2001
MONARCH POPULATION
DYNAMICS MEETING

MEETING AND WORKING GROUP SUMMARIES

PREPARED BY KAREN OBERHAUSER AND MICHELLE SOLENSKY

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Cover photo by Carol Trench, Minneapolis MN. Other photos by Karen Oberhauser, except that on page 15 by Karen Hanson, St. Croix Falls WI. This volume is the first part of two. The second part will consist of a meeting Proceedings.

TABLE OF CONTENTS

MEETING GOALS AND BACKGROUND

The monarch butterfly has received a great deal of attention from both government and non-government agencies in Mexico, the US and Canada—from research, conservation and education perspectives. This attention results from many features of its biology, including a spectacular and unique (among insects) migration, during which a single individual can traverse all three countries; its popularity and recognition among the public; and potential impacts of human activities, such as habitat destruction and pesticide use, on monarch populations. Agencies within all three North American governments have carried out activities in support of monarch conservation since the 1997 North American Conference on the Monarch Butterfly (US Fish and Wildlife Service 1998, Hoth et al. 1999), and many other organizations are doing the same. However, sound conservation and management require an understanding of the factors that affect population dynamics. Participants in the 5th Annual Meeting of the Trilateral Committee for Wildlife and Ecosystem Conservation and Management Monarch Working Table (Feb. 2000) agreed that a continent-wide approach to the factors that affect monarch distribution and abundance is important. This group recommended a "continental diagnosis" that would pinpoint vulnerable stages and locations for monarchs, synthesizing existing information and detailing what else needs to be known. The outcome of such a diagnosis would be the knowledge required to promote informed and cooperative monarch conservation on a continental scale.

The Monarch Population Dynamics Meeting, held 20-23 May 2001 in Lawrence Kansas, was a direct result of the recommendations of the 2000 Trilateral Monarch Working Table. During the 2001 meeting, scientific presentations on monarch population dynamics were followed by discussions of key parameters necessary for an understanding of monarch population dynamics. These discussions and presentations have formed the start of a unique project—an attempt to understand the annual dynamics of a migratory insect with a continental distribution. Specific outcomes achieved during the meeting, and goals of resulting projects, include:

- synthesizing existing data on monarch population dynamics during all stages of the annual cycle (begun at the meeting and to be continued during data synthesis and modeling work),
- identifying future research priorities (accomplished at the meeting),
- informing monarch conservation and management efforts (policy recommendations formulated at the meeting), and
- promoting the monarch as a symbol of tri-lateral cooperation for conservation (ongoing project for many meeting participants).

LIST OF PRESENTATIONS

Presentations made during the meeting are listed below. Many of these, and other relevant papers, will be available in their entirety in a Meeting Proceedings to be published within the next year.

Names and affiliations of presenters and other meeting attendees are listed in Appendix A.

Overwintering Biology and Conservation

Lincoln Brower – Keynote Address: Changing status of the forests in the monarch butterfly overwintering areas in Mexico

Monica Missrie: The expansion of the Monarch Butterfly Biosphere Reserve

Dennis Frey: Spatial and temporal patterns of monarch overwintering abundance in western North America

Eligio Garcia: Behavioral analysis of monarch butterflies (*Danaus plexippus* L.) in their overwintering sites in Mexico

Christian Manion: Thanksgiving counts and western population dynamics

Eduardo Rendón Salinas: Forest structure, cover and regeneration of the monarch butterflies' overwintering sites in Sierra Chincua, Michoacan, Mexico

Paul Cherubini: A photo tour of monarch overwintering sites along the California coast

Kingston Leong: Analysis of California's monarch overwintering habitats using GIS

Andres Keiman: Successional dynamics and self-clearing in the oyamel forest of the Monarch Butterfly Biosphere Reserve

Bill Calvert: Estimates of the population size of monarch overwintering colonies in Mexico

Breeding Biology

Eneida Montesinos: Genetic structure of migratory and local populations of monarch butterflies in Mexico: Implications for the conservation of the migratory phenomenon.

Michelle Solensky: Heritability of male mating success in monarch butterflies (*Danaus plexippus*)

Laura Jesse: Stability of common milkweed (*Asclepias syriaca*) infestations in cropland and adjacent areas

Michelle Prysby: Temporal and geographical variation in monarch densities: Using citizen scientists to document monarch population patterns

John Obrycki: The occurrence and abundance of *Danaus plexippus* L. (Lepidoptera: Danaidae) on *Asclepias syrica* (Asclepidacea) in corn agro-ecosystems

Karen Oberhauser: The importance of agricultural habitats to eastern NA monarchs

Linda Rayor: *Polistes* wasp predation on monarch caterpillars

John Pleasants: Monarch populations in agricultural fields: Possible reasons for oviposition preference and the impact of agricultural practices

Tammy Hoevenaar: Influence of plant cardenolides and latex on the foraging behavior of first instar monarch larvae

Migration

Elizabeth Howard: Analysis of spring monarch migration patterns 1997 – 2001

Chip Taylor: A general theory to explain the movement of migrating monarchs across latitudes: Part I – The migration south

David Gibo: A general theory to explain the movement of migrating monarchs across latitudes: Part II – The migration north

Andrew Davis: Monarch migration on the eastern shore of Virginia: Monitoring methods and stopover ecology of fall migrants

Roberto Solis: Ecological and geographical features of monarch migration (*Danaus plexippus*) in México

Sandra Perez: Monarch butterfly (*Danaus plexippus*) populations in North America

Steve Malcolm: Wing wear as an indicator of spring migration tactics in eastern North American monarch butterflies

Integrating/Modeling

Sonia Altizer: Transmission and population dynamics of the protozoan parasite, *Ophryocystis elektroscirrha*, in monarch butterflies

Johannes Feddema: Simulating the migration and development of the monarch butterfly (*Danaus plexippus*)

David James: Monarch migration and winter aggregation in Australia: An endangered phenomenon

Myron Zalucki: Spatial and temporal population dynamics of monarchs down-under: Lessons for North America

Regulation

Wayne Wheling: The role of the United States Department of Agriculture in safeguarding the monarch butterfly

Poster Presentations

Mary Bishop Kennedy and Kristin Duncan: Are all migrating monarchs in reproductive diapause?

Mary Bishop Kennedy, Stephanie Spurgat and Bethany Leach: Do monarch larvae use visual or chemical stimuli to find milkweed?

Jane Borland, Tiffany Watkins, Trey Crumpton, Carol Johnson, Brenda Montes, and James Tovar: Characteristics of fall migratory monarch butterflies

Ilse Ortabasi: Kinder Magic Software

Cindy Petersen and Jill Clancy: A silent killer

Cindy Petersen and Sarah Peterson: Danger: Weevils

Annette Strom, Jenna Proctor and Britteny Saline: Effects of common garden chemicals on invertebrates

Annette Strom, Jenna Proctor and Britteny Saline: Population fluctuations

MONARCH BIOLOGY WORKING GROUPS

Meeting participants spent the final day of the Monarch Population Dynamics Meeting in working groups. Morning sessions focused on the state of current knowledge on monarch biology. For these sessions, meeting participants were self-assigned to groups that addressed three main biological topics: monarch breeding, migration, and overwintering. The groups had approximately two hours in which to discuss the following questions:

- What do we know about this stage of the cycle? (e.g. its timing, habitat requirements, mortality factors, population size fluctuations, etc.)
- What important gaps remain in our understanding of this stage of the cycle?
- How should these gaps be filled?

Each group had a facilitator and a scribe; these individuals volunteered for these roles prior to the meeting. The time available for discussion was limited, and groups did not feel that they had completely covered the topics when scheduling constraints required that the discussions end. The summaries below represent what each group felt were the most important considerations within their topics. Each working group chose one member (usually the facilitator) to present a report to the entire participant group immediately after their meeting. The summaries include some input from the larger group, but are based mostly on the notes taken by the scribe during the discussion. Because the discussions took different directions in each group, summary formats vary.

Breeding Biology

The monarch breeding biology working group divided their discussion into four areas: habitat requirements, factors that affect the timing of monarch growth and development, factors that cause mortality during the breeding stage, and factors that affect net reproductive rates.

A. Habitat Requirements

Milkweed

- We know that monarchs are milkweed specialists, but we don't know the extent to which they use different species. (e.g. How much do they oviposit on different species, how well do the larvae perform on each, and how common are the different species?) Current evidence suggests that there is little difference in performance of larvae on different milkweed species, but we haven't studied all of the life stages (e.g. How does the milkweed species eaten by larvae translate into adult lifetime reproductive success?).
- Milkweed species exist in different habitats. For example, within *A. syriaca*, there is geographical variation in habitat types in which the plants grow and in how the monarchs use their host plant. We don't know the effect of habitat type or land use on the abundance of *A. syriaca* or the use of this (and other) species by monarchs.
- What is the distribution and abundance of different milkweed species over space and time? We need detailed phenology, species, and location information. We should identify the top ten plants that monarchs use, and focus on these.
- Woodson (1954) is still very accurate in describing the distribution of milkweed species, but what are the population dynamics of milkweed species?
- For a given place and time, what are the short- and long-term effects of climate on milkweed abundance, growth, etc.? How do natural plant succession dynamics affect milkweed distribution and abundance? Could we use the work of weed scientists?
- We should link host plant utilization to its distribution and density. How do these features of host plant biology affect per plant densities of monarchs?
- What are the effects of abiotic conditions (especially rainfall) on milkweed development?
- *Asclepias syriaca* has a peculiar root system that ramifies underground, and can cover thousands of meters. A single genet can form hundreds of thousands of ramets, and it is the only species in the genus that does this. Monarch migration may be driven by the distribution of *A. syriaca* in space and time. Can we study evolutionary shifts in *Asclepias syriaca?*
- We recently learned that agricultural habitats are very important to monarch production, probably contributing over 70% of the monarchs that arise in the upper Midwestern US (Oberhauser et al. 2001). What would happen if changing pest control practices decreased milkweed availability in these habitats?

Adult resources

Few studies have focused on habitat requirements for adults during the breeding period. Important questions include:

- Are nectar resources limiting for adults?
- To what extent do adults rely on nectar for survival, what are the primary nectar sources, and how do these coincide with milkweed location? How does proximity of milkweed to nectar sources affect oviposition dynamics?
- What are the effects of temperature, rainfall, and humidity on nectar resources?
- We tend to find most monarchs in habitats where there are a) milkweeds, b) nectar resources, and c) trees or other roosting sites. How important are roosting sites as a resource for breeding adults?

B. Timing

Many factors will affect monarch growth and development rates, and the timing of reproduction and migration.

- Are there sublethal effects of pesticides, Bt corn, herbicides, and natural enemies on larval growth rates?
- How does plant condition (e.g. water content, nitrogen levels, herbivore damage, and age) affect larval development rates?
- Monarch larval monitoring data show that peaks in breeding can be offset by more than a month among years. What factors affect the timing of these peaks? What is the relationship between first adult arrival times and peaks in larval abundance?
- What are the effects of initial arrival of adults and development time of larvae on per female replacement rates over the course of a summer?
- We know that developmental rate is linked tightly to temperature, with cold temperatures extending development times. Day-degree accumulation is overridingly important to development and generation time, but extremely high temperatures can inhibit growth. This effect needs to be quantified.
- How does growing season length affect the number of generations?
- To what degree do the generations overlap?
- What is the effect of temperature on the timing of diapause? What environmental factors induce diapause, and what initiates migration? To what extent are migration and diapause linked?
- What are the effects of weather variables other than temperature on the timing of breeding and larval growth rates?
- How do the timing of arrival and larval development coincide with predator and parasitoid abundance?
- Monarchs appear to lay eggs as they migrate. What are the tradeoffs between breeding and migration, and what is the degree to which they co-occur?
- How common are continuously breeding populations in North America, where do they occur, do they persist among years, do they mix with the migratory population, and do they occur only in places where tropical milkweed has been cultivated?

C. Mortality Factors

It will be useful to take a life table approach to understanding what accounts for most monarch mortality—natural enemies, milkweed defenses or abiotic conditions. We know little about the causes or effects of adult mortality during the breeding season; since this will affect the population net reproductive rate, this is an important gap in our knowledge. Questions related to mortality are summarized below.

Parasites, predators and pathogens

- What are the most important monarch predators?
- What monarch stages and sizes are most susceptible to different predators?
- What is the phenology of the predators?
- How is monarch mortality affected by variation in natural enemy abundance over time and space?
- What conditions make a particular predator or pathogen a great risk? We need to expand the geographic scale to ask when and where certain predators have the greatest impact.
- We know that ants are important predators on larvae; that spiders, assassin bugs, and wasps may consume eggs and larvae; and that several pathogens may be important sources of mortality (e.g. *Ophryocystis elektroschira*). There have been many published studies on natural enemies, and we need to compile a review of natural enemies of monarchs.
- To what degree does climate affect natural enemy presence and abundance, and larval susceptibility to them?

Abiotic conditions

- How do extreme weather conditions (hot and arid conditions, or cold and wet conditions) affect larval and adult mortality during the breeding period?

Plants

- How important are plant defenses in overall larval mortality, and how does this vary among host plant species?

D. Variations in population size

We need to know the impacts of many factors on net reproductive rates, and how these vary over space and time.

- How do land use changes (e.g. agriculture, habitat destruction, pesticide use, transgenic crops) affect monarch mortality and reproduction? Do these changes have secondary effects on natural enemies of monarchs?
- We should monitor plant densities, habitat types, temperature, predators, eggs, larvae and adults in order to estimate yearly changes in population size. Monitoring sites should represent different geographic locations and habitat types. Ideally, we should have observers in different specified locations, and should combine the data with land use patterns and randomize site selection on a large scale.
- 4th of July Butterfly Counts (North American Butterfly Association 2001) might allow us to determine adult abundance during breeding periods. These data could then link geographic variation in abundance to milkweed density and climatic factors. Many participants felt that the 4th of July count data are difficult to interpret, but we could compare larval densities to 4th of July, migration, and overwintering data to see whether they are correlated and, if so, at what temporal scale.
- Relatively little work has been done to show where monarchs breed and what milkweed species they use in the western part of the US. In addition, we should compare larval abundance and survival in the east and west.

Migration Biology

The migration working group discussed the spring journey north and fall journey south. They highlighted two major research priorities, one for each migration.

- *Spring*. Is departure from the overwintering sites in Mexico happening earlier? We need detailed monitoring of departure, including the timing of the first butterflies leaving, when the majority of them leave, and when the last butterflies leave. This should be correlated with temperature, forest conditions, and butterfly condition; and with the phenology of the milkweed plants required for oviposition.
- *Fall*. Systematic and consistent monitoring is needed across the range of migrating monarchs. This monitoring should include the number of monarchs observed (including when no monarchs are observed), the temperature, altitude of flight, presence of larvae, and behavior of the monarchs. There should be a central data repository for this information.

Other topics of discussion are outlined below. Under each category, key information that the group felt was already known and that which is still needed are summarized.

Spring Migration

A. Timing and Route

- Recent Journey North data (Journey North 2001) and Malcolm et al. (1993) provide knowledge of how far overwintered monarchs travel, and the timing of their arrival in different parts of the southern US. Wing wear provides a reasonable way to distinguish these monarchs from the new spring generation.
- It has been suggested that monarchs are departing earlier from the overwintering sites, but this needs to be quantified and correlated with microclimatic and other conditions, such as milkweed availability, mating behavior, and monarch condition.
- There is much we don't understand about the Southern Florida population. We know the origin of the population that arrives in the fall, but not if or how many monarchs migrate north from Florida.
- What is the migratory status of Gulf Coast populations? We know that some reproduce all year; do they all? What is their role in the spring migration?
- Is there density dependent mortality in the first generation (egg to adult)? What are the major sources of mortality during this generation?
- What are the movement patterns of the 2^{nd} and 3^{rd} generations (direction and distance)?
- Does cloud cover affect monarch orientation and is climate change increasing the number of cloudy days?
- How do climatic conditions and food availability affect flight altitude and how does wind direction vary with elevation?
- How are energetic requirements for adults affected by weather?

B. Habitat Requirements

- How much milkweed is available at southern latitudes during the spring migration, and how much reproduction occurs in the southern part of the spring migratory path (especially in Mexico)?
- What is the phenology of milkweed availability during the spring migration? What is the relationship between the timing of milkweed and floral resources and monarch departure from Mexico?
- What factors affect the travel speed of spring migrants?
- What cues trigger monarch departure from the overwintering sites?
- Monarchs leave the southern US when milkweed is still available. Is this due to lethal heat? What triggers their departure?
- What are the resource requirements of returning monarchs as they migrate through Mexico? Do they differ from requirements in southern US? When and where are their roosting breaks, and what habitat requirements are there for roosting sites?

C. Mortality Factors

- We know that predation by fire ant larvae is a major source of mortality for first generation larvae (Calvert 1996). How does this compare to other sources of mortality?
- What are the effects of droughts on water and food availability for adults during the spring migration, and how does the availability of these resources affect adult survival?
- What is the relationship between lipid reserves at the end of the overwintering period and mortality?

D. Population Size and Fluctuations

- We can measure population size as the monarchs depart from Mexico. Are there ways to measure the population after departure so that we can estimate adult mortality during the migration?
- How many adults remain and reproduce in Mexico due to depleted lipid reserves?
- Does pesticide use during the spring affect the size of the first spring generation?

Fall Migration

A. Timing

- We know that the migration starts in August in the North, and correlates with altitude angle of the sun (Taylor and Gibo unpublished). We also have a fairly clear understanding of how weather patterns affect monarch flight.
- How many generations migrate south?
- What proportion of migrants are reproductive, and when and where do these individuals reproduce?

B. Habitat Requirements

- We know that migrating monarchs roost in trees at night. Can other vegetation be used as effectively as trees?
- What habitat features make some sites good roosting sites, and how important are these features to monarch survival during the fall migration?
- How important is nectar availability during the fall migration? Should nectar be present at roosting sites? How often do monarchs need to obtain nectar as they migrate south?

C. Mortality Factors

- Drought/desiccation, predation, and traffic all cause some mortality during the fall migration, but the relative importance of each of these is not known.
- How do storms affect mortality?
- How does pesticide use affect mortality?
- Do rearing practices and release of diseased monarchs affect population health?

D. Population Size

- We need a uniform monitoring system to assess numbers during the fall migration.
- How important are the offspring of reproductive migrants to the overwintering population size?

E. Origin/Destination

- Tagging (Monarch Watch 2001) and stable isotope data (Wassenaar and Hobson 1998) suggest a Midwest origin for many adults. These findings should be verified with more data, since year-to-year climate variation may affect the relative contribution of different locations to overwintering populations.
- Where do adults overwintering along the Pacific Coast and Gulf Coast come from, and where do they go when they disperse?
- How many migrants reproduce on their way south? Where do they and their offspring go?
- We need more complete documentation of migratory routes, and the effects of weather and geography on these routes.

F. Weather

- Atmospheric motion systems affect monarch movement, and monarchs seem to be able to detect wind direction, and use wind as they migrate. What are the effects of seasonal progression in weather conditions and atmospheric motion systems on monarch movement?
- Can monarchs avoid storms as they migrate?

Gaps related to both migratory periods: Database and monitoring needs

- We need a database of weather conditions accessible to citizen scientists participating in projects such as Journey North (Journey North 2001), the Monarch Larval Monitoring Project (Monarch Lab 2001), and Monarch Watch (Monarch Watch 2001).
- A monitoring system in northern Mexico should be developed for the fall and spring migrations, and findings correlated with those of other monitoring projects.
- Programs that monitor migratory monarchs should encourage observations and reports of altitude of flying butterflies as well as location and time.
- Monarch monitoring should occur across the continent.
- Whenever possible, monitoring programs should develop and encourage the use of consistent data forms.
- Monitoring projects should encourage use of central data repositories.

Overwintering Biology

The overwintering working group discussed the extent of our understanding of monarch overwintering biology in both California and Mexico. Participants agreed that both overwintering locations were equally important, and should receive continued research attention. They discussed the fact that a great deal of work in both locations has not yet been published, and that compiling and disseminating what is already known about overwintering biology should be a top priority.

A. Habitat Requirements

Microhabitat

- In California, Leong has collected information about microhabitat requirements (Leong 1990), but this needs to be coordinated with plant ecology studies.
- In Mexico, we need to understand the relationships between microclimatic conditions, lipid content of adults and mortality. We need to synthesize information on monarch physiology and behavior with plant ecology.
- Are biological requirements the same for the eastern and western populations? It would be useful to establish weather stations in three diverse colonies in both Mexico and California to monitor ambient conditions.

Resource assessment

- When we establish the forest conditions that are optimal for monarchs, we need to determine how much appropriate habitat exists near overwintering sites. We could then determine the amount of habitat that could potentially be used by monarchs on a regional scale.
- How important are nectar resources and proximity to water during the winter?
- Since habitat differs greatly between California and Mexico, improved information sharing and on-site visits by scientists from both regions will facilitate a better understanding of general monarch requirements during overwintering. We should facilitate visits by Mexican scientists to California sites.

B. Timing

Arrival and departure

- The basic timing of overwintering in both locations is well-studied; we know when monarchs arrive in and depart from the overwintering sites.
- In California, colonies begin to form in mid-October, but there is no precise information about colony break up. How far do dispersing butterflies fly initially? Do they form smaller clusters in new sites?
- There is no milkweed in close proximity to overwintering sites at the time of dispersal except in Santa Barbara. How does proximity to milkweed affect monarch reproductive status and the timing of colony break-up?
- What is the relationship between site abandonment and habitat quality?
- What are the costs of leaving overwintering sites before the majority of the population leaves? Monarchs may be leaving earlier in the season than they have in the past, and is important to study the causes and effects of this change. Further study is necessary to assess potential impacts of global warming and habitat degradation on dispersal.
- In Mexico, the timing of arrival is fairly well known, but departure time is not well documented. Colonies differ in time of dispersal, and this should be studied with respect to latitude, geography and microclimate. Garcia Serrano will start documenting declines in colony numbers this year in concert with his forest research.

Differences between males and females

- How does reproductive activity in the colonies affect dispersal, and is this different for males and females? Are these dynamics different in Mexico and California, and if so, why?
- Frey is collecting substantial data on changing sex ratios over time. California colonies approximate a 60/40 male:female sex ratio early in the winter, but that this is closer to 90/10 at the end of the season.
- In Mexico, both sexes appear to leave together. Brower has unpublished data that show an equal sex ratio of arriving migrants in Texas.

C. Population Dynamics and Genetics

Baseline data on population dynamics and genetics are required to define and monitor population health. Key data include the following:

- In California studies of long and short term population dynamics have been limited and unpublished.
- In Mexico, data are also unpublished, but many have been collected. These data need to be compiled and disseminated. Further study is needed on the demographic structure of colonies, including information on mortality rates of butterflies of different ages and condition.
- Studies are needed to investigate genetic differences between monarchs overwintering in Mexico and California (the so-called Eastern and Western populations). Altizer (2001) found different parasites and different susceptibilities between populations, which suggests genetic differentiation.

D. Site Monitoring

- We need to establish monitoring efforts to periodically update the status of overwintering sites and colony populations. We would like to see annual monitoring in both California and Mexico. This monitoring should focus on assessing relationships between monarch numbers, mortality rates, and site habitat quality.
- In California, there are 390 sites, 60% of which are on private land. The relationships between habitat quality, number of individuals, and mortality in many of these colonies, which tend to be relatively small, can be explored through mark/recapture studies that are currently in progress. Frey has established a standard method of monitoring, collecting relevant data in 10 sites over a 20 week period.
- In Mexico, mark/recapture techniques are prohibitively difficult, but monitoring could be possible by recording parameters like mortality and tracking forest conditions.

E. Habitat Restoration

- We need to continue to explore habitat restoration and enhancement protocols. This may be more practical in California, where overwintering sites tend to be smaller and more accessible.

DISSEMINATION AND SYNTHESIS WORKING GROUPS

Afternoon working groups focused on applied issues, using both information presented during the research talks on Monday and Tuesday, and discussion during the Wednesday morning biology working groups, to shape their discussions. Participants were self-assigned to groups with the loose charges of discussing:

- how to integrate current knowledge by modeling monarch population dynamics,
- monarch-related education and outreach, and
- policy recommendations and implementation.

Each group discussed important issues related to their topic, and then recommended actions and possible participants in these actions.

Modeling and Data Synthesis

It will be useful to model monarch population dynamics for many reasons. Some of these include:

- To add to basic knowledge of insect population dynamics in general, and of migratory species in particular.
- To test for correlations between population numbers at different times and locations.
- To assess long-term trends in abundance.
- To test hypotheses related to the impact of various factors on population dynamics.
- To formulate predictions about potential impacts of global warming and other anthropogenic changes on monarchs.
- To estimate a minimum population size needed to sustain monarchs under different climatic conditions.

The group discussed two basic types of models: bioclimatic models that include on monarch phenology and location (i.e. when and where do we expect to see monarchs?), and mechanistic models that include both bioclimatic information and temporal variation in monarch abundance.

Bioclimatic model

Bioclimatic models have already been constructed by Feddema (presented at this meeting) and Zalucki (1999, this meeting), and the group discussed these models and possible ways to integrate and refine them. The models would be driven by parameter data on both milkweed and monarchs, and phenological data on the presence of monarchs, milkweed and nectar sources. Parameter data that would be required for these models include:

Milkweed

- Water balance
- NDVI (normalized difference vegetation index)
- NPP (net primary productivity)
- Actual evapotranspiration

Monarchs

- Temperature

Mechanistic models that include monarch abundance

In addition to the parameter data summarized above, mechanistic models would require data on both monarch abundance the effects of various factors on population growth rates. There was some discussion of whether abundance data should be actual or relative numbers. It was agreed that we need to be able to measure monarchs at two stages in their annual cycle. We have fairly accurate data for the overwintering period, and could use larval monitoring data to estimate numbers at some consistent point during the breeding period. Aerobiotic features could be explicitly added to both of these models. This would allow us to model monarch diffusion in directions and speeds influenced by the wind and other atmospheric conditions. Movement models could be validated with radar or spotting scopes.

The group discussed submitting a proposal to NCEAS (the National Center for Ecological Analysis and Synthesis) and to the NSF Biocomplexity Program for funding to construct these models.

Parameters that will affect population growth rates, and should thus be included in mechanistic models of monarch abundance include:

Mortality

- Milkweed and nectar availability
- Temperature/humidity, including effects of extreme weather
- Natural enemies
- Anthropogenic factors

Reproduction

- Food availability (flower phenology, competition for nectar, nectar quality)
- Temperature
- Milkweed distribution and abundance

Education and Outreach

This working group discussed various citizen science projects related to monarchs. They felt that many individuals and groups are interested in being involved in such projects, and that the data are useful to scientists as we try to understand monarch biology. They also agreed that the monarch is an ideal organism to use for inquiry-based learning at all levels.

A major point that arose during the discussion was the need for more coordination among the various monarch-related citizen science programs. The group suggested that we compile a list of all of the different projects to share with all monarch Citizen Science programs. This would allow us to refer potential participants to the program that best suits their interests and abilities. The information for each project should include what questions are being addressed, what kinds of data are required, why the questions are of interest and what the citizen scientists may gain from their participation.

Additional points that the group felt should be considered in developing and carrying out citizen science projects included:

- The internet cannot be the only tool, since many people have limited or no access to this means of communication.
- State and regional coordinators should be recruited and trained.
- We need to be aware of the time involved for the volunteers, and the difficulty of what we are asking them to do. In many cases, it may be best to have easy, medium and hard levels of participation, with different data sheets available for each.
- Sustainability and funding should be considered early in the life of a project. People will become discouraged if many projects start and then end within a few years.
- We need to consider methods for soliciting more volunteers to participate in citizen science. Possible outlets for recruiting include:
    - Master gardener and master naturalist programs
    - Native plant societies and wildflower groups
    - State and national science teacher organizations and publications (e.g. NSTA, NABT)
    - Project Wild and Project Learning Tree
    - National, state and local conservation agencies and natural resource departments
    - National Conservation Training Center
    - National Wildlife Federation's Backyard Habitat program
    - National Audubon Society
    - Nature centers, zoos and butterfly houses
    - Senior citizen organizations

Many of the knowledge gaps discussed during the monarch biology working group meetings (and described previously in this volume) could be addressed by citizen science projects, and leaders of these projects may find it useful to refer to the summaries of these discussions as they design and refine their data collection protocols and goals.

Policy Recommendations for Monarch Butterfly Conservation

After participating in monarch biology working group sessions (breeding, migration, and overwintering biology), the policy working group discussed conservation goals and research priorities. They drafted a list of policy recommendations that were presented to and discussed by all conference attendees, and further developed at a meeting sponsored by WWF-Canada in Toronto, Ontario on June 11, 2001. A draft of the recommendations was circulated among conference attendees for comment and further development, and then all participants were asked to prioritize each item based on the following scale:

N: No opinion
0: Not a priority
1: Low priority
2: Moderate priority
3: High priority
4: Very high priority

Twenty-seven of the 83 meeting participants submitted their opinions by rating each recommendation: 14 scientists, 4 student presenters, 3 teachers, 3 naturalists, and 3 others.

Final recommendations, divided by stage of the monarchs' annual life cycle, are listed below. Each section is further divided into recommendations that identify (a) regulatory policies deemed necessary to protect monarchs from further habitat loss or degradation and (b) research priorities with applied significance. Items are ordered within categories according to their mean priority rank (from highest to lowest priority).

It is important to note that although these recommendations are targeted towards monarch butterfly conservation, most goals described below will protect or restore habitat for a wide range of native plants, invertebrate, and vertebrate species throughout North America.

BREEDING BIOLOGY

Policy Recommendations	Mean Rank (s.e.)
1. *Assess ecological effects of all new genetically modified plants before they are licensed for commercial use.* JUSTIFICATION: One or more strains of genetically modified Bt-corn that could have had significant impacts on monarch populations were licensed before adequate ecological tests were carried out. While some have argued that the strains of Bt corn currently in use may have minimal impact on monarch populations (e.g. Sears et al. 2001), any future Bt-corn strains should be carefully tested on a broad range of non-target Lepidoptera before they are licensed or widely used. It is particularly important to assess toxicity of the pollen and any other tissue that is dispersed from the plant.	3.31 (0.20)
2. *Remove milkweed species and other native flowering plants from the noxious weed list in Canadian provinces and the United States.* JUSTIFICATION: Monarch larvae are milkweed specialists, which means that they only eat milkweeds and therefore cannot survive without an adequate supply of milkweed plants. Maintaining milkweeds on noxious weed lists is in direct opposition to the protection of monarch butterflies. To protect monarchs, we need to also protect their host plants. Mandating their destruction clearly counters this objective.	3.23 (0.21)

3. *Restore and maintain native grass and wildflower mixes along roadsides and utility corridors rather than cultivated grass and ornamental plantings that require herbicides and mowing.* 3.08 (0.13)
JUSTIFICATION: A large portion of publicly-owned lands in semi-urban and rural habitats are roadsides and utility corridors. These areas are often unnecessarily modified by removing trees and native vegetation and replacing them with grass seed, sod, mulch, or ornamental shrubs and trees. This practice is costly and time-consuming, and often results in erosion, increased pesticide use and mowing, and represents a major loss of habitat for animals that depended on native herbaceous plants at all stages of their life cycle. By allowing natural recolonization of these areas with native grass and wildflower species, leaving existing native vegetation in place, or restoring habitats with native plants, roadsides can be improved as critical areas for monarchs and other organisms while simultaneously saving maintenance costs, reducing risk of colonization by invasive species, and beautifying highways and other areas.

4. *Increase public awareness of the benefits of maintaining semi-wild landscapes and planting native vegetation.* 3.00 (0.23)
JUSTIFICATION: One of the greatest threats to monarchs and other native butterflies is habitat loss through development for residential, agricultural, and commercial purposes. Residential development typically destroys monarch breeding areas, converting fields of host plants and wildflowers into concrete, lawns, and a highly predictable subset of ornamental shrubs and plants. The resulting loss of biodiversity has effects that ripple through multiple trophic levels, and these plantings often require wastefully high maintenance in the form of watering, pesticide applications, and mowing. If even a small percentage of managed vegetation in developed regions of North America were restored to native plants (including milkweed), this would represent an enormous gain of breeding habitats and nectar resources for many butterfly species, including monarchs. This goal could be advanced through (1) public service announcements in the media, (2) education programs aimed at nurseries, landscaping, and lawn service businesses promoting the benefits of landscaping with native flora, and (3) stricter limits on the sale of exotic plants and ornamental shrubs.

5. *Where farmers or municipalities mow roadsides or other areas once or more per year, these mowing events should be scheduled as infrequently as possible. If mowing must occur, efforts should be made to adjust the timing and area mowed to protect host plants and nectar resources for monarchs and other native insects.* 2.73 (0.20)
JUSTIFICATION: Selective mowing can maintain monarch habitat by preventing encroachment by trees and shrubs, and a patchwork of habitats results in higher species diversity. Mowing open areas at times of the year that will not harm monarchs or milkweed will help to maintain a mosaic of habitat types. The lowest risk times will vary with latitude and specific locations, but in general mowing during the spring and fall in the south, and during mid-summer in the North, is most likely to disrupt monarch breeding and migratory behavior.

6. *Encourage schools and communities to create butterfly gardens and milkweed areas, primarily focusing on native plant species.* 2.73 (0.22)
JUSTIFICATION: Such gardens will provide settings for school children and citizens to learn about butterfly biology, increase public awareness of butterfly habitat requirements (including both host and nectar plants), and restore habitats in urban and suburban areas. Use of native plants will promote the survival of native fauna.

7. *Limit biocide (e.g. pesticides, herbicides) use in non-agricultural habitats, such as yards, gardens, golf courses, parks, and roadsides.* 2.58 (0.22)
JUSTIFICATION: Chemical biocides are commonly used in agricultural settings, but are also available to the general public for lawn and landscape maintenance. Not only does scientific data point to these compounds as being increasingly toxic to humans and wildlife, but many insecticides may have devastating effects on wild insect populations far beyond their intended targets. Such pesticides should first be extensively tested for toxicity against monarch butterflies and other non-target insects at various stages of their life history. Whenever possible, narrow-spectrum insecticides or herbicides (or alternatives to spraying) should be employed to limit threats to monarchs and other species that utilize habitats near agricultural and residential areas and bodies of water. These changes will result in higher survival of monarchs and milkweeds, in addition to other native insect species and their host plants.

An example of implementation of such limits is the recent ruling by Canada's Supreme Court that cities and towns can enact bans on pesticides based solely on the public perception that such products are harmful, even when there is no scientific proof of a health risk. In 2001, the city of Halifax was the first North American city to ban insecticides, herbicides, and fungicides used for "cosmetic" reasons.

8. *The United States Department of Agriculture (USDA) should consider the effects of the interstate transfers of butterflies on scientific research when establishing butterfly shipping and transfer regulations. In order to monitor and develop permanent records, it should also carefully collect and publish information about release dates and locations, and about the number of monarchs released into the wild.* 2.16 (0.21)
JUSTIFICATION: Scientists studying population dynamics often need to measure rates of emigration, immigration, survival, and mortality. Large releases of butterflies of the species under investigation could significantly impede a researcher's ability to collect accurate data. Scientists must be able to distinguish between wild and released organisms to produce meaningful results. Therefore, the sale, transfer, and release of large numbers of monarchs or other butterflies (e.g. over 500 per shipper per year) into the wild should be reported to a central database at the USDA. At the present time, scientists that study monarchs and other free-living species have no way of knowing whether insects they capture are captive-reared or wild. Protocols for either (a) reporting or (b) marking all released individuals would greatly assist us in evaluating the scale of this enterprise and its impacts on wild populations.

Furthermore, it is important that the USDA distinguishes between shipping for scientific research, education, and commercial distribution when issuing permits. There should be a board of reviewers to judge the scientific merits of research applications. Until we have more evidence on the degree of interchange between western and eastern monarchs, transfers should continue to be limited to within these geographic regions (i.e. maintain the Rocky Mountain barrier that is currently being enforced).

Research priorities

9. *Monitor the effects of land use patterns and habitat types on milkweed abundance and monarch development and survival.* 3.35 (0.19)
JUSTIFICATION: Given our new knowledge of the importance of agricultural habitats to breeding monarchs (Oberhauser et al. 2001), we need to access reliable data on land use patterns throughout the monarch's breeding range. These data are lacking, especially in Canada. Once we have such data, linking them to variation in monarch distribution and abundance will result in improved understanding of the impacts of different land use patterns on monarch populations. This effort is closely tied to establishing a continent-wide monitoring program focused on tracking monarch abun-

dance during their breeding and migratory phases (including citizen science projects such as Journey North (Journey North 2001) and the Monarch Larval Monitoring Project (Monarch Lab 2001). We recommend expanding these into a large-scale, federally-funded program to involve the public in determining the geographic regions and habitat types that are most critical to monarch reproduction and survival.

10. *Assess changes in herbicide use that result from herbicide tolerant crops, and subsequent effects on milkweed density in agricultural fields and adjacent habitats.* 3.23 (0.19)
JUSTIFICATION: Given the importance of agricultural habitat to monarchs and the increased portion of fields that contain herbicide tolerant crops, it is possible that changes in herbicide use could result in a significant decrease in milkweed availability. However, it is also possible that milkweed will be able to tolerate increased herbicide use in fields and their adjacent habitats. We need to test these hypotheses.

11. *Assess effects of different weed and insect control practices on milkweed and monarch densities.* 3.19 (0.18)
JUSTIFICATION: Given the importance of agricultural habitat to monarchs, changes in weed and insect control practices could have significant impacts on monarch populations. However, very little is known about how different practices (or the timing of their application) affect monarchs or milkweed. Improved understanding of these effects could be used to help inform field management practices that control crop pests while minimizing impacts on monarchs and other beneficial insects.

12. *Study the population genetics of monarchs breeding in Mexico during the spring, summer, and fall.* 2.28 (0.17)
JUSTIFICATION: The resident and summer breeding populations in Mexico are thought to be small, and it is possible that they are sink populations of the eastern North American migratory monarchs that overwinter in Mexico (Montesinos, in prep.). Recent proposals to distribute monarch eggs, larvae and adults and nonnative milkweeds in southern Mexico and near the overwintering sites raise issues about appropriate legislation. Genetic studies of local populations in Mexico will help us to understand possible effects of such releases on the local and migratory populations, and will guide future policy formation.

SPRING AND FALL MIGRATION

Policy Recommendations

13. *Institute a continent-wide tagging system and data repository for following the movements of migrating monarchs in North America.* 3.15 (0.19)
JUSTIFICATION: At the present time, tagging efforts directed at monitoring fall and spring migrants are scattered and non-standardized. Monarch Watch (Monarch Watch 2001) is the largest tagging organization, but several other researchers and members of the public use their own systems of tags and contact information for reporting recovered butterflies. This makes it extremely difficult for scientists interested in monarch migration to access consistent, large-scale databases on monarch tagging sites and recovery dates and locations (and therefore, much effort is wasted in tagging monarchs at the present time). Initiating a continent-wide standard tagging system that is federally funded and provides free tags (i.e. like the federal bird-banding laboratories) will go a long way towards making the data more reliable and more useful to scientists. This should involve a central reporting unit for communicating all tagging and recovery information, and these data would then be freely available to both scientists and the general public in the United States, Canada, and Mexico.

14. *If it is determined that certain sites are consistently used as stopover sites by migrating monarchs, increase protection of these sites in Canada and the United States to prevent further habitat destruction and degradation.* 3.12 (0.21)
JUSTIFICATION: While more dispersed than the overwintering sites in Mexico and California, sites where substantial numbers of monarchs aggregate along the migratory route to roost and nectar are an important link in the monarch migratory phenomenon and should be protected (Davis, in review). These habitats are likely to provide critical shelter and resources (water, nectar, vegetation) to sustain monarchs en route to wintering sites, a journey that may encompass over 2000 miles.

Research priorities

15. *Develop a consistent monitoring program to assess the importance of vegetation structure, disturbance, nectar availability, and roosting sites to monarch presence and abundance at migratory stopover sites.* 3.04 (0.19)
JUSTIFICATION: Very little is known about landscape features associated with monarch migration stopover sites, or the importance of these sites to monarch survival during the fall migration. This is an important gap in our understanding of monarch conservation requirements. Because hundreds or thousands of public citizens tag and track migrating monarchs each fall, we recommend (a) establishing a system for citizens to report aggregations of 100 or more monarchs during the fall migration period, and (b) initiating a research program aimed at characterizing resources and monarch behavior at these stopover sites.

16. *Study the behavior and biology of monarchs in Mexico during the spring migration, including type of flight, distance traveled, distribution of the sexes, oviposition, and larval survival and phenology.* 2.85 (0.19)
JUSTIFICATION: The farther monarchs journey from their winter roost sites in Mexico the more dispersed they become and therefore more difficult to locate and observe. Little is known or documented about monarch behavior through Mexico on their spring migration northward. Study in the early part of the journey would help complete the knowledge of their cycle including the location (latitude) where the first spring generations are reared. Such studies could also provide information that aids in locating and studying them farther along on their journey northward, and would help to inform conservation efforts in Mexico.

17. *Evaluate the species distribution, abundance and quality of monarch host plants in Mexico, especially along the route and during the time of the spring migration northward.* 2.85 (0.20)
JUSTIFICATION: If preliminary evaluations of monarch behavior indicate that spring migrating monarchs do oviposit in Mexico, a survey of the range and abundance of host plants would be valuable information. Correlation of host plant and monarch behavior information could indicate whether the location of the first spring generation is governed by timing, latitude, location of abundant host plant or other factors, and would help to inform conservation efforts in Mexico.

18. *Assess the effect of planting non-native (e.g. tropical) milkweeds along the fall migratory route and at monarch overwintering sites.* 2.50 (0.23)
JUSTIFICATION: Most milkweed species native to North America are highly seasonal, senescing during the fall with new stalks emerging each spring and summer. By the time that most monarchs migrate south in the fall (in a presumably non-reproductive state), native milkweeds have usually died back or are in the process of senescing. This means that it is very rare for resident, continuously-breeding monarch

populations to persist in North America (with the exception of the extreme southern tip of Florida) because their host plants do not support this behavior. Moreover, each spring monarchs oviposit on newly-emerged milkweed stalks that were not exposed to the previous years' butterfly populations. Recent evidence suggests that continuously-breeding monarch populations, and those that reproduce close to their overwintering sites, are much more likely to become heavily parasitized by an important protozoan disease (Altizer et al. 2000). Because this disease has been shown to have negative effects on monarch survival and reproduction (Altizer and Oberhauser 1999), activities that support the unnatural persistence of resident breeding monarchs have the potential to elevate parasite prevalence to levels that could negatively impact eastern migratory monarchs. In particular, tropical milkweeds planted in Texas may support year-long monarch populations that are heavily infected with this disease (Arceneaux et al. 2001). Recent anecdotal evidence indicates that spring migrating monarchs that pass through this region of Texas may become contaminated with parasites and spread the disease throughout a broader range of their breeding habitats during the spring and summer.

In addition to increasing disease transmission, non-native milkweed plantings on the migratory routes or near overwintering sites could increase reproductive behavior (and disrupt migratory behavior) during the migration or overwintering period. Recent research (Goehring and Oberhauser in review) suggests that exposure to milkweed can bring female monarchs out of diapause prematurely.

OVERWINTERING BIOLOGY

Policy Recommendations

19. *Create a new philosophy of administration for the Mexican reserve that represents not only a government body that diagnoses problems and administers laws, but also integrates as many objectives, projects, and activities as possible in the Reserve communities. This administration should work closely with community members, scientists, and non-government organizations (NGOs).* 3.43 (0.22)

JUSTIFICATION: People in the communities in and near the Mexican overwintering sites have already progressed toward conservation goals, providing evidence that they are capable of initiating and carrying out appropriate management programs. The overwintering sites and their surrounding forests are threatened, partly because the Reserve was not sufficiently discussed and defined with the ejiditarios (Smith 1986, Jordan 1995, Akiba 1997, Nabuurs and Lioubimov 2000, and Agbayani et al. 2000).

Once we have created a new territorial design for the Reserve, we must encourage leaders of and citizens from other countries to participate in protecting the Reserve with financial and other support.

20. *Contribute to the trust fund established to compensate Mexican landowners in the new Monarch Butterfly Biosphere Reserve and help them develop alternative sources of income.* 3.38 (0.19)

JUSTIFICATION: Monarchs overwintering in Mexico are threatened, in part, because they are concentrated in a very small area. They cannot withstand extreme winter temperatures (below -8^{o}C) and must survive locally in a few overwintering sites from Nov. – Mar. each year (Brower et. al., in press). Because the entire eastern North American monarch population resides on a few vegetational islands in an area smaller than the state of Delaware during the winter months, destruction and habitat degradation at overwintering sites could have disastrous effects. The Mexican government, working with NGOs in Mexico, the United States and Canada, has made substantial strides toward protecting monarch overwintering sites, but the compensation fund that has been established is inadequate to assure complete funding of the core area ejido owners and continued protection of the sites. It is also critical to protect and manage

the new buffer zones that protect the ecological integrity of the overwintering phenomenon. The Mexican federal and state governments and the U.S. and Canadian governments, as well as NGOs and citizens, should be encouraged to contribute to the protection of these habitats. One possible method of implementation would be to link this directly to the assessment of overwintering population size, i.e. a butterfly "roosting land tax". For example, every American and Canadian butterfly that roosts in Mexico might cost the U.S. and Canada a penny a butterfly (this money could be raised by a combination of government & private donations). This method would put a premium on assessing the number of overwintering butterflies and preserving the overwintering habitat, and provide money directly to the local community.

This fund is presently administered through WWF Mexico and Fondo Mexicano para la Conservacion de la Naturaleza (FMCN).

21. *Signs should be posted at overwintering sites in both California and Mexico describing the biology of monarch butterflies, their complex habitat requirements, and ways to minimize the impact of tourism.* 2.50 (0.21)
JUSTIFICATION: There currently are few signs at the Mexican overwintering sites and only limited information available at some overwintering sites in California. Informational signs would provide a better experience for tourists and would encourage respectful behavior, minimizing the negative impact of ecotourism on the monarchs and the forest. It is necessary to have signs and information available as much for precaution as to inform tourists about monarch biology and forest ecology.

Research priorities

22. *Understand the quality of overwintering forests and evaluate the impact of different types of perturbations on forest dynamics.* 3.46 (0.20)
JUSTIFICATION: Preserving the forest in which monarchs overwinter is an important aspect of monarch conservation in North America. If we can understand forest ecology and the impact of perturbations, we will be better equipped to set up necessary protection programs and restrictions on abuses, thus providing the knowledge necessary for general resource management.

23. *Study rehabilitation of perturbed and reforested overwintering sites at the landscape level, monitor changes in soil use, and create pilot habitat restoration plots.* 3.19 (0.19)
JUSTIFICATION: We cannot adequately plan a resource administration program, particularly with respect to timber resources, without knowing the potential for forest regeneration and recuperation of perturbed sites. The Michoacan Reforestation Fund (Michoacan Reforestation Fund 2001) has begun important work in this area, and their results should be used to inform future reforestation and regeneration programs.

24. *Assess the impact of tourism on monarch butterfly overwintering aggregations, in both Mexico and California.* 2.65 (0.21)
JUSTIFICATION: There are several potential negative impacts of tourism at the overwintering sights. For example, the sheer number of people and, in some areas, horses, on the trails winding through the overwintering colonies makes the trails dusty, sometimes coating monarchs with dirt. Monarch clusters are also sensitive to elevated levels of carbon dioxide, so many people breathing or talking near clusters can cause the butterflies to drop from the trees to the ground, where they are more susceptible to predation. Quantifying the proportion of monarchs affected by ecotourism or the possible mortality rate as a function of number of visitors to protected sites will help ascertain the potential impacts of this activity.

25. *Study monarch overwintering habitat and climatic requirements at the meso- and micro-climate level.* 2.64 (0.20)
JUSTIFICATION: Scientists who have studied monarch mortality at the overwintering sites are currently attempting to understand the relationship between monarch survival during the overwintering period and forest conditions. However, little is known about the overwintering sites at the meso-climate level. With progress in this area, we could understand the conditions that monarchs require, based on the type and quality of the vegetation. Integrating this knowledge with an understanding of micro-climatic requirements would help to predict impacts of global climate change on monarchs, as well as inform conservation efforts.

26. *Identify factors that contribute to the timing of monarch dispersal from overwintering sites.* 2.54 (0.22)
JUSTIFICATION: Overwintering aggregations are a fluid, fluctuating entity throughout much of the overwintering period, and can sometimes take several weeks or even months to fully disband. As scientists continue their studies of the break-up of overwintering aggregations and factors that might cause these aggregations to disband at a premature and potentially suboptimal time, it will be important to first clearly define the timing and conditions associated with spring dispersal from roosting sites.

GENERAL MONARCH CONSERVATION

Policy Recommendations

27. *Encourage public participation in citizen science projects, such as the Monarch Larval Monitoring Project (Monarch Lab 2001), Journey North (Journey North 2001) and Monarch Watch (Monarch Watch 2001), that improve understanding of monarch biology and result in a more ecologically literate public.* 3.40 (0.16)
JUSTIFICATION: This participation results in both increased public awareness of monarchs and their habitat, and improved understanding of monarch biology. One way to encourage public participation is for funding agencies to designate funds for citizen science projects aimed at monarch conservation (and other monitoring/conservation efforts involving the general public). The Larval Monitoring Project and Journey North are supported by the National Science Foundation and the Annenberg Foundation, and these fund-raising strategies can be used as models for other projects. National Parks and Wildlife Reserves might also aid in publicizing and participating in such programs on federal lands.

28. *Encourage the wildlife and natural resource agencies of the United States, Canada and Mexico to establish a Monarch Butterfly Working Group to facilitate and fund tri-national cooperation for monarch conservation, public education and outreach.* 3.33 (0.20)
JUSTIFICATION: In 1998, these agencies agreed to form such a working group, but the group has only met once since then and no further meetings are planned. A group composed of scientists, government officials and NGO members that met regularly could inform and promote conservation efforts and enhance communication among the three countries. In order for such meetings to occur, funds must be available for travel and expenses of those involved, and the meetings need to be publicized, especially among the scientific community. In addition, this group should seek funds for applied research and help translate research findings into appropriate policy recommendation. Printed reports made available in English and Spanish would also facilitate communication and cooperation. Strong public support for such a group would make the governments more likely to follow through on the 1998 agreement.

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