U.S. Fish and Wildlife Service

Setting Objectives for Managing Key Deer

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Executive Summary

The U.S. Fish and Wildlife Service (FWS) is responsible for the protection and management of Key deer (*Odocoileus virginianus clavium*) because the species is listed as Endangered under the Endangered Species Act (ESA). The purpose of the ESA is to protect and recover imperiled species and the ecosystems upon which they depend. There are a host of actions that could possibly be undertaken to recover the Key deer population, but without a clearly defined problem and stated objectives it can be difficult to compare and evaluate alternative actions. In addition, management goals and the acceptability of alternative management actions are inherently linked to stakeholders, who should be engaged throughout the process of developing a decision framework. The purpose of this project was to engage a representative group of stakeholders to develop a problem statement that captured the management problem the FWS must address with Key deer and identify objectives that, if met, would help solve the problem. In addition, the objectives were organized in a hierarchical manner (i.e., an objectives network) to show how they are linked, and measurable attributes were identified for each objective. We organized a group of people who represented stakeholders interested in and potentially affected by the management of Key deer. These stakeholders included individuals who represented local, state, and federal governments, non-governmental organizations, the general public, and local businesses. This stakeholder group met five full days over the course of an eight-week period to identify objectives that would address the following problem:

> *"As recovery and removal from the Endangered Species list is the purpose of the Endangered Species Act, the U.S. Fish and Wildlife Service needs a management approach that will ensure a sustainable, viable, and healthy Key deer population. Urbanization has affected the behavior and population dynamics of the Key deer and the amount and characteristics of available habitat. The identified management approach must balance relevant social and economic concerns, Federal (e.g., Endangered Species Act, Wilderness Act, Refuge Act) and state regulations, and the conservation of biodiversity (e.g., Endangered/Threatened species, native habitat) in the Lower Keys."*

The stakeholder group identified four fundamental objectives that are essential to addressing the problem: 1) Maximize a sustainable, viable, and healthy Key deer population, 2) Maximize value of Key deer to the People, 3) Minimize deer-related negative impacts to biodiversity, and 4) Minimize costs. In addition, the group identified 25 additional objectives that, if met, would help meet the fundamental objectives. The objectives network and measurable attributes identified by the stakeholder group can be used in the future to develop and evaluate potential management alternatives.

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Introduction

The U.S. Fish and Wildlife Service (FWS) is responsible for the protection and management of Key deer (*Odocoileus virginianus clavium*) because the species is listed as Endangered under the Endangered Species Act (ESA). The purpose of the ESA is to protect and recover imperiled species and the ecosystems upon which they depend. Deciding which actions should be taken to recover the Key deer is a complicated task and each possible action is likely to have different ecological, social, and political ramifications.

The Key deer is a subspecies of the common white-tailed deer (*Odocoileus virginianus*) and endemic to the Florida Keys. Key deer diverged from mainland ancestors when they became isolated on what is now the Florida Keys during the rapid sea-level rise that followed the Pleistocene Epoch (Lazell 1984). Europeans first documented the Key deer about 1575 (Dickson 1955) and by the late 1940s, over–hunting and poaching had nearly driven them to extinction, when 50 or fewer deer were believed to exist. Following a hunting ban in 1939, increased law enforcement, and the establishment of the National Key Deer Refuge (NKDR) in 1957, deer abundance increased (Dickson 1955, Hardin et al. 1984, USFWS 1999).

The historical range of the Key deer includes all of the larger islands and many of the smaller, adjacent keys of the Lower Keys, which have seasonal or permanent freshwater (Barbour and Allen 1922, Dickson 1955, Hardin et al. 1984). There are few details regarding the history of range constriction (Hardin et al. 1984). Deer were extirpated from the westernmost keys, Key West and Stock Island, by approximately 1910. Since 1951 (Dickson 1955, Klimstra 1992, Watts 2006), the range has been restricted to areas between the Johnson Keys to the east and Sugarloaf Key to the west.

The current range of Key deer is estimated to encompass 24,305 to 24,676 acres (9,835 to 9,986 ha; Lopez 2001, USFWS 2006). The core population (~75%) occurs on two adjacent mainline keys, Big Pine Key (BPK) and No Name Key (NNK). However, even though BPK and NNK contain about 75% of the species' numbers, these two keys include only about 31% of the area occupied by Key deer (7,463 acres or 3,020 ha). The deer population on BPK and NNK, as well as Big Munson Key, were estimated to be at or near carrying capacity in 2001 (Wilmers 1995, Harveson et al. 2006). The amount of upland habitat and fresh water availability are the primary factors why these islands are important to the Key deer population (Klimstra et al. 1974, Folk et al. 1991).

Recovery of the Key deer, in the context of the ESA, will likely require addressing a number of issues, including deer browsing and habitat quality, access to unnatural food sources, deer-vehicle collisions, and disease. Consequently, a host of management actions possibly could be undertaken to recover the Key deer population, but without a clearly defined problem and stated

objectives it can be difficult to compare and evaluate alternative actions (Williams et al. 2009, 2012). The purpose of this project was to develop a problem statement that captured the decision problem the FWS must address with Key deer, along with stakeholder values, and to identify objectives that decision-makers and stakeholders want to achieve in this management situation. In addition, the objectives were organized in a hierarchical manner to show how they are linked, and measurable attributes were identified for each objective.

The approach we used with this project is consistent with policy of the U.S. Department of the Interior (Departmental Manual, Part 522, 1 February 2008). We coordinated this project with Nancy Finley, refuge manager for National Key Deer Refuge, and Brian Powell, who is responsible for the recovery plan for Key deer with FWS Ecological Services. We organized a stakeholder group composed of representatives of government agencies, non-governmental organizations interested in Key deer, local citizens, and people from the local business community. This stakeholder group met five days during January-March 2014 to develop a problem statement and identify objectives and measurable attributes. This report summarizes the outcomes of these workshops and related activities held on Big Pine Key, Florida.

Stakeholder Group

A news release issued on 22 November 2013 announced the formation of a stakeholder group and solicited interested parties to contact Duane Diefenbach for more information about the purpose of the group and the planned workshops (Appendix I). The purpose of the news release, in particular, was to recruit interested persons who could represent business interests in the community. Those people interested in participating as a stakeholder were asked to submit a short statement indicating why they were interested in participating and who they would represent (e.g., private citizen, business, or other organization).

The participants in the stakeholder group were selected by Duane Diefenbach and Tyler Wagner. Selection of participants was constrained by a need to limit the group to 12 people (not including science advisors) to ensure that the group was small enough to permit communication among all particpants. More importantly, however, the stakeholder group needed to include people who represented county, state, and federal governments, private citizens, non-governmental organizations (environmental groups and property owner associations), and local businesses.

The participants selected were:

- Michael Roberts, representing Division of Growth Management for Monroe County.
- Barbara Hormuth, resident of Big Pine Key.
- Joyce Newman, representative for Last Stand (http://www.last-stand.org).
- Alicia Putney, representing Key Deer Protection Alliance (http://www.keydeer.org).
- Chad Anderson, biologist; Phillip Hughes, ecologist; and Tom Wilmers[1], wildlife biologist for National Key Deer Refuge.
- Randy Grau, biologist with Florida Fish and Wildlife Conservation Commission.
- Robert Ehrig[2], resident of Big Pine Key.
- Kathryn Brown, representing No Name Key Property Owner's Association.
- Susan Rich, local resident and realtor.
- Ed Kilheffer, local resident and business owner.

In addition, Laurie McHargue was designated as an alternate for Michael Roberts and Mary Bakke was an alternate for Kathryn Brown.

Science Advisors

Additional members of the stakeholder group were a number of experts on Key deer, including Dr. Nova Silvy and Dr. Roel Lopez from Texas A&M University, Dr. Nils Peterson from North Carolina State University, and Dr. Doug Mader of Marathon Veterinary Hospital.

[1] Retired as of March 2014.
[2] Resigned from the stakeholder group and did not participate in the last (third) meeting.

Figure 1. Participants involved in the structured decision making workshops for managing Key deer, January 15, 2014. From left to right: Nova Silvy (science advisor), Roel Lopez (science advisor), Tom Wilmers, Nils Peterson (science advisor), Susan Rich, Chad Anderson, Barbara Hormuth, Joyce Newman, Mary Bakke (alternate for Kathryn Brown), Phillip Hughes, Michael Roberts, Randy Grau, Robert Ehrig (resigned from the group), Brian Powell (decision maker), Ed Kilheffer, Alicia Putney. Not pictured are Doug Mader (science advisor), Kathryn Brown, and Nancy Finley (decision maker).

Public Meeting

A public meeting was held on 15 January 2014 to provide an opportunity for the general public and news organizations to learn more about the project and introduce the stakeholders. A news release was issued on 7 January 2014 announcing the names of members of the stakeholder group and who they represented (Appendix I). Also, the time and location of the public session of the working group was announced.

The morning of Wednesday, 15 January 2014 was a session open to the public and held at the First Baptist Church on Big Pine Key. This public meeting was followed by a closed-door meeting of the stakeholder group and science advisors at the headquarters of Key Deer National Wildlife Refuge on Big Pine Key, 15-16 January 2014.

The morning session open to the public included presentations by Phillip Hughes, ecologist for National Key Deer Refuge, on the laws and regulations that give responsibility for management of the Key deer to the FWS. Doug Mader, D.V.M. presented an overview of injuries and diseases that occur in Key deer. His talk was followed by a presentation by Drs. Nova Silvy and Roel Lopez, Texas A&M University, summarizing research conducted on the population ecology of Key deer over the past 30 years. Chad Anderson, ecologist with the National Key Deer Refuge, presented an overview of the plant communities in the Lower Keys and our current understanding of how deer browsing has affected those plant communities.

After the series of presentations related to the ecology of Key deer, Dr. Nils Peterson, North Carolina State University, presented results of research studying the human dimensions of Key deer issues. The last presentation by Dr. Tyler Wagner provided the stakeholder group and the public with an overview of Structured Decision Making and how this process was going to be implemented to address the management challenges of the FWS in carrying out its responsibilities for managing Key deer.

Figure 2. Public meeting held at First Baptist Church on Big Pine Key, Florida to provide information to the public on the purpose and goals of the Key deer workshops. The meeting was attended by members of the public and members of the stakeholder group and included presentations by the scientific advisors.

Structured Decision Making

The best decisions are ones that best meet the objectives of the person making the decision. For simple problems, choosing a solution oftentimes is readily accomplished with little effort or controversy. However, natural resource problems are usually complex and different decision makers could likely select different alternatives to address the same management problem. Complex situations are where Structured Decision Making (SDM) can help make better decisions by thoroughly analyzing the problem.

SDM is a formalized way of analyzing decisions and is based on the premise that a transparent approach to decision making, that acknowledges the interdependence of science and values in the decision making process, greatly increases the likelihood of management success. Consequently, SDM is a transparent approach to decision making that explicitly addresses the uncertainties associated with a decision and lends itself to fully documenting (i.e., communicating) the decision process (Conroy and Peterson 2013).

In SDM a decision can be broken down into 5 steps:

1. Define the problem
2. Identify objectives, including fundamental objectives (ones that directly address the problem) and means objectives (objectives that help achieve the fundamental objectives).
3. Identify possible alternatives (actions) for addressing the problem
4. Evaluate the alternatives with respect to objectives and uncertainties.
5. Select the best alternative (i.e., make a decision).

This project was focused solely on accomplishing the first two steps of the SDM process: defining the problem and identifying objectives. The first two steps of SDM are usually the most difficult and critical aspects to making decisions (Gregory et al. 2012, Conroy and Peterson 2013). Defining the problem and identifying objectives are difficult because this is where the values of all stakeholders need to be clearly identified. The advantage of carefully framing the problem and identifying objectives is that once stakeholders agree upon the objectives then evaluating alternatives becomes possible because alternatives are evaluated based on how well they meet identified objectives.

An important aspect of SDM is that the various steps may be revisited during the process of making a decision. For example, after identifying the problem and the objectives that, if met, will help solve the problem, one should return to the defined problem to make certain the problem is correctly framed. Consequently, although this report presents the results of framing the problem and outlining objectives for solving the problem, these may need to be revised in the future as alternative actions are identified and evaluated.

Decision Makers

For any given problem there is always someone who has the responsibility and authority to make the final decision on what action(s) is to be used to address the problem. For this problem, the decision makers were identified as Nancy Finley, refuge manager for the National Key Deer Refuge and Brian Powell, Ecological Services. Brian Powell is responsible for the FWS Recovery Plan for the Key deer. These two employees of FWS approved the final problem statement developed by the stakeholder group.

Problem Statement

The first task of the stakeholder group was to draft a statement of the problem to be addressed in the workshops. Problem statements should describe what triggered the need to make a decision and identify laws or regulations directly relevant to the problem. Most importantly, however, the statement describes the problem succinctly.

As a starting point, the decision makers created a draft problem statement for the stakeholder group:

> *"How to establish a healthy and wild Key deer population in the Lower Keys."*

The stakeholder group discussed the problem and identified some ideas and language that should be included in the statement. The group identified relevant laws, a succinct statement of the problem, and what needed to be considered when addressing the problem. The group agreed the problem statement should be easily understood by anyone not familiar with the issues related to Key deer.

Several problem statements with minor differences in wording were identified by the end of the first day with the intent to finalize the statement the following morning (Appendix II). The following morning, Joyce Newman presented a revised statement, which was unanimously accepted by the group with minor wording revisions. The following problem statement was approved by the decision makers:

> *"As recovery and removal from the Endangered Species list is the purpose of the Endangered Species Act, the U.S. Fish and Wildlife Service needs a management approach that will ensure a sustainable, viable, and healthy Key deer population. Urbanization has affected the behavior and population dynamics of the Key deer and the amount and characteristics of available habitat. The identified management approach must balance relevant social and economic concerns, Federal (e.g., Endangered Species Act, Wilderness Act, Refuge Act) and state regulations, and the conservation of biodiversity (e.g., Endangered/Threatened species, native habitat) in the Lower Keys."*

Developing Objectives

Following acceptance of the problem statement, the stakeholder group began identifying objectives that the decision makers hoped to achieve relevant to the decision problem. At this stage of first identifying and listing objectives, no distinction was made between Fundamental objectives (those important in their own right) and Means objectives (those that help achieve Fundamental objectives – see next section for further explanation). Identifying objectives was achieved by first listing concerns related to Key deer as part of a free-format discussion where ideas were recorded (Appendix III). The workshop facilitators then organized these concerns by theme and the group consolidated the concerns (e.g., some concerns were duplicative) and converted them to objectives. In most cases, objectives were readily stated as minimizing or maximizing some attribute of the problem (Table 1).

Table 1. Concerns for addressing the management of Key deer grouped by topic theme and resulting objectives identified by the stakeholder group, 16 January 2014. Note that objectives do not correspond one-to-one with expressed concerns and not all objectives listed in this table were retained by the stakeholder group.

Concerns (by theme)	Objectives (by theme)
Education:* • Lack of education and outreach (also misdirected outreach?) • Refuge visitor center directs people to subdivisions (to see deer) • Visitors need a place for visitors to see Key deer • Need for dissemination of disease research results • Attitudes about "my" deer vs "wild" deer • Fear of takings claims • Local attitudes towards the deer • Transient character of Keys human population • Deer are scapegoats for "all" restrictions on property rights • Public mistrust of the government • Lack of public understanding about the role that Key deer conservation has played helping other species	• Maximize ecological literacy (fundamental ecological relationships) • Maximize education of disease ecology • Maximize education about the effects of feeding • Maximize appropriate viewing opportunities • Maximize communication between researchers and public • Maximize regulatory literacy *Education must be an on-going, long-term commitment
Habitat: • Excessive fuel loads on refuge property • Loss of habitat • Lack of habitat restoration • Constriction in Key deer range • Habitat impacts from increasing populations of Key deer in non-core areas • Fire regime implementation insufficiently mimics natural fire/wet season regime in the Lower Keys • Invasion/exotic pest plants/animals in natural landscape • Cumulative impact of decisions/actions by individual landowners	• Minimize fuel loads on refuge property • Minimize loss of habitat • Maximize habitat restoration (hardwood hammock, pine rocklands, freshwater resources) • Maximize appropriate Key deer range • Maximize natural disturbance regime (fire) • Minimize deer-related impacts to biodiversity • Minimize invasive/exotic pest plants/animals in natural landscape

Table 1. Continued.

Concerns (by theme)	Objectives (by theme)
Habitat (continued):	
• Habitat loss, damage, and fragmentation, and loss of species caused by management actions • Concern about biodiversity • Lack of habitat restoration for hardwood hammocks • Lack of habitat restoration of pine rocklands • Inadequate long-term planning for restoration and maintenance of freshwater resources • Potential negative impacts of Cudjoe Key sewer plant	• Maximize habitat quality on private lots • Minimize negative effects of management on resources • Create long-term plan for restoration and maintenance of freshwater resources • Minimize impacts of public construction projects • Maximize land acquisition
Uncertainties:	
• Lack of information on carrying capacity • Overall lack of data to inform decision-making o Lack of resources to gather those data • Sea level rise • No long-term solution/ no long-term viability (sea-level rise) • Uncertainties/fears about growing Key-deer-related regulatory burdens in the future • No contingency plan for catastrophic events (e.g., disease, drought, hurricane) • No contingency plan for sea level rise • Climate change	• Create contingency plan for catastrophic events (e.g., disease, drought, hurricane) • Incorporate sea level rise and climate change considerations into contingency plans
Feeding deer:	
• Lack of enforcement of feeding prohibition • Feeding deer unhealthy food • Unintentional feeding (garbage) • Feeding of deer for commercial tourism purposes • Loss of “wildness” in many (most?) individuals in the deer herd	• Minimize intentional feeding • Minimize unintentional feeding (e.g., access to garbage) • Maximize “wildness” of deer

Table 1. Continued.

Concerns (by theme)	Objectives (by theme)
Monitoring: • Detecting deer impacts on habitat • Detecting deer population changes	• Develop appropriate monitoring design to assess future management actions
Deer health: • Need to target deer numbers that address herd health • Free-roaming domestic animals	• Minimize transmission/incidence of disease (includes physical injury and mortality)
Deer population: • Unnatural uneven population distribution throughout range • Overabundance in some areas • Too many deer • Need to target deer numbers that address population viability • Constriction in Key deer range? • Lack of deer in non-core areas (eggs all in one basket) • Negative impacts by deer on habitat necessary for other species • Artificial selection (e.g., for harmful behavior) • Maintaining genetic diversity • Skewed sex ratios	• Minimize areas of overabundance • Maximize distribution throughout range • Minimize ganging (large groups of deer) • Minimize extinction risk
Regulations: • Concerns that HCP is being pushed aside/weakened • Limitations on management options • Prohibitions on fencing yards • Given resources, limited support/mechanisms (e.g., in courts) to solidify law enforcement • Long-term lack of political and agency will to enforce existing regulations	• Maximize refuge management options • Maximize support for enforcement of existing regulations • Maximize enforcement of existing regulations • Maximize inter-governmental communication and coordination • Maintain existing regulatory protections

Table 1. Continued.

Concerns (by theme)	Objectives (by theme)
Community:	
• Deer-caused property damage • Potential negative economic impacts resulting from Key deer management • Lack of environmental stewardship by the public • Perception of "too many deer" rather than "not enough habitat" • Long-term poor relations and perceptions between members of the community and conservation organizations • Lack of community interaction with refuge staff/programs • Shift in community attitudes toward coming to meetings • Key deer conversation weighted toward conservation and away from people concerns	• Minimize risk of private property damage during the implementation of management options • Minimize deer-caused property damage • Minimize negative economic impacts resulting from Key deer management • Maximize timely interactions and communication between refuge staff and the community • Maximize personal environmental stewardship • Maximize efforts to engage the public
USFWS:	
• Refuge staff turnover (loss of continuity/institutional memory) • Current fire management policy • Misperceptions within local communities that all land-use restrictions are refuge related • Limited refuge resources for law enforcement • Limited refuge resources/staff to facilitate interaction of refuge staff within the community • Limited refuge staff • Insufficient interaction of refuge staff within the community	• Maximize institutional memory • Minimize staff turnover • Maximize documentation of management actions or outcomes
Research:	
• Lack of integrated deer/vegetation research agenda • Lack of forecasting tools/information (e.g., infrastructure change, climate-related ecology) • Need for updating existing research findings	• Maximize integration of research activities • Maximize application of existing forecasting tools and research findings

Table 1. Continued

Concerns (by theme)	Objectives (by theme)

Vehicles:
• High numbers of deer-caused motor vehicle accidents
  o Deer mortality
  o Human health perspective
• Traffic and highway level of service (LOS)
• Lack of speed limit enforcement on secondary roads
• Too many roadkills
	• Minimize deer - vehicle collisions
	• Maintain LOS
	• Maximize intergovernmental coordination on speed limit enforcement

Developing an Objectives Network

Objectives can be organized into a network that explicitly indicates their hierarchical nature. For example, accomplishing objectives to "minimize deer-vehicle collisions" and "minimize areas of deer overabundance" will both help accomplish the objective to "minimize deer-caused property damage." How objectives were related to one another (i.e., their hierarchy) was identified by the stakeholder group.

When developing an objectives network it is important to distinguish between Fundamental Objectives and Means Objectives. A Fundamental Objective is one that passes the "Why Is That Important?" (WITI) test. If the answer to this question is phrased as something like "because it is," or "because of a law," then it is deemed a Fundamental Objective. If the answer to the WITI test is "Because it will help us meet our objective to …," then it is a Means Objective that helps accomplish a Fundamental Objective.

To facilitate the process of developing an objectives network for the stakeholder group, we organized the objectives into four major areas of concerns: 1) minimizing extinction risk, 2) reducing deer-related impacts to biodiversity, 3) reducing deer-caused property damage, and 4) education and outreach. We did not necessarily see each major group of concerns as meeting the definition of a fundamental objective, but they allowed us to group objectives into simpler sub-networks (Appendix IV). Furthermore, some objectives were listed in more than one sub-network.

By the conclusion of the second two-day workshop, the stakeholder group had developed an objective network (Appendix V) that identified four fundamental objectives:

1. Minimize deer-related negative impacts to biodiversity,
2. Maximize a sustainable, viable, and healthy Key deer population,
3. Minimize costs, and
4. Maximize value of Key deer to the People.

We note that these four fundamental objectives align with the three major components of the discipline of wildlife management: the animal, its habitat, and societal values (Giles 1978, Krausman 2002). The fundamental objective regarding deer-related impacts to biodiversity reflect the stakeholder group's recognition that deer, primarily through browsing, have the ability to affect plant species diversity and consequently other animal species (Barrett and Stiling 2006, 2007) and that sufficient quality and quantity of habitat is essential to sustain Key deer. Similarly, the objective related to the health of the Key deer population reflects the recognition that there are factors directly impacting the species, such as deer-vehicle collisions (Lopez et al. 2003). Finally, the stakeholder group recognized that society must value Key deer if it is going to protect the species with the limited funds available for their management.

The objective network was further refined following additional discussions of the stakeholder group during the final workshop (Figure 3). At the conclusion of the project the objective network included four fundamental objectives and 25 means objectives. The means objectives were linked to one or more of the fundamental objectives.

In addition to the objectives network, the stakeholder group retained a box (background color in blue at lower left in figure) labeled “Monitoring program” as a reminder that monitoring aspects of the environment will be important to managing Key deer and to determine if management actions are meeting objectives (see also Figures A4-1 and A5-1). Such monitoring could provide information on habitat conditions, deer relative abundance, deer-vehicle collisions, compliance with regulations, etc. Although monitoring is not an objective per se, it is critical to providing information for making decisions and evaluating the success of meeting objectives related to solving the problem.

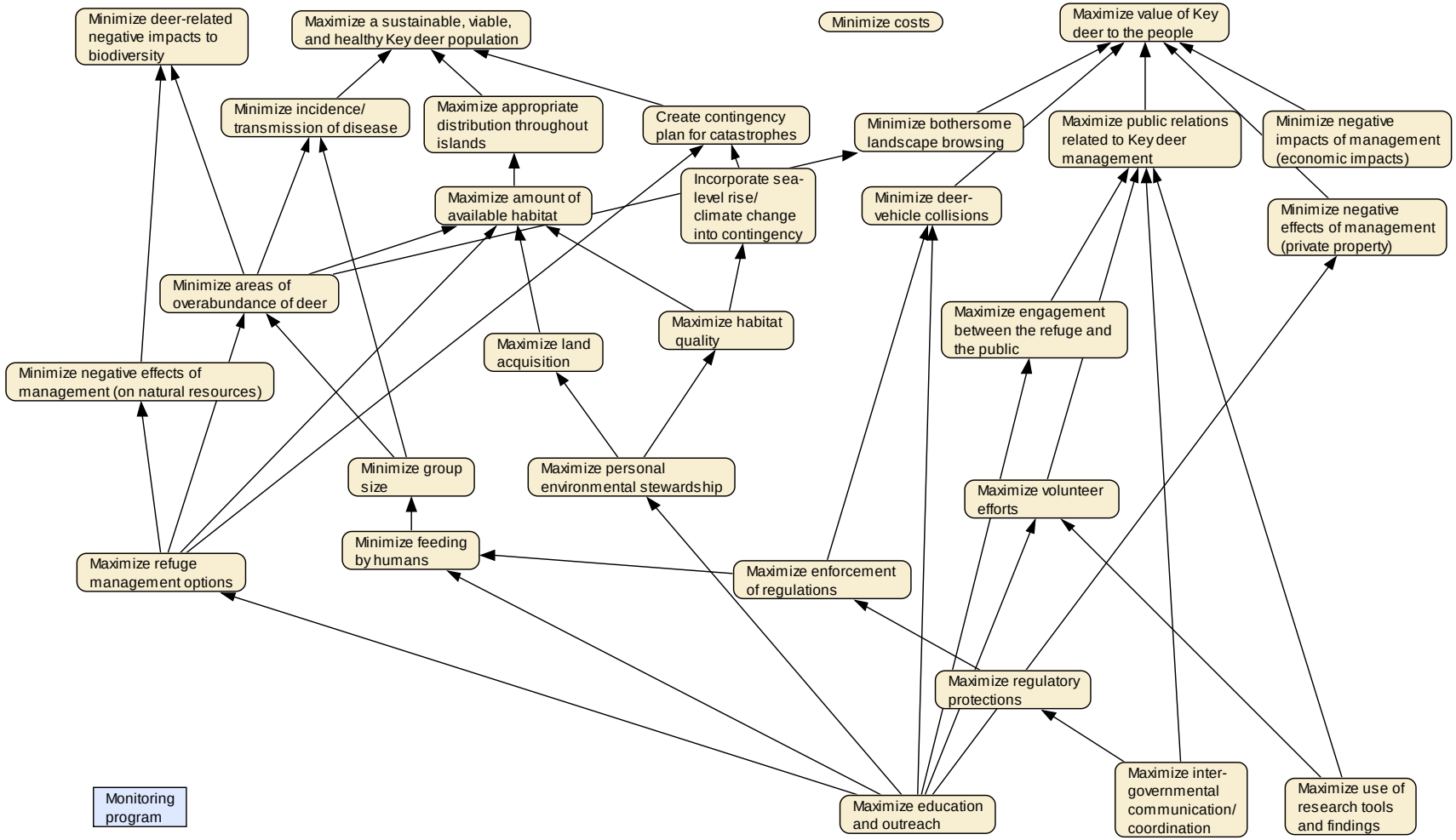

Figure 3. Objective network developed by the stakeholder group.

Measurable Attributes of Objectives

An objectives network is used to evaluate how well alternative actions meet specified objectives. However, in order to be able to evaluate alternatives measurable attributes are needed for each objective. For example, if an objective is to minimize costs, each alternative can be compared according to the expected number of dollars needed to implement each alternative.

Not all objectives, however, can be readily quantified. If no measure is available, not even one based on expert judgment, then the objective is unlikely to be of much help in making a decision despite its importance. Without being able to specify or quantify an objective it will be impossible to compare predictive outcomes of actions and evaluate trade-offs among objectives. Other objectives might be very important to the problem, but the expected outcome with respect to a given action may be difficult to estimate or predict. In such cases, constructed scales based on expert judgment (e.g., 1 = excellent, 2 = good, …, 5 = very poor) may have to be used to evaluate alternatives or perhaps the measurable attribute is really a proxy for the real attribute of interest. For example, the number of deer-vehicle collisions reported to law enforcement agencies might be a useful proxy for the actual number of deer-vehicle collisions because not all collisions are reported.

The stakeholder group identified a measurable attribute for each objective but in some cases multiple attributes were identified (Table 2). Although only one attribute is required to evaluate an objective, the cost or feasibility of obtaining the data for some attributes may be more expensive than others. Because this project did not consider or evaluate alternatives we have retained all potential measurable attributes for consideration. In some instances, the stakeholder group recognized that it was likely the objective only could be assessed in a qualitative manner so they indicated the attribute could be rated on a constructed scale (e.g., low, medium, and high).

Discussions about attributes led to simplification of the objective network (cf. Figure 3 versus Appendix V) by eliminating or combining some objectives. These changes were recognized as necessary by the stakeholder group because the objective could not be measured or because the same measurable attribute applied to different objectives.

A detailed explanation of the reason behind each means objective, and the measurable attributes, is provided in Appendix VI.

Table 2. Measurable attributes for each objective included in the objective network.

	Objective	Measurable attribute
1	Minimize negative effects of management (on natural resources)	• Number of resources negatively affected
2	Maximize refuge management options	• Number of management events/options
3	Minimize incidence/transmission of disease	• Prevalence of diseases (X, Y, and Z)
4	Minimize areas of overabundance of deer	• Diversity of woody tree species (proxy) • Group size • Number of deer • Relative deer density across range (captures obj. 4 & 7) • Density relative to carrying capacity
5	Minimize group size	• Average group size
6	Minimize feeding by humans	• Prevalence of chronic feeders (intentional and unintentional)
7	Maximize appropriate distribution throughout islands	• Relative deer density across range (captures obj. 4 & 7)
8	Maximize amount of available habitat	• Acres of available habitat
9	Maximize land acquisition	• Acres of land acquired
10	Maximize personal environmental stewardship	• Number of people/households participating in stewardship and incentive programs
11	Create contingency plan for catastrophes	• Yes/No - Development of a contingency plan
12	Incorporate sea-level rise/climate change into contingency	• Yes/No – Develop plan
13	Maximize habitat quality	• Prevalence of highly palatable (to deer) native plants • Acres of high quality habitat • Number of permanent freshwater sources
14	Maximize engagement between the refuge and the public	• Number of workshops and scientific presentations • Number of contact hours with community • Percentage of "satisfied customers" (members of the public) • Hours on community projects • Number of different outlets for the public to gain access to refuge information

Table 2. Continued.

	Objective	Measurable attribute
15	Maximize public relations related to Key deer management	• Satisfaction of public
16	Maximize use of research tools and findings	• Yes/No – previous work acknowledged/incorporated into current management • Implementation of relevant research findings
17	Maximize volunteer efforts	• Number of volunteer hours
18	Maximize education and outreach	• Number of programs/workshops/newspaper articles • Number of different outlets used to disseminate information (e.g., research findings) • Percent of participants that learn something as assessed pre-post workshop, etc.
19	Minimize bothersome landscape browsing	• Percentage of landowners who state deer are eating their landscapes and are bothered by it
20	Minimize deer-vehicle collisions	• Number of deer roadkills
21	Maximize regulatory protections	• Potential for loss/weakening of regulations and protections: low, medium, high
22	Maximize enforcement of regulations	• Number of citations per infraction • Proportion of laws being enforced
23	Maximize inter-governmental communication/coordination	• Number of agencies coordinating to enforce the laws • Number of inter-agency agreements
24	Minimize negative impacts of management (economic impacts)	• Constructed scale: Low, medium, high
25	Minimize negative effects of management (private property)	• Constructed scale: Low, medium, high
26	Minimize costs	• Dollars (time, personnel, dollars)
27	Minimize deer-related negative impacts to biodiversity	• Native plant and animal species diversity
28	Maximize a sustainable, viable, and healthy Key deer population	• Ratio of abundance/carrying capacity
29	Maximize value (importance) of Key deer to the people	• Proportion of people who say Key deer are "important"

Summary

A series of SDM workshops was held to develop a statement describing the need for the FWS to develop a management plan that explicitly accounts for the legal, social, and environmental constraints of Key deer management and recovery. This problem statement was agreed upon by a stakeholder group and approved by the FWS decision makers. Given the agreed upon problem statement, a series of objectives also was identified. Furthermore, these objectives were linked in a hierarchical manner and potential measurable attributes were identified.

The identified problem statement, objectives, and measurable attributes can serve as the basis for future discussions about potential management alternatives related to Key deer recovery. Importantly, the objectives and measurable attributes will allow for a transparent and objective process for comparing the efficacy of future management actions, even given competing objectives.

We reiterate that this report presents just the first two steps in the SDM process in making decisions regarding a natural resource management problem. If the FWS decides to continue further with this work then future stakeholder groups or resource managers will likely have to revisit the objectives, and possibly even the problem statement. As specific actions (alternatives) are considered it may become evident that how specific objectives are quantified needs to be changed, or that some objectives were missed. These are common occurrences when addressing management problems and are why SDM is an iterative process, often requiring revisits to the various steps in the process to make sure the problem is being addressed as well as possible.

Acknowledgments

We would like to thank all members of the stakeholder group for their professionalism and hard work on this project. Defining objectives is a difficult and time-consuming task that requires focused attention and careful listening to other people’s ideas and opinions. The dedication and participation of the stakeholder group made our task much easier. We thank the scientific advisors, Drs. N. Peterson, N. Silvy, R. Lopez, and D. Mader, for their time and contributions to this project. Their willingness to provide their time and expertise was of great assistance to the discussions of the stakeholder group.

Also, we acknowledge the contribution of Phillip Hughes in providing background information on the management of Key deer that helped us develop the Introduction to this report. This information was part of the draft Recovery Plan for the Key deer. Funding for this project was provided by the U.S. Fish and Wildlife Service under a contract to D. R. Diefenbach and T. Wagner through The Pennsylvania State University.

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Appendix I

News Releases

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Penn State Ag Sciences News 11/22/2013
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Stakeholder group to address management of Key deer

UNIVERSITY PARK, Pa. -- Researchers from The Pennsylvania State University are seeking participants for a stakeholder group to identify goals and objectives for managing Key deer. The Key deer is a subspecies of white-tailed deer only found in the Florida Keys and is listed as federally endangered.

The primary purpose of the workshops will be to identify goals and objectives for maximizing the long-term survival of the species and minimizing deer-human conflicts.

The U.S. Fish and Wildlife Service is funding the workshops. Nancy Finley, refuge manager for the Florida Keys Refuge Complex, noted that the refuge is initiating this work "to improve understanding and integration of community concerns and needs into the long-term management of Key deer."

The stakeholder group will convene for three workshops in January-March 2014.

Facilitating the workshops will be two scientists from the Pennsylvania Cooperative Fish and Wildlife Research Unit at The Pennsylvania State University, Drs. Duane Diefenbach and Tyler Wagner. Dr. Diefenbach is unit leader and adjunct professor of wildlife ecology and is nationally recognized for his research on white-tailed deer. Dr. Wagner is assistant unit leader and adjunct professor of fisheries ecology. Diefenbach and Wagner have worked together to facilitate a number of workshops dealing with fish and wildlife management problems.

"The purpose of the stakeholder group will be to identify a set of objectives that need to be accomplished to maximize that Key deer will persist yet minimize deer-human conflicts," said Diefenbach. "Identifying a clear set of objectives is a critical first step before identifying and prioritizing actions to protect Key deer."

Wagner concurs and noted, "Setting objectives seems simple, but is a difficult process. Without clearly identifying objectives we cannot begin to decide which actions will be most effective at meeting management goals."

The Key deer is a subspecies of white-tailed deer that evolved in the Florida Keys. White-tailed deer on islands tend to be smaller than their mainland counterparts, but Key deer are especially tiny. Adult males may weight as little as XX lbs, and fawns weigh as little as XX lbs – ZZ% of a typical white-tailed deer.

Key deer were named "toy" deer by Ding Darling, a political cartoonist and conservationist, who first called the Nation's attention to the plight of species. Key deer probably numbered as few as 20 animals when Key Deer NWR was created in 195? and have been listed as federally endangered since 19??

A number of stakeholders have already been identified and have agreed to participate in the workshops. These stakeholders include representatives from Monroe County government, Florida Freshwater Fish and Wildlife Commission, The Nature Conservancy, U.S. Fish and Wildlife Service, Key Deer Protection Alliance, and local citizens.

Also participating in the workshops will be experts on Key deer, including Drs. Nova Silvy and Roel Lopex from Texas A&M University, Dr. Nils Peterson from North Carolina State University, and Dr. Doug Mader of Marathon Veterinary Hospital.

The Penn State researchers are seeking additional participants who can represent the local business community and others who may be affected by future decisions to manage Key deer. Diefenbach noted, “We need to keep the stakeholder group small but we want to ensure good representation from the local community. We still have a couple of openings available and encourage participation.”

Anyone interested in participating in the workshops should contact Dr. Duane Diefenbach via e-mail at DRD11@psu.edu or calling 814-865-4511.

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Penn State Ag Sciences News 1/7/2014
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Key deer workshop scheduled, stakeholder group formed

UNIVERSITY PARK, Pa. -- The first of a series of workshops to identify objectives for managing Key deer will be held Jan. 15.

The meeting, which is part of a joint research effort by the U.S. Fish and Wildlife Service and Penn State related to the management of the federally endangered animal, will run from 8:30 a.m. to noon at the First Baptist Church at 300 Key Deer Blvd. on Big Pine Key.

The first session of the meeting will be open to the public, providing an opportunity to learn more about the purpose of the workshops and who is involved in the stakeholder group.

"We will provide the public and participants in the workshops with an overview of the most current knowledge of Key deer as well as an overview of what to expect from the workshops," said Duane Diefenbach, leader of the Cooperative Fish and Wildlife Research Unit at Penn State.

Diefenbach, with help from Tyler Wagner, assistant unit leader of the Penn State research unit, will lead the stakeholder group during three meetings to be held before the end of March.

Key deer are listed as federally endangered and were the impetus for the creation of the Key Deer National Wildlife Refuge in 1957. The U.S. Fish and Wildlife Service is responsible for managing the species and developing a plan for recovery, with the intent of removing Key deer from the endangered species list.

"We solicited participation in the working group from a broad array of stakeholders, including county, state and federal agencies, local citizens, nongovernmental organizations, and local business owners," said Diefenbach. "The purpose of the workshops is to engage people who are interested in and affected by the management of Key deer and the efforts to protect this endangered species."

The number of participants in the working group had to be limited so that everyone has an opportunity to fully engage in discussions during the meetings, noted Wagner.

"However, we have been able to recruit excellent representation from a broad array of interests potentially affected by management of Key deer," he said.

Participants in the workshops include the following stakeholder representatives:

--Michael Roberts and Laurie McHargue, representing Division of Growth Management for Monroe County.

--Barbara Hormuth, resident of Big Pine Key.

--Joyce Newman, representative for Last Stand.

--Alicia Putney, representing Key Deer Protection Alliance.

--Chad Anderson, Phillip Hughes and Tom Wilmers, biologists for Key Deer National Wildlife Refuge.

--Randy Grau, biologist with Florida Fish and Wildlife Conservation Commission.

--Robert Ehrig, resident of Big Pine Key.

--Kathryn Brown, representing No Name Key Property Owner's Association.

--Susan Rich, local resident and realtor.

--Ed Kilheffer, local resident and business owner.

The working group will rely on information and advice from a number of experts on Key deer, including Nova Silvy and Roel Lopez from Texas A&M University, Nils Peterson from North Carolina State University, and Dr. Doug Mader of Marathon Veterinary Hospital. Each will give presentations as part of the session open to the public.

Parking at the First Baptist Church is free and doors will open at 8 a.m. Seating will be available on a first-come basis. For information, contact Diefenbach at 814-865-4511 or by email at DRD11@psu.edu.

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Appendix II

Draft Problem Statements

Below is a bullet list of topics listed during a brainstorming session about the problem statement, followed by draft problem statements identified on the first day of the workshop. The draft statements are listed in order of development.

- Constraints of ESA (more relevant to Actions)
    - Will not allow management actions that meet the definition of a "taking" even if they are beneficial (e.g., apply birth control in areas of high deer density)
    - Certain tools not available if listed as endangered
    - Management of other listed species will influence options for Key deer
- Wild/not wild
- Viable/ sustainable
- How to protect and manage healthy deer (population) in an urban setting, which entails additional constraints
- Pressure for further development
- … goal to delist (ESA)
- Biodiversity of ecosystem – vegetation and fauna
- Human health, safety, and welfare
- Property rights

1. A number of federal regulations (ESA, Wilderness Act, etc.) constrain the potential management actions that could be used to manage Key deer. In addition, urbanization has affected the behavior and population dynamics of the species, and the amount and characteristics of available habitat. Also, other Threatened and Endangered species affect what potential management actions are available. Given this complex socio-ecological situation, the USFWS needs an approach to maintain viable and healthy Key deer populations in order to ultimately de-list them under the Endangered Species Act. The identified approach must take into account the flora and fauna (i.e., biodiversity) in the Keys, and human health, safety, and welfare.

2. Federal (Endangered Species Act, Wilderness Act, Refuge Act, etc.) and state regulations constrain the potential management actions that could be used to manage Key deer. In addition, urbanization has affected the behavior and population dynamics of the species, and the amount and characteristics of available habitat. Also, other Threatened and

Endangered species affect what potential management actions are available. To achieve the purpose of recovery and removal from the Endangered Species list, and given the complex social and ecological situation, the U.S. Fish and Wildlife Service needs an approach to maintain a sustainable, viable and healthy Key deer population. The identified approach must take into account the flora and fauna (i.e., biodiversity) in the Keys, and human health, safety, and welfare.

3. Federal (Endangered Species Act, Wilderness Act, Refuge Act, etc.) and state regulations constrain the potential management actions that could be used to manage Key deer. In addition, urbanization has affected the behavior and population dynamics of the species, and the amount and characteristics of available habitat. Also, other Threatened and Endangered species affect what potential management actions are available. To achieve the purpose of recovery and removal from the Endangered Species list, the U.S. Fish and Wildlife Service needs an approach to maintain a sustainable, viable and healthy Key deer population. The identified approach must take into account the complex social and ecological situation and explicitly consider the needs of the community.

4. Federal (Endangered Species Act, Wilderness Act, Refuge Act, etc.) and state regulations constrain the potential management actions that could be used to manage Key deer. In addition, urbanization has affected the behavior and population dynamics of the species, and the amount and characteristics of available habitat. Also, other Threatened and Endangered species affect what potential management actions are available. To achieve the purpose of recovery and removal from the Endangered Species list, the U.S. Fish and Wildlife Service needs an approach to maintain a sustainable, viable and healthy Key deer population. The identified approach must consider locally relevant social and economic concerns.

5. As recovery and removal from the Endangered Species list is the purpose of the Endangered Species Act, the U.S. Fish and Wildlife Service needs a management approach that will ensure a sustainable, viable, and healthy Key deer population. Urbanization has affected the behavior and population dynamics of the Key deer and the amount and characteristics of available habitat. The identified management approach must balance relevant social and economic concerns, Federal (e.g., Endangered Species Act, Wilderness Act, Refuge Act, etc.) and state regulations, the existence of the other Endangered and Threatened species, and native biodiversity in the Lower Keys.

Appendix III

Free-form List of Concerns Identified by the Stakeholder Group

Lack of education and outreach (also misdirected outreach?)
Excessive fuel loads on refuge property
Refuge visitor's center directs people to subdivisions (to see deer)
Feeding deer
Lack of enforcement of feeding prohibition
Attitudes about "my" deer vs "wild" deer
Feeding deer unhealthy food
Too many deer
Visitors need a place for visitors to see Key deer
Unintentional feeding (garbage)
Deer health
Unnatural uneven population distribution throughout range
overabundance in some areas
Loss of habitat
Need to target deer numbers that address
Pop viability
Herd health
Lack of habitat restoration
Constriction in Key deer range
Habitat impacts from increasing populations in non-core areas
Detecting deer impacts on habitat
Lack of information on carrying capacity
Detecting deer population changes
Overall lack of data to inform decision-making
Lack of resources to gather those data
Free-roaming domestic animals
Lack of deer in non-core areas (eggs all in one basket)
Sea level rises
No contingency plan for catastrophic events (e.g., disease, drought, hurricane)
Fear of takings claims
Concerns that HCP is being pushed aside/weakened
Local attitudes towards the deer
Transient character of Keys human population
Refuge staff turnover (loss of continuity/institutional memory)
No long-term solution/ no long-term viability (sea-level rise)
Fire regime implementation insufficiently mimics natural fire/wet season regime in the Lower Keys
Limitations on management options
Current fire management policy
Lack of integrated deer/vegetation research agenda
High numbers of deer-caused motor vehicle accidents
    Deer mortality
    Human health perspective

Deer-caused property damage
Prohibitions on fencing yards
Invasion/exotic pest plants/animals in natural landscape
Potential negative economic impacts resulting from Key deer management
Key deer conversation weighted toward conservation and away from people concerns
Deer are scapegoats for “all” restrictions on property rights
Misperceptions within BPK and NNK communities that all land-use restrictions are refuge related
Uncertainties/fears about growing Key-deer-related regulatory burdens in the future
Public mistrust of the government
Lack of public understanding about the role that Key deer conservation has played helping other species
Lack of public environmental stewardship by the public on BPK and NNK
Traffic and highway level of service (LOS)
Lack of speed limit enforcement on secondary roads
Cumulative impact of decisions/actions by individual landowners
Perception of “too many deer” rather than “not enough habitat”
Limited refuge resources for law enforcement
Given resources, limited support/mechanisms (e.g., in courts) to solidify law enforcement
Long-term lack of political and agency will to enforce existing regulations
Feeding of deer for commercial tourism purposes
Long-term poor relations and perceptions between members of the community and conservation organizations
Habitat loss, damage, and fragmentation, and loss of species caused by management actions
Insufficient interaction of refuge staff within the community
Limited refuge resources/staff to facilitate interaction of refuge staff within the community
Limited refuge staff
Lack of community interaction with refuge staff/programs
Shift in community attitudes toward coming to meeting
Concern about biodiversity
Negative impacts by deer on habitat necessary for other species
Lack of habitat restoration for hardwood hammocks
Lack of habitat restoration of pine rocklands
No contingency plan for sea level rise
Climate change
Inadequate long-term planning for restoration and maintenance of freshwater resources
Too many roadkills
Lack of forecasting tools/information (e.g., infrastructure change, climate-related ecology)
Potential negative impacts of Cudjoe Key sewer plant
Artificial selection (e.g., for harmful behavior)
Maintaining genetic diversity
Goats and sheep (although not known to be present, they are a potential disease risk or competitor to Key deer)
Loss of “wildness” in many (most?) individuals in the deer herd
Need for updating existing research findings
Need for dissemination of disease research results

Appendix IV

Draft Objective Sub-networks

The facilitators of the workshops developed separate objective networks based on four general themes related to the various objectives identified: 1) extinction risk, 2) negative impacts of deer to biodiversity, 3) property damage, and 4) education and outreach. These four networks were to assist the stakeholder group to initiate discussions for identifying fundamental versus means objectives and organizing the objectives in a hierarchical framework linking all objectives into a single network.

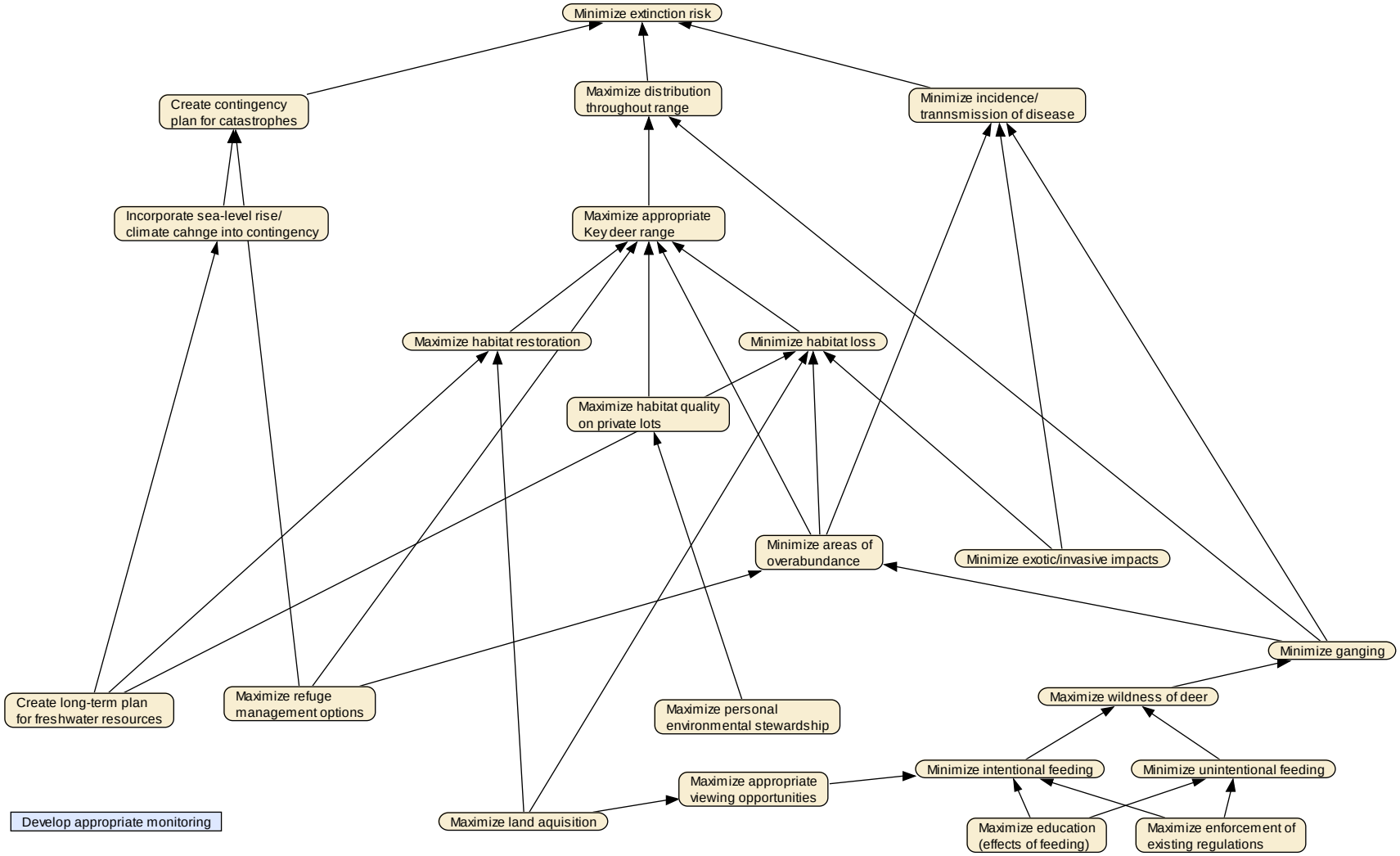

Figure A4-1. Objectives that support the objective to minimize extinction risk.

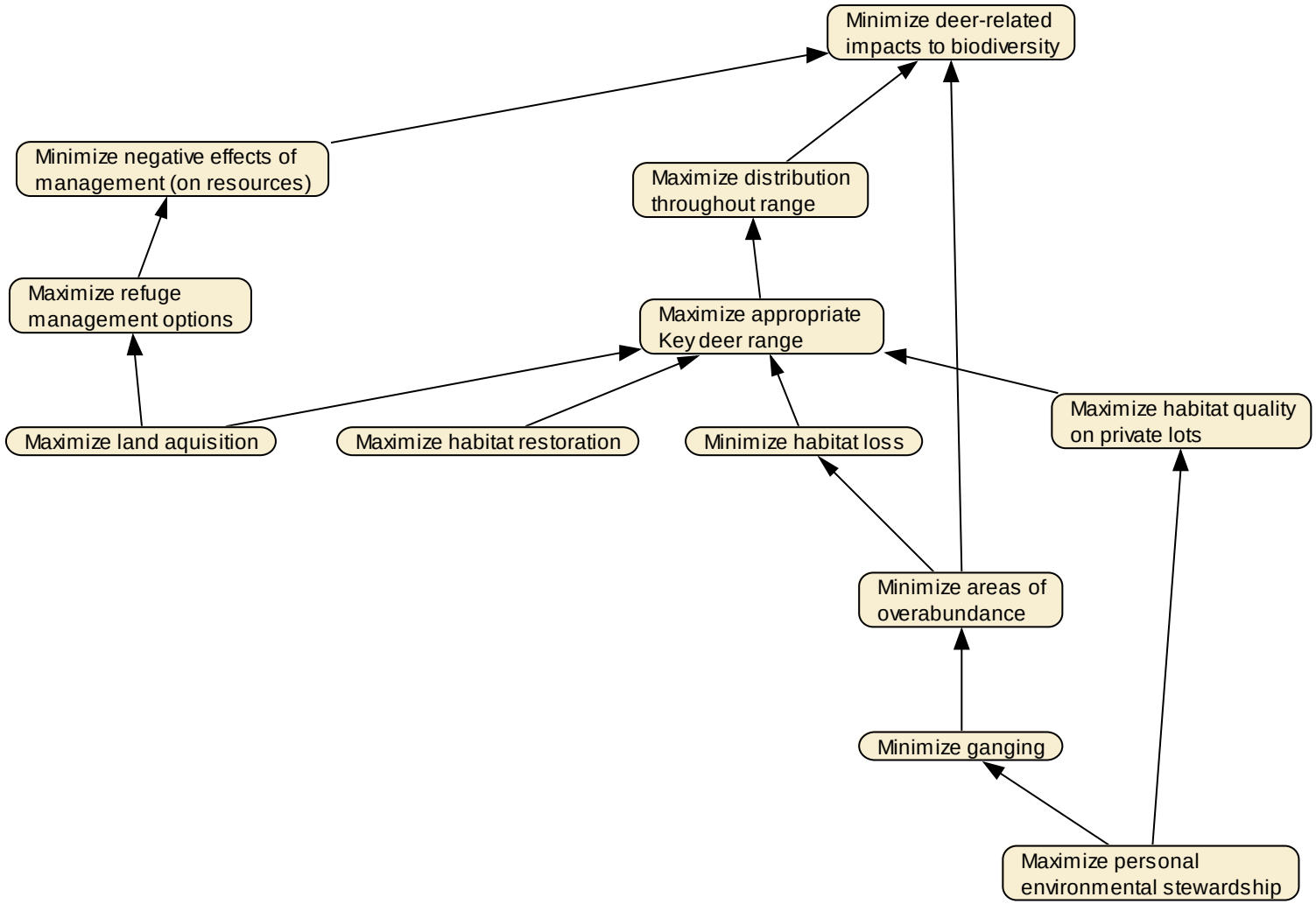

Figure A4-2. Objectives that support the objective to minimize deer-related impacts to biodiversity.

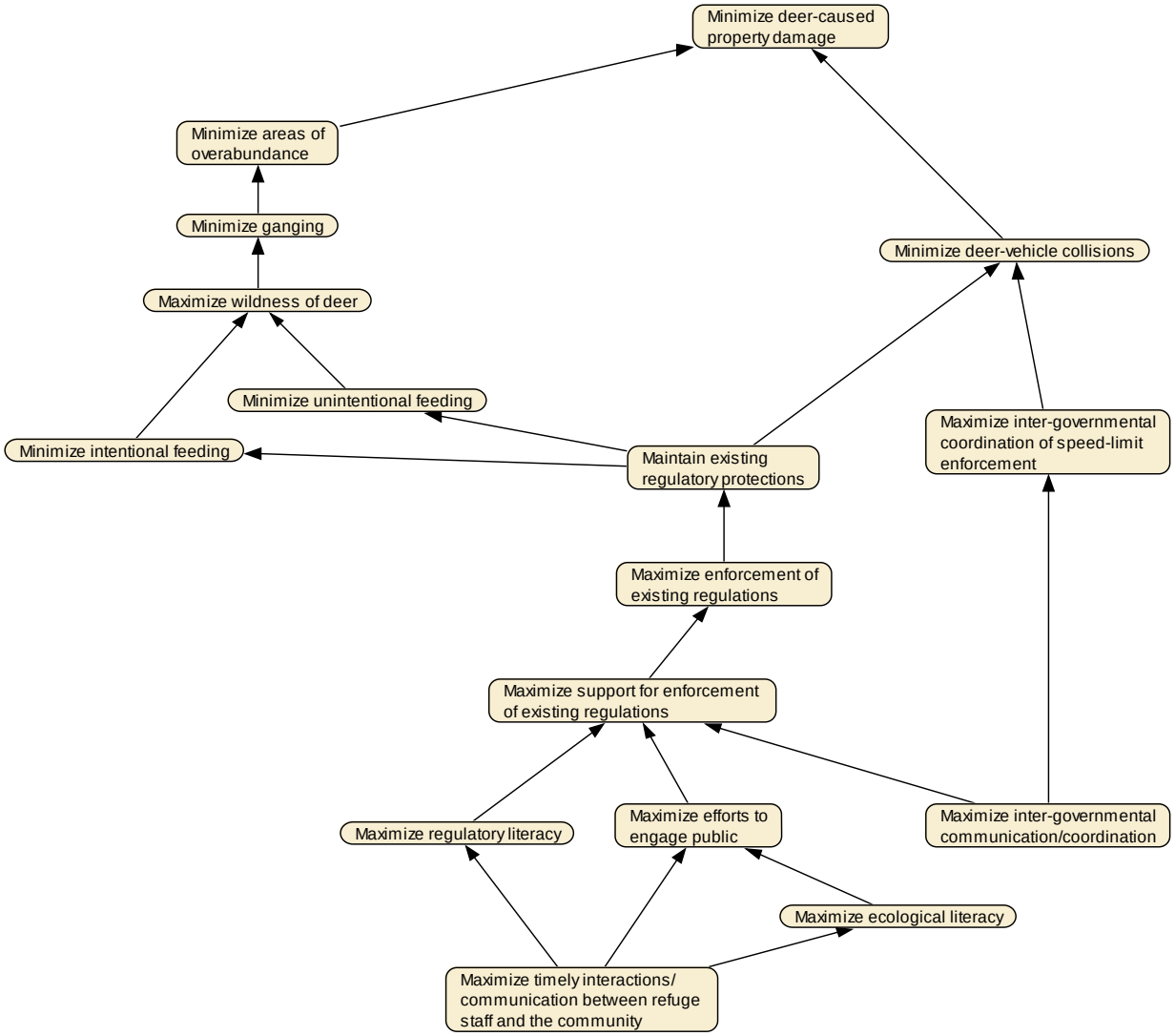

Figure A4-3. Objectives that support the objective to minimize deer-caused property damage.

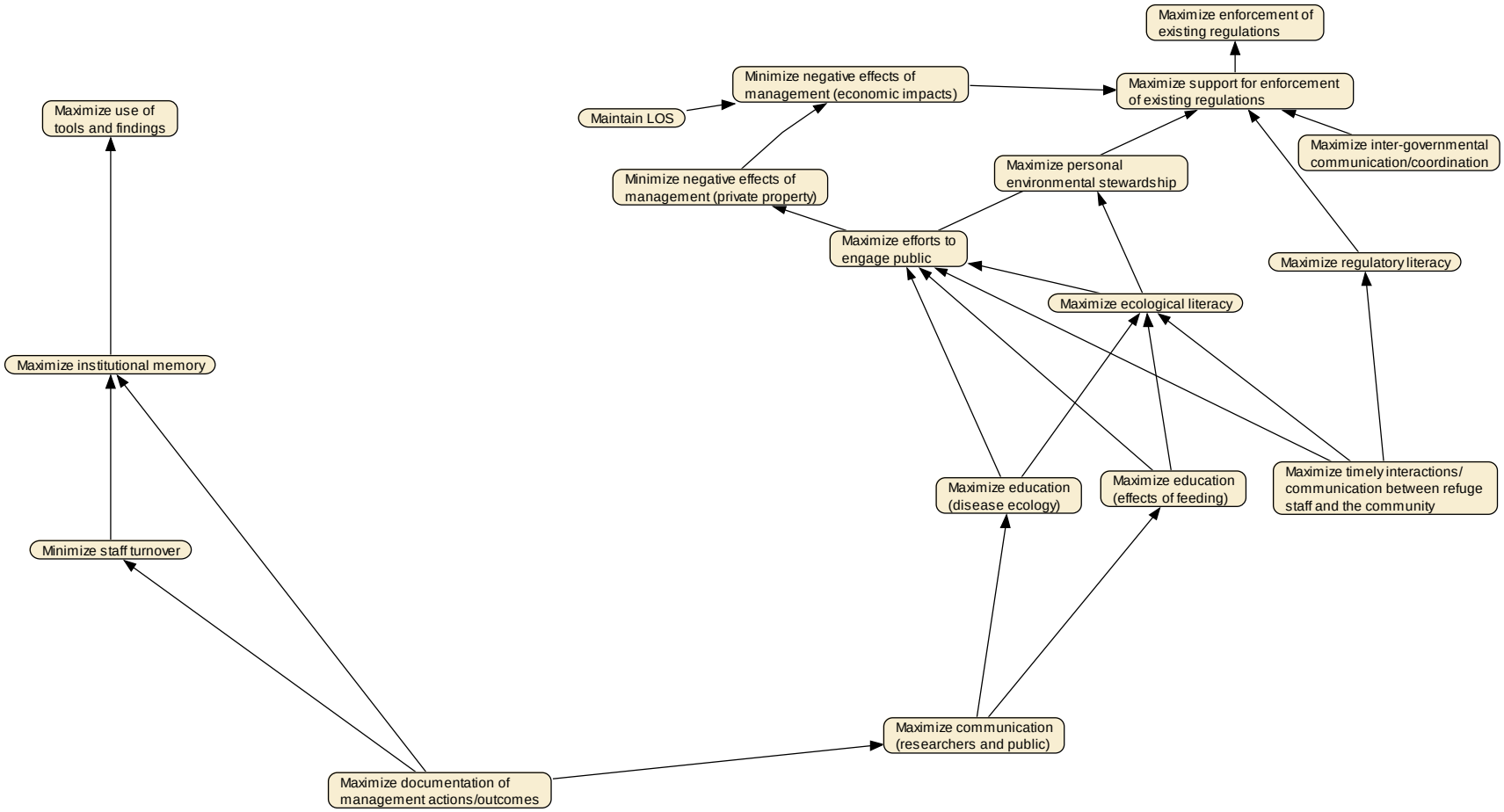

Figure A4-4. Objectives that focus on education and outreach and documentation by the Key Deer National Wildlife Refuge.

Appendix V

Initial Objective Network

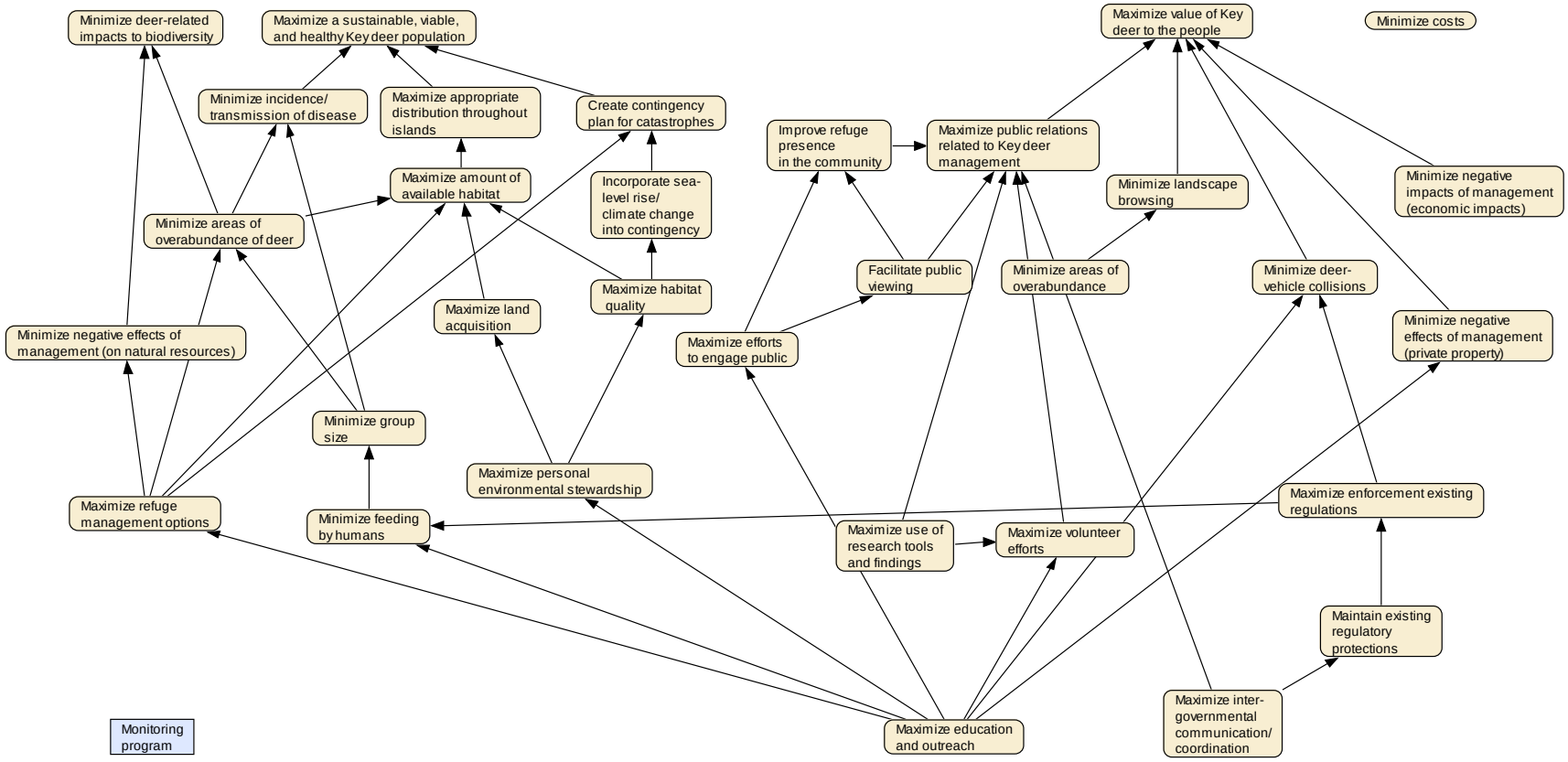

Figure A5-1. Objective network developed by the stakeholder group at the conclusion of the second two-day workshop. The box labeled “Monitoring program” is a reminder that monitoring will be important to evaluate the effect of management actions or for monitoring the status of environmental conditions (e.g., habitat conditions, deer-vehicle collisions, etc.).

Appendix VI

Explanation of Means Objectives

Objective 1: Minimize negative effects of management (on natural resources)

Measurable attribute – Number of resources negatively affected

Although it is desirable for management to maximize benefit to Key deer, stakeholders recognized that some actions that are beneficial for Key deer may be detrimental to other species. This objective expresses that need to consider other species along with Key deer when evaluating possible management alternatives.

Objective 2: Maximize refuge management options

Measurable attribute – Number of management events/options

This objective was proposed in recognition that because Key deer currently are listed as endangered under the ESA, certain management alternatives might be precluded even if they might benefit Key deer. Delisting or downlisting are examples of actions that might expand the number of other possible management alternatives that could be considered, and thus would help achieve this particular objective.

Objective 3: Minimize incidence/transmission of disease

Measurable attribute – Prevalence of diseases (X, Y, and Z)

One of the Fundamental objectives is to maximize a sustainable, viable and healthy Key deer population, which includes health of individuals in the population. Minimizing disease incidence and transmission helps to achieve this fundamental objective.

Objective 4: Minimize areas of overabundance of deer

Measurable attribute – Diversity of woody tree species (proxy); Group size; Number of deer; Relative deer density across range (captures obj. 4 & 7); Density relative to carrying capacity

This objective was proposed for several reasons. Reducing localized overabundance reduces risk of disease transmission, reduces risk of damage to residential landscapes (e.g., unacceptable browsing), and potentially could spread deer out so that use of all available habitat is maximized (objective 7). Several attributes were proposed in recognition that some might be more economical to measure whereas others might be more reliable. The most useful metric might be a function of several different attributes.

Objective 5: Minimize group size

Measurable attribute – Average group size

Minimizing the average group size of deer is a means for directly addressing objectives 3 and 4. Based on previous research on Key deer, group size reflects the amount of feeding of deer by humans and is related to the density of deer.

Objective 6: Minimize feeding by humans

Measurable attribute – Prevalence of chronic feeders (intentional and unintentional)

Artificial feeding encourages ganging behavior (i.e., increases group sizes of deer), so minimizing such feeding should help to meet objective 5. The proposed measurable attributes recognizes that some people intentionally feed deer, whereas elsewhere feeding might be unintentional (e.g., failing to prevent access to garbage).

Objective 7: Maximize appropriate distribution throughout islands

Measurable attribute – Relative deer density across range (captures obj. 4 & 7)

This objective recognizes that, in general, populations with a widespread distribution are less susceptible to random and possibly detrimental events than are populations with highly restricted ranges. Therefore, this objective addresses the fundamental objective to maximize viability of the Key deer population.

Objective 8: Maximize amount of available habitat

Measurable attribute – Acres of available habitat

Clearly some habitat within the Keys (e.g., Key West) is not suitable for Key deer. But making as much habitat as possible as suitable as possible will allow the most extensive distribution of Key deer within the Keys. Thus, this objective is a means to address objective 7.

Objective 9: Maximize land acquisition

Measurable attribute – Acres of land acquired

This objective was proposed with the understanding that managing public land for Key deer (i.e., making it suitable for Key deer) is more straightforward than convincing private landowners to do the same. Thus, increasing the number of acres of publicly-owned land should address objective 8.

Objective 10: Maximize personal environmental stewardship

Measurable attribute – Number of people/households participating in stewardship and incentive programs

Notwithstanding objective 9, much of the remaining Key deer habitat in the Lower Keys is privately owned, and management consequently depends on landowner attitudes. This objective assumes that people who have a strong ethic of environmental stewardship are most likely to improve the habitat on their land in a way that benefits Key deer, or might be most willing to swap or sell land to a public entity to reduce fragmentation. This objective is a means to address objectives 9 and 13. The measurable attribute was proposed in recognition that what people do (participation) likely is a better metric of attitude or ethic than what they know (education).

Objective 11: Create contingency plan for catastrophes

Measurable attribute – Yes/No - Development of a contingency plan

Although arguably a decision problem of its own rather than a means objective, this point was retained as an objective because the stakeholder group expressed concern about catastrophic events such as hurricanes that potentially could decimate the Key deer population, or rising sea-levels that could inexorably threaten population viability (see objective 12 below).

Objective 12: Incorporate sea-level rise/climate change into contingency

Measurable attribute – Yes/No – Develop plan

This objective addresses objective 11. Rising sea-levels pose a threat to freshwater resources that are an essential component of high quality Key deer habitat. Again, this objective arguably might not be viewed as a means objective for the current decision problem but a component of a decision problem dealing with catastrophes. But we included it here because it was identified as a major concern by the stakeholder group.

Objective 13: Maximize habitat quality

> *Measurable attribute* – Prevalence of highly palatable (to deer) native plants; Acres of high quality habitat; Number of permanent freshwater sources

The measureable attributes for this objective identify how stakeholders defined high quality habitat. Inasmuch as high quality habitat is more suitable for Key deer than low quality habitat, and many permanent freshwater sources are a better hedge against storm surges or rising sea-levels, this objective is a means to address objectives 8 and 12.

Objective 14: Maximize engagement between the refuge and the public

> *Measurable attributes* –Number of workshops and scientific presentations; Number of contact hours with community; Percentage of "satisfied customers" (members of the public); Hours on community projects; Number of different outlets for the public to gain access to refuge information

Education and outreach (objective 18) supports many other objectives in the network and maximizing engagement between the public and refuge staff was recognized by the group as being important to improving public relations. The group identified a number of attributes that could be used to assess how well this objective was being accomplished.

Objective 15: Maximize public relations related to Key deer

> *Measurable attribute* – Satisfaction of public

This objective is supported by several other objectives related to engaging the public. The stakeholder group felt that the public would be more accepting of management actions if they understood why the refuge was taking specific actions and there was greater communication between the refuge and the public. How well the refuge was meeting this objective could be assessed with surveys of the public assessing satisfaction.

Objective 16: Maximize use of research tools and findings

Measurable attributes – Yes/No – previous work acknowledged/incorporated into current management; Implementation of relevant research findings

The stakeholder group recognized that the refuge had conducted a lot of research related to Key deer and that this work was not readily available to the public or it was not being used to make management decisions. The stakeholder group felt that this objective could be assessed by whether this research was being used.

Objective 17: Maximize volunteer efforts

Measurable attribute – Number of volunteer hours

Maximizing volunteer efforts was believed to be helpful for improving public relations with the public and could be readily assessed by the number of hours that members of the public volunteer in community projects to benefit Key deer.

Objective 18: Maximize education and outreach

Measurable attributes – Number of programs/workshops/newspaper articles; Number of different outlets used to disseminate information (e.g., research findings); Percent of participants that learn something as assessed pre-post workshop, etc.

The stakeholder group recognized that education and outreach was crucial to successfully achieve a number of objectives because it was essential that the public understand the reason behind any type of action. As indicated in Figure 3 this objective affects all the fundamental objectives. The group identified several attributes that could be used to assess how well this objective was being achieved.

Objective 19: Minimize bothersome landscape browsing

Measurable attributes – Percentage of landowners who state deer are eating their landscapes and are bothered by it

Damage to landscaping was recognized by the stakeholder group as a problem that could be addressed by minimizing deer overabundance. People will be more willing to tolerate deer, or be more likely to engage with the refuge, if they were not suffering financial loss from excessive browsing. In turn, this would address a fundamental objective to maximize the value of Key deer to the People.

Objective 20: Minimize deer-vehicle collisions

Measurable attributes – Number of deer roadkills

Deer-vehicle collisions were recognized as an ongoing problem that needs to be minimized. Such collisions are a major mortality source for Key deer and are having an effect on dispersal and sex ratios in southern Big Pine Key. This objective could be assessed by tracking roadkills, as is currently done by the refuge.

Objective 21: Maximize regulatory protections

Measurable attribute – Potential for loss/weakening of regulations and protections: low, medium, high

The stakeholder group recognized that some potential actions could lead to a weakening of regulatory protections, such as downlisting to threatened status. When considering alternative actions, the group agreed decision makers should choose alternatives that maximize protections for Key deer given competing objectives. This objective could be assessed using a constructed scale of low, medium, and high.

Objective 22: Maximize enforcement of regulations

Measurable attributes – Number of citations per infraction; Proportion of laws being enforced

A concern was expressed by the stakeholder group that some current state and federal laws and regulations, such as feeding of deer and speed limits, were not being enforced. Enforcing certain laws and regulations could help accomplish other objectives and could be measured by the proportion of infractions that result in citations or the proportion of relevant laws and regulations being enforced.

Objective 23: Maximize inter-governmental communication/coordination

Measurable attributes – Number of agencies coordinating to enforce the laws; Number of inter-agency agreements

There are county, state, and federal agencies that have responsibilities related to Key deer management. Coordination among these agencies would help meet many objectives (e.g, objective 22). Achievement of this objective could be assessed by the inter-agency agreements and coordination.

Objective 24: Minimize negative impacts of management (economic impacts)

Measurable attributes – Constructed scale: Low, medium, high

Potential actions related to managing Key deer could have impacts to the local economy (e.g., loss of development opportunities). The group recognized that such negative economic impacts should be minimized. The effects of various alternative actions on the economy could be assessed on a constructed scale. It may be possible that for certain alternatives that economic impact could be measured monetarily.

Objective 25: Minimize negative effects of management (private property)

Measurable attributes – Constructed scale: Low, medium, high

Similar to the objective above, potential actions could have effects on private property. For example, various habitat management actions could have different levels of risk for damage to private property. The group agreed that chosen actions should minimize this risk. This risk may need to be assessed on a constructed scale such as low, medium, and high.