

# Sounds produced by Norwegian killer whales, *Orcinus orca*, during capture

Sofie M. Van Parijs<sup>a)</sup>

Norwegian College of Fishery Science, University of Tromsø, 9037 Tromsø, Norway

Teo Leyssen

Rozenlaan 8, 3650 Dilsen-Stokkem, Belgium

Tiu Similä

Institute of Marine Research, P.O. Box 1870 Nordnes, 5817 Bergen, Norway

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To date very little is still known about the acoustic behavior of Norwegian killer whales, in particular that of individual whales. In this study a unique opportunity was presented to document the sounds produced by five captured killer whales in the Vestfjord area, northern Norway. Individuals produced 14 discrete and 7 compound calls. Two call types were used both by individuals 16178 and 23365 suggesting that they may belong to the same pod. Comparisons with calls documented in Strager (1993) showed that none of the call types used by the captured individuals were present. The lack of these calls in the available literature suggests that call variability within individuals is likely to be large. This short note adds to our knowledge of the vocal repertoire of this population and demonstrates the need for further studies to provide behavioural context to these sounds. © 2004 Acoustical Society of America. [DOI: 10.1121/1.1763954]

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## I. INTRODUCTION

Cetaceans produce a vast array of underwater sounds for the purpose of communication and foraging (e.g., Herman and Tavolga, 1980). Acoustic communication has been shown to be important in mediating cetacean social interactions (Tyack, 1999). Studies of the acoustic behavior of individual animals have provided insights into the social contexts in which cetaceans use communication (e.g., Caldwell *et al.*, 1990). In particular, studies of individual signal production in cetaceans have increased the understanding of the function of signals in social and group cohesion (e.g., Caldwell and Caldwell, 1968; Caldwell *et al.*, 1990; Janik and Slater, 1998).

Killer whales, *Orcinus orca*, produce a wide range of variable underwater sounds. Most information on the sounds produced by killer whales have been derived from studies carried out around British Columbia, where they have been shown to use a variety of call types, in particular clan specific dialects (e.g., Ford and Fisher 1982; Ford, 1989; Ford, 1991). The sound production of northern Norwegian killer whales is less well known. Two previous studies have described some of the sounds that occur within this population; one study described 23 discrete calls (Moore *et al.*, 1988), while another described a range of calls among which a number that are thought to be pod specific dialects for six out of nine pods (Strager, 1993, 1995). To date no information is available on the sound production of individual killer whales from this region. In this study we aim to increase our knowledge concerning the vocal behavior of individuals during

capture. In northern Norwegian waters the presence of killer whales is associated predominantly with the presence of herring (Similä *et al.*, 1996). Five killer whales were captured for the purpose of tagging while in their wintering feeding grounds around the Vestfjord area of northern Norway. Recording calls from individuals is logistically difficult in the wild, especially in cetaceans that travel in close groups composed of several individuals, and is frequently only possible in a captive animal. In this short note we provide a detailed description of the sounds produced by individual killer whales during their brief capture.

## II. METHODS

This study was carried out between late November to mid December 2000 and 2001 in the Vestfjord area, northern Norway (68° to 69°N, and 14° to 16°E). Killer whales were captured using a herring net set from a purse-seine vessel. The sex, age class and where possible the identity of the individual was determined with reference to an existing photographic catalog for this region (Similä, 1997). The whales were captured for the purpose of deploying satellite transmitters. During the handling process continuous recordings were made of the sounds of each captured whale. A hydrophone was placed 0.5 m in front of the head of each individual and recordings were made of any sounds that were produced during handling. Recordings of the sounds were made using a HTI SSQ94 hydrophone (sensitivity: -170 db, frequency response: 5 Hz–30 kHz) and a Sennheiser microphone (MD421-II, sensitivity: -170 dB *re*: 2 mV/Pa, frequency response: 30 Hz–17 kHz ± 3 dB) and a digital audio tape recorder (Sony TCD—D8: frequency response 5 Hz–22 kHz ± 1.0 dB) in 2000 and a omni directional Sony microphone

<sup>a)</sup>Address for correspondence: Sofie Van Parijs, Norwegian College of Fisheries Science, University of Tromsø, 9037 Tromsø, Norway. Electronic mail: sofie@npolar.no

TABLE I. Details on the five killer whales and the call types that were made during capture.

Whale ID	Capture		Length (m)	Sex	Pod	Recording		
	Date	Age				Time (min)	Discrete	Compound
14976	24/11/01	Adult	6, 10	M	KA1	1'15	N1	
16175	01/12/00	Sub adult	4, 80	F	NC	8'06	N2, N3, N4, N5	N6
16178	22/11/01	Juvenile	4, 30	F	?	21'31	N7i	N7ii, N8i, N8ii
16179	05/12/00	Juvenile	4, 10	F	NY14	43'09	N9i, N9ii, N10i, N10ii, N10iii, N11, N13	N12
23365	30/11/01	Juvenile	3, 20	M	NW	1'19	N14	N8i, N7i

ECM-T145 and minidisk MZR55 (frequency response: 50 Hz–15 kHz) in 2001. The recordings were digitized and displayed as spectrograms (Fast Fourier Transforms,  $dt$ : 10 ms,  $df$ : 102 Hz, FFT size: 512) using the BatSound analysis PC software program (Pettersson Elektronik A. B., 1996).

Sounds were divided into two broad categories: discrete and compound calls (e.g., Awbrey *et al.*, 1982; Dahlheim and Awbrey, 1982). Discrete calls consisted of a single pulsed call while compound calls were composed of a sequence of pulsed calls. No other call types, such as whistles (Thomsen *et al.* 2001; Thomsen *et al.*, 2002), variable or aberrant (Ford, 1989) were observed. Only high quality records, where all sound contours were distinctly measurable on the spectrograms were used for these analyses. Sounds were categorized into groups based on their spectral contours. Discrete and compound calls were compared, using two independent observers, with those documented in a sound catalog of known pods from northern Norway obtained from Strager (1993) and those documented from unknown killer whales in Iceland and from northern Norway obtained from Moore *et al.* (1988).

### III. RESULTS

Five whales were captured during the study period: one adult, one sub adult and three juveniles. Two were males and three were females (Table I). The adult male, 14976, was kept in the water during the capture, which limited the duration of the recordings that were made of this individual. All individuals were thought to belong to separate pods, however, 16178 is not present in the existing photo identification catalog and could not be ascribed a pod number. Each individual produced sounds almost continually during handling (14976=was vocal 89% of the recording period, 16175=81%, 16178=89%, 16179=78%, 23365=92%). All individuals produced discrete calls: the sub adult and all individuals except for the adult male produced compound calls (Table II). In total, 14 discrete call types were described and seven compound calls (Fig. 1). Two call types, one discrete and one compound, were used both by 16178 and 23365. All discrete and compound calls were compared with those described in the above-mentioned sound catalogs. The Strager (1993) catalog contained the documented sounds for 10 pods of which one was pod NC. Individual 16175 is thought to belong to the NC pod. However, 16175 used none of the sounds produced by the NC pod during capture. All other individuals came from other pods than those described in this catalog. Comparisons were made between spectrograms of

23 discrete calls recorded in northern Norway and 35 discrete call types recorded off Iceland (Moore *et al.*, 1988). From the northern Norwegian calls, N18i and N23i, from Moore *et al.* (1988) resembled N2 from our recordings, while N14i resembled N8 and, N9 resembled N1. From the Icelandic calls no clear resemblances were found with our recordings. However, more detailed comparison was not possible, given the available information.

### IV. DISCUSSION

The calls used by individual killer whales during capture were highly variable and most individuals produced more than one call type. Killer whales in British Columbia use distinctive call dialects based on discrete call types (e.g., Ford and Fisher, 1982; Ford 1989, 1991). Discrete calls are used in numerous behavioral contexts including foraging, traveling, group resting and socializing (Ford, 1989). These calls can show variability within an individual particularly during “excited” behavioral states as described in Ford (1989). A number of discrete calls have been described for the northern Norwegian killer whale population (Moore *et al.*, 1988; Strager 1993, 1995). Furthermore, Strager (1995) showed that dialects are thought to exist in the northern Norwegian population, at least for six of the nine recorded pods.

TABLE II. The total number of calls recorded for each call type for the five captured individuals (ID).

Call type	ID 14976	ID 16175	ID 16178	ID 16179	ID 23365
N1	7				
N2		9			
N3		18			
N4		1			
N5		1			
N6		2			
N7i			121		12
N7ii			10		
N8i			65		9
N8ii			43		
N9i				77	
N9ii				34	
N10				54	
N10i				154	
N10ii				7	
N11				35	
N12				7	
N13				20	
N14					6

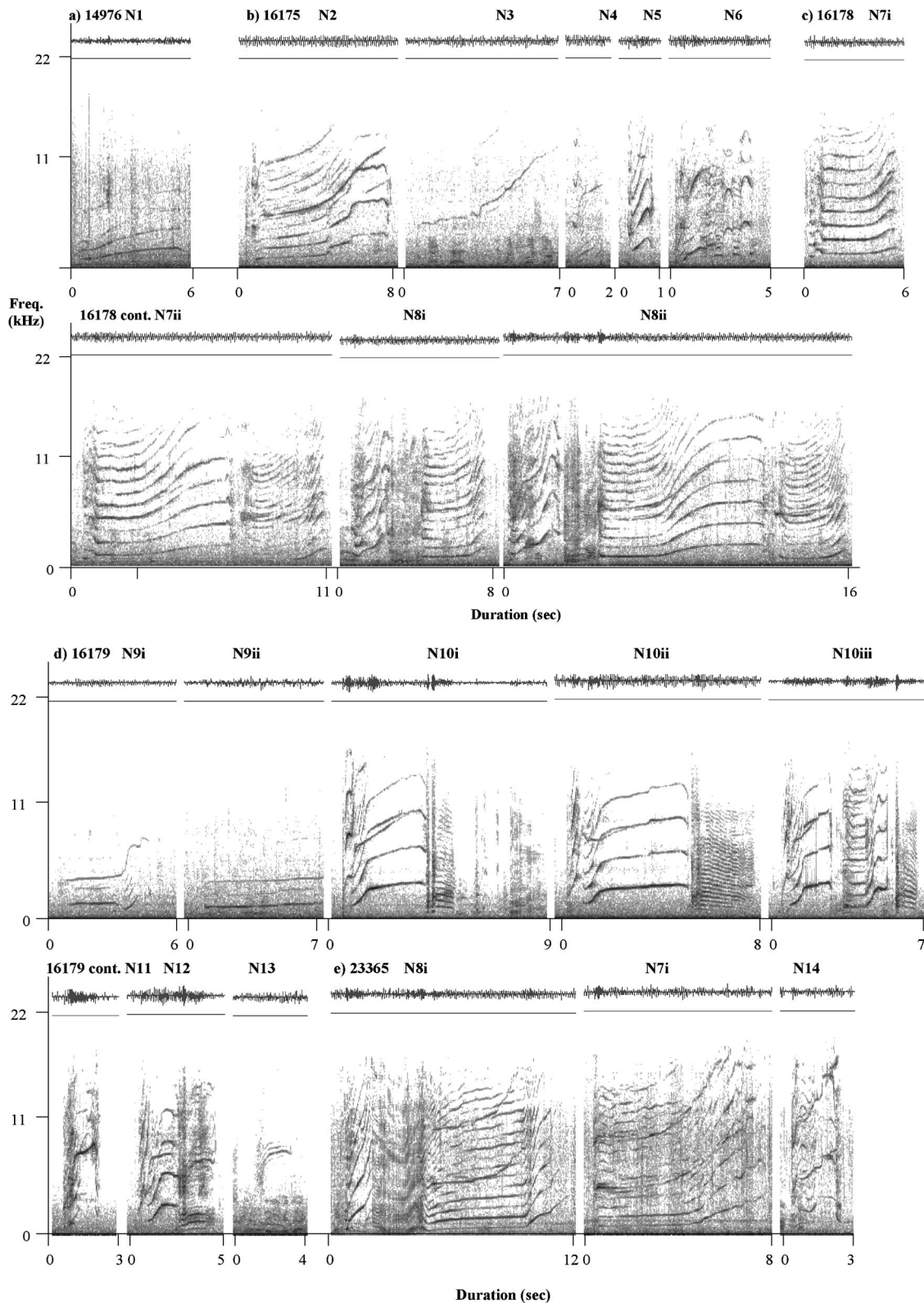


FIG. 1. Spectrograms of sounds produced by the five, (a) 14976, (b) 16175, (c) 16178, (d) 16179, (e) 23365, individual Norwegian killer whales during capture. Different sounds are defined as in Strager (1993) as N for Norway, followed by a number defining the call type.

We thought that it was likely that discrete calls and possibly call dialects would be used in preference to other call types during stressful circumstances. One of the pods that exhibited call dialects was the NC pod, to which captured individual 16175 belonged. None of the calls recorded from

16175 were similar to those recorded from the NC pod. Given that pod dialects can exhibit large variability it is impossible to determine whether individual 16175 was using a variant of its pod's specific dialect or a call related directly to the stress of the capture.



Two call types, one discrete and one compound, were used both by individuals 16178 and 23365. It was not certain which pod individual 16178 belonged to however it might be possible that these two individuals belonged to the same pod based on the sounds that they produced. However, after capture these individuals were not re-sighted together and their movements and area usage very different (<http://www.imr.no/orca>). Certain call types recorded from individuals during capture resembled four of those reported by Moore *et al.* (1988) obtained from Norwegian killer whales.

It is difficult to draw any definitive conclusions from the call types recorded by individual killer whales during capture, primarily because too little is known about the sound production of the northern Norwegian killer whales. Although restricted, this study documents the sound production of five individuals during capture. It demonstrates that killer whales used a wide variety of call types during capture. Clearly, individual call usage and composition is complex and variable and requires further investigation. Through documenting a number of their sounds in this study we hope to stimulate and help develop a more clear understanding of the sound production of the northern Norwegian killer whale population.

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