Preliminary Investigation of Vocal Variation in the Mexican Spotted Owl (Strix occidentalis lucida): Would Vocal Analysis of the Four-note Location Call be a Useful Field Tool for Individual Identification?

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Abstract.—Individual identification, especially in rare species, can provide managers with critical information about demographic processes. Traditionally, banding has been the only effective method of marking individuals. However, banding's drawbacks have led some researchers to suggest vocal analysis as an alternative. We explore this prospect for Mexican Spotted Owls (Strix occidentalis lucida) using a visual examination of the male four-note location call. While there appears to be a low level of within-individual variation, preliminary investigation suggests there is enough pattern overlap between different owls to caution against using visual examination of vocalizations as a field method to identify individuals.

Many species of birds, including some owls, have been shown to exhibit individual variation in their songs and calls (Appleby and Redpath 1997, Catchpole and Slater 1995, Falls 1982, Otter 1996). This variation suggests that owls might use vocalizations to recognize not only conspecifics, but individual neighbors (Falls 1982). If birds are using vocalizations to recognize each other, might it not be possible for humans to use the same cues to identify specific individuals? In the past, identifying individual birds has usually required banding, but if the level of inter-individual variation in a species song or call is high, it presents the possibility that vocalizations could provide an alternative method for recognizing individuals. This is especially appealing for birds which are widely dispersed and difficult to locate, like many threatened or endangered species, including the Mexican Spotted Owl (Strix occidentalis lucida).

Banding programs require properly supervised personnel who are trained in safe capture techniques. Field crews must often spend long days to locate owls at roost sites or use traps to capture owls at night, each of which demands extensive field time. For example, it has been estimated that marking individual Mexican Spotted Owls for population estimates may increase the costs of management and recovery by up to 40 percent (USDI 1995). In contrast, tape recording owl vocalizations could be relatively inexpensive and therefore cost effective. Most owl surveys already incorporate the use of broadcast calling to locate individuals, and it is currently a major census technique for the Mexican Spotted Owl (USDI 1995). This provides an opportunity for field crews to tape record owl responses as part of their standard survey procedure.

We decided to explore the feasibility of a vocal identification method for Mexican Spotted Owls using tape recordings we had collected in 1995 and 1996 as part of a larger study on vocal dialects and genetic structure. Individual identification through call type has recently been suggested for some other owl species, both informally at the agency level and in recent literature (e.g., Galeotti et al. 1993, Otter 1996). However, the accuracy and efficiency of vocal analysis as a management tool is still debatable. It was not found to be a reliable field marker in studies of Bald Eagles (Haliaetus leucocephalus) (Eakle et al. 1989). The dependability of vocal analysis may vary with the species and with the methods used for analysis (Gilbert et al. 1994).

Recorded vocalizations can be used as a tool for identifying individuals by generating a pictorial display of the call as a spectrograph. In the

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past, the generation of spectrographs required special equipment, but it is now possible to use a personal computer to create equivalent displays, not only in the lab, but also potentially in the field with a portable computer (for example with the CANARY software program produced by the Cornell Lab of Ornithology, Ithaca, NY).

Spectrographs can be analyzed either through a straightforward visual examination, or by the more time consuming technique of quantifying time and frequency variables to establish individual differences using statistical methods (e.g., Appleby and Redpath 1997, Otter 1996). Because analysis of spectrographs using time and frequency variables is much more complex and labor intensive, we believe that visual examination is at present the only efficient field technique for identifying individuals. While it may be theoretically possible to write a computer program based on quantitative statistical analysis, in a practical sense this would still be beyond the capabilities of most field projects. Our objective in this analysis was to determine if a visual examination could reliably identify individuals and/or distinguish among populations. We hope this preliminary study provides managers with some insight into the possible use of vocalizations to identify individual Spotted Owls in the field.

METHODS

We tape recorded male Mexican Spotted Owls in five mountain ranges in New Mexico during the spring and summer (breeding season) of 1995 and 1996. The male four-note location call is the most commonly heard call and the most frequently recorded (Ganey 1990). Females also give four-note location calls, but much less frequently and they do not engage in long calling bouts. Males generally give 1 to 2 four-note location calls per night. We recorded spontaneous four-note calls but, if none occurred, we then solicited calls from the males using playback. Vocalizations were recorded using a PMD 221 Marantz Recorder, a Sennheiser microphone and a 56 cm (22 inch) fiberglass parabola. Most of the owls recorded were also banded with U.S. FWS band on one leg and one color band on the other leg for individual identification. For owls that remained unbanded only one season of recording per territory was used in the analysis. We determined the sex of an owl by observing size and behavior. Males are generally smaller and have a lower frequency vocalization (see Forsman 1983). Owl calls were digitized and displayed as spectrographs using a Macintosh computer in the laboratory.

RESULTS

We examined six spectrographs each from two males (San Mateo male #29786 and Zuni male #77366) which were chosen because both were recorded on several occasions, both within and between years (figs. 1 and 2). Each set of six spectrographs included samples from three separate recording sessions, two from 1995 and one from 1996. Establishing a low level of intra-individual variation is an essential prerequisite for any method of inter-individual identification. Visual inspection shows there is a striking consistency in note shape and structure over time for both males, but there is variation in the spacing or timing of individual notes (figs. 1 and 2). The consistency of note shape and structure for these two males suggests that owls may retain an individual call type within and between seasons.

We then visually inspected spectrographs from a total of 21 male Mexican Spotted Owls to determine the feasibility of identifying individuals and/or populations by call. These included the Zuni Range in northwestern New Mexico (n = 5), the Black Range in southwestern New Mexico (n = 6), the San Mateo Range in southwestern New Mexico (n = 7), the Magdalena Range in southwestern New Mexico (n = 1), and the Jemez Mountains in north central New Mexico (n = 2). We then chose the first quality recordings of each male (n = 2-6) and examined them for unique and/or identifying characteristics. We assessed visual similarities among the spectrographs in note shape and call structure. While many calls show unique traits which might potentially serve as identifying characters, there were some calls that showed marked similarities. One of the most notable overlaps can be seen in spectrographs from two males in the adjoining Upper and Lower Hoyt Canyon territories in the Black Range (fig. 3).

We also grouped calls by mountain range. Cursory visual inspection revealed that the greatest variation in note shape and structure occurred in the third note of the four-note call. We assigned three descriptive types: type A, a single-peak note, type B, a double-peak note, and type C, an intermediate note shape. Three

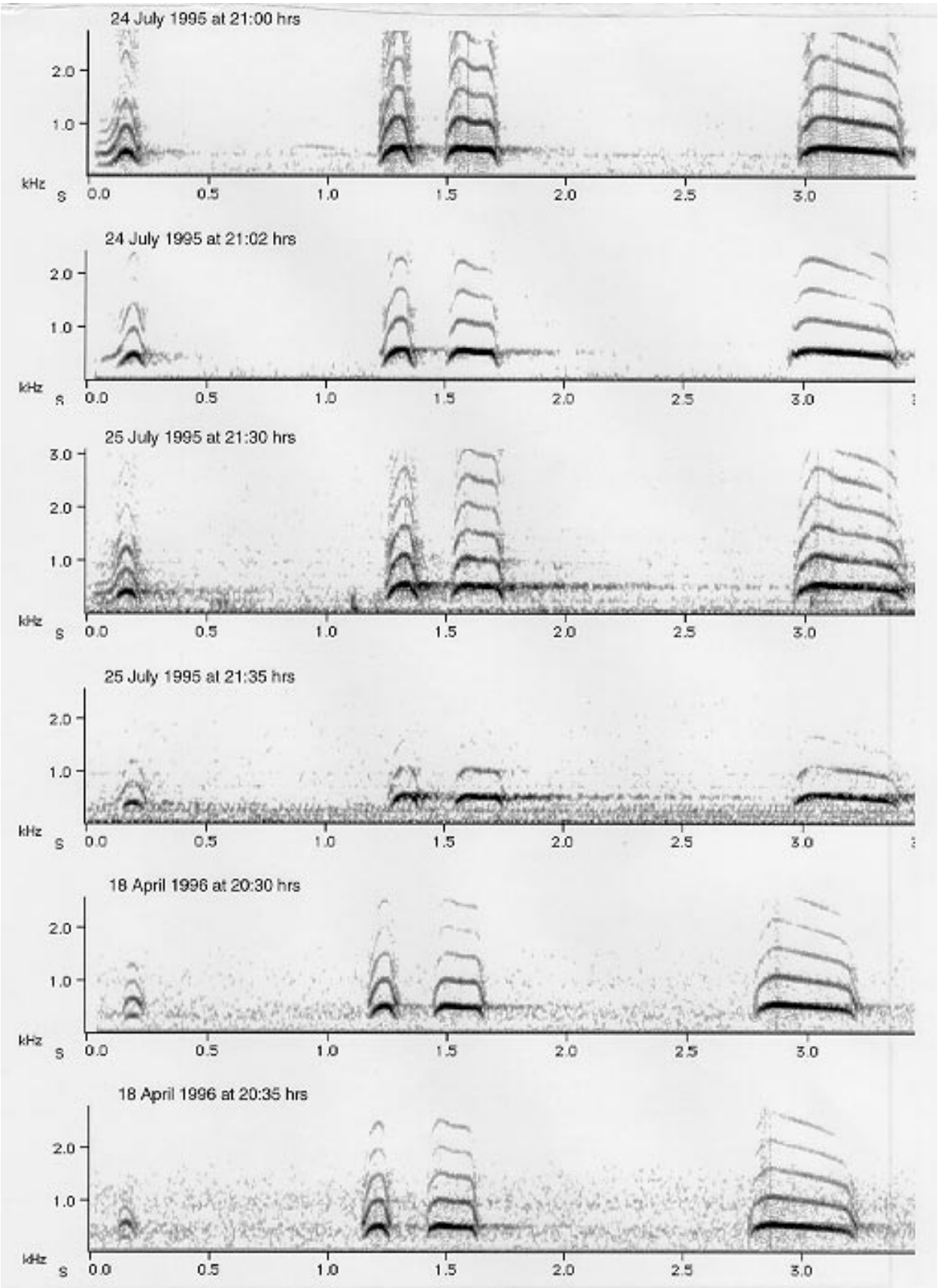

Figure 1.—Sample spectrographs from one male Mexican Spotted Owl (Strix occidentalis lucida), San Mateo #29786. Spectrographs are taken from three separate recording sessions in 1995 and 1996 in New Mexico. Time in seconds is represented on the x-axis and frequency in kHz is represented on the y-axis. Note both the consistency in note shape and structure over different recording sessions and the variation in note timing, or spacing.

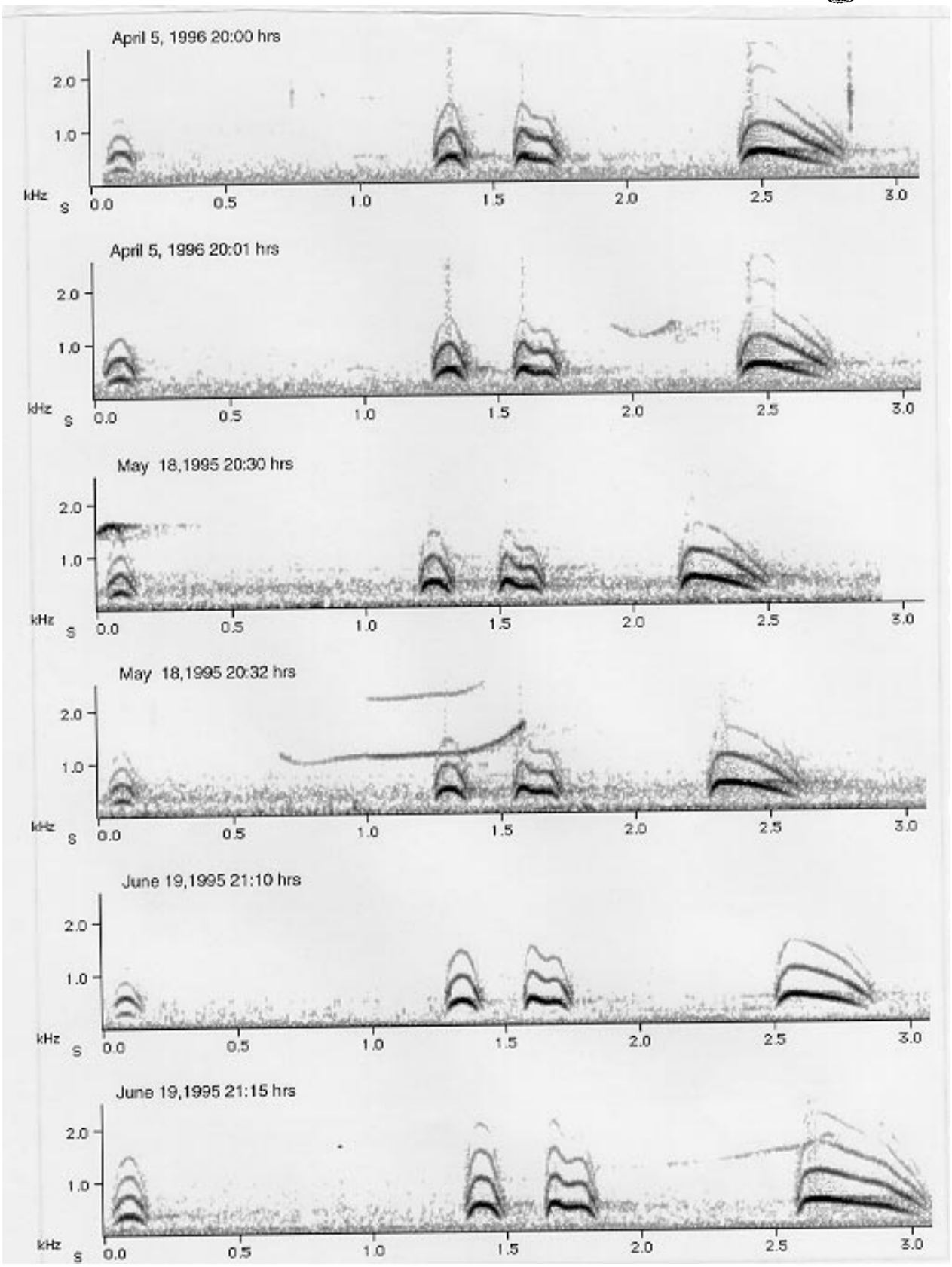

Figure 2.—Sample spectrographs from one male Mexican Spotted Owl (Strix occidentalis lucida), Zuni #77366. Spectrographs are taken from three separate recording sessions in 1995 and 1996 in New Mexico. Time in seconds is represented on the x-axis and frequency in kHz is represented on the y-axis. Note both the consistency in note shape and structure over different recording sessions and the variation in note timing, or spacing. The shape and structure of the third note is seen in the Zuni population, but not in the other mountain ranges. The long horizontal portions are overlapping whistle calls given by the mated female which was present and vocalizing at the same time.

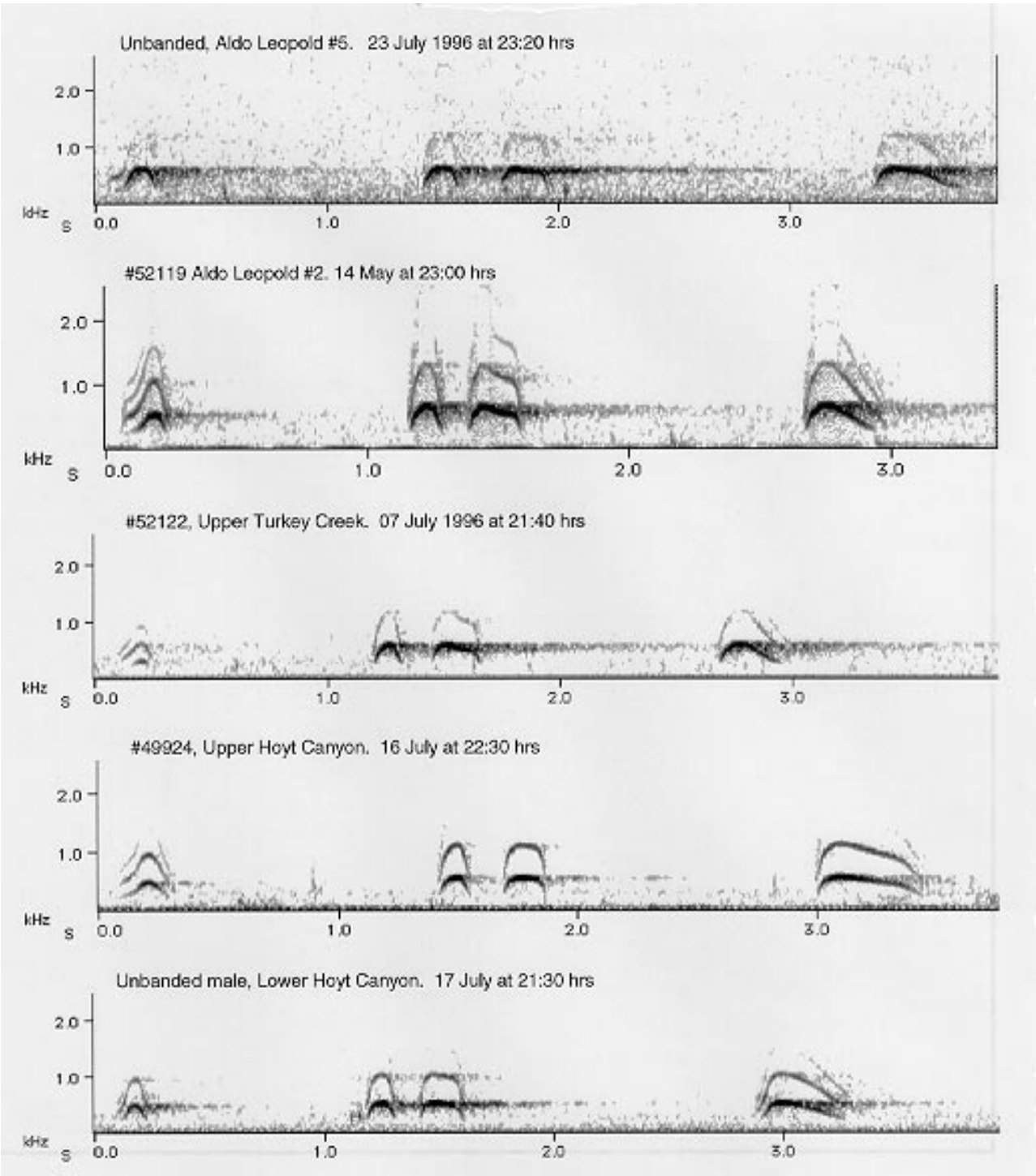

Figure 3.—Sample spectrographs from five male Mexican Spotted Owls (Strix occidentalis lucida), from the Black Range, New Mexico. One spectrograph per individual is given. Time in seconds is represented on the x-axis and frequency in kHz is represented on the y-axis. Note the similarity in note shape and structure between #49924, Upper Hoyt Canyon, and the Unbanded male from the adjacent territory, Lower Hoyt Canyon.

of the five males recorded in the Zuni Mountains possessed the type B, or double-peak note (table 1). Zuni male #77366, shown in figure 2, displays this type B structure in the third note. None of the owls in the other four mountain ranges exhibited this type of call. Males from the remaining four mountain ranges overwhelmingly possessed the type A, or single-peak note (15 of 16 observations). One intermediate, or type C note, was observed in the Black Range male #52119, Aldo Leopold #2 (shown in fig. 3) .

Table 1.—Occurrence of type A (a single-peak note), type B (a double-peak note), and type C (an intermediate note shape) from Mexican Spotted Owls (Strix occidentalis lucida) in New Mexico mountain ranges.

Range	Type A	Type B	Type C
Zuni (5)	2	3	-
Black (6)	5	-	1
San Mateo (7)	7	-	-
Magdalena (1)	1	-	-
Jemez (2)	2	-	-

DISCUSSION

For researchers working on threatened or endangered species a new, and potentially less invasive technique for identifying individuals holds great appeal. Thanks to the recent portability of personal computers, field biologists now possess the ability to rapidly digitize vocalizations and include spectrographs as part of their field tools. For this process to be an effective field method, individuals should be readily identifiable from spectrographs without lengthy and time consuming statistical analyses.

Our examination of four-note calls for two individuals (San Mateo #29786 and Zuni #77366) suggests that there was a fairly low level of intra-individual variation in note shape and structure. However, differences in the spacing or timing of notes were evident (figs. 1 and 2). This variation in timing could be a recording artifact (due to battery power or tape quality), but more likely it reflects the level of excitement of an owl at a particular recording time, resulting in a speeding up, or slowing down, of the pacing of the four-notes. Eakle et al. (1989) noted a similar problem in recordings of Bald Eagle calls and related it to changes in motivation. This suggests that individual identification of Mexican Spotted Owls by call cannot be based on spacing differences and may need to depend solely on note shape and structure.

Our preliminary examination of two male owls suggests that individuals do maintain note shape and structure over time. However, is there enough variation between birds to reliably identify individuals from a visual inspection of spectrographs? We looked at spectrographs of four-note calls from 21 male Mexican Spotted Owls and found that while some owls appear to posses unique and identifying notes, there were several individual males with strikingly similar calls. The visual similarity among some four-note calls points out a major problem for discriminating individual owls using spectrographs. It is unlikely that visual cues alone could separate all males with accuracy. Although a quantitative analysis may reveal differences between individuals, it is not likely to provide a suitable field method at least for the immediate future.

Even if individuals living in the same mountain range cannot always be identified, vocalizations may provide an index for delimiting some populations. Interestingly, the most northern and physically distant population in our sample, the Zuni Mountains, had three out of five individuals with a rare double-peak (B type) structure in the third note. This implies that there is some level of vocal divergence among populations. Since all individuals with the type B note could be categorized as part of the Zuni population, the type B note may serve as a population-specific marker . The Zuni mountain populations, however , also contained the type A note and therefore may present a transition zone between two note types. Further research on owl call shape and structure within this geographic area is needed.

CONCLUSIONS

At this time, we believe that the field utility of vocal analysis to identify individual owls depends on a method that can assess call variations using a visual examination of the spectrograph. Our preliminary investigation, however, suggests that there may be too much overlap in the calls of certain owls to reliably

identify individuals. We agree that expanded quantitative analysis could possibly illuminate differences which are not readily identifiable by eye and we are currently conducting such an analysis which utilizes time and frequency variables. In the future, computer programs may provide field crews easy access to complex analyses, but at present, for most field projects this is not a realistic option.

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