BIRD'S-EYE VIEW EDUCATION PROGRAM: MOLT FOCUS REPORT

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Abstract. Bird age can be determined by a variety of phenotypic characteristics. Skull ossification and feather molt can help determine age in most birds, but factors such as feather wear, degree of body molt, time of year, and variation in molt strategies can make ageing birds difficult in many cases. Ageing birds requires an advanced level of training, as well as great attention to detail. Below, we provide pictures of how we determine age in birds that we capture at our songbird banding stations at the MPG Ranch.

Introduction

Individual age and sex information are the two most critical pieces of data collected on birds at passive-effort mist-netting stations (DeSante et al 2015). A wealth of demographic information can be generated from these data, including estimates of productivity and survivorship (DeSante et al 2015, Ralph et al 1993). Techniques such as assessing a bird's degree of skull ossification and other non-plumage related characteristics can be reliable methods for determining age. However, they are not useful in the early part of the breeding season; differences in feather shape, quality, and patterns of replacement during the annual cycle allow for micro-ageing at this time of the year. An understanding of life history strategies and molt strategy, as well as a highly trained eye, all contribute to accurate age classifications.

Molt and Life History

Feathers are structures unique to birds that function in many ways, including flight, thermal insulation, and sexual selection. Maintaining functional feathers is essential. Birds must replace feathers as they degrade over time. The most common causes of feather wear are exposure to sunlight and physical abrasion they encounter while moving through habitat (Howell 2010).

Molt is the process through which birds grow new feathers. North American banders follow the revised Humphrey-Parkes (HP) molt classification system. Developed in the late 1950's, the HP system divorces the study of molt from the superficial appearance of the bird (Humphrey & Parkes 1959, Howell et al 2003). This separation allows a more thorough groundwork for the study of molt in an evolutionary context. In the HP system, plumages are labeled by the molt that preceded it (Table 1). The most relevant age codes to ageing passerines are compiled in Table 2. Following codes laid out by the Canadian Wildlife Service and the Bird Banding Laboratory, age classes at banding stations are assigned based on a calendar-year system (Pyle 1997). It is important to note that North American banders recognize every bird's birthday as 01 January.

Table 1. Important molt terms.

Molt term	Description	Resulting Plumage
Molt limit	The presence of more than one generation of feathers, within and/or between feather tracts.	N/A
Pre-juvenal molt	Occurs in nest. Only time in a bird's life it will grow all flight feathers simultaneously.	Juvenal Plumage
Pre-formative molt	Another molt undergone by many hatch-year birds following the pre-juvenal molt. Typically involves the replacement of only a portion of a birds feathers. Often results in molt limits.	Formative Plumage
Pre-basic molt	Occurs in after-hatch-year birds. Involves replacement of all feathers, including systematic replacement of flight feathers.	Basic Plumage
Pre-alternate molt	Occurs in many species of North American passerines. Extent of feather replacement varies widely between species, but often a bird grows brighter feathers before the breeding season.	Alternate (or Mixed Alternate-Basic) Plumage

Table 2. Age-class descriptions.

Age	Definition
Hatch Year (HY)	A bird born in the current calendar year
Second Year (SY)	A bird born in the previous calendar year
After Hatch Year (AHY)	A bird born in at least the previous calendar year
After Second Year (ASY)	A bird born at least two previous calendar years ago.

Contrary to our colloquial usage of the word 'nest' to describe a safe, homey place, actual bird's nests are extremely risky places. There is selective pressure on young passerines to leave the nest as quickly as possible. When nestlings undergo pre-juvenal molt, it is the only time in a bird's life it will grow all of its flight feathers simultaneously. The energetic demands required to grow feathers, coupled with the pressure to reach fledging stage, result in feathers poorer in quality than their adult counterparts. Thus, there are detectable differences between feathers grown during the pre-juvenal molt and feathers grown during subsequent molts. Juvenile feathers are characterized by a lower barb-density, a more tapered shape, the presence of growth bars, and, oftentimes, less vibrant and extensive coloration (Howell 2010).

Most after-hatch-year passerines in North America undergo a complete replacement of their feathers once a year, including a systematic replacement of their flight feathers. This complete replacement of feathers is called the pre-basic molt (Figure 1). Because the systematic replacement of flight feathers does not occur in hatch-year birds, evidence of the pre-basic molt can assist in separating after-hatch-year birds from hatch-year birds. Passerines will go through this complete replacement of feathers (pre-basic molt) at the same time each year for the rest of their lives. This is why most passerines cannot be aged beyond the AHY/ASY age class; the plumage cues we use to age birds will be the same every year starting from their second fall, or the pre-basic molt that occurs during their second year. Most migratory songbirds undergo their pre-basic molts between the breeding season and fall migration. Hatch-year birds of many species, relatively fresh off their juvenal molt, will also replace some feathers during this period. This 'extra' molt inserted in the cycle is called the pre-formative molt. This molt typically involves most to all body feathers, some to all wing coverts, but rarely does it include replacement of flight feathers. The presence of multiple generations of feathers, both within and between tracts, is termed a molt limit (Pyle 1997). The presence and absence of molt limits is the most useful tool for ageing birds during most of the summer breeding season.

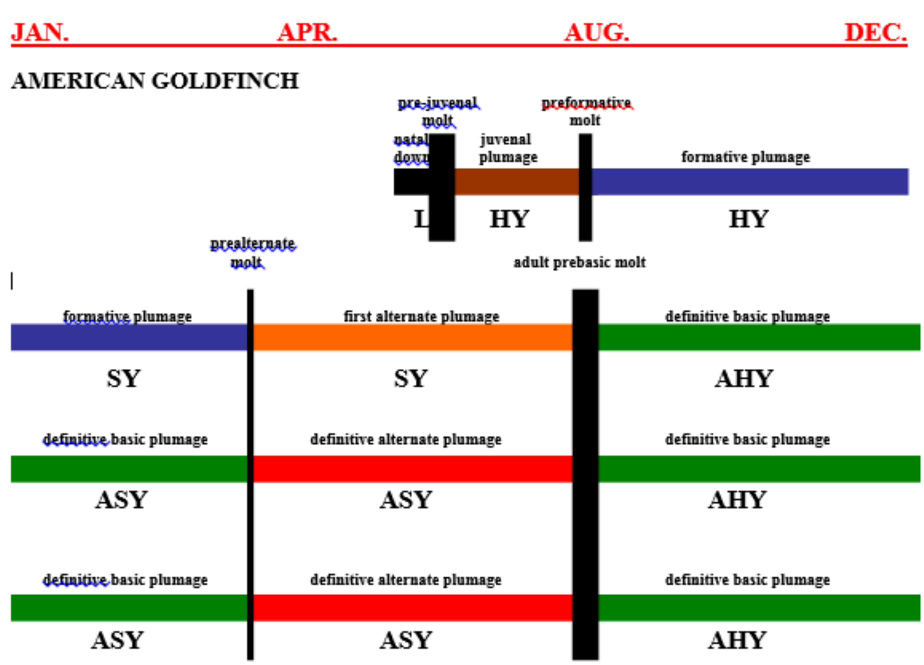
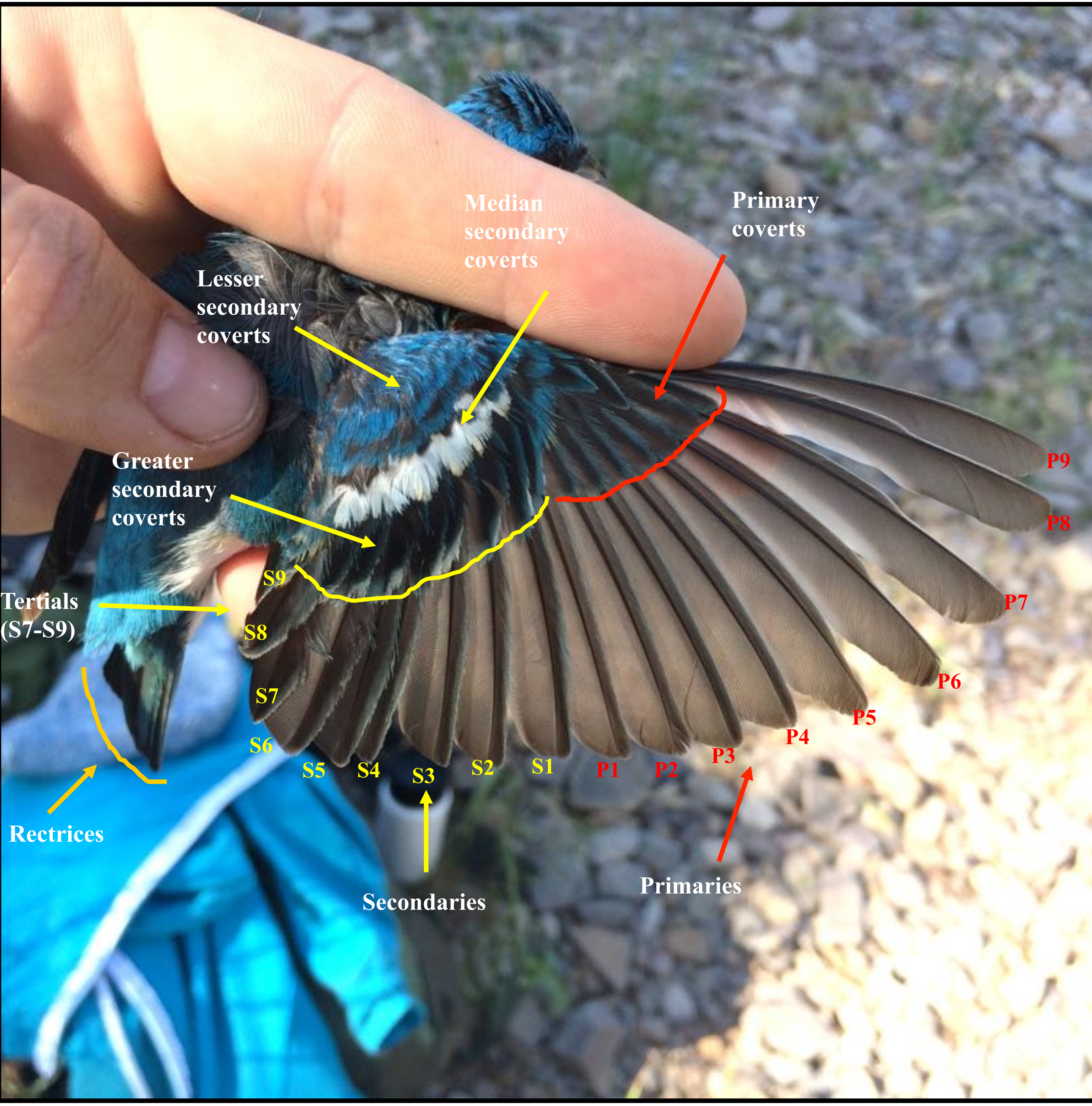


Figure 1. A typical passerine molt cycle.



Here is an open wing of a Lazuli Bunting, with its feather tracts and individual flight feathers labeled.

The tail of this second-year Black-headed Grosbeak, photographed on 8/21/15, is an excellent example of why feather replacement is necessary. Note the chips and nicks along the tips and sides of the feathers. One of the central rectrices is worn down almost totally to its shaft. These feathers were grown during the pre-juvenal molt, and are over a year old in this photograph. This bird will soon undergo its pre-basic molt.

Occasionally, we can age birds without looking at any feathers. Assessing a bird's level of skull ossification is the most reliable technique, but some species have other diagnostic characteristics. For example, the lower mandible of young Yellow Warblers is a fleshy color (top), which transitions to the darker color seen in the Yellow Warbler on the bottom.

This hatch-year Gray Catbird, photographed on 8/12/15, is undergoing its pre-formative molt. The undertail coverts in the yellow circle were grown during its pre-juvenal molt. The feathers in the red circle are its incoming formative feathers. This is a great example of the textural differences between juvenile feathers and feathers grown during subsequent molts. The incoming feathers are richer in color, with a much higher barb density.

The undertail coverts of this hatch-year House Wren, photographed on 7/1/15, are an excellent example of feather texture and coloration we see only in juvenile birds. The feathers are loosely barbed and we are able to easily count individual barbs with the naked eye. This House Wren will lose these feathers during its pre-formative molt which takes place the fall following the summer they hatch (Figure 1). House Wrens will replace the pictured undertail coverts with feathers that have a higher barb density, lighter color, and a more complex barred pattern.

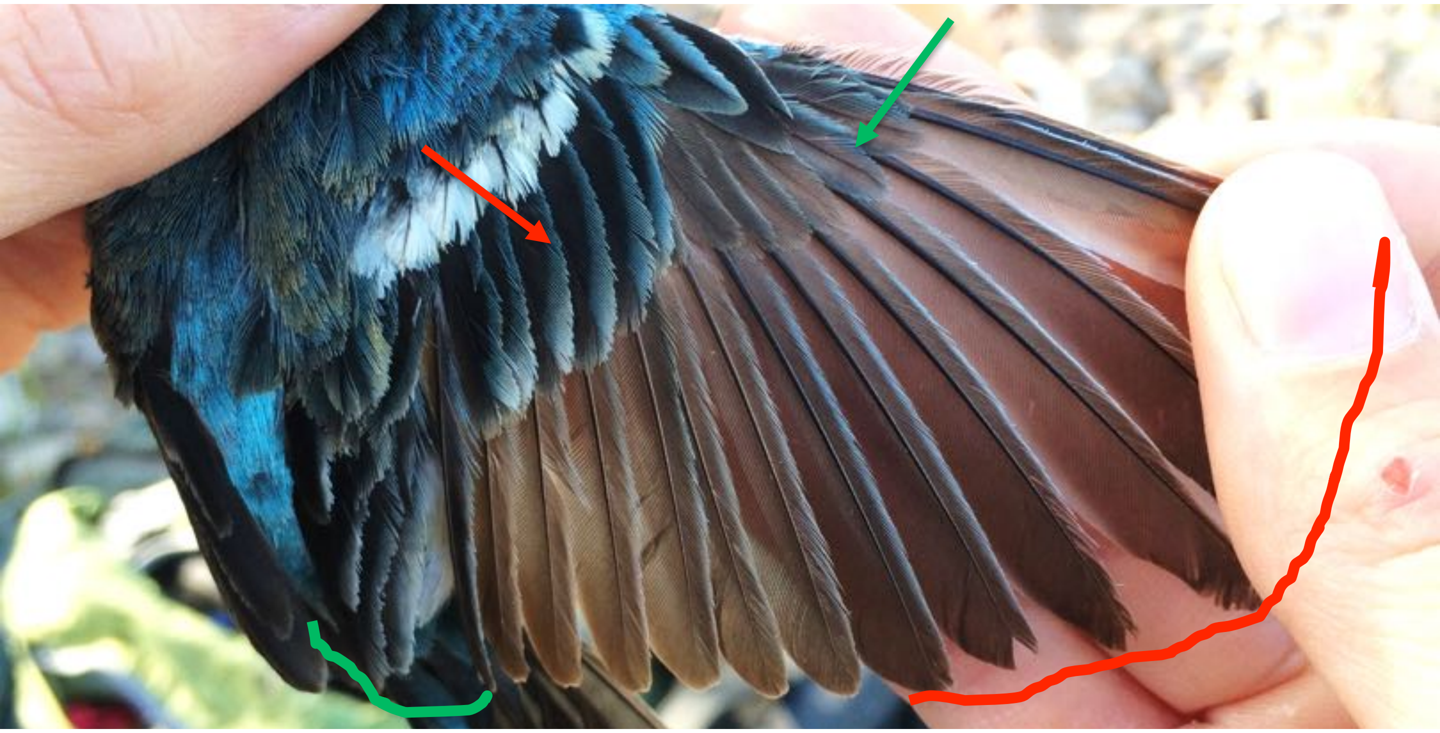
For some species, we can use the shape of the outer rectrices to determine age. The American Robin on the left has a broad, wide, and square rectrix (green line), indicating an after hatch year bird. The American Robin on the right has a pointed and tapered outer rectrix (yellow line), indicating a hatch year bird.

These two Yellow Warblers, photographed in August 2013, are of different age classes. The bird pictured on top is undergoing its adult pre-basic molt. Because it is systematically and symmetrically replacing each of its flight feathers, we know the bird is at least an after-hatch-year bird (second year or older). The bird pictured on the bottom is a hatch-year. Compare the intensity of the yellow edging of the greater coverts and primary coverts between the two birds. The hatch-year bird's edging (black bracket) is noticeably duller than the after-hatch-year's (red bracket).

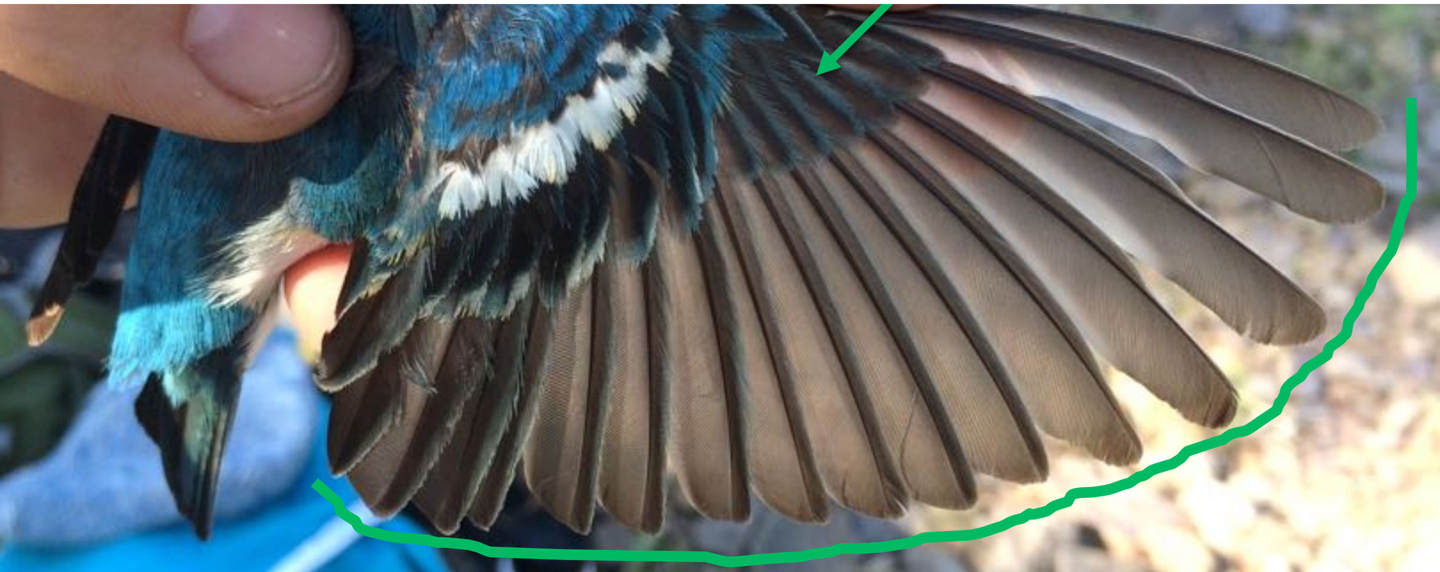
We can see clear plumage differences in a second-year (top) and after-second-year (bottom) Western Tanager captured on 6/1/15. The second year bird grew its primary coverts (yellow arrows), primaries (green arrows), and the majority of its secondaries (purple arrow) during its pre-juvenal molt. Note the difference between the second-year bird's primary coverts and the after-second-year bird's below it. The second-year bird's coverts are a duller color, show more wear, and are slightly more diminutive and less rounded at the tips. Also note the contrast between the second-year bird's primary coverts and its greater coverts (red arrow).

Molt limits are often more subtle than those shown in the second-year Western Tanager from the previous slide. This second-year Gray Catbird, photographed on 6/1/15, has a molt limit in the greater coverts. The green line marks the boundary between feathers grown during the pre-formative molt on the left (red arrow), and feathers grown during the pre-juvenal molt on the right (yellow arrow). Note the more tattered and loosely-textured juvenile feathers. They also have cinnamon edging which is absent in the fresher, more densely barbed formative feathers.

This second-year Lazuli Bunting, photographed on 6/23/15, has an eccentric pattern of flight feather replacement. The molt strategy of the Lazuli Bunting is different from most other species. Lazuli Buntings are 'molt migrants', meaning they migrate to an area distinct from their breeding and wintering grounds to undergo molt each fall (Greene et al. 2014). This bird replaced its greater coverts (red arrow), outer two primary coverts (green arrow), primaries 3-9 (red line), and secondaries 5-9 (green line) during its pre-formative molt. There is a stark contrast between the replaced and retained flight feathers in terms of degree of weather, brightness of the blue leading edge, overall color, and the color of the shafts of the feather. From this information, we were able to age this Lazuli Bunting a second year bird.



Here is an after-second-year Lazuli Bunting, also photographed on 6/23/15, to compare to the second-year bird above. Note the uniform primary coverts (green arrow) and flight feathers (green line), which were all grown in during the adult prebasic molt. All feathers are basic feathers, making this bird an after-second-year bird.



Woodpeckers have more complex molt patterns than most passerines. In contrast to songbirds, woodpeckers do not reach a definitive plumage in their second fall. As a result, banders are able to micro-age woodpeckers to a more precise degree than passerines. For example, this Red-naped Sapsucker, photographed on 6/15/15, was aged as a third-year bird. The inner five primary coverts have been retained since its pre-juvenal molt (yellow arrow). The outer two primary coverts were replaced during its pre-basic molt the previous year

Conclusion

In contrast to other survey techniques, catching and banding birds give us the opportunity to learn about population demographics. We can ask questions about factors influencing survival, reproduction, and response to change. Accurate ageing of birds generates more robust data and, thus, provides more precise estimates of vital rates (productivity, survival, and population changes). When combined with natural history information of each species, this information can enhance the effectiveness of conservation activities, as well as our overall understanding of avian population dynamics.

On the MPG Ranch, we use age ratios of adults and young birds to determine productivity estimates for our most frequently captured species and compared those estimates to productivity at the N. American scale (Table 3). This year we found House Wrens and Yellow Warblers had a very high proportion of juveniles. Although it cannot be explained in a single year, the conditions for breeding appeared to be very good on the floodplain. From 2011 to 2014, the RI value on the MPG Ranch varied (0.37 to 0.59 for House Wrens, 0.33 to 0.91 for Yellow Warblers) and some of this variation can be attributed to annual variation. However, increases in the RI value could also indicate better site condition. Continuing to operate a bird banding station in the long-term will allow us to detect changes over time as the restoration process takes place and as the bird community evolves with those changes.

Table 3. Age classifications and reproductive indices of the top 5 species captured at MPG Ranch during the summer of 2015. HY = Hatch Year, SY = Second Year, AHY = After Hatch Year, ASY = After Second Year, MPG RI = Reproductive Index for MPG Ranch birds, N.A. RI = mean Reproductive Index for N. American birds (1992-2006).

	Age						
Species	**HY**	**SY**	**AHY**	**ASY**	**Unk. Age**	**MPG RI**	**N.A. RI**
House Wren	65	0	40	0	7	1.625	0.664
Gray Catbird	15	11	16	15	0	0.357	0.316
Yellow Warbler	18	5	6	3	2	1.286	0.282
Cedar Waxwing	5	7	19	0	0	0.192	0.022
Lazuli Bunting	2	12	5	2	0	0.105	0.158

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