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WHALE and PORPOISE VOICES

A PHONOGRAPH RECORD

by

WILLIAM E. SCHEVILL and WILLIAM A. WATKINS

WOODS HOLE OCEANOGRAPHIC INSTITUTION

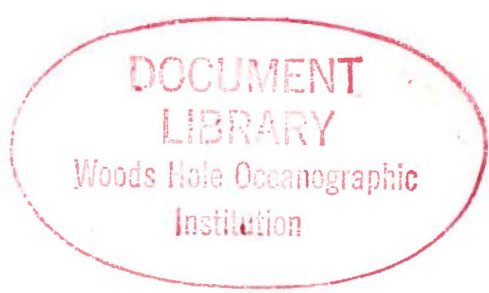
Woods Hole, Massachusetts

1962

The porpoises on the jacket of the record are **Stenella plagiodon**, photographed by Jan Hahn from R/V Atlantis in the Gulf of Mexico, near Pensacola, in February 1951.

We are indebted to the Graphic Reproduction Department of the Woods Hole Oceanographic Institution (especially Messrs. C. S. Innis, C. R. von Dannenberg, and C. E. Spooner) for great pains in preparing the illustrations.

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WHALE AND PORPOISE VOICES

A PHONOGRAPH RECORD

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The vocal sounds of cetaceans are a little known and even less understood feature of the complex adaptation of these animals, whose ancestors lived on the dry land, to an entirely aquatic existence. Even in the clearest surface waters, sight is limited to about a hundred feet or less in daytime, and visibility ranges are mostly negligibly short for fast-swimming animals, so that they are effectively partly or wholly blinded. Therefore sound and hearing have an especially important place in their lives. Sound is used not only in direct communication, but also to a large degree in navigation and hunting (echo-location). The excerpts presented here are samples of such sounds made by eighteen species, all obtained by eavesdropping in the open sea (except for the *Inia* selection, which was made in captivity). These recordings have not been speeded up or slowed down, and so are true in natural frequency and time; there has been no editing or filtering except as noted.

Sound recording at sea suffers from the handicap that ordinarily the loudest sounds are those made by one's own ship. Not only the machinery on board, but also the movement of water against the hull contributes to this high background. Our preferred way of dealing with these problems is to stop all shipboard machinery and remove the hydrophone as much as several hundred feet from the ship. The actual apparatus used has varied from time to time, as noted below, in the table.

This work was done in the Geophysics Department of the Woods Hole Oceanographic Institution with the financial support of the United States Navy, Bureau of Ships and Office of Naval Research (mainly the Biology Branch), and lately also of the National Science Foundation (Environmental Biology). We have, of course, been greatly helped by many of our colleagues, particularly Dr. J. B. Hersey, whose sympathetic encouragement is especially acknowledged, and Dr. R. H. Backus, who has often been with us at sea; we note below the assistance of certain others in field recording.

To supplement the phonograph record and the remarks thereon, and to visualize the structure of these calls, we present spectrograms made on a Kay Electric Company sound spectrograph (Vibralyzer). Although we find these a more informative presentation, especially of the squeals and complex sounds, we give for comparison a traditional oscilloscope photograph of a series of three clicks (Figure 1). The spectrograms show frequency as the ordinate and time as the abscissa on the indicated scales.



From these it may be seen that the sounds originally recorded range in frequency from below 40 cps to over 24,000 cps, although of course you should not expect to hear the ultrasonics.

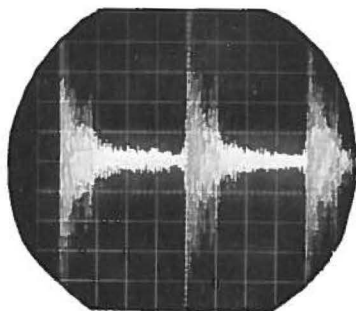
As we have said on the record, the odontocete utterances are characterized by impulsive clicks at varying repetition rates, up to a few hundred in a second (Figure 2). Sometimes, when they are widely spaced, their regularity is easily noted, and has led non-biological observers to suspect artificial origin. Such slow regularity is often observed in *Physeter* (sperm whales), and in this record may be noted also in *Globicephala macrorhyncha*.

The characteristic sharp impulsive clicks of the odontocetes are very broad-band in frequency, so much so that some of them may be called grey, if not white. Thus they show as vertical lines on the sound spectrograms, often extending entirely across the picture (Figures 2, 11, 19, 25, 29); an oscilloscope shows them as a burst of noise (Figure 1). This noisiness and the sharp onset or front distinguish them markedly from the well-known sonar impulses of bats, most of which are either single frequency or frequency modulated, without a sharp front (Griffin 1958);* a partial exception is the genus *Rousettus*, whose pulses have sharp fronts and a noisy tail, but begin with a discrete frequency (Novick 1958).

Another conspicuous characteristic of most odontocetes is the whistle-like squeal, which normally consists of a single but often changing frequency, and which may be prolonged for more than a second. The frequency range of these squeals appears to vary characteristically with the species; but since we know the voice of no more than one fifth of all cetacean species, we may some day have to revise this statement.

We believe that the clicks are used in echo-location (Schevill and Lawrence 1956, for example) as well as in communication, and that the squeals are primarily communicative. Several observers have noted that a single animal can click and squeal simultaneously (well shown by Lilly and Miller 1961).

* See references on p. 24.



← 0.025 →
TIME-SECONDS

FIGURE 1

Oscilloscope photograph of three clicks from a tape recording (60 ips) of a solitary captive *Tursiops truncatus* in a reverberating pool. The repetition rate is 40 per second. Note the conspicuous echo about 6 milliseconds after the pulse.

When we consider the speed of sound in sea water (about 4800 feet per second) and the short ranges involved in food capture and communication within the herd (say, mostly from a hundred or so feet down to a very few inches), it becomes apparent that these animals must be capable of a high degree of discrimination and resolution to extract information from the clutter of sound — calls and echoes — bouncing about in a herd (Figure 2 was made by a solitary porpoise). How this is done, and how well, are among the many unsolved problems waiting for us.

Discussion of some of these points may be found in Schevill, Backus, and Hersey 1962, with spectrograms of calls of *Delphinus*, *Physeter*, and *Eubalaena*.

We eschew the lexicographically respectable term “dolphin” because of the inevitable semantic disputes which it provokes, and instead follow the usage of seamen, who generally say “porpoise” for any small cetacean. The use of “dolphin” often involves one in arbitrary distinctions between porpoises and dolphins (better coped with in the technical nomenclature); moreover, “dolphin” has for long been widely applied to the beautifully colored warm-water pelagic fishes of the genus *Coryphaena*, to the confusion of poet and biologist alike.

We use the animals' technical names; very few cetaceans (those that are hunted commercially and some others) have true “common” or vernacular names; most of the “common” names given in the literature are artificial, and are here dismissed as book names. These serve no useful

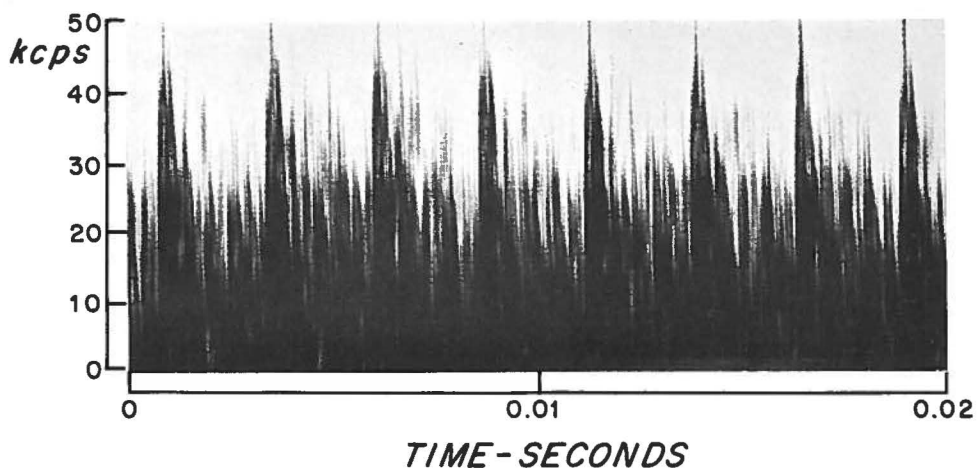


FIGURE 2

Sound spectrogram of a rapid burst of clicks from a tape recording (60 ips) of the same *Tursiops* as in Figure 1. The repetition rate is nearly ten times that of Figure 1. Note the numerous echoes between the clicks.

purpose, and often merely confuse. This confusion can be international. For instance, **Delphinus delphis** (Figure 5) is called "white-side" in Russian books, while in Norwegian, English, and Russian "white-sided" is applied to **Lagenorhynchus acutus** (Figure 14); it is consequently not especially surprising that a recent Russian paper on **Delphinus delphis** is indexed in English under **Lagenorhynchus acutus**. This is what comes of taking common names too seriously.

For the benefit of those unfamiliar with these animals, we give sketches and photographs, with the actual size indicated by a ratio. Most of them appear dark in the sea (except for **Grampus**, many of which are so splotched or dappled with grey as to appear almost white, and **Inia**, which are pale, and adult **Delphinapterus**, which are white). Many have distinctive color patterns, as may be seen from the figures. The senior author is responsible for the identification of the species and for the photographs and sketches (three of these are adapted from published pictures: **Grampus** after W. H. Flower (1872, Trans. Zool. Soc. London, 8, 1, pl. 1), **Physeter** after L. H. Matthews (1938, Discovery Rpts., 17, pl. 3), and **Megaptera** from G. M. Allen (1916, Mem. Boston Soc. Nat. Hist., 8, 2, pl. 16); our Figure 16 is by N. Strekalovsky. Further remarks on the species and their geographical distribution will be found in the phonograph record, and are not repeated here.

INIA GEOFFRENSIS

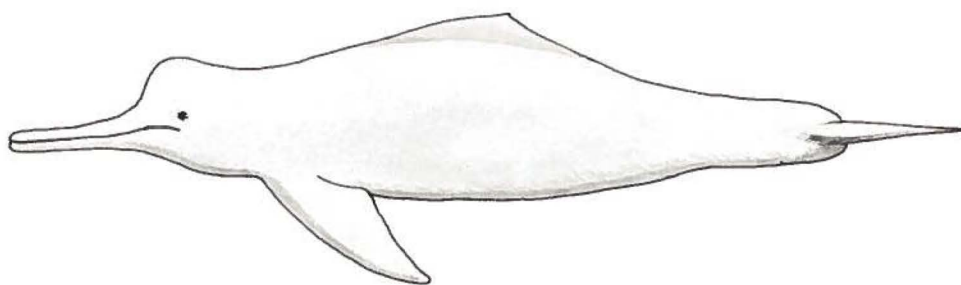


FIGURE 3 (Reduction 1:17)

Recorded with the assistance of Malcolm K. Smith on 3 October 1956 at Silver Springs, Florida; the animals had been brought from the Amazon River in Colombia.

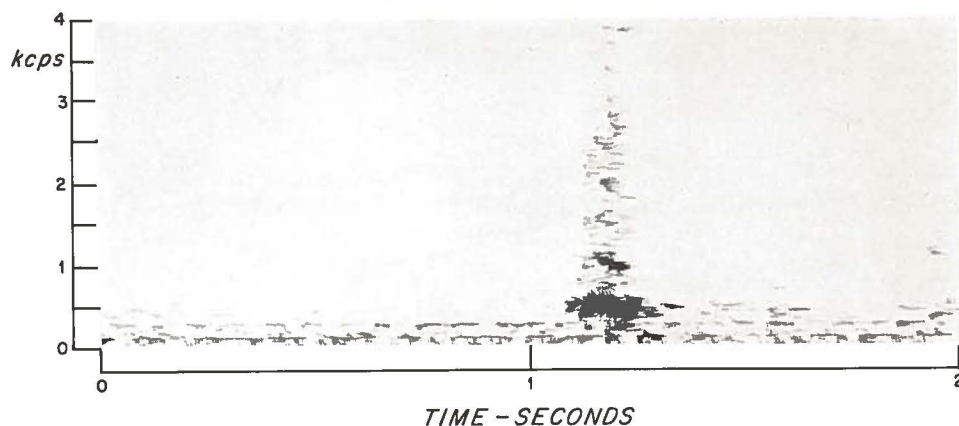


FIGURE 4

The sound in Figure 4 has a fundamental frequency centering on 500 cps, and has several harmonics. It is the next to the last call heard in this selection.

DELPHINUS DELPHIS

Saddleback



FIGURE 5 (Reduction 1:19)

The English name "common dolphin" has been impartially used for this and several other species in different parts of the world. We use instead the descriptive fishermen's name, "saddleback" porpoise.

This cosmopolitan species has many varieties. One of these, named *bairdi*, was recorded near Catalina Island, California, in March.

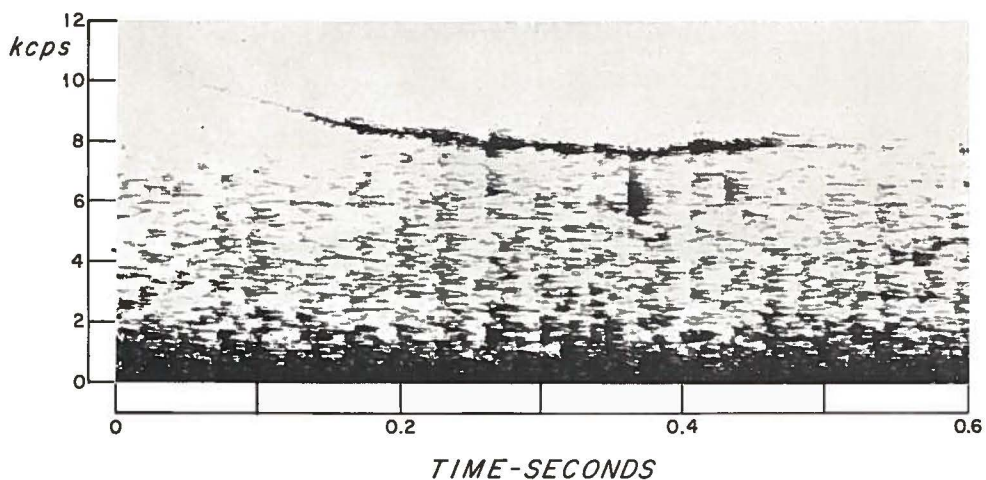


FIGURE 6

The squeal shown in Figure 6 slopes down from beyond 10,000 cps to 8,000 cps and then rises slightly. It is one of the middle group of calls in this cut.

The next selection is of the typical form of *Delphinus delphis* (Figure 5), recorded in August 60 miles south of Marthas Vineyard, Massachusetts. The porpoises were as close as 30 yards to the hydrophone.

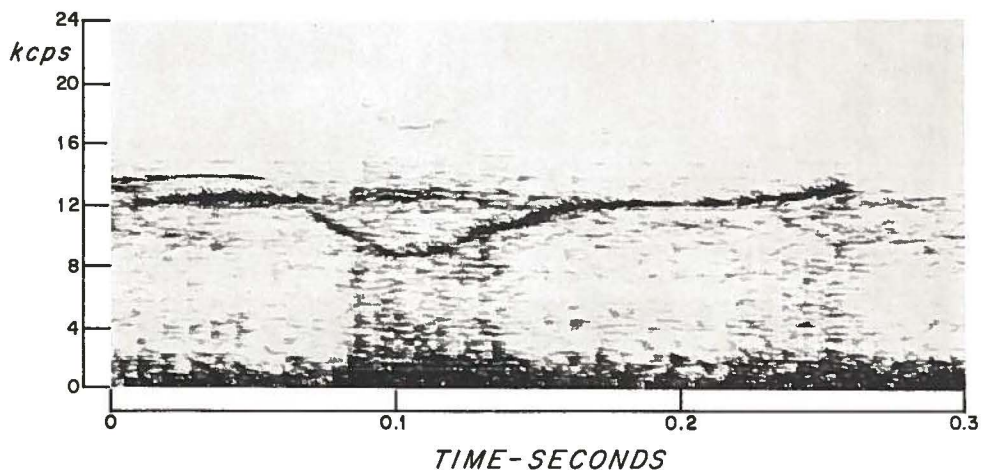


FIGURE 7

The squeals in Figure 7 are from the first part of this cut; bursts of clicks show as background.

STENELLA STYX

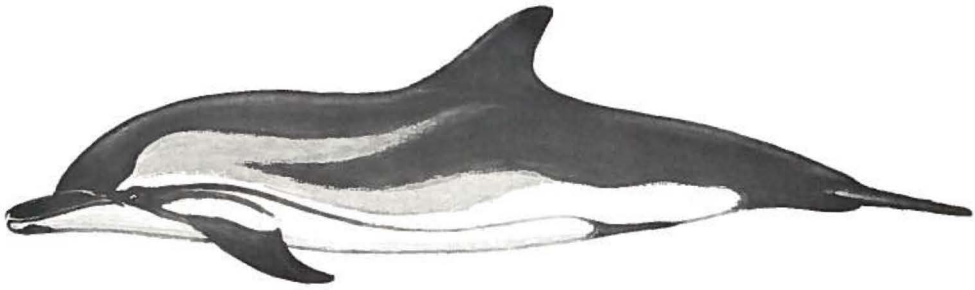


FIGURE 8 (Reduction 1:17)

Recorded in August 140 miles off New York.

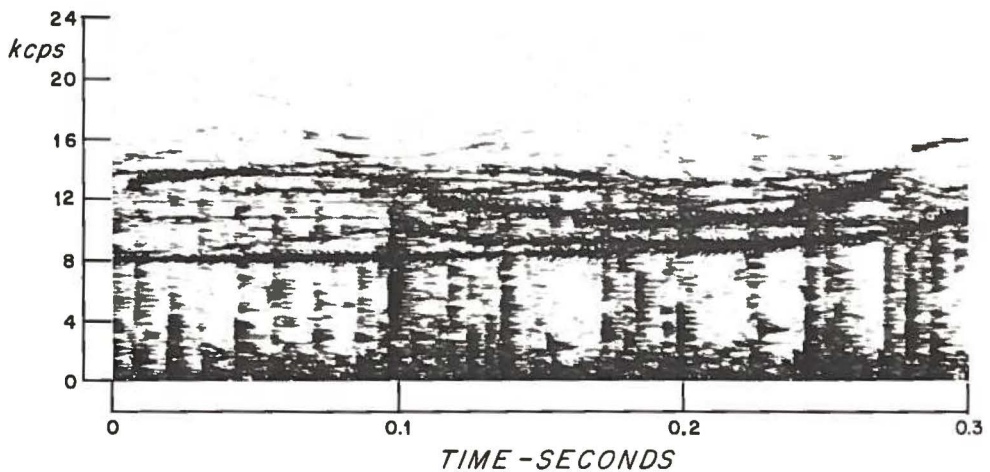


FIGURE 9

The squeals in Figure 9 are from the beginning of this cut and show a spread in frequency from 8,000 to 16,000 cps. Clicks are sharply outlined.

STENELLA PLAGIODON



FIGURE 10 (Reduction 1:19)

Recorded in August, 60 miles off Cape May, New Jersey. See Wood 1954 for a discussion of sounds of this species in captivity.

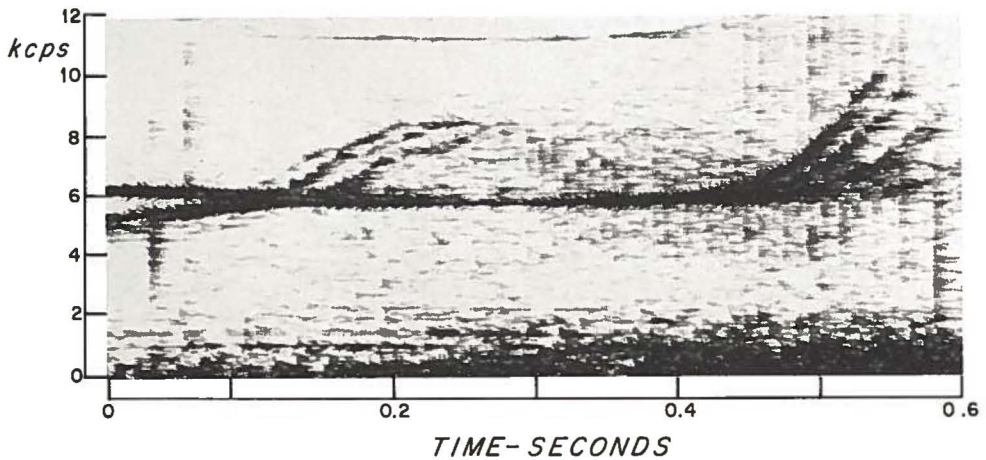


FIGURE 11

The squeals shown in Figure 11, the first of this cut, mostly have a strong 6,000 cps component and a sharp rise in frequency at the end of the call.

TURSIOPS TRUNCATUS

Bottlenosed Porpoise

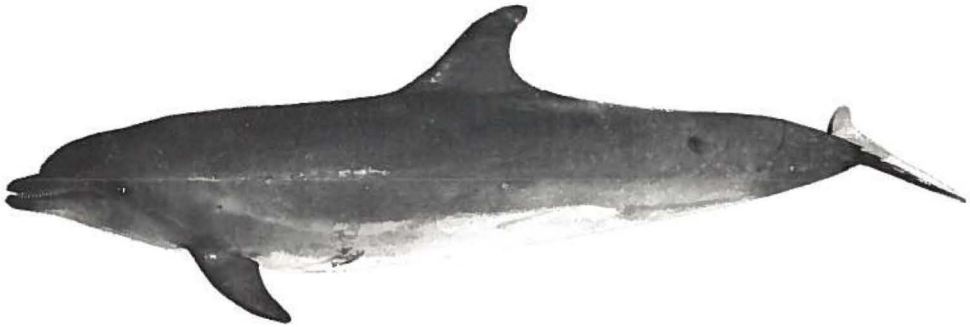


FIGURE 12 (Reduction 1:22)

Recorded in April in Biscayne Bay, near Miami, Florida. A 1500 cps high-pass filter and a 1600 cps dip filter were used in this copy to eliminate generator whine, and loud water noise has been edited out.

In 1952 Marine Studios published a phonograph disc of the sounds of captive *Tursiops*, with commentary by F. G. Wood, Jr., considerably expanded in a later article (Wood 1954).

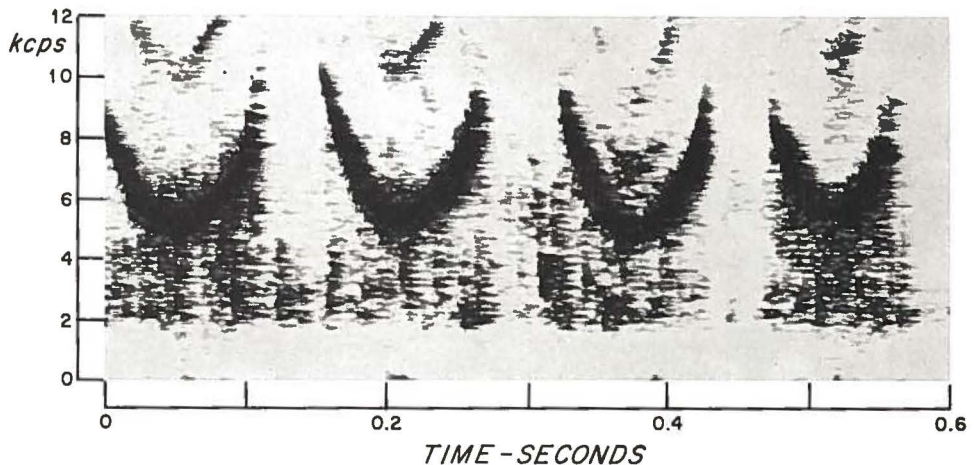


FIGURE 13

The four squeals shown in Figure 13 are those at the beginning. These squeals start at about 10,000 cps, swing down to 5,000 cps, and then back to 10,000 cps; the second harmonic is indicated.

LAGENORHYNCHUS ACUTUS

White-sided Porpoise



FIGURE 14 (Reduction 1:22)

Recorded in September in the Gulf of Maine off the Northern Edge of Georges Bank ($42^{\circ} 21'N$, $66^{\circ} 58'W$).

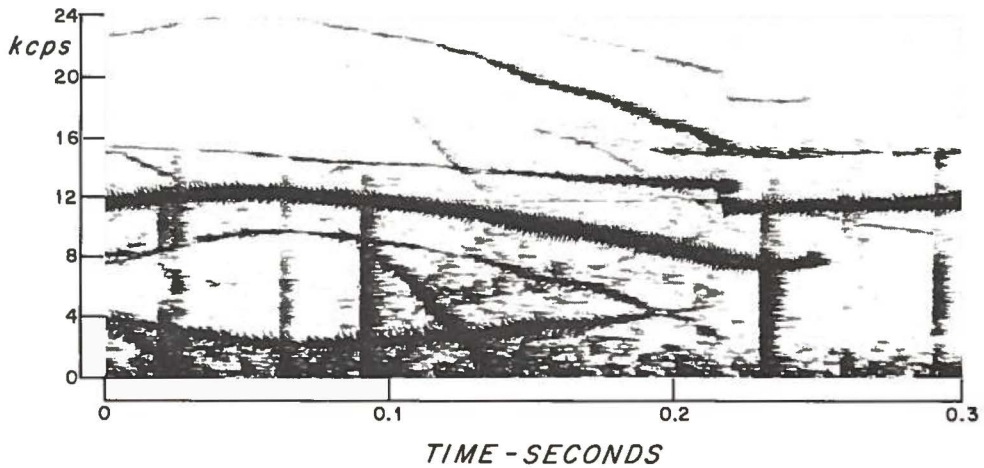


FIGURE 15

Figure 15 portrays squeals ranging in frequency from less than 1,000 cps to 24,000 cps, as well as a few clicks. These are the first squeals on this cut.

LAGENORHYNCHUS ALBIROSTRIS

White-beaked Porpoise



FIGURE 16 (Reduction 1:22)

Recorded in February off Cape Elizabeth in the Gulf of Maine, with the assistance of Robert Cottell.

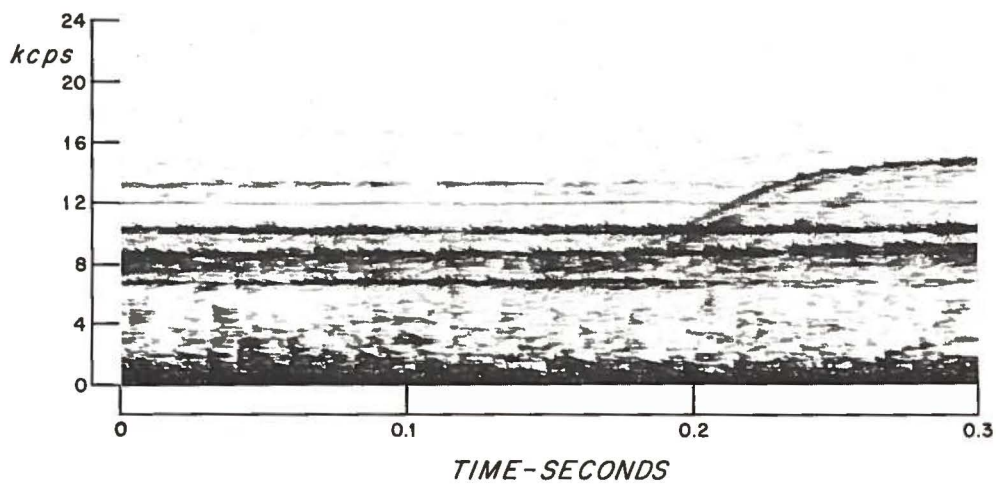


FIGURE 17

The squeals in Figure 17 range from 6,500 cps to 15,000 cps.

PSEUDORCA CRASSIDENS



FIGURE 18 (Reduction 1:42)

Recorded in August about 170 miles east of Maryland.

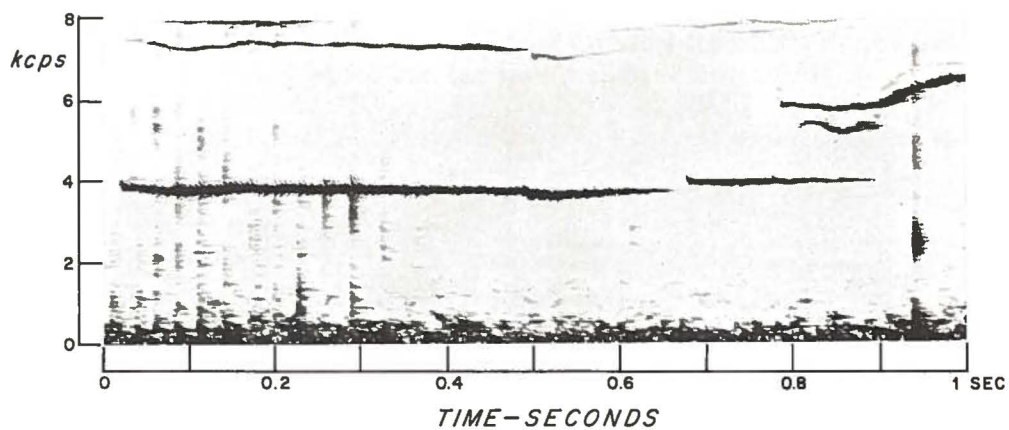


FIGURE 19

The characteristic nearly single-frequency squeal is portrayed along with some variable frequency squeals in Figure 19. These range from 4,000 cps to 8,000 cps. Some clicks are visible in the background. This series is near the middle of the cut.

GLOBICEPHALA

Pothead, Blackfish, Pilot Whale



FIGURE 20 (Reduction 1:50)

Although Figure 20 represents *Globicephala macrorhyncha*, it will serve to show the general appearance of the other species as well.

GLOBICEPHALA MELAENA

Recorded in July in Trinity Bay, Newfoundland.

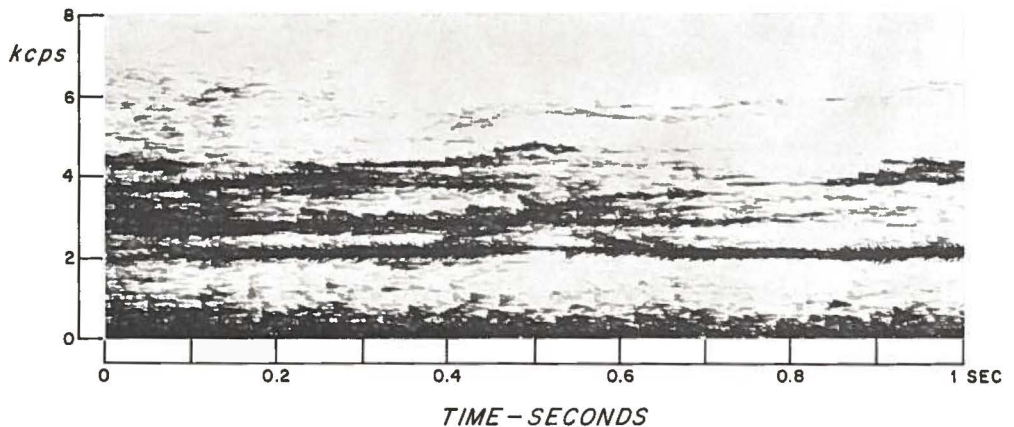


FIGURE 21

Figure 21 shows squeals from the first part of this cut. They range from 2,000 cps to 4,000 cps.

GLOBICEPHALA MACRORHYNCHA

Recorded in March in the Tongue of the Ocean in the Bahamas. An occasional loud water slap has been edited out in making this copy.

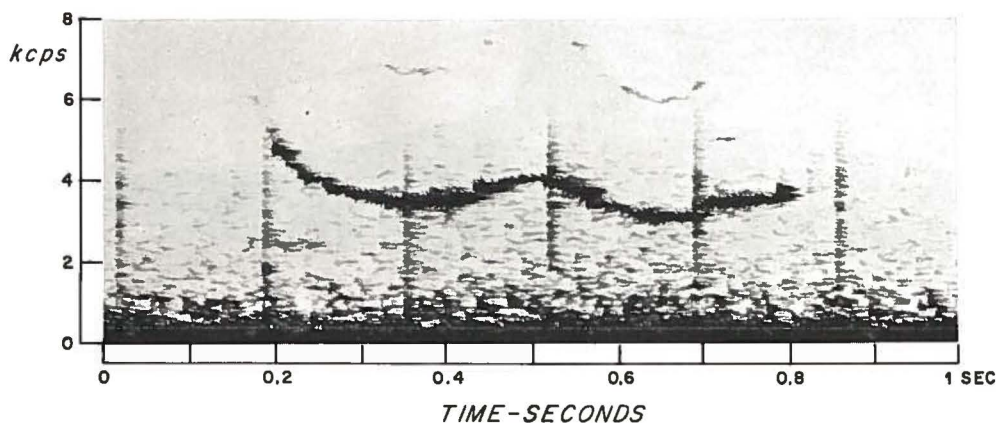


FIGURE 22

The squeal shown in Figure 22, the fourth in this cut, covers a frequency range from 6,000 cps to 3,000 cps. Regularly timed clicks appear in the background.

GLOBICEPHALA SCAMMONI

Recorded in March off the west side of Catalina Island, California. Loud water noise has been edited out, but no filters have been used.

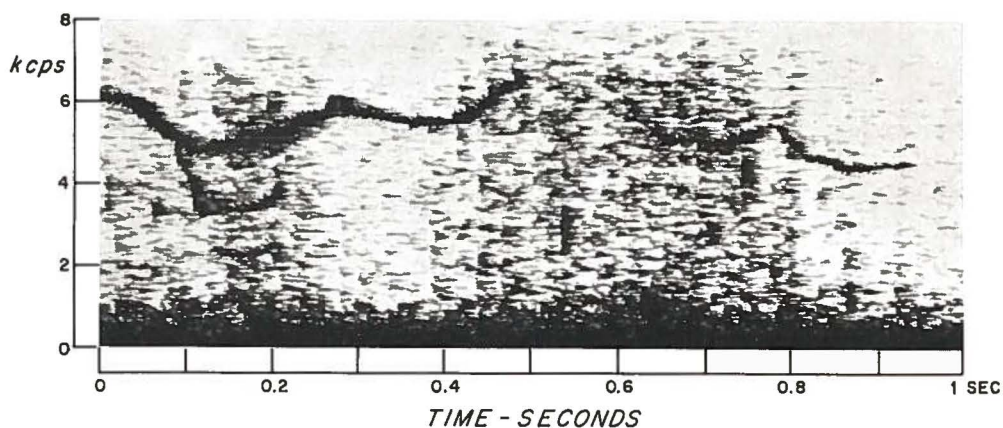


FIGURE 23

The squeals of Figure 23 are from the last portion of this cut; they range from about 6,000 cps to 4,000 cps.

GRAMPUS GRISEUS

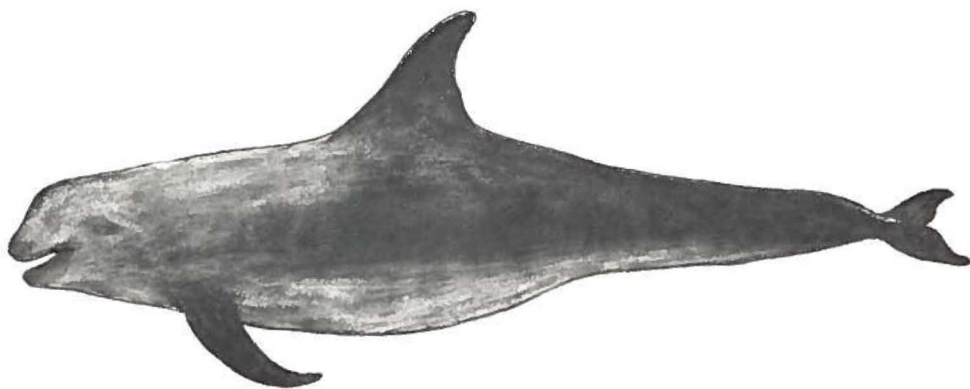


FIGURE 24 (Reduction 1:30)

Recorded in July some 90 miles east of Delaware.

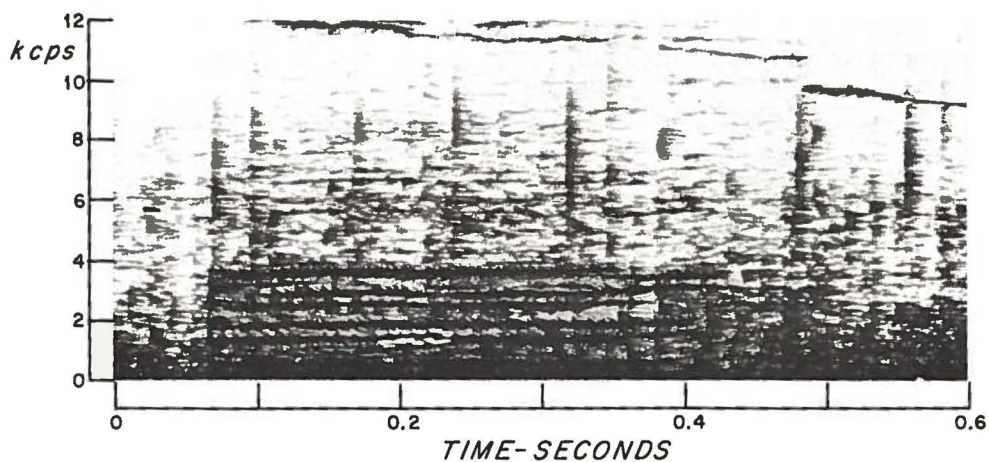


FIGURE 25

Figure 25 shows the typical *Grampus* rasp and squeals of 12,000 to 8,000 cycles, from the beginning of this cut.

DELPHINAPTERUS LEUCAS

Beluga, White Whale

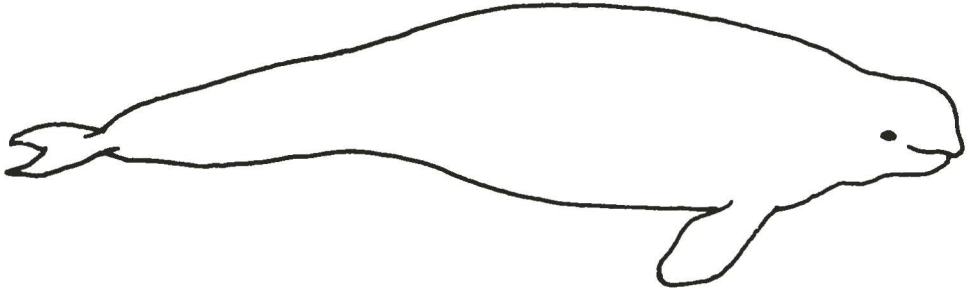


FIGURE 26 (Reduction 1:33)

Recorded in July 1949 in the lower Saguenay River, Quebec. This is a natural sequence from the original disc (Schevill & Lawrence 1950.)

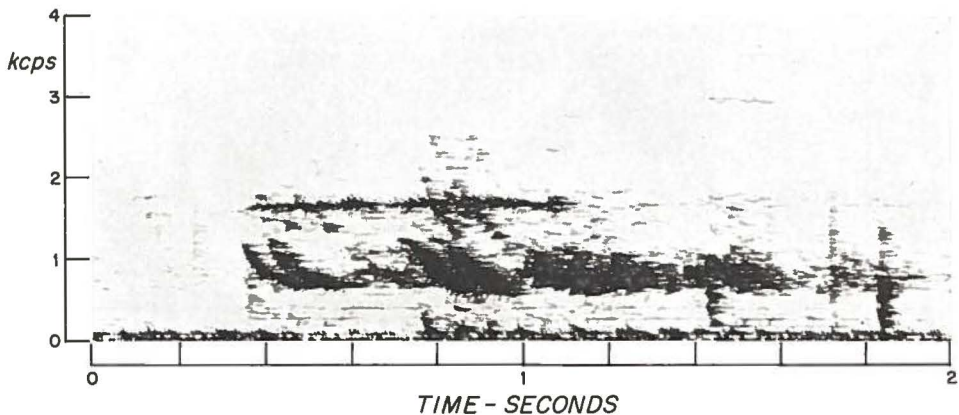


FIGURE 27

Figure 27 shows the third series of calls in this cut. These range in frequency from about 1,200 to 700 cps. There is also a 1,700 cps squeal. An occasional click shows through the background.

PHYSETER CATODON

Sperm Whale, Cachalot



FIGURE 28 (Reduction 1:130)

Recorded in August about 100 miles east of Delaware.

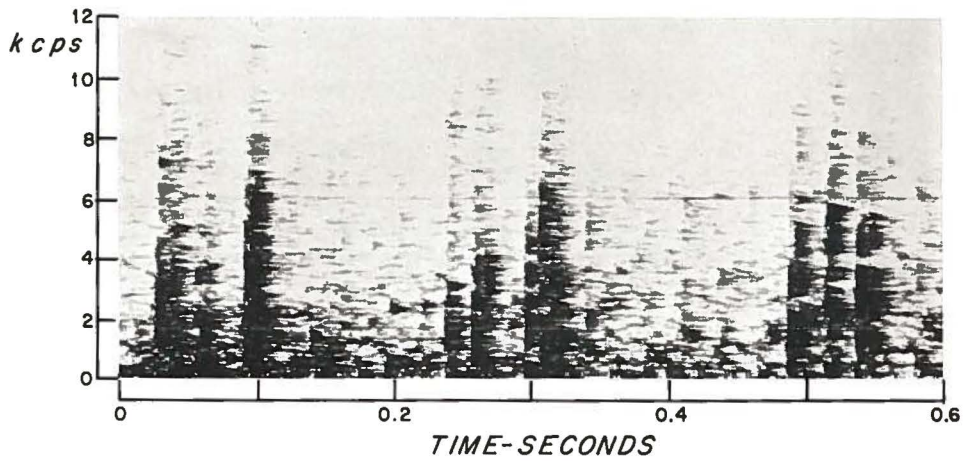


FIGURE 29

The clicks shown in Figure 29 are the last few clicks of this cut.

EUBALAENA GLACIALIS

Right Whale, Nordkaper

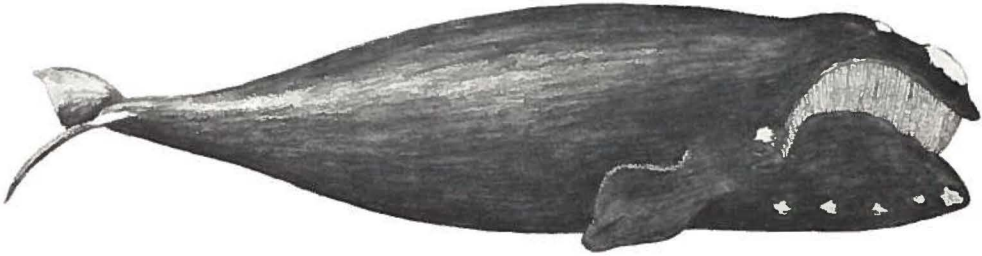


FIGURE 30 (Reduction 1:120)

Recorded by Karl E. Schleicher in April within a half mile of the shore of Marthas Vineyard, Massachusetts.

This copy is an edited series including the higher level sounds from approximately 30 minutes of recording. A 740 cps dip filter has been used to eliminate generator whine.

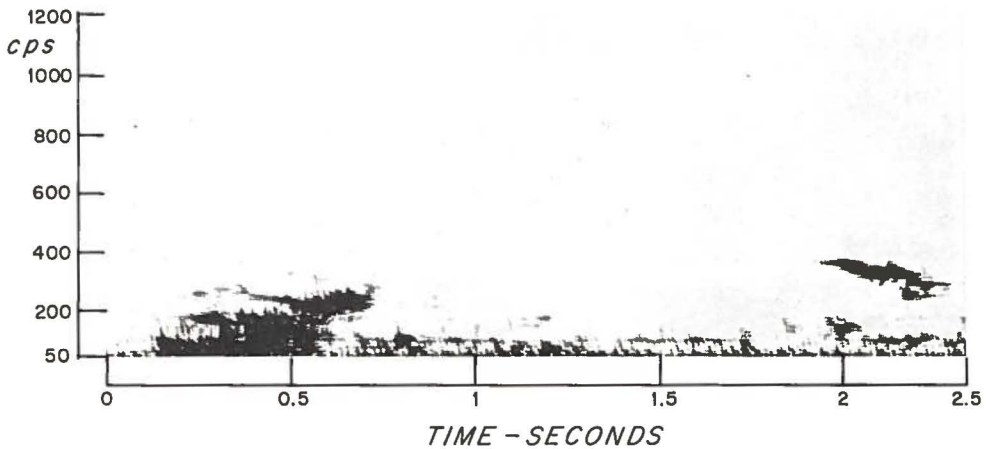


FIGURE 31

Figure 31 shows the first two moans of this cut. These have all their energy below 400 cps.

MEGAPTERA NOVAEANGLIAE

Humpback



FIGURE 32 (Reduction 1:110)

Recorded in September, 45 miles east of Boston ($42^{\circ} 21'N$, $70^{\circ} 10'W$.)

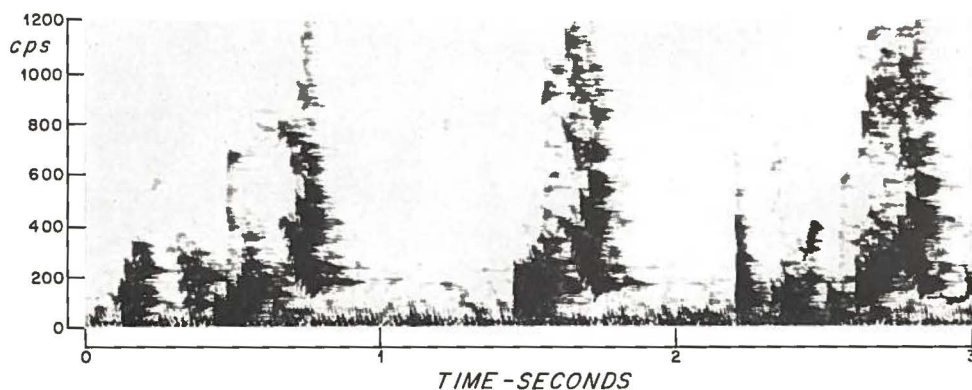


FIGURE 33

Figure 33 shows the 3 lower frequency calls at the end of this cut. The Columbia University Geophysical Field Station (G. Hamilton, F. Watlington) in Bermuda has recorded many more spectacular sounds during the spring migrations of these whales.

BALAENOPTERA PHYSALUS

Finback

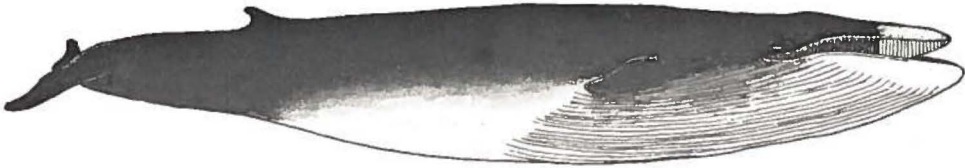


FIGURE 34 (Reduction 1:160)

Recorded in September 42° 21'N, 70° 04'W.

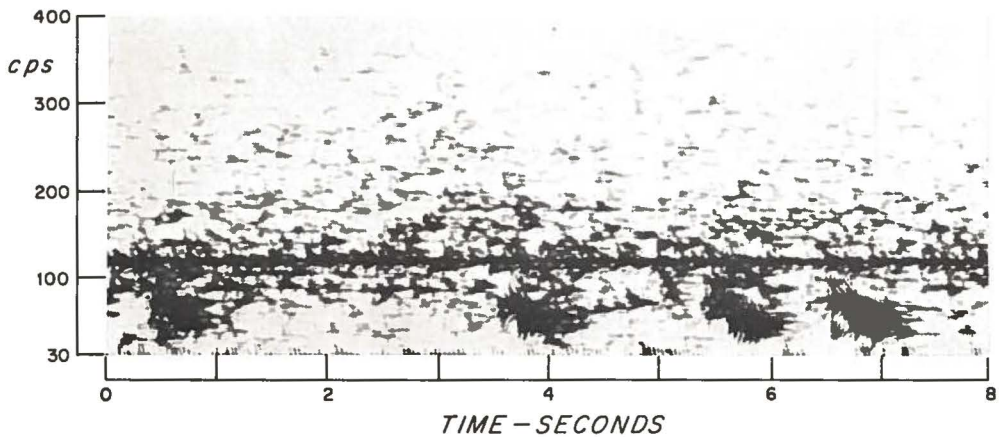


FIGURE 35

The moans shown in Figure 35 range from 75 to 40 cps. The band at 120 cps is the ship's generator. The sounds shown are the first four on this cut.

SIDE 1

Record Cut & Species	Hydrophone	Amplifier	Recorder	System Frequency Response
Cut 2 Inia geoffrensis	Rochelle salt (Woods Hole)	Battery-powered (Woods Hole)	Magnecorder (Pt6J) 30 ips Model	Fairly flat 50—12,000 cps
Cut 3 Delphinus bairdi	Rochelle salt (Woods Hole)	Battery-powered (Woods Hole)	Magnemite (Amplifier Corp. of America)	100 to 9,000 cps
Cut 4 Delphinus delphis	AX-58 (Brush Development Corporation)	Transistor (Woods Hole)	Crown (B822)	Flat 30—10,000 cps Good to 30,000 cps
Cut 5 Stenella styx	AX-58 (Brush Development Corporation)	Transistor (Woods Hole)	Crown (B822)	Flat 30—10,000 cps Good to 30,000 cps
Cut 6 Stenella plagiodon	AX-58 (Brush Development Corporation)	Transistor (Woods Hole)	Crown (B822)	Flat 30—10,000 cps Good to 30,000 cps
Cut 7 Tursiops truncatus	QBG (projector- receiver)	McIntosh (20-W-2)	Magnecorder (Pt6J) 30 ips Model	Fairly good 30—30,000 cps
Cut 8 Lagenorhynchus acutus	AX-58 (Brush Development Corporation)	Transistor (Woods Hole)	Crown (B822)	Flat 30—10,000 cps Good to 30,000 cps
Cut 9 Lagenorhynchus albirostris	AX-58 (Brush Development Corporation)	Woods Hole Suitcase	Magnecorder (Pt6J)	Flat 30—10,000 cps Good to 18,000 cps

SIDE 2

Record Cut & Species	Hydrophone	Amplifier	Recorder	System Frequency Response
Cut 1 <i>Pseudorca</i> <i>crassidens</i>	AX-58 (Brush Development Corporation)	Transistor (Woods Hole)	Crown (B822)	Flat 30—10,000 cps Good to 30,000 cps
Cut 2 <i>Globicephala</i> <i>melaena</i>	Rochelle salt (Woods Hole)	Battery-powered (Woods Hole)	Magnemite (Amplifier Corp. of America)	100 to 9,000 cps
Cut 3 <i>Globicephala</i> <i>macrorhyncha</i>	Rochelle salt (Woods Hole)	Battery-powered (Woods Hole)	Magnemite (Amplifier Corp. of America)	100 to 9,000 cps
Cut 4 <i>Globicephala</i> <i>scammoni</i>	Rochelle salt (Woods Hole)	Battery-powered (Woods Hole)	Magnemite (Amplifier Corp. of America)	100 to 9,000 cps
Cut 5 <i>Grampus</i> <i>griseus</i>	AX-58 (Brush Development Corporation)	Woods Hole Suitcase	Magnecorder (Model Pt6J)	Flat 30—10,000 cps Good to 18,000 cps
Cut 6 <i>Delphinapterus</i> <i>leucas</i>	Rochelle salt (Woods Hole)	3 tube (Woods Hole)	Dictating Machine (Gray Audograph)	100 to 4,000 cps
Cut 7 <i>Physeter</i> <i>catodon</i>	AX-58 (Brush Development Corporation)	Transistor (Woods Hole)	Crown (B822)	Flat 30—10,000 cps Good to 30,000 cps
Cut 8 <i>Eubalaena</i> <i>glacialis</i>	AX-58 (Brush Development Corporation)	Woods Hole Suitcase	Magnecorder (Model Pt6J)	Flat 30—10,000 cps Good to 18,000 cps
Cut 9 <i>Megaptera</i> <i>novaeangliae</i>	AX-58 (Brush Development Corporation)	Transistor (Woods Hole)	Crown (B822)	Flat 30—10,000 cps Good to 30,000 cps
Cut 10 <i>Balaenoptera</i> <i>physalus</i>	AX-58 (Brush Development Corporation)	Transistor (Woods Hole)	Crown (B822)	Flat 30—10,000 cps Good to 30,000 cps

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