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ABSTRACT

The Wrentit (Chamaea fasciata) *is the quintessential and most common bird of the scrub land community of California. Wrentits are monomorphic and uniform in size and plumage, making it difficult to age. Ageing is primarily done by skull ossification and the outer iris color, which is brown in hatching-year birds, turning to maroon in after-hatching-year birds. Using paint chips for comparison, I found that determining outer iris color was difficult for banders to determine and was not a reliable method to determine age in Wrentits.*

INTRODUCTION

The Wrentit (*Chamaea fasciata*) is the only member of the family Tamaliidae in North America. It is a common resident bird of the southern California scrubland community and the most commonly banded bird at the Zuma Canyon bird banding station near Malibu outside of greater Los Angeles (Sakai 2016). Its distinctive call is often called the "Voice of the Chaparral" (Quinn and Keeley 2006).

Wrentits are monomorphic in size and plumage (males and females are similar). It is generally uniformly brown, with buffier and indistinctly streaked underparts (Geupel and Ballard 2002, Dunn and Alderfer 2006, Sibley 2014). Cloacal protuberance and brood patch are not reliable for sexing birds, as both sexes develop these characteristics. There are only a few millimeter differences in wing and tail lengths at the extremes. Thus, virtually all Wrentits are sexed "unknown" (U) in banding studies (Pyle 1997).

Regarding ageing this species, Pyle (1997) notes that juvenile and hatching-year (HY) birds are similar in plumage to adults or after-hatching-year (AHY) birds, except that they have slightly more loosely textured undertail coverts, typical of many young birds. Molt is not helpful for most birds, as both HY and AHY birds can undergo a complete molt; a small proportion of HYs can undergo an eccentric molt, retaining juvenile inner primaries and outer secondaries (Flannery and Gardali 2000, Elrod et al. 2010), and can be aged HY in fall, but individuals that underwent complete molts cannot be aged. Otherwise, the key difference (Pyle et al. 1987, Pyle 1997, Geupel and Ballard 2002) is the changing color of the outer iris. In HY birds, from Apr to Oct, the outer iris is reportedly brownish-gray to brown, sometimes with red flecking, and in AHY birds, from Sep to Aug, the outer iris is reportedly reddish brown to maroon (Pyle 1997).

This change in eye color with age is not unique to Wrentits. Other families of passerines showing eye color change with age include members of the families Cuculidae, Picidae, Vireonidae, Corvidae, Aegithalidae, Troglodytidae, Mimidae, Sturnidae, Bombycillidae, Parulidae, Emberizidae, and Cardinalidae (Pyle 1997, Garrod 2014a,b; Ramos et al 2015). This list becomes longer if one includes additional non-passerines (Pyle 2008).

Although eye color seemed straight forward enough, my banders always seem to have a problem with this characteristic. "What is brown?" "What is maroon?" Two banders looking at the same bird would have differing opinions on the color of the outer iris. A preliminary examination of the data indicated that the "wrong" iris color was present at the wrong times of the year. So I devised a test to see if the Pyle (1997) species account for Wrentits is accurate and to assess whether or not we could solve the color problem.

METHODS

This work was conducted at the Zuma Canyon bird banding station located in the Santa Monica Mountains near Malibu 34° 01′ 54″ N, 118° 48′ 44″ W outside of greater Los Angeles Zuma Canyon is in the Santa Monica Mountains National Recreation Area and is a south -facing drainage into the Pacific Ocean.

There is typically no surface water in the vicinity of the banding station and mist nets, except after heavy rains. The banding station is 1.5 km N of the ocean in the parking lot at the trail head.

Banding cycles are approximately every two weeks for this year round, constant-effort banding station. Ten to seventeen 12-m mist nets are used, depending upon personnel. Banding begins at sunrise and continues for six hours. Birds are processed approximately following the MAPS (Monitoring Avian Productivity and Survivorship) protocol (DeSante et al. 1992) More specifically, birds were aged as HY or AHY in summer and fall by skulling and other characteristics (Pyle 1997). Birds were determined to be in breeding condition based on cloacal protruberance and/or brood patch (Pyle 1997) however. presence is reliable to age as an adult bird.

I began by reworking the Tabular Pyle (Sakai and Ralph 2002) for Wrentits that I had written earlier (Sakai, unpublished) to incorporate skull ossification and eye color on the age bar graph for Wrentit. This is presented in Table 1.

The two main characteristics in ageing Wrentits are skull ossification and outer iris color (Pyle 1997). HY birds begin appearing in Apr and have incompletely ossified skulls. HY bird skulls begin ossifying in Sep. After 1 Sep, HY birds are not distinguishable from AHY birds by skull alone, if the skull is ossified; hence, all birds after 1 Sep with ossified skulls are aged Unknown (U).

HY birds begin appearing in Apr (Pyle 1997) or late Apr (Geupel and Ballard 2002) and have a brown ring around the outer iris. The brown outer irises are retained until the end of Oct. Beginning on 1 Sep, HY birds can begin to have maroon outer irises and are not distinguishable from AHY birds by outer iris color; hence, maroon outer iris color birds in Sep-Oct are aged U. In Nov-Dec, all birds should have maroon outer irises and ossified skulls and are aged U. A bird with maroon outer iris color with an incompletely ossified skull is a HY bird.

Table 1. Skull and outer iris color criteria used to age Wrentits by month using Pyle (1997).

Trait	Age	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Skull	HY				Open	Open	Open	Open	Open	Open	Open	Open	Open
	AHY	Ossified	Ossified	Ossified	Ossified	Ossified	Ossified	Ossified	Ossified				
	U									Ossified	Ossified	Ossified	Ossified
Iris	HY				Brown	Brown	Brown	Brown	Brown	Brown	Brown		
	AHY	Maroon	Maroon	Maroon	Maroon	Maroon	Maroon	Maroon	Maroon				
	U									Maroon	Maroon	Maroon	Maroon

Table 2. List of Glidden colors used to determine Wrentit eye color.

Glidden Color Code	Glidden Color Name	Glidden Color Code	Glidden Color Name
GL027	Cinnamon Stick	GLR26	Deep Coral
GL028	Sweet Tea	GLR27	Rich Raisin
GL029	Crisp Autumn Leaves	GLR28	Bold Sangria
GL030	Fresh Baked Pumpernickel	**GLR29**	**Deep Garnet***
GL031	Spiced Gingerbread	GLR30	Red Delicious
GL032	French Mustard	GLR31	Terra Cotta Rose
GLR05	Candy Apple	GLR32	Cranberry Zing
GLR06	Red Geranium		

*Color in bold was considered "maroon".

To test this outer iris color problem, I went to the paint section of my local Home Depot retailer. I randomly selected Glidden paints, and picked out color chips for the various shades of brown to maroon to reddish (see Table 2). The chips were arranged on a sheet and laminated. A Munsell soil chart has often been suggested to determine and quantify color (Wood and Wood 1972, Ramos et al. 2015); however, maroon falls outside the range of the Munsell soil chart. The bander and one other person at the station independently looked at the color of the outer iris and determined what color chip best matched the bird's outer iris color. Trial work for this study began in 2012 as the protocol was fined tuned, making sure all banders understood the protocol; therefore, results from Wrentits captured and processed from 2013-2015 are presented here.

Based on the above,

Prediction 1 From Jan-Mar, all birds are AHY birds and should have maroon outer iris color.

Prediction 2 From Apr-Aug, all birds with incompletely ossified skulls are HYbirds and should have brown outer iris color.

Prediction 3 From Apr-Sep, all birds with completely ossified skulls are AHY birds and should have maroon outer iris color.

Prediction 4 From Nov-Dec, all birds should have maroon outer iris color

Prediction 5 All recapture birds from a previous year are AHY birds and should have maroon outer iris color.

RESULTS

All birds processed are shown for each of the three years and combined. **Table 3a**

Prediction 1. The species account for Wrentit in Pyle (1997) indicates that from Jan-Mar, all birds are AHY and should have maroon outer iris color. In 38.9% of the birds, both banders determined the bird had a maroon outer iris. In 35.4% of birds, the two banders did not agree on the outer iris color (Brown/Maroon). Even if one considers these birds to have maroon outer iris color, the remaining 25.7% of the birds had brown outer iris color, contrary to expectations.

Prediction 2. All Wrentits captured in Apr-Aug recorded with an incompletely ossified skull are HY birds and should have brown outer iris color. **Table 3b** shows that 68% of these birds had brown outer iris color. Outer irises in HY birds are not reported to start becoming maroon until Sep (Pyle 1997). Some of our birds' outer irises may have turned maroon earlier (Aug) than noted by Pyle (1997).

Prediction 3. All birds captured in Apr-Aug with a completely ossified skull are AHY birds and should have maroon outer iris color. HY bird skulls do not become completely ossified until Sep. Yet only 31.4% of birds recorded with completely ossified skulls had maroon outer irises **(Table 3c)**. In fact, more birds recorded with ossified skulls had brown outer irises (42.4%).

Prediction 4. By Nov, all HY bird irises should have changed from brown to maroon. Thus, all birds (HY and AHY) in Nov-Dec should have maroon outer irises. However, we found that only 41.9% of the birds had maroon irises **(Table 3d)**. Brown outer irises were found in 36.0% of Wrentits.

Prediction 5. All recaptured birds (birds banded in a previous year) are AHY birds by definition and should have maroon outer irises. **Table 3e** shows that less than half (40.8%) of the birds had maroon outer irises.

One of the findings is the inconsistency of determining color. **Table 4** presents the percentage of birds by year, where the two banders did not agree on the outer iris color on a particular bird. In 27.3% of birds the two banders did not agree on the color of the outer iris.

There were 16 occasions in which a bird was captured and processed twice in the same morning. In only 25%

of the case was the color determination of the pair of banders the same the second time the bird was processed. There were 17 occasions in which the same bander conducted the color determination. In only 7/17 cases did the bander make the same selection the second time.

DISCUSSION

Pyle Species Account - Pyle (1997) indicates on several occasions that time determinations for reliable age and sex criteria should be considered provisional and that he welcomed others to show more accurate time determinations. Obviously, there is a certain amount of variability in the species itself. On more than one occasion, the Bird Banding Laboratory questioned my ageing of a bird, stating that the date was too early or too late for ageing the bird in question, and I had to defend my call on the bird. There are five subspecies (Pyle 1997, Geupel and Ballard 2002). Geographically, the species ranges from the Columbia River gorge down into Baja California Norte, a distance of approximately 2000 km. This is enough distance for some variability. Yet, the Bird Banding Laboratory requires banders to document ages that fall outside of Pyle's dates.

Outer Iris Color Determination - In all cases, the percentage of birds having the appropriate eye color was not close to what was expected. Even if all of the birds in which the banders could not agree on the outer iris color (brown/maroon) are included in the appropriate iris color group for each prediction, approximately a third of the birds did not match the predictions Tables3a-3e.

Table 3a. Numbers and percentages of Wrentit outer iris colors in Jan-Mar in AHY birds.

Year	Months	AHY Birds	Brown	Brown/-Maroon	Maroon*
2013	Jan-Mar	33	7	12	**14**
2014	Jan-Mar	104	26	38	**40**
2015	Jan-Mar	7	4	1	**2**
	Totals	144	37	51	**56**
	% of Total		25.70%	35.40%	**38.90%**

* Expected outer iris color in boldface.

Table 3b. Numbers and percentages of Wrentit outer iris colors in Apr-Aug for HY birds (with open skulls).

Year	Months	HY Birds	Brown	Brown/-Maroon	Maroon
2013	Apr-Aug	28	**16**	8	4
2014	Apr-Aug	2	**1**	1	0
2015	Apr-Aug	20	**17**	1	2
	Totals	50	**34**	10	6
	% of Total		**68.0%***	20.0%	12.0%

* Expected outer iris color in boldface.

Table 3c. Numbers and percentages of Wrentit outer iris colors in Apr-Aug in AHY birds (with closed skulls).

Year	Months	Skull Closed	Brown	Brown/-Maroon	Maroon*
2013	Apr-Aug	55	24	14	**17**
2014	Apr-Aug	18	5	4	**9**
2015	Apr-Aug	45	21	13	**11**
	Totals	118	50	31	**37**
	% of Total		42.4%	26.3%	**31.4%**

* Expected outer iris color in boldface.

Table 3d. Numbers and percentages of Wrentit outer iris colors in Nov-Dec (HY and AHY birds).

Year	Months	All Birds	Brown	Brown/-Maroon	Maroon*
2013	Nov-Dec	91	29	19	**43**
2014	Nov-Dec	22	11	5	**6**
2015	Nov-Dec	23	9	6	**8**
	Totals	136	49	30	**57**
	% of Total		36.0%	22.1%	**41.9%**

* Expected outer iris color in boldface.

Table 3e. Numbers and percentages of outer iris color in recaptured Wrentits banded in a previous year.

Year	All Year	All	Brown	Brown/-Maroon	Maroon*
2013	Jan -Dec	15	4	6	**5**
2014	Jan -Dec	68	19	21	**28**
2015	Jan -Dec	20	7	4	**9**
	Totals	103	30	31	**42**
	% of Total		29.1%	30.1%	**40.8%**

* Expected outer iris color in boldface.

Table 4. Number and percentage of birds that banders could not agree upon outer iris color.

Year	Number of birds processed	Number of birds which banders could not agree apon outer iris color (Brown/Maroon)	%
2013	244	62	25.4%
2014	152	52	34.2%
2015	110	24	21.8%
	506	138	27.3%

Of the five predictions, the first and the fifth are the most telling, as all birds in these two tests are known AHY birds. In predictions 2-4, the argument could be made that the bander did not determine ossification of the skull correctly. An explanation for the results of Predictions 1 and 5 may be that not all birds attain maroon outer irises by the end of Dec, retaining a brown outer iris into the SY. This could be the case in our population, where breeding starts earlier than in Wrentits breeding farther north.

One possibility is that it might be possible to micro-age birds as Second Year (SY) in Jan-Mar. It seems unlikely that all birds scored as having brown outer irises were mis-aged. It might be that some SY Wrentits might have "windows" in their skulls (Pyle indicates that some HYs in Jan can still have incompletely ossified skulls), but my banders often do not skull Wrentits early in the year. I hope to examine older adults of other species such as White-eyed Vireo (*Vireo griseus*) and Northern Mockingbird (*Mimus polyglottos*) can retain iris colors of younger birds (Pyle 1997), and such may be the case with known AHY Wrentits records with brown outer irises. The findings from Prediction 1 is not critical for ageing Wrentits as a bird bander, but they illustrate the outer iris color problem.

Other birds may never attain a distinct maroon outer iris, as I found birds as old as 13+ years that were determined to have brown outer irises. Older adults of other species such as White-eyed Vireo and Northern Mockingbird can retain iris colors of younger birds (Pyle 1997), and such may be the case with known AHY Wrentits records with brown outer irises.

A third possibility would be that there may be changes in color through the seasons. I hope to monitor this with future recaptures.

Another question might be "what is maroon?" Most of us have a fair idea of what the color maroon is. In the past, colors were given verbal descriptions. Maroon was described as chestnut, brownish crimson or claret, which are imprecise descriptions themselves, although these descriptors are used in the paint industry (see Table 1). Colors were formalized with the arrival of computers. In the early days, Apple and Microsoft apparently agreed on the basic colors using the RGB models to create uniform colors on different computer screens and televisions. Even then, looking at the color maroon on two different monitors, one can detect a difference. In another color test, I scanned the Deep Garnet (GLR29) color chip using my personal home scanner, a CanoScan LiDE 700F. I had two scanning programs available, MP Navigator EX and ArcoSoft PhotoStudio 6, and used the default settings. When I showed the two images produced by the two programs on a single monitor, there was a detectable difference in the "maroon" color.

Second, I predicted that presenting maroon in an array with other colors would help banders determine the iris color as maroon or brown. Even then, color was in the eyes of the beholder. Two banders could not agree on the iris color 27.3% of the time (Table 4). To further complicate the iris color problem, a bander could make a different color choice when presented with the same bird recaptured a second time during the same morning on more than half of the occasions. It might be noted that I did not point out ahead of time what was considered "maroon", not wanting to bias color selection. It is not clear if this helped or hindered outer iris color determination.

An anecdotal event may best illustrate the problem. I once had a group of visitors to one of my alternate banding sites. We captured and banded a Wrentit. I made sure that the bander determined the outer iris color per protocol. As I explained what and why we were doing this to our visitors, I thought it might be enlightening for the visitors try to determine the iris color. The result was that the six visitors selected six different shades of brown/maroon from the color chart.

Third, we quickly learned that lighting conditions were critical. Direct sun tended to wash out colors, while shade darkened colors. Banding days had varying

degrees of sunlight or cloudiness as well as a changing of these conditions through the banding period, so having uniform conditions would be helpful. Our station is outdoors, and we do not have access to an artificial light source. Thus, we tried to find a happy median of conducting our color evaluations in bright light but not direct sunlight. Of course, the problem here is that not all days are sunny. It would not surprise me if banders having the luxury of an indoor banding station would come up with different findings with artificial lighting, with further differences based on the light source (incandescent, fluorescent, LED, CFL or even a flashlight). I suggest that banders score iris color in uniformly shaded but well-lit, outdoor lighting conditions, as these conditions will be present on both sunny and cloudy days. Additionally, as the study progressed, banders pointed out that the brown or maroon was not uniform over the entire outer iris. Some areas of the outer iris seemed to be "more brown" or "more maroon". This was especially evident if one used an optivisor.

Another aspect of the brown vs maroon outer iris color is that this color change is not instantaneous but gradual. Garrod (2014a,b) in studying eye chroma presented early work showing that there is a gradual change in eye color in seven species of passerines. Preliminary findings (Garrod 2014a,b) show a fairly distinct difference between HY and AHY birds, but there is a gradient of color indicating quite an overlap between HY and AHY birds. This is likely the case in other species whose eye color changes with age including White-eyed Vireos, Mockingbirds, and probably Wrentits.It may be that we are catching birds changing from brown to maroon and this may be confusing to banders. It may be that birds with intermediate eye colors cannot be aged.

Last, skulling is not easy for a bander to master. Skulling errors may occur as often as determining outer iris color. Older adults of other species such as White-eyed Vireo and Northern Mockingbird can retain iris colors of younger birds (Pyle 1997), and such may be the case with known AHY Wrentits records with brown outer irises. During the months when HY bird skulls start to close (Sep-Oct), both HY and AHY birds are undergoing a complete molt. Invariably, the head is in a heavy molt, making it quite difficult to skull birds. This is also the time during which the outer iris color is changing from brown to maroon.

I began trying to track down the origins on the Wrentit outer iris color issue. I could not find any peer-review literature on this subject. Geupel and Ballard (2002) mentions this characteristic in the *Birds of North America*. Pyle mentions it in both his 1997 identification guide as well as its predecessor (Pyle et al. 1987). Pyle (pers. comm.) indicated that this characteristic came from Point Blue Conservation Science (formerly Point Reyes Bird Observatory). Checking, I found that although this characteristic has long been used at Point Blue, it was never published in a peer-reviewed journal (D. Humple, pers. comm.). G. Geupel (pers. comm.) at Point Blue, indicated the use of this characteristic dates back to the 1980s.

RECOMMENDATIONS

Considering the problems determining outer iris color, it should not be the primary method to ageWrentits. Rather, age in Wrentits should be determined by skull ossification.

- Birds can be aged AHY if cloacal protruberance or Brood Patch is present.

- Birds in Jan-Mar are by definition AHY birds and should have completely ossified skulls and maroon outer irises. Efforts should be made to determine if birds can be micro-aged. Wrentits with brown outer irises and/or incompletely ossified skulls (windows) during this time would be SY birds.

- The outer iris color of recaptured birds banded in a prior year are AHY birds by definition. These birds should be checked and tracked to determine if there is some seasonal color change.

- Older adults of other species such as White-eyed Vireo and Northern Mockingbird can retain iris colors of younger birds (Pyle 1997), and such may be the case with known AHY Wrentits records with brown outer irises.

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Wrentit at nest
by George West