WORKSHOP ON THE STATUS OF SOUTH AMERICAN SEA LIONS ALONG THE DISTRIBUTION RANGE

Valparaíso, Chile, 15-17 June 2009

Organizing Committee

Doris Oliva, Enrique A. Crespo, Silvana L. Dans and Maritza Sepúlveda

Report of the workshop summarized by Enrique A. Crespo

The ***Workshop on the status of South American sea lions along the distribution range*** was identified as a regional priority by attendees to the workshop carried out in Valdivia, Chile, on 18 and 19 October 2002, who set priorities for the conservation of aquatic mammals in Latin América[1]. In that opportunity it was established the need of organizing a workshop in order to define the present status of the South American sea lion from southern Brazil in the Atlantic Ocean up to the coasts of Perú in the Pacific Ocean passing through Southern South America. This workshop should include colleagues from Argentina, Brasil, Chile, Perú and Uruguay. It was in 2008 that an Organizing Committee took the task to plan the meeting.

The initiative emerged also as part of the policies of the new administration of the Latin American Society of Experts in Aquatic Mammals (SOLAMAC) such as was defined in the last meeting carried out at Montevideo, Uruguay, in October 2008 for the period 2008-2010.

The workshop was organized and carried out with the financial support of Yaqu-Pacha, the Zoo d´Amneville (France), the Dutch Zoo Conservation Fund (The Neatherlands), the Direction of Research of the University of Valparaíso, the Sub-secretary of Fisheries of the Government of Chile and the Latin American Society of Specialists of Aquatic Mammals (SOLAMAC)[2]. Thanks are given to all of them.

The workshop was carried out in Valparaíso, Chile, from 15 to 17 June, 2009. A welcome was given to all participants listed in Appendix I by Dr Enrique A. Crespo President of SOLAMAC. Words of welcome were also given by Dra. Doris Oliva on behalf of the Dean of the University of Valparaíso and the Sub-secretary of Fisheries of the Government of Chile. Chairmen and reporters were elected for all sessions and the provisional agenda was approved. The working papers presented and discussed at the workshop is detailed in the Appendix II.

[1] Hucke-Gaete, R., E.A. Crespo & R. Schlatter. 2004. "Aquatic Mammals in Latin America: Proceedings of the Workshop on Identifying High-Priority Conservation Needs and Actions Con las contribuciones de: S.L. Dans, A.K. Lescrauwaet, F. Trujillo, E. Secchi, D. Palacios, J. Urbán, A. Aguayo, I. García-Godos, y presentado a la CMS (Convention on the Conservation of Migratory Species of Wild Animals), 36p.

GENERAL OBJETIVES OF THE WORKSHOP

- Assess the status of sea lion population in the distribution area (Argentina, Brazil, Chile, Falkland (Malvinas) Islands, Perú and Uruguay).
- Assess regional conflicts between sea lions and human activities (fisheries, aquaculture and tourism).
- Assess about administration measures applied to the species and management plans per country.
- Assess about priority or vacancy areas in research for conservation and potential financial sources.

SPECIFIC OBJETIVES

- Assess population trends along the distribution range.
- Identify management units by means of genetic markers, ecological stocks and movements and migration.
- Assess impact levels from abundance estimations, mortality rates and predation on salmon farms and fishing gears.

AGENDA OF THE WORKSHOP

Presentations by invited participants were organized in 6 sessions, each one allowing for questions and comments at the end of the session and a final discussion. Those sessions were defined by subjects with the detail below:

1. Status and trend
2. Stock identification
3. Trophic ecology
4. Reproduction and behavior
5. Interactions with fishing and aquaculture activities
6. Management and administration

EXECUTIVE SUMMARY

SUMMARY OF THE SESSIONS

Session 1: Status and trend of South American sea lions by regions

Perú: This species is the most abundant pinniped along the Peruvian coast and it has been listed as vulnerable under the threat of extinction in Perú due to drastic demographic changes as a result of the impacts of low food availability and the unusual timing of the severe El Niño event of 1997-1998. Censuses conducted between 1984 and 2006 by IMARPE (before and after the 1997-1998 El Niño event (ENSO)) which covered 71 haul out areas from Los Órganos (04°10'S 81°07'W) to Morro Sama (18°00'S 70°53'W). As a result of the 1997-1998 ENSO, the population declined from 144,087 to 27,991 individuals, implying a decrease of roughly 81%. According to the last reported national census carried out by IMARPE, there were 118,220 sea lions on the Peruvian coast in 2006, representing 34.45% females, 31.82% pups, 3.2% adult males, 11.72% juveniles and 17.05% undetermined. It is believed that the population recovery of South American sea lion along the Peruvian coast was due to the restoration of the normal levels of the reproduction as a result of the improvement in food availability as well as migration from northern Chilean colonies (Oliveira & Majluf WP1). The census population size (N) is usually the only information available for most threatened species and for evolutionary matters, the effective population size (N_e) is a prime concern. The first estimate of N_e of the Peruvian population of *O. flavescens* that takes into account the effects of mating system and variation in population size caused by the severe 1997-1998 El Niño resulted in N_e value of 7,715 specimens which represents 6.53% of N. It is believed that the estimated N_e for the Peruvian population is not a critical value, because it is more than the mean minimum viable population for vertebrates (7,000 breeding age adults) (Oliveira & Majluf WP2).

Chile (Northern region): aerial surveys were carried out by Bartheld *et al*. (WP3) in February 2007 by means of two high resolution photographic series in each rookery. A total of 96 rookeries were recorded with 42% of breeding places and 58% of haul outs with a total of 70.286 individuals (Region I: 40,769 ± 1,152; Region II: 21,313 ± 758; Region III: 4,678 ± 56 and Region IV: 3,525 ± 28. The respective number of pups was: 10,870, 3,446, 1,405 y 1,.448. The proportion of age classes was 16-41% pups, 7-15% males, 36-40% females, 8-28% juveniles and 4-11% undetermined individuals. A comparison between this study and one carried out in 1997 indicates a 20% increase in the population taking into account differences in the methodology and the potential migration of animals from Perú during the ENSO events. The total number of rookeries decreased but the breeding rookeries increased from 30 to 40. The given numbers indicate that the northern region holds 54% of the total population of Chile.

Chile (Central region): the central coast of Chile (between Valparaíso and Región de la Araucanía) was surveyed by Sepúlveda *et al*. (WP4) in January and February 2007 by means of aerial and boat surveys. Once localized the rookeries by air they were visited by boat and photographs were taken. Census was corrected by different correction factors according to the type of rookery and age classes present. The changes found in the abundance during the last 35 years were analyzed. A total of 17,800 sea lions were found in 33 colonies (6 breeding rookeries and 27 haul outs). By means of population parameters of *O. flavescens* and other species of otariids an age-structured demographic model was developed in order to project the population. From 1970 a 1985 an increase of sea lions was recorded, while after 1985 the population seems to remain stable or slightly declining (Sepúlveda *et al*., WP4). The low abundance of sea lions in this region may be explained by the low food availability and fluctuations related to ENSO events.

Chile (Southern region): two aerial surveys complemented with boat surveys were carried out in summer and winter 2007 in sea lion rookeries of Regions X and XI by Sielfeld *et al*. (WP5). In Region X 57 colonies were found of which 6 were haul outs. In Region XI 36 colonies were

recorded of which 25 were haul outs. The total number of sea lions in Region X was 35,456 of which 5,066 were pups. In Region XI a total of 10,289 individuals were counted of which 1,782 were pups. Applying correction factors a total of 46,682 sea lions is estimated for both regions. Winter counts accounted for 39,066 individuals in Region X and 4,205 sea lions in Region XI. A comparison with the 1988 surveys indicates an increase in Region X and a decrease in Region XI. These changes in population numbers are associated with the increase and intensification of salmon farming activities in Region X.

Uruguay: the stock present in Uruguay is the only one which showed evidence of decline. The population size in the two breeding colonies Isla and Islote Lobos and Islas Cabo Polonio was estimated in 12.000-13.000 sea lions for 2005, and should be declining at a rate of 2% annually (Paéz, 2005). More recent analysis using the number of pups present between 1995 and 2007 showed a decline of -1.62 % [-2.10; -1.15]. (Pedraza et al. WP without number). In spite of the negative trend the decline is not as sharp as the one calculated previously by Paéz. In addition, the rate between pup/male showed an increase of about 12% annually, which suggests a change in structure in which the males decline fastly.

Argentina (Northern region): sea lion colonies in Buenos Aires province are located between the large breeding grounds of Uruguay and Patagonia. Only 4 non-breeding colonies are found, two harbors (Mar del Plata and Puerto Quequén) and two settlements (Banco Culebra and Isla Trinidad), most of which are composed of males or juveniles. During the breeding season a total of 300 sea lions are found, while during the winter the total increases to 500-700. Historical information indicates that the population in the XIX century was about several thousand of individuals. Applying correction factors the total number of Buenos Aires Province may reach 2,000 individuals (Rodríguez *et al*. WP6).

Argentina (Coasts of Patagonia): sea lions in Patagonia were severely depleted during the XX century and numbers were down to less than 10% of the original size. Even still the numbers are below the originals most of the stocks are increasing heterogeneously. The northern Patagonian stock (between 41.03ºS; 62,8ºO and 43.34ºS; 65.05ºO), has increased at a rate of 5,7% the last 25 years. The total number of sea lions counted in 2007 was 32,126 while the total estimated with correction factors was 58,000. In central Patagonia (between 43,57ºS; 65,23ºO and 45,23ºS; 66,70ºO), the population also showed a positive and sustained trend, counting in 2004 24,146 sea lions, estimating a rate of increase of 6%. In southern Patagonia (between 46.01ºS; 67.59ºO and 54.88ºS; 68.56ºO) the trend is unknown given the insufficient data. The numbers are well below of those estimated in the 40´s. In the Falkland Is. (Malvinas Is.), the number of pups is 2.7% of those born in 1930. However, a positive trend is observed since the 90´s (8.5 % from 1990 to 1995, y 3.8% from 1995 to 2003) (Dans *et al*. WP7).

A summary of sea lion numbers for the whole region is shown in Tables 1 and 2, and location of rookeries during the breeding season in shown in Figure 1.

Changes in social structure of Patagonian population: together with the increase in number of sea lions observed in northern Patagonia, an expansion of the colonies was noted with change in the social structure and the spatial distribution. The new colonies showed a change in the social composition starting with haul out or non-breeding places and turning to breeding rookeries or mixed social structures. A hypothesis of dispersion of first-breeding individuals from high density breeding places (with a lack of enough space or the avoidance of sexual harassment) was tested. Those mechanisms together with phylopatry and site fidelity should promote the settlement of new colonies closer to focal colonies than given by chance. There was found a significant spatial clustering of new breeding colonies to 7 focal ones (Grandi *et al*. WP8).

Table 1. Population size of South American sea lions *Otaria flavescens* in the Southeastern Pacific Ocean

Region	Breeding colonies	Haul out colonies	Estimated number	Pup production (%)	Year
Perú					
Total	71		118220		2006
Chile Norte (18º - 32º S)					
I	16	5		27	
II	16	22		16	
III	5	16		30	
IV	3	13		41	
Total	40	56	70286	24	2007
Central Chile (32º - 39º23´ S)					
V	1	11		11	
VI	1	2		26	
VII	1	1		3	
VIII	2	11		21-1	
IX	1	2		10	
Total	6	27	18179	10	2006
Southern Chile (39º23´- 55º48´S)					
X	49	8	35456	14	2007
XI	11	25	10289	17	2007
XII	15	57	2606	12	2001
Total	75	90	48351*	14	2007

*Considers the estimation for 2001 for Region XII

Table 2. Status and trend of South American sea lion populations *Otaria flavescens* in the Southwestern Atlantic Ocean

Region	Breeding colonies	Haul out colonies	Estimated number	Pup production (%)	Year
Uruguay					
	2		12000		2005
Buenos Aires Province					
	0	4	2500	0	2008
Patagonia					
Río Negro-Northern Chubut	24	5	55116	19	2005
Central and southern Chubut	34		43462	22	2004
Santa Cruz	2	26	17710	12	1995
Tierra del Fuego	12	13	4447	16	1995
Malvinas Is. (Falkland Is.)	68		7500*	35	2003
Total			500000		1930

*estimated from pup proportion observed in 1995 and number of pups counted in 2003

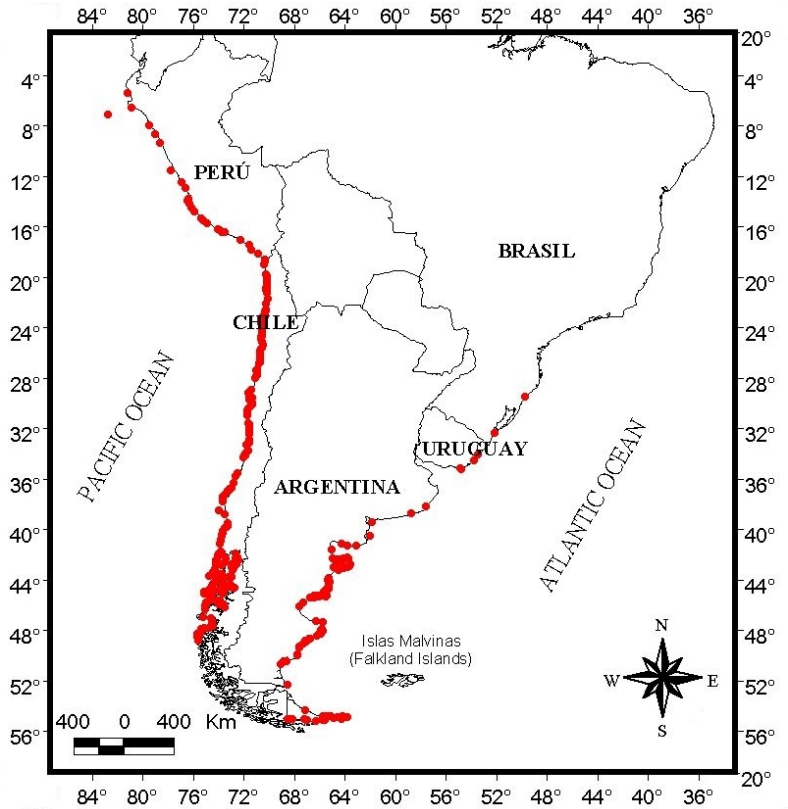

Fig. 1: location of sea lion rookeries in South America

Session 2: Genetics, movements and stocks identification

The Southern sea lion (*Otaria flavescens*) is widely distributed along both the Atlantic and the Pacific coasts of South America. The species was intensively hunted during the last two centuries. Despite its wide distribution and its well-known commercial exploitation, there are very few studies that analyzed the morphological and genetic differences among its populations as well as population subdivisions along the species distribution. Among previous studies of there is one by Szapkievich *et al.* (1999) who studied 11 loci of blood isozimes and found no differences between Uruguay and Península Valdés. On the other hand Túnez *et al.* (2006) found significant differences in mitochondrial citocrome b between them. In this regard three papers were presented at the workshop.

A paper presented by Oliveira *et al*. (WP 9) evaluated the population structure and the evolutionary history of the Southern sea lion based on the analysis of 10 microsatellite loci and mtDNA sequences from four sea lions populations (Brazil (= Uruguay)=27, Peru=29, Argentina=17, Chile=12). The results from both molecular markers indicate significant structuring between Pacific and Atlantic populations (mtDNA Fst = 0.09; st=0.80; microsatellites Fst=0.10 and Rst= 0.13 *P*< 0.05). mtDNA results suggest extreme female phylopatry and microsatellite results a very restricted inter-oceanic gene flow mediate by males since early Pleistocene. Demographic analysis shows that the species did not recently suffer any significant reduction in genetic diversity. This degree of genetic differentiation suggests complete and prolonged isolation to the extent that we believe the Atlantic and Pacific populations should be considered distinct evolutionarily significant units (ESUs).

Another paper presented by Feijoo *et al*. (WP 10) studied the genetic and ecological independence between two areas with important breeding activity: a) the coast of Uruguay with Isla de Lobos, Cabo Polonio and La Coronilla and b) Patagonian coast from Punta Bermeja to Tierra del Fuego. Both areas suffered population reduction due to exploitation. However, in present days the Patagonian stocks increase at a rate of 5,7% annually while the Uruguayan colonies decline at a rate of 3% annually. The paper by Feijoo *et al* analyzed 46 sequences of

820 base pairs in the mitocondrial control region and the analysis in process of 60 indivuals with 6-12 microsatellite loci. The mitocondrial análisis hold a strong separation between Uruguayan and Patagonian stocks (F_{ct}=0.46/P-value<0.05). The same structure is found in three Patagonian colonies studied (Santa Cruz vs Chubut centre-south F_{st}=0.38; Santa Cruz vs Chubut North F_{st}=0.43; Chubut center-south vs Chubut Nortt F_{st}=0.31, all with P-values <0.05. Microsats data allow understanding both sexes supply as a consequence of biparental inheritance to the genic flux between different populations. They also allow exploring recent bottlenecks caused by sea lion exploitation in XIX and XX centuries.

A paper presented by Weinberger *et al* (WP 11) explored the existence of metapopulations along the Chilean coast based on three distribution aggregations: 1) to the north of 30°S (Regions I-III), 2) a second one from 30°S to 50°S (Regions V-XII), and 3) a third one in the extreme south (Magellan and Tierra de Fuego, Region XII). Molecular markers of maternal lineage (D-loop *mt*DNA) and 10 microsatellite loci were analyzed. This pattern suggests the existence of three metapopulations even at present there are not enough data. Preliminary, a trend is suspected of increasing genetic differentiation with distance and a possible genetic structure between northern and southern rookeries. Genetic flow is possibly dispersed by males.

Regarding movements of animals throughout the coast, a paper was presented by Giardino *et al*. (WP 12) about the seasonal movements of sea lions between the non-breeding rookery of Puerto Quequén (38º35´S, 58º42´W) and rookeries of Uruguay and Patagonia. A total of 516 sea lions were marked with alphanumeric codes by hair decolorizing in four consecutive breeding seasons (2003--2008) (Giardino *et al*. WP 13). Most of the animals traveled to other rookeries during the breeding season and many of them (> 70%) returned to the original colony. In average the animals lasted for 50 days with a maximum of 106 days of absence at P. Quequén. The animals were found in the close non-breeding colony of Mar del Plata during the whole year, while interchange with Uruguay (Isla de Lobos and Las Pipas), Río Negro (Punta Bermeja) and Península Valdés (Punta León, Punta Norte, Puerto Pirámides and La Armonía) were found during the breeding season. Adult males were found holding adult females in Uruguay and Patagonia and returned with wounds after the breeding season where seems to exist a particular linkage to Buenos Aires colonies where they spend the rest of the year.

Session 3: Trophic ecology

Interactions between sea lions and fisheries include those that involve indirect effects of fisheries and competition for fishing resources. The diet of sea lions has been studied along the distribution range as well as presumably competition with artisanal and industrial fisheries (Aguayo & Maturana 1973; George-Nascimiento *et al.* 1985; Sielfeld *et al.* 1997; Koen-Alonso *et al*. 2000; Oliveira *et al.* 2008). In order to evaluate such interactions is also important to locate foraging areas as well as diving behavior at the open sea. Preliminary results were presented at the workshop by Campagna & Fallabella (WP 14) suggesting that the distribution of foraging areas are conditioned by batimetry with a preference by sea lions of depths lower than 200 meters. This dependence of shelf waters is in agreement with studies carried out in Uruguay (Rodríguez *et al.* WP 15; Riet Sapriza *et al.* WP 16) and Argentina (Campagna *et al.* 2001) where foraging trips include coastal movements to longer distances of about 200km. The Pacific coast with a shorter shelf may reduce available habitat and increase interactions with fishing activities (Campagna & Fallabella WP 14). Diving behavior was characterized by several studies (Werner & Campagna 1995; Riet Sapriza *et al.* WP 16; Dassis *et al.* WP 17) in which was pointed out that sea lions perform mainly frequent, short and benthic dives (between 1.5 and 2 min). Most of the time is spent in shallow waters (2-10 m, 10-20 m and 20-30 m).

A study with stable isotopes in Uruguay supports the feeding in a coastal-benthic ambient by females (Franco-Trecu *et al.* WP 18). Results of current stomach contents analysis in southern Brazil were in agreement with a benthic feeding strategy (Oliveira and Ott WP 19).

Competition with other predators is an important objective to study in the near future, in particular with the South American fur seal (*Arctocephalus australis*). In Uruguay and other regions both species share breeding rookeries like (Isla de Lobos and Cabo Polonio), therefore a potential for competition exists between both species as well as by sexes, age classes and

breeding areas (Franco-Trecu *et al.* WP 18). Preliminary studies indicate that at least during the breeding season the females of both species do not share feeding resources and that both sexes of sea lions explore different feeding areas (Franco-Trecu *et al.* WP 18).

The competition for feeding resources and nutritional stress has been proposed as an explanation for the decline of sea lions in Uruguay together with illegal killing, by catch and a decline in the reproductive success. With this regard the cost of diving in captive sea lions was estimated by Dassis *et al.* (WP 20). In agreement to what is expected for marine mammals, this study indicated that the metabolic rate for diving is 3 times the basal rate estimated as a function of body weight.

Traditional feeding habits studies have listed the main preys for the sea lions in different regions (Aguayo & Maturana 1973; George-Nascimiento *et al.* 1985; Sielfeld *et al.* 1997; Koen-Alonso *et al.* 2000; Naya *et al.* 2000; Oliveira *et al.* 2008). However, the workshop considered important to study with refined detail the feeding items of the sea lions in each area. With this respect a study was presented to the workshop about the recovery of otolits of different preys in faeces (Rodríguez *et al.* WP 21).

It was also pointed out by the workshop to study the distribution of the most important fishing resources in the distribution area of the sea lion. It was considered a priority to estimate the population consumption of commercial species. The only antecedent with this regard was a estimation in northern and central Patagonia carried out by Koen-Alonso *et al.* (1999) who found that a population of 67.800 sea lions consumed a total of 148.000 tons of food. The common hake (*Merluccius hubbsi*) was about the 49% of the total take. It was considered also important to compare the sizes of prey taken by sea lions and the fishery by video recorders and environment data recording for each foraging event.

As a general conclusion the trophic ecology of the sea lions shows a wide disparity of development in different regions. While some concepts and values can be extrapolated to different regions it was clear that the different population trends along the distribution range reflect different situations at a lower spatial scale, possibly regulated by local factors like different habitats or different levels of human pressure.

Session 4: Physiology, behavior and reproduction

There are numerous papers on the behavior of the sea lion during the breeding season. However, the participants noted the absence of information regarding particular aspects associated to the reproduction (breeding cycle, embryonary diapauses, embryo implantation, sexual maturity) or social conduct (effect of marginal males on the breeding system, maternal care, intra and interespecific aggressiveness, harem density dispersal pattern). In addition there was noted a lack of demographic parameters useful for population dynamics with very few exceptions. The participants also noted that behavioral studies were less developed in comparison to the previous decade while satellite telemetry received an important impulse.

With respect to individual behavior a study was carried out at Mar del Plata by Mandirola *et al* (WP 22). They found that the animals in the harbor are not located randomly. On the other hand there were found associations by age and sex classes and sexual maturity. It was also found that some dyads are more frequent than expected by chance while others are less frequent. The participants concluded that behavioral studies in human made buildings like harbors should demand important investments to promote studies related to sea lion management and public and animal security and sanity. Another paper by Acevedo *et al* (WP 23) studied variations in the breeding pattern and synchronism through latitude and longitude between Chilean and Atlantic rookeries. The results indicated no difference between Pacific and Atlantic colonies but important difference by latitude, where northern rookeries start breeding earlier than southern ones. The workshop considered that synchronism of breeding may be related to local and regional events like productivity.

Regarding demographic parameters a paper was presented about the estimation of age at sexual maturity (ASM) by Grandi *et al* (WP 24). ASM was related to body growth and was determined to occur in females at 4.83 ± 0.55 years ($\bar{x}$ ± DS), recording the first ovulation during the 4th year and complete sexual maturity of females during the 5th year. Males were

recorded as mature during the 4th year and all males beyond the 6th year were physiologically mature. Reproductive maturity is delayed until the 9th year when the male acquires physical and behavioral maturity in order to be able to hold females. With respect to body growth males and females do not show any difference until the second year while from the 3rd. males show a significantly higher growth rate than females. ASM was found in males to be at 9 years around 86,2% (212,19cm) of the asymptotic length while in females it was found to be at 4.83 years at 84,1% (147,65cm) of the asymptotic length. Sexual maturity criteria in females were based on the presence of *Corpora lutea* or *Corpora albicantia.*

Other demographic parameters were estimated by Svendsen *et al* (WP 25) who analyzed pup mortality during the breeding season with social structure in the context of an increasing population. Two zones were compared with different social structure in which one was a traditional breeding rookery and the second is more recently developed with a majority of juveniles. A higher mortality was found in recently developed groups which double that of older and traditional ones indicating disadvantages of breeding in new groups. The new groups grow faster than older ones and receive possibly immigrating juvenile animals. The higher pup mortality could be related to the presence of sub adult males and the inexperience of breeding females.

A long term study was presented to the workshop about the presence of sea lions at Rio Valdivia estuary as well as in other rivers surrounding the city (Osman *et al*. WP 26). The study period involved 20 years. In the former years few solitary individuals were recorded, while in the last three years the number of sea lions increased steadily occupying coastal boardwalks of the city. The behavior of this individuals was recorded periodically censusing by age and sex categories. A seasonal patter was observed with lowest numbers in summers and highest in winter. The social composition includes adult and sub-adult males and juveniles. The daily pattern shows that highest numbers to occur between 8:00 am and 6:00 pm.

Session 5: Interactions with fisheries and other impacts

Interactions with artisanal fisheries and salmon culture activities were studied throughout the region and distribution range of sea lions. However, there are different degrees of results achieved. A first paper was presented to the workshop regarding interactions with artisanal fisheries in Uruguay (Szteren WP 27). The study started a decade ago along the coast of La Plata River and the Atlantic ocean coast. The methodology included interviews to fishermen and on board evaluations. Gillnet and long-line fisheries were included in the study. From 2001 to 2004the study continued in Piriápolis where higher interactions were detected. CPUE values did not show differences with or without sea lions. Fishing catches did not differ between years, seasons or fishing gears. In addition, the overlap with South American fur seals for fishing resources was studied and between them and the artisanal fishery. The coincidence between both pinnipeds was very high and about of 90% of the total consumption corresponds to three preys. The overlap with the fishery was low but higher for the sea lion. There is no concluding evidence of a relationship of lower fishing catches with the presence of sea lions.

With regards to the interactions in Argentina a paper was presented to the workshop summarizing all interactions between sea lions and different types of fisheries (Crespo *et al*. WP 28). From San Clemente del Tuyú (36°S) to Bahía Blanca (40°S) artisanal vessels operate gillnets, purse seines and trawls for croakers and sharks among other bony fish species. The sea lions interact with gillnets but do not get entangled but the interaction is limited to the eating of the liver of caught fish by the sea lions. Another evidence of interaction was shown when a experiment was carried out with pingers in order to prevent the entanglement of franciscanas (*Pontoporia blainvillei*) in gillnets (Bordino *et al*. 2002). In Patagonia during the last decades an industrial fishery composed of 190 vessels was developed including trawls, jigging and longline vessels. Trawling involved 80% of the fishery while jigging increased in the 90´s. Targets of the fishery were the hake (*Merluccius hubbsi*), the shrimp (*Pleoticus muelleri*) and the Argentine squid (*Illex argentinus)*.Sea lion catches were quantified during the 90´s between 42º and 47° S. By-catch was evaluated in 9 different strata of the trawling fishery considering the mouth of the net, the target species, time of the day and depth of operation. The sea lions were by-caught in

all types of trawls and the capture rates varied between 0.002 and 0.02 individuals per day and per vessel. Highest rates were recorded in bottom trawls operated for hake and pelagic trawls for shrimp. The total mortality rates were estimated between 150 and 600 individuals. More recently the interaction was evaluated from 2005 to 2009 at Golfo San Matías, between 41° and 42°S. A small bottom trawling fishery operates there since 1971 for demersal species (18 to 35m length, 50 to 250 TRB, power between 300 and 800 HP). Main target is common hake. Since 2006 an observer program was started and by-catch of marine mammals was recorded formally. Since February 2006, nine sea lions were caught in 454 tows allowing calculating a catch rate of 0.02 sea lions per tow. In 1996 a long-line artisanal and industrial fishery was started. Between February and October 2004 the sea lions were recorded to damage the catches which reached 16.67% of the fishing trips (n = 24 trips). This damage consisted in 14.85% of the total catch per day.

A paper was presented to the workshop by Pavés *et al*. (WP 29) with regard to interactions between sea lions and fisheries in northern Chile Arica (I Región), Tocopilla (II Region), Obispito (III Región) and Los Vilos (IV Región). The objective was to evaluate the degree of operational interactions, the economic impact, and sea lion mortality. 97 shipments were carried out and 140 tows were analyzed from May to July 2007. From 1 to 18 sea lions were recorded in 57% of the set tows and 75% of the recovered tows. Arica and Tocopilla showed interactions 100% of the times while Obispito and Los Vilos recorded only 50% and 30%. The interaction was more frequently on catches (46%), gear (1%) or both (10%). Caught fish was damaged in 94% by sea lions and the rest by other predators. Fire guns were used in 3% of the cases causing mortality to one sea lion. The economic analysis showed no differences in the income of fishermen with or without sea lions or the profits obtained by the fishermen. Given the average income received, 17% was used for financing costs of the activity, 6% corresponded to looses and 78% to benefits. This situation supplies evidence that the interaction with sea lions has effects on the catches, but the economic impact is related to other factors such as target species, fishing methodology, market price and fishing management. Therefore, the sea lions are not the main factor affecting the fishermen profits. However, the fishermen increase the fishing effort to compensate and mitigate the damage. The use of fire guns affects the sea lion conservation and increases the risks for the fishermen.

Since many decades ago a conflict was recognized between sea lions and fishing and aquaculture in Chile. The conflict with fisheries, either artisanal or industrial is perceived as a competition for the same resources. Sea lions damage catches and fishing gear. A new interaction was developed in southern Chile with salmon culture activities. In this case the sea lions bite the salmons through the net, increasing mortality of fish and allowing salmon escape through the holes. A paper was presented by Sepúlveda & Oliva (WP 30) to the workshop summarizing the interaction between sea lions and extractive and aquaculture activities with regards to geographic and temporal variability, threats to sea lion populations, economic impact, mitigation measures and research and management programs priorities by scientists, NGO´s, fishermen, salmon farm owners and government authorities.

Session 6: Administration and management

A paper was presented to the workshop by Rodríguez & Bastida (WP 31) about the conflicts of the sea lion colony established in Mar del Plata Harbor. This colony was established as a permanent settlement in the early 70´s. The sea lions occupied decks inside the harbor progressively up to 1987 when the conflicts with fishermen declined to a minimum. In 2000 the harbor authorities decided to expand the activities to the area where the sea lions occupy. Therefore the sea lions should be moved to a new settlement built at 800 m of the original one and close to the mouth of the harbor. This task was transferred to a local NGO. The strategy employed was reducing the surface of the original settlement. After 4 years the sea lions did not occupy the new facilities and went back to the inner part of the decks starting again the conflicts with the fishermen. The sea lions are found in any part of the harbor in close contact with fishing products and in physical contact with fishermen and visitors. This experience demonstrated once more the improvisation and the lack of clear policies in official institutions.

Given the interactions between artisanal fisheries and salmon farms with sea lions, the Sub-secretary of Fisheries of Chile conceived an action plan in order to develop a management plan (Oliva *et al.* WP 32). The action plan was designed under a participative scheme in which the public and private sectors of Los Lagos Region were involved. The management plan consisted of 4 phases of which the first 3 were carried out with the support of a Technical Assessment Group and a sustainable development philosophy. The *Descriptive Phase* of the plan considered economic and social backgrounds of the artisanal fishing activities, salmon farming and tourism, the population abundance of sea lions and the records of the interactions between the sea lions and the activities. The *Ordering Phase* designed 13 mitigation measures of which 5 were for artisanal fishery, 5 for salmon farming and 3 for the conservation of the resources. During this phase biological indicators were developed (population trend and health), social indicators (logbook advice) and economic indicators (fish mortality, valorization of looses) in order to evaluate the efficiency of the measures. The *Operational Phase* developed a Research Plan for a period of 5 years in order to update the Management Plan and monitoring of the indicators. The projects were grouped in 5 areas: a) interaction studies, b) conservation and management, c) feeding, d) population dynamics and e) population monitoring. On the base of these results the Sub secretary of Fisheries should execute the *Normative Phase* in order to put into practice the designed measurements.

The Research Plan for the sea lion emerges as part of the Management Plan which main objective is to decrease and mitigate the conflicts with the artisanal fishery and salmon farming in southern Chile (Sepúlveda *et al*. WP 33). The objective of the Research Plan is to update and perform the quality of the information required for decision making. The Technical Assessment Group includes academics, NGO´s, salmon farming representants, artisanal fishermen and government authorities. The Research Plan comprises general and specific objectives for the 5 areas detailed above, methodology and budgets. The projects were ordered in a temporal scale in agreement of the members of the Technical Assessment Group.

General conclusions and recommendations at the ecosystem level

- Given that global warming models predict stronger and more frequent El Niño events in the future it was recommended to investigate relationships between population fluctuations and environmental variability related to ENSO and climate change.
- Related to the former point the migration connection between Chile and Perú was identified as a priority and should be studied in detail.
- Develop cooperative and integrative international projects about global change, population dynamics of sea lions, competitors and preys, in order to evaluate direct and indirect effects of fisheries and other human impacts.
- Establish monitoring programs through population studies in order to evaluate environmental and biological changes.
- Determine indicators of ecosystem health developed from population variables like sea lion pup growth and / or survival. Evaluate the possibility of use of sea lions as indicators of climate change, given that the species accomplish with the following characteristics: wide range in latitude, two oceans, two environments (one fluctuating and one constant).
- Include other species of pinnipeds like the South American fur seal or seabirds like the Magellanic penguin in multispecies analysis in order to evaluate competition for fishing resources.

General conclusions and recommendations at the population level

- Standardize protocols between research groups, for census, evaluation of changes in diet, estimation of demographic parameters for population modeling, and environmental variability.
- The development of new colonies and disappearing of others was noted throughout the distribution range. It was also noted the transforming of juvenile or haul out areas in

breeding rookeries and an important variability in the rate of increase of pups in different rookeries. A recommendation was agreed in order to keep monitoring throughout the distribution range the abundance, the number of colonies, the rate of development and extinction of colonies, the rate of increase, changes in diet, etc.

- At a lower spatial scale the process of migration of individuals to new breeding areas suggest the existence of density-dependence factors given that the rates of increase of pups in new areas are much higher than those of focal colonies.
- Study social behavior and its effects on pup survival and genetic characteristics of the population. Intensify studies on reproduction in different regions, in particular development and re-absorption of corpora ovarica, embryonic diapausa and delayed implantation.
- Continue and intensify studies related to association between sea lions and areas of human use like harbors or cities with regards to a better management of the species as well as matters of public health and security.
- Explore alternatives to artisanal fisheries with declining fishing resources, increase value of fishing products or complement with other activities like tourism.
- Study and monitor pathologies in the wild, parasitism, zoonotic diseases, pollution, etc.
- Coordinate research with satellite transmitters between groups in order to integrate results.

Recommendations for geographic regions

- Quantify sea lion mortality in fisheries and aquaculture throughout the distribution range. Implement observer programs. Include social and economic aspects of the interaction when studying conflicts with human activities like fisheries or salmon farming. Evaluate also the impact of the real or perceived damage. Gather high quality data on fishing stocks, fishing effort and main prey of sea lions for every region.
- The southern tip of South America was identified as of extreme priority given the absence of information about population trend and genetic pertaining. There were identified at least two evolutionary units but this could change after analyzing information from the extreme south.
- Evaluate and quantify causes of sea lion decline in Uruguay.
- Monitor the sea lion population changes associated to re-location of salmon farming activities in southern Chile. Change in population numbers in Region X could be associated with the increase, intensification and relocation of salmon farming activities.

A next workshop was agreed to be held in Uruguay in the next two years in order to continue with a conservation policy for the South American sea lion. Reports in Spanish will be distributed to all government organizations, NGOs in the region, Universities and Research Centers.

APENDIX I: INVITED PARTICIPANTS

NAME	COUNTRY	ATTEND
Enrique Crespo	Argentina	Y
Silvana Dans	Argentina	Y
Florencia Grandi	Argentina	Y
Claudio Campagna	Argentina	Y
Gisela Giardino	Argentina	Y
Mariela Dassis	Argentina	Y
Agustina Mandiola	Argentina	Y
Larissa Rosa de Oliveira	Brazil/Perú	Y
Guillermo Svendsen	Argentina	N
Diego Rodríguez	Argentina	N
Ignacio Túnez	Argentina	N
Adrián Schiavini	Argentina	N
Luis Cappozzo	Argentina	N
Marcelo Cassini	Argentina	N
Doris Oliva	Chile	Y
Maritza Sepúlveda	Chile	Y
René Durán	Chile	Y
Layla Osman	Chile	Y
Alejandra Urra	Chile	Y
Anelio Aguayo	Chile	Y
Patricia Hinostroza	Chile	Y
Walter Sielfeld	Chile	Y
Italo Campodónico	Chile	Y
Héctor Pavés	Chile	Y
Constanza Weinberger	Chile	Y
Jorge Acevedo	Chile	Y
Patricia Majluf	Perú	Y
David Thompson	United Kingdom	N
Diana Szteren	Uruguay	Y
Valentina Franco Trecu	Uruguay	Y
Federico Riet Sapriza	Uruguay	Y
Matías Feijoo	Uruguay	Y
Enrique Páez	Uruguay	N

APENDIX II: LIST OF WORKING PAPERS PRESENTED AT THE WORKSHOP

1. Larissa Rosa de Oliveira & Patricia Majluf. Effective population size for southern sea lion along the peruvian coast.
2. Larissa Rosa de Oliveira & Patricia Majluf. Recovery of the Peruvian Southern sea lion population after the strongest El Niño event in history.
3. Bartheld, José Luis, Héctor J. Pavés, Claudio Vera, Cristian Manque, Diego Miranda & D. Sepúlveda. Cuantificación poblacional del lobo marino común en el litoral chileno, entre los 18ºs a 32ºs (I a IV Región).
4. Sepúlveda, Maritza, Alejandra Urra, Doris Oliva, M. José Pérez, Rodrigo Moraga, Javier Arata, Patricia Inostroza & Walter Sielfeld. Abundancia y estado poblacional del lobo marino común *Otaria flavescens* en la zona central de Chile.
5. Sielfeld, W., D. Oliva, M. Sepulveda, M. Buscaglia, R. Moraga, M.J. Pérez, H. Pavés & P. Hinostroza. Abundancia del lobo marino común en el sur de Chile: potenciales efectos de la actividad de salmonicultura.
6. Rodríguez, Diego, Gisela Giardino, María Agustina Mandiola, Pablo Denuncio, Mariela Dassis, Martín Sotelo, Paula Polizzi, María Trassens, Victoria Massola, Marcela Gerpe & Ricardo Bastida. Estatus de los asentamientos de *Otaria flavescens* en el norte de Argentina.
7. Dans, Silvana, Enrique A. Crespo, M. Florencia Grandi, Nestor A. García y Guillermo Svendsen. Estado actual y tendencia de los lobos marinos de un pelo en el Atlántico Sud-occidental**.**
8. Grandi, M. Florencia, Silvana L. Dans y Enrique A. Crespo. Cambios en la composición social y distribución espacial de colonias de *Otaria flavescens* en una población en expansión.
9. Oliveira, Larissa Rosa, Marcelo Coelho Miguel Gehara, Patrícia Majluf, Susana Cárdenas, Juan Ignacio Túnez, Héctor Páves, Constanza Weinberger, Marcelo H. Cassini & Sandro Luiz Bonatto. Phylogeography of the Southern sea lion, *Otaria flavescens* (Otariidae)*:* early Pleistocene divergence between Atlantic and Pacific populations.
10. Feijoo, Matías, Enrique P. Lessa, Enrique A. Crespo. Análisis de la estructura genética de *Otaria flavescens* en la zona de cría (Uruguay-Argentina) del Atlántico sur.
11. Weinberger, Constanza, P. Marquet & S. Faugeron. Metapoblaciones de lobo marino común, *Otaria flavescens*, en Chile: análisis de redes genéticas.
12. Giardino, Gisela, María Agustina Mandiola, Ricardo Bastida & Diego Rodríguez. Movimientos estivales de machos de *Otaria flavescens* entre Puerto Quequén (Argentina), Uruguay y Patagonia.
13. Giardino, Gisela, María Agustina Mandiola, Julián Bastida, Pablo Denuncio, Mariela Dassis, Ricardo Bastida & Diego Rodríguez. Aplicación de técnicas de marcado y reavistaje por medio de la decoloración de pelo en el lobo marino de un pelo: es realmente efectivo?
14. Campagna, Claudio & Valeria Falabella. Predicción de áreas de alimentación en base a pocos datos, de pocos animales y pocas agrupaciones.
15. Rodríguez, Diego, Mariela Dassis, Alberto Ponce de León, Ricardo Bastida, César Barreiro, Donald Calkins, Shannon Atkinson & Randall Davis. Movimientos y áreas de forrajeo de hembras de *Otaria flavescens* provenientes de Isla de Lobos (Uruguay).
16. Riet Sapriza, Federico G., Daniel P. Costa, Valentina Franco Trecu, Luis A. Hückstadt & B. Louise Chilvers. Áreas de forrajeo y patrón de buceo de hembras de león marino *Otaria flavescens*, durante la primera etapa de la lactancia en Isla de Lobos, Uruguay.
17. Dassis, Mariela, Alberto Ponce de León, Ricardo Bastida, César Barreiro, Donald Calkins, Shannon Atkinson, Randall Davis & Diego Rodríguez. Comportamiento de buceo en hembras de lobo marino de un pelo (*Otaria flavescens*) provenientes de Isla de Lobos (Uruguay).
18. Franco-Trecu, Valentina, David Aurioles-Gamboa, Federico Riet-Sapriza & Dan P. Costa. ¿Co-uso de recursos alimenticios? Un estudio isotópico sobre la segregación por

sexo, clase de edad y área de cría en *Otaria flavescens* y su solapamiento con *Arctocephalus australis*.
19. Oliveira, Larissa Rosa & Paulo Henrique Ott. Feeding ecology of the Southern sea lion, *Otaria flavescens*, and its interactions with local fishery activity in Southern Brazilian coast.
20. Dassis, Mariela, Diego Rodríguez, Donald Calkins & Randall Davis. Medición experimental del consumo de oxígeno durante el buceo en *Otaria flavescens.*
21. Rodríguez, Diego, Laura Rivero & Ricardo Bastida. Estimación de la recuperación de otolitos en fecas de *Otaria flavescens* a través de estudios experimentales de alimentación.
22. Mandiola, María Agustina, Gisela Giardino, Ricardo Bastida, Marcelo Farenga & Diego Rodríguez. Patrones de asociación individual en la colonia de lobos marinos de un pelo del Puerto de Mar del Plata (Argentina).
23. Acevedo R., Jorge & Anelio Aguayo – Lobo. Variación geográfica en la reproducción del lobo marino común, *Otaria flavescens* Shaw 1800, entre ambas costas de América del Sur.
24. Grandi, M. Florencia, Silvana L. Dans, Enrique A. Crespo y Néstor A. García. Madurez sexual y crecimiento corporal del lobo marino de un pelo, *Otaria flavescens*, en Patagonia.
25. Svendsen, Guillermo, Silvana Dans, Enrique A. Crespo & Florencia Grandi. Mortalidad de crías asociada a cambios en la estructura social y al aumento poblacional.
26. Osman, Layla P., Cardyn S. & Díaz M.P. Comportamiento del lobo marino común (*Otaria flavescens*) en el Rio Valdivia, Chile.
27. Diana Szteren. Interacciones entre el león marino sudamericano y la pesca artesanal en Uruguay.
28. Crespo, Enrique A., Silvana L. Dans, Alejandra Romero, Raul Gonzalez, Néstor A. García, Mariano Koen Alonso & Susana N. Pedraza. Interacciones entre lobos marinos comunes y pesquerias en la costa argentina.
29. Pavés, Héctor J., José Luís Bartheld, Claudio Vera, Diego Miranda-Urbina1 & Cristian Manque. Interacciones operacionales entre ejemplares del lobo marino común y la pesquería artesanal de pequeña escala del norte de Chile.
30. Sepúlveda, Maritza & Doris Oliva. Conflictos entre el lobo marino común *Otaria flavescens* y actividades pesqueras y de acuicultura en Chile.
31. Rodríguez, Diego & Ricardo Bastida. El traslado de la colonia de lobos marinos de un pelo del Puerto Mar del Plata: la ausencia de un plan racional reaviva un conflicto luego de 25 años.
32. Doris Oliva, M. José Pérez, Maritza Sepúlveda, M. Matamala & Anelio Aguayo. Plan de manejo para mitigar las interferencias entre del lobo marino comun *Otaria flavescens* y las actividades de pesca y acuicultura en Chile.
33. Sepúlveda, Maritza, Doris Oliva, Walter Sielfeld, M. José Pérez & Anelio Aguayo. Plan de investigación del lobo marino común *Otaria flavescens* para mitigar los conflictos con la pesca artesanal y acuicultura en Chile.
34. Pedraza, S.N., V. Franco-Trecu & A. Ligrone. Tendencias poblacionales de *Otaria flavescens* y *Arctocephalus australis* en Uruguay. Working paper without number presented at the workshop.

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