

PRELIMINARY RESULTS ON THE DISTRIBUTION OF WINTERING
HUMPBAC WHALES (*MEGAPTERA NOVAEANGLIAE*)
IN FRENCH POLYNESIA 1997-1999



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ABSTRACT

The distribution of wintering humpback whales has been investigated during the 1997-1999 period, by carrying on dedicated small boat surveys (1997-1998-1999) and participating to a large vessel survey (1999). Every year, survey programs were organized on a 12m sailboat during the September to November period: a three-observer standard sighting protocole was maintained, with systematic hydrophone sampling to detect singing whales. Small boat surveys took place in the Society Islands (1997); Windward Islands (1998-99) and Australes Islands (1999) and totalled 3298km of effective effort (less than Beaufort 4 conditions), mostly in inshore waters, and 55 sightings on groups of whales numbering one to four animals. Five mother-calf pairs were detected, in October and November. Research vessel survey was opportunistic and took place from 5 July to 6 August 1999 from the 85m R/V « L'Atalante », with one observer on-board. An effective sampling effort of 3605km was obtained mostly in open sea waters of the Australes Archipelago area (22°S to 25°S). Seventeen groups of whales totalling 20 individuals were detected. A relative abundance index (RAI) was estimated to quantify the whale presence for every survey: a consistent estimate of 3 to 4 whale/100km of effort was obtained in the Windward and Australes Islands (small boat survey). A consistent singing rate (ratio of hydrophone samples with a whale singing) of 32 to 36% was obtained in the Windward Islands, from a total of over 900 hydrophone listening stations. We also discuss the possible distribution range of whales in other archipelagos of French Polynesia from indirect data obtained during other surveys. The most uncertain situation is found in the Tuamotus Archipelago, counting 70 islands, where humpbacks may be found around numerous islands, still to be surveyed.

INTRODUCTION

Southern humpback whales (*Megaptera novaeangliae*) are known to feed around Antarctica during austral summer and to winter in tropical latitudes from July to December (Winn and Reichley, 1985; Patterson, 1991; Dawbin, 1997). Their migration cycle has been particularly well studied off eastern and western Australia (Patterson, 1991; Dawbin, 1997). In spite of some geographical variation of the males breeding song, whales wintering off eastern Australia and around islands of the western Pacific, particularly the Tonga are thought to feed in Antarctic Area V waters (Helweg *et al.*, 1998). Up until very recently, little was known about southern humpback whales wintering in central Pacific, noticeably in the waters of French Polynesia. Their presence was signaled off Moorea and in adjacent waters by Poole (1993), and in the Society Islands by Gannier and Gannier (1998). Humpback whales are commonly seen in French Polynesia from July to November, their presence is well documented around Tahiti, Moorea and Rurutu, where scientific or whale-watching programs are carried on regularly (Lefèvre *et al.*, 1999; Poole, 1999; Gannier, 2000a). However, due to the spatial extension of French Polynesia (118 islands in five archipelagos) and to the modesty of research effort, it has been impossible to determine the exact distribution range of wintering humpback whales. This report summarizes results obtained during the 1997-1999 period from three small boat dedicated surveys and one research vessel opportunistic survey, in the Society and Australes Islands. Humpback whale presence in the Marquesas, Tuamotus and Gambier Islands is also discussed.

MATERIAL AND METHODS

Data collection

Surveys were carried on from two types of vessel during the wintering period (July-November) of the southern humpback whale: the 85m research vessel « L'Atalante » was used as a platform of opportunity during program *Zepolyf2* off the Australes Islands (July-August 1999) and a 12m auxiliary sloop was used during the September-November period from 1997 to 1999.

The large vessel survey took place from 7 July to 5 August 1999, while R/V « L'Atalante » was engaged in geophysical research over a large area embodying much of the Australes Archipelago, located at about 23°S latitude, some 350 miles south of Tahiti (Figure 1). One observer was searching with naked-eye from the upper deck (15m

above the surface), the vessel cruising at 18.5km/h. The searching was interrupted when the wind speed exceeded Beaufort 5. This was a passing mode survey: species identification was done with a 12x50 binocular. An effective effort of 4438km was achieved during this geophysical survey, representing 239 hours of sighting effort.

The dedicated survey program was carried on using a 12m auxiliary sailboat during three successive years: in 1997 the Leeward and Windward Islands were sampled, in 1998 the research area was the Windward Islands, and in 1999 the Windward and Australes Islands were sampled (Figure 1). The same field protocol was adopted during the three surveys: visual searching was combined to systematic acoustic sampling. The boat moved on zig-zag tracks around islands, mostly inshore using diesel propulsion (speed 10km/h), and survey took place with wind speed less or equal to Beaufort 4. Three active observers shared the frontal sector, searching with naked eyes. Whales were positioned upon detection, radial distance and bearing estimates were recorded, and were thereafter approached. One acoustic listening was performed every 2.8km.

Data processing

Data were first entered into a computer database (dBase IV), and processed with a geographical software package (*Oedipe*) used for mapping and effort calculations (Massé & Cadiou, 1994). To quantify the whale presence, an index of relative abundance was estimated for every survey (RAI), as the average number of animals sighted per kilometer of effective effort:

$$RAI = n \times S / L$$

where *n* is the number of on-effort sightings, *S* is the mean school size and *L* is the effective sampling effort. This index was derived from the line transect estimator formulation in Buckland *et al.* (1993). It may be assumed to be unbiased, provided that detection performance (*i.e.* effective search width, *esw*) does not vary between surveys. For a given survey protocol (*i.e.* same platform and number of observers), and a given species, the assumption of constant *esw* holds if sighting conditions are supposed to be constant on average. Sighting conditions may vary with wind speed, swell height and luminosity. Wind in excess of Beaufort 4 can have adverse effects on the detection of cetaceans (Hiby & Hammond, 1989; Buckland *et al.*, 1993). Hence, for the processing of different RAI, only sampling effort obtained with sea state of Beaufort 4 or less was retained.

Sighting rates and RAI were estimated with *Distance* 2.2 software (Laake *et al.*, 1994), only primary sightings were considered. The daily effort was taken as the unit sample. The *esw* was arbitrarily taken as 4 km, a value twice larger than any perpendicular distance estimated during the survey. Confidence intervals were estimated on the basis of a log-normal distribution of the relative abundance index.

Acoustic data is mapped and a simple « singing rate » is computed to quantify the whale acoustic activity:

$$T \% = 100 \times (P / N+P)$$

where P is the number of positive listenings (*i.e.* when a whale song is heard during the listening) and N is the number of negative listenings. T% is calculated for every year of survey.

RESULTS

Small boat surveys: effort

A total of 3298km were covered on effort, including 1056km in 1997, 894km in 1998 and 1349km in 1999 (Figure 2). There were 17 samples in 1997, 18 samples in 1998 and 24 samples in 1999. In 1997, both Windward and Leeward Islands were sampled; in 1998 we covered only Windward Islands. In 1999 Windwards Islands were covered in addition to Tubuai and Rurutu, in the Australes Archipelago.

Small boat surveys: sightings

A total of 55 groups of whales were observed in-effort during the sailboat programs. Eleven sightings were obtained in 1997 (22 individuals), 15 in 1998 (28 individuals) and 29 in 1999 (44 individuals). In 1999, 23 sightings were made in Society Islands (Figure 3), and 6 in the Australes (Figure 6)

Humpback whales were often observed in groups of 1-2 animals, generally very close to the reef barrier (less than 1km) and only once farther than 10km (Figure 3). Groups of 3 or 4 animals were seen every year, and only in the Windward Islands (Tahiti, Moorea and Maiao). 53% of sightings were of single animals, 30% of pairs, and there were 7 in-effort sightings of 3 animals and 3 of groups of 4 animals.

Seven sightings of mother with yearling (individual 7 to 8m long) occurred mostly in September; in 4 cases the mother was escorted by one (2 sightings) or two large-sized animals. We obtained 5 sightings of mother/newborn-calf pairs, in October and November; on one occasion a male (identified as such because he was singing) was

escorting the pair. Humpbacks seemed to be less frequent around Raiatea-Tahaa than around islands located more to the east (Figure 3).

Small boat surveys: Relative Abundance Index

During sailboat surveys, the sighting rate varied from 0.0193 group/mile in 1997 to 0.0606 group/mile (CV=26%) for Australes Islands in 1999 (Table 1). However, mean school size were higher in the Society Islands, with a maximum of 2.0 in 1997, resulting in more convergent RAI estimates for the set of surveys. The index was 2.08 whale/100km in 1997, for islands of both Windward (Tahiti and Moorea) and Leeward (Huahine, Raiatea, Tahaa) groups. For 1998 and 1999, the RAI estimates in the Windward Islands are similar with 3.13 whale/100km and 3.18 whale/100km, respectively, although mean school size decreased from 1.87 to 1.61 (Table 1). A higher estimate of 3.81 whale/100km was obtained in the Australes (Rurutu and Tubuai), although high CV (29.3%) and low sample size must be accounted for.

Acoustic results

Singing rate in the Society islands varied slightly from 32.0% in 1997 (309 samples), to 36.4% in 1998 (214 samples) and 35.8% in 1999 (344 samples). In 1997, small islands such as Moorea and Huahine appeared to be more attractive to singers than large islands such as Tahiti or Raiatea-Tahaa (Figure 4). In the Australes (1999) the singing rate was only 6.4%: no singer was heard in Tubuai, when there was one singing whale in Rurutu.

Research vessel survey: effort

A total of 4438km was covered on-effort, during 22 workable days, including 3605km with wind speed lower than Beaufort 4. As opposed to small boat surveys, this effort was not concentrated around islands; however, area surveyed was not random because the geophysical survey focused on sea-mounts and areas of unknown bottom topography. The surroundings of four islands were sampled as well as some shallow banks (Figure 5).

Research vessel survey: sightings and RAI estimate

A total of 17 groups of whales were observed in-effort including an estimated total of 20 individuals (Figure 6); 2 sightings were recorded some 200km south of Tahiti. Interestingly, sightings were not limited to the surroundings of islands. Whales were observed close to Rimatara and Rurutu; but bad weather prevented efficient searching close to Tubuai. Due to the distance, 3 sightings were not identified with certitude, however as blows and surface behavior did not correspond to large rorqual species or to

sperm whales, these whales were recorded as probable humpbacks. Number of sightings and effective effort resulted in an index of 0.55 whale/100km.

DISCUSSION

These results are obtained from sampling in two archipelagos, in offshore and inshore waters, during 3 years. The surroundings of 10 islands have been covered: in particular Tahiti, Moorea, Maïao, Huahine, Raiatea and Tahaa in the Society Islands, and Rimatara, Rurutu, Tubuai and Raivavae in the Australes Islands.

Population status

Several authors assume the humpback population wintering in central Pacific (east of the Cook islands and including this archipelago) belong to the little studied Area VI « stock », presumably feeding in Antarctica east 170°W (Hauser *et al.*, 1999; Reeves *et al.*, 1999). Winn and Reichley (1985) do not mention humpback whales off French Polynesia when they present results from Gaskin (1976), showing that individuals seen in the Cook Islands had previously been marked in the Area V. To date, the population identity of humpback whales wintering in French Polynesia remains unclear, and before this question is better substantiated by genetic, acoustic and photo-identification results, no eventuality can be discarded. The option of animals from Area I, known to winter usually off western South America (Florez-Gonzalez L., 1991), wandering into central tropical Pacific has not been taken into account in the literature.

Winter distribution range

Over 140 islands are found in the tropical area over a 3000km extent between 160°E (Cook Islands) and 130°E (Pitcairn) and French Polynesia itself accounts for 118 islands in five archipelagos. From reports of diverse sources, Poole and Darling (1999) consider humpback whales to have occurred around 25 islands and 4 archipelagos, during a ten years period. However these data are not effort-corrected and cannot deliver a consistent picture of the humpback distribution, since in some areas whales can be recorded once or twice during the wintering period, when in other areas (Huahine, Moorea, Tahiti, Rurutu, Tubuai) several animals are seen throughout the season. Moreover, islands involved in some touristic activity are likely to report more easily on whale sighting than other islands (the majority).

In this study, small boat surveys have been carried on around 8 islands of two archipelagos and show a consistent effort-corrected RAE of over 3 whales/100km in the

Windward and central Australes Islands. Furthermore, acoustic activity associated to breeding has been recorded around 7 islands; and additional sighting and song data was obtained in Makatea (northern Tuamotus) in 1998 (*pers.data, unpublished*). The research vessel results show that whales are distributed over a wide area in July (Figure 5); due to the timing of survey, early in the wintering season, this extended distribution is consistent with northwards migration of part of the population, although we may not exclude several offshore shallow banks to be used throughout the season by wintering whales.

The question of the extent of wintering range in French Polynesia is important because the magnitude of population size is directly related to it: population estimates would be totally different if the main wintering component was grouped around 10-15 islands (for example, the northern Australes, the Society Islands and the neighbouring Tuamotus), or if a good proportion of the 75 Tuamotus Islands shelter winter residents. From our small boat surveys, we estimated about 70-100 whales to be present around 8 islands (Gannier, 2000b). Unfortunately, few complementary elements allow us to determine the distribution range in the Tuamotus, even roughly.

The Marquesas is the northernmost archipelago of French Polynesia, located at about 140°W and 9°S. Before reaching this area, humpback whales migrating northwards pass close to about 20 islands, beginning at 23°S. We did not observe humpback during our survey of November 1998-February 1999 (Gannier, 1999). Nevertheless, humpback whales are observed there from time to time, according to local people; a mother-calf pair was seen on 24 August 1998 near Hiva Oa (Michel Oberlin, Hanaïapa, Hiva Oa, Marqueses, January 1999, *pers.comm.*). This in agreement with elements communicated to S. Leatherwood in 1990 (Reeves *et al.*, 1999); Poole and Darling (1999) had no humpback records from the Marquesas. These elements suggest that humpback winter presence in the Marquesas has been marginal, during recent times.

In the Gambier archipelago, located far southeast at 136°W and 23°S, we were told that humpback whales are seen every year on a few occasions in July-August, but rarely in September-October (Francis Sanford, Rikitea, Gambier, Dec.1999, *pers.comm.*). This is not in total disagreement with the communication cited by Reeves *et al.* (1999), who states whales were seen there in August-September. The question of the humpback distribution in the southernmost islands of French Polynesia (Gambier, southern Australes) cannot be considered regardless of weather conditions, and noticeably of sea

surface temperature. SST in tropical Pacific can vary substantially from year to year, *i.e.* during an « El Nino-La Nina » sequence, a situation happening in 1998-1999. From hydrological surveys, we know that SST at 23°S may varie between 22.5°C and 25°C (Rancher and Rougerie, 1993), when variations are less considerable in the Society Islands, about 17°S. For example, during our small boat survey in October 1999, we measured a steady increase of SST from 22.4°C at Tubuai (23°20'S) to 26°4°C in Tahiti (17°40'S) (Gannier, 2000b).

A lower temperature may influence whale distribution, preventing in particular mother-new born calf pair to stay a long time in the coldest places. According to Lefèvre *et al.* (1999), four newborn calves were seen regularly off Rurutu in 1998 (El Nino « warm » year), when only one mother-calf was observed in 1999 (La Nina « cold year »), and briefly (Yves Lefèvre, Rurutu, Australes, 11 Oct. 1999, *pers.comm.*). Hence, during cold years, mother-calf pairs could rather favour warmer waters found in the Societies and Tuamotus.

Migration timing

Available data during the period of study seems to be in agreement with Dawbin (1997) for the northbound migration, with an early record of a juvenile humpback in Bora Bora on 10 July 1998 (Pierre-Philippe Tricottet, Punaauia, Tahiti, Sept. 1998, *pers.comm.*). For the southbound migration, the last available records off Tahiti are on 5 December 1999 (a song heard by scuba divers) and 12 December 1999 (sighting of 2 individuals) (Nicolas Castel, Eleuthera Plongée, Punaauia, Tahiti, December 1999, *pers.comm.*); these late records are in agreement with results of Patterson (1991), off eastern Australia. However, it is apparent from our small boat surveys that sighting frequency decreased from the end of October, with the exception of mother calf-pairs, seen in October and November. The late presence of calving females in wintering areas is mentionned in the literature (Dawbin, 1997).

CONCLUSION

The present report brought a significant increase of knowledge about humpback whales distribution in French Polynesia, because consistent survey methods deliver effort-corrected results. However, an immense domain in the Tuamotus Islands remains to be studied before the true humpback distribution range in French Polynesia can be

described. Only future progress in genetic, acoustic and photo-identification may help to determine the population status of humpback whales wintering in central south Pacific.

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TABLES

Table 1: Sighting rates et Relative Abundance Index for Small boat surveys.

Year	1997	1998	1999	1999
Area	Windward- Leeward	Windward	Windward	Australes
sighting rate n/L	0.193 E-01	0.311 E-01	0.366 E-01	0.606 E-01
(CV%)	(35.4)	(25.3)	(23.5)	(25.5)
School size	2.0	1.87	1.61	1.16
(CV%)	(11.7)	(14.7)	(11.5)	(14.3)
RAI ind./100km	2.08	3.13	3.18	3.81
(CV%)	(37.2)	(29.2)	(26.2)	(29.3)

FIGURES

Figure 1: Area of Study and the south central tropical Pacific Ocean.

Figure 2: Sampling effort: small boat survey in the Society Islands.

Figure 3: Humpback whale sightings in Society Islands (1997-1999)

Figure 4: Location of listenings during the 1997 survey

Small cross relates to a negative listening, star relates to a low-medium level song heard during the listening, and square relates to a high level song.

Figure 5: Sampling effort: research vessel survey

Figure 6: Humpback whale sightings: Australes Islands.

Open square relates to sighting obtained during the small boat survey, black square to sighting made during the large vessel survey.

Figure 1: Area of Study and the south central tropical Pacific Ocean.

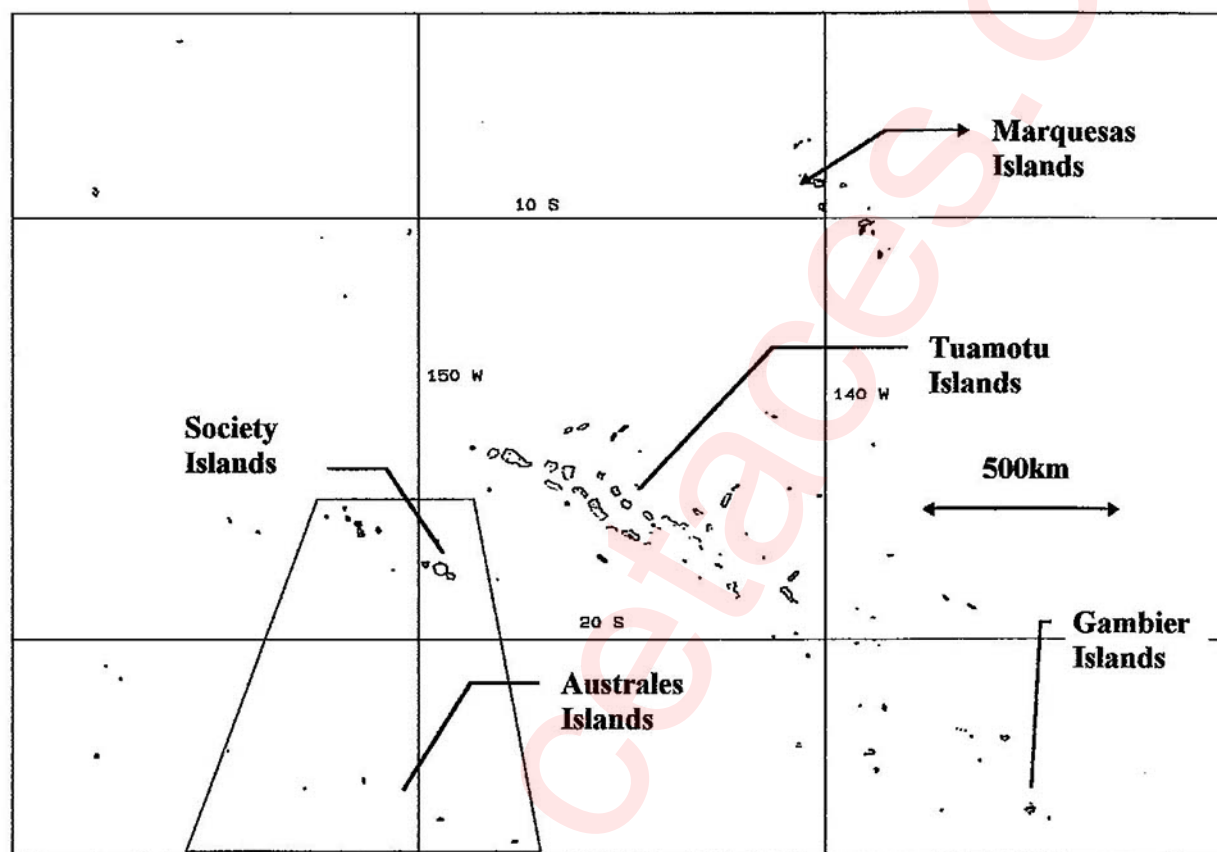


Figure 2: Sampling effort: small boat survey in the Society Islands.

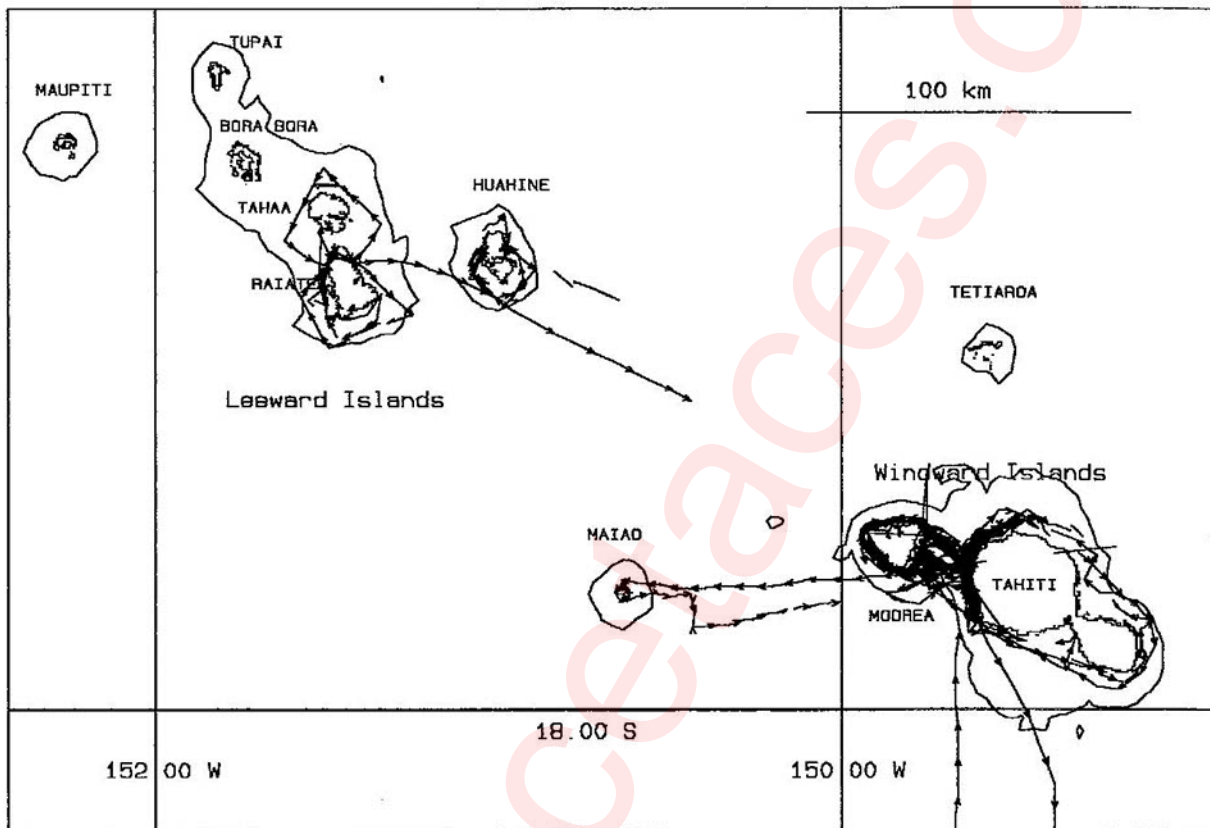


Figure 3: Humpback whale sightings in Society Islands (1997-1999)

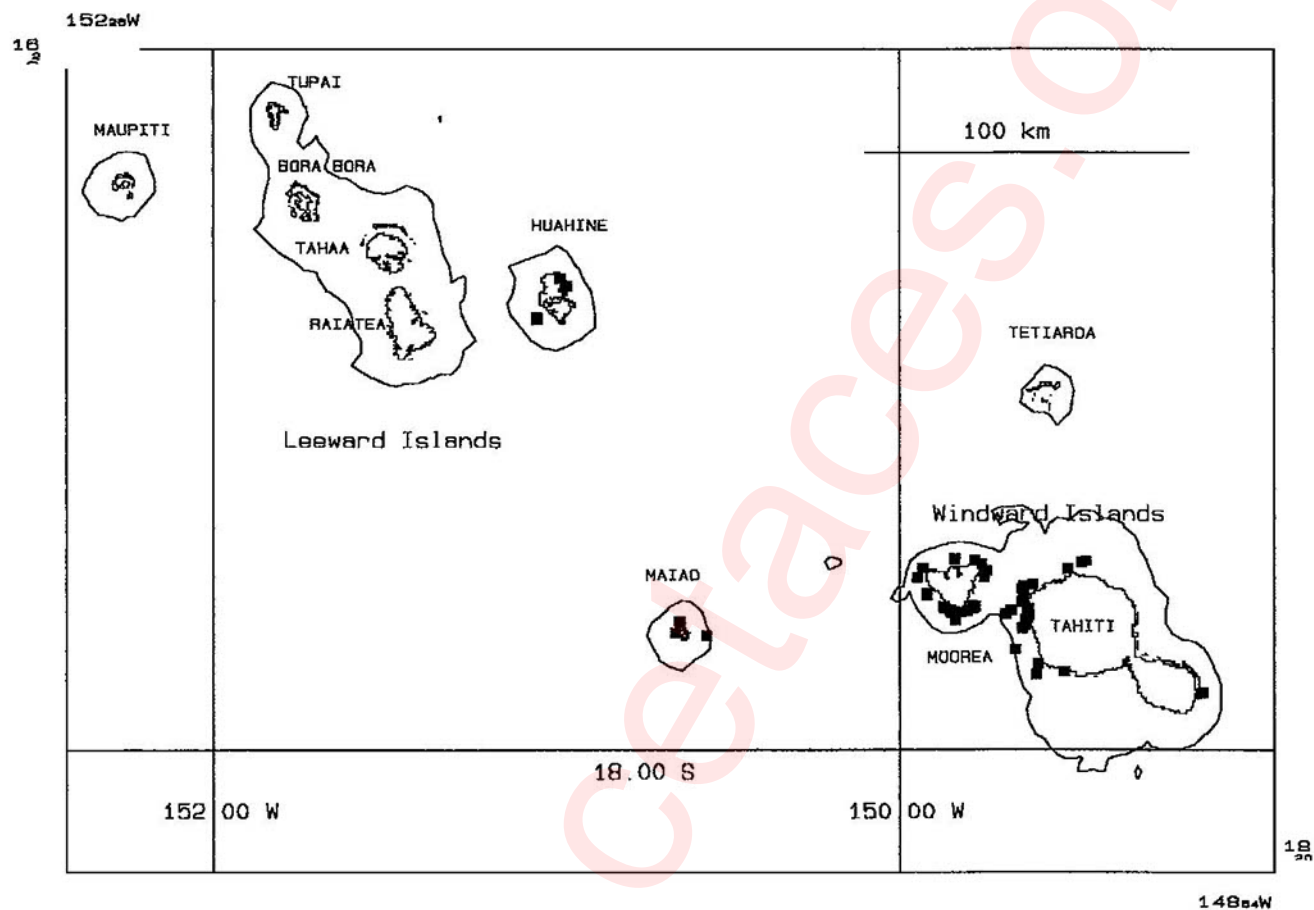


Figure 4: Location of acoustic contacts during the 1997 survey

Small cross relates to a negative listening, star relates to a low-medium level song heard during the listening, and square relates to a high level song.

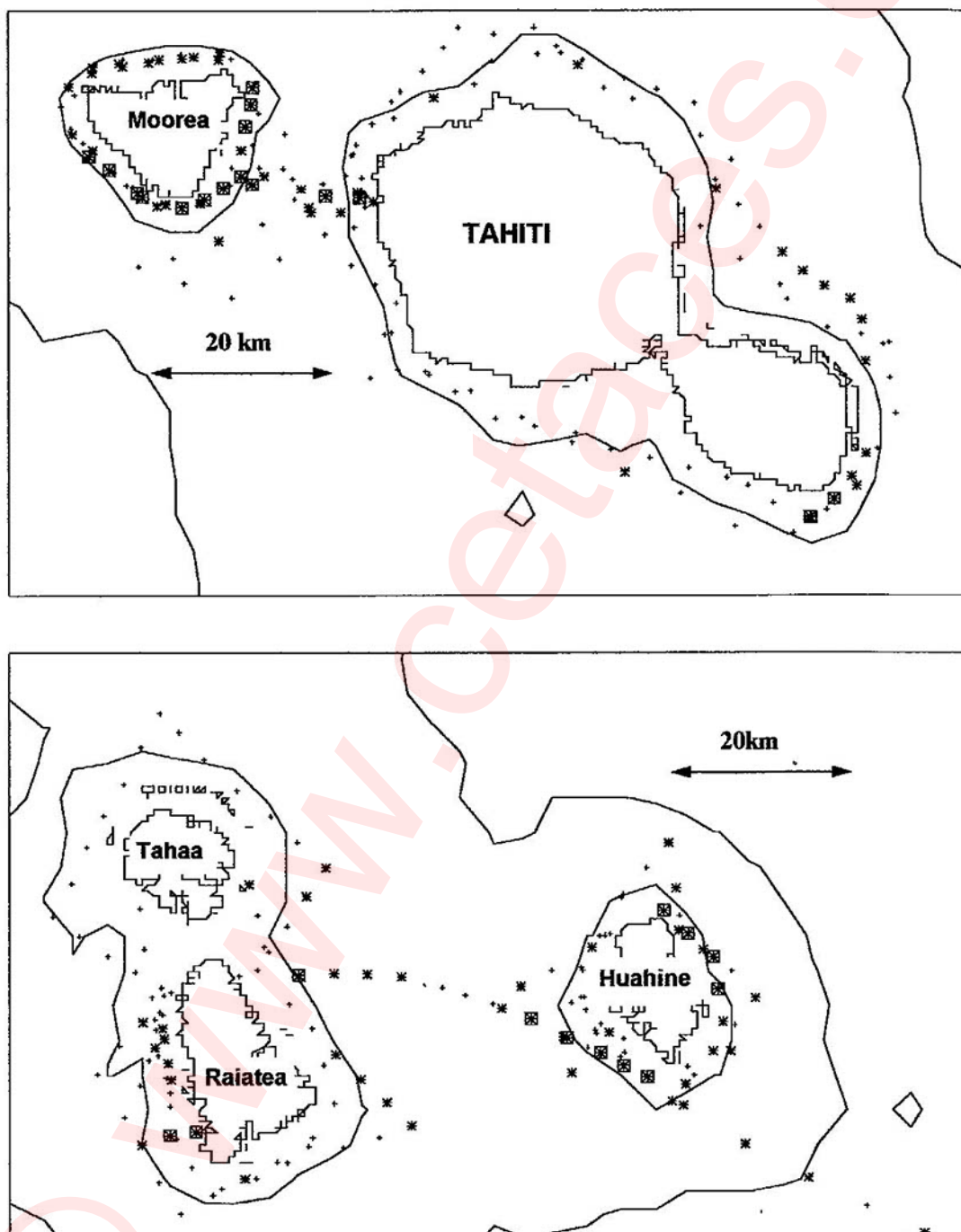


Figure 5: Sampling effort: research vessel survey

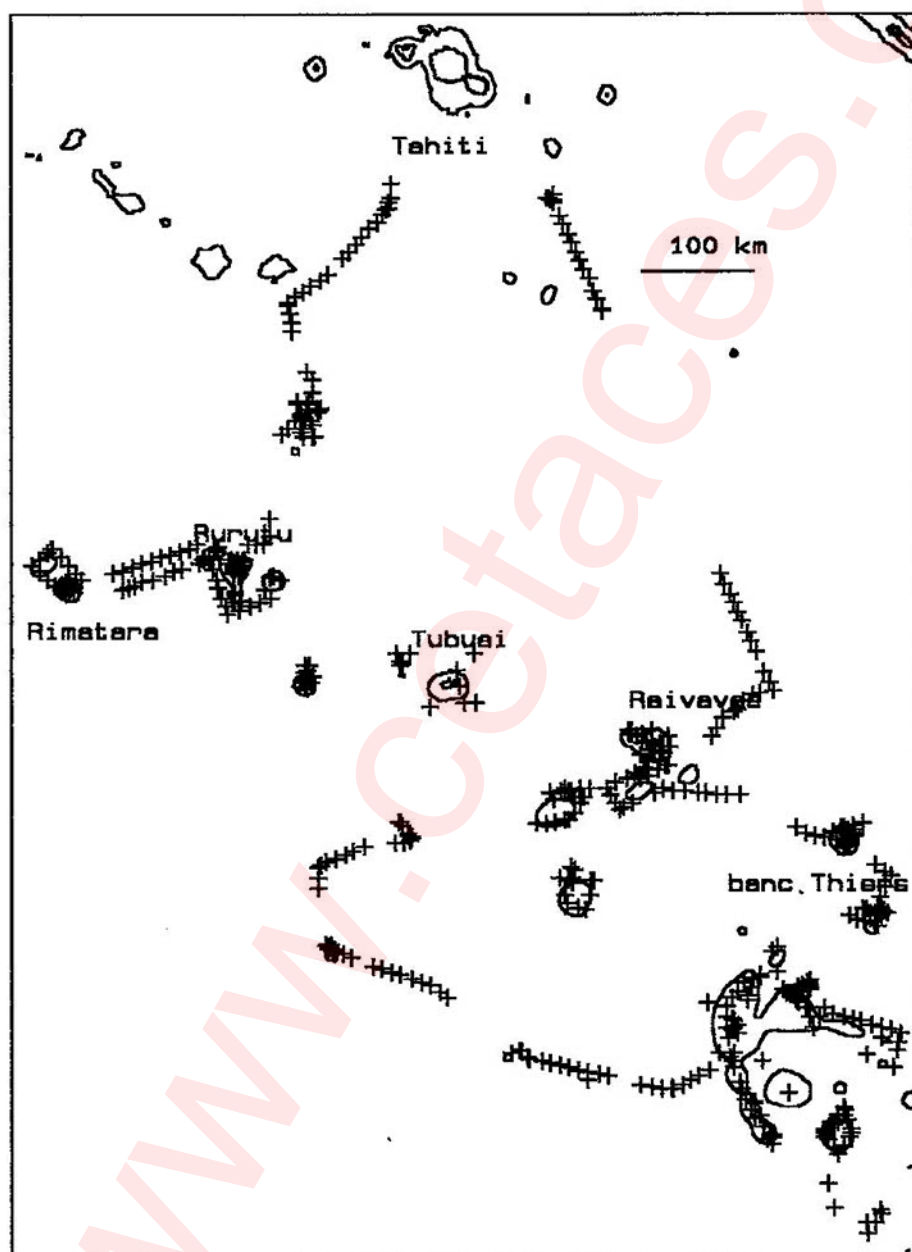


Figure 6: Humpback whale sightings: Australes Islands.

Open square relates to sighting obtained during the small boat survey, black square to sighting made during the large vessel survey.

