

Individual variation in song of the Kirtland's Warbler

(Dendroica kirtlandii)

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1989

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INTRODUCTION

Most male wood warblers (Parulinae) in the genera Seiurus, Oporornis, and Geothlypis have a single song (exclusive of flight songs) but many in the genera Dendroica, Setophaga, Mniotilta, Parula, Vermivora, and Wilsonia typically have two functionally different classes of songs (Ficken and Ficken 1962, Lemon *et al* 1987). One class (called Group-A, Type B, primary, Type I, accented, repeat mode, or singing behavior A songs) is thought to be used primarily in intersexual communication (primarily mate attraction and maintenance of the pair bond) and another class (referred to as Group-B, Type A, secondary, Type II, unaccented, serial mode, or singing behavior B songs) seems to be used primarily in intrasexual communication (mostly agonistic interactions between males) (see Kroodsma 1981, 1989; Staicer 1989). These two classes of songs are defined by song structure and variability, how the song is delivered, rate of delivery of song, when the song is sung diurnally and seasonally, social environment when the song is sung, and other aspects of singing behavior (see Kroodsma 1981, 1989 and Staicer 1989).

Although there may be considerable interspecific and intraspecific variation in the number and variation of song types within each functional class of song, primary songs (used in this report in the sense of Kroodsma 1989) appear to be more stereotypic than secondary song (Kroodsma 1981, 1989; Staicer 1989). The Grace's Warbler (Dendroica graciae) has a repertoire of 5 to 9 songs, and the 1 to 4 primary songs may not be shared

with neighbors (Staicer 1989). A simpler pattern is exhibited by Blue-winged Warblers (Vermivora pinus), where each male has one primary song and one secondary song. Males apparently share the same primary song (within and between populations) but individuals from different populations have different secondary songs as do some males within a population (Lanyon and Gill 1964, Kroodsma 1981).

Although little has been published on song of the Kirtland's Warbler (Dendroica kirtlandii), Mayfield (1960) identified two categories of song, the "normal" ("waterthrush" song (which appears to function at least as primary song), and "chatter" ("wren") song (which seems to be secondary song or perhaps comparable to the "jumble" song of the Chestnut-sided Warbler (Dendroica pensylvanica (Lein 1978))). Each male apparently sings at least one of each class of song. Mayfield (op. cit.), Walkinshaw (1983) and others (W. Irvine, J. Probst, S. Taylor, J. Weinrich, personal communication) also noted that songs may be individually distinctive, especially the beginning and ending of song (Mayfield op. cit.). Mayfield (op. cit.) further stated that "after a few days one finds it possible to identify every individual by song alone." These findings suggest that it is possible to use song to identify individual Kirtland's Warblers in the field. The objective of this study was to determine if songs of male Kirtland's Warblers can be individually identified by sonagrams and, if so, which song(s) can be used for this purpose.

Data collection. I recorded the songs of 49 male Kirtland's Warblers at four Michigan sites: Bald Hill (Crawford Co.: T27N, R1W, Sections 19-21, 28-30), Mack Lake (Oscoda Co.: T25N, R3E, Sections 11-17, 20-23, 26, 27), Stephan Bridge (Crawford Co.: T27N, R2W, Sections 31 and 32 and T26N, R2W, Sections 5 and 6), and St. Helen (Roscommon Co.: T23N, R1W, Section 1). Recordings were made in 1989 (all times EDT) on 17 May (06:00-14:30), 18 May (06:00-13:00), 19 May (05:55-14:30), 20 May (05:40-12:00), 28 May (05:55-11:00 and 19:00-21:00), 29 May (06:00-10:30), 15 June (06:00-16:00), 16 June (06:00-16:00), 17 June (06:00-15:30), and 26 June (09:00-14:30), 27 June (06:30-13:00) and 28 June (06:00-11:30). Most recording was done in the morning when singing activity is greatest (Mayfield op. cit.; Hayes, Probst, and Rakstad 1986).

For each bird, I mapped where it was recorded, the date and time of the recording, whether it was accompanied by a female, and any interactions noted with other Kirtland's Warblers. I attempted to record a minimum of 10 songs during each recording session. Individuals were identified by their color-band combination or, for unbanded birds, by associating a distinctive song with a particular location. Unbanded birds singing the same song type at one site at different times or dates were considered to be the same bird. Unbanded birds were obviously identified with less certainty than banded birds since at least some birds

are seen outside their territories occasionally (J. Probst, personal communication). Thus, examining the notes of John Probst and Mark Nelson on location and song features of unbanded birds greatly helped in identifying these birds.

Most recordings were made at Bald Hill and Mack Lake, where many males were color-banded. I recorded several color-banded birds at Bald Hill relatively intensively to more adequately describe their song repertoires and to determine the conditions in which different song types were sung. Less intensive recording of individuals was done at Mack Lake, Stephan Bridge, and St. Helen. Recordings from birds in these areas were obtained to document the range of song variation in Kirtland's Warblers and to describe variation in song between sites.

Recordings were made on TDK high bias CrO₂ cassette tapes with a Marantz Superscope CD-330 tape recorder and a Sennheiser directional microphone ME-80.

Song terminology. Terminology used to describe song is modified from Mulligan (1966), Kroodsma (1974) and Staicer (1989). Note is defined as a continuous trace on a sonagram. A syllable is a note or group of notes identified as a discrete component of song. Syllable types, each with characteristic frequency, temporal and shape features, are designated by a letter. Syllables on a morphological gradient were given the same designation. Thus, similar but non-identical syllables could be designated by the same code. A syllable type may occur in the repertoire of more than one male and is the most finely

distinguished unit of song analyzed here. A song type is defined as a stereotypic sequence of syllables repeated in a consistent manner in the repertoire of an individual. Songs of the same song type may vary in the number of characteristic syllable types of that song type or a song may be sung without its typical beginning or ending.

Song analysis. Sonagrams were made with a Kay Elemetrics Model 5500 sonagraph using both a 330 Hz (wide band) and 59 Hz (narrow band) filter. Sonagrams presented in this report were made with the wide band filter.

RESULTS

The first Kirtland's Warbler reported on the breeding grounds in 1989 was on 15 May (Jerry Weinrich, personal communication). Approximately one-third of the males had returned to Bald Hill by 17 May (John Probst, personal communication). The first females were seen on 18 May at Bald Hill but all color-banded males observed on that date at Bald Hill (males 38, 100, 106 and 205) seemed to be unmated. Males 38 and 100 had paired by 20 May; none of the males at Stephan Bridge were thought to be have been paired on 20 May. By 28 May most males at Bald Hill seemed to be paired.

I recorded over 1,930^{NEW} songs from 49 male Kirtland Warblers in 1989. Eighteen males were recorded at Bald Hill, 21 at Mack Lake, five near Stephan Bridge Road, and five near St. Helen (see

Appendix I for a summary of data on each bird recorded and Figs. 1-4 for maps showing where each bird was located). Seventeen of the 49 birds were color-banded. Of these birds, I recorded over 100 songs from four birds from mid-May through late-June, which included that portion of the breeding cycle from territorial establishment through the nestling stage.

First songs of the day were heard at 05:55 EDT on 19 May (Mack Lake), 05:55 EDT on 20 May (Bald Hill) and 06:05 EDT on 28 May (Bald Hill). I did not hear or record distinctive dawn songs nor detect any difference in singing behavior at this time compared to later in the day except that a high proportion of time was devoted to singing.

Virtually all recordings were of "normal" song; I was able to record "chatter" song from only one color-banded bird (see Fig. 5b for a sonagram of a "chatter" song-106 right column) and perhaps two unbanded birds. "Chatter" songs were shorter than most "normal" songs but at least two birds sang "primary" songs that closely resembled "chatter" songs. I first heard a bird sing "chatter" song on 17 May, before females had arrived, during an agonistic encounter between two males. "Chatter" song was heard most frequently later in the breeding season but only 2.5% of the songs recorded were of this class of song. "Chatter" song was delivered more rapidly than "normal" song, was heard during male/male agonistic encounters and while birds were perched and no other males or females were noted in the vicinity. Twice I heard up to four males singing "chatter" song simultaneously and,

at least audibly, the songs of the different males could not be distinguished from each other. In one of these situations, on 28 May at Bald Hill, "chatter" songs were sung while the birds perched and "normal" song was sung before and after the period in which "chatter" song was heard. One of the birds closely observed did not change song perches or its behavior during transitions from "chatter" song to primary song.

Muted "chatter" and "normal" songs were heard occasionally, especially during encounters between males (when it was delivered rapidly), while foraging, or in the presence of a female (when it was given more slowly or intermittently).

"Normal" song is sung in bouts. The two birds which had more than one song type (50 and ML89-111) sang both song types during the same bout. All other birds had one song type (this includes variants of a song type) and no birds were known to have changed song types during the 1989 field season. "Normal" song was the predominant song heard during territory establishment through the nestling stage (I did not record birds after the nestling period). It was used during male/male agonistic encounters, during courtship (although the rate of song was low during courtship), in the presence of females, while foraging, and was sung frequently from song perches.

Sonagrams of all song types recorded are presented in Fig. 5 (see Appendix II for the song type(s) given by each male recorded). The distribution of the 20 different song types (unique sequences of syllable types) by location is summarized in

Four song types (20%) were shared between birds. Up to 15 birds, including those within and from different populations (Bald Hill, Mack Lake and Stephan Bridge) shared a single song type comprised of the sequence of syllables F-C-G (see Fig. 6 for a lexicon of syllables recorded in 1989). Of those birds with song type F-C-G, there were variants, especially in the number of times each syllable was repeated in the song of different individuals and, to some extent, in the rate at which syllables were sung. The number of repetitions of each syllable within a song of a bird varied little. Some birds, for example, consistently (but with some variability) repeated syllable F two, three or four times, and there was similar variation for syllables C and G. This kind of variation resulted in the identification of seven variants of the F-C-G song type. Thus, songs of the same song type from different birds varied in length and the number of syllables in a song. In addition, minor differences in syllable structure (see Fig. 7 for variation observed in the most variable syllables) could contribute to the individual identity of birds. However, even with these minor variations, some primary songs of some individuals are not distinguishable from each other (see, for example sonagrams of the following groups of birds: 205 and 216; 117, SB89-2, SB89-3 and SB89-5). The syllable sequence of K-C-G defined another song type that was widely shared; four Bald Hill males and five Mack Lake birds had this song type although none

seemed to share an identical variant of that song type.

Other song types varied by addition or omission of a syllable or substitution of another syllable with similar time and frequency characteristics. Syllables C and L (see Fig. 6 and Fig. 7) both occurred in the middle of many song types and differed only in that C has an inverted "W" shape and the two notes of syllable L are parallel to each other. Another pair of syllables found in the repertoire of many birds, F and K, especially at the beginning of songs, were distinguished by F having two wide frequency parallel notes without a chevron while syllable K was characterized by a chevron at the end of the syllable (see Fig. 6 and Fig. 7). These minor differences may be difficult to distinguish in the field and, with poor recordings, in sonagrams.

Unique sequences of audibly distinctive syllables, or unusual combinations of syllables, permitted unambiguous identification by song of approximately 18% of the birds sampled (38, BH89-8, BH89-16, ML89-64, ML89-72, ML89-78, ML89-92, SB89-1, and SB89-4). Among these unique songs were two songs used as primary song but with the syllables of "chatter" song; the song of SB89-4 had syllables I, J, D and E (see Fig. 5j) and that of ML89-64 had syllables I, B, and E (see Fig. 5g), all or most of which were found in the "chatter" song of male 106 (see Fig. 5b, 106 right column), which had syllables I, J, D, and E (the rate of delivery of these syllables in "chatter" song is faster than those in primary song however). Only seven syllables (A, N, P,

*one in 5
could
be identified*

Q, R, S) were restricted to the repertoire of one bird and collectively these syllables occurred in only four birds. Syllable H, upon further examination, seemed to be a reduced version of subsequent syllables and, as a result, may not be a distinct syllable. It was dropped from analysis even though the syllable, as defined, appears in some sonagrams.

DISCUSSION AND RECOMMENDATION

Results from this study suggest that there is too much similarity in primary songs of Kirtland's Warblers to permit individual recognition of many birds by sonagrams. Too few songs of secondary ("chatter") songs were obtained to determine if secondary songs are individually distinctive but "chatter" songs are sung so irregularly through June that it is unlikely that these songs would be useful for this purpose. Some individuals share song types that are virtually indistinguishable with sonagrams and others are so similar they probably could not be reliably identified in the field. Only about 18% of the 49 birds I recorded in 1989 could be confidently identified by sonagrams alone. Further, it is not known if Kirtland's Warblers retain the same song type from year to year (which is to be expected even though at least one warbler, the Yellow Warbler (Dendroica petechia), may add, drop or modify song types between years (Spector 1989)). Some warblers also have song types which are rarely sung (Spector 1989, Nolan 1978, Staicer 1989) and this

*best - ...
can be*

could compound problems in identifying individuals by song when recording efforts are minimal (by chance one of these songs could be recorded initially and then never be recorded again without intensive work).

Consequently, given that male Kirtland Warblers share song types, that there may be rare song types and that the stability of repertoires from year to year is unknown, it seems likely that sonagrams of song will be of limited use in the identification of individual Kirtland's Warblers.

ACKNOWLEDGEMENTS

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Table 1. Numbers of each song type recorded at each locality in 1989. Each song type is identified by the sequence of syllables in that song type.

SONG TYPE	LOCALITY			
	Bald Hill	Mack Lake	Stephan Bridge	St. Helen
A-B-C-D-E			1	
D-L-G		1		
D-S-K-T-S		1		
E-C-G		1		
F-C-G	9	3	3	
F-L-G	2	1		1
F-M-G	1			
F-M-L-G		1		
I-B-E		1		
I-J-D-E			1	
K-C	1			
K-C-G	4	5		1
K-E-C-G				1
K-L-G				2
K-U-C-G		.1		
L-F		1		
P-N	1			
Q-E-M-R		1		
T-C-G		1		
?-C-G		1		

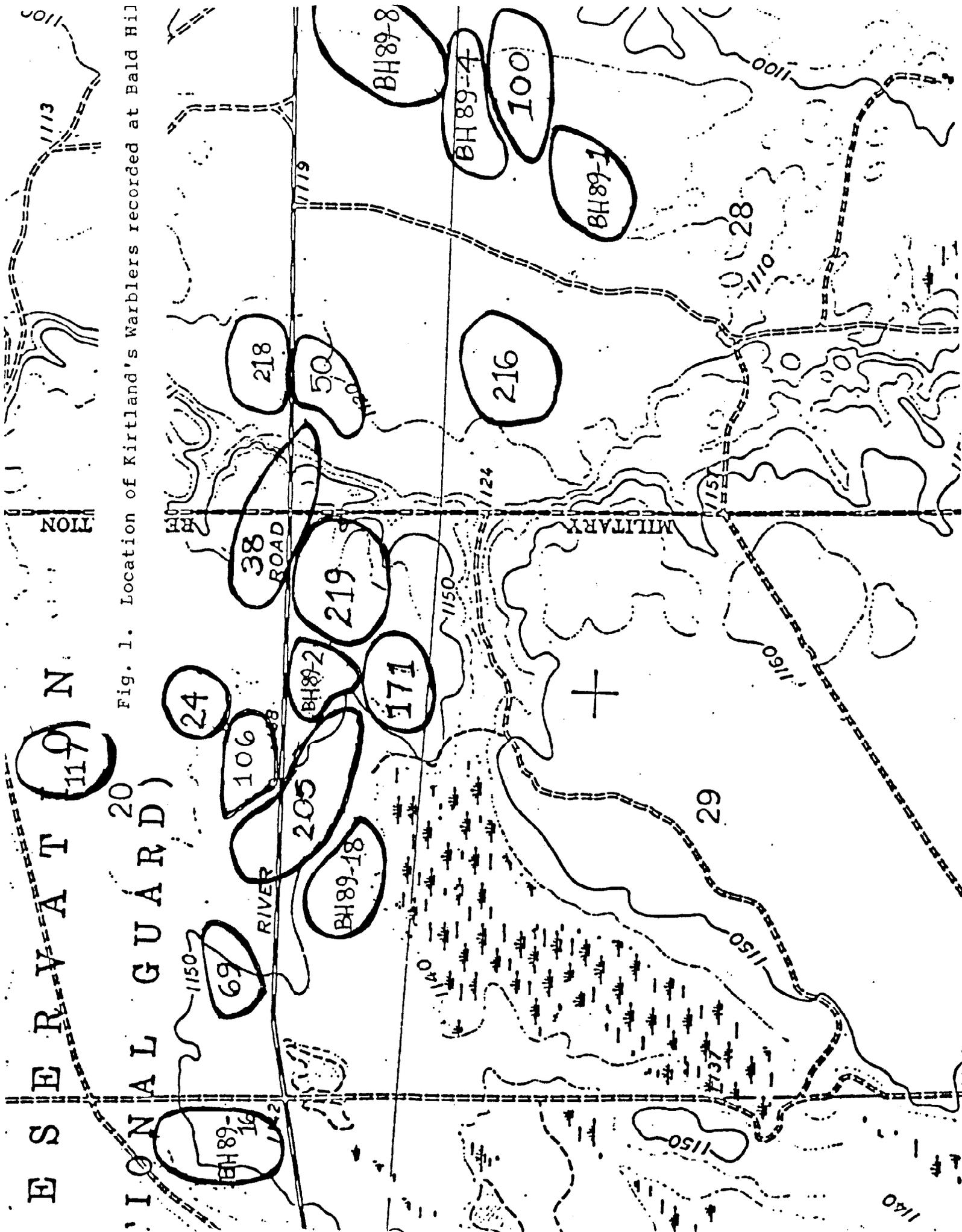


Fig. 1. Location of Kirtland's Warblers recorded at Bald Hill

Fig. 3. Location of Kirtland's Warblers recorded at Stephan Bridge Rd.

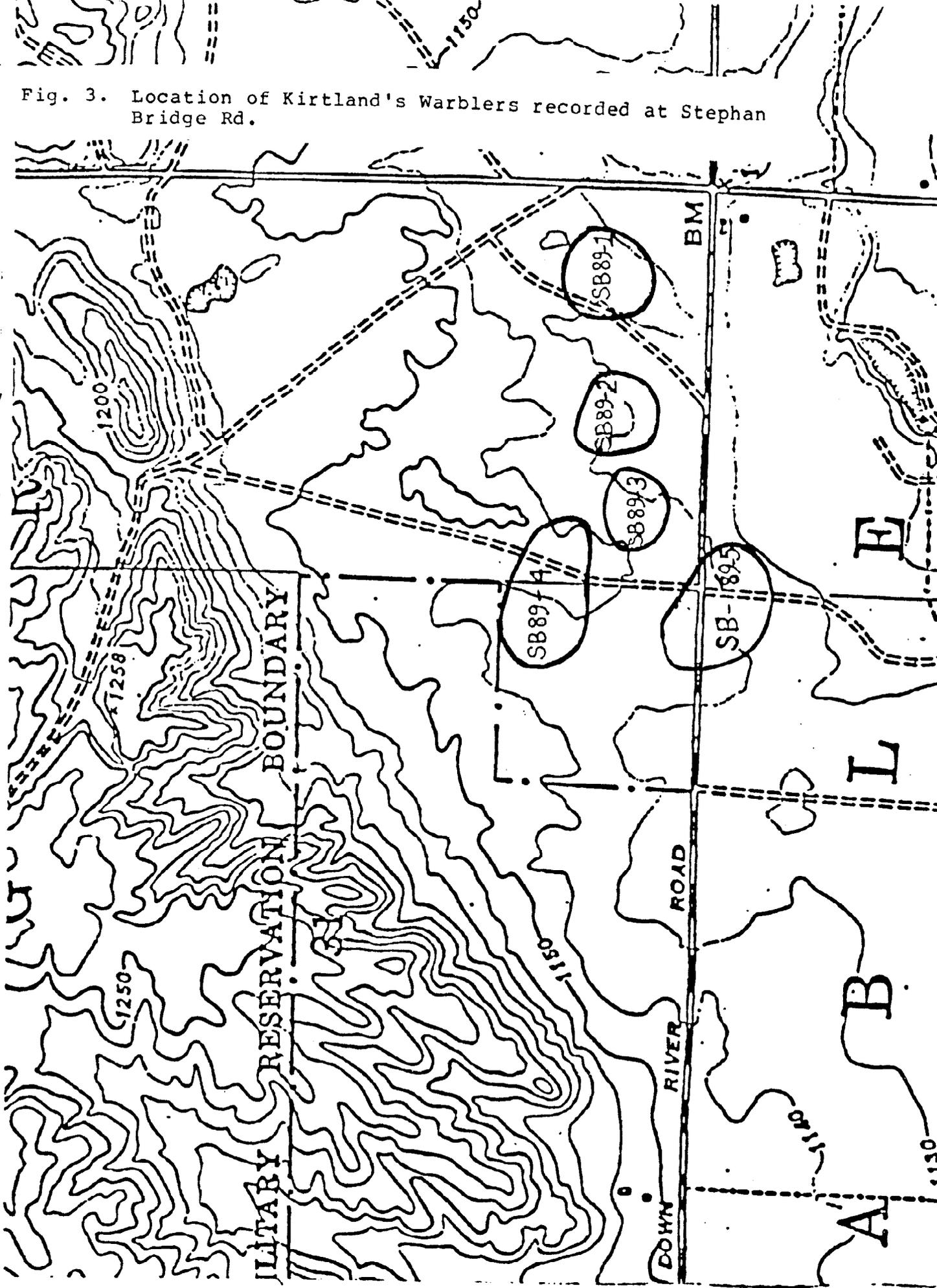


Fig. 4. Location of Kirtland's Warblers recorded at St. Helen.

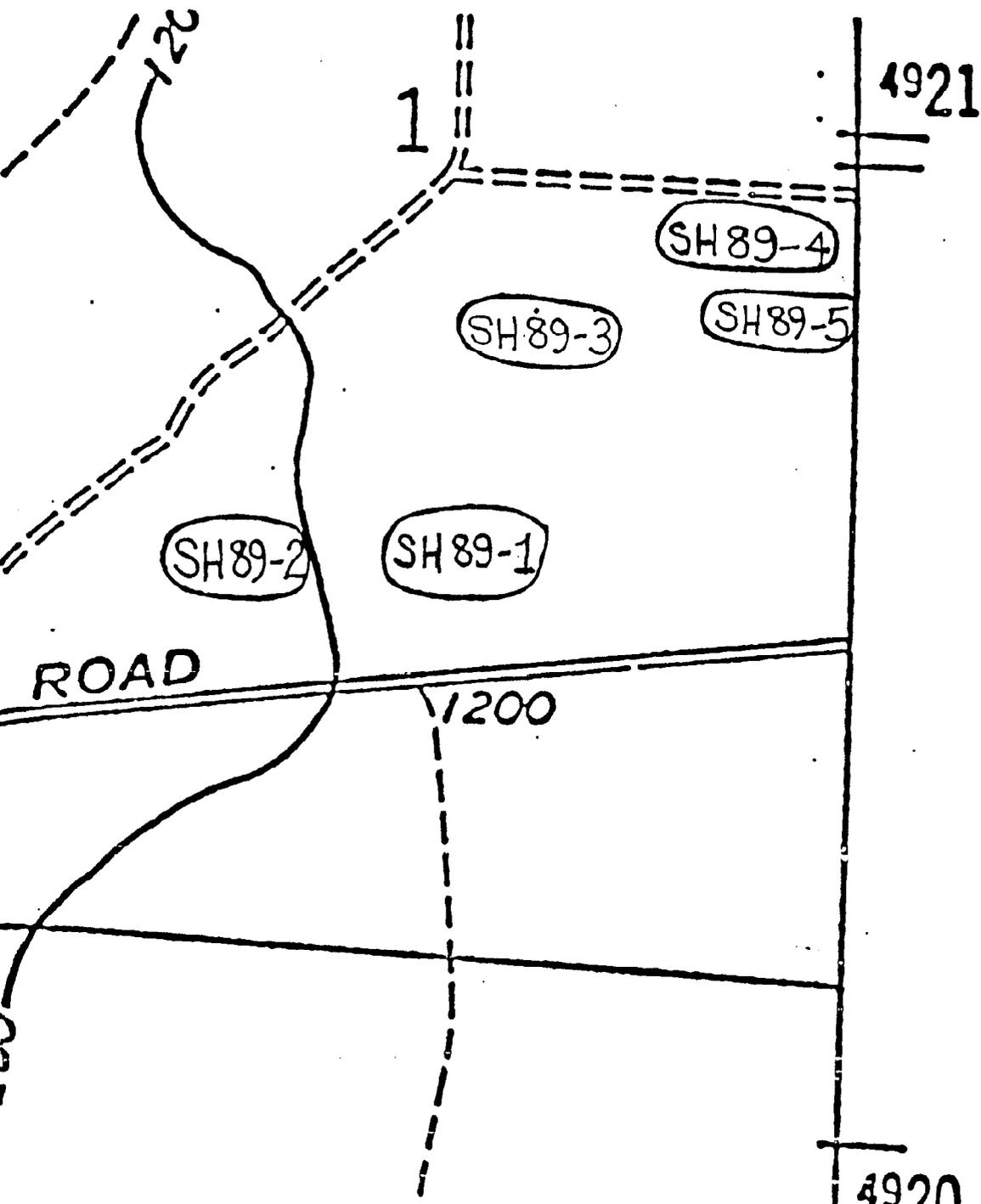


Fig. 5. Sonagrams of songs of Kirtland's Warblers recorded in 1989. The numeric or alpha-numeric code in the upper right hand corner of each sonagram identifies the individual that sang the song illustrated by the sonagram (see Appendix I for a list of those individuals). Sonagrams of songs of birds from Bald Hill are in Figs. 5a-5e, from Mack Lake in Figs. 5e-5i, from Stephan Bridge in 5j and from St. Helen in 5k.

Fig. 5a. Sonagrams of songs of Kirtland's Warblers recorded in 1989.

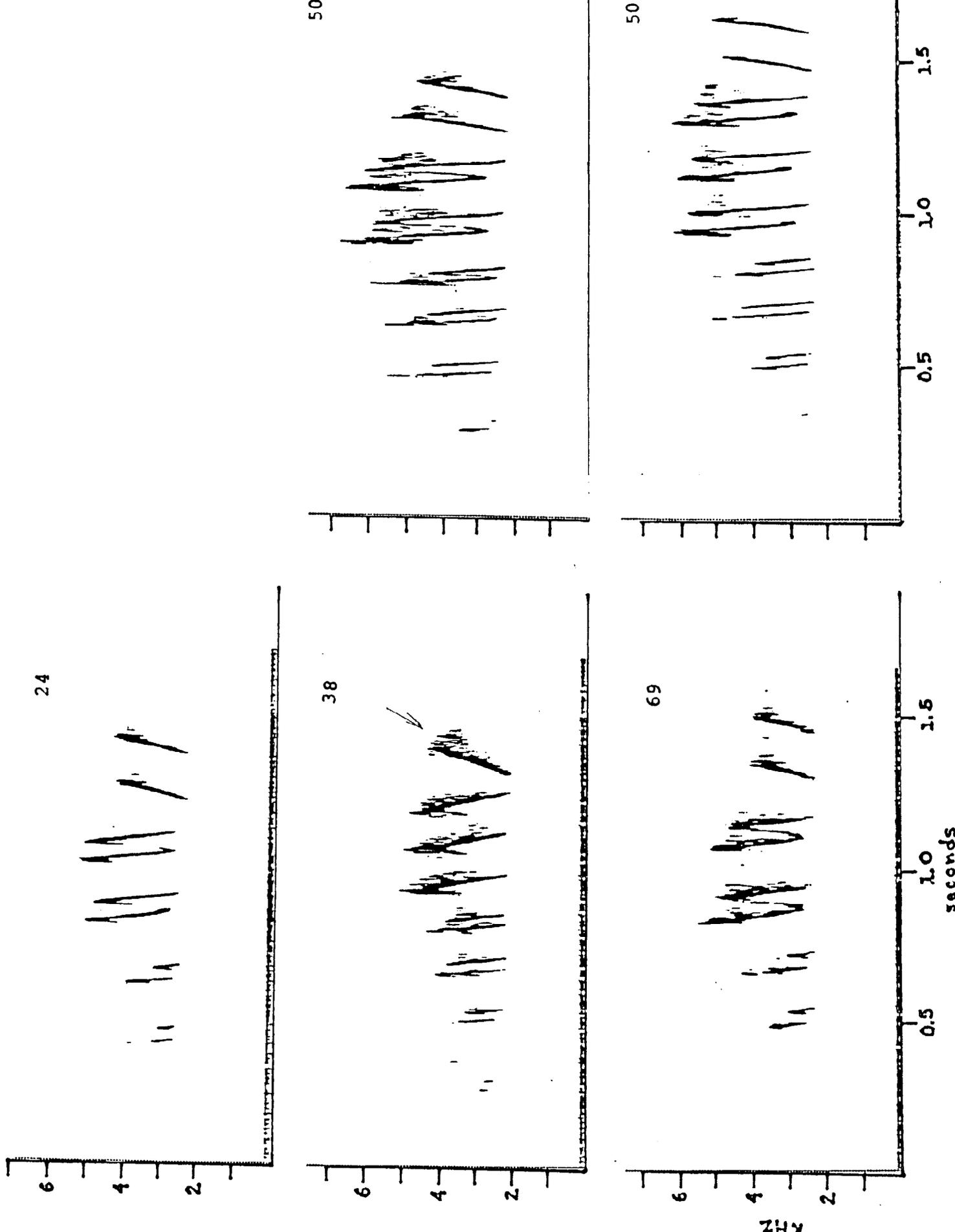
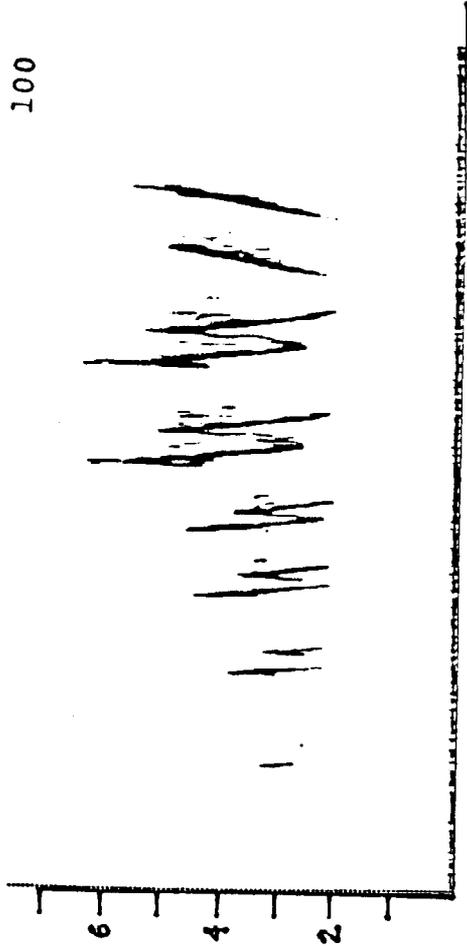
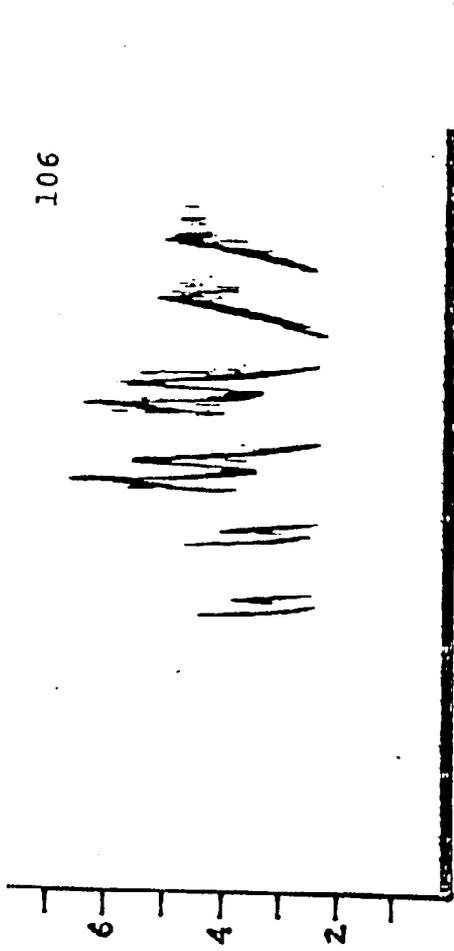


Fig. 5b. (continued)

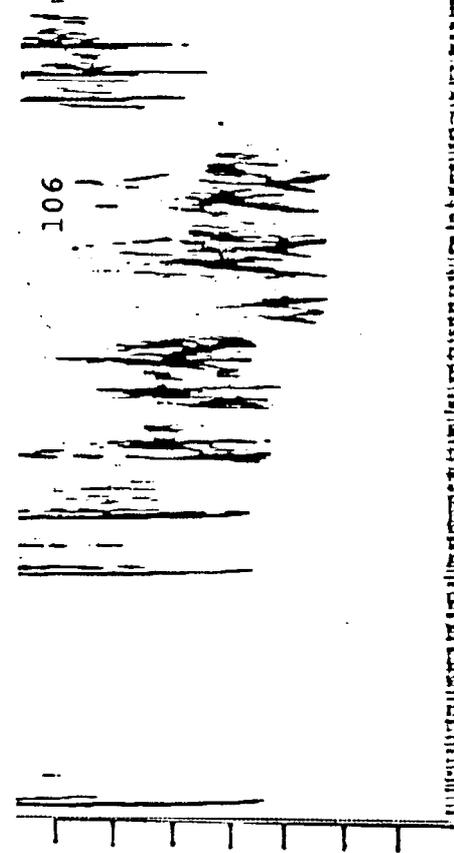
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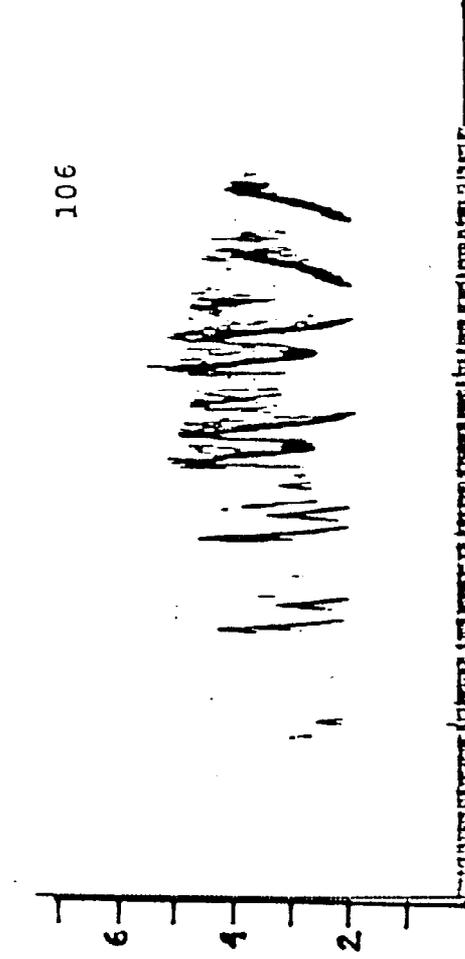
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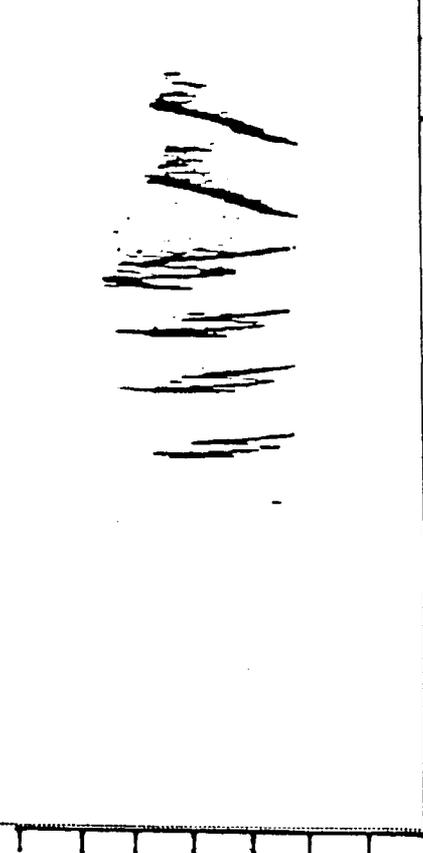
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117



106



seconds

0.5

1.0

1.5

1.5

1.0

0.5

Fig. 5c. (continued)

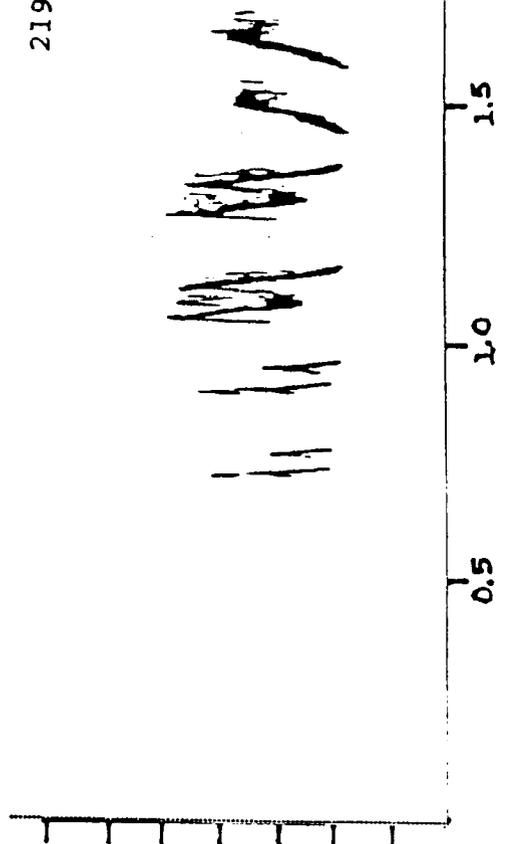
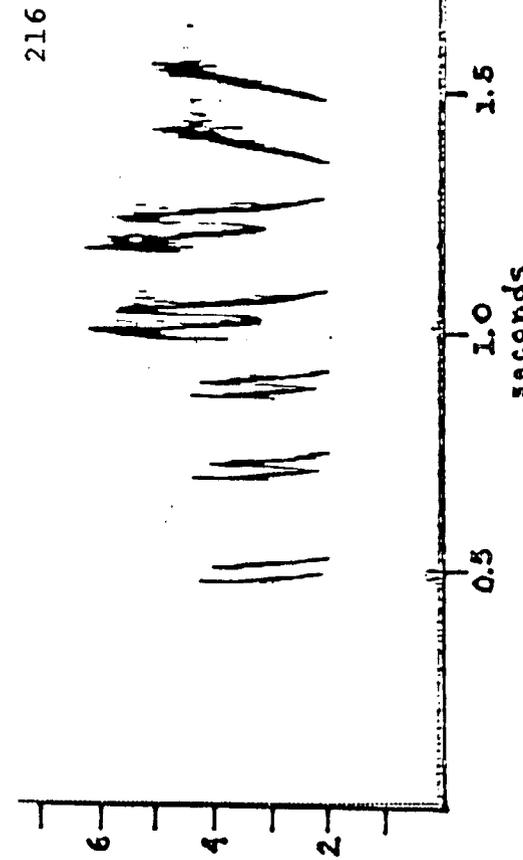
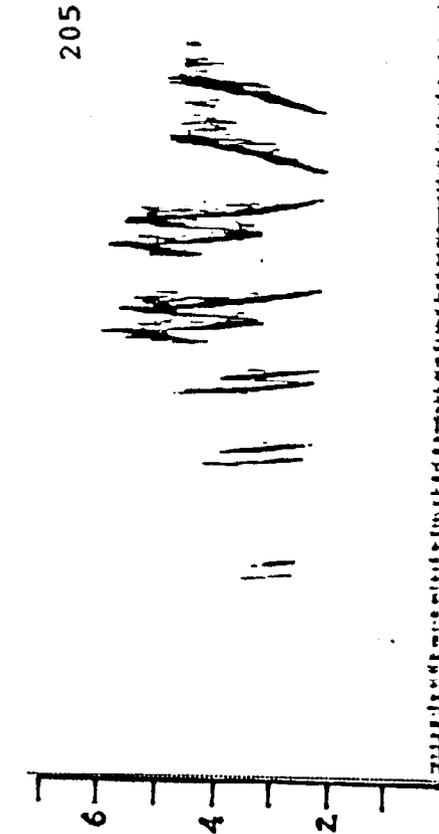
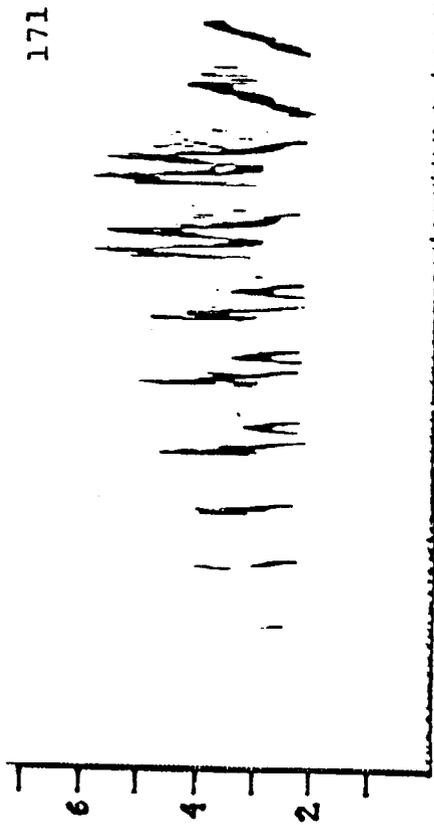


Fig. 5d. (continued)

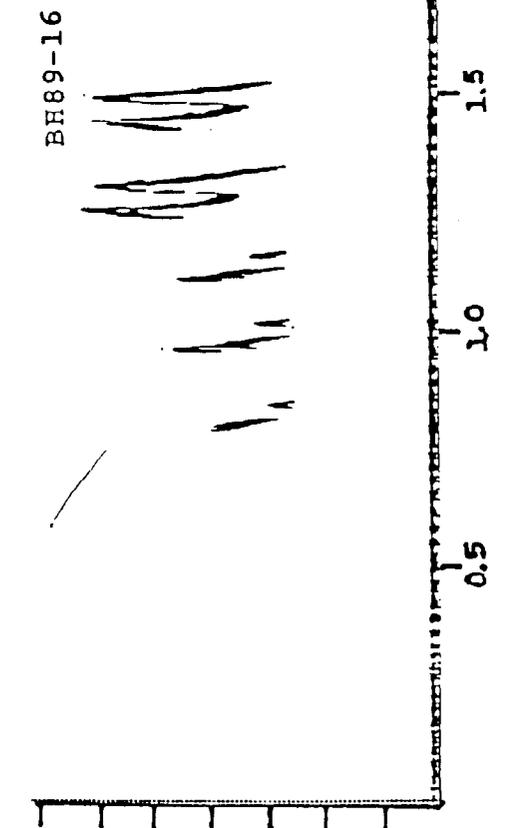
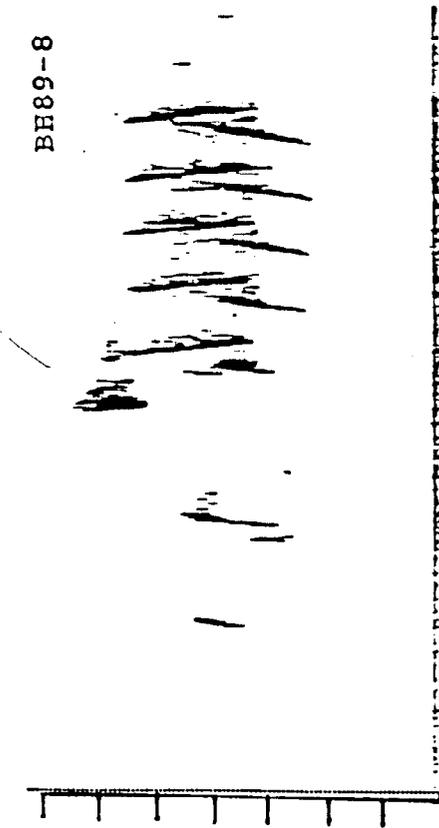
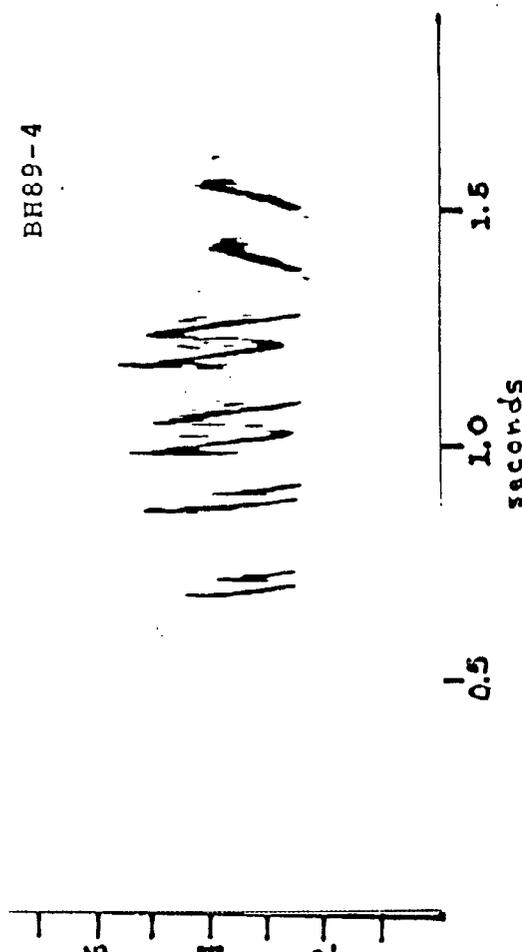
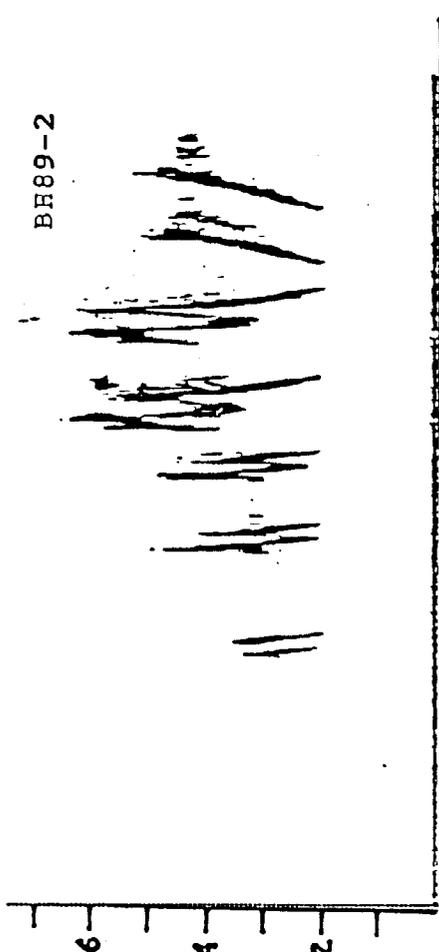
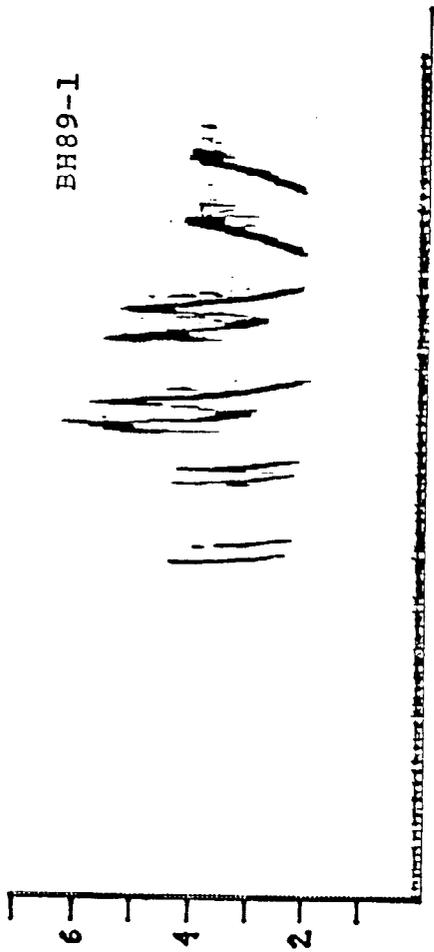


Fig. 5e. (continued)

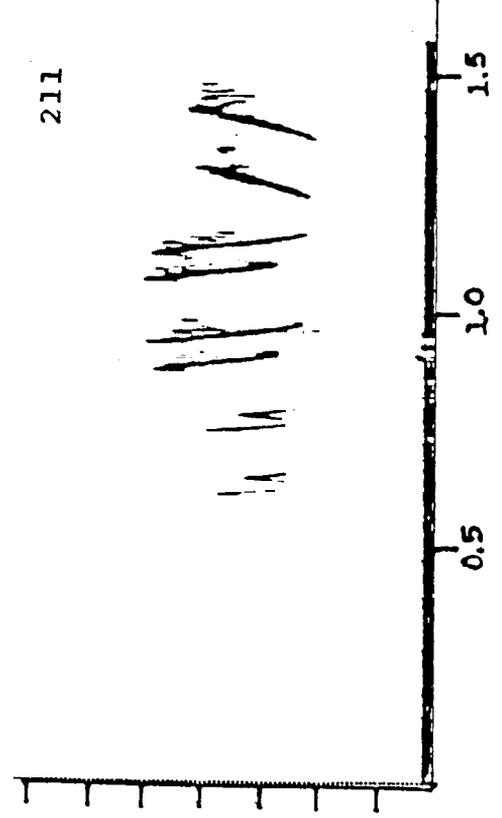
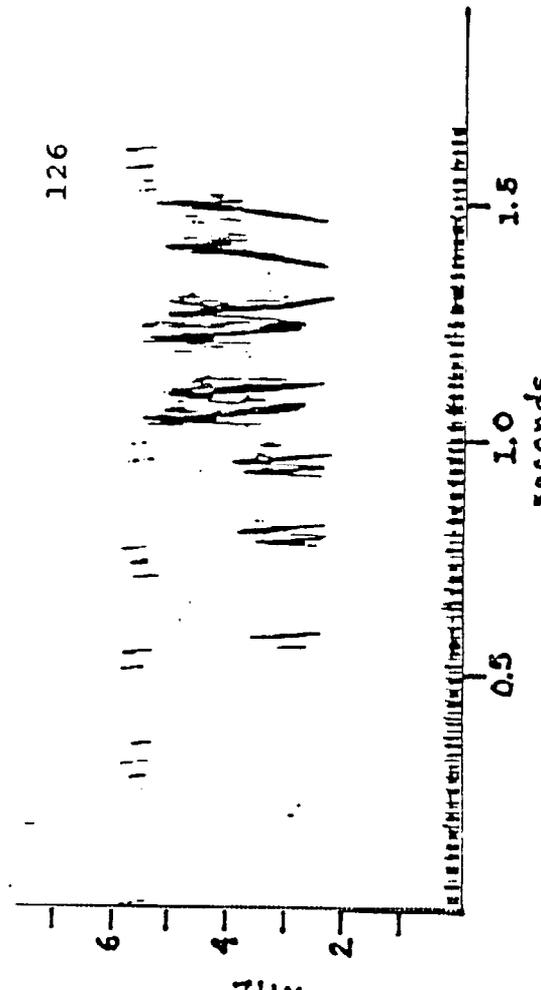
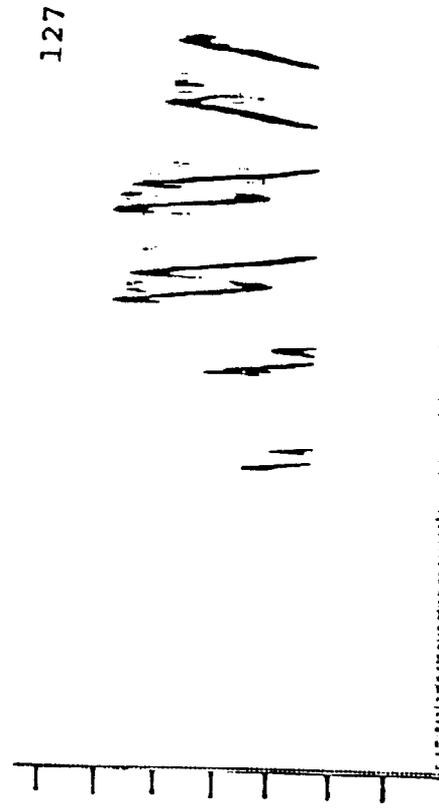
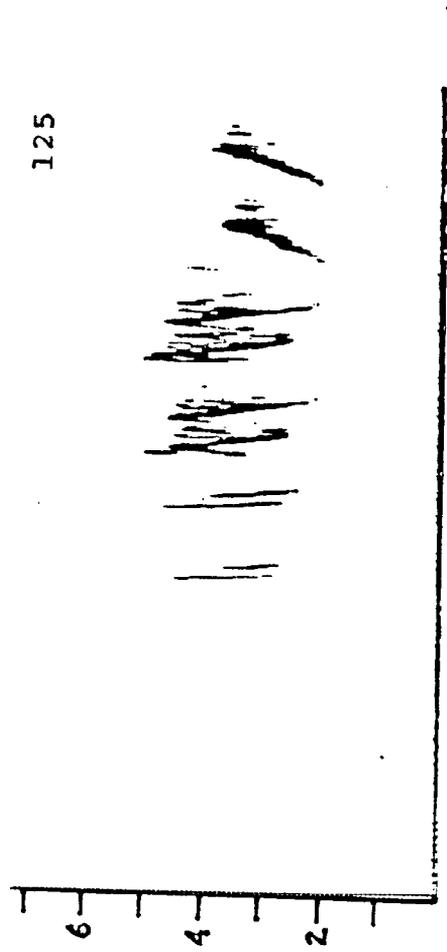
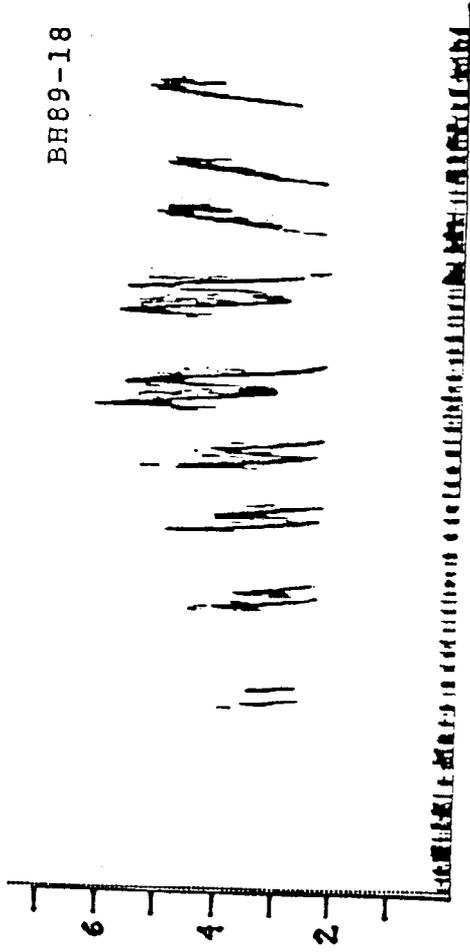


Fig. 5f. (continued)

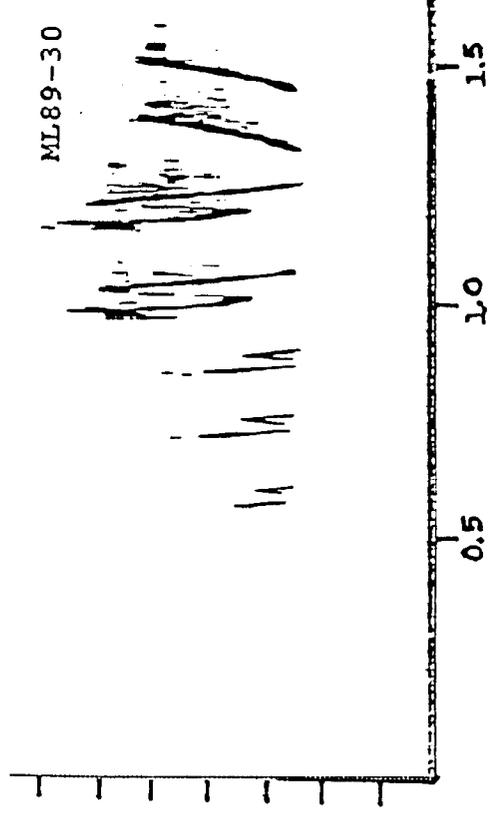
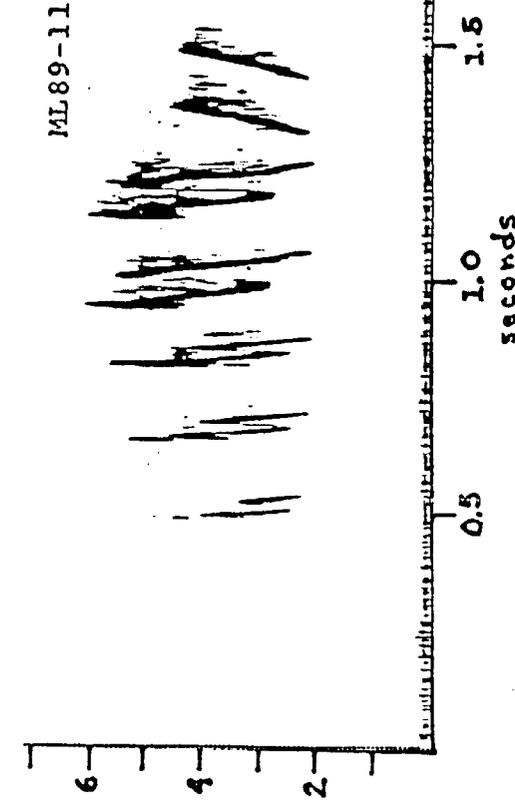
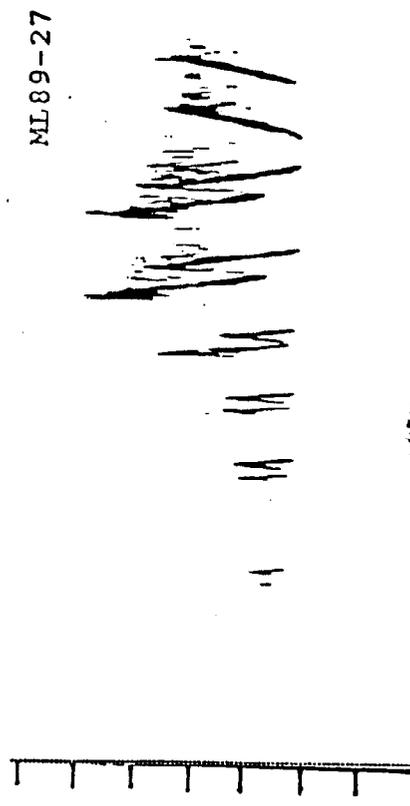
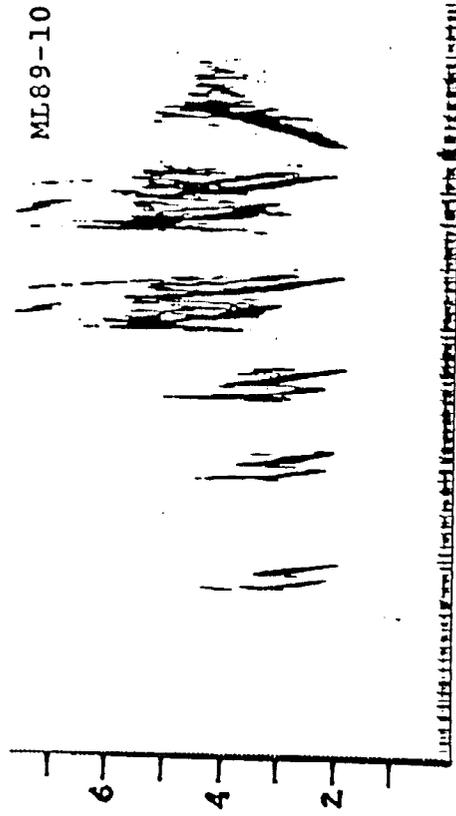
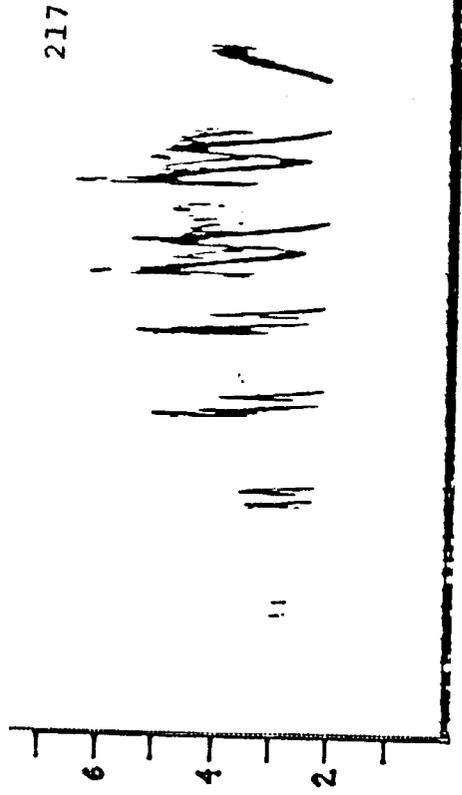


Fig. 59. (continued)

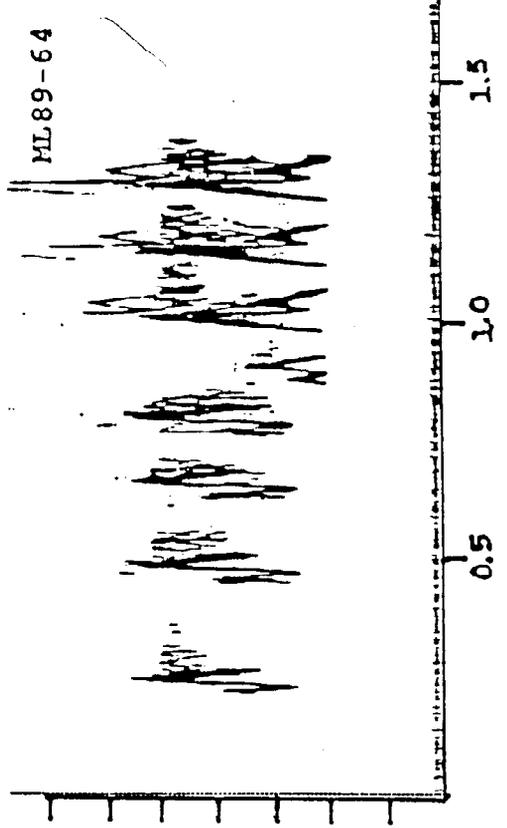
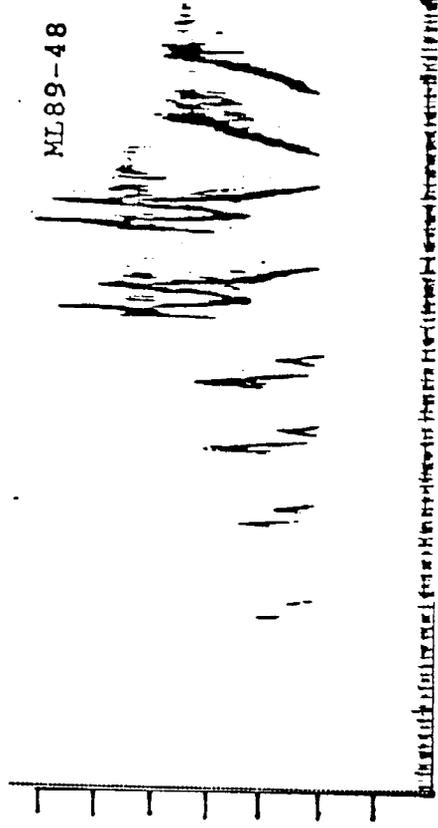
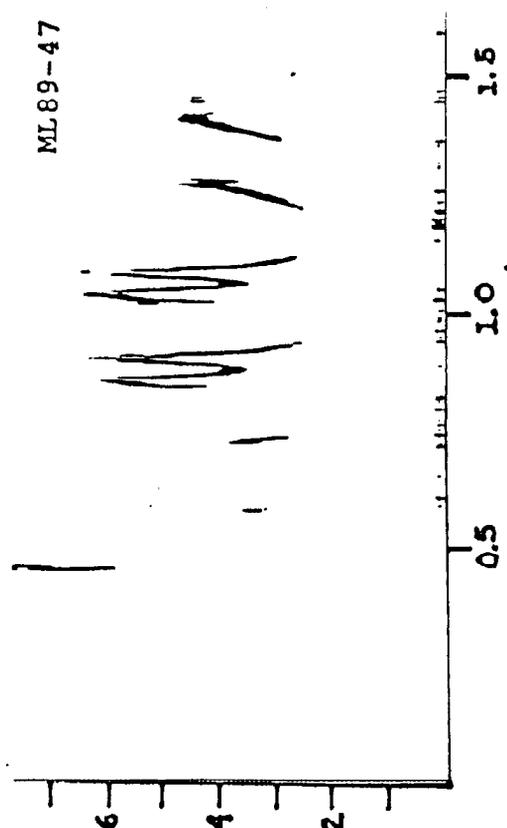
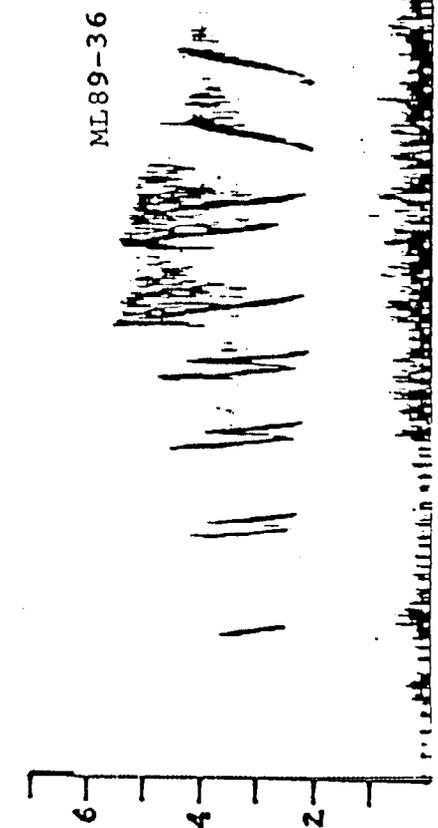
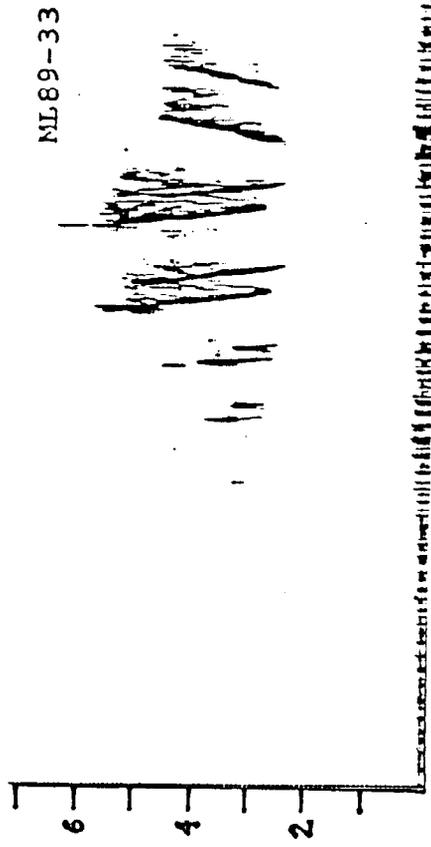
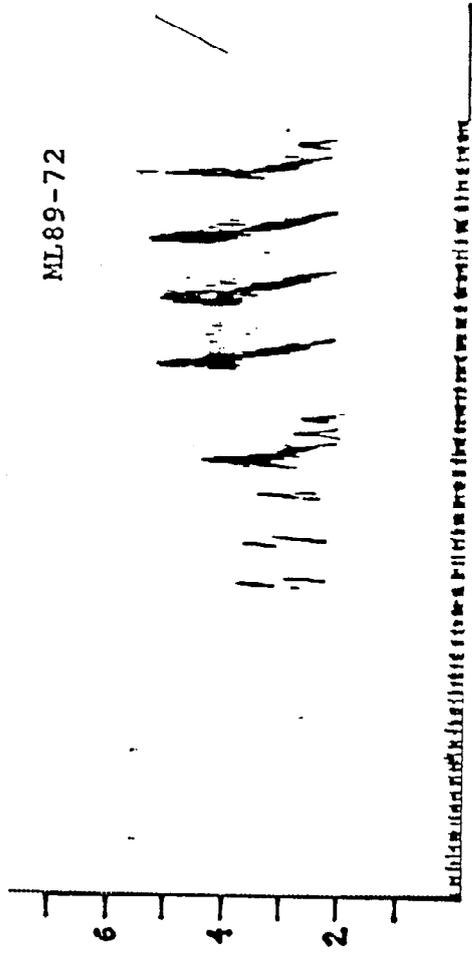
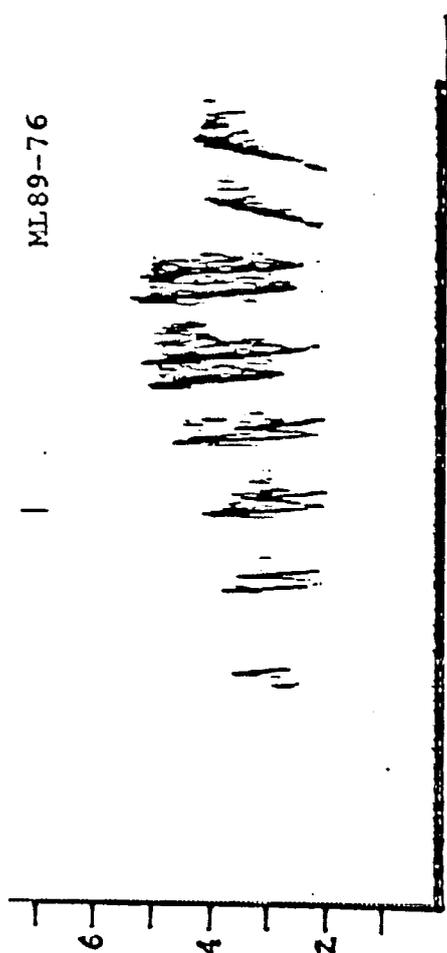


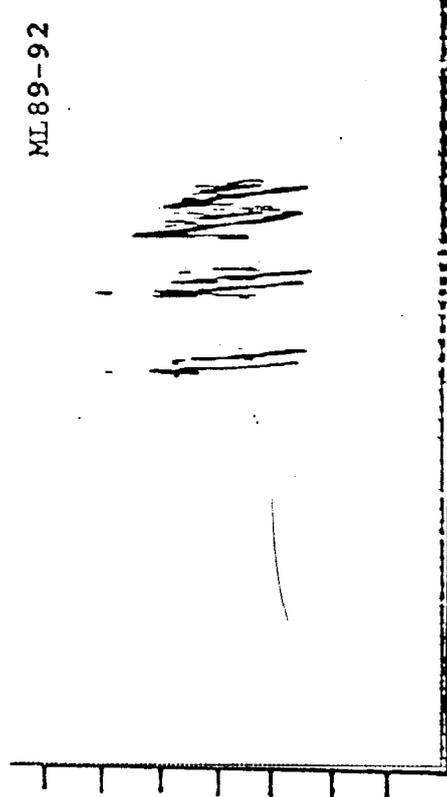
Fig. 5h. (continued)



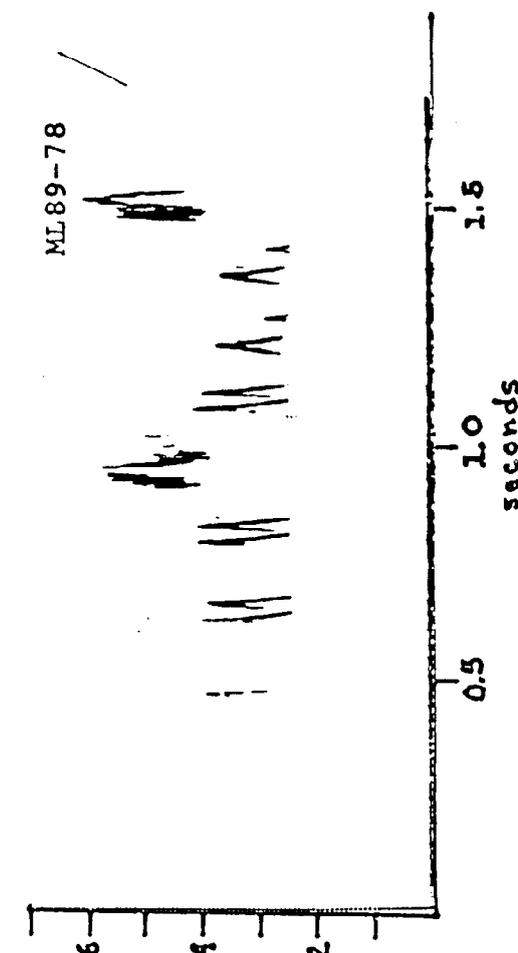
Vertical axis label: 2, 4, 6



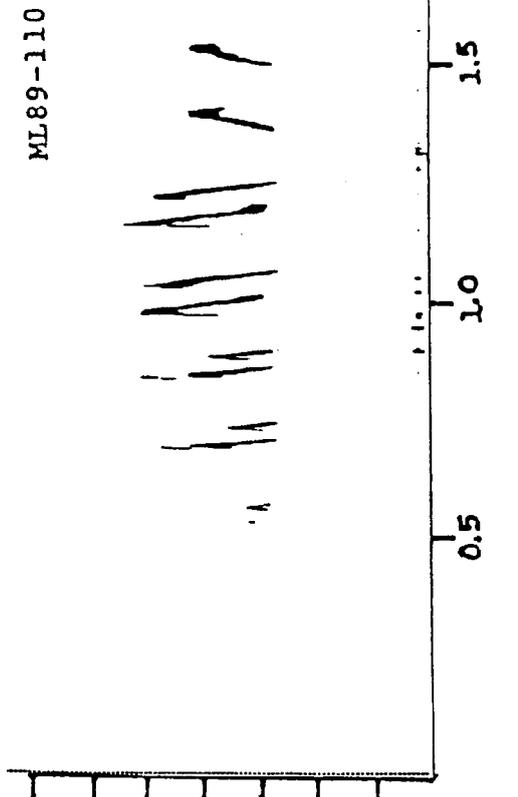
ML89-76



ML89-92



ML89-78



ML89-110

seconds

KHz

Fig. 5i. (continued)

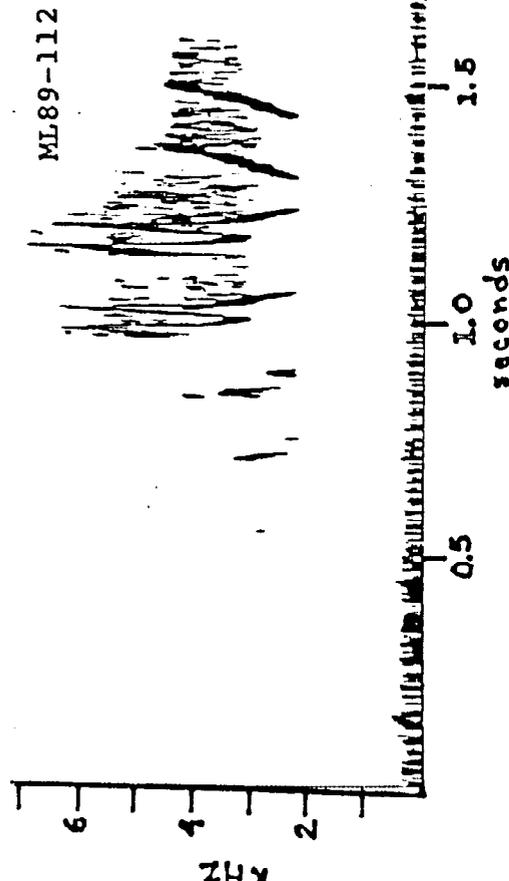
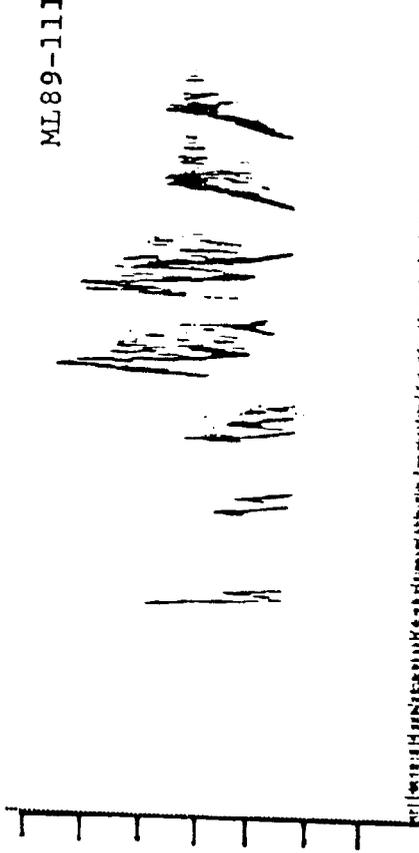
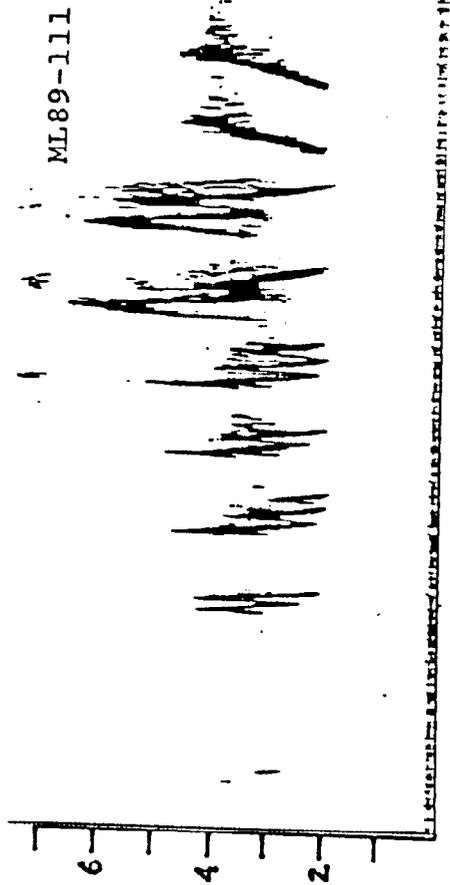
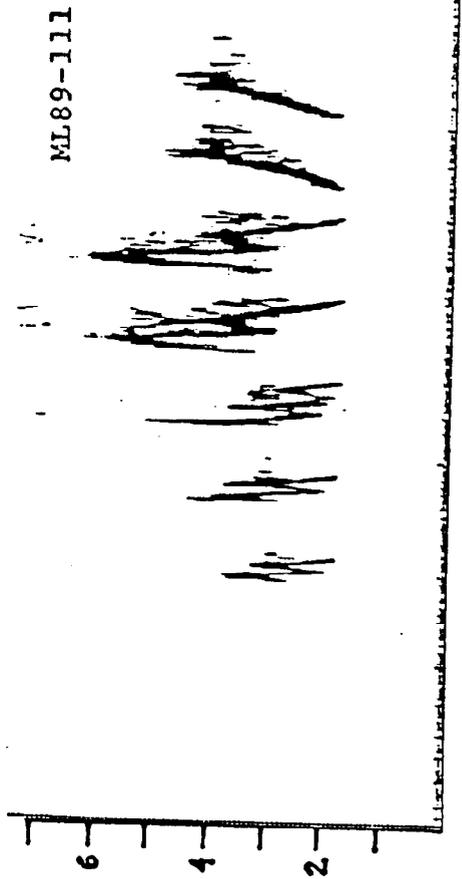


Fig. 5j. (continued)

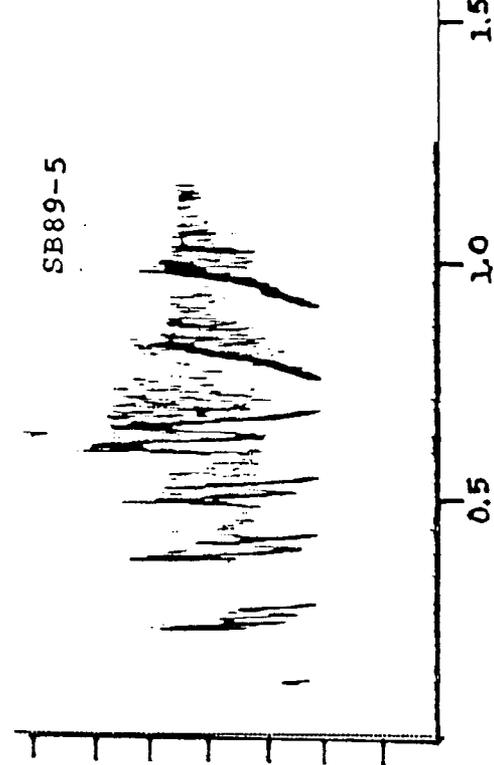
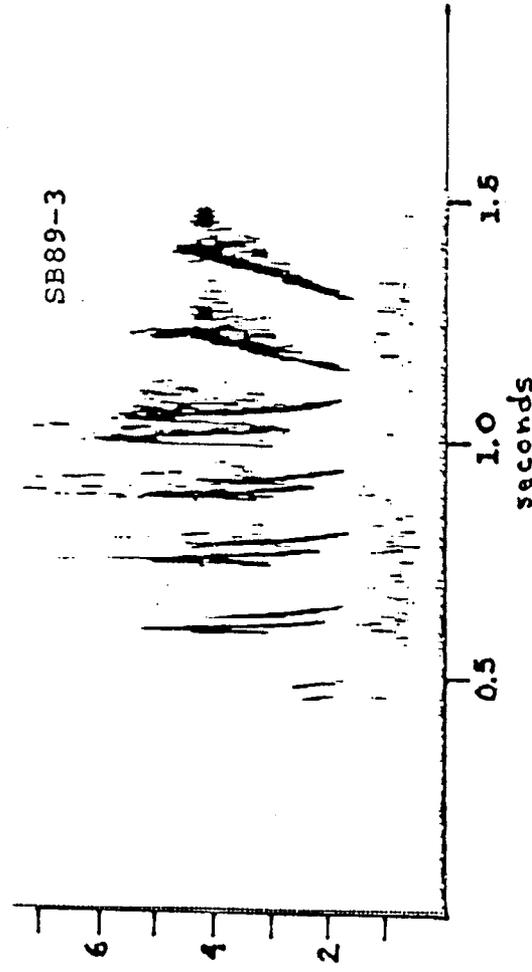
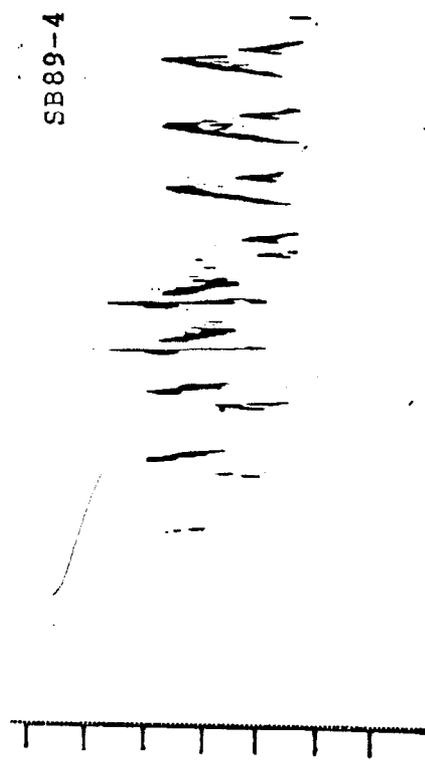
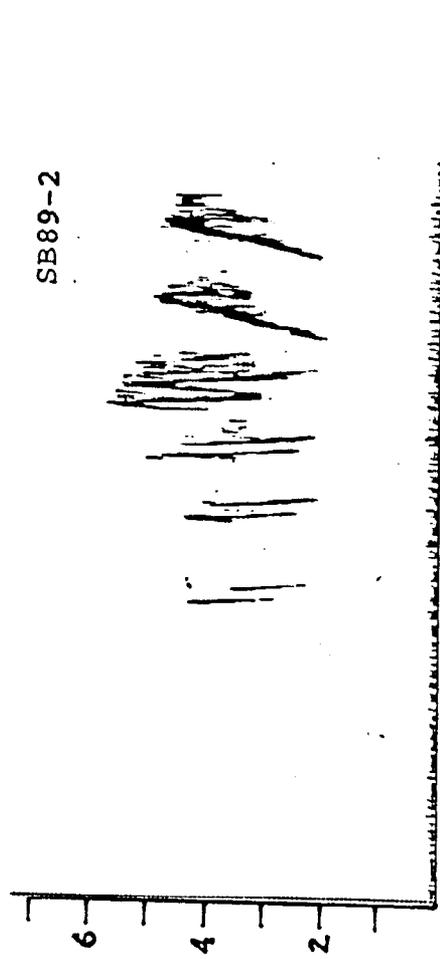
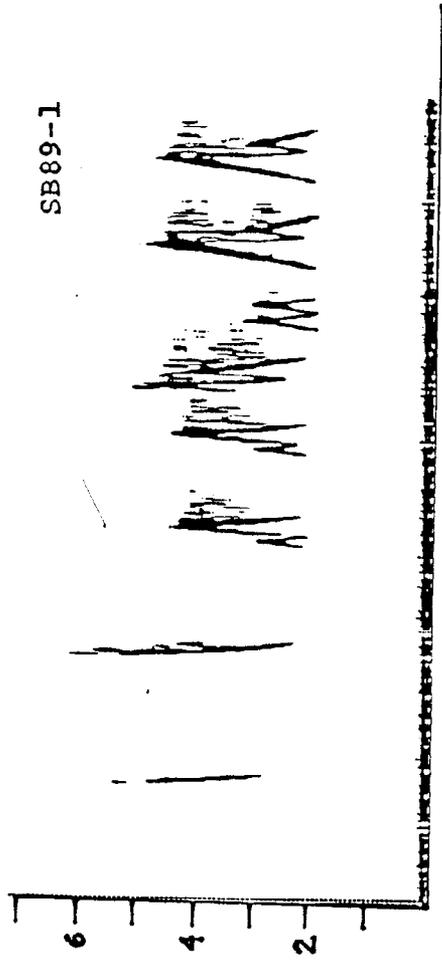


Fig. 5k. (continued)

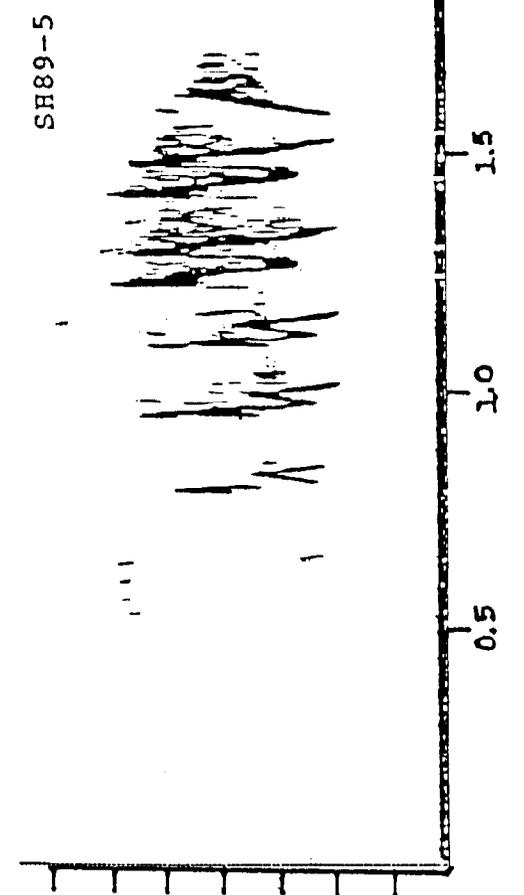
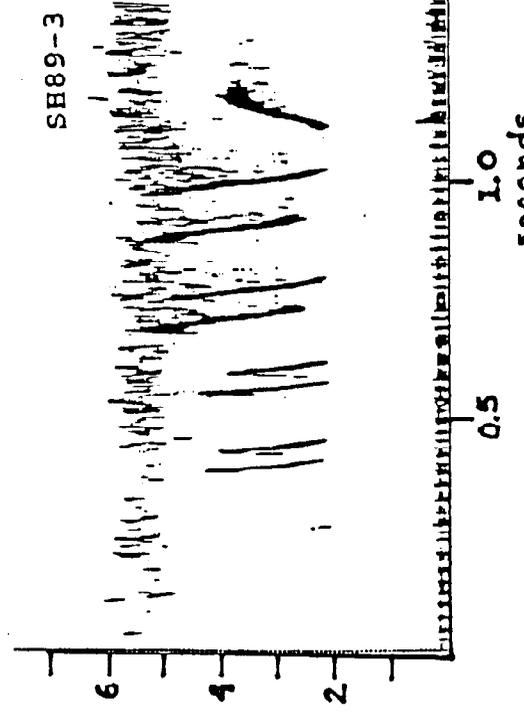
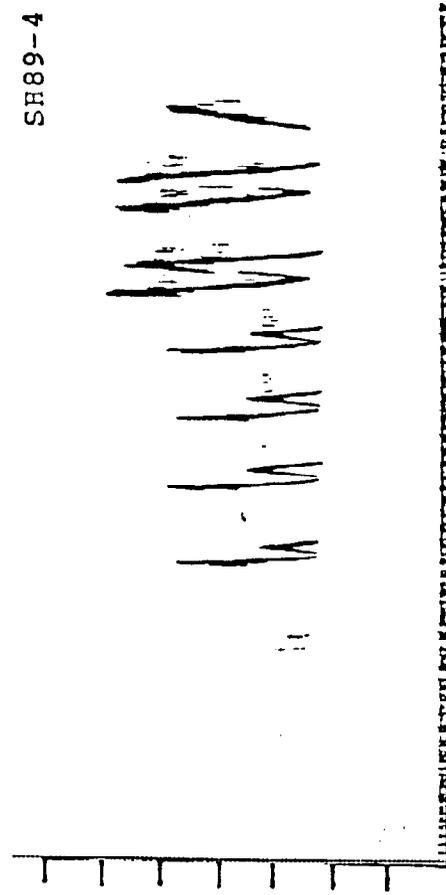
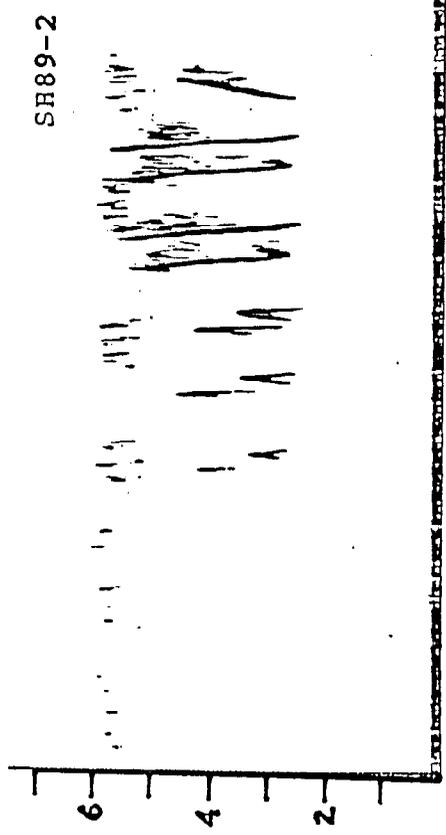
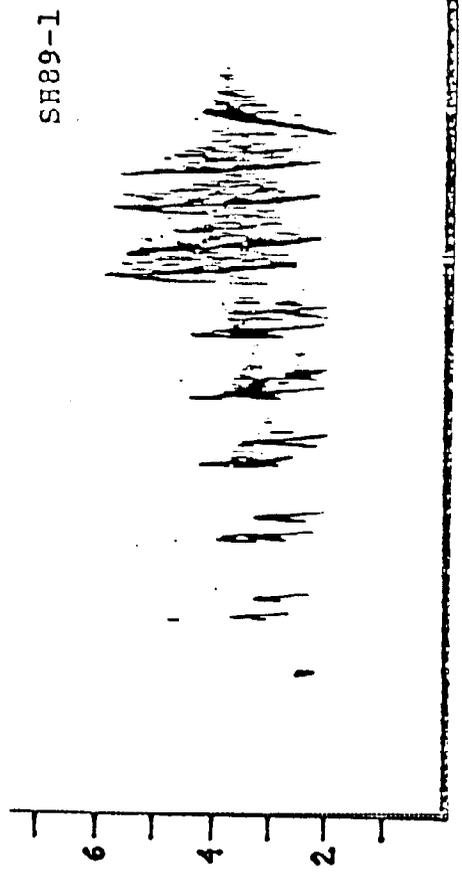


Fig. 6. Lexicon of syllable types defined from songs of Kirtland's Warblers recorded in 1989.

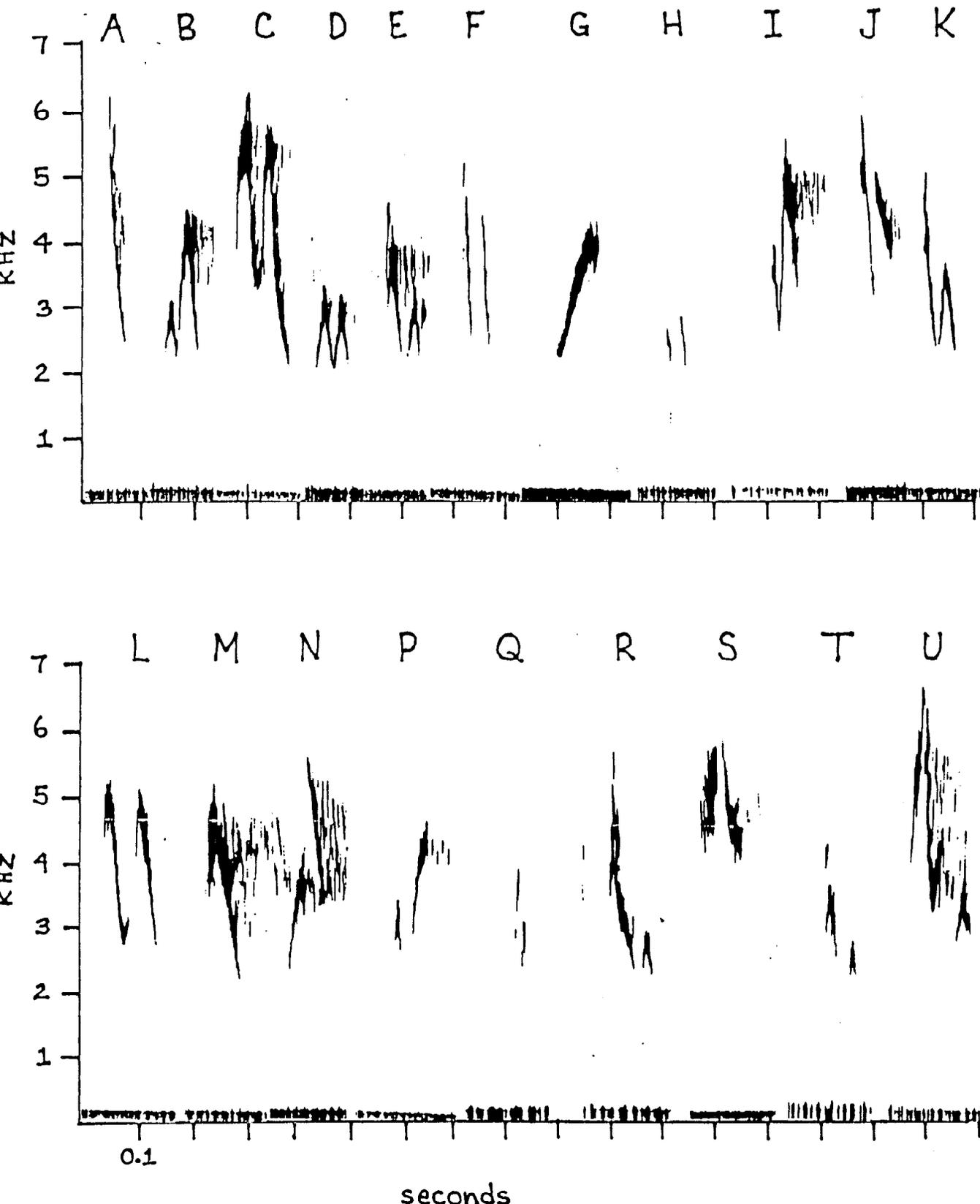
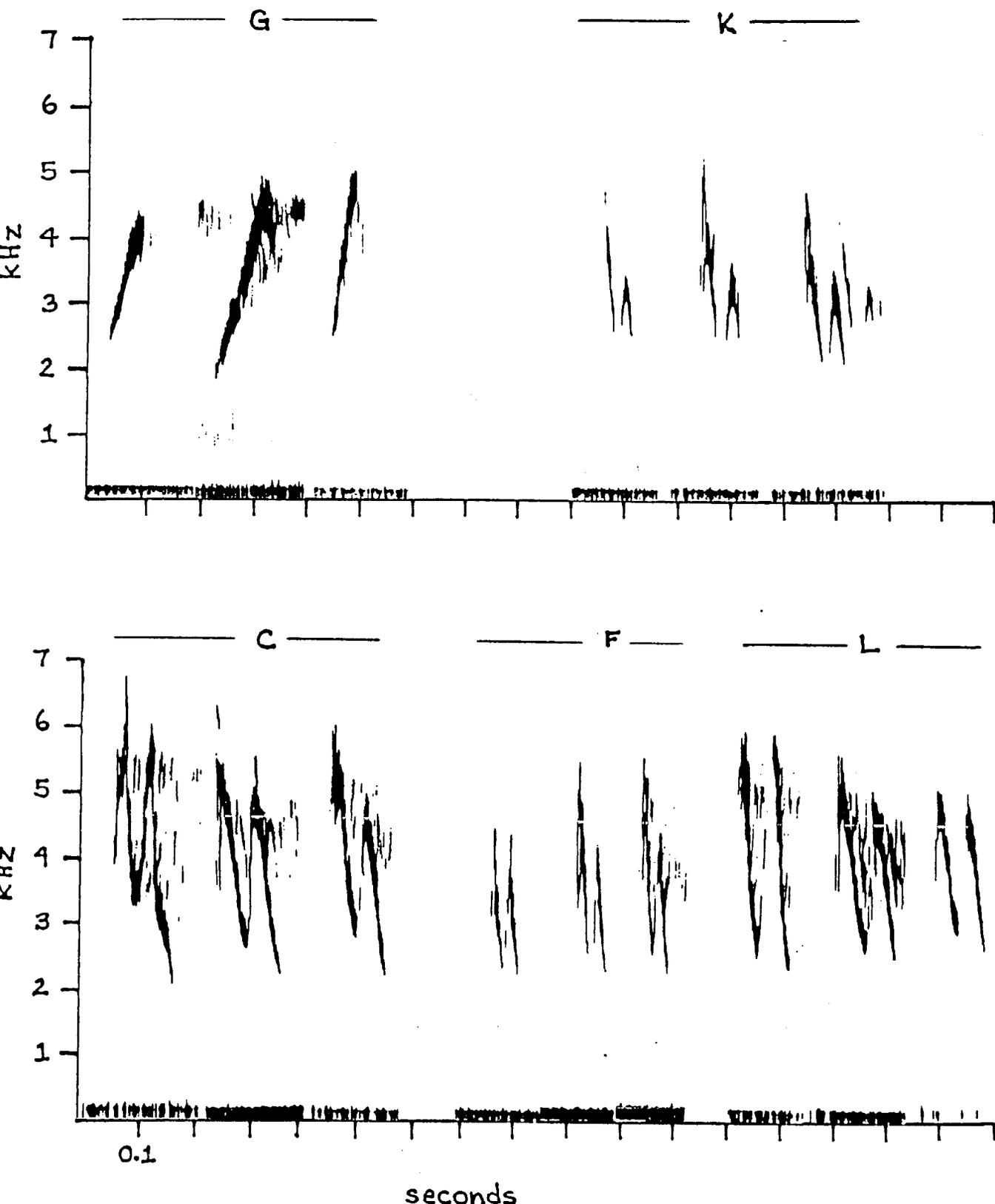


Fig. 7. Variation in syllable structure for the five most variable syllable types recorded in 1989.



Appendix I. Location, date(s) of recording, and number of songs recorded in 1989 by individual Kirtland's Warbler.

INDIVIDUAL ^a	LOCATION	DATE(S) RECORDED	# SONGS RECORDED
24 (2010-17810) RAL-GY	Bald Hill	17 May; 15 June	62
38 (2020-67054) GG-ALR	"	17,18,20,28 May 15,26 June	143
50 (2020-63039) BG-RA1	"	20 May 15,16,26 June	74
69 (2020-63047) ALY-GB	"	28 June	14
100 (2020-63072) BY-ALY	"	17,18,20,28 May 26 June	55
106 (2020-63078) RG-ALY	"	17,18,20,28 May 15,16,28 June	194
117 (2020-63089) GB-YA1	"	16 June	43
171 (2020-63144) RR-ALB	"	28 May; 16,26 June	62
205 (2020-63201) ALG-YB	"	17,18 May 15,16,26 June	122
216 (2020-63232) GA1-GY	"	20,28 May 15,26,28 June	108
218 (2020-63234) GA1-RG	"	16,26,28 June	86
219 (2020-63234) GA1-RR	"	15,16,26 June	136
BH89-1 (unbanded)	"	17,20,28 May	30
BH89-2 "	"	17,18,20,28 May	50
BH89-4 "	"	15,16 June	31
BH89-8 "	"	20 May; 16 June	57
BH89-16 "	"	28 June	29
BH89-18 "	"	28 June	14
125 (2020-63096) YB-YA1	Mack Lake	19 May; 17,27 June	37
126 (2020-63097) YG-YA1	"	17 June	4

Appendix I. (continued)

127 (2020-63005) YR-YA1	Mack Lake	19 May	18
211 (2020-63227) GA1-BR	"	27 June	1
217 (2020-63233) GA1-RB	"	27 June	37
ML89-10 (unbanded)	"	19 May	6
ML89-11	"	"	7
ML89-27	"	"	9
ML89-30	"	"	9
ML89-33	"	17 June	15
ML89-36	"	"	17
ML89-47	"	"	13
ML89-48	"	19 May, 17 June	12
ML89-64	"	19 May	3
ML89-72	"	17, 27 June	38
ML89-76	"	27 June	18
ML89-78	"	"	26
ML89-92	"	17 June	10
ML89-110	"	27 June	18
ML89-111	"	19 May	51
ML89-112	"	17 June	21
SB89-1	Stephan Bridge	18 May	8
SB89-2	"	"	3
SB89-3	"	"	13
SB89-4	"	18, 20 May	26
SB89-5	"	20 May	30
SH89-1	St. Helen	29 May	5

Appendix I. (continued)

SH89-2	(unbanded)	St. Helen	29 May	1
SH89-3	"	"	"	11
SH89-4	"	"	"	50
SH89-5	"	"	"	50

a

For banded birds, the first number is the reference number on the output that lists all color-banded birds, the number in parentheses is the U.S. Fish and Wildlife Service band number, the sequence of four letters refers to the band combination of color-banded birds (read left to right, top to bottom; RAL-GY has, on its left leg, a red (R) band over a U.S. Fish and Wildlife (Al) band and a green (G) over yellow on its right leg; B = blue. For unbanded birds, the prefix BH signifies Bald Hill, ML = Mack Lake, SB = Stephan Bridge, SH = St. Helen. 89 refers to a bird recorded in 1989 and the number following the hyphen corresponds to numbers assigned to birds by John Probst at Bald Hill or Mark Nelson at Mack Lake.

Appendix II. Location and song type by individual Kirtland's Warbler recorded in 1989 (see footnote in Appendix I for explanation of coding used to identify each individual).

INDIVIDUAL	LOCATION	SONG TYPE ^a
24	Bald Hill	2K-2L-2G
38	"	3F-3M-G
50	"	3F-2C-2G 3F-3L-2G
69	"	2K-2C-2G
100	"	3K-3C-2G
106	"	2F-2C-2G 2F-2C-2G (variant)
117	"	3F-C-2G
171	"	5K-2C-2G
205	"	3F-2C-2G
216	"	3F-2C-2G
218	"	4F-2C-2G
219	"	2K-2C-2G
BH89-1	"	2F-2C-2G
BH89-2	"	2F-2C-2G
BH89-4	"	3F-2L-2G
BH89-8	"	2P-5N
BH89-16	"	3K-2C
BH89-18	"	4F-2C-3G
125	Mack Lake	2F-2L-2G
126	"	3D-2L-2G
127	"	2K-2C-2G
211	"	2K-2L-2G
217	"	3F-2C-G

ML89-10	Mack Lake	3F-2C-G
ML89-11	"	3F-2C-2G
ML89-27	"	4K-2C-2G
ML89-30	"	3K-2C-2G
ML89-33	"	2K-2L-2G
ML89-36	"	4F-M-L-2G
ML89-47	"	2?-2C-2G
ML89-48	"	4K-2C-2G
ML89-64	"	4I-B-3E
ML89-72	"	2Q-E-3M-R
ML89-76	"	4K-2C-2G
ML89-78	"	2D-S-K-2T-S
ML89-92	"	3L-F
ML89-110	"	3K-2L-2G
ML89-111	"	4E-2C-2G 4E-2C-2G (variant) 3K-U-C-2G
ML89-112	"	3T-2C-2G
SB89-1	Stephan Bridge	2A-2B-C-D-2E
SB89-2	"	3F-C-2G
SB89-3	"	3F-C-2G
SB89-4	"	3I-3J-D-3E
SB89-5	"	3F-C-2G
SH89-1	St. Helen	3K-2E-2C-G
SH89-2	"	3K-2L-G
SH89-3	"	2F-2L-G

SH89-4	St. Helen	4K-2L-G
SH89-5	"	3K-2C-G

a
All song types of each bird recorded are listed. Letters refer to syllables illustrated in Fig. 6; the number prefix is the number of syllables of that type at that position in the song. The sequence of syllables in a song type is from left to right.