PRELIMINARY RESULTS OF MODIFIED DVIDEO-ID TECHNIQUE AND APPLIED TO PEALE'S DOLPHINS, *LAGENORHYNCHUS AUSTRALIS* (PEALE, 1848) AT AÑIHUÉ RESERVE, CHILE

GIAN PAOLO SANINO (1, 2, 3) AND JOSÉ L. YÁÑEZ (2, 3)
(1) Añihué Reserve, Bajo Palena, Región de Aysén, Chile;
(2) Centre for Marine Mammals Research - LEVIATHAN, Postal code 7640392 Santiago, Chile;
research@cmmrleviathan.org;
(3) National Museum of Natural History - MNHN, Casilla 787, Santiago, Chile

ABSTRACT

Located on the continental shore of Chilean Patagonia at the northernmost limit of Aysén Region (43°47.93'S; 72°58.43'W), Añihué Reserve has approximately 17 nautical miles of marine coastline containing highly diverse habitats. Two small natural elevation sites, R1 (43°47.78'S; 72°58.72'W) and R2 (43°48.76'S; 72°58.78'W), were selected as observatories on Tonina Beach from where graphic material was produced during 2011with the collaboration of volunteers, during daylight and sea state lower than force four (Beaufort), using/testing several SLR camera models, occasionally a Sony HDR-FX7 camcorder and a Hero GoPro underwater camera. Digikam, a Linux/KDE photographic management application, was used as a graphic SQLite database to classify the frames and run dataset queries based on "tags" selections of natural marks. Tonina Beach in Añihué Reserve is visited by at least 68 individuals of *L. australis*, patrolling and foraging in very shallow waters in small groups that may fuse occasionally. Despite recording effort being highly concentrated during summer, the collected graphic material included: dolphins in all seasons; distributed among 10 of 15 possible seasonal combinations (66.67 %); with re-identified individual in all four seasons; several re-identifications in winter of individuals sighted during summer (N=11; 26.19 %); and more than third of the individuals (N=25) were identified between mid-autumn and mid-spring. These first results suggest that the coastal *L. australis* populations, at least in front of Añihué Reserve, present a high fidelity to the site not supporting previous hypothesis of significant seasonal/migratory movements for the species and, provide alternative explanations to seasonal variations of recorded abundance. DVideoID, an individual identification protocol based on graphic records of natural marks produced during chase from moving platforms, proved to be reliable also under "sit and wait from the shore" mode of data production. The method, entirely based on free opensource applications, was modernized by switching from a traditional database client to a tagged graphic database approach, simplifying the process for managing information and is presented in recognition of the need for method standardization. The most useful tags to identify Peale's dolphin individuals were skin marks from bites, especially on the dorsal fin; the presence of dorsal nicks (whose origins are also related to bites); and marks due to skin pathologies. Añihué Reserve proved to be a site suitable for long term cetacean studies even when collecting data directly from the shore, avoiding potential impacts of mobile observation platforms. The extremely low number of juveniles (N=5) and calves (N=1) from a total of 68 dolphins and, the high prevalence of skin diseases (N=35; 51.47 %), are a source of special concern. Their potential relationship with the local salmon farming industry, which has facilities on both coastal boundaries of the reserve, needs to be evaluated.

Key words: individual identification, *Lagenorhynchus australis*, natural marks, DVideo-ID, Añihué Reserve.

RESUMEN

Resultados preliminares de la técnica modificada DVideo-ID, aplicada en delfines australes, *Laghenorhynchus australis*, en Reserva Añihué, Chile. Ubicada en la costa continental del límite norte de la región de Aysén en Patagonia (43°47.93'S; 72°58.43'W), Reserva Añihué posee aproximadamente 17 millas náuticas de costa marina de gran diversidad ambiental. En playa Toninas, dos pequeñas elevaciones naturales, R1 (43°47.78'S; 72°58.72'O) y R2 (43°48.76'S; 72°58.78'O), fueron seleccionadas como observatorios desde donde fue producido el material gráfico en colaboración con voluntarios a lo largo de 2011, con luz diurna y estado del mar con fuerza inferior a cuatro (Beaufort), utilizando/probando varios modelos de cámaras SLR, ocasionalmente una video grabadora Sony HDR-FX7 y una cámara submarina Hero GoPro. Digikam, una aplicación de gestión fotográfica Linux/KDE, fue utilizada como base de datos SQLite gráfica para clasificar los cuadros y correr consultas basadas en selecciones de "etiquetas" de marcas naturales. Playa Tonina en Reserva Añihué, es visitada por al menos 68 individuos de *L. australis* que patrullan y forrajean en aguas poco profundas en pequeños grupos que pueden fusionarse ocasionalmente. Pese a la concentración estival del esfuerzo de registro, el material colectado incluye: delfines en todas las estaciones; distribuidas en 10 de las 15 combinaciones estacionales posibles (66,67 %); con un individuo reidentificado en todas las estaciones; varios individuos avistados en el verano fueron reidentificados en pleno invierno (N=11; 26,19 %); y más del tercio de los individuos (N=25) fueron identificados entre mediados de otoño y primavera. Estos primeros resultados, sugieren que las poblaciones costeras de *L. australis*, al menos en Reserva Añihué, presentan una alta fidelidad al sitio no apoyando las hipótesis previas de desplazamientos/migraciones estacionales significativos/as para la especie y aportan explicaciones alternativas a las variaciones estacionales de la abundancia registrada. El protocolo de identificación individual DVideoID, basado en el registro gráfico de marcas naturales producido desde plataformas móviles durante "seguimientos", demostró también ser confiable en modo estacionario de producción de datos. El método, basado enteramente en aplicaciones gratuitas de código abierto, fue modernizado al cambiar desde clientes tradicionales de bases de datos a una aproximación de base de datos SQLite gráfica basada en "etiquetas", simplificando la administración informática y es presentado en reconocimiento de las necesidades de estandarización metodológica. Las etiquetas que resultaron más útiles para la identificación individual de delfines australes, fueron las marcas de dientes por mordidas especialmente en la aleta dorsal, la presencia de muescas dorsales (cuyo origen también fue relacionado a mordidas) y las marcas producidas por patologías en la piel. Reserva Añihué demostró ser un sitio adecuado para el desarrollo de estudios cetológicos de largo plazo incluso colectando datos directamente desde el litoral evitando los impactos potenciales de las plataformas móviles. El número extremadamente bajo de juveniles (N=5) y crías (N=1) para un total de 68 delfines y la alta prevalencia de enfermedades de piel (N=35; 51,47 %) son una fuente de especial preocupación. Su relación potencial con la industria salmonera, con granjas en ambos límites de la Reserva, requiere ser evaluada.

Palabras clave: identificación individual, *Lagenorhynchus australis*, marcas naturales, DVideo-ID, Reserva Añihué.

INTRODUCTION

Chilean Patagonia has a complex geography, carved by the most extreme forces of nature, the action of glaciers and volcanoes resulting in a complex geography of thousands of islands, canals and fjords providing a great variety of unique and highly diverse environments. However, this complex geography also poses difficulties to connectivity. As expected, cetacean occurrence has been studied primarily following commercial pathways. In northern Patagonia, this is done mainly on the eastern coast of Chiloé island, complemented by the use of commercial vessels that supply the few urban sites in the continental coast of Los Lagos and Aysén regions, as opportunistic platforms. However, with the exceptions of a few cases (*e.g.* San Ignacio de Huinay Foundation), this strategy limits survey areas to primary shipping lanes, resulting in the majority of the continental inshore without systematic study effort of study, mainly due to the high access costs. The development of an intense and extensive salmon and mussel farming industry in this area (Bushmann *et al*. 1996; Sullivan-Sealey and Bustamante 1999), despite the lack of previous studies of cetacean population dynamics, adds instability and threatens the possibility of assessing coastal wildlife populations in their natural condition. The aquaculture industry, represented by moored farms and their associated services, is potentially a source of diverse threats including chemical and acoustic pollution, eutrofication, collisions, introduction of exotic species and habitat exclusion (Alvial 1991; Beveridge *et al*. 1994; Claude and Oporto 2000; Heinrich 2006; Ribeiro 2003; Ribeiro *et al*. 2005, 2007; Soto *et al*. 2001; Tobar *et al*. 2000; Van Waerebeek *et al*. 2007). In this context, systematic studies on the continental shore of Chilean Patagonia are urgently needed to both assess cetacean occurrence and diagnose the potential impacts of human activities.

The use of commercial vessels may be, in some cases, the only source of data and for a lower cost, but also may produce the least reliable data. Their path represents the area of highest nautical traffic, therefore, potentially, the area most affected by collisions, underwater noise (produced by vessels) and are not designed based on the habitat use of the species of interest but on navigation safety including little more than just the major shipping lanes. The ships are primarily ferries whose design and transport policies limit access to suitable on-board sites for survey sighting efforts. The primary commercial vessels or ferries in northern Patagonia are, M/V Pincoya (MMSI: 725001070) with 8.8 knots of average speed retrieved by the Automatic Identification System (AIS), M/V Alejandrina (MMSI: 725000344) with 8.6 knots of maximum speed (service or average speed were not available), M/V Mailén (MMSI: 725001080) with nine knots of average speed, M/V Evangelistas (MMSI: 725016600) with 8.4 knots of average speed and M/V Don Baldo (MMSI: 725000627) with 11.4 knots of average speed (Lekkas 2012; Naviera Austral 2012). Their low average speed has the potential of kin sampling production and therefore, strongly limits the accuracy of the surveys. Additionally, Patagonia is known by its severe weather conditions (*e.g.* more than 3,000 millimeters of annual rain in Chaitén - Meteochile 2012). Ports are frequently closed and navigation restricted even during the summer, limiting access to areas of study and also limiting how systematic these efforts can be.

Small boats have better access to the habitat used by coastal cetacean species, but have more limited range (*i.e.* availability of fuel and safe natural ports), are more affected by weather conditions and, limit the equipment that can be used (*e.g.* open cabin boats exposing the equipment to rain).

Considering this context, it seems useful to locate sites on the continental shore in front of Chiloé Island as they may be suitable for long term studies (*i.e.* private land with marine boundaries), nearby but not directly on the main shipping lanes and not entirely exploited by the aquaculture industry (*i.e.* with small and naturally protected bays and coastline areas still free from aquaculture farms and other mayor human activities). It appears it would be productive to invest efforts in these sites, to collect data independent of the season and navigation conditions. Moreover, data collected directly from the shore (*ca.* Ribeiro *et al*. 2005) would provide an approach without the potential negative impacts of boats (*e.g.* noise, collision trauma, responses by association with salmon farm boat services, among others).

Acquired for conservation purposes, Añihué Reserve (RA) is a private coastal reserve, providing most of the features previously described; it is now the site of an effort to provide basic infrastructure to develop studies of applied science with the goal of increasing knowledge about the local environment and providing solutions to the increasing threats it faces (Añihué Reserve 2012). The present contribution corresponds to the preliminary results of efforts recently initiated to assess the local cetacean populations there. Focused on Peale's dolphin, *Lagenorhynchus australis*, this manuscript looks to test the feasability to collect data directly from shore by elaborating a local individual identification catalog. If successful, this would allow long term studies with higher weather and nautical independence to be pursued. Non- invasive methods, as indirect studies based on natural marks, have to be applied preferentially since any harassment can result in negative associations from the subjects to the study site, undermining the main goals. Photo-ID or photographic individual identification of the members of a population can provide valuable information, minimizing errors when estimating population size and home range size, among their descriptors (Ballance 1987; Defran *et al*. 1990; Würsig and Würsig 1977; Würsig and Jefferson 1990). However, it demands great effort since its efficiency in producing identification frames is limited by the short time that individuals are at the surface; it also tends to limit the source of identifying marks to a narrow body section (*e.g.* dorsal fin). Sanino and Yáñez (2001) proposed DVideo-ID as a set of protocols governing the approach to the subjects, and data recording, processing, analyzing and management steps, while extending the source of graphic information to the entire body, short term natural marks (*e.g.* skin disease marks and even epiparasite presence) and introducing digital video as it was suggested by Würsig and Jefferson (1990) without the photographic timing restrictions. DVideo-ID resulted in a significantly higher efficiency than the traditional photographic method and contributed with a proposal for method standardization, but it has not been previously tested in a "from shore sit and wait" approach. A secondary goal of this contribution is to propose adjustments to this technique based on the current status of digital technology.

MATERIALS AND METHODS

Area of study and observation sites

Originating from tectonic, glacial, volcanic and sedimentary forces, Añihué Reserve (RA; 43°47.93'S; 72°58.43'W) is located on the continental coast of Cisnes Commune, at the northernmost limit of Aysén Region (ca. Región Aysén del General Carlos Ibáñez del Campo) in Chilean Patagonia (see Figure 1).

Palena River separates the property from the closest town, the small port of Raúl Marín Balmaceda. The Reserve's sandy and rocky shores, with several coastal islands and islets, face to the West towards the Corcovado Gulf. To the north, RA is close to Pitipalena, an important inland water body that provides natural protection to marine species during winter storms; it receives two branches of the Palena River. To the

South, RA is the northern limit of Las Guaitecas Archipelago, close to Refugio Channel and includes the delta of Añihué River. Therefore, RA includes, in a small area, a high diversity of environments.

Previous reports of the presence of cetaceans, from local inhabitants of Raúl Marín Balmaceda, RA's General Manager Felipe González-Díaz and sighting records from Nomads of The Seas' scientific tourism operation (PS unpublished data; Sanino 2011), included several coastal and offshore dolphin species ranging in front of RA's coastline, with *Lagenorhynchus australis* (Peale's dolphin) being the most abundant species followed by *Cephalorhynchus eutropia* (Chilean dolphin). This contribution only includes information regarding *L. australis*. RA has three wooden cottages in front of a 2.1 km long sandy beach known as "Tonina" (*ca*. small dolphin); as this is the location of the main infrastructure of the Reserve's marine coastline, it therefore was selected for this preliminary study.

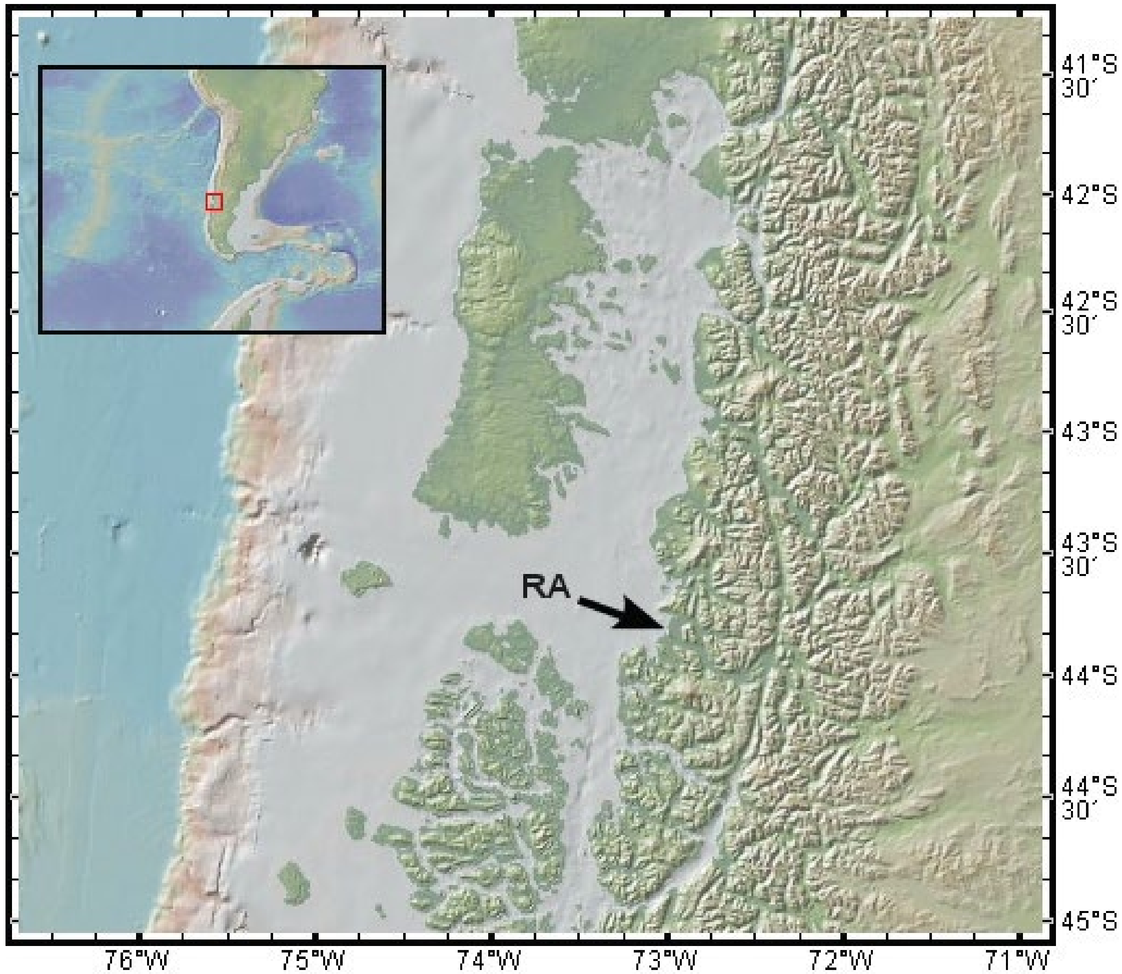

FIGURE 1. Location of Añihué Reserve (RA) in Aysén Region, Chilean Patagonia.

The beach has two natural sites or rocky mounds of higher elevation (of about five meters), 1,800 meters apart, that were selected for survey sighting efforts. The observatory "Roca 1" (R1; 43°47.78'S; 72°58.72'W), located at the northernmost limit of Tonina Beach, has a 106º horizontal field of view centered at bearing 237º and includes a basic wooden shelter to allow surveys regardless of the weather. "Roca 2" (R2; 43°48.76'S; 72°58.78'W) is located close to the southernmost limit of the same beach, has 114º of horizontal field view centered at bearing 323º and is located 130 meters from a cottage (see Figure 2).

Observers and equipment

Volunteer applications were received by Añihué Reserve and the Centre for Marine Mammals Research LEVIATHAN. Volunteer candidates were selected based on their motivation, prior experience with SLR cameras and ability to undertake field work in remote areas. After a two day training workshop, the final volunteers were selected to participate as both observers and data collectors in RA. Observers were located at R1 and R2, singly or in pairs, with binoculars (7x50), android phones and SLR cameras from 9:00 to 12:00 and from 14:00 to18:00 every day except Sundays. During 2011, observers used their own cameras, with lenses of 200 millimeters or less. A Nikon D300 SLR camera with a VR 400 millimeters lens was provided to the project. In December 2011, an SLR camera (Nikon D5100 / 55-300 mm) was acquired to contribute to these efforts. Additional cameras were tested with the support of the volunteers' personal equipment, including: Canon S2-IS, Canon EOS Rebel XS, Nikon D3000 and Nikon D3100.

Occasionally, video and photography data, including underwater video (GoPro Hero), were collected from a boat belonging to the Reserve, Añihué M/V; a seven meters long, polyethylene plastic boat with two Yamaha 100 HP 4-stroke engines and a fiberglass closed cabin.

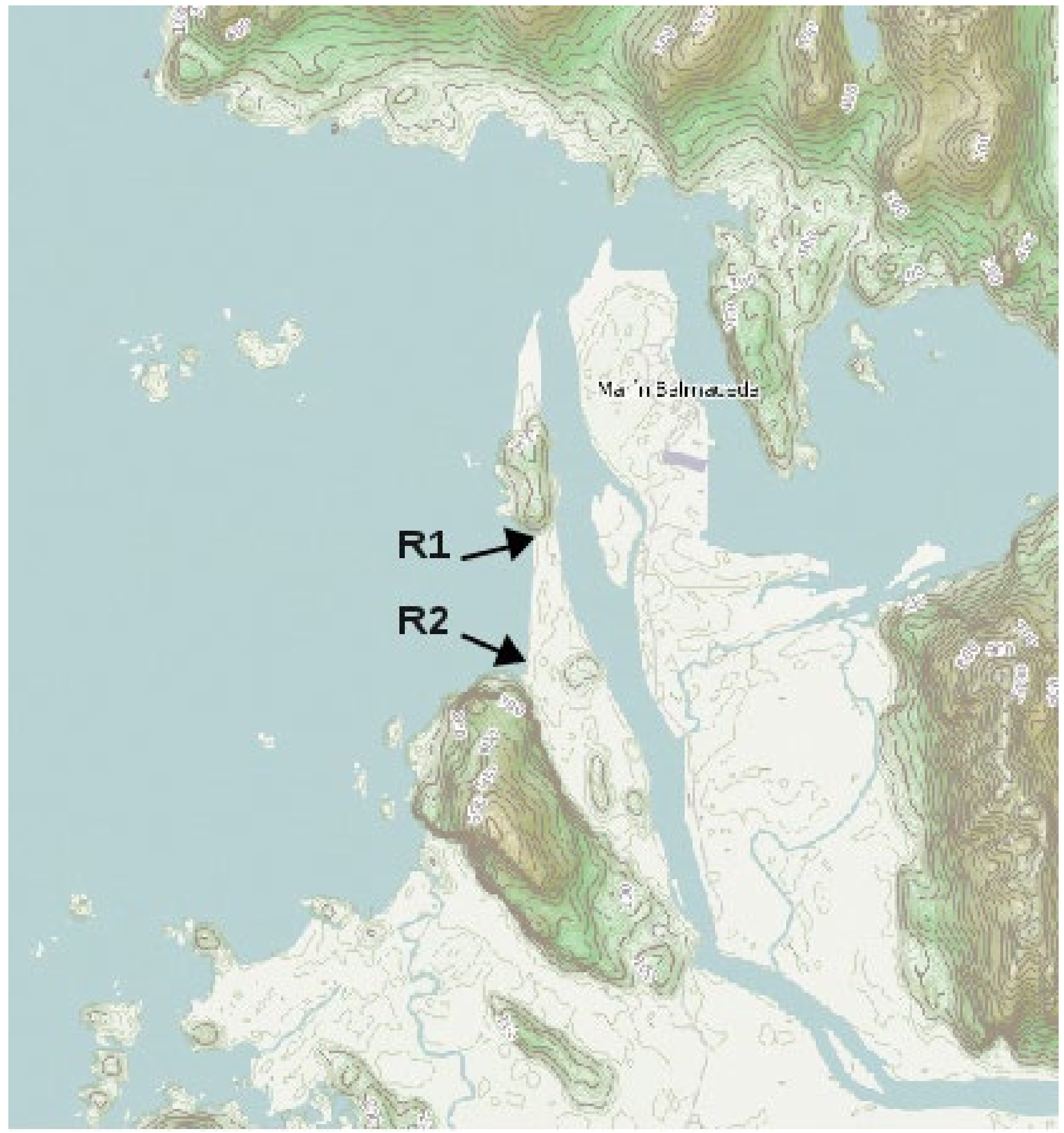

FIGURE 2. Location of observation sites at Añihué Reserve, R1 and R2.

During three days, a 20X camcorder (Sony HDR-FX7) was used from shore as well as from the boat in order to test the potential of HDV/1080i standard digital video in producing ID frames.

Dolphin individual identification

GENERAL METHOD

We applied DVideo-ID technique for dolphin individual identification (Sanino and Yáñez 2001) with adjustments described here in order to address that data is collected from fixed locations on the shore rather than from a moveable platform (*e.g*. boat).

APPROACHING THE DOLPHINS

Sanino and Yáñez (2001)'s contribution was mainly designed to be used when approaching dolphin from boats. However, coastal dolphins of RA swim at less than 50 meters from the shore, just behind the main waves in waters with a seabed at three meters depth or less. It was decided not to use boats as the primary platform for data collection because: use of Leviathan II, our sailboat for research purposes, would have been unsafe this close to shore; available kayaks do not provide enough height to produce the requested material both in quality and abundance; and we do not agree with stressing the individuals by positioning them between the shore and a boat which also could result in negative responses from the dolphins (*e.g*. evasion) and therefore, pose more difficulties for our work. The main source of the collected data was from land, reducing potential perturbation caused by the presence of boats; the occasional use of the RA's motorboat was limited to approach dolphins only in deeper waters or, mooring it at specific and safe sites following the protocols proposed by Sanino and Yáñez (2000).

IMAGE PRODUCTION

Recording video or taking photos of cetaceans presents several problems, sourced from the observer as well as from nature itself. The first problem is focus. The use of manual focus is desirable but restricted to only very experienced users because the time of the animals at the surface is very short and the exact site is not always predictable. Therefore, the most common focus setting is autofocus. However, autofocus presents some limitations because both the subject and background are moving and not always with enough contrast creating the conditions for the camera's processor to change the focal length back and forth repeatedly without achieving focus lock, a process known as "focus hunting" (Erkes 2012). In general, with SLR cameras, we selected the preset mode for fast/sport with centered single point autofocus, considering that several of the observers were inexperienced with this equipment. More experienced users tested the efficacy of Nikon's 3D focus tracking feature, expected to increase the AF cycle speed by automatically shifting the focus point to multiple focus areas to track fast moving targets (Nikonusa 2012). Whenever light allowed it, the camcorder's shutter speed was set on 100 fps or more and qualitative tests were done from the land and the boat with autofocus (single point and 3D focus tracking) and manual focus. Tests with and without tripod and steadycam (*i.e*. steadycam Merlin) support also were performed.

Underwater video was attempted from RA's motorboat with a GoPro camera attached to a pole. These were dragged aside RA's motorboat during dolphin bow and wake-riding events, following the protocol to approach dolphins "without stops" proposed by Sanino and Yáñez (2000), but with speed between seven and 14 knots based on tests with L. australis in the same region previously undertaken by Nomads of the Seas (Sanino, unpublished data).

In Patagonia, the weather often includes heavy rain, limiting the time that lenses can be exposed in order to record images. In addition, the subjects tend to change their behavior by limiting surface time and, waves mask the bodies, limiting the general sightability. The behavior of the subjects can also either contribute to or make more difficult the collection of good identification images. The closer they approach to the observer and the longer their surfacing time, better results can be achieved. Observers were instructed to collect graphic vouchers of every sight event, but only attempt to produce material for individual identification when Beaufort wind force was lower than four, without rain and when natural marks were visible with binoculars.

Observers were requested to use a default "zooming" technique based on setting their zoom feature out until framing the subject(s) and then rapidly zooming-in all the way while continuously shooting, then repeating the process again. This way, the time to frame was diminished and some of the photos had a higher chance to achieve a closer look.

ID FRAME SELECTION

The ID frames resulted from the selection of photos as well as frames captured from the camcorders, all produced and transferred in digital format to a PC computer (AMDx64 with OpenSuSE Linux 12.1). The images from the SD memory cards were detected and downloaded directly by the open source application Digikam (v. 2.5.0) with kipi-plugins temporarily to a common subfolder named "NN", under a main ID folder. Images from video were transferred from miniDV tapes by connecting the camera to the computer with a firewire cable (IEEE1394) when using the FX7 camcorder; directly from the SD card when using the GoPro underwater camcorder; and retrieving the video files with the GNU General Public License 2 application for video edition Kdenlive (v. 0.9.2). By using the "Timeline" tools, the best frames were selected and then captured onto single image files (1440x1080) with the "Extract Frame" tool; these files were stored together in the same folder as the images downloaded with Digikam.

Images were qualified based on criteria proposed by Sanino y Yáñez (2001), then were considered ID frames (even partial body images) when they presented no significant technical defects; contained any recognizable natural mark(s) bigger than 50x50px; and a dorsal fin height of at least 100px. Other images were not included in the ID catalog production, but qualified following Sanino and Fowle (2006) for other purposes. An arbitrary and qualitative score was assigned to each ID frame, by using Digikam's "stars" feature, with five stars being the highest level of quality. The highest-rated ID frame was assigned as the individual's "Album Thumbnail". Comments on the images were noted in their "caption" section under "Description".

ID FRAME CLASSIFICATION

Perhaps the most important improvement of the DVideo-ID method presented here is the technique to classify ID frames. While the original method proposed using an album manager to graphically sort and compare the images, it used a separate database to assign to each individual a set of discrete characters based on their source and body location, totaling 100 options (Sanino and Yáñez, 2001). The form, ID details, served then to perform queries on the catalog by selecting among the options, those shared with a candidate ID frame to reduce the size of the material to be compared with the candidate that will become a new individual or become a re-identification of a known individual. By using this query, the effort to compare the material is reduced regardless of the size of the entire catalog. For the present contribution we profit from the fact that Digikam is in fact a graphic interface to a SQLite database. Then providing all the features of SQLite databases, in a graphic way instead of through SQL coding, in the same application where the images are visually managed and compared. For queries outside Digikam, its database file was able to be connected to SQLite browsers (*e.g*. Spatialite-gui) and even LibreOffice.base (an opensource office suite) using an OBDC converter.

One album, or folder, was assigned to each individual. The album's "caption" feature was used to add quick notes as well as the information that the original DVideo-ID method managed through the ID form.

ID frames were described by noting all the contained marks suitable for individual identification. Therefore, the characteristics that were managed at the individual level by DVideo-ID, were now addressed at a lower level; on each ID frame. The lower level did not increase the numbers of individuals with whom to compare a candidate ID frame with, because when performing a query/search, the results were sorted by individuals. The identification properties of the ID frames are noted in Digikam by using the "Tags" right sidebar feature that inserts them on the file's metadata (*i.e*. EXIF), by using the "Write Metadata to all images" feature or assigning this action as default on the application's settings. To write metadata to the image files was not necessary but resulted useful as a backup as well as when the ID database/catalog has to be copied or moved to another computer. The information of the Tags is transported contained in the image files.

Some images included more than one individual in the frame. For these cases, the images were copied into as many album folders as individuals they contained. To specify which individual was addressed by each individual album, a text noting its plane on the image was added to the file's description (x-default caption metadata on the right side bar), with the individual on the first plane being the closest to the camera. Then the information was transferred to the image's metadata, acquiring the described benefits. Additionally, for these cases, we used the "people" tag feature with the code of the individuals. This information was internally stored only on Digikam's SQLite database file, but became a useful tool to tag, the identification of each individual directly on the image and then search specific individuals with the filter feature.

INDIVIDUAL CODING

The folder for each individual was named with a unique code, of the form "RAx_y" to identify the subjects; where "RA" is for the location "Reserva Añihué", "x" as a number corresponding to the generation (being "a" for the adults, "a+1" for juveniles, and "a+2" for calves, and all new individuals increasing in one respect the previous year), and "y" as an incremented number corresponding to the individual (see Table 2).

NATURAL MARKS

The Tags were designed based on natural marks described in the IDetail form of DVideo-ID; attempts were made to keep them as simple as possible but containing easily recognizable characters that contribute to re-identification. The list included modifications, based on characteristics of L. australis, that were useful for identification. To ease the process of addressing the location of body marks, even by inexperienced contributors, we proposed the use of a simplified method of sectioning the body. These included:the fins; in antero-posterior direction, the head as the area from the snout tip to the anterior margin of the flippers; next the thorax, until the anterior margin of the dorsal fin (for species with dorsal fin not located in the central area of the body or without it, we propose the use of the lower rib as the margin); then the abdominal section with posterior margin at the level of the anus, recognizable also by its inflection of the ventral margin on a lateral view; and the peduncle limited by the anterior margin of the flukes. The tags were set in Digikam as a tree with root on "My Tags", then "ID" and "Cetaceans". A "species" tag, was added to use the tree for additional species as well. The description of body marks considered is presented by the next table.

INDIVIDUAL TAGS SUMMARY

After selecting the corresponding tags for each ID frame, the individual's attributes are distributed among the images composing its album. As previously mentioned, the album's properties can be used to add notes describing the individual's characteristics but they are not transferred to the metadata and they do not provide a graphic summary for quick checks. Three images were added to each album, corresponding to the schematic drawing of each body side and the left profile of the dorsal fin. As file names, we used the individual's code but adding "0_" to the left side and "1_" to the right side, to serve as an individual reference and in order to appear listed first among the files of each dolphin.

These images were modified with Gimp image editor in order to include the individual's characteristics graphically, using layers for each type of natural mark, and were also assigned all the tags of the individual. These images were saved in Gimp XCF file format to preserve transparency and layer structure for future reference and modification. Then, each of these images corresponded to a graphical summary of the individual's entire body size and became accessible by the filters/queries. Two ways to modify the graphics were used: a) directly altering the image using an editor (e.g. Gimp) and/or b) manually drawing the features directly on the printed images and scanning them until having the time to modify the original files. The second way (b) was used also to introduce the information retrieved from direct analysis of the videos.

SEARCH AND COMPARISON PROCESS

To compare an ID frame with the catalog to test if it corresponds to a known individual, the candidate picture was first characterized with tags. These tags, all at once or by separate searches became the criteria to request Digikam to list all the matching ID frames, decreasing the number of comparisons to make.

Digikam provides several tools to search or filter the catalogs. We selected a combination of tools, staring by switching from "Albums" to "Tags" tab on the left side bar. A tree with the Tags was presented, where single tag queries could be done in one step. To search the catalog based on a multi-tag criteria, two steps were needed: a) select the species under Tags tab on the left side bar to set the ID frames universe where to search, and b) the selection of specific tags with the "Tags Filter" option under the "Filters" tool of the right side bar. The "Tag Matching Condition" was set on "AND" instead of the default "OR" option to get an additive effect between the selected tags during the filtering process. The search then produced a list of ID frames matching with the selected tags, sorted by albums (individuals in our case).

TABLE 1. Description of the individual identification characters used as tags to classify graphic material from Añihué Reserve.

Mark	Options Description
2-View	Since the purpose of the tags is to allow re-identification of individuals based on external marks of the entire body, the view of the frame/photo was addressed by this tag section as: 2a.Dorsal; 2b.Right side; 2c.Left side; and 2d.Ventral.
3-Teeth	Skin marks, represented by equidistant parallel lines separated by less than seven millimeters, were attributed to bites originated by intraspecific interactions and noted as "teeth marks". These were differentiated from predation bite marks, based on the relative distance between the consecutive teeth marks. When the scar is in focus and the image was taken with any of the two main Nikon SLR cameras, we were able to calculate the distance between the line marks, based on the "Focus Distance" length information included in the NikonLd2 or Ld3 section of the *Makernote* Metadata of the file; information stored automatically in every photo and accessed with Digikam by the "Metadata" sidebar feature. Teeth tag was decomposed by body section: 3a.Head; 3b.Thorax; 3c.Abdomen; 3d.Peduncle; and 3e.Dorsal fin. Additionally, three complementary tags were added to track the evolution in time of these marks: 3f.Actual for Teeth marks with pink/reddish color or with white material (fat) protruding from the injuries; 3g.Recent for marks brighter than the adjacent skin; and 3h.Old for marks of the same or darker tone than the adjacent skin.
4-Dorsal nicks	The presence of notches or nicks on the trailing edge of the dorsal fin, were addressed by their number (4a.0, 4b.1, 4c.2 to 4, and 4d.More than 4) as well as by their vertical location(s) (4f.Upper third; 4g.Central third, and 4h.Lower third). Sanino and Yáñez (2001) recognized on the trailing edge of the dorsal fins, parts significantly thinner in some *Tursiops truncatus*, assigned as "dorsal weaknesses" that probably would become, in the near future, the sites of notches/nicks, and, therefore, recommended to include them as identification characters, particularly for young individuals still without nicks. We included this character in the tag "4e. Dorsal weakness".
5-Probable skin disease	Often, skin disease presents external symptoms easily recognizable providing not only a useful character for pathology monitoring, but also a valuable tool for short term individual comparison. Lesions and scars of poxvirus/tattoo skin disease (TSD) have been recorded in the region (Sanino *et al.* 2008; Van Bressem *et al*, 2009a, 2009b) and are suitable for individual identification. As an identification character, skin disease lesions and scars were addressed by their location (5a.Head; 5b.Thorax; 5c.Abdomen; 5d.Peduncle; and 5e.Dorsal fin).
6- Probable collision trauma	Van Waerebeek *et al* (2007) presented graphic evidence of collisions that may indirectly become a useful mark source for individual identification on surviving specimens. Depending on the angle of a bite, teeth marks may resemble superficial linear lesions caused by contact with a boat's hull (Sanino and Yáñez, 2001). Therefore, we only attributed trauma presented as linear open wounds or deep linear scars to probable collisions with the hull of boats, and curved deep parallel cuts to trauma caused by contact with propellers. Probable collision trauma was addressed by the location of the marks (same anatomical sections of other tags but assigning them the number "6") but without specifying the source of it.
7-Probable fishing trauma	From field observation evidence, longline/net entanglements tend to produce linear superficial wounds, single or in few parallels, sometimes accompanied by compression of the skin; these are thinner than teeth marks on the body. On fins, they can produce deep single cuts similar to propeller trauma, but straighter and without the close parallel cuts. Single or few, parallel, thin and straight skin body marks or single straight and deep cuts on fins were assigned with the Probable fishing trauma tag and addressed by their location on the body (same anatomical sections of other tags but assigning them the number "7").

TABLE 1: *Continuation*

Mark	Options Description
8-Unidentified line	Straight lines of an unclear source, were assigned to Unidentified line tag, addressed by the location on the body (same anatomical sections of other tags but assigning them the number “8”).
9-Dark dot	Color pattern in *L. australis*, particularly on the margins between the clear and dark areas, presents imperfections in the pigmentation that are suitable to be used for individual identification, but require outstanding, and therefore rare, image quality. However, some individuals did present distinct dark dots inside the clear patterns on their body, resulting in a useful mark. Special care was taken to differentiate dark pigmentation dots, and those artificially created by the shade of water drops suspended on the air. During training periods, the use of high-speed continuous shooting or video provided consecutive images to help distinguish the drop shade from dark pigment dots. Dark dot tag was addressed by the location of the mark on the body (same anatomical sections of other tags but assigning them the number “9”).
10-Unidentified spot	Distinct spots on the skin of unclear source, were addressed by the location of the mark on the body (same anatomical sections of other tags but assigning them the number “10”).
11-Dorsal bitonality	*L. australis* presents a dorsal fin with a bi-tonal pattern with, in general the leading edge darker than the trailing edge. However the proportion of dark v/s clear varies among individuals, providing an additional character for individual identification; this is particularly useful when identifying individuals without distinct notches. The Dorsal bitonality was addressed by the following tags: 11a. All dark; 11b. Mostly dark (more than half); 11c. Half; and, 11d. Mostly clear.
12-Dorsal shape	Dorsal fin shape also varies among individuals, providing a useful tool for identification, particularly among small groups. The Dorsal shape was addressed by the following tags: 12a. Falcate; 12b. Curved hook; 12c. Short triangular; 12d. Tall triangular; 12e. Blunt; 12f. Sharp; 12g. Anterior bulk (some dorsal fins presented a distinct prominence on the lower section of their leading edge); and 12h. Trauma (presence of a severe partial or complete injury regardless of the probable cause).
13-Sex	Sexual behavior provided complementary attributes that in small groups of dolphins was useful for individual identification. The female tag was assigned to adults with the permanent presence of a calf nearby. The male tag was attributed to individuals that consistently displayed a behavior of swimming upside down under other adults, or when a penis was visible.

Because Digikam sorts the Tags alphabetically on the Tag tree, we used numbers in order to have them displayed in a user- defined manner. To assign a tag to an ID frame, the box of that tag was selected. An empty or not selected Tag box was considered as a lack of information and not the absence of a mark.

To visually compare a candidate picture with others from the catalog, Digikam provides a tool named “light table”. A window where several images can be compared together, regardless their location and without having to copy them. The candidate ID frame was then exported to the Light table (Ctrl+L or “Place onto Light Table”). Then the search was performed and the ID frames of the catalog better matching the candidate where exported as well to the Light Table (Ctrl+shift+L or “add to Light Table”), where each picture was able to be displayed with temporary applied effects (e.g. zoom, framing), helping the comparison.

To produce the intended search, special care had to be taken to select only the right tags. If the result of the search produced no pictures, then a more general query had to be used. For example, by selecting the tag “3-Teeth” and deselecting any sub-tag about teeth, the search produced all the ID frames with marks attributed to teeth bites regardless their anatomical location.

RE-IDENTIFICATION PROCESS

Right after assigning the first ID frame to the first identified individual, the chances of re-identifying an individual begin. This is the process by which an ID frame is compared with those already assigned to individuals, with the possible outcomes of being assigned as a new individual, a re-identification of a known individual or set in standby temporarily.

A re-identification occurs when identification marks of the candidate picture match those from a known individual. However, to assign a new individual is more complex because two conditions have to be satisfied; 1) the candidate has to fail in matching the catalog of known individuals, but also 2) it has to prove that is different. In other words, it can happen that the catalog of known individuals is composed by pictures from the right side of the body. Then we get a picture from the left side of the body. Assuming in this example that no characters were shared between the two sides, the candidate will easily satisfy the first condition since the left side does not match with the catalog. However, we cannot argue with confidence that this is a new individual, because it can happen that it corresponds to an already known dolphin but characterized only by the right side of its body. Then the first condition does not allow, on itself to exclude the possibility that the candidate corresponds to a known dolphin. To be assigned to a new individual, the candidate should be able to be excluded from the known catalog. To do that, a second comparison has to be done to check if in all the individual albums, there is at least an ID frame that shows a comparable area of the body and the marks are still comparable based on their relative duration. If all the albums contained material comparable to the candidate frame (ca. body side, angle), but their marks differ to the candidate (e.g. dorsal fin shape, nicks, teeth marks), then a new folder/album was created in order to locate the candidate picture assigned as a new individual.

Those ID frames that satisfy the first but not the second condition remain temporarily in the NN folder until the second condition can be tested. Subfolders NNx were used to locate groups of ID frames of this status that were known to correspond to the same NN individual despite its “Standby” status.

Mr. Felipe González-Díaz, General Manager of Añihué Reserve, undertook an intense training on each step of the individual identification technique described here, both in the field and in the laboratory, and oversaw the volunteers’ performance in the field. To limit the diversity of criteria during the process, one of the authors (GPS) made the final validation of the ID catalog.

Folders or individual album containing more than one ID frame collected from sighting events of different days were renamed by adding the text “- reID” and the individual considered re-identified.

RESULTS

Individual Identification

Dolphins were sighted from the shore in Añihué Reserve, generally in small groups with school size of less than 12 individuals. There were a few exceptions of school sizes of approximately 30 individuals; these were recorded mainly by underwater video deployed from a small boat.

Between January and December 2011, 773 ID frames attributed to 68 individuals of *L. australis* were produced, corresponding to 62 adults, five juveniles and one calf. Among the identified individuals, 42 were also re-identified. Some individuals were distinct but limited graphic material (*e.g.* one body side) did not yet allow us to test if they corresponded to a previously identified individual. These 22 candidates

TABLE 2: Individual identification catalog based on tags of coastal L. australis at Añihué Reserve.
Tags are identified by their code, listed in Table 1, and noted in binary style corresponding “1”to the presence of the tag and “0” to its absence.

Inds.	3a	3b	3c	3d	3e	3f	3g	3h	4a	4b	4c	4d	4e	4f	4g	4h	5a	5b	5c	5d	5e	6a	6b	6c	6d	6e	7a	7b	7c	7d	7e	8a	8b	8c	8d	8e	9a	9b	9c	9d	9e	10a	10b	10c	10d	10e	11a	11b	11c	11d	12a	12b	12c	12d	12e	12f	12g	12h
RA2-1	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0
RA1_1	0	0	1	1	1	0	1	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0
RA1_2	1	0	1	1	1	0	1	0	0	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0
RA1_3	0	1	1	0	1	0	1	1	1	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	1	0	0	0	1	0	1	0	1	0
RA1_4	1	0	1	1	1	0	1	1	0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	1	1	0	0	0	1	1	0
RA1_5	0	0	0	1	1	0	1	0	0	1	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0
RA1_6	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
RA1_7	0	0	0	0	1	0	1	0	0	0	0	1	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
RA1_8	0	0	0	0	1	0	0	1	0	1	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	1	1	0	1	0	0	0	1	0	0	0	1	0	1	0	0
RA1_9	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0
RA1_10	0	0	1	1	1	0	1	1	0	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1	0	0	0	0	1	0	0
RA1_11	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
RA1_12	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
RA1_13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	1	0
RA1_14	0	0	1	1	1	0	1	1	0	0	1	0	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0
RA1_15	0	0	0	0	1	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
RA1_16	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	1	0	0	0	1	0	0	0
RA1_17	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	0	0	0	0
RA1_18	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
RA1_19	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0
RA1_20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RA1_21	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0
RA1_22	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0
RA1_23	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	1	0
RA1_24	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0
RA1_25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
RA3_1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
RA1_26	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
RA1_27	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0
RA1_28	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	1	0	1	0	0	1	0	0	0	0
RA1_29	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0
RA1_30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
RA1_31	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	1	0
RA1_32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0
RA1_33	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0
RA1_34	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	1	0	0
RA1_35	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0
RA1_36	0	0	0	0	1	0	0	1	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	1	0	0	0	0	1	0	0	0	0
RA2_2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
RA1_37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	1	0
RA1_38	0	0	0	0	1	0	1	0	0	1	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0
RA1_39	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	1	0
RA1_40	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0
RA1_41	0	0	0	0	1	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0	1	0	0	0	0	1	1	0
RA1_42	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	1	0
RA1_43	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0	1	0	0
RA1_44	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	1	1	0	0	0	0	0	1	0	1	0	0	0
RA2_3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0
RA1_45	0	0	1	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
RA1_46	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	1	0
RA1_47	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
RA1_48	0	0	1	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	1	0	1	1	0	1	0	0	1	0	1	0	0	0	0	0	1	0
RA1_49	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0
RA2_4	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	1	0	0	1	0	0
RA1_50	0	0	1	0	0	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0
RA1_51	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0
RA1_52	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
RA2_5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	1	0	0	0
RA1_53	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0
RA1_54	1	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0
RA1_55	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	1	0	0	0	0	1	0	0
RA1_56	0	0	1	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
RA1_57	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0
RA1_58	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	0
RA1_59	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1
RA1_60	0	0	1	1	0	0	0	0	0	0	1	0	0	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0
RA1_61	1	0	1	1	1	0	1	1	0	1	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0
RA1_62	0	0	1	0	0	0	0	1	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1	0

were kept temporarily as NNx. Among them, eight were re-identified.

The following table presents the individual identification results based on accumulated tags obtained from data gathered during 2011 in Añihué Reserve.

Tags and natural marks

Only tags related to trauma attributed to fishing interactions were not represented in the analyzed material; individuals were assigned an average of 10.69 tags. The number, position and type of dorsal fin nicks were particularly useful since the mark is visible from both sides of the body; they were present in 38 individuals (55.9 %). However, in several cases, these were visible only on the highest quality images (see Figure 4). Teeth marks useful for identification were found on 34 individuals (50 %), present on all sections of the body, but were particularly abundant on the dorsal fin and in some cases in the dorsum, visible from both sides. Teeth marks tend to remain over time but change from a clear color (or absence of pigment) to a darker tone (see Figure 3).

FIGURE 3. Sample of changes in teeth marks over time; used for individual identification of Peale’s dolphin, *L. australis*, in Añihué Reserve, Aysén region (Patagonia – Chile). Black arrow indicates the site of teeth marks, with the right picture taken 172 days after the left picture.

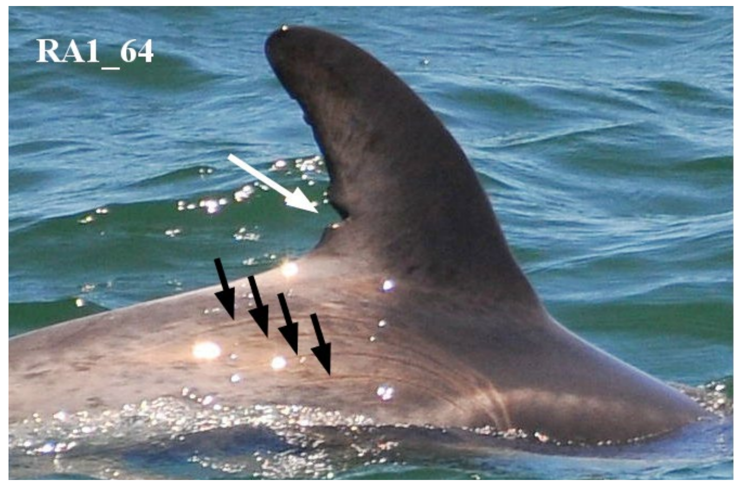

FIGURE 4. Sample of teeth marks /bites attributed to predation on Peale’s dolphin, *L. australis*, in Añihué Reserve, Aysén region (Patagonia – Chile). Black arrows indicating individual teeth marks; white arrow indicating a distinct nick.

Few changes in the number or shape of nicks were recorded in the year; these mostly were associated with the appearance of new teeth marks.

While the abundant teeth marks were attributed to intraspecific and most probably intra-population interactions, characterized by several linear and parallel marks equidistant by almost the same width as the lines themselves (ratio separation v/s line width around 1:1), some cases included teeth marks characterized by wider and longer lines separated by a space approximately 10 times their width (10:1 of ratio of separation v/s mark width) greatly exceeding the separation between teeth for the species (e.g. individuals RA1_14 and RA1_62). Based on their shape, these marks were attributed to cetacean bites from larger odontocetes, likely orcas, considering the teeth separation, and therefore they were assigned as natural predation marks (see Figure 4).

The heterogeneous distribution of pigment patches provided natural marks that were both useful for individual identification and reliable over time. However, the most distinct marks were also those with the shortest life span. Skin disease marks of several types (TSD or poxvirus and others) were present on 35 individuals (51.47 %), and distributed on all body sections. The next figure illustrates a sample variety of skin disease marks.

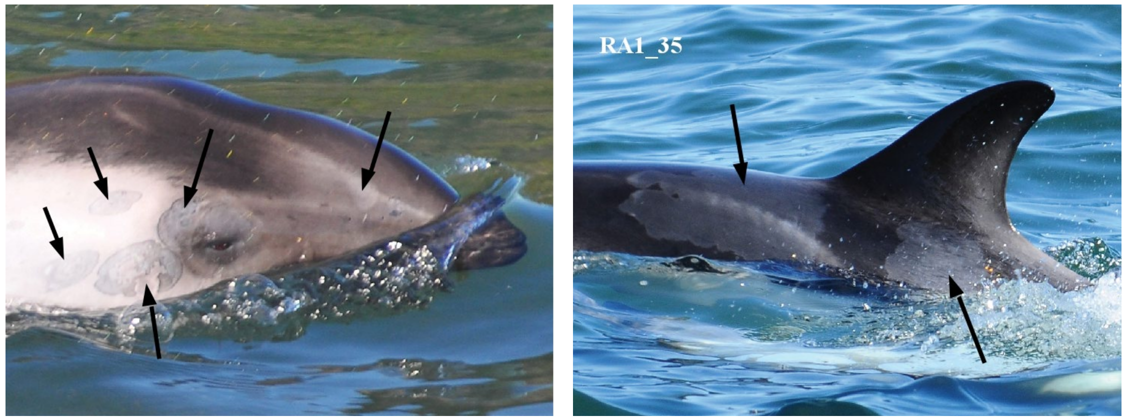

FIGURE 5. Sample of skin disease marks used for short-term individual identification of Peale's dolphin, *L. australis*, in Añihué Reserve, Aysén region (Patagonia – Chile). Black arrows indicate the location of pathological lesions.

The most distinct marks were of a traumatic source, including injuries on several body sections. The dorsal fin was the most common site of severe injuries. The origin of the trauma was attributed in some cases to interaction with boats; therefore, they were not assigned as "natural" marks but were used anyway for individual identification. The next figure shows some of the most distinct and frequently re-identified cases.

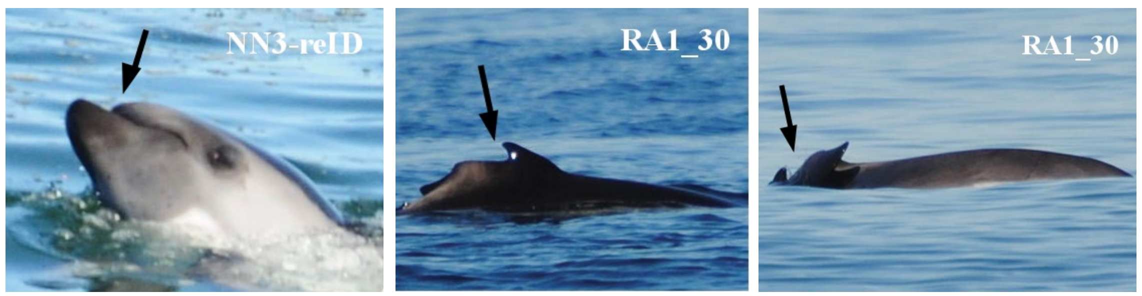

FIGURE 6. Sample of marks of a traumatic origin, used for long-term individual identification of Peale's dolphin, *L. australis*, in Añihué Reserve, Aysén region (Patagonia – Chile). Black arrows indicating the location of the marks. Central and right images belong to the same individual, with its dorsal fin almost completely severed.

Individual Occurrence

To simplify the analysis of time distribution of the re-identified individuals for the analysis of data from 2011, the records were grouped by week. The individuals' records ranged from one to seven different weeks (X : 2.04; SD: 1.28), and the individual seasonal occurrence resulting from the numbers of subjects grouped among the 15 possible combinations of seasons is presented by next table.

TABLE 3. Individual seasonal occurrence of *L. australis* in 2011, as the number of individuals recorded among the 15 possible combinations of seasons in Añihué Reserve.

	Season combinations	Inds.	%/total
1	Summer	31	45.59%
2	Autumn	0	0.00%
3	Winter	5	7.35%
4	Spring	4	5.88%
5	Summer + Autumn	2	2.94%
6	Summer + Winter	3	4.41%
7	Summer + Spring	14	20.59%
8	Autumn + Winter	0	0.00%
9	Autumn + Spring	0	0.00%
10	Winter + Spring	1	1.47%
11	Summer + Autumn + Winter	1	1.47%
12	Summer + Autumn + Spring	0	0.00%
13	Summer + Winter + Spring	6	8.82%
14	Autumn + Winter + Spring	0	0.00%
15	Summer + Autumn + Winter + Spring	1	1.47%

Image quality

As expected, autofocus provided better results under sufficient light conditions and/or with cameras with fast processors. Lower light conditions increased "focus hunting" problems and manual focus offered better chances of success. In general, centered single point autofocus provided the best results. However, 3D focus track feature increased the number of images with accurate focus during continuous fast shootings, as long as the subject presented a high contrast compared to the background and the late was not rich in moving elements distracting the processor from the subject (*i.e.* very small waves caused by fast changes of wind speed).

Shooting photos or videos from a boat did tend to transfer the movements of the boat to the camera even inside small and calm bays due to the wake created by our own boat. The use of steadycam significantly diminished the unbalance but it prevented the user from adjusting the camera to frame and zoom at the needed speed considering our moving targets, producing even more difficulties particularly with short distances (less than 30 meters). The use of stabilizers (*e.g.* steadycam) resulted in benefits only from an aesthetic approach. In comparison, the shooting from the shore did not involve the same problems as doing it from the boat but, the subjects tended to be farther posing difficulties to match the focus point with the subject. As expected, the use of oiled head tripods from the observatories tended to minimize the focus problems even while following the moving targets; this is particularly useful under lower light conditions. Shooting with the use of remote controls (wired or wireless) had to be assigned to the hand used on the tripod's handle during target tracking with photo cameras. The same results were achieved with the inexpensive Sony VCT-80AV Remote Control Tripod for the camcorder while eliminating the need of the built-in steadyshot feature.

CONCLUSIONS AND DISCUSSION

Inshore presence of Peale's dolphins in Añihué Reserve

Tonina Beach in Añihué Reserve is visited by at least 68 individuals of *L. australis*, patrolling and foraging in very shallow waters in small groups that may occasionally fuse into larger numbers.

Seasonal movements have been proposed for Peale's dolphins in some areas mainly based on seasonal variations in the recorded abundance from coastal surveys (Goodall *et al*. 1997; Lescrauwaet 1997) as well as from platforms of opportunity (Viddi *et al*. 2010), despite their recorded presence year round and non-comparable study efforts between the seasons; hence there is evidence for seasonal changes in abundance and differing use of inshore areas, but the direction of movements remains unknown (Heinrich 2006).

Despite the higher recording effort in summer (more personnel and better climate conditions) than during other seasons in 2011, the collected graphic material includes dolphins in all seasons; in 10 of 15 possible seasonal combinations (66.67 %); with RA1_28 re-identified in all four seasons; re-identifications in winter of individuals sighted during summer (N=11, 26.19 %); and more than a third of the individuals (N=25, 36.76 %) were identified between mid-autumn and mid-spring. These first results support the hypothesis that the presence of coastal L. australis at population and individual level presents a high fidelity to the site year round, at least in front of Añihué Reserve, and do not support the alternative hypothesis of significant seasonal/migratory movements. The low number of calves (with fetal rings) recorded during summer (N=1) does not allow us to support, in RA's inshore, movements for summer calving as suggested by Lescrauwaet (1997) for populations of Magellan's Strait. Instead, our most frequently recorded behaviors on site were patrolling and foraging.

We do not support the direct assumption based only on abundance changes, of significant seasonal movements and even "migrations", as it has been proposed. Due to the complex geography of the species' range and the environmental differences between summer and winter affecting the data collecting process, making generalizations at a species level would be premature. Considering the limitations of the methods employed, merely the atmospheric and therefore sea state differences may be enough to explain the differences between seasonal recorded abundance affecting the subjects' sightability.

A scenario that may explain the collective findings is that the coastal environment is rich enough to sustain populations composed of schools of small numbers year round without significant movements, describing a strictly coastal distribution assuming stability of the habitat (*i.e*. no aquaculture farms have been introduced into the area); neighboring populations may overlap with local schools over fine scale sites that present significant seasonal increment on food availability (*e.g*. summer coastal upwelling and/or river contributions); and the same temporal aggregation pattern may also occur occasionally in deeper waters (not far from the coast), foraging collectively over high density schools of prey during some hours without constituting a "migration". In any case, individual identification is the key to make progress on this issue, since otherwise we may assume all populations of Peale's dolphins present the same patterns, which may not necessarily be the case; as it has been found between inshore and offshore ecotype-related populations of bottlenose dolphins, *Tursiops truncatus*, in the same country but in an area with less geographic complexities than Chilean Patagonia (Sanino *et al*. 2005). This alternative scenario also is consistent with some of the possible ecological explanations suggested by Viddi *et al*. (2010).

School size dynamics were not analyzed for this contribution but differences in abundance of individual identifications between summer and other seasons were explained mainly by differences in recording effort and other variables that also seem to play a role. The probability of re-identification of a subject is not stable in time nor equal among all individuals; it depends on four main elements: a) individual's sightability; b) the capacity of the collector to produce the graphic record; c) how distinctive are marks; and d) individual's site occurrence due to the "sit and wait" style of our study. How visible and distinct the marks are on individuals varies among the subjects but in general we expected they would ease the identification process. However, our results showed that the individuals more frequently re-identified were not necessarily those with "easier to recognize" marks but those with collaborative behavior (*e.g*. approaching the shore or duration at surface). Also, the height of the observation sites was crucial for our study but their distance to the subjects varied daily mainly due to tides, affecting both "a" and "b" elements. Seasonal variations of the subjects' sightability, and therefore affecting the collection of data for individual identification as well as abundance, was qualitatively found to be affected by sea state (both wind speed and height of the waves) and also seasonal changes of the subjects' behavior. In winter, the dolphins seem to diminish their activity on the surface and increase their dive time, shortening the duration of the sighting time as well as the number of individuals on the surface compared to the number underwater, unveiled during displays of surfing behavior (see Figure 7). Therefore, the dolphin school size was easy to be underestimated due to the seasonal behavior change, when based only on the activity at the surface.

FIGURE 7. Sample of coastal surfing behavior of Peale's dolphin, *L. australis*, unveiling large school sizes (N=13) in winter (July 14th), in Añihué Reserve, Aysén region (Patagonia – Chile).

We recommend to consider seasonal behavior changes among the list of variables that may affect differences in recorded abundance and to modify the data collecting methods accordingly. Further studies on home range dynamics of schools with previously individually identified members will contribute to this issue, while our preliminary findings based on individual identification clearly show that dolphins are present at the site during all seasons; seasonal abundance change was attributed to seasonal differences on effort, sea state based sightability, and the behavior of the subjects.

Proposal to update DVideoID method

DVideoID method, was designed based on material produced during chase from moving platforms. However, despite the variable effort (*i.e*. changes on the number of volunteers, individual skills, camera capacities and features, behavior of the subjects and weather conditions), the proposed update of the method presented by Sanino and Yáñez (2001) proved to be reliable also under "sit and wait" mode of data production. Therefore, we present this proposal in recognition of standardization needs, and the available technology that allows a graphic database approach in order to simplify the management process of the information used for individual identification based on natural marks. This method was entirely based on free opensource applications.

The graphic recording of the presence of dolphins from the shore, in comparison with following the animals by boat, may reduce the time to collect data as the subjects control the duration of their exposure and sometimes, only one side of the body may be recorded. Also, as a first effort, we based the ID frame production on photography rather than digital video due to equipment and volunteer training costs. These two modifications may explain the lower efficiency of this method compared to the original DVideo-ID results, but further studies based on digital video from both the shore and underwater are needed to assess its full potential. The use of images of both sides of the dolphins summarizing all the tags also provided a simplified version of the catalog for quick checks in the field. Collecting data at Tonina Beach was, most of the time, the only functional method considering the low depth in which the dolphins ranged (even in one meter depth) and the inability to use boats due to safety concerns.

Digikam's Tag feature resulted more flexible than a database form with a character list, allowing to be edited directly (adding or removing Tags) and at anytime without compromising the already input data. The most useful tags to identify the individuals of *L. australis* in Añihué Reserve were bite marks, particularly on the dorsal fin, followed by the presence of nicks on the dorsal fin (the origin of which is also related to bites), and marks due to skin pathologies. We present the first documented evidence of predation on Peale's dolphin. The use of natural marks provides a method for which artificial tagging is not needed; however, knowledge of their relative life span is required, as well as that such marks be considered dynamic. Continued monitoring is needed to provide further details in this regard. Special care had to be taken to avoid the confusion between dorsal fin nicks or notches with the common artifacts produced by differential brightness of horizontal patterns of the water on dark margins of the dorsal fin. This is a common problem with photos taken from a distance or when taken with old versions of CMOS sensors or single CCD sensor cameras.

In general, pods with larger school sizes tended to be more active on the surface, exposing more of their body, and therefore facilitating the data collecting process. Underwater video was also limited by the time in contact with the individuals. Its benefits were to record the entire body from different angles and to assess the school size with higher accuracy than the estimates from the surface. However, only large groups stayed in the same site long enough to allow a diver to record them. Attaching the underwater camera to the boat's hull was useful since it allowed us to follow the animals and, pods with larger school sizes got closer and presented wake or bowriding behaviors long enough to record them. However, the angle during these behaviors was not the most productive (*e.g.* views of only the front or back of the animal, bubbles as visual noise) and the recording quality was strongly affected by water transparency. It seems that small groups (*ca*. smaller than five individuals) tend to be more evasive. This finding highlights the benefits of collecting data from the shore, while it suggests that collecting data from boats close to the subjects may select larger size groups over small ones and therefore under-estimate Peale's dolphin densities.

During this study, several cameras were tested; Nikon models D5100 and D300 provided the best performance. Lenses used included focal lengths of 300 and 400 millimeters, but the produced material indicates that even lenses of focal length of 200 millimeters were sufficient, most of the time, to produce material suitable for identification purposes; larger focal length lenses needed more experienced users. Among camcorders, the HDR-FX7 from Sony proved to be the best choice considering its low costs and its optical 20X lens eliminating the need for converter lenses. Its major drawbacks were the need of highly trained users and more light demands compared to the photo cameras. Its major benefits were: to allow continuous tracking of the subjects while moving; recording the area before the animals surface; access to more sections of the body during the surfacing process; and better distinction of natural marks from artifacts (*e.g*. dark spots on the skin due to shadows from suspended water particles or, dorsal fin nicks artificially created by high contrast spots on the background water). Some DSLR cameras have built-in video capabilities, even continuous progressive autofocus (*e.g*. Nikon D5100) but these are slower (and nosier) than a dedicated video camcorder. We recommend the use of video over photo cameras during ideal light and weather conditions but the advantages of video are diminished with increasing distance from the targets. Only limited efforts were made with underwater video, due to focal problems experienced by the housing of the GoPro Hero camera; this was only recently fixed by replacing the original lens with a flat lens.

The analytical step went without difficulties due to its protocol, with data production being the critical step of the method. Together with the four elements previously described, the main sources of difficulties were the use of unfeatured cameras and the costs of replacing equipment damaged by the saline environment.

Long term studies in Añihué Reserve

Añihué Reserve proved to be a site suitable for long term cetacean studies, even permitting data collection directly from the shore. This is particularly important for behavioral studies as information can be acquired without the potential impacts that a mobile observation platform (*e.g*. a boat) may produce.

The individual identification catalog produced, despite it being limited to one year of material, is a source of concern considering the extremely low number of juveniles (N=5) and calves (N=1), out of a total of 68 individuals identified and, the high prevalence of skin disease (N=35, 51.47 %) among individuals. Inshore and neritic cetacean populations living in areas affected by environmental factors may be physiologically challenged to mount an adequate immune response against infectious agents, as tattoo skin disease TSD (Van Bressem *et al*. 2009). Evaluation of the possible relationship between the high prevalence of skin diseases (as an indicator of cetacean population health) and low recruitment, with the local salmon farming industry (with facilities on both coastal boundaries of the reserve) is urgently needed.

Finally, the year-long presence of Peale's dolphins in Añihué Reserve, as well as their visibility from the shore, proves that at least these pods are potentially suitable for seasonal independent dolphin watching operations in Chilean Patagonia, potentially extending the market (*e.g*. to young, elderly and individuals sensitive to motion sickness) without the negative environmental impacts, high costs and limitations of boat-based tourism.

ACKNOWLEDGMENTS

This study was developed for Añihué Reserve as part of its contributions to our knowledge of the wildlife of Chilean Patagonia and its conservation. Special thanks to Mr. Felipe González-Díaz, General Manager of Añihué Reserve (e-mail: ffgonz@gmail.com), for his vision, trust and support for a series of studies from which this effort is part. Mr. González-Díaz has been actively involved at every step, contributing with diverse skills as Captain, manager, diver, designer and creator of the first observation site shelter, in selection and oversight of the personnel, in providing equipment for our scientists and even collecting part of the data used here; for their endurance in collecting data in Patagonia's challenging weather, to Constanza Cifuentes, Katja Hockun, Sofía Martínez V., Audrey Reilly, Ana Josefa Rojas and Elias Spinn; special thanks to Antonieta Quiroz who provided our accommodations and transport management for the expeditions; and thanks to Ann Michels, for her kind review of this manuscript.

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Contribución recibida: 20 jul.2012; aceptada: 00.00.00