Identification of Individual Orange-crowned Warblers by Song Pattern and Territory

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Many avian studies are based upon, or benefit from, the identification of individuals. Such identification usually requires marking individuals, and color banding of legs is frequently used. Color banding allows positive identification, but the method has disadvantages. Most importantly, perhaps, sighting bands can be difficult, and at times I have required over an hour to identify the bands of an individual. Additionally, banding requires netting or trapping of subjects, and this can be difficult and time consuming. Other disadvantages of color-band identification are discussed by Saunders (1924). If reliable, a method of individual identification not requiring bands could have advantages for many studies.

Of various avian phenotypic characteristics showing individual variability, song pattern is one of the most prevalent. Even so, the extent of individual differences detectable by ear, which might be used to separate individuals, varies greatly among species (Borror, 1961; Saunders, 1924). Saunders states that two types of song pattern variation, variation among individuals and variation within individuals, can affect one's ability to separate members of a population. The more interindividual variation, and the less intraindividual variation, the easier separation becomes. In analyzing five species, Saunders found both factors varied, giving a range from two species in which separation of individuals by ear was impossible, to one species, the Field Sparrow, *Spizella pusilla*, in which such separation usually was possible. Borror (1961), Falls (1969), Hann (1937), Mayfield (1960:160), and Thompson (1970) also report success in identifying the individuals of certain species by distinctive song pattern.

Regardless of the above-mentioned work, I know of no prior study which attempts to establish a success rate for individual acoustic recognition within a population. Thus one using this technique, alone or in combination with other clues, has previously had no indication of a possible success rate. Results of studies based on the technique potentially could be flawed if the technique was not 100% reliable. I undertook the present study, in conjuction with other investigations, in an attempt to establish a success rate for individual acoustic recognition of the Orange-crowned Warbler, *Vermivora celata* Say. I used occupied territory as an additional natural identity clue.

I found *V. celata* a suitable test subject for several reasons. The species is a common spring and summer resident in mixed Central California woodlands, a persistent singer during part of its breeding season (Gilbert, unpublished data), and, perhaps most importantly, I felt that I could identify individuals by ear with relative ease.

Methods

I conducted the present study during the springs of 1983, 1984, and 1985 in Tilden Regional Park, Contra Costa County, located in central, coastal California. During the study I banded individual male *V. celata* with one U.S. Fish and Wildlife Service aluminum band and three randomly-selected color bands. I ran tests on 20 color-banded birds. The number of banded individuals in my study area varied from year to year, depending upon the number of new birds banded and the number of banded returnees. In addition to banding selected individuals, I made symbolic notation of the song patterns of all singing *V. celata* in my study area. These notations were based upon any distinctive aspect of song pattern which I could detect by ear. I frequently took subsequent notes on individual songs. I used the symbolic notations and notes in later identification of individuals.

During tests, I initially predicted the identity of a presumably banded individual, considering equally both territory and song pattern clues. I assumed that a bird occupying a given territory from day to day, and displaying the same song pattern(s), as determined from memory and field notations, was, in fact, the same individual throughout that time period. If, however, a territorial occupant's song pattern(s) appeared to change from one day to the next, or if an individual with a characteristic pattern(s) appeared to change its territory, then I considered the possibility of a new individual. I tested predictions by observing a test subject's legs with ten-power binoculars. An incorrect color band combination, or an absense of bands, meant a misidentification. I always predicted a bird's identity before sighting its legs. I made a test whenever the opportunity presented itself, but I never tested a given individual more than once a day. I derived an accuracy rate by dividing the total number of identity tests into the number of correct predictions.

Results and discussion

I summarize my results in Table 1. It became apparent to me, however, that certain conditions inherent in my tests confounded any attempt to produce a single, unequivocal value for success rate. Most importantly, using color-banded birds changed the observational situation. For example, a misidentification based on song pattern and territory could be "caught" and corrected if the bird was banded. If the bird was unbanded, however, such a misidentification could be perpetuated indefinitely. Thus a success rate derived from using color-banded birds would tend to be higher than that actually existing where song pattern and territory were the only identity clues. The success rate I determined, therefore, is probably too high. Unfortunately, I can imagine no alternative methodology which would yield a more realistic result.

Table 1. Success rates for identification of individual *V. celata* based on their distinctive song patterns and territories.

Measure	1983	1984	1985	Total
Number of identity tests	17	107	49	173
Number of positive tests	17	101	45	163
Success rate	100%	94.4%	91.8%	94.2%

In spite of these problems I can justifiably conclude that my success rate was not 100%. Also, I feel that an expectation of 100% accuracy on many subjects over an extended time would be overly optimistic, regardless of the care taken.

Certain aspects of *V. celata* behavior may have contributed to my less-than-perfect identification accuracy. Initially, although many individuals appeared to have remarkably stable song patterns over the breeding season, others seemed to change their songs. Although I have not analyzed these changes sonographically, they seemed to include adding elements onto existing song patterns, incorporating new song patterns to give repertoires of two or more songs, and abandoning old patterns for completely new ones. The vocal plasticity demonstrated by some individuals seemed to represent "song matching" with the songs of neighbors.

Song matching, as documented for many species (e.g., see Jenkins, 1977; Kroodsma, 1974; Payne, 1982, 1983), involves, in many cases, a first-year bird learning and reproducing the song pattern(s) of an established neighbor. Although individuals of some species apparently can change their established song patterns (e.g., Jenkins, 1977; Payne, 1973), more commonly initial song matching as a juvenile gives a bird its first, and perhaps only, pattern, or repertoire. Such matching, whether occurring only during an early sensitive phase, or after initial singing has developed, can result in "song neighborhoods" (Payne, 1983), where nearly all individuals within a limited area display similar vocalizations. Although not all neighboring *V. celata* I studied sang similarly, I did encounter several apparent song neighborhoods, varying from two to seven or more individuals. These neighborhoods complicated my effort to separate individuals by ear, although I usually could do so from minor differences in their singing. Occasionally, however, two neighbors were indistinguishable to my ear.

A final complicating factor in my attempts to identify individual *V. celata* by song and territory was the fact that a few individuals varied their territorial boundaries. This happened especially among early-season arrivals, which sometimes ranged over several potential territories before settling in one. Generally, however, territorial changes seemed to be less confusing than changes in song pattern.

I conclude that a technique for identifying individual *V. celata* by song pattern and territory alone may be inappropriate for studies requiring perfect or near-perfect accuracy for many individuals over an extended time. But my experience suggests that most, perhaps all, identification errors based on song and territory can be caught and corrected if one uses color banding as a back up. The two field techniques seem to have complementing strengths and weaknesses, color banding allowing more certain identification, while identification by song and territory allows easier tracking of individuals. Combining the two techniques could facilitate some long-term field studies which otherwise might be difficult or impossible.

Identification of individual *V. celata* by song and territory alone may be acceptable for studies of single-morning increment, and/or studies of just one or a few individuals. Although conclusions of this study are not strictly applicable to other species, they might guide the design of studies on species with singing behavior similar to *V. celata*.

Summary

I conducted field tests for three seasons to determine the efficacy of identifying individual Orange-crowned Warblers by song pattern and territory alone. Such a technique, if reliable, might have unique field applicability. I tested my success using the technique through backup identification with color bands. I determined that my overall accuracy was less than 100%, and concluded that an expectation of complete accuracy using these techniques would be unwarranted. I suggest, however, that combining identification by song and territory with color

banding may allow accuracy rates acceptable for some long-term studies. Also, short duration studies on a limited number of subjects might be possible using only song and territory identification. This study's results are strictly applicable only to *V. celata,* but could guide research on other species.

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(Western)

Carpal Compression as a Variable in Taking Wing Chord Measurements

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Wing chord length is a commonly taken measurement of banded birds, used (1) to separate species and sex classes of *Accipiter* hawks, (2) in combination with other measurements to separate species and sex classes of *Empidonax* flycatchers, (3) in combination with tail measurements to separate Black-capped Chickadee (*Parus atricapillus*) and Carolina Chickadee (*P. carolinensis*), among other examples (Bird-Banding Manual 1984). Wing chord data have also been used to study wing loadings and flight characteristics of birds (Greenwalt 1975).

Various sources illustrate or discuss different methods for making wing chord measurements. Roberts (1955) describes wing chord as "the distance from the bend of the wing to the tip of the longest feather across the chord of the naturally curved feather." He shows no compression of the bend of the wing in the taking of the measurement. Pettingill (1970) describes it similarly and recommends the measurement be made with dividers without any compression of the bend of the wing.

The Bird-Banding Manual (1984) describes wing chord as "the length of the closed wing in natural position from the bend to the tip of the longest primary." It is taken with a rule equipped with a right-angle end stop with the "bend of the wing firmly against the stop" and the tip of the longest primary allowed to just touch the rule without any flattening or straightening. This method produces compression of the bend of the wing. Spencer (1976) defines wing chord as the "distance of the closed wing from the foremost extremity of the carpus to the tip of the longest primary feather" using a "stopped rule." He acknowledges the existence of three chords:

Method 1—Unflattened wing = Minimum chord
Method 2—Flattened chord = Intermediate chord
Method 3—Flattened and straightened wing = Maximum chord