

Socioecology of killer whales (*Orcinus orca*) in northern Patagonia, Argentina

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ABSTRACT

Observations of killer whales in northern Patagonia, Argentina were conducted using photo-identification techniques between 1985 and 1999. Thirty killer whales have been identified in the study area since 1975 but a core group of 17 have been found to return to the area each year. Boat and shore observations were conducted during both the austral summer-autumn season 1985-1999 and the austral winter season 1992-1993, using the *individual follow* protocol. The objective of this paper is to describe the long-term association and composition of killer whales groups in northern Patagonia. The 17 individuals regularly seen in the region were seen in group sizes ranging from 1 – 8 animals, with three groups; PNA ($n = 6$), PNB ($n = 2$) and PNC ($n = 9$), seen most regularly.

Six individual killer whales were presumed dead between 1988 and 1993, as they were no longer sighted.

The simple association index shows that the majority of long-term associations among northern Patagonia killer whales were high. After 1993, changes in the group composition were observed between A, B and C groups. Dispersal of both sexes from groups larger than three individuals was observed and it may be related to foraging strategies and provisioning. Individuals from different groups left their maternal groups to make up new groups.

Key words: Killer whale, *Orcinus orca*, socioecology, association, Patagonia

INTRODUCTION

The killer whale, *Orcinus orca*, is a cosmopolitan predator, present in all seas and oceans of the world (*e.g.*, Heyning, & Dahlheim, 1988; Hoyt, 1990; Baird, 2000; Ford, 2002 and Dalla Rosa *et al.*, 2002). Variations within some populations of killer whales have been identified. These variations are based on morphology, diet, size and composition of social groups and behavioral ecology (Bigg, 1982; Bigg *et al.*, 1987; Baird & Stacey, 1988; Ford *et al.*, 1994; Ford & Ellis, 1999; Baird, 2000, Ford, 2002; Pitman & Ensor, 2003). The populations which have been studied the longest (since 1973) are those found off the Pacific North West coast of North America (*e.g.*, Bigg, 1982; Balcomb *et al.*, 1982; Leatherwood *et al.*, 1990; Bigg *et al.*, 1987 and 1990).

Since 1975 killer whale studies off northern Patagonia have been undertaken at Punta Norte (42°05'S, 63°46'W), Península Valdés. These studies focused mainly on killer whale foraging strategy, diet, provisioning, food sharing and seasonal distribution. Research methods included photo-identification (Bigg, 1982), from which an identification catalogue was compiled (López & López, 1985; Hoelzel, 1991; Iñíguez 1990, 1991, 1992, 2001). This on-going study presents the data from 1985 – 1999 and includes the animals at Punta Norte and other areas of Northern Patagonia. Prey has included South American sea lions (*Otaria flavescens*) and southern elephant seal (*Mirounga leonina*) and the seasonal distribution of killer whales is correlated to the distribution of their preys (Iñíguez, 2001)

It presents the long-term evolution and composition of the Northern Patagonia killer whales groups.

MATERIALS AND METHODS

Killer whales were observed at Northern Patagonia (summer 1985-1999, spring 1995 and winter 1992). Using photo-identification techniques described by Bigg (1982) and Leatherwood *et al.* (1990) we individually identified 17 animals. In this study, killer whales were assigned to groups after they had been encountered on

more than five occasions, over the length of the 1985 - 1999 field seasons and spend more than 50% of their time together. Groups were designated alphabetically, using three letters, PN to indicate Patagonia Norte and A to C to distinguish Groups. Individuals were designated numerically, in ascending order as they were photo-identified. PNA, PNB and PNC groups have been documented previously (López & López, 1985, Hoelzel, 1991 and Iñiguez, 2001). For the present study, individual C1 (described in this paper) = C2 from the previous study (Hoelzel, 1991) and C3 (described in this paper) = C1 (Hoelzel, 1991).

Killer whales were classified into four categories: Adult male, Adult female, Calf and Immature/Other, following the description system of Bigg (1982) and Leatherwood *et al.* (1990). Observations were made from shore and from a 4.5 m inflatable boat powered by a 35 hp outboard engine. Field notes on identity of individual killer whales (based on photo-identification), location and association were recorded on a daily sheet.

In addition, to describe and quantify the level of association between two killer whales, the simple association index between pairs of individuals recommended by Ginsberg and Young (1992) was calculated as:

$$SR = \frac{x}{(x + y_a + y_b)}$$

where, x = total number of times that two killer whales were seen together, y_a = number of sightings of the first killer whale without the second, and y_b = number of sightings of the second killer whale without the first. SR can range from 0 for two individuals never seen together to 1 for two individuals always seen together. This index has been used to describe associations of bottlenose dolphins (*Tursiops truncatus*) in South Carolina (Gubbins, 2002), Hector's dolphins (*Cephalorhynchus hectori*) in New Zealand (Slooten *et al.*, 1993) and mammal-eating killer whales in the eastern North Pacific (Baird and Whitehead, 2000).

For this study we defined long-term as a period of 12-14 years.

RESULTS

Size and Group composition

Between 1985 and 1999 killer whales were observed on 276 occasions. The 17 individuals were originally classified into three groups (PNA, B and C). At the end of the study, (taking into consideration newborns and individuals no longer sighted) group compositions were as follows; PNA ($n = 6$) comprised of three adult females, two immatures and one calf between 1985 and 1993, after which A3 and A5 mixed with other groups (Iñiguez, 2001); PNB ($n = 2$) comprised of two adult males, and PNC ($n = 9$) comprised of three adult females, one adult male, four immature and one calf (Table 1).

Based on data presented, adult males represented 17.7 %, adult females 35.3 %, immatures 35.3 % and calves 11.8 %. Table 2 summarizes the composition of the sex/age classes of the killer whale groups of PN, and similar data for killer whales from British Columbia and Alaska.

Of the 276 sightings, group size ranged from 1 to 8 whales ($\bar{X}=2.14$, $SD=1.82$)(Fig. 3)

Age and Sex classification of three male killer whales

When first seen in 1975 (López, *pers. comm.*) B1 had the characteristic large dorsal fin of an adult male killer whale. Estimates for male killer whale sexual maturity range from 11-12 years (Olesiuk *et al.*, 1990) to 16 years (Bigg *et al.*, 1987), and Hoelzel (1991), using the estimation of 16 years, calculated B1 to be at least 29 years old in 1987. After 1993, B1 was no longer sighted (Iñiguez, 2001) and was approximately 35 years old.

In 1975, B2 was an immature male who by 1976, acquired an adult male dorsal fin (López, *pers. comm.* cited in Hoelzel, 1991). Based on estimates for male killer whale sexual maturity B2 was approximately 37 - 40 years old in 1999.

C3 was an adult male in 1975 when first seen by López (*pers. comm.*) and would be at least 16 years old of age then is at least 40 years old in 1999.

Intergroup interactions

PNB group interacted with both A and C groups ($n = 43$). B2 was observed multiple times ($n = 38$) and during these observations was sighted with all members of A, B and C groups, with the exception of A6.

Fig. 2 shows the changes of Group members between 1985 and 1999. After 1993, changes in the group compositions were observed. First, an association between A and B groups was observed on 12 occasions, and since 1994 between A and C groups ($n=1$).

C3 dispersed from C group (6 individuals and possibly C3's maternal group) and B2 dispersed from A3 and A5.

Therefore dispersal of both sexes from groups larger than three individuals was observed in northern Patagonia.

Association indices

The database contained a total of 136 associations on which two individuals were seen together. The simple association index shows that the majority of long-term associations among northern Patagonia killer whales were high (Fig. 4). Thirteen pairs of individuals had an association index of ≥ 0.5 .

DISCUSSION

Killer whales off northern Patagonia form foraging associations between all three groups (*i.e.* A3, A5 and B2 for one season, A3, A5 and C3 for at least two seasons, and A3 and C group for one season). This might be explained by high prey availability, and high accessibility to hunting areas, or by allowing mating to occur. B1 and C3 were never seen together between 1985-1999, in contrast to López (*pers. comm.*) who sighted B1 and C3 together during the beginning of his study in 1975.

Baird and Dill (1996) reported that groups with three killer whales virtually never contained members of more than one group, implying that groups containing one or two individuals do not join to form foraging coalitions of three individuals.

Differences in the proportion of adult male, adult female, immature and calf compositions within the three compared populations (Table 2) might be attributed to research limitations found in all killer whale studies. These are suggested by Leatherwood *et al.* (1990) to be: 1) adult females which are senescent or without calves can be mis-classified as immature, 2) the criteria for various age/sex classes were not defined uniformly and 3) published figures presumably refer only to a single year (usually the most recent) in a multi-year study.

The male killer whales of northern Patagonia seem to have a long average life expectancy (*i.e.* approximately 35 years for B1, 40 years for B2 and at least 47 years for C3). While previous studies estimate maximum longevity to be 35-40 years (Dahlheim and Heyning 1999), the average life expectancy for the well studied Vancouver Island fish-feeding *residents* has been calculated at approximately 29 years for males and 50 years for females, with an expected maximum longevity of 50-60 years for males and 80-90 for females (Olesiuk *et al.*, 1990). The average age at death for the southern *residents* males was 27.6 years, with a maximum age of 43 years (Taylor and Plater, 2001).

Dispersal of both sexes from groups larger than three individuals was observed with northern Patagonia killer whales. Iníguez, (2001) noted that larger groups (>three whales/group) spend no more than 5 five days in the same area; by contrast, smaller groups (= two whales/groups) stay longer in the same area. Hoelzel (1991) suggested that killer whales at Punta Norte are social and hunt together and provision each other. Northern Patagonia killer whales group size is associated with foraging (Hoelzel, 1991). However, groups larger than six individuals were also observed during our studies: *i.e.* A-group (1986-1990) and C-group (1985-1999). A maximum of 10 whales ($n=2$) which may belong to the 17 killer whales identified in this study, were recorded at Golfo Nuevo in November and December of 1996 respectively (G. Moreno, *pers. comm.*). Baird and Dill (1996) suggest that the formation of large groups of mammal-feeding *transients* off British Columbia might function to familiarize young whales with other individuals in the population, particularly to facilitate the cooperative hunting of dangerous prey. Dispersal also occurs among groups of elephant seal-eating killer whales at the Crozet Islands (Barrett-Lennard and Williams, 2002).

Demographic factors possibly influencing group splitting of *resident* off British Columbia were described by Ford and Ellis (2002): they proposed 1) the death of matriarch in the matriline, 2) maturation of offspring and 3) the proportion of males in the matriline. They showed that groups are less permanent than originally

thought and proposed that matriline, not groups, be considered the fundamental units of social organization in *resident* killer whales.

The association between B1 and B2 was 0.32 before B1 were no longer sighted in 1993 (Iñiguez, 2001). Hoelzel (1991) reported the two adult male killer whales frequently sighted together off Northern Patagonia (B1 and B2) are closely related and obtain an advantage by foraging together. Lone *transient* males, however, do not appear to join with other lone males at British Columbia. A third adult male off Northern Patagonia (C3) stayed with C-group until 1994, almost a year after a newborn (C8) was observed in the group. Baird (2000) suggests that a first-born male may stay with his mother his entire life, while a second-born male may disperse from its maternal group, remaining solitary for a period of time. A number of transient groups off British Columbia were comprised of solitary adult males (Bigg *et al.*, 1990).

The average group size of killer whales off Northern Patagonia in this study was 2.14 and may be explained because larger groups patrolling pinniped rookeries over multiple day periods may reduce the number of capture rate; the longer periods and higher killer whale counts increase the pinnipeds ability to recognize and avoid danger at northern Patagonia (Iñiguez, 2001). Around Vancouver Island, British Columbia, *transient* killer whales were observed foraging, and most frequently found in groups of three, the group size at which individual energy intake rates may be maximized (Baird and Dill, 1996).

Associations among northern Patagonia killer whales remained high (>0.5). Although dispersal did occur in some instances, in the following years the new associations remained high.

It is possible that the same demographic factors influencing group splitting of *resident* off British Columbia, can be applied for northern Patagonia killer whales: the death of matriarch in the matriline (*i.e.* A1, A2 and may be C2), maturation of offspring (*i.e.* C5, C6 in C group) and the proportion of males in the matriline (*i.e.* C3 and C6 in C group).

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REFERENCES

- Baird, R.W. (2000). The Killer Whale: Foraging, Specializations and Group Hunting. In J. Mann, R.C. Connor, P.L. Tyack & H. Whitehead (eds.). *Cetacean Societies: Field Studies of Dolphins and Whales*. pp. 127-153. The University of Chicago Press, Ltd., London. 433p.
- Baird, R.W. & H. Whitehead. (2000) Social organization of mammal-eating killer whales: group stability and dispersal patterns. *Can. J. Zool* **78**: 2096-2105.
- Baird, R.W. & L.M. Dill. (1996) Ecological and social determinants of group size in *transient* killer whales. *Behav. Ecol.* **7**:408-416
- Baird, R.W. & P.J. Stacey. (1988). Variation in saddle patch pigmentation in populations of killer whales (*Orcinus orca*) from British Columbia, Alaska and Washington State. *Can. J. Zool.* **66**:2582-2585.
- Barrett-Lennard, L. & R. Williams. (2002). Killer whale workshop on population dynamics, population structure, and life-history. *Proceedings Fourth International Orca Symposium and Workshops*, September 23-28, 2002, CEBC-CNRS, France. 25-31.
- Balcomb, K. C. III, J. R. Boran & S. L. Heimlich. (1982). Killer whales in Greater Puget Sound. *Report of International Whaling Commission.* **32**, 618-685
- Bigg, M. A. (1982) An assessment of killer whales (*Orcinus orca*) stocks off Vancouver Island, British Columbia. *Report of the International Whaling Commission.* **32**, 655-666.
- Bigg, M.A., G.M. Ellis, J.K.B. Ford & K.C. Balcomb (1987). Killer whales: A study of the identification,

- genealogy and natural history in British Columbia and Washington State. Nanaimo, BC: Phantom Press.
- Bigg, M.A., P.F. Olesiuk, G.M. Ellis, J.K.B. Ford, & K.C. Balcomb (1990). Social organization and genealogy of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. *Report of the International Whaling Commission, Special Issue 12*: 383-406.
- Dahlheim, M. E. and Heyning, J. E. (1999). Killer whale *Orcinus orca* (Linnaeus, 1758). In *Handbook of marine mammals*, vol. 6. The second book of dolphins and the porpoises (ed. S. H. Ridgway and R. Harrison), pp. 281-321. Academic Press, San Diego.
- Dalla Rosa, L., E. Hoyt, M. Iñiguez, M. Morcillo Moreno, M. Morrice, M. Taylor, V. Tossenberger, I.N. Visser, M. Prideaux, M. Simmonds & S. Dolman. (2002). *Orcinus orca* a species complex. Unpublished Report of Whale and Dolphin Conservation Society. 31p.
- Ford, J.K.B. (2002). Killer whale (*Orcinus orca*). Pp. 669-676. In *Encyclopedia of Marine Mammals*. (W.F.Perrin, B. Würsig & J.G.M.Thewissen Eds.). Academic Press. 1414p.
- Ford, J.K.B., G. M. Ellis & K. C. Balcomb (1994) Killer whales: The natural history and genealogy of *Orcinus orca* in British Columbia and Washington State. UBC Press, Vancouver, British Columbia. 102 pp.
- Ford, J.K.B. & G.M. Ellis (1999). Transients: Mammal-hunting killer whales. UBC Press, Vancouver, British Columbia. 96 pp.
- Ford, J.K.B. & G.M. Ellis (2002). Reassessing the social organization of resident killer whales in British Columbia. *Proceedings Fourth International Orca Symposium and Workshops*, September 23-28, 2002, CEBC-CNRS, France. 72-74.
- Ginsberg, J.R. & T.P.Young. (1992). Measuring association between individuals or groups in behavioural studies. *Anim. Behav.* **44**: 377-379.
- Gubbins, C. (2002). Association patterns of resident bottlenose dolphins (*Tursiops truncatus*) in a South Carolina estuary. *Aquatic Mammals* **28.1**, 24-31
- Heyning, J.E. & M.E. Dahlheim (1988) *Orcinus orca*. Mammalian Species N° 304, *American Society of Mammalogists* **15** (January), 1-9.
- Hoelzel, A.R (1991) Killer whale predation on marine mammals at Punta Norte, Argentina; food sharing, provisioning and foraging strategy. *Behavioral Ecology and Sociobiology*. **29**, 197-204.
- Hoyt, E. (1990). Orca: The whale called killer. Third Edition. Camden House/Firefly, Toronto, pp. 1-291
- Iñiguez, M.A. (1990) The presence of killer whales (*Orcinus orca*) and their interactions with other animals in Argentina. *Abstracts Third International killer whales Symposium*, March 9-12, 1990. Victoria, Canada:9.
- Iñiguez, M.A. (1991) Killer whales. En H.L.Capozzo y M.Junín (Eds.) Estado de Conservación de los Mam. Marinos del Atlántico Sudoccidental. *Informes y Estudios del Programa de Mares Regionales del PNUMA N° 138*, 92-95.
- Iñiguez, M., A. R. Vila, V. Falabella & C. Campagna (1992) Técnicas de incidencia de predación de *Orcinus orca* en el área de Punta Norte. *Resumen Quinta Reunión de Especialistas en Mamíferos Acuáticos de América del Sur*. Septiembre 28 - Octubre 2, Buenos Aires:
- Iñiguez, M.A. (2001). Seasonal distribution of killer whales (*Orcinus orca*) in Northern Patagonia, Argentina. *Aquatic Mammals*. **27(2)**, 154-161.
- Leatherwood, S., C. O. Matkin, J. D. Hall & G. M. Ellis. (1990). Killer whales, *Orcinus orca*, photo-identified in Prince William Sound, Alaska, 1976 through 1987. *Canadian Field-Naturalist* **104 (3)**, 362-371.
- López, J. C. & D. López (1985) Killer Whales (*Orcinus orca*) of Patagonia and their behavior of intentional stranding while hunting near shore. *Journal of Mammalogy*. **66(1)**, 181-3.
- Olesiuk, P.F., M.A. Bigg, and G.M. Ellis, (1990) Life history and population dynamics of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. *Report of the International Whaling Commission, Special Issue 12*: 209-243.
- Pitman, R.L. & P. Ensor (2003) Three forms of killer whales (*Orcinus orca*) in Antarctic waters. *J. Cetacean Res. Manage.* **5(2)**:131-139.
- Slooten, E., S.M. Dawson & H. Whitehead (1993) Associations among photographically identified Hector's dolphins. *Can. J. Zool.* **71**: 2311-2318.
- Taylor, M. F. J. and Plater, B. (2001). Population viability analysis for the southern resident population of the killer whale (*Orcinus orca*), pp. 27. Center for Biological Diversity, Tucson, Arizona.

Table 1. Killer whale group composition including new and no longer sighted individuals (1985-1999).

Group	Identified killer whale	Sex	Age class	Previous identification	Years sighted
PNA	1	Female	Adult	---	1985-1990
	2	Female	Adult	---	1985-1990
	3	Female	Immature/Adult	---	1985-1999
	4	Male (?)	Immature	---	1985-1988
	5	Female (?)	Immature	---	1985-1999
	6	Unknown	Calf	---	1990-1991
PNB	1	Male	Adult	---	1985-1993
	2	Male	Adult	---	1985-1999
PNC	1	Female	Adult	C2 (Hoelzel, 1991)	1985-1999
	2	Female	Adult	---	1985-1991
	3	Male	Adult	C1 (Hoelzel, 1991)	1985-1999
	4	Female	Immature/Adult	---	1985-1999
	5	Unknown	Immature	---	1985-1999
	6	Male	Immature	---	1985-1999
	7	Unknown	Immature	---	1985-1992
	8	Unknown	Calf/ Immature	---	1993-1999
	9	Unknown	Calf	---	1994-1999

Table 2. The age/sex composition of northern Patagonia killer whales population sex/age class compared to populations in British Columbia and Alaska.

Location	Proportions (in %)				Source
	Adult males	Adult females	Immature	Calves	
British Columbia	23	34.1	38.5	4.4	Bigg (1982)
Alaska	22.4	9.5	64.2	3.9	Leatherwood <i>et al.</i> (1990)
Northern Patagonia	17.65	35.29	35.29	11.77	This paper

Fig 1. Location of the study area: (1) Rio Negro estuary; (2) Punta Bermeja; (3) San Antonio Oeste; (4) Punta Buenos Aires; (5) Punta Norte; (6) Caleta Valdés; (7) Punta Cerro; (8) Punta Delgada, (9) Morro Nuevo; (10) Punta Pirámides; (11) Punta Ninfas and (12) Punta León.

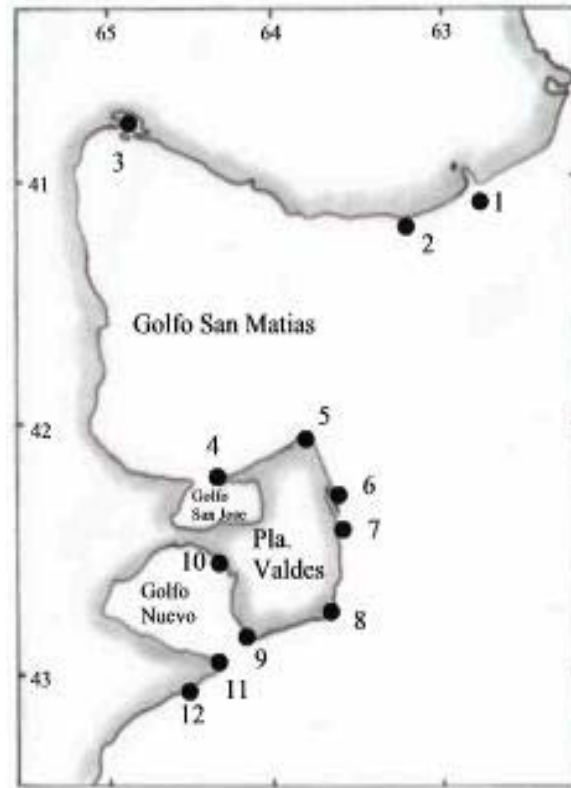


Fig.2: The composition and evolution of northern Patagonia killer whales groups between 1985 and 1999.

Key: PNA, PNB and PNC designates groups found off Patagonia & A1...A6, B1, B2, C1...C9 indicates individuals within a group.

(†) designates individuals no longer sighted.

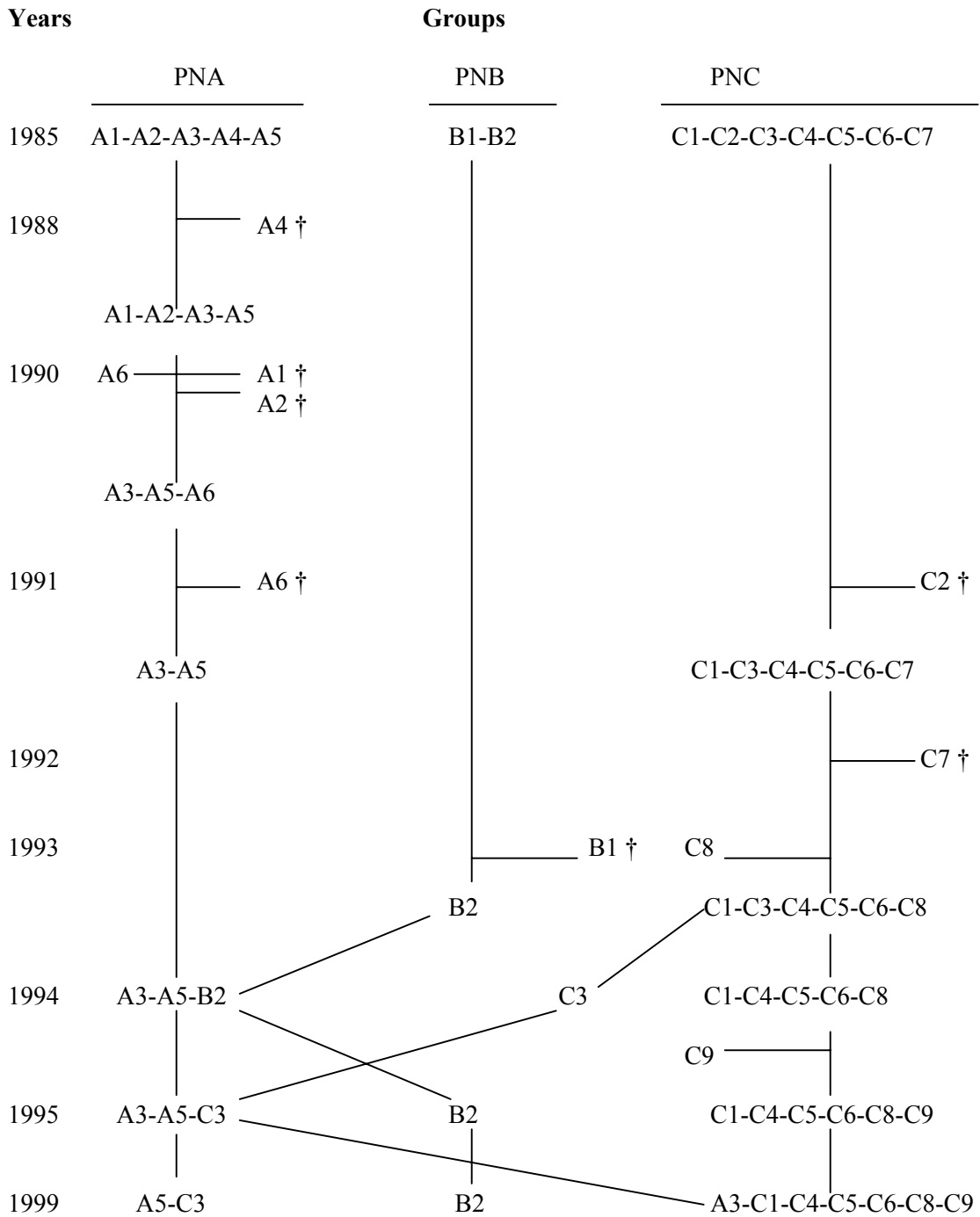


Fig. 3: Group size of *Orcinus orca* in northern Patagonia including all the sightings

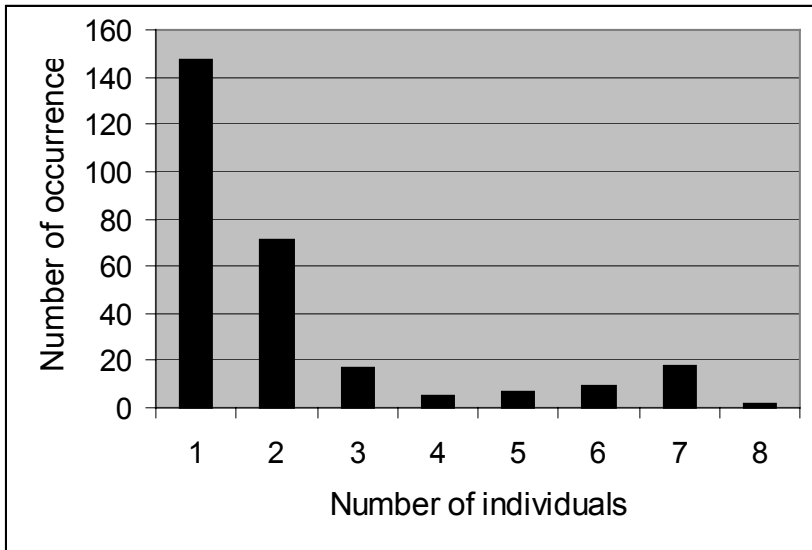


Fig. 4: Histogram of simple ratio association index of dyads of Patagonia killer whales ($n=136$)

