-ID teams from 2006-2009.



Western gray whale calf photographed in 2004 from 0.5 km (top) and 1 km (bottom) from shore in 2009 by G. Gailey.



- Distance to successfully photo-ID an individual was highly dependent on environmental conditions and lighting at the time.
- From 2004-2009, a total of 165 days of shore-based photo-ID efforts yielded 144 individuals with a mean of 5.6 resightings (range 1 - 26).
- Vessel-based efforts from 1995-2009 photo-ID'd 181 individuals from this small critically endangered population.
- We believe the shore-based photo-ID efforts were highly successful to:
 - supplement vessel-based photo-ID efforts, and
 - provide the ability to identify individuals when weather conditions, such as high sea states, did not permit vessel-based surveys.



A discovery curve illustrating the cumulative number of western gray whales identified from 2004 – 2009 by shore-based photo-ID efforts.

REFERENCES:

Würsig, B. and T. Jefferson (1990). Methods of Photo-Identification for small cetaceans. Reports of the International Whaling Commission Special Issue 12:43-52.

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CAMERA COMPARISONS ACROSS OUR STUDY YEARS

YEAR	CAMERA	LENS	Megapixels	Location
2004	Nikon D1x	100-400 mm	6.0	Russia
2005-2009	Nikon D1x	300-800 mm	12.0	Russia
2008-2012	Canon EOS 20D	70-200-mm	8.2	SOCAL
2008-2012	Canon EOS 40D	100-400 mm	10.1	SOCAL
2008-2012	Canon EOS 60D	100-400 mm	18.0	SOCAL
2011-2012	Nikon D300S	80-400 mm	12.3	Galveston
2013	Nikon D800*	80-400 mm	36.3	SOCAL
2013	Canon EOS 7D	100-400 mm	18.0	SOCAL

*Nikon D800 is full-format (35mm effective) while the others are not, and a Nikon D800 at 36.3 MP would be only about 28-29 MP for a different camera.

Highlights

- Opportunities for photo-ID, instantaneous species ID, and behavioral ecology studies have increased dramatically with improved resolution in photography.

- These advances have
 - increased the distances at which photo-ID is possible,
 - decreased the costs,
 - increased efficiency and speed of species ID in the field
 - overcome conditions (e.g., increased internal lens stabilization)

- For example, in 1990, Würsig & Jefferson stated "dolphins are usually not individually identifiable from the air" when the authors were referring to non-digital photographic formats. However, our studies herein show that the advances in digital photography and improved lenses, particularly advances in internal stabilization, indicate this may be possible.

GALVESTON SHIP CHANNEL, TEXAS – Shore-based Photo-ID

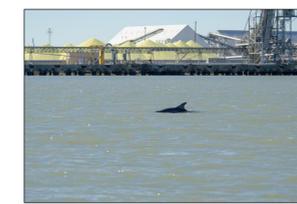
Between September 2011 and January 2012 we conducted a feasibility study to assess the possibility of photo-identifying common bottlenose dolphins (*Tursiops truncatus*) from the coast in the Galveston Ship Channel, Galveston, TX, USA. This population has been studied from boats and via theodolite for over 30 yrs but no one had previously attempted photo-ID from shore here until recent camera technological advances.

We used a Nikon D300S reflex camera (12.3 MP) equipped with a NIKKOR 80-400 mm f 4.5-5.6 D-VR. Photos were taken from shore along a 1 km stretch of coast, by a standing or seated person using a monopod. The monopod increased stability while allowing for the quick adjustments necessary to take photos during the dolphins' short-lasting surfacings. All images were shot in RAW format and processed with Adobe Lightroom 4.

Dolphin photos were obtained on 21 days, totaling 14 observation hr. From 1349 photos, we photo-identified 59 dolphins at distances up to 400 m. Ten individuals were re-sighted in three or more days, and 14 in two days. The remaining 35 were seen only once.



Tursiops truncatus, about 400 m from the camera, 11 November 2011 (photo by G. Bearzi)



Tursiops truncatus, about 380 m from the camera, 11 January 2012 (photo by G. Bearzi)

