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MAPS Chat

An occasional newsletter of the Monitoring Avian Productivity and Survivorship (MAPS) program

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Connecting Wintering and Breeding Sites of Migratory Songbirds Using New Isotopic and Genetic Methods

Kristen Ruegg, Ph.D.,
UCLA, Center for Tropical Research

Scientists and birdwatchers alike have noted precipitous population declines in many species of migratory songbirds during the last thirty years. However, the transitory nature of migratory birds makes it difficult to pinpoint the exact cause of these declines. Some postulate that habitat loss on the tropical wintering grounds is the cause, while others suggest that forest degradation on the temperate breeding grounds may be negatively influencing reproductive success. Songbirds are also undoubtedly affected by disturbances along the migratory pathway. Without the ability to relate specific breeding and wintering populations and their associated migratory routes, developing effective management strategies remains a challenge. Historically, efforts to correlate breeding, wintering, and migratory populations have relied on large-scale banding programs. However, recapture of banded birds, especially on their wintering grounds, is rare.

At UCLA's Center for Tropical Research (CTR), we have been developing an alternative method for tracking migratory movements of birds that eliminates the need for recapturing banded birds. Our team includes a combination of empirical scientists, statisticians, and on-the-ground field biologists from UCLA, UC Santa Cruz, The Institute for Bird Populations and the University of Oklahoma. Together, we have been developing molecular tags that use genetic and isotopic information from a single feather to track where an individual was born and where it molted its feathers. As a result, a feather collected at one stage of the migratory cycle can be used to make essential links between where the bird may be going and from where it came. The tools we are developing can be used to help inform conservation decisions in the face of climate change, increased habitat loss, avian diseases, and other anthropogenic stressors.

Feather Collection

We want to take this opportunity to thank all of you who have contributed to the feather collections over the years for your contributions to this project. Without your support a project of this magnitude would not be possible. In efforts to connect populations of migratory

Also in this issue:

bird using biological tags, CTR has worked closely with many of you at MAPS banding stations as well as banders that are part of the Landbird Monitoring Network of the Americas (LaMNA) program, and the Monitoreo de Sobrevivencia Invernal (MoSI) program. Our contributors operate bird-banding stations during wintering, breeding, and migratory periods across North, Central and South America. At each location, field researchers capture birds in mistnets, pull two rectrices (one inner and one outer from the opposite side of the tail), then release the birds. The feathers are placed in small manila envelopes and shipped to CTR where they are curated, cataloged and preserved for future use.As a result of your efforts we have built a collection of more than 150,000 feathers from across the breeding wintering and migratory range of many species of migratory birds. The collection represents an invaluable, irreplaceable source of information about migratory birds that can be utilized to address important biological questions now and for years to come.

While our main project has been to uncover patterns of migratory connectivity, there are other valuable sources of information that can be extracted from feather samples. For example, nitrogen and carbon isotope ratios can give an indication of trophic level consumption. We are currently exploring the possibility that trophic level consumption may shift with fluctuations in climate and food availability in four species of passerine, that breed in the Pacific Northwest: Pine Siskin, Swainson's Thrush, Wilson's Warbler, and MacGillivray's Warbler. This project has been made possible by the availability of feathers from several MAPS stations in the Pacific Northwest for which we have samples that span a 15-year time period. The results are still preliminary, but some data suggests that adult Wilson's Warblers may eat higher on the food chain in years with greater insect abundance. This could, in turn, influence productivity and survivorship.

"... a feather collected at one stage of the migratory cycle can be used to make essential links between where the bird may be going and from where it came."

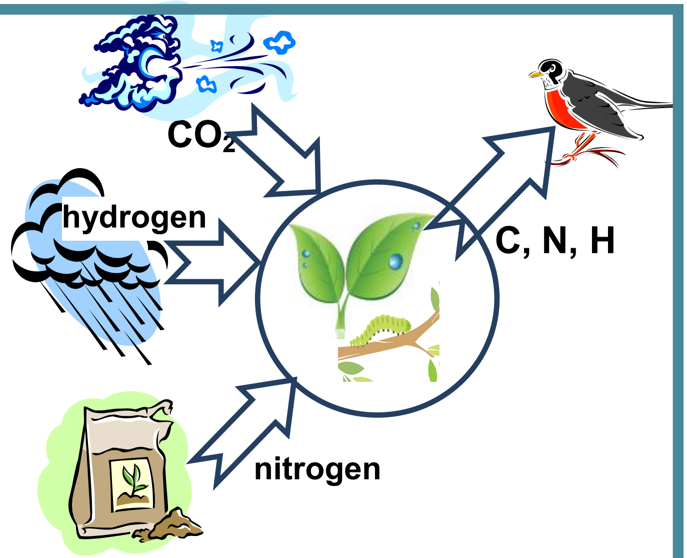
MacGillivray's Warbler.

Wilson's Warbler.

Development of Isotopic and Genetic Markers for Connectivity

Until recently, the spatial scale for identifying where particular breeding populations spend the non-breeding season using biological tags was too coarse to detect drivers of local population dynamics. However, our team has been leveraging recent advances in genetic and isotopic analysis and we are now capable of defining where migratory birds winter and breed at a much finer spatial resolution. The implementation of isotopic methods, led by Associate Professor Jeffrey Kelly at the University of Oklahoma, consists of quantifying the ratio of different forms of hydrogen in a feather that vary predictably with geography. As a result, each feather will have a distinct isotopic signature that provides information about where the feather was molted. Isotopic methods have been employed with increasing frequency in the last decade, but thus far provide only course scale resolution of migratory connections.

Alternatively, genetic methods identify the breeding location of a particular individual using population-specific genetic signatures. By utilizing genome-wide DNA sequencing techniques, we recently sequenced over one hundred thousand genetic regions from two target taxa, Swainson's Thrush and Wilson's Warbler. Currently, Dr. Kristen Ruegg,



Atmospheric carbon (C), hydrogen from water (H), and nitrogen (N) from the soil are incorporated by plants and insects which are then eaten by birds. These elements then become part of the bird and give the feathers their isotopic signature.

a Senior Research Fellow at the Center for Tropical Research, and Dr. Eric Anderson of UC Santa Cruz are analyzing these data to identify population-specific genetic markers. While the analyses are still preliminary, the results look very promising, suggesting thousands of population-specific markers exist for identifying breeding origins of birds. The great advantage of the population specific genetic markers that we are currently developing is that once the markers have been discovered, thousands of individuals can be screened at many population-specific loci rapidly and at relatively low cost. Thus, we envision being able to screen the majority of samples from within our current collection as well as any additional samples sent to us by individuals at bird banding stations.

Development of Novel Statistical Techniques

When birds molt on the breeding grounds, the genetic and isotopic signatures yield two independent sources of information about breeding origins. Previously, there was no way to combine these two sources of information about breeding origins into a single analytical framework. However, recent statistical advances by two of our collaborators, UCLA Assistant Professor John Novembre and his graduate student Colin Rundel, have yielded important new results. The most recent data indicate that when genetic and isotopic data are combined, we can identify breeding origins of birds with greater resolution than when using either method independently (Figure 1).

The novel statistical techniques we have developed, combined with the genome wide data we are currently generating, provide a powerful method for identifying migratory connections. In the future we hope to expand the development of molecular tags to other species of concern. The resulting information on migratory connections can be used to help address current challenges facing migratory birds such as climate change, the spread of avian disease, and the population specific effects of collisions with wind turbines and cell phone towers.●

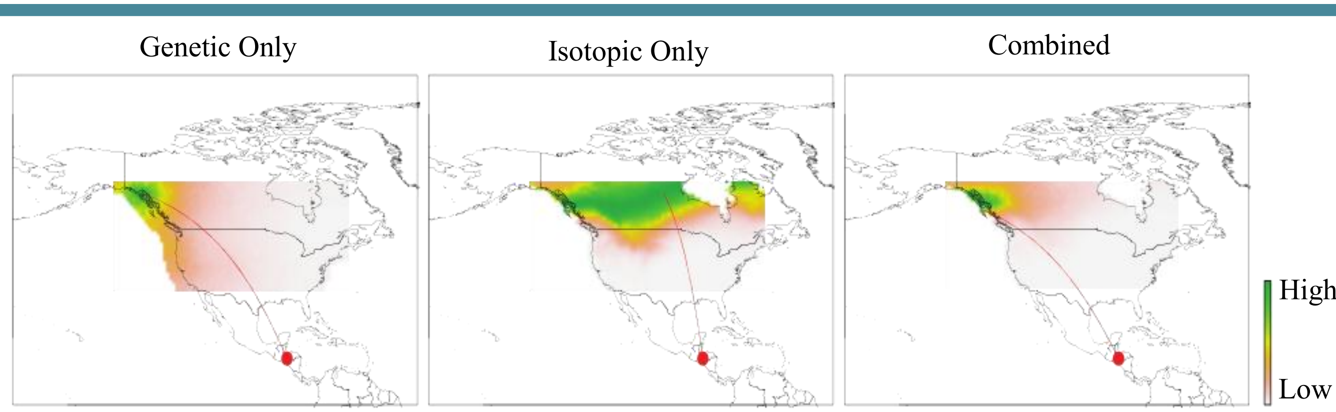
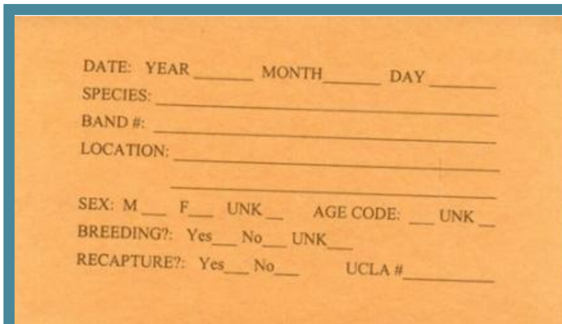


Figure 1. Biological Tags Provide a Powerful Method for Identifying Populations
This figure depicts the power of combining genetic and isotopic data into a single analytical framework. The red dot (●) indicates the wintering location where the feather was sampled, while the green shaded areas indicate the predicted breeding location. The greatest resolution of breeding populations is attained when genetic and isotopic data are combined.

Feather Growth Rate and Molt Duration in North American Passerines as a Function of Migration and Molting Strategies

Dave DeSante, IBP and MAPS Founder

If you are like most MAPS contributors, you've probably wondered what becomes of those tail feathers that you so meticulously pluck from select species, place in small envelopes on which you record the date, location, species, age, sex, and band number of the individual from which it was taken, and send off to the Center for Tropical Research at UCLA. The lead article by Kristen Ruegg in this issue of MAPS Chat provides part of the answer to that question, perhaps a part about which you already had some idea – that the feathers would be used to help establish migratory connectivity for the target species, that is, to help connect the breeding and wintering locations of various populations of some of our best loved Nearctic-Neotropical migratory landbirds. But as Kristen points out in her article, UCLA researchers and colleagues are using the feathers to provide other new and interesting information as well, such as an indication of the trophic level consumption of the individual from which the feather was taken.


DATE: YEAR ______ MONTH ______ DAY ______
SPECIES: ______
BAND #: ______
LOCATION: ______

SEX: M __ F __ UNK __ AGE CODE: __ UNK __
BREEDING?: Yes __ No __ UNK __
RECAPTURE?: Yes __ No __ UCLA # ______

Feather pull envelope provided by UCLA.

Another very creative use of the feathers was recently developed and described by Ivan de la Hera of the Netherlands Institute of Ecology and the University del Pais Vasco, Spain, in conjunction with Borja Mila of the National Museum of Natural Sciences, Spain, and David F. DeSante of The Institute for Bird Populations, and is scheduled to be published in the April 2012 issue of *The Auk*. In this study, Ivan measured the growth rate of tail feathers taken from 589 individuals belonging to 98 species of North American passerines by means of ptilochronology. This technique is based on the presence of "growth bars," a pattern of alternating dark and light bands on each feather perpendicular to the rachis (shaft), where one dark band (produced during the day) plus one light band (produced during the night) corresponds to one day of feather growth. Ivan placed the feathers on a black card and marked the length of the feather occupied by 10 growth bars using two


Growth bars on tail of Carolina Chickadee.

entomological pins. After removing the feather from the card, Ivan measured the distance between the pins to 0.01 mm with a digital caliper. This length, the length of feather synthesized in 10 days, was defined as the feather growth rate. Ivan also measured the mass of the feather (to 0.1 mg using a high resolution digital balance) and, in order to control for expected variation in feather growth rate and mass caused by interspecific differences in feather size, the overall length of the feather using the digital caliper.

For this study, we only used feathers taken from individuals that, when sampled, carried tail feathers produced during a definitive prebasic molt (i.e., a complete molt that involved all flight feathers and that did not occur during the fledging period). Thus we excluded all individuals aged HY, SY, or AHY and only included individuals aged ASY. Limited by this stringent age requirement, we generally only used feathers collected as part of MAPS, because of the extremely thorough verification process that characterizes age determinations in the MAPS program (see, aren't you glad you used MAPSPROG?).

We combined migration and molt strategies to create five species groups that represent life history strategies found in Nearctic passerines, and classified each of the 98 species into one of the five species groups: sedentary species with summer molt, partially migratory species with summer molt, fully migratory species with summer molt, fully migratory species with Mexican monsoon stopover molt, and fully migratory species with winter molt.

We found that feather growth rate (thus molt duration) differed significantly among the five species groups after controlling for feather length. For species molting within the breeding range during summer, we found a marked increase in feather growth rate (thus a decrease in molt duration) when going from sedentary to partially migratory to fully migratory species. Winter-molting migratory species, however, showed slow feather growth rates (thus long molt durations) similar to summer-molting sedentary species. These results suggest that (1) migration constrains the time available for molting between breeding and autumn migration and results in an acceleration of feather growth rate (thus, in molts of shorter duration); and (2) that winter molt may have evolved as a strategy in migratory species to avoid the temporal constraints experienced during summer. That 7 out of the 8 winter-molting species were aerial foragers (swallows or flycatchers) that need to molt slowly in order to maintain their ability to capture insects in flight lends further support to this hypothesis. Both of these results agree with results Ivan de la Hera previously found for Palearctic passerines.

Tree Swallow.

In marked contrast, however, we found that species with stopover molt during the Mexican monsoon had the highest mean feather growth rate (shortest molt duration), which was similar to but tended to be even higher than the growth rate of summer-molting fully migratory species. Such a rapid molt in these species may be possible because of a flush of primary productivity (and subsequent insect abundance) during the monsoon season. Stopover molt is apparently an uncommon phenomenon in the Palearctic and was not previously investigated by de la Hera.

An expected trade-off between feather growth rate and feather mass would predict a negative relationship between growth rate and mass, i.e., slower growth rates would be expected to produce feathers with greater mass. Indeed the generally poor quality of juvenal (compared to adult) flight feathers is thought to be at least partially caused by their lower mass which is a result of the need for a very high growth rate in order to get out of the nest as quickly as possible (the nest may well be the most dangerous place a bird ever experiences in its life). It was surprising, therefore, that we found a positive relationship between feather growth rate and feather mass that was driven primarily by stopover molting migrants having the highest growth rates and the highest feather mass, and by winter-molting migrants having the lowest growth rates and lowest feather mass. This latter result differed markedly from de la Hera's Palearctic results for which winter-molting migrants molted more slowly but produced more massive feathers than summer-molting migrants. Apparently, the quality (resource availability) of the winter habitat also plays a major role in controlling the quality of feathers produced there.

This work clearly illustrates why we go to so much trouble to make our MAPS data as accurate and standardized as possible. When we began cooperating with UCLA to collect feathers from birds captured in the MAPS program, we never dreamed that the feathers could be used to address such interesting and potentially important topics as feather growth rates, molt durations, trophic level consumption, and habitat quality. And many of these topics can only be addressed with known age-group individuals, thus requiring detailed data verification procedures. In effect what we are doing in the MAPS program is leaving a resource – a database – for future researchers to use to answer questions that we cannot yet even ask!! Here at IBP, we understand and deeply appreciate the lasting importance of all of our cooperators' generous contributions of MAPS data and we thank you sincerely for those data. And we know that future researchers, maybe even future generations, will thank you as well. ●

MAPS Operator Profile:

As MAPS operators, you spend numerous hours in the field collecting data, then entering and verifying it, before passing it on to us in the office. Through short notes, phone calls and your data, we get to know you over the years but often you don't get to know one another. We wanted to take some time and make some connections between all of you who are so important to us and the program. In this MAPS Chat we present a banding biography which will introduce you to some long time MAPS banders.

Rich and Brenda Keith

Rich Keith, MAPS Bander

Rich and Brenda Keith at their Pitsfield banding station.

Our first banding experience came in 1987, at the Kalamazoo Nature Center (KNC). By 1989 we were hooked, volunteering five days a week. The Michigan Bird Banders conference that November introduced MAPS, a new program. We asked our master bander if we could try MAPS banding on our southwest Michigan property, "Pitsfield." He said, "Sure, but I don't think you will catch enough birds to make it worthwhile." Following MAPS protocol for 1990, we established 19 net lanes and ran them four days per period. In 1991 we had 27.5 nets up; 18 of these locations are still used today. And Brenda says one of us is obsessive.

That first breeding season, we banded 814 birds and recorded 318 recaptures. During MAPS seasons only at Pitsfield to date, we've handled about 11,000 new birds and 5,000 recaptures. Along the way we have documented some fascinating changes to the site. This property was homesteaded by Rich's great-great-grandfather in 1846 and the northern 40 acres have always been mature woods. The southern 40 acres were shallow gravel pits, corn, and wheat until 1962. This section has become a mosaic of edge in woodland, supporting many species. We have documented 80 breeding species (Veery added in 2011), including ten species of warbler. Most abundant is Gray Catbird with 2,700 new and 1,500 recaps. Most years see over 50 Gray Catbird returns up to ten years old. In 2004 we captured a family of White-eyed Vireo, one of only two breeding attempts confirmed during the second Michigan Breeding Bird Atlas (www.mibirdatlas.org). Both parents were banded on May 19 three HY were banded on August 8; 28 recaptures occurred through October 12. On June 25, 2006 we captured a non-breeding Virginia's Warbler, the third Michigan record for the species.

Having such success during summer led us to keep the nets up for fall migration starting in 1990, banding seven days per week August 25-October 31. Since 2007 we have banded two days per week the rest of the year, November-May. Sometime in 2012 we will band our 100,000th bird and handle our 35,000th recapture — looking at all seasons combined at Pitsfield alone. All sites combined, we are approaching 500,000 birds banded and have over 115,000 recaptures.

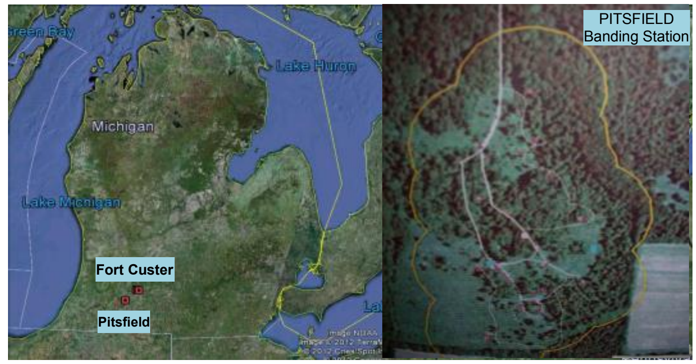
Recently we took the name Kalamazoo Valley Bird Observatory (KVBO) to better reflect what our banding program accomplishes. Last fall we had 16 banders, assistants, and volunteers on the schedule and several more occasional volunteers. We also work with researchers on various projects. In 1997, we were asked to look for ticks. We'd noticed a handful of ticks previously; the new protocol had us blowing through a straw to examine the bird's head, especially the ears. The results astonished us. In 1997-1998 we removed about 5,000 ticks from

Adult tick on the eyelid of a WTSP captured during spring migration.

8,000 birds. In 2004, we began working with researchers from Michigan State University, documenting the invasion of *Ixodes scapularus* (*I. scap.*), or blacklegged tick (formally known as deer tick). Since then we have removed 25,000 more ticks from about 40,000 birds. Only 13 of these ticks (from three passing migrants: Swainson's Thrush, Hermit Thrush, Connecticut Warbler) have been blacklegged ticks. Additionally, *Borrelia burgdorferi* (*Bb*), the pathogen which causes Lyme disease in humans and canines, has been found in *Ixodes dentatus* and *Haemaphylis leporispalustris* ticks at Pitsfield (rabbits are the preferred host for the adults of both these species). This is the first time *Bb* has been identified in the absence of an established *I. scap.* population. So far six species of tick have been documented at Pitsfield, including the first *Ixodes brunneus* in Michigan.

From 1994 to 1998, we operated a second MAPS station, KINGS, about a mile away. On the first day we captured birds that had been banded at Pitsfield as far back as 1990. We enjoyed KINGS but did not have a lot of help in those days and stopped running it after five years.

For many years, Brenda wished to do more with the Ruby-throated Hummingbirds we captured and released. To her delight Allen Chartier offered to train her in 2005. She has banded most of the Ruby-throated Hummingbirds captured at Pitsfield since 2007, almost 1,500 now. Each year over 30 Ruby-throated Hummingbirds from previous years return. We never imagined there were so many here.



Since 2009 we have operated three additional MAPS stations at the Fort Custer Training Center (FCTC) near Augusta, Michigan and are finding exciting things there in both birds and ticks. Brenda and Allen have banded several hundred Ruby-throated Hummingbirds each year at two sites just outside of FCTC. Several have been recaptured in the Fort, up to two and a half miles from the original banding site. Most were netted in subsequent seasons but one female was recaptured during the same season, which is quite curious. We removed ticks from FCTC birds every year and in 2011 MSU researchers identified them and found most to be blacklegged ticks. In fall 2011 we banded migrating birds at FCTC five days a week. Most of the several hundred ticks we removed were also blacklegged and we are waiting to find how many have *Bb* in them.

It is a privilege to work with the birds and we are fortunate to have adopted IBP protocols early in our career – they have served us well. We are looking forward to our 23rd year of MAPS.●

New MAPS operators join the flock — Welcome!

The following operators joined the MAPS Program during 2011 or early in 2012. Most are beginning operations at a new station but others have inherited a previously operated station. We look forward to including them as part of the MAPS banding community for many years to come. A warm welcome!

Yousif Attia Calgary, AB ● **Bruce R. Bacon** Mercer, WI ● **Frederic Beaudry** Alfred, NY ● **Laura E. Bell** Crookston, MN ● **John Brokaw** Truckee, CA ● **John P. Carpenter** Wilmington, NC ● **Michael Collins** Memphis, TN ● **Ed Conrad** Trabuco Canyon, CA ● **Charles Darmstadt** Montpelier, VT ● **Samantha DeSando** Rochester, NY ● **Ken Foster** Calgary, AB ● **Steven Gabrey** Natchitoches, LA ● **Chris Godwin-Sheppard** Calgary, AB ● **Anthony L. Gurzick** Durango, CO ● **Chuck Hathcock** Los Alamos, NM ● **John Holloway** Parris Island, SC ● **Sarah Johnson** Manitowish Waters, WI ● **Larry Kamees** Sandia Park, NM ● **Lisa Kiziuk** Newton Square, PA ● **John P. Loegering** Crookston, MN ● **Lauren Morgan-Outhisack** Trabuco Canyon, CA ● **Charles Pinckney** Parris Island, SC ● **Kurt D. Reed** Fort Atkinson, WI ● **Melanie Reichley** North East, MD ● **Dana Ripper** Marshall, MO ● **Josh Sayers** Calgary, AB ● **Jennifer Schlick** Jamestown, NY ● **Kyle Shepard** Mobile, AL ● **Joseph Smith** Cape May, NJ ● **Aaron Stelker** Marshall, MO ● **Pat Stinson** Bossier City, LA ● **Emily Thomas** Warren, PA ● **Dr. John Waud** Pittsford, NY ● **Lisa Wilson** North East, MD ● **Theresa Yednock** Hopkins, SC

Molt Limits and Plumage Fields: Using code 'A'

Ron Taylor, IBP staff biologist

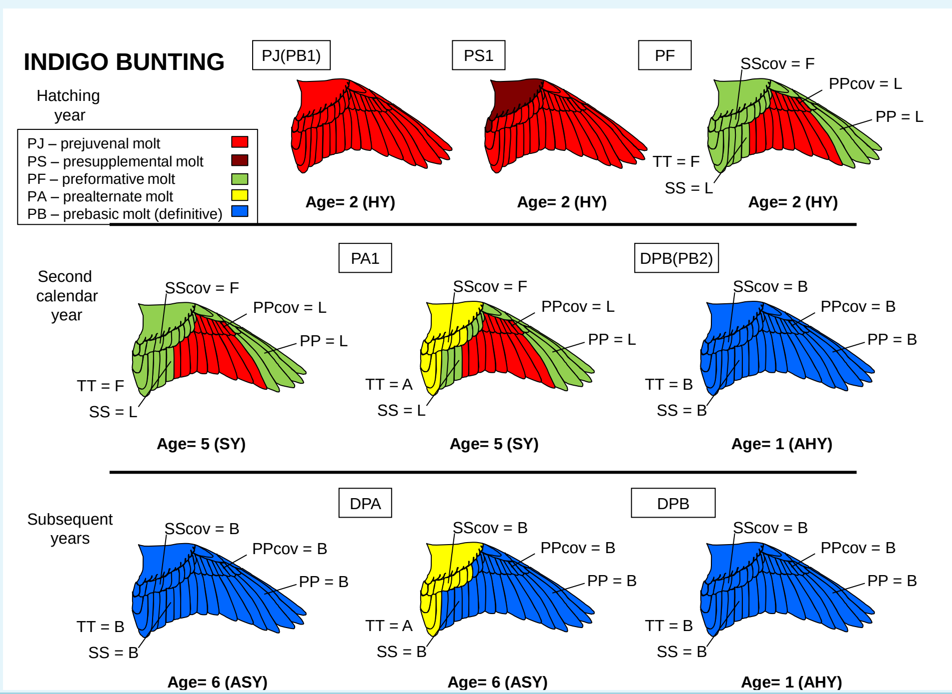
The lesser used Molt Limits and Plumage (ML&P) codes ('R', 'M', and 'A') have probably caused confusion at your banding site at least once – and likely more often than that. In the March 2011 MAPS Chat, we clarified when it is appropriate to use codes 'R' and 'M'. This time, we want to tackle 'A', which is used for feathers replaced during the prealternate molt.

Prealternate (PA) molts do not occur in all passerines and, when present, often don't involve flight feathers (or maybe just a few). A few commonly captured species with this prealternate molt pattern include Yellow Warbler, Yellow-rumped Warbler, Indigo Bunting, and Scarlet and Western Tanagers. There are a few species that have more extensive PA molts, such as Lesser Goldfinch (limited to incomplete) and Bobolink (complete). Feathers that are replaced during the PA are often from tracts that aren't diagnostic for aging, i.e. the body and head, and/or are very exposed, i.e. the inner greater coverts and tertials. To top it all off, the PA replaced feathers are often similar looking in SY and ASY birds.

The MAPS Manual states to use 'A' when "**ALL** feathers in the feather tract are of alternate plumage; if **ANY** juvenile, formative, or basic feathers are present, the alternate feathers should be ignored and the code for the feather tract should be based on the other feathers, that is 'J', 'L', 'F', or 'B'." For example, in an SY bird, if you have a tract such as the greater coverts that may have both alternate and formative feathers, you would score the tract 'F'. Similarly, in an ASY bird, greater coverts with alternate and basic feathers would be scored 'B'. If however a tract was completely replaced in the prealternate molt, e.g the tertials, the tract would be scored 'A'. The only tracts that should get "A" (other than in Bobolink) should be the greater coverts and tertials, and for the greater coverts the only two common species I've ever scored "A" were Yellow Warbler and Indigo Bunting. "A" is most commonly found for tertials, probably 20-30 species among sparrows, flycatchers, warblers, buntings, etc.

Even though we don't often record 'A' in the ML&P columns, recognizing fresh feathers resulting from the PA molt may provide another clue in helping determine age to a finer scale than AHY. Since, in many species, the PA can be more extensive in SY birds than in ASY birds, by comparing the bird we have in our hand with the PA description in the Molt section of the species' account, we may get information that will reinforce other feather clues that will tip the scales toward a SY or ASY age designation.

I hope this article has been helpful and will send you with increased confidence into the 2012 season!



Click on image to link to larger PDF image

The illustration above contains an example showing how the molt limits and plumage code 'A' is used. Note that:

1) For age classes SY and ASY the tertials are completely replaced in the prealternate, so both age classes would get coded 'A'. The identical coding in this case makes the tertials unhelpful for ageing.
2) The greater coverts in both age classes were only partially replaced and the retained formative or basic feathers still allow this tract to be helpful for ageing .