Cerulean Warbler Risk Assessment & Conservation Planning Workshop

National Conservation Training Center
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Table of Contents

INTRODUCTION 4
METHODS 4
PRESENTATIONS 5
EVENING SESSION OF ENVIRONMENTAL FACTORS 6
HISTORICAL POPULATION SIZE AND TREND 6
Methods 6
Results 8
Discussion 9
CERULEAN WARBLER LIFE HISTORY 10
Methods 10
Results 10
Discussion 12
CAUSAL FACTORS 12
Methods 13
Results 14
List of Propositions 14
Non-Breeding Season 14
Non-Breeding and Breeding Linkage 15
Breeding Habitat - Loss and Degradation of Quality Propositions 16
Specific Causes of Habitat Loss and Degradation in the Breeding Range 17
Atmospheric Effects 18
Direct Mortality 18
General 18
Discussion 18
POPULATION PROJECTIONS 19
Methods 19
Results 20
Discussion 21
SETTING CONSERVATION GOALS 22
Methods 22
Results 23
Discussion 23
CONSERVATION ACTIONS 23
Methods 23
Results 24
List of Conservation Actions 24
Discussion 26
CONCLUSION 26

List of Figures

Figure 1. Range-wide population trend using two statistical methods. 7
Figure 2. Sample score sheet for historical population size and abundance exercise..... 8
Figure 3. South American distribution of habitat using modeled parameters. 15
Figure 4. Sample score sheet for assessing future population trend. 19
Figure 5. Probability of 90% decline in *t* years. 20
Figure 6. Categories of Conservation Actions with summed scores. 24

List of Tables

Table 1. Final scores for historical population size and trend exercise.. 9
Table 2. Life History Attributes..... 11
Table 3. Final results of the exercise to assess future population trends. 21

INTRODUCTION

The U.S. Fish and Wildlife Service convened a panel of experts to discuss Cerulean Warbler biology as it relates to addressing two impending management decisions. One, the Service has until the fall of 2006 to decide whether to propose Cerulean Warbler for protection as threatened or endangered under the Endangered Species Act. Two, the FWS Migratory Birds program has selected Cerulean Warbler as a "focal species" for measuring its success in bird conservation and has set a deadline of September 30, 2006, for development of a Conservation Action Plan for the species. This Plan will reinforce Cerulean Warbler objectives and priorities of Partners in Flight, the Cerulean Warbler Technical Group, Joint Ventures, and other partners by guiding the Service's internal budget allocation process and helping to catalyze other budget initiatives on behalf of Cerulean Warblers.

METHODS

We broke down the overarching management decisions into smaller pieces and converted key management questions into analogous biological questions. Key areas of inquiry that emerged were: (1) historical population size and trends, (2) future population trend, (3) factors causing the population trend, (4) appropriate population goals, and (5) conservation actions to achieve desired population goals. The agenda focused on these five broad areas of biological interest (Appendix 1).

We convened a workshop at the National Conservation Training Center, on June 12, 13, and 14, 2006. Cerulean Warbler experts, quantitative and general ornithologists, and experts in land use participated on a panel (Appendix 2). We reviewed available information, facilitated discussions about available information, conducted scoring exercises to characterize uncertainty and elicit discussions, and evaluated options for answering critical biological questions in the face of uncertainty. We did not seek consensus among panelists; instead, we focused on fully probing and understanding the bases for, and extent of, differences of opinion or interpretation. Discussions at the workshop focused on scientific and technical information. Panelists did not discuss or recommend management decisions related to the Endangered Species Act, but they provided input on potential conservation actions for consideration when drafting the Focal Species Action Plan.

Other participants in the workshop included Fish and Wildlife Service biologists, and outside observers who served as peer reviewers of the process (Appendix 3). Four Fish and Wildlife Service biologists facilitated the workshop, and another three were silent observers to the process. The independent observers monitored the workshop and informed the meeting facilitators if they observed biases in workshop design, facilitation, or unbalanced participation from panelists. Meeting notes taken by the independent observers are included in Appendix 4.

We broke the workshop into two sections. The first section included a day of presentations by some panelists and other invited experts. The second section, on days 2 and 3, was a facilitated workshop. During the workshop section, we asked panelists a variety of questions and quantified their beliefs about the certainty with which they could answer questions. Panelists received numerical identifiers during the first exercise. We used these identifiers instead of names throughout the workshop to preserve anonymity of the panelists. Our facilitators used the distribution of anonymous scores to elicit discussion about why there are similarities or differences in beliefs. The purpose of this method was to identify sources of information and knowledge used by panelists when drawing conclusions about Cerulean Warblers, and to discuss the assumptions panelists were using where information was unavailable or uncertainty was high. Panelists had opportunities to re-score exercises after the discussions.

This document describes the proceedings, presents the raw scores, and summarizes the discussions elicited during the workshop. It also contains sections containing interpretations of the discussions, which we produced after the workshop and present as separate boxes highlighted in yellow. Contents of this document follow the order of the agenda: (1) presentations, (2) historical population size and trend, (3) life history, (4) limiting factors and threats, (5) future population trend, and (5) conservation goals and actions.

PRESENTATIONS

The objective of this session was to present the current knowledge of Cerulean Warblers and their habitats. Tom Will, Fish and Wildlife biologist from the Midwestern Division of Migratory birds moderated the day's agenda. Presenters had 20 minutes to present material, and approximately 10 minutes to answer questions from workshop participants. Dr. Will gave panelists first opportunities to ask questions of presenters, and then opened the floor for questions from the other participants, if time remained. The presentations were centered on two central themes: (1) life history and population- and demographic-based information, and (2) habitat-based information. The following paragraphs describe the presentations within each theme. Refer to Appendix 2 for the correct order. Copies of all presentations are included in Appendix 5.

The first block of presentation focused on Cerulean Warbler life history, population size and trend, and habitat use. Paul Hamel, a Cerulean Warbler expert from the USDA Forest Service's Southeast Hardwoods Forest Research Station, began the workshop with a presentation of Cerulean Warbler life history. John Sauer, USGS Patuxent Wildlife Research Station, explained his trend analysis of breeding bird survey (BBS) data. Wayne Thogmartin, USGS Upper Mississippi Experiment Station, delivered information on a new analysis he conducted using BBS information to project future population trends. Ken Rosenberg followed with a presentation about population size estimates based on BBS data. Randy Dettmers discussed habitat use and correlations with a PowerPoint slide show about Cerulean Warbler breeding habitat selection. Wayne Thogmartin presented the results of an analysis of Cerulean Warbler breeding habitat

correlations using BBS information and USDA Forest Service forest inventory data. Maria Isabel Moreno, Director of Research with Pro Aves, discussed information on Cerulean Warbler distribution in South America.

The second block of presentations included material on land use, habitat trends, and Cerulean Warbler demographic analyses. Steve Morey facilitated a discussion about the long-term history of changes in the Eastern hardwood forest (Appendix 6). Mark Nelson presented specific information about the statistical basis for forest inventory data used in Dr. Thogmartin's habitat analysis. Jason Jones and David Buehler, each presented material about demographic analyses they had conducted using data from Ontario, Canada, and various locations in North America, respectively. Pat Keyser, Cindy Tibbott, and Brett Butler delivered talks on habitat use and trends with information about private forest management, mountain top mining, and general land use trends, respectively. Maria Isabel Moreno, ended this session when she returned to the podium to present material on habitat changes in South America.

EVENING SESSION OF ENVIRONMENTAL FACTORS

Steve Morey facilitated a discussion on the evening of June 12 to discuss sources of information on environmental factors that may be affecting Cerulean Warbler populations. The focus of the evening session was on factors that were not addressed in the presentations earlier in the day. Topics discussed in the evening session included wind towers and other aerial obstacles, contaminants in North and South America, climate change, avian disease, and long-term habitat change. Refer to Appendix 7 for notes of the discussion.

HISTORICAL POPULATION SIZE AND TREND

The purpose of this section of the agenda was to elicit opinions about the reliability of the Partners in Flight population size estimate and the USGS trend analyses of BBS data. Panelists for this session included: David Buehler , Brett Butler, Randy Dettmers, Paul Hamel, Jason Jones, Pat Keyser, Maria Isabel Moreno, Mark Nelson, Ken Rosenberg, and Wayne Thogmartin.

Methods

Steve Morey introduced this session of the agenda and explained its purpose. Before engaging panelists in discussion about population size and trend, Jean Cochrane explained the methods for an exercise the panelists would be participating in, which we designed to elicit beliefs and stimulate discussion about population size and trend. We reviewed the PIF population size estimate, including the +/- 50% brackets, and explained that we had rounded off the population estimate to the nearest 100,000. We also reviewed the trend estimate and discussed the Bayesian 95% credible interval (equivalent to a traditional or 'frequentist' statistical confidence interval) of the hierarchical analysis. We displayed graphics of John Sauer's analysis of BBS data (Figure 1) and asked panelists to answer two questions:

- What was the true Cerulean Warbler range-wide population size in the 1990s?
- What was the true historical range-wide population trend for Cerulean Warblers from 1966 to 2005?

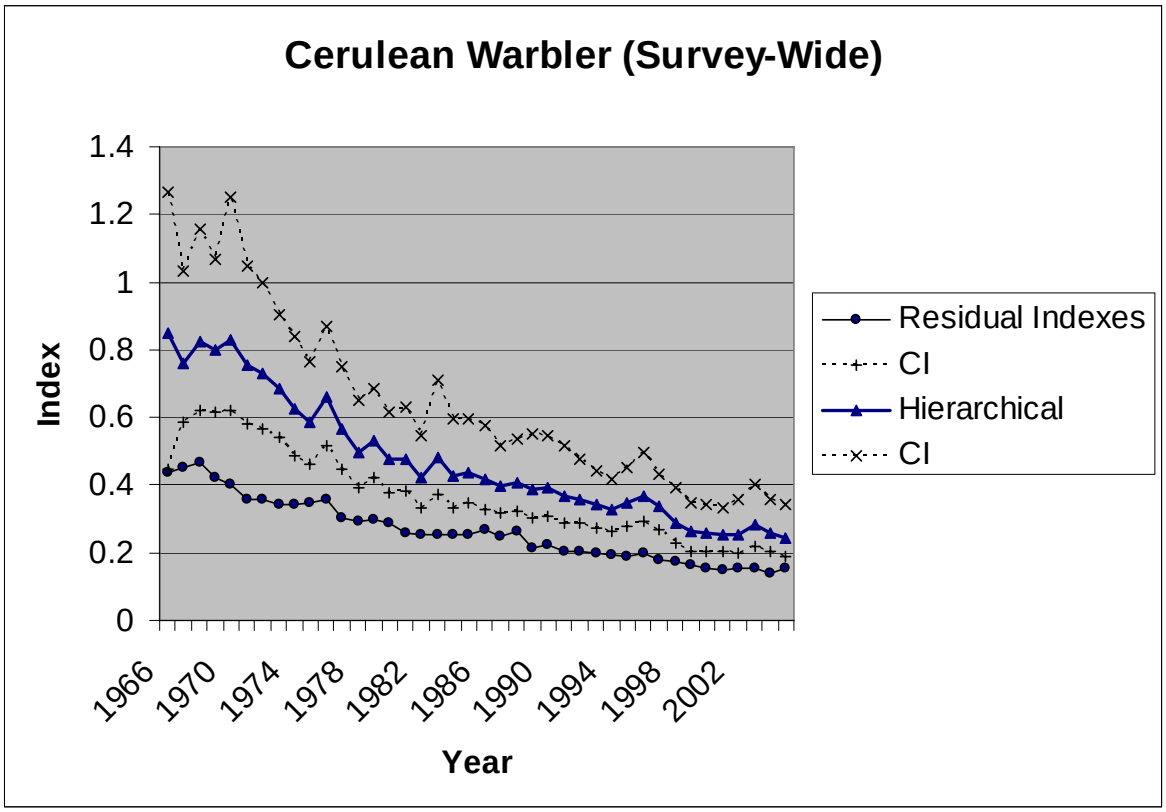

Figure 1. Range-wide population trend using two statistical methods.

Each panelist had 100 points to allocate among pre-identified categories for each question according to the following instructions (Figure 2).

We're asking you questions about the historical population size and trend for the Cerulean Warbler. For each question, put 100 points under the answer(s) that best reflects your belief. You may spread your points between different answers in any amounts to reflect uncertainty in the correct answer. For example, putting 100 points in one answer indicates total belief that answer is correct. In contrast, dividing your points evenly between answers indicates you have no reason to believe one answer more than another answer.

What was the true Cerulean Warbler population size rangewide in the 1990s?

Population Size Rangewide	Score
Much less than the PIF estimate (< 300,000)	
Lower half of ~ PIF estimate range (300,000 - 600,000)	
Upper half of ~ PIF estimate range (600,000 - 900,000)	
Much greater than the PIF estimate (>900,000)	

Must sum to 100

What was the true historical population trend for Cerulean Warblers rangewide 1966-2005?

Rangewide, the Cerulean Warbler population trend from 1966-2005 was:	Score
Less decline than BBS c.i. (< 2.0%/yr decline or positive)	
Within BBS c.i. (between -2.0 and -4.2%/yr)	
More decline than BBS c.i. (> 4.2%/yr decline)	

Must sum to 100

Figure 2. Sample score sheet for historical population size and abundance exercise.

Panelists had as much time as needed to answer the questions. We collected and transcribed the handwritten score sheets into Excel spreadsheets, and displayed the results anonymously onscreen in the front of the room. Steve Morey facilitated a discussion about the reasons behind the scores and sources of information and uncertainty. Panelists rescored the question after the discussion.

Results

Through their scores, all of the experts expressed a belief that the true population size in the 1990s and the 40-year population trend were most likely within the upper and lower bounds of the available estimates (Table 1). Each of the ten panelists' put the majority of their likelihood or belief points (thus, their mode scores) within the upper and lower bounds of the Partners in Flight population size estimate for the 1990s. One panelist's mode was spread evenly between the upper and lower halves of the bounds; eight other panelists had modes within the category labeled "upper half of ~PIF estimated range."

Only one panelist had a mode in the lower half of the PIF estimated range. All of the panelists' mode scores for the population trend estimate were within the calculated credible interval. Notes from the discussion are contained in Appendix 4 and Appendix 8.

Table 1. Final scores for historical population size and trend exercise. Each vertical column represents a different panelist's scoring (with the panelists in random order). PIF is Partners in Flight. The BBS c.i. is the Breeding Bird Survey 95% credible interval for the average annual rate of population change. Cells containing the modes or most likely answers are highlighted in blue.

What was the true Cerulean Warbler population size rangewide in the 1990s?

Population Size Rangewide										
Much less than the PIF estimate (< 300,000)	0	0	5	0	5	5	0	5	0	0
Lower half of ~ PIF estimate range (300,000 – 600,000)	5	20	40	30	10	30	20	70	10	30
Upper half of ~ PIF estimate range (600,000 – 900,000)	70	80	40	40	70	40	60	25	70	55
Much greater than the PIF estimate (>900,000)	25	0	15	30	15	25	20	0	20	15

What was the true historical population trend for Cerulean Warblers rangewide 1966-2005?

Rangewide, the Cerulean Warbler population trend from 1964-2005 was:										
Less decline than BBS c.i. (< 2.0%/yr decline or positive)	20	10	10	20	20	3	5	5	10	15
Within BBS c.i. (between -2.0 and -4.2%/yr)	70	80	80	60	75	95	80	75	80	75
More decline than BBS c.i. (> 4.2%/yr decline)	10	10	10	20	5	2	15	20	10	10

Discussion

Overall, panelists expressed a high degree of belief in the population size (70 to 100 out of 100 points) and trend estimates (60 to 95 out of 100) derived from BBS survey data, within the bounds described for each estimate. Most of the panelists (9 of 10) also believe that the point estimate for population size (560,000 birds c. 1995) may have underestimated the true population size because the survey methods may tend to undercount rather than over count Cerulean Warblers (see discussion in box, below). In general, the panelists believe the population was most likely between 600,000-900,000 birds a decade ago.

All of the panelists expressed strong belief that the true, average annual population trend from 1966-2005 was within the credible interval of – 2.0 to – 4.2 per year. Panelists expressed that the methods for using BBS data to estimate trends has been vetted, published, and accepted by the scientific community. Panelists expressed that potential biases in the data collection methods are, for the most part, mitigated by the statistical methods for analyzing the data. In particular, the aforementioned potential to undercount birds is presumed to have been present consistently across the survey period, and thus would not affect the trend estimate.

CERULEAN WARBLER LIFE HISTORY

The purpose of this session was to review basic knowledge about Cerulean Warbler life history and stimulate thinking about how the species' life history traits contribute to population resiliency or vulnerability to threats. We specifically asked panelists to explain the differences between Cerulean Warblers and other wood warblers and neotrotical migrants. Panelists for this session included: David Buehler , Brett Butler, Randy Dettmers, Paul Hamel, Jason Jones, Pat Keyser, Maria Isabel Moreno, Mark Nelson, Ken Rosenberg, and Wayne Thogmartin.

Methods

Steve Morey described the purpose and methods for this discussion. We displayed a simple matrix with columns for life history trait, measures, and notes. Panelists filled in the matrix by (1) identifying life history traits, (2) stating known measures of the traits, and (3) expressing how the trait was likely to influence the species' population trend. We encouraged specific discussions to clarify use of terms, if differences in interpretation were apparent. Not all boxes were completed during the discussion because (1) insufficient time was available for discussion, or (2) information was not available to complete the matrix.

Results

Panelists constructed the following life history table during the discussion. The purpose of the table was to focus discussion in order to clarify the group's understanding of terms and to stimulate thinking about Cerulean Warbler life history traits. The table is not a comprehensive treatment the species life history.

Table 2. Life history attributes.

Attribute	Measures	Notes
Demographic Attributes		
migration	early in fall normal timing in spring	risk of hurricanes in spring, concentrated in staging and stopover locations transgulf, maybe in concentrations information gap on fall migration molt migrant? Spring concentration of experienced animals
female survival, dispersal, senescence, habitat choice, -- general biology	unknown, needs measurement	
renest after success	single brooded	because early fall migration?
renest after failure	3 to 4 attempts (max of 7 in Ontario)	
breeding site fidelity	regionally specific according to isotope info (info on males only) no info on females	may increase vulnerability
adult inter-annual breeding dispersal	capable of this dispersal higher than expected	increase resiliency most evidence in isotope data - need more info ratio between adult and juvenile dispersal may be different in CERW and other warblers
non-breeding site fidelity		
migratory connectivity	suggestion of north to north, south to south connection	suggestion from isotope data that birds in breeding range tied to same non-breeding range -- could increase risk
juvenile survival	Unknown	in Ontario at least 1 of 18 has returned
natal dispersal	hint from isotope that CERW lower than other warblers lower than expected	are birds tracking favorable environmental conditions?
habitat specialization		can we quantify suitability?
clutch size		
brood size		partial brood reduction?
life span in wild	up to ~ 6 years	
lifetime repro success		
generation length		
food habitats	can include nectar in non-breeding	
foraging ecology		
body size and weight	small	tied to vulnerability in migration

Attribute	Measures	Notes
age dependent repro success		relationship to survival
social behavior - non breeding	mixed species flocks in non-breeding season may be hyper-dispersed on non-breeding grounds	increased vulnerability because of need for lots of habitat something affecting resident species could influence CERW
social behavior - breeding	unknown	other species interactions (e.g., nest material squabbles, coloniality, etc) could have effect. Raises question of minimize size and density requirements.
mating system	mixed - poly levels of EPF	
Habitat Selection Attributes		
habitat selection in non-breeding grounds	specialist - precipitation and temperature	may be more specialized than most migrants need to know core areas need to know if male and female differential in selection hint of some altitudinal separation between males and females in Venezuela
post fledging habitat use	unknown, needs measurement	could be tied to young seral stage, this habitat is diminishing in Appalachians.
habitat selection in breeding grounds	strongly selective for rare features, such as large deciduous trees and forest structure landscape dependent patch size	may be some flexibility but likely more picky than most warblers forest fragmentation could increase risk in portions of range don't know response to disturbance

Discussion

Researchers continue to collect life history information on Cerulean Warblers. Some existing information indicates that Cerulean Warblers may have life history and habitat selection characteristics that distinguish them from other wood warblers. We have summarized the meeting notes and conducted additional review of literature to describe Cerulean Warbler life history. The following text describes FWS's post-workshop findings, which are based on relevant discussions during the workshop and the literature (citations will be added).

CAUSAL FACTORS

The purpose of this portion of the agenda was to describe and evaluate the relative contribution of environmental factors to the estimated population decline. Panelists for

this session included: David Buehler , Brett Butler, Randy Dettmers, Paul Hamel, Jason Jones, Pat Keyser, Maria Isabel Moreno, Mark Nelson, Ken Rosenberg, and Wayne Thogmartin.

Methods

Tom Will described the purpose and methods for this section and facilitated the discussion. We displayed a copy of population trend used in the previous exercise (Figure 2) so that it could be used as a frame of reference for this discussion.

Panelists brainstormed a list of causal factors that might explain the population trend in Figure 2, and then listed additional factors that might be influential in the future. We gave panelists the following "framing guidelines" to assist them in developing propositions about causal factors:

Propositions should address:

- Population-level effects;
- Geographic scale of Bird Conservation Region (BCR) size or larger;
- Proximal causes; and/or
- Temporal scale outside the range of normal annual variability including repetitive annual events with cumulative effects. Think about life span and the temporal scale at which long-term effects occur.

And,

- State a cause and effect relationship. For example, A will have an affect on CERW because of B (e.g., change in demographic rate, if possible).

We typed the list of causal propositions onscreen for panelists to review and edit as items were added to the list. Panelists did not critique the merits of each proposition during the brainstorming. We added a proposition at the end to capture unknown causes of population decline.

When panelists were comfortable that the list was complete, they were given a chance to lump or split propositions, in an effort to level the scale and scope of the list of propositions. We grouped remaining propositions into categories, and printed a copy of the propositions for each panelist.

Panelists then participated in an exercise to rank each proposition based on its influence relative to the other propositions. We elicited individual scores from each panelists by asking them to decide which factor would have the greatest relative contribution to Cerulean Warbler future long-term (i.e., 40 - 100 years) population trend and to write in 100 for its "relative impact" rank next to the factor on the handout. Then we instructed panelists to decide which factor would have the least relative contribution to Cerulean Warbler population trend and write in 0 for its "relative impact" rank. Panelists were instructed that 0 did not mean zero impact. Similarly, 100 points did not mean complete or exclusive contribution to the trend. For each of the remaining factors, panelists were asked to estimate their relative contribution on a 0-100 scale by comparing them with the

greatest and least impact factors. They wrote their "relative impact" score next to each proposition on the list. Tied scores were acceptable. We explained that because scores were relative and not absolute measures of impact, they could not be compared across panelists.

We compiled the scores and presented the results in a ranked-order histogram, from highest to lowest scoring propositions. During a discussion of the scores, it became apparent that the propositions had not been described to equivalent degrees of resolution or scale (e.g., leveled adequately to allow direct comparison scoring), or to eliminate overlap between the propositions (e.g., 'double counting'). In particular, propositions addressing causal factors in the breeding range were described to a finer scale and contained more overlap than did the propositions covering the non-breeding range. During the discussion, some panelists said that they scored each breeding habitat factor with a cumulative score, as if all breeding habitat issues were combined. Other panelists indicated that they scored the incremental impacts of each causal factor. Some of the panelists were also uncomfortable with comparing their individual relative rankings without a common reference of magnitude of absolute impacts.

Although panelists were satisfied with the overall content of the propositions, they did not all become comfortable with the utility or interpretation of quantitative, comparative rankings because we did not have time in the agenda to (1) resolve the uneven scales, resolution, and redundancy between the propositions, (2) more fully clarify the ranking method, or (3) reiterate the exercise with re-scaled propositions.

Results

Panelists generated the following list of propositions to describe reasons for the estimated population decline. Because of the problems explained above, we are not including the detailed numerical scoring results in this report. Instead, we present the meeting notes (Appendix 4) and summarize the discussion contained in the meeting notes in the discussion section.

List of Propositions

Non-Breeding Season

1. Clearing of forest habitat in the mid-elevation, principally eastern slope, Northern Andes range (Figure 3 modeled original non-breed habitat area, Figure 4 modeled Colombia and boarder countries current habitat area) resulted in decrease in over winter survival or condition for migration because of the unquantified suite of biological effects related to habitat loss.

2. Patch sizes and connectivity (fragmentation) has led to declines in over-winter survival on the non-breeding grounds.

3. Change in the cover of shade plantations will result reduction in available habitat in the non-breeding season.

Non-Breeding and Breeding Linkage

4. Migratory connectivity (linked fidelity between breeding and non-breeding site) renders CERW disproportionately susceptible to habitat losses in both parts of the range.

5. Loss of suitable stop-over in the southern US and Central America has led to increase in mortality during migration.

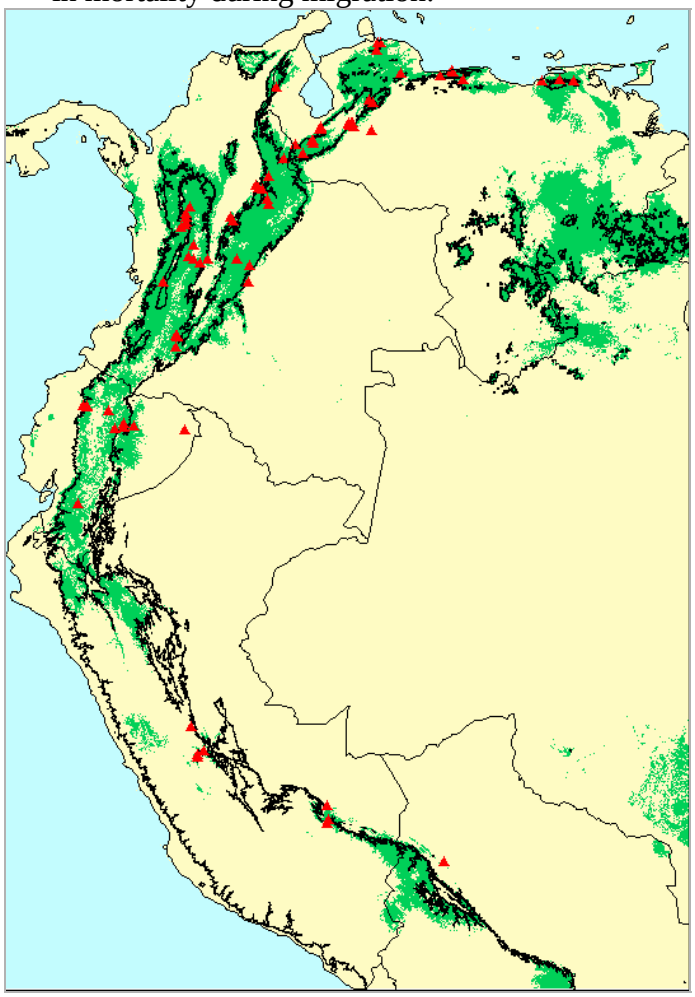

Figure 3. Original South American distribution of potential habitat (green highlighted area) using modeled topographical and climatological parameters (from Moreno presentation, Appendix 5).

After the meeting Maria Isabel Moreno sent the following map of current habitat distribution in Colombia.

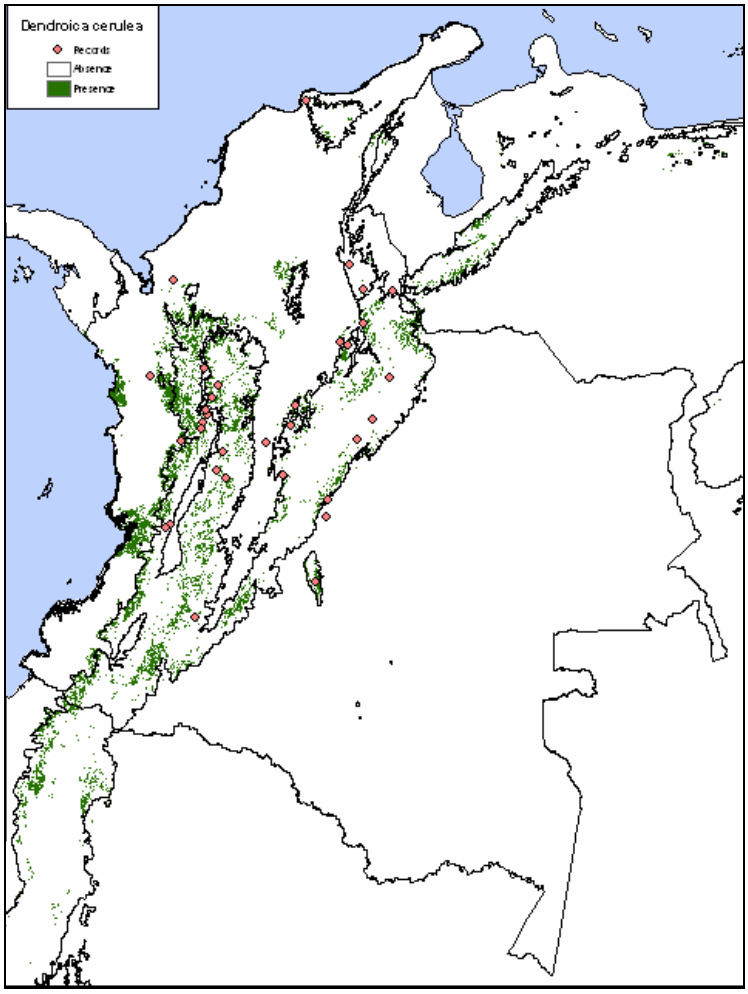

Figure 4. Current distribution of Cerulean Warbler habitat in Colombia and boarder countries from modeled parameters (Maria Isabel Moreno, Pro Aves, from Moreno presentation, Appendix 5, unpublished 2006). Documentation of habitat loss from other areas was not available, but assumed to be similar to losses in Colombia.

Breeding Habitat - Loss and Degradation of Quality Propositions

6. Landscape-scale extent and configuration (loss and degradation of quality) of breeding habitat in the MAV and the Ohio Valley (alluvial bottoms) has lead to lower reproductive success because of increased nest predation and parasitism.

7. Increased area in agricultural production within the breeding range has increased over-winter survival of cowbirds and resulted in higher populations of cowbirds leading to increased nest predation and parasitism.

8. Increased predation (variety-mammals, birds, herps) on eggs and nestlings led to decreased nest success and productivity.

9. Within stand loss of heterogeneous habitat structure (degradation of habitat quality) in the Appalachian BCR, as mediated by various disturbance agents (fire and deer), led to decreased nest success, reduced recruitment, and other unquantified demographic responses.

10. Changes in structure and composition of breeding habitat resulted in lower nest site availability and led to lower nest success for a variety of reasons.

11. Decades of high grading the tall emergent trees from the forest has created a structural change and resulted in lower nest site availability and led to lower nest success.

12. Loss of quality post-fledging habitat is leading to increasingly lower juvenile survival.

13. Forest management (disturbances such as logging) in the Appalachians (BCR 28) is responsible for loss and degradation of quality of breeding habitat, leading to reduced reproductive output.

<u>Specific Causes of Habitat Loss and Degradation in the Breeding Range</u>

14. Proliferation of large-scale surface mining over the past few decades in the Appalachians has had a disproportionate affect on CERW through loss of forests in the core of the range. The associated creation of hard edges has decreased the quality of habitat around the edges.

15. Urbanization and associated infrastructure throughout the range of the species has removed and fragmented habitat has resulted in population decline.

16. Tree pathogens have reduced the numbers of elm, chestnut, and oak trees leading to change in diversity or structure of forest breeding habitat.

17. Oak diseases or lack of oak regeneration will restructure the forest.

18. Large increase in white-tailed deer populations has resulted in lack of regeneration of oak trees and loss of understory affecting habitat structure.

19. Catastrophic wildfire will result in major loss of forest cover on a wide scale.

20. Changing forest ownerships resulting in increased parcelization of forests will contribute to fragmentation and will result in habitat loss.

21. Dramatic reduction of forest industry markets will result in change in forest structure.

Atmospheric Effects

22. Because of climate change, an increasing disconnect in the flush of insects relative to when the birds need them is pushing females to their energetic limits and affected females reproductive output.

23. Acid rain.

Direct Mortality

24. Increased violent weather in the Gulf of Mexico will further reduce survival.

25. Avian diseases will result in increased mortality.

26. Frequency and intensity of natural catastrophic forest disturbances will result in decreased forest quality.

27. Wind power development

General

28. Unknown causes

Discussion

Important information emerged when panelists discussed the results of the exercise. All panelists agreed that loss of habitat in the species' non-breeding range, particularly the eastern slope of the Northern Andes, was a primary contributor to the species' noted population decline. Factors dealing with loss of stand heterogeneity in breeding habitat (factors 9, 10, and 11 above) received the highest scores for factors dealing with breeding range.

One panelist cautioned against comparing scores for non-breeding habitat against the scores for breeding habitat because of the different levels of scale and overlap in the factors. To illustrate the difference, the panelist noted that 23 of the 28 factors dealt with incremental effects of factors on the breeding habitat, and only three factors described the combined effects of habitat loss in the non-breeding range. Several panelists agreed that this presented problems with scoring the propositions and interpreting the results.

Panelists discussed how to deal with the differences in scale, and concluded that this species' persistence depends on having its needs fulfilled throughout is annual cycle in all parts of its range. The notes reveal a general agreement that changes in habitat for breeding, migration, and over-winter habitat all must be considered when assessing the species risk; however, some panelists persisted in their conclusion that loss of habitat in the Northern Andes is the biggest contributor to the noted population decline.

It is important to note that we were not seeking consensus in this, or any other, exercise. We did not have sufficient time on the agenda to further probe the causal factor analysis,

nor were there empirical data available to resolve the uncertainty about cause and effect relationships.

POPULATION PROJECTIONS

The purpose of this session was to elicit panelists' beliefs about projected population trends for the Cerulean Warbler in next 100 yrs. Panelists for this session included: David Buehler , Brett Butler, Randy Dettmers, Paul Hamel, Jason Jones, Maria Isabel Moreno, Mark Nelson, and Wayne Thogmartin.

Methods

Steve Morey facilitated this session and Jean Cochrane described the exercise. We initiated this session by asking panelists to distribute 100 points among the following categories to represent their beliefs about the future population trend for Cerulean Warblers. Specifically, they were directed to think about the 'playing out' over the next 100 years of the ecological and population consequences of what they believe about Cerulean Warblers today, including everything discussed so far (natural history, trend and abundance estimates, cause and effect factors). They were not to speculate about any new developments in future time periods (e.g., future threats or future conservation practices); simply to project forward from the information they have about life history and current status and trends for the species' and its environment. Panelists could spread their 100 points between the possible answers to indicate their extent of certainty in which answer is correct. Uncertainty may be due to both lack of knowledge and limited predictability of random future events.

Rangewide, the future cerulean warbler population trend will be:	Average annual trend	Score
Essentially no decline or increasing	0 to +	
Decline less rapidly than projected by 40-yr trend	decline < -2.0%/yr	
Decline by lower half of range projected by 40-yr trend	decline -2.0 to -3.1%/yr	
Decline by upper half of range projected by 40-yr trend	decline -3.1 to -4.2%/yr	
Decline more rapidly than projected by 40-yr trend	decline > -4.2%/yr	

(must sum to 100)

Figure 5. Sample score sheet for assessing future population trend.

We displayed two graphic representations onscreen of the estimated future population trend from Wayne Thogmartin's presentation (Figure 1 and Figure 6) (Appendix 5) while panelists filled in their score sheets.

We transcribed results onto an excel spreadsheet and displayed them anonymously onscreen. Panelists discussed patterns in the scores and reasons for panelists' point distributions. Panelists were given an opportunity to rescore their answer sheets after the discussion. The group conducted a qualitative sensitivity analysis after the final scoring by answering specific questions about "what if" the future is different.

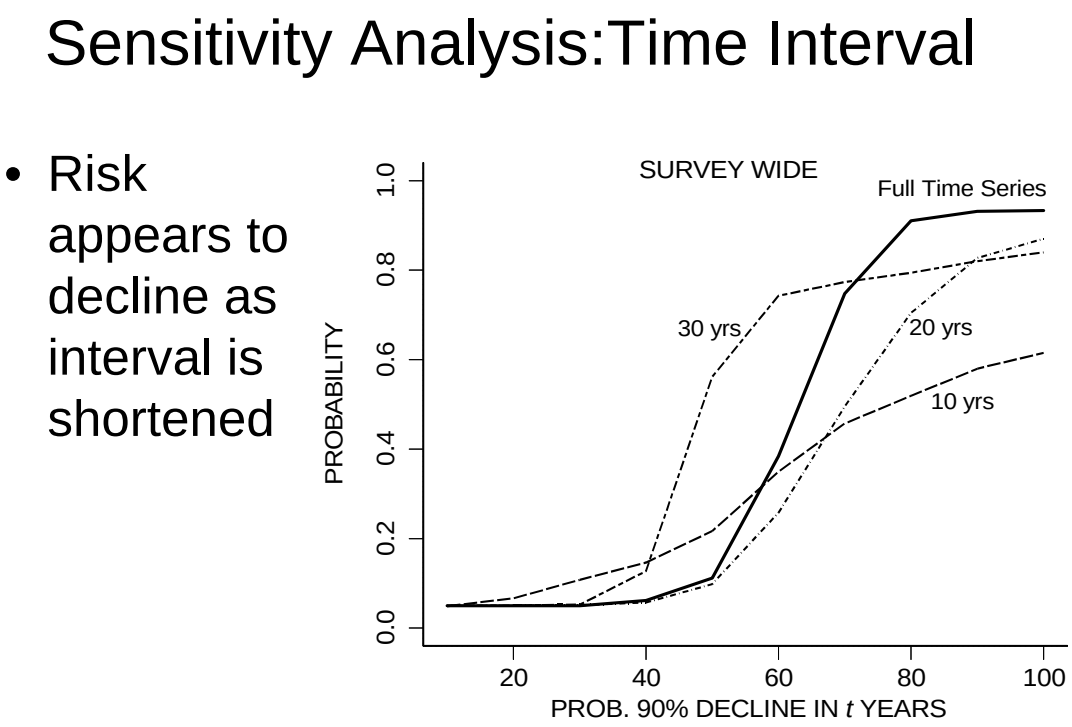

Figure 6. Probability of 90% decline in *t* years (Thogmartin presentation, Appendix 5).

Results

Table 3 presents the final or post-discussion scores for the exercise on estimating future population trends. Notes of the facilitated discussion are contained in Appendix 4 and Appendix 9.

Table 3. Final results of the exercise to assess future population trends.

Rangewide, the future cerulean warbler population trend will be:

Decline		***Scores***							
~ none to +	0 to +	**0**	**5**	**10**	**0**	**0**	**3**	**5**	**0**
< 40-yr trend	<-2.0%/yr	**0**	**10**	**10**	**10**	**0**	**17**	**10**	**10**
lower range 40-yr trend	-2.0 to -3.1%/yr	**40**	**30**	**50**	**25**	**10**	**27**	**20**	**35**
upper range 40-yr trend	-3.1 to -4.2%/yr	**55**	**40**	**25**	**40**	**80**	**35**	**50**	**40**
> 40-yr trend	>-4.2%/yr	**5**	**15**	**5**	**25**	**10**	**18**	**15**	**15**

Discussion

This was the capstone exercise for the workshop and helped bring resolution to the causal factors discussed earlier in the agenda. Panelists explained that they believed that the future population trend was likely to continue into the future as it has in the past. Most of the panelists believed that the true future population trend was probably going to be in the -3.1 to – 4.2 half of the credible interval, although the trend could also be less or more steep. Half of the panelists can foresee a small chance that the population will be stable or increasing, on average, over the long-term future; the other four panelists could only foresee some level of continuing decline across 100 years. Many different reasons were presented for the belief that the population will continue to decline at 3% or greater per year on average, including, but not limited to:

- The species' recent population decline has been steady despite apparent lessening of the rate of conversion of original tropical forests to agriculture or non-useable habitats in Cerulean Warbler non-breeding range.
- Birds have continued to decline despite the ongoing regrowth or recovery of large areas of mature Eastern hardwood forest, especially in the Appalachian core breeding region.
- Adverse population level effects could be occurring from climate change, through changes in prey availability and forest structure, and increased hurricane frequency in migration corridors.

We asked panelists to consider a few scenarios to test the sensitivity of their final scores to assumptions about key causal factors. For example, we asked, "would you change

your scores if mountain-top mining ceased today?" Most panelists said that they would shift some points to a more optimistic category, but that their modes or most likely belief about the future trend would not change. In contrast, many panelists stated that they would redistribute points and shift modes, when they answered the question "would you change your scores if all habitat loss in the non-breeding grounds ceased today?" Panelists indicated that they would not change modes if we acquired certain knowledge that Cerulean Warbler social behavior is not any more colonial than other warblers. In contrast, they would change modes if nest success and number fledged went to the best, most optimistic rates to be expected throughout the range. To conclude this exercise, we asked each panelist to suggest any additional factors that would change their mode. We did not seek concensus or agreement for any of these factors. The final list included:

- Contrary evidence of decline because of better population monitoring
- Decrease in migration risk
- Post fledging survival is better or worse than currently thought
- *Corvid* populations decline
- If we find that there are different problems with females that we cannot figure out by studying males and it dramatically alters the species' risk potential

The discussion about and other scenarios are presented in Appendix 4 and 9.

SETTING CONSERVATION GOALS

The purpose of this exercise was to discuss appropriate conservation goals for the Fish and Wildlife Service's Migratory Bird Focal Species Action Plan. Panelists for this session included: David Buehler , Brett Butler, Paul Hamel, Jason Jones, Maria Isabel Moreno, Mark Nelson, Wayne Thogmartin, and Tom Will.

Methods

Randy Dettmers facilitated the discussion about setting population goals. He explained that goal setting is an administrative process, without nationally-standardized guidelines. To stimulate discussion, Dr. Dettmers asked panelists to choose a preferred answer from among four choices to the following question:

What is the most appropriate goal for the CERW population in 40 years from now?

Choices for answers were:

- Arrest decline within 40 years (e.g., by year 2046 population is no longer declining)
- Stable population equal to current population (e.g., arrest the decline and restore the population to 2006 size, by 2046)
- Population increase < 2x current
- PIF goal = 2x current

After scoring, panelists engaged in discussion about their scores. A fifth answer was added for the rescore:

- Arrest decline within 20 years and have growing population within 40 years

Panelists re-selected their preferred answer and the exercise concluded.

Results
The selection by the panelists was nearly unanimous, with only one participant not selecting the newly added goal to arrest the decline within 20 years and have a growing population within 40 years. Actual scores are as follows:

- Arrest decline within 40 years (1 vote)
- Stable population equal to current population (0 votes)
- Population increase < 2x current (0 votes)
- PIF goal = 2x current (0 votes)
- Arrest decline within 20 years and have growing population within 40 years (7 votes)

Notes of the discussion are contained in Appendix 10.

Discussion
Panelists acknowledged that the goal of arresting the species' decline within 20 years and having a growing population within 40 years was a compromise between facing the realities of a long-term decline with poorly understood and difficult to alter causes and providing a motivational goal of increasing numbers to stimulate conservation efforts.

CONSERVATION ACTIONS

The purpose of this session was to construct a prioritized list of conservation actions that, if implemented, would achieve the population goals established in the previous section. Panelists for this session included: David Buehler , Brett Butler, Randy Dettmers, Paul Hamel, Jason Jones, Maria Isabel Moreno, Mark Nelson, Wayne Thogmartin, and Tom Will.

Methods
Steve Morey facilitated this session. He asked panelists to brainstorm conservation actions that would enable Cerulean Warbler populations to reach the levels prescribed in the goal recommended in the previous exercise. Panelists were asked to select the three most important conservation actions. Totals were summed for each item and the results were displayed onscreen. Panelists then suggested specific actions within the broad categories, and lumped the eight broad categories into four.

Results

Panelists generated a list of broad conservation categories and selected the three actions they thought were most important to achieving desired conservation goals (Figure 7). After reviewing the list, panelists lumped the broad categories until only four remained, then they suggested the following specific actions within each of the categories

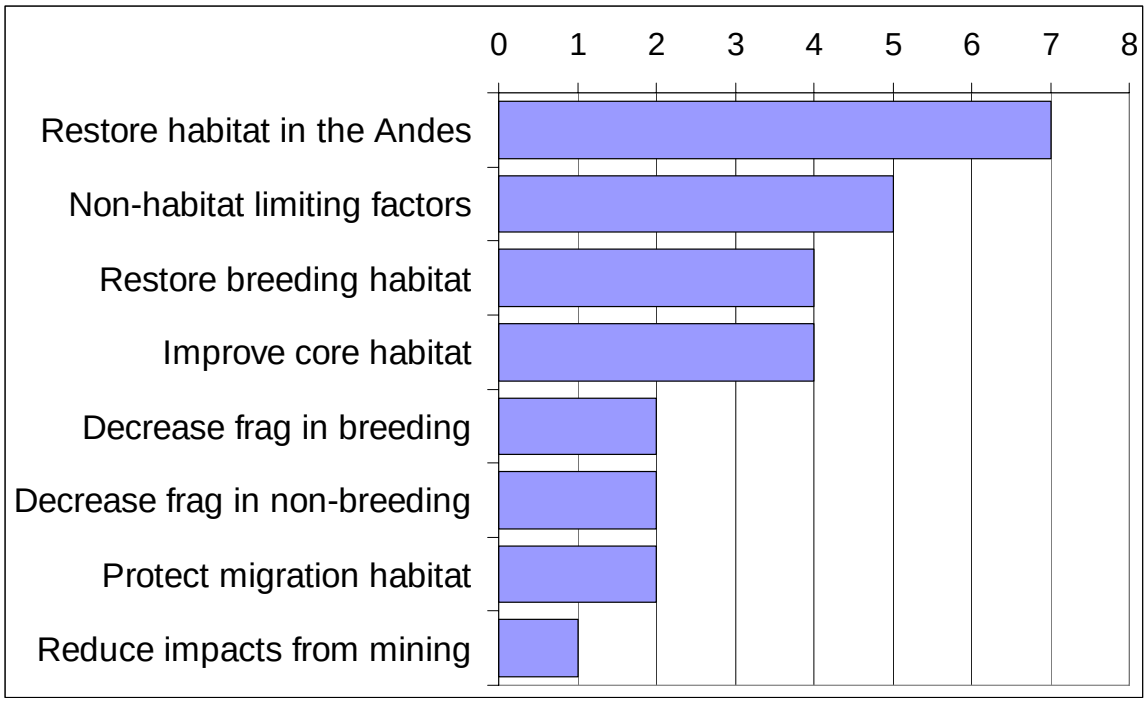

Figure 7. Categories of Conservation Actions with summed scores.

List of Conservation Actions

1. Restore habitat in the Andes
    a. Reduce the deforestation rate
    b. Strategically place new habitat where it decreases fragmentation
    c. Conserve current habitat (protection areas and protect existing CERW habitat features)
    d. Improve understanding of distribution of age and sex groups among habitats and the value of different habitat for the different groups to target habitat protection
    e. Complete and maintain habitat map
    f. Research on wintering grounds
    g. Provide conservation incentives for landowners
        i. Coffee crop subsidies
        ii. Pay landowner taxes
    h. Influence government to reduce the tax rate
    i. Create and maintain programs to bring conservation dollars to the Andes (ecotourism, fund raising, etc.)
    j. Conservation education

2. Identify and address non-habitat limiting factors – better understand the nature of the problems
    a. Model the potential for the effect of catastrophic weather events (excluding habitat effects)
        i. To refine goals for population potential
        ii. Present information to policy makers
        iii. To
    b. Explore the role of mercury contamination
    c. Explore the potential effects of disease
    d. Identify foraging constraints of migratory fattening
    e. Learn about post fledging survival and activity
    f. Establish extent and pattern of migratory connectivity
    g. Learn about dispersal
    h. Learn about the biology of females to understand if their conservation needs are different than males
        i. e.g., tree selection by males might be different than female tree selection – does this result in different management needs?
    i. Study intrinsic limits to fecundity to target management
    j. Assess and reduce risks about collisions (including off-shore oil platforms, wind farms, etc.)
    k. Investigate correlations between climate change and forest availability to better predict future population change and management needs
    l. Develop annual stage-specific life history model
    m. Conservation education

3. Restore and improve habitat in the breeding range
    a. Decrease forest fragmentation on the breeding grounds
    b. Reduce impacts from mining
    c. Improve our understanding between the relationship of a specific silvicultural practices and habitat use by segments of the population
    d. Find the resources to conduct demographic research, on the scale at which it is needed, to identify attributes of quality habitat
    e. Target large patches of forest lands in the core of the range for conservation easements
    f. Develop and test BCR-specific habitat suitability index models (HSI), produce estimates and maps of habitat area
    g. Develop CERW-friendly forest reclamation Rx
    h. Conservation incentives for Federal and State programs
    i. Reforest the MAV
    j. Develop and communicate forest management Rx for all population segments (males, females, juveniles, other non-breeders, ?)
        i. Develop Rx for moving lower quality mature forest into higher quality habitat
    k. Understand the requirements for quality post-fledging habitat and provide it

   l. Conservation education
   m. Improve the use of FIA and other inventory data for linking habitat information with bird populations

4. Protect migration habitat
   a. Map migratory stopover habitat to prioritize conservation efforts
   b. Protect key conservation areas
   c. Document patterns of use of migratory stopover habitat by population segment
   d. Identify patterns in the patterns in the movements to understand individual connections between breeding and non-breeding grounds and timing of passage between them
      i. Tag on human social connectivity outreach
   e. Provide quality of spring migratory landfall habitat
      i. Fire escape & 7/11
      ii. Encourage and provide incentives for habitat

Discussion

Additional research, population and demographic modeling, and continued cooperative efforts among entities throughout the species range will be necessary to target projects and achieve desired results. Conservation actions suggested through this process were meant to be part of a larger adaptive management process that includes appropriate monitoring and research to further our understanding of Cerulean Warblers and fill critical information gaps. The recommendations from this workshop will go forward within the Fish and Wildlife Service, so long as they compliment PIF and Technical Group activities.

CONCLUSION

Presentations, results of scoring exercises, and verbal deliberations leave the impression that Cerulean Warblers face multiple factors across all different parts of species' annual cycle. The most likely future, absent new developments (either threats or conservation measures), as predicted by the panelists is for a steady course, with the population decline continuing into the future at rates similar to those documented over the 40 years of the Breeding Bird Survey.