2001

Adaptive Harvest Management Working Group

ADAPTIVE HARVEST MANAGEMENT WORKING GROUP

Holiday Inn Capital Plaza
Sacramento, California
April 10-13, 2001

This report provides a summary of presentations and discussions that occurred at the 13th meeting of the Adaptive Harvest Management (AHM) Working Group. The primary purposes of this meeting were to review stock-specific AHM efforts, and to consider the future strategic direction of AHM, especially as it relates to development of a new Environmental Impact Statement for migratory bird hunting. (Note: this report needs to be printed in color to properly view some of the figures).

Flyway Status Reports *- State and Federal Working Group Representatives*

Atlantic Flyway. – In general, AHM seems well accepted now as a useful and desirable approach to waterfowl harvest management. We have support for further developing the application of AHM to stocks other than mallards, especially black ducks and wood ducks, and to explore how multiple stocks can be integrated into regulatory decisions. However, there are still some unrealistic expectations and misunderstandings that we must continue to address.

There is general acceptance of the current model set for eastern mallards, in that there are no strong disagreements over basic population dynamics or harvest effects. However, there is room for improvement in the recruitment modeling, since the models have not predicted age ratios well, and seem to over-predict population growth on average. Simple environmental variables are lacking because they did not perform well, so more complex forms may be needed. There may be other factors, such as predator abundance, that affect annual recruitment rates, but we have no way to factor those into our models.

There are still some concerns about basing regulatory packages entirely on the status of eastern mallards and the likelihood that we will have liberal (60-day) seasons in almost all years. Although most states support this approach, some southern states are concerned about declining midwinter counts of mallards, which they believed come from the Great Lakes region (part of the mid-continent population). Dave Otis recently estimated that only 10-30% of the mallard harvest in North and South Carolina came from reference area 14, and that 80-90% of the harvest of mallards from that area occurred in the Mississippi Flyway, so reasons for the apparent decline are unclear. Similar concerns exist about the potential impacts of 60-day seasons on wood ducks and some diving duck species, which makes it important to begin work on harvest strategies for multiple stocks.

For other species, there is interest in expanding opportunity for black ducks, especially in coastal areas, where the current restrictions may be limiting overall hunter participation. The principal question is how do we integrate an AHM approach for black ducks and mallards, since these species may have an inverse relationship, not just a concurrent harvest. We are confident that Mike Conroy is leading this investigation in the right direction.

Wood ducks may present us with an ideal situation for AHM, because there is considerable disagreement about the effects of harvest on wood duck populations since we expanded to 60-day seasons. With limited monitoring data, we have not clearly determined their current status, and some are concerned that wood duck harvest increases have not been equitable throughout the flyway (i.e., mostly in the south). With this species there are also questions about integration with mallards because hunting regulations may affect these species differently (e.g., season opening dates have more effect than season length in the northern states).

To get Technical Section input on how to integrate multiple species into regulatory decisions, we need to come up with 2-3 basic alternatives for consideration. Right now, the concepts are too vague and overwhelming to get meaningful input. The topic of regulatory packages has been quiet recently, but there remain concerns about other species, especially diving ducks, with bag limits in our current liberal package.

We had an evening AHM workshop at our winter Tech Section meeting that was very well received. Those of us who attended the 2-day workshop in Louisiana presented a 2-hr demonstration of STELLA and ASDP software to teach some basic lessons on the importance of model form (exponential vs logarithmic growth), harvest control and environmental variation, number of packages, effects of population goals, etc., on optimal harvest strategies. I think we succeeded in bringing many of the Technical Section reps further along in their understanding of AHM and we plan to make this a regular part of future winter meetings.

<u>Mississippi Flyway.</u> – Concerns remain about (1) the utility of the very restrictive option in the regulations package (20 days, 3 duck bag limit in the Mississippi Flyway), (2) closed cells in the decision matrix in the range of historic population levels and habitat conditions, and (3) annual increments of regulations changes (e.g. liberal to restrictive option in a single year). Additional analyses during 2000 led to a joint flyway recommendation (#2) during summer 2001 to:

> (1) eliminate the very restrictive option;
> (2) replace open cells with the "restrictive" alternative to a population level of $\leq$4.5 million; below this level, year-specific decisions on closed seasons would be based on both biological and sociological considerations;
> (3) urge the Service , through the AHM Working Group, to evaluate influence of year-to-year constraints on regulations increments on AHM performance; and
> (4) suggest that the Service strongly consider limiting increments of year-to-year change to single regulations "steps"

This was not approved by the full technical representation nor revisited by the joint flyway councils. The Mississippi Flyway AHM Committee remains concerned about these issues. Although we support the joint recommendation #1 from summer 2001 for a schedule and criteria for changing AHM regulations packages, we believe that addressing the particular issues from recommendation #2 should remain a high priority. The Upper Region Regulations Committee added a priority that involves consideration of hunter satisfaction as future AHM development proceeds.

A review of papers presented at the 2000 North American Wildlife and Natural Resources Conference was the basis for discussion about the primary objectives for duck harvest management and the degree to which these are captured by the AHM process. In particular, challenges summarized by Fred Johnson were discussed which included 1) harvest management objectives and goal setting, 2) partial control with harvest management, and 3) continuing desire to accounting for spatial, temporal, and organizational variation.

An evening workshop was dedicated to a summary of the past year's evaluations of AHM elements and a AHM "refresher course" held during December in Lafayette, LA attended by several Mississippi Flyway technicians. During the February workshop, harvest management expectations and progress with AHM were reviewed, the results of an evaluation of model variables and constants were reported, and technicians briefly explored software and models used during the December workshop.

<u>Central Flyway.</u> – The Central Flyway (CF) continues to support on-going AHM efforts. We believe that the following issues need to be addressed as AHM continues.

In recent years, staff-time devoted to AHM in the Division of Migratory Bird Management (DMBM) has steadily declined. However, the workload for addressing technical and non-technical aspects of AHM remains high. The Central Flyway urges DMBM to address its short-term and long-term plans for staffing and other resources committed to AHM, and communicate these plans to the AHM Working Group.

The lack of a current estimate for mallard band reporting rates continues to be a major obstacle for making progress with AHM. The lack of reporting rates also appears to restrict our ability to pursue changes in duck hunting regulations (e.g., framework date extensions). So far, DMBM has been unsuccessful in obtaining full funding for a reward band study. This issue needs to be addressed and should be a priority. (Note: A position statement on the need for a band-reporting rate study was developed and is included in this report.)

Recommendation #1 from the July 2000 Joint Flyway meeting states that all Flyways will develop, through the AHM Working Group, a revised set of guidelines for establishing AHM regulatory packages. Although DMBM has announced its intention to develop a revised SEIS on migratory bird hunting during the next several years, the CF believes that the AHM Working Group needs to continue working on guidelines for packages. In addition, further work is needed on multiple-stock approaches to AHM and developing AHM objectives.

<u>Pacific Flyway.</u> –

Frameworks: At their March meeting, the Pacific Flyway Council narrowly supported the National Flyway Council recommendation regarding framework extensions. The Study Committee continues to be concerned about the advisability of further changes in packages and raised several issues in response to the request for extended frameworks. The Study Committee maintains its support for past joint flyway recommendations dealing with the stability of regulation packages, and the need to preserve

harvest levels among flyways.

We believe that framework extensions have the capability to alter the distribution of harvest among the flyways even further from those levels agreed to as a part of the joint flyway recommendation in July, 1996. If these changes are implemented, realignment of regulation packages to reflect flyway differences is warranted.

Western Mallards: As part of the western waterfowl survey initiative, the Pacific Flyway conducted experimental breeding pair surveys in central British Columbia in 1999 and 2000 to assess mallard breeding densities there. Additional survey work is planned for 2001. British Columbia is believed to be a significant source of western mallards, and almost all of the province is excluded from existing USFWS-CWS surveys.. Preliminary indications are that up to 500,000 mallards breed in areas of British Columbia not covered by USFWS-CWS surveys.

In combination with the Division of Migratory Bird Management, the Pacific Flyway is reviewing the population models that Sue Sheaffer prepared. Two areas clearly need attention: there is a question of scale between population assessment data currently available within the range of the western mallard; and improvements to models of recruitment are needed. We hope to achieve considerably more progress in the upcoming year and we expect to hear an update from Fred Johnson on this effort tomorrow.

Sharing the AHM experience: We identified a need last year that more work in needed to communicate both within the Study Committee and Council what the effects and costs are likely to be when managing the harvest of multiple stocks of ducks under AHM. As a result of the December 2000 training workshop in Louisiana, the Pacific Flyway Study Committee held a summary workshop in March. Summaries of the presentations provided by USFWS and USGS personnel were provided to the Study Committee and most felt that this was a positive incremental increase in the understanding of AHM principles and practices. More work in this area is probably needed. We continue to believe that most hunters in the Pacific Flyway will not actively engage in the process until season restrictions are implemented.

Northern Pintail progress: As a result of Joint Flyway Council action in July 2000, a workshop on pintail ecology and management was held in Sacramento in March 2001. Over 60 people attended the 2 day workshop and summary reports are currently being prepared. The goal of the workshop was to develop a consensus-based plan that identified management and research needs to improve the status of pintail. Some progress was made, and some issues that may affect AHM for pintails were identified.

The Pacific Flyway believes that the technical development of an AHM process for pintails is further ahead than that for western mallards. However, some issues, such as seasons-within-seasons or species-specific regulations are anticipated to be addressed in the upcoming revision to the EIS for migratory game bird hunting. In addition, efforts to reassess the existing population goals under the North American Waterfowl Management Plan may affect AHM for northen pintails.

AHM Training - *Fred Johnson*

An AHM training workshop was held December 5-6, 2000 at the National Wetlands Research Center in Lafayette, Louisiana. The purpose of the workshop was to enhance the understanding of AHM by biologists directly involved in the regulatory process, and to help those biologists communicate AHM concepts and practices to their peers and constituents. The training workshop consisted of lectures and exercises covering harvest theory, population modeling, decision theory, and Bayesian learning. The workshop was attended by 25 state and federal biologists who completed an evaluation form at the end of the workshop. On a scale of 1-5 (with 5 being the best score), respondents on average rated the overall quality of the workshop as 3.9, the overall utility of the workshop as 3.8, the breadth of subject matter as 3.8, the level of technical detail as 4.0, the utility of handouts as 4.0, the performance of instructors as 4.3, and the balance of presentations and exercises as 3.6. When asked whether the workshop enhanced their ability to communicate about AHM and whether the workshop answered all of their major questions, the respondents' average scores were 4.0 and 3.8, respectively. The communications subcommittee subsequently discussed this workshop, as well as other training needs, and made recommendations that are included in the list of meeting action items.

The Human Dimensions of Waterfowl Harvest Management - *Dave Case*

At the April 2000 AHM meeting in Maryland, Dale Humburg and Dave Case gave a presentation and lead a discussion on incorporating hunter preferences/satisfaction into AHM in a more explicit manner. A subcommittee of the AHM working group (Humburg, Padding, Moore, Gammonley, Serie, Case, Kraege, and Swift) was appointed to discuss how to proceed on this issue.

The subcommittee met at the joint Flyway Council meeting last July. The group reiterated the importance of this issue and discussed a number of options for proceeding. The recommendation from the group was that a "think tank" of experts be assembled to frame the issue and outline options for dealing with it. Their work should be compiled into a white paper type of report for distribution and review among various interests. This "think tank" approach is modeled after a similar effort that Dave Case and Phil Seng facilitated on the role of hunter education in hunter and shooter recruitment for the National Shooting Sports Foundation.

The AHM Working Group reconfirmed their interest in seeing this issue addressed and recommended the FWS and/or subcommittee pursue options for making it happen. The Working Group felt the white paper should include specific recommendations on how to proceed. They would like to see a first draft of the white paper by the AHM meeting next year.

Development of a Programmatic EIS for Migratory Bird Hunting - *Dave Case & Jerry Serie*

A special session was held for the AHM Working Group to develop recommendations on how the U.S. Fish and Wildlife Service should structure and conduct the EIS process. Following a presentation on the EIS process by Jerry Serie, the Working Group reviewed and discussed a series of questions regarding the strategic direction of AHM:

1. Is harvest an appropriate performance metric (i.e., basis of a management objective)?
   A. If so, should we also set explicit goals for harvest allocation?
   B. If not harvest, then what is the appropriate metric, how is it related to regulations and population dynamics, and how would it be monitored?

2. Under what conditions do we need to establish goals for population size? How should these goals be traded off against other management objectives?

3. Should learning become an explicit objective (i.e., should we move from passive to active adaptive management)?

4. What are appropriate criteria (e.g., number, range, empirical basis) for establishing or revising the set of regulatory alternatives?

5. How should we apply the principles of AHM to species/populations for which there is little basis for constructing predictive models?

6. What are appropriate criteria for establishing a set of alternative models (i.e., how do you determine "key uncertainties")?

7. What are the appropriate temporal, spatial, and organizational scales of harvest management (i.e., to what degree do we account for these sources of variation in population dynamics)? How do we distinguish what is desirable from what is practical?

The principal result of the discussion was a recognition that the Working Group has no direct role in the EIS process, but should instead focus on addressing the strategic direction of AHM in the future. The Working Group expects, however, that the results of this strategic planning will be useful to the USFWS as it prepares an EIS for migratory bird hunting. Fred Johnson has the lead in drafting a white paper describing the strategic issues and possible directions for review by the Working Group at next year's meeting. A brief report of the strategic issues will be developed in the interim for communication purposes.

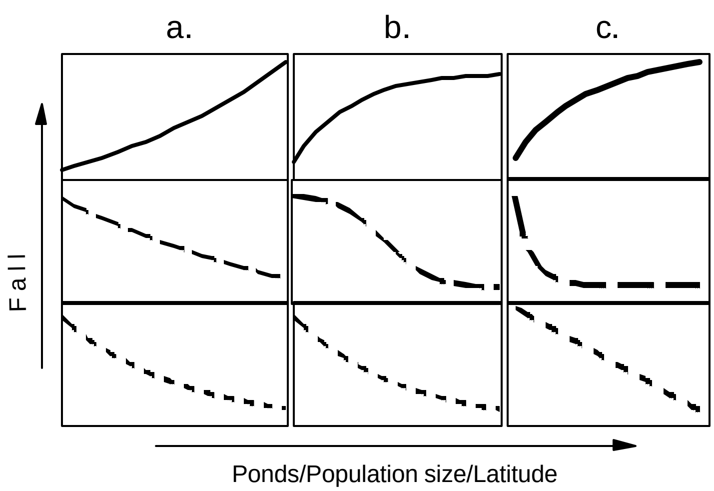
AHM for Midcontinent Mallards

Models of Reproduction - *Jim Dubovsky*

We continued efforts toward developing alternative models of recruitment for the midcontinent population of mallards. These efforts focused on attempts to model recruitment as a function of the number of ponds in Prairie Canada and the northcentral U.S. in May, the size of the spring population (birds counted in May survey strata 1-18, 20-50, 75-77, and in Minnesota, Wisconsin, and Michigan), and a variable that describes the center of the pond distribution in May. We concentrated efforts on these variables because they consistently occurred in models that had the lowest values of Akaike's Information Criterion. Previous work indicated that fall age ratios (immature females:adult females)

were negatively related to the size of the spring population, positively related to the number of ponds in May, and negatively related to the latitude of the pond distribution ($R^2 = 0.80$) (Fig. 1a). Because optimal strategies may be sensitive to the form (e.g., linear, logistic) of the recruitment function, we attempted to fit additional models with different forms to the 1974-95 data. One model we considered treated fall age ratios as a reverse logistic function of population size, and a logarithmic function of ponds in May and the latitude of ponds (Fig. 1b). However, repeated attempts at fitting this nonlinear model failed to produce a reasonable model. Although statistically significant models were produced, parameter estimates appeared far from those considered reasonable, and standard errors for the estimates were extremely high (CVs ≥ 100%). Such results generally indicate problems with model fit. Another model we considered treated fall age ratios as a negative exponential function of population size, a logarithmic function of ponds in May, and a linear function of latitude of ponds (Fig. 1c). This model did produce reasonable estimates for the parameters, although standard errors were still somewhat high for some variables. During the next several months we will attempt to reparameterize the latter model to solve these remaining problems. We intend to explore the influence of incorporating these additional recruitment models on optimal strategies prior to the next AHM meeting in April 2002.

Figure 1. Modeled relationships between fall age ratios and ponds (solid line), size of the spring population (dashed line), and latitude of ponds (dotted line).



Models of Survival - *Bill Kendall*

The current model set for mallard survival consists of an additive model, where any hunting mortality is added to other sources of mortality to lower annual survival, and a completely compensatory model, where up to a point any hunting mortality has no effect on annual survival because those birds would have died from some other cause. In one sense these two hypotheses nicely frame the question of how

hunting affects survival. However, they are flawed in two ways as they are implemented as part of the predictive population models used in AHM.

First, there is evidence from previous studies that the amount of compensation, as it's defined in these models, might have changed over time. If that's the case, then neither of these models provides a good predictive model because for them the amount of compensation is static. Relatedly, the notion of compensation is derived from an underlying idea that post-harvest mortality rate is density-dependent. Whereas the compensatory and additive models predict annual survival strictly as a function of kill rate, a density-dependent model would predict it as a function of kill rate and some function of population size. This is a more robust and mechanistic model that could exhibit either "additive-like" behavior or "compensatory-like" behavior. For example, if post-harvest mortality were well-represented by a logistic curve then it would appear more additive when density was in a range where the curve was flat, and more compensatory for density values where the curve had a substantial slope to it.

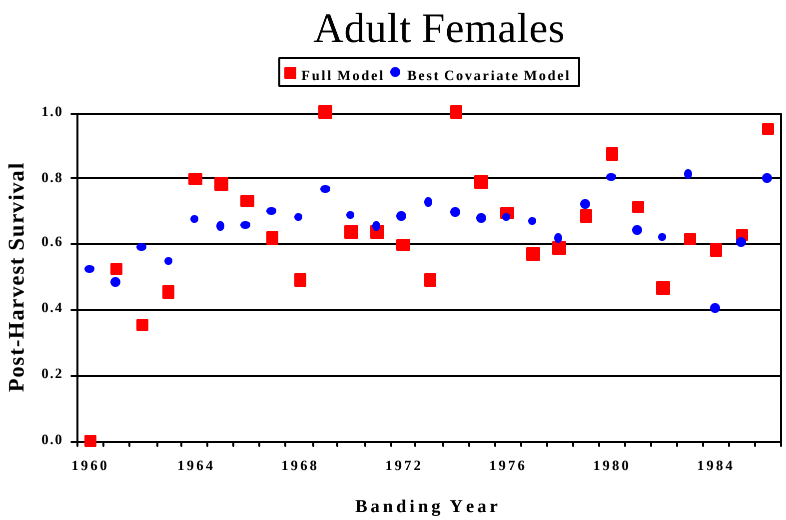
The second problem with the current survival model set is that survival is treated as a deterministic process. That is, for any kill rate we assume that the same annual survival rate will always occur. This is due partly to theory fixing the amount of compensation (it's either compensatory or it's not, with no uncertainty within a model), and partly to ignoring sampling error in survival in the absence of hunting.

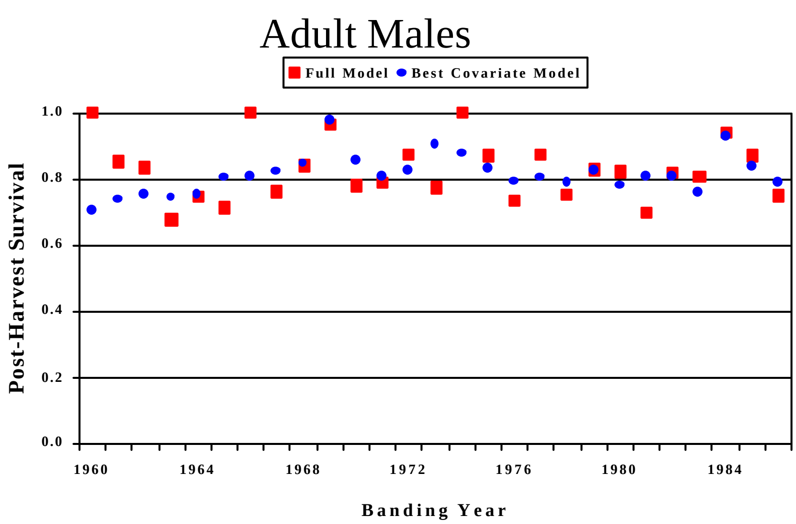
We analyzed data from banding reference areas 3, 4, and 5, using years 1960-87, attempting to remedy the problems above. In order to incorporate kill rate we needed estimates of crippling rate (we used 0.20) and band reporting rate. We incorporated uncertainty and geographic variation in band reporting rates by simultaneously analyzing reward band data from the late 1980's. We began with the following model:

$$S_{tas} = (1 - K_{tas})q_{tas}$$

where S is annual survival rate, K is kill rate, and q is survival of non-hunting sources of mortality. Each of these is time (t), age (a), and sex (s) specific. This model is equivalent to the additive model because q is not affected by kill rate. We also considered models where q is a logistic function of the following variables: in one case population size, number of ponds, and row crop acreage for year t+1; in another post-harvest population size (derived from the previous spring's population size, assumed summer survival, recruitment, and kill rate); and in another midwinter inventories (summarized by Fred Johnson years ago).

Results: Although the best fitting models, based on AIC, included some function of the covariates we considered, they involved several interactions, are not interpretable, and could very well be spurious. The following graphs from banding reference area 4 are representative of the results of this modeling process.





Among the models that did not include covariates the best-fitting models had q vary by time and sex for reference area 4, and by age and sex for reference areas 3 and 5. Subsequent modeling indicated that the best fitting model of this type for all three reference areas was one where q varies by time, but that time variation is the same for each age and sex.

In summary, from this analysis we found no density dependent function that would be useful as a predictive model for survival. This could be due to a lack of a good estimate of post-harvest population size, missing the resource that is limiting for these birds, or measuring either one at the wrong spatial scale. However, it could also be due to a true lack of density-dependence in the years for which we have data. The limited amount of temporal variability in q , at least for males, does not leave much room for density dependence.

Developing a new model set for survival: Despite these results there are still some things we can do to improve the current model set for survival. To develop a new additive model that includes uncertainty more fully we modeled q as a function of time and sex for each of the remaining mid-continent banding reference areas (2, 6, 12, 13, 14, ignoring 1 and 7 due to extremely sparse data). We calculated the mean and variance in q across years within a reference area, and then averaged across reference areas, weighting by BPOP. From this exercise we arrived at a predictive model for q for the mid-continent, which treats post-harvest survival rate as a random process with a mean of 0.81 (se=0.04) for males and 0.68 (se=0.07) for females. These estimates are similar to those for S_0 from the current additive model, not surprisingly with more variance: 0.80 (se=0.02) for males and 0.64 (se=0.02).

Given the results above, there are three basic options for modifying the survival model set: (1) replace the current additive model with a new one such as above and leave the compensatory model as is; (2) replace the additive model and <u>replace</u> the compensatory model with 1 to 3 density-dependent models that are qualitatively reasonable given what we know about mallards; (3) replace the additive model and <u>add</u> 1-3 reasonable density-dependent models, leaving the current compensatory model at least as a benchmark. If program ASDP can handle it, I recommend option 3.

In developing these density dependent models in an ad hoc fashion based strictly on theory some familiar questions come up: (1) should post harvest population size alone represent density or should it be that divided by some unit resource? (2) Should post harvest density be used for males and the following spring BPOP for females? (3) Should we assign variances as well as values to the parameters of the density dependent model? Question number 3 is a familiar one with respect to updating model weights.

In conclusion, the analysis of mallard bandings has shed some light on improving the AHM model set for survival. It has provided a way for improving the additive model. It has not, however, revealed any patterns that could be used in building a predictive density dependent model. Nevertheless, and despite current model weights, the possibility of compensation due to density dependence should still be included in the model set. We need to find the best way to do so.

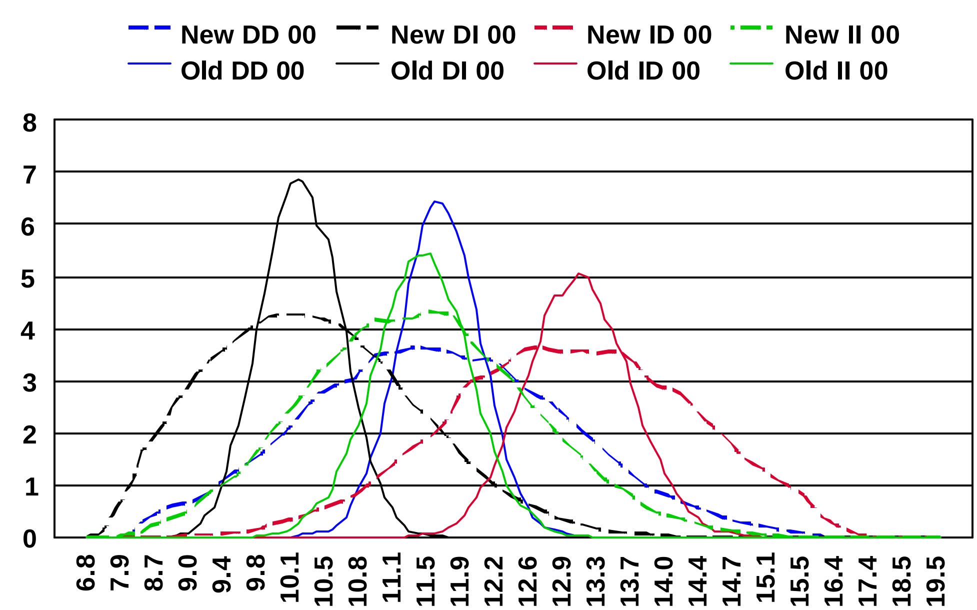
<u>Updating Model Weights</u> - *Bill Kendall*

The current method for updating model weights was developed using model predictions as defined in the process for finding an optimal harvest policy (Johnson et al. 1997). This includes models that are

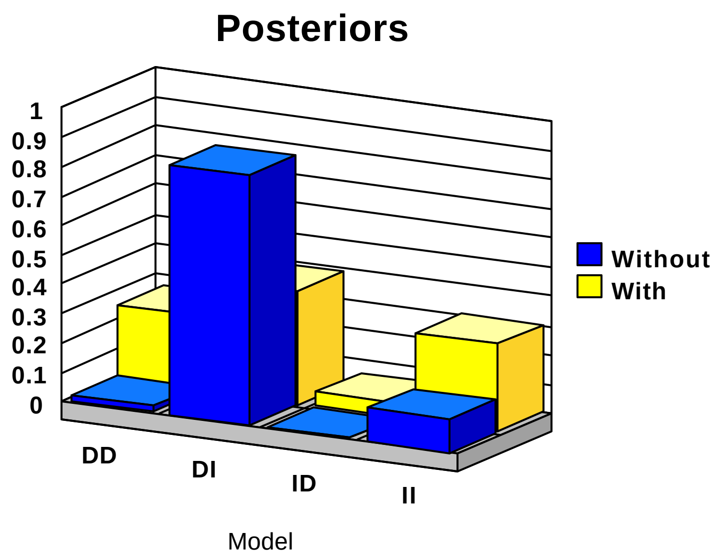
mostly deterministic, with the only stochasticity being variation in harvest rates due to partial controllability and variation in the rainfall that produces spring ponds (the latter has no effect on updating weights). We have also included the uncertainty in the true BPOP and number of ponds due to sampling error. The resulting distributions of predictions under a given model are narrow. Although we expect in this case that the direction of change in weights is unbiased, weights shifted very quickly at the beginning of the process and the process has been very volatile with respect to which model does a better job of prediction in a given year.

Sources of variation that have not been included in the updating process include the variance of prediction that stems from the linear regression model for recruitment, sampling error associated with survival in the absence of hunting (and thereby uncertainty in summer or winter survival rates), and uncertainty in crippling loss rate and sex ratio in the spring. Initially these sources were not added for two reasons. First, only the weakly density-dependent (dd) recruitment model and the additive survival model are based directly on a statistical analysis. The other two survival and recruitment models were derived by modifying these empirical models based on theory, and therefore expressing uncertainty for these models was not as straightforward. Second, and related, the AHM process does not preclude models that are derived subjectively, assigning model structure and parameter values with or without attendant expressed uncertainty through variances. In light of these two points, we ignored some sources of uncertainty in order to achieve a 'level playing field' on which the models should compete.

Given the volatility of the updating process for mallards, and given that we have arrived at a reasonable approach to incorporate more uncertainty, it is time to do so. The figure below provides an example of the effect on the distribution of model predictions of incorporating variance in the prediction of recruitment, where 'New' includes the extra variation (DD = strongly dd recruitment, compensatory mortality, DI = strongly dd recruitment, additive mortality, ID = weakly dd recruitment, compensatory mortality, and II = weakly dd recruitment, additive mortality).



This comparison can translate into a big difference in model weights. This is illustrated by the figure below, where the prior weights are even for each model ("With" means with the added variance in recruitment).



The section on mallard survival model in this report provides a method for incorporating uncertainty into the prediction from the additive survival model, and indicates some points that need to be worked out for the compensatory survival model.

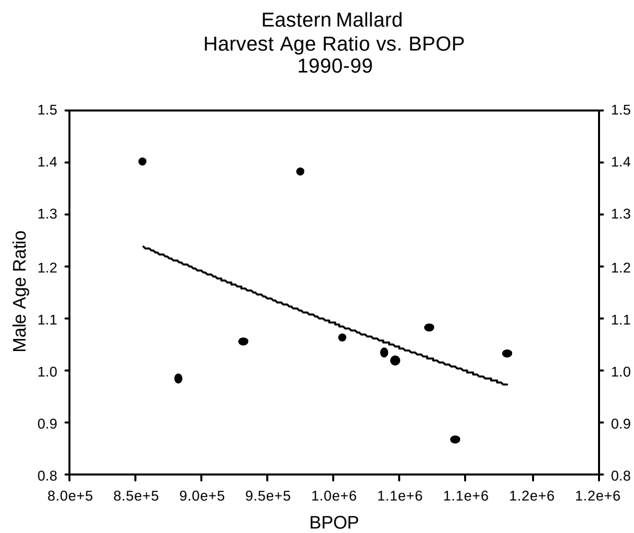
The potential effect of a bias in some part of the annual cycle that has led to a problem with the "balance equation" for mallards has not been explored. Identifying this and correcting for it is also very likely to change the values of model weights. However, it would likely not by itself change the optimal harvest policy, because the average (across models) prediction for the population dynamics under a given regulations package would probably be the same.

In conclusion, despite the volatility of the updating process to date, and the narrowness of the prediction interval under any given model, the four models as a group have done a reasonable job of predicting BPOP in the years since this process has begun. Although the weight on the compensatory model is very low at this point, it would be extremely premature to conclude that this model has been 'disproven' and discard it. We are making progress in our view of the updating process and in developing models that more appropriately reflect the hypotheses we started with and incorporate new hypotheses. This progress should be incorporated into modifying the operational model set and updating process for AHM.

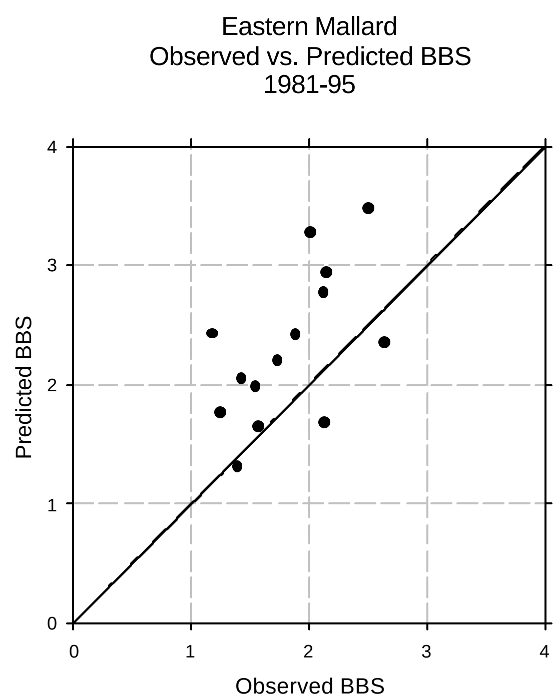
AHM for Eastern Mallards - *Fred Johnson*

I reviewed the data and assumptions used to create the current model set for eastern mallards. That model set is comprised of eight models, which are formed by the combination of two alternative

density-dependent reproductive models, two alternative models relating the Breeding Bird Survey (BBS) indices and estimates of breeding-population size, and two survival models representing an additive and partial-compensation hypotheses for females. Several years have passed since the development of these models, and some revisions may be in order. In particular, it may now be possible to model fall age ratio directly as a function of population size (BPOP), rather than the BBS index.



Of continuing concern, however, is the possibility the estimated survival rates, fall age ratios, or both are positively bias. If so, harvest strategies derived from these estimates may be overly liberal. Therefore, further investigations of this potential bias is a high priority.



Managing the Joint Harvest of Midcontinent and Western Mallards – *Fred Johnson*

The purposes of this presentations were: (1) to explore the management implications of the western-mallard models developed by Dr. Sue Sheaffer; (2) to identify some concerns about the nature of those models; (3) to present results based on a simulated joint harvest of western and midcontinent mallards; and (4) to discuss future needs for the project. The Sheaffer model for western mallards that assumes additive hunting mortality was compared with the currently favored model for midcontinent mallards. Based on these models, estimated natural mortality rates are almost identical for the two mallard stocks. Both stocks appear to exhibit density-dependent reproduction, although the density-dependent effect seems to be much more pronounced in western mallards. Based on these stock-specific models, the optimal harvest rates (on adult males) for maximizing harvest under average water conditions were 0.19 and 0.45 for midcontinent and western mallards, respectively. Despite this difference in optimal harvest rates, there was only a 1% gain in simulated harvest utility from a joint harvest strategy for midcontinent and western mallards compared to a harvest strategy based on midcontinent mallards alone. When a joint strategy was considered, the Pacific Flyway had regulations different from the other Flyways in only 20% of the simulated years. The simulations of a joint harvest strategy were based on stock-specific management objectives and Flyway-specific regulations.

A number of concerns about the model for western mallards surfaced in the course of this investigation. Most importantly, the model predicts changes in population size that are biased high and are uncorrelated with observed population changes based on the Breeding Bird Survey (BBS). The positive bias in predicted population size may be the result of a positive bias in estimated survival or reproductive rates, as is suspected in other mallard stocks. However, the fact that predicted changes in western-mallard population size were uncorrelated with observed changes is particularly worrisome. I suspect that the reason for a lack or correlation involves the mix of spatial and temporal domains of scale that were used to parameterize the western mallard model. Another possibility involves the reliability of the BBS index, which is only weakly related to aerial surveys of mallards in a few Pacific Flyway States.

In conclusion, the currently available model(s) of western mallards do not appear to provide a sound basis for implementing a joint harvest strategy with midcontinent mallards. I recommend a re-assessment of all available data of historic population sizes, and re-estimation of vital rates that are coincident in time and space. It should be recognized, however, that available data on population size and vital rates are sparse, and this may prevent for harvest-management purposes the inclusion of some breeding areas currently considered part of the western-mallard range.

AHM for Pintails - *Mike Runge*

An adaptive harvest management program for pintails has been evolving over the past three years, and it is reasonable to expect that we can discuss the details of implementing such a program at this time next year. But in order for an AHM program to be instituted for pintails, several issues need to be resolved. The two most important questions are value-oriented; the others are technical issues that are not expected to pose substantive problems. These value-oriented questions concern the management

actions and the objective function, and are not unique to pintails—for any individual species proposed for inclusion in an AHM framework, these questions will need to be answered.

Key question #1. -- *How will decisions about pintail harvest interact with decisions about mallard harvest?* (1) Will pintail and mallard harvest regulations be set independently (with separate season lengths and bag limits)? (2) Will pintail and mallard harvest regulations have the same season length, determined jointly, and separate bag limits? Or, (3) will pintail bag limits be set conditionally upon a season length determined by mallard dynamics? The interim pintail harvest policy follows the third approach, and, based on limited discussions, the prevailing sentiment seems to be that this approach is preferred. Ultimately, it is up to the Fish and Wildlife Service to make this decision, with input from interested parties. Those interested parties should step forward at this time to make recommendations.

Key question #2. -- *How much do we want to forego harvest opportunity in order to allow the population to recover?* At the heart of this question is the concern that the pintail population has been in decline for the past 30 years. The recent Northern Pintail Workshop (Sacramento, CA, March 23-25, 2001) focused on articulating the hypotheses and evaluating the evidence for the decline. While there seems to be little concern that harvest is the primary cause of the observed decline, harvest may be hindering recovery. To what extent should a desire for recovery temper the objective of maximum harvest? In the interim pintail strategy, this is handled by setting a harvest that still allows for a 6% population growth rate. In the mid-continent mallard AHM strategy, this is handled by devaluing harvest when the population falls below the NAWMP goal. For pintails, there is evidence that the optimal equilibrium population size (the equilibrium population size at which annual harvest is maximized) is lower than the NAWMP goal of 5.6 million. Therefore, if we include a devaluation of harvest, it will likely have a more restrictive effect on optimal harvest rates for pintails than it does for mallards. This will serve to allow recovery to occur more quickly (provided the presumed habitat limitations are mitigated). The question is how stringent to make this devaluation (i.e., the degree to which population recovery should be traded for harvest). Again, interested parties need to make their concerns known.

I believe the answers to these 2 questions will have a much more profound impact on the properties of the AHM strategy for pintails than will any of the remaining decisions about technical detail. How to have these questions appropriately addressed (who to solicit for input, how to balance that input, etc.) is not clear. At the Working Group meeting, it was proposed that we prepare a report that presents the various options that arise out of these questions, and considers that ramifications of each. This would allow interested parties to react to a specific set of options.

Two technical challenges to the implementation of AHM for pintails have become evident in the last 2 years. First, there is an apparent negative bias in the breeding population size estimates in years when the pintails overfly the prairies. Second, the basic accounting model of the population (the "balance equation") overpredicts the breeding population size by about 30% on average for reasons unknown. Both of these problems are due to biases in the monitoring system, but the exact nature and cause of the biases is not known, thus, a precise solution is not yet available. Nonetheless, it is possible to

implement an empirical correction for these biases, and efforts are underway to identify possible causal explanations.

Bias in BPOP. – When the breeding population size estimate (BPOP) is plotted against the average latitude of the breeding population (LAT), a strong negative trend is evident. Thus, all other things being equal, when the birds are situated at higher average latitudes during the breeding season, the estimated population size is smaller. But, such a result could be an artifact of temporal trends in both variables. However, when both variables are detrended (by taking first differences), the pattern remains. In other words, in years when the average latitude of the breeding population increases by a large amount (i.e., when the breeding population is located farther north than the year before), the estimate of the breeding population size decreases by a substantial amount. This is strong evidence that birds are undercounted in the northern part of the breeding range relative to the southern part. This has been suspected for a long time, and there is other evidence that this is occurring. It is a big problem for implementation of AHM if BPOP is going to be a state variable, because changes in the BPOP from year to year reflect not only changes in the population size, but also changes in the distribution of the population. Thus, without correcting for this bias, BPOPs from one year to the next are not necessarily comparable. Ideally, we would solve this by having good estimates of detectability of pintails in different parts of the breeding range. Then, shifts in the distribution of pintails shouldn't affect the estimate of the breeding population size. However, that involves substantial operational changes in the May survey program, including the addition of annual visibility corrections for northern strata, changes that are not feasible in the short term. Instead, we should be able to estimate the relative bias as a function of LAT, and use this to find an empirical correction to this problem.

Bias in the balance equation. -- An even more troubling problem is that the balance equation doesn't balance. The balance equation is a simple population model that predicts the breeding population size in year $t + 1$ from the observed breeding population size in year t, the observed harvest age-ratio, and the observed annual survival rates (estimated from banding data). In all duck models currently in use, it is assumed that this equation is an unbiased predictor of the next breeding population size, and additional structural detail is added to the model from there. This equation is an accounting equation, and makes very few assumptions about the population dynamics. For pintails, the predicted BPOPs are on average 31% higher than the observed BPOPs in year $t + 1$. This is a very big issue for the implementation of AHM because it means the underlying population models predict much stronger growth of the population than is actually the case. Without correction, this would lead to overharvest. As noted above, the balance equation itself is nearly above reproach, so the cause of this bias must lie in either the survival rate estimates (from banding data) or the estimates of reproduction (from the harvest age-ratios). Note that a systematic, consistent bias in BPOP would *not* explain this problem. No strong evidence currently exists to identify a cause of this bias. Again, an empirical correction for this probably can be found.

Development of other components. – (1) A set of alternative models has been developed, and has been discussed by the AHM Working Group, as well as by a number of pintail biologists and managers in the Pacific Flyway. It may require some small modifications, and should be discussed more formally by the Flyway Study Committees, but most of the work on this element is complete. (2) Development of a

set of management actions, and expected harvest distributions for each, will depend on the answer to Key question #1 above. To explore the ramifications of the answer to this question, historical harvest data will be used to estimate distributions under each scenario. This has not yet been completed, but should not pose any substantive problems. (3) The objective function has not been specified (see Key question #2 above). The assumption is that it will be maximization of harvest over the long-term, subject to a possible devaluation of harvest when the population size falls below some level. Future work will explore the impact of different forms for the devaluation function.

Expectations. – By this time next year, the AHM Working Group can expect a full report on the implementation of adaptive harvest management for pintails. This report will describe the details of the various components, including the estimation of harvest distributions under different packages, the form of the harvest devaluation in the objective function, the set of alternative population models, and the methods of correcting the known biases in monitoring data. The report will consider the alternative answers to the two key questions listed above, and will compare the performance of the AHM strategy under the various scenarios.

A draft of the report will be prepared in time for the December Flyway technical committee meetings. We expect that the Flyways will review the report between that time and the March meetings, and forward comments and concerns. A revised report will then be prepared for the April 2002 AHM Working Group Meeting. The Working Group can make suggestions and the issue can be forward to the Flyway Councils for discussion at the July 2002 meetings. The Flyway's responses will be considered by the Fish and Wildlife Service. It is reasonable to expect that the requisite decisions can be made so that an AHM strategy can be put in place in time for the 2003 regulations cycle.

The draft report will be prepared by Michael Runge (USGS Patuxent) in cooperation with a small committee of representatives from the Flyways.

Harvest Strategies for Wood Ducks - *Pam Garrettson and Graham Smith*

We modeled the potential effects of increasing wood duck bag limits in the Atlantic and Mississippi Flyways from 2 to 3 birds/day. We used a simple balance equation for females, where $N_{t+1} = N_tS_t + N_tA_tS_t^{'}$, where N=absolute abundance, S=adult survival, S'=juvenile survival, and A=reproduction, as measured by juvenile/adult age ratios in the harvest.

Because we don't have a measure of absolute abundance for wood ducks (N), we used the breeding bird survey index for wood ducks (BBS) and assumed a linear relationship with N. We then used empirical estimates of survival and reproductive rates to predict successive year changes in the BBS index, and compared these predictions with the observed BBS indices. We set the intercept of the relationship between predicted and observed BBS indices to 0, and estimated a slope such B_{pred} = "B_{obs} (Equation 2). In all cases ">1, suggesting a positive bias in survival or reproductive rates.

We divided survival into hunting season and non hunting season components to obtain the expanded balance equation: B_{t+1} = "Bt(1-K_t)S_0+ A_t (1-K_t)S_0') + , (Equation 3), where 1-K=survival during

the hunting season, Kt=kill rate, S_0=survival rate in the absence of hunting and , is an error term that describes the variation in how closely the observed vs. predicted BBS regression (used to generate the slope correction parameter "), fit the data. All of the model variables/parameters have associated uncertainty. For Kt, So, At, and , we have measures of this uncertainty, and used it to simulate the effects on model outcomes. In general, for each parameter we used variance measures to generate a normal distribution for each region, from which a value for the variable was randomly chosen during repeated runs (n=200) of the expanded balance equation (Equation 3).

We calculated mean expected changes in BBS/year, along with standard deviations and standard errors, separately by region, due to differences in data quality among regions. We then obtained flyway-level population change predictions by multiplying the expected population changes for each banding region by the proportion of the flyway BBS index each contributes, then adding them together. We modeled two crippling loss rates (0.2 and 0.4), and various kill rates, ranging from current levels, to kill rates expected with bag increases, a kill rate threshold, above which projected population changes are negative.

For the Atlantic Flyway**,** modeling exercises suggested wood duck populations would start to decline when: (1) kill rates were increased to 50% above the 1988-1992 average, assuming crippling losses of 20%; and (2) when kill rates were increased by 30%, assuming crippling losses of 40% . In the Mississippi Flyway, modeled populations were even more tolerant of increased harvest, as projected population change for the flyway was stable or positive until: (1) kill rates reached 140% of the 1988-1992 average, given crippling losses of 20%; and (2) kill rates were increased by 70%, assuming crippling losses of 40%. Current estimated kill rate, assuming a band reporting rate of 0.82 (our most recent estimate for mallards), are comparable to 1988-1992 average kill rates, so presumably wood duck populations in both flyways could tolerate similar increases in kill even during years of liberal regulations.

Results of modeling suggest wood duck populations could tolerate a bag increase to 3 birds per day, but suggest that Atlantic Flyway wood ducks are more vulnerable to increased harvest than those in the Mississipi Flyway. AF (crippling loss 40%) threshold kill rates occurred when kill rates were increased by approximately 30%, which is within the bounds of increased expected harvest with a one-bird increase in the wood duck bag. High variances around projected population changes, particularly in the southern banding regions of both the Atlantic and Mississippi Flyways, also offer reason for caution. However, we think the tendency for projected population changes in southern banding regions to appear less robust in the face of increased harvest is due to their higher variances (due to poor data) rather than any biological factor we can discern.

Meeting Action Items

1. <u>Hunter satisfaction</u> - Dave Case, lead. Draft white paper by next April.

2. <u>Harvest distribution</u> - Jerry Serie, lead. Draft summary report by next April.

3. Multi-stock AHM - Fred Johnson, lead. Draft report on the implications of scale specification for harvest, harvest distribution, and population size prior to next April's meeting. A short synopsis of the issue is to be prepared for use at this summer's Flyway Council meetings. Next April's meeting will have this subject as the central theme.

4. Midcontinent mallard models - Mike Runge, lead, with Jim Dubovsky, Bill Kendall, Fred Johnson, Jim Gammonley, Dale Humburg. A "notice of intent" to modify the model set will be provided to Flyway Council's this summer. Specific recommendations will be available by December, and discussed at the SRC meeting in January 2002.

5. Eastern mallard models - Gary Costanzo, Bryan Swift, Fred Johnson. Update and revise mallard model set as specified in this report as soon as possible.

6. Western mallard models - Don Kraege, Fred Johnson. Continue work towards an acceptable model set. We need substantive progress by the winter 2002 Pacific Flyway meeting.

7. Pintail AHM - Mike Runge, lead. Recommendations and implications for model set should be available by April 2002.

8. Investigating spatial, temporal, and organization variability in duck population dynamics - Pam Garrettson and Mark Otto. A draft report will be available by April 2002.

9. AHM Communications Strategy - Dave Case, lead (assuming appropriate contracts are issued). A revised communications strategy should be completed as soon as possible.

10. AHM papers from 2000 North American conference - Dave Case, lead. Speak to Ken Williams about binding the three articles for distribution.

11. AHM training - Jim Dubovsky, Jim Gammonley, Dave Case. Work together to convert Dubovsky's presentation for administrators to a CD with a script (possibly with a narrator). Case will handle production.

12. AHM technical support within USFWS - Fred Johnson, lead. We need an AHM SOP, particularly in light of erosion of technical expertise in the USFWS. We also need a "pot of money" to procure technical assistance when needed from other organizations (e.g., USGS).

13. Communicating anticipated regulation changes - Fred Johnson, lead. Prepare a short document describing the implications of "knife-edge" harvest strategies as soon as possible.

14. Care & feeding of AHM - Dave Sharp and Bob Trost. There are increasing concerns about maintaining the AHM effort and progress, particularly in the face of drought. We need to prepare a draft letter from AHM Working Group to Tom Melius with cc to Flyway Council

chairs, and alert them to our concerns. This letter should be ready by the June 2001 SRC meeting.

15. Position statement on band-reporting rate study - Jim Dubovsky and others. ASAP. (final statement attached to this report)

16. Next AHM meeting - Dave Sharp and Jim Gammonley. Week of April 15th, 2002 in Central Flyway. Location TBA.

AGENDA

AHM Working Group Meeting
April 10 -13, 2001 / Sacramento, CA

Tuesday - April 10

8:00-8:30	Welcome / introductory remarks	FJohnson
8:30-10:00	Flyway / federal AHM reports (15min ea)	Federal & State reps.
10:00-10:20	break	
10:20-10:40	Status of AHM training efforts	FJohnson
10:40-11:20	Hunter-satisfaction "committee" report	Case
11:20-12:00	History of hunting regulations and harvest distribution	Serie
12:00-1:30	lunch	
1:30-3:00	Development of the programmatic EIS	Case
3:00-3:20	break	
3:20-4:30	Development of the programmatic EIS	Case

Wednesday - April 11

8:00-8:10	Introductory remarks	FJohnson
8:10-8:30	AHM for multiple mallard stocks *(postponed)*	FJohnson
8:30-10:00	Stock-specific AHM - Midcontinent mallards	Dubovsky / Kendall
10:00-10:20	break	
10:20-12:00	Stock-specific AHM - Midcontinent mallards cont'd	
12:00-1:30	lunch	
1:30-2:00	Stock-specific AHM - Eastern mallards	FJohnson / Swift
2:00-3:00	Stock-specific AHM - Western mallards	FJohnson / Kraege
3:00-3:20	break	
3:20-4:30	Stock-specific AHM - Pintails	Runge

Thursday - April 12

8:00-4:30	Field trip	Yparraguirre

Friday - April 13

8:00-8:10	Introductory remarks	FJohnson
8:10-8:55	Stock-specific AHM - Black ducks *(postponed)*	FJohnson
8:55-9:40	Stock-specific AHM - Wood ducks	Garrettson
9:40-10:00	Stock-specific AHM - AP Canada geese *(postponed)*	FJohnson
10:00-10:20	break	
10:20-12:30	meeting synthesis	

The Need for a Reward-Band Study

Position Statement
AHM Working Group
April 13, 2001

Adaptive Harvest Management (AHM) was implemented by the U.S. Fish and Wildlife Service (FWS) in 1995 in an effort to better link data from monitoring programs to harvest-regulations decisions for ducks. Over the past decade, Federal and State biologists have made extensive use of the information from operational surveys designed to assess duck abundance, production and harvest. As a result, several models of population dynamics for various stocks of ducks (e.g., mid-continent mallards, eastern mallards, northern pintails) have been developed to better manage harvests of these birds.

The North American Waterfowl Banding Program is an essential component of these efforts. Waterfowl are live-trapped, banded, and released annually, and a proportion of these banded birds are subsequently harvested by hunters. The band-reporting rate (i.e., the proportion of bands from hunter-shot birds that are reported to the Bird Banding Laboratory [BBL]) is required to estimate several parameters essential to model population dynamics. For example, the reporting rate is used in conjunction with recovery rates (i.e., the proportion of the banded birds that is shot and retrieved by hunters each year) to yield information about the harvest rate on populations. Additionally, the harvest rate of immature birds relative to that of adult birds is used in conjunction with harvest age-ratio data (derived from harvest surveys) to estimate the annual recruitment rate of waterfowl. Precise estimates for these two parameters (i.e., harvest rate and production) are critical to the AHM Working Group's efforts to develop useful population models. The AHM process is compromised when these parameters cannot be estimated accurately and precisely.

Historically, estimates of the band-reporting rates for mallards suggested that only about one-third of banded mallards shot and retrieved by hunters were reported to the BBL; rates for other species are unknown. In an effort to improve the cost-effectiveness of the banding program and to provide more precise information to help refine waterfowl management, managers in the FWS, the Canadian Wildlife Service, and the Flyways devised a strategic plan to increase reporting rates. The plan included changing inscriptions on the bands to include a toll-free telephone number by which hunters could report the bands. Unfortunately, a necessary drawback to changing band inscriptions entails enduring a period of time during which reporting rates would be changing and uncertain, thus precluding direct estimation of harvest and recruitment rates.

Beginning in 1995, bands with the toll-free number were placed on mallards. Since that time, reports of bands to the BBL via the toll-free number have increased from about 14% to 92% of all reports. Results of a small-scale pilot study (using only adult male mallards in a restricted geographic area) conducted during 1998-2000 suggest that reporting rates of toll-free bands for that cohort have stabilized over the last 3 years at about 80%. Although these results suggest that changing to toll-free bands may have doubled reporting rates, earlier studies indicate that band-reporting rates for mallards

vary geographically and perhaps by gender of birds. Thus, using reporting rates from this small-scale study to estimate harvest and recruitment rates of mallards would be imprudent.

In addition to its efforts to refine the AHM process for mallards, the Working Group has been asked to assess other issues related to harvest management as AHM has evolved. For example, the Working Group has been asked to assess the potential effects of framework-date extensions on optimal harvest strategies. In those assessments, we stated that we are unsure how the extensions would affect harvest rates, due to extremely limited and dated experience with such extensions. The assessments are based on information that is at least a decade old, before changes in reporting rates due to altering band inscriptions occurred. An adequate assessment of the effects of framework-date extensions on optimal harvest strategies would require contemporary estimates of harvest rates, which in turn require contemporary estimates of reporting rates.

Also, there is a strong desire by stakeholders to include other species (e.g., wood ducks, black ducks, geese) into the AHM process. For some species, band-recovery data are the primary source of information for developing appropriate management recommendations. Managers believe that demographics of hunters harvesting these various stocks are sufficiently different to cause reporting rates to differ from those estimated for mallards. Thus, using reporting rates specific to mallards would not adequately address needs related to modeling and monitoring efforts for these other stocks of birds.

Given these arguments, it is the position of the AHM Working Group that a large-scale reward-band study is absolutely critical to assess the ramifications of changing regulatory alternatives (e.g., altering framework dates, season lengths, bag limits). Further, such a study would provide us with contemporary information necessary to refine the AHM process for mallards, and would enhance the possibility of using the AHM process for managing other stocks of waterfowl. Results from the pilot study suggest that reporting rates likely have stabilized at a new, higher rate. Thus, we believe it is time to move forward with a full-scale reward-band study that (1) encompasses a greater geographic area for mallards, (2) can detect whether reporting rates differ between males and female mallards, and (3) can assess whether reporting rates differ among stocks of waterfowl. Without contemporary estimates of reporting rates for the new toll-free bands, we cannot conduct adequate assessments for the issues with which we have been tasked.