TEMPORAL VARIABILITY OF SPINNER DOLPHIN RESIDENCY IN A BAY OF TAHITI ISLAND (1995-2001).

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INTRODUCTION Long-beaked spinner dolphins (*Stenella longirostris*) are common delphinids in French Polynesia, ranking first in sighting frequency in the Society Islands (Gannier, 2000). In this archipelago, they use sheltered sites for resting and socializing purposes as was studied by Poole (*unpublished PhD dissertation*) in Moorea Island. They are believed to feed mainly on mesopelagic fishes and squid, during darkness in water 100 to 1500 meter deep. The « Baie des Pêcheurs » is located in the western (leeward) side of Tahiti Island (Figure 1). It is probably the most exposed spinner resting site in French Polynesia, due to anthropic activities on the nearby shore and along the Punaruu River, whose mouth is in the bay. The spinner dolphin presence has been studied here from October 1995 to December 2001.

STUDY SITE The « Baie des Pêcheurs » is located 13km south of Papeete (capital of French Polynesia), along the populated western coast of Tahiti. It is a 1200 x 500 meter gap in the coral reef-lagoon system, with an area of 0.55 km^2. Depth gently increases to 25 meter within the bay and steeply reaches 100 meter in the center part of the bay. Industrial activities are important along the Punaruu River, including an energy plant, a brewery factory and gravel extraction in the river bed. Three international hotels are within 20 minutes of boat ride. The water quality is influenced by swell, river inputs and the current flowing into the bay from the southern lagoon, depending on the southwesterly swell.

MATERIAL AND METHODS 869 shore-based sighting sessions were carried out during the period of study, one observer using 8x25 binoculars from the same sighting site. They commonly lasted 5 or 10 minutes and took place from 6:30 to 16:00 local time. Several environmental parameters were recorded, mostly using semi-quantitative variables:

- cloudiness (index 1 to 5)
- water turbidity (index 1 to 5 relating to the proportion of the bay area occupied by turbid waters)
- current intensity (index 1 to 3 relating to the current outflowing from southern lagoon, Figure 1)
- swell (index 1 to 5, 1 being unconspicuous swell and 5 being swell height over 2 meter)
- sighting conditions index (3 to 6, 6 being perfect and 4 being the low limit for effective sighting)

The presence/absence of the dolphin was noted together with the following variables on dolphin position, spatial structure and activity pattern:

- radial position in the bay (related to six conspicuous locations on the shore)
- distance to shore (eye estimate, refered to one mooring buoy 500 meter from shore)
- minimal and maximal estimates of school size
- school structure (grouped, spreaded, sub-groups)
- surface activity (active, resting, coherent swimming, interactive behavior)
- number of breaching events (standardized for a 5 minutes period)

- number of boats visiting the dolphins at close distance

Residency rates were computed from presence/absence recordings (as frequency of presence). Different time strata were considered:

- time of the day (to establish the duration of daily residency)
- month (to obtain monthly average residency rates)
- year (over 12 months except for 1995)

Other sighting parameters were analysed:

- minimal and maximal school sizes (by year and month, only for sighting condition index >4))
- mean distance to shore (by hour and year)

To compare residency rates, T-test were made assuming a normal distribution for parameters $(p ; [(p)(1-p)/(n-1)]^{0.5})$, with p the residency rate for the whole period .

RESULTS A total 804 sighting sessions were performed with good sighting conditions and showed an average morning residency rate of 72.8% with school sizes (Smin-Smax) ranging from (10-20) to (120-200). Dolphins generally stayed slightly beyond the limit of turbid waters caused by the river flow, which is often kept within 300 meter from shore by the outflowing lagoon current. Average distance from dolphins to shore generally varied from 350m to 550m (Fig.1), with a global increase from early in the morning (before 9h00) to noon (11h00-13h00).

Dolphins were found farther offshore in 1999 compared to 1998 (ANOVA, F=14.9, p>0.995), with a mean distance of 527m in 1999 against 403m in 1998 (T=3.95, p>0.995) and 327m in 2000 (T=5.96, p>0.999) (Table 2 and Fig. 1).

In average, their residency rate decreased from 78.4% (8h01-9h00 period) to 28.6% (15h01-16h00), showing a plateau around 75% up until 11h00 (Fig. 2). The hourly residency rate thus indicated that spinner dolphins started to leave the site from 11h00. This is in agreement with the increase of distance to shore shown above.

Monthly residency rates taken before 11h00 were higher from June to October, with frequencies over 80% (Table 1) and lower from December to April (less than 70%), with signifant difference (T-test; p >0.95) between March (f=65.3%) and October (f=83.3%). Yearly residency rates showed a near-significant dissimilarity with a value of 63.3% in 1999 (Table 2), compared to other annual rates of 72-76% and in particular 1998 and 2000 (T-test; p >0.90).

School size estimates varied daily from 10-20 and 120-200. Monthly averages of school size showed heterogeneity (ANOVA; F=2.96; p>0.99) with lower estimate in April and August.Yearly average estimates of mini and maxi school sizes showed respective ranges of 30.0-42.0 and 48.6-70.6, respectively (Table 3). In both cases, the 1999 average was the lowest estimate, significantly different from either 1998 or 2000 estimates (T-test; p>0.99).

DISCUSSION Much variable school size ranges showed that the « Baie des Pêcheurs » resting site is not frequented by a dedicated group of spinner dolphins, but by an agregation of individuals. This is to be related to the recognized social structure fluidity of this species demonstrated in Hawaii (Perrin and Gillpatrick, 1994). Lower school sizes in April and October do not relate apparently to the reproduction cycle.

The decrease of the residency rate from the morning (8h00-11h00) to the afternoon and the parallel increase of distance to shore showed that dolphins leave the resting site between 11h00 and 16h00. Limited data also show they can enter the bay as soon as the sunrise (5h45 to 6h30) and they were sometimes observed -by boat- feeding 1-3km offshore 2 hours before sunset (*unp. data*). However factors influencing the duration of resting in the bay are not presently known.

Lower monthly residency rate in December-April coincide with the apparent calving period and the warm (SST = 28°C-30°C) and rainy season.Convergent signs showed that spinner dolphins has been less present in the site during 1999: average residency rate fell to 64.5%, mean distance to shore augmented to 527m and lower mean school sizes were observed. El Nino event affected French Polynesia from mid-1998 to mid-1999, with effects on sea surface temperature and unknown influence on pelagic higher trophic levels. The Punaruu River and « Baie des Pêcheurs » were exposed to an unusually strong rain episode in December 1998, which significantly altered water turbidity for several months. It is not known if spinner dolphins directly reacted to water turbidity in the resting site or were influenced by changes in prey availability in their nearby feeding areas.

CONCLUSION Our study showed that dolphin sensitivity to the resting site « quality » may be high. This quality is influenced by antropogenic activities: turbidity suffer from industrial activity along the Punaruu valley, and concern rises regarding higher exposure to dolphin-watch boats (affecting 13% of sightings in 1998, 21% in 1999 and 44% in 2000). Both types of potential disturbance are now under scrutinity.

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Table 1. Monthly residency rate 1995-2001 (calculated before 11h00)

Month	sample size	dolphin presence	residency rate
Jan.	75	53	0.707
Feb.	78	54	0.692
Mar.	72	47	0.653
Apr.	75	54	0.720
May	66	51	0.773
June	49	42	0.857
July	24	24	1.000
Aug.	23	21	0.913
Sep.	61	48	0.787
Oct.	42	35	0.833
Nov.	52	41	0.788
Dec.	69	49	0.710

Table 2. Yearly residency rate and mean distance to shore (*data for 1995 is for Oct.-Dec. period)

Year	sample size	residency rate %	average Dshore (m)	SE Dshore
2001	127	86.6	384.6	138.7
2000	71	75.0	325.3	84.6
1999	79	63.3	525.4	93.1
1998	132	72.9	400	187.7
1997	87	73.6	355.7	237.8
1996	58	75.9	307.4	149.2
1995 *	44	88.6	365	153.9

Table 3. Yearly estimates of mean school sizes Smin and Smax

Year	sample size	Smin	Smin range	SE Smin	Smax	Smax range	SE Smax
2001	124	39.70	10-120	21.20	70.60	20-200	33.60
2000	68	41.10	8-100	19.90	65.20	15-130	27.80
1999	69	30.00	5-60	11.90	48.60	15-100	18.50
1998	93	38.90	5-100	16.70	62.30	20-150	24.70
1997	55	42.00	20-100	16.60	69.20	30-130	20.90
1996	35	32.80	8-60	13.20	59.50	15-100	19.60

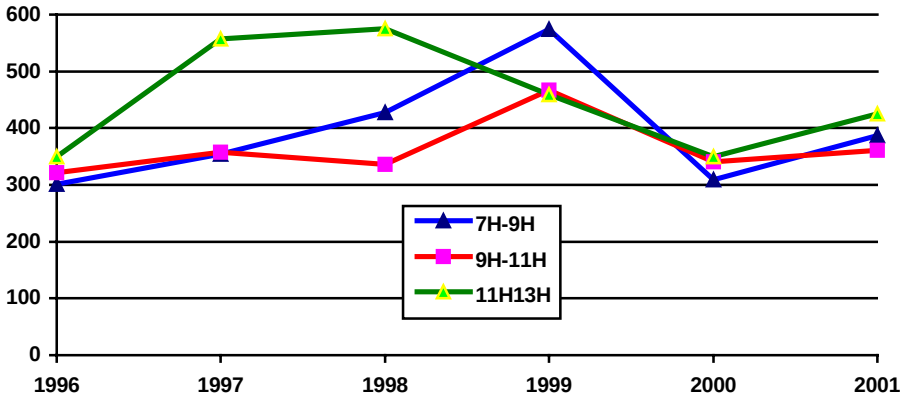

Fig. 1. Distances from shore (m) with year and time.

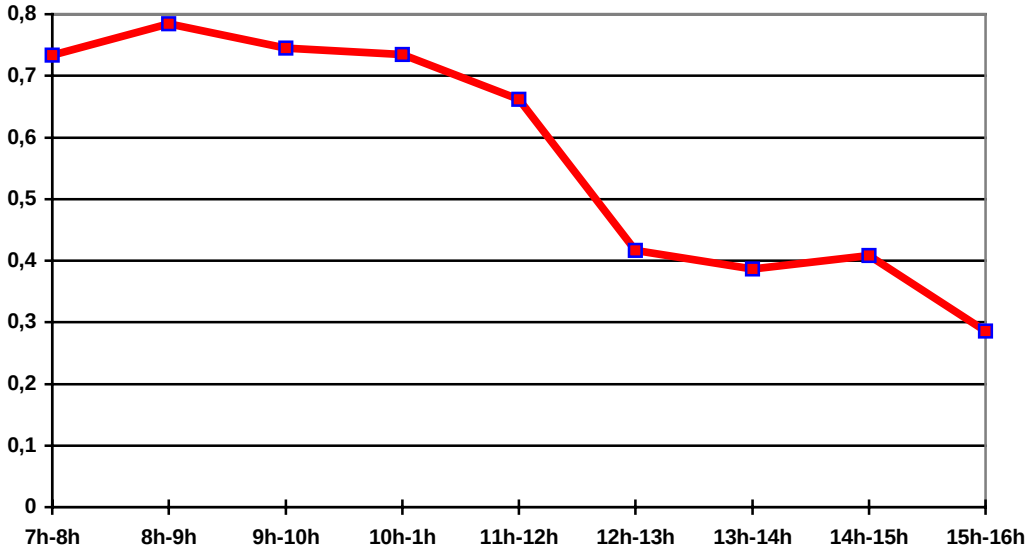

Fig. 2. Residency rate with time of the day.