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Tennessee's Comprehensive Wildlife Conservation Strategy

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This document was produced as a collaborative effort between the Tennessee Wildlife Resources Agency & The Nature Conservancy – TN Chapter:

The mission of the Tennessee Wildlife Resources Agency is to preserve, conserve, protect, and enhance the fish and wildlife of the state and their habitats for the use, benefit, and enjoyment of the citizens of Tennessee and its visitors. The Agency will foster the safe use of the state's waters through a program of law enforcement, education, and access.

In keeping with this mission, the Agency recognizes its long-standing partnership with sportsmen and the significant contributions that sportsmen have made and continue to make to benefit all fish and wildlife, including non-game species. In submitting this Comprehensive Wildlife Conservation Strategy, the Agency expresses its intent that implementation of this plan be conducted in a way to achieve the Agency's mission, while sustaining and promoting hunting and fishing in Tennessee.

The Nature Conservancy is a nonprofit organization with the mission to preserve plants, animals, and natural communities that represent the diversity of life on earth by protecting the lands and waters they need to survive.

CHAPTER 4

Monitoring, Management, Research, & Review Plans

To ensure the long-term success of the CWCS, significant effort must be made to monitor the effectiveness of conservation actions after implementation. All steps taken to manage GCN fauna must be able to adapt in response to changing conditions on the ground. Furthermore, thresholds for decision making must be set to determine when actions have either achieved their desired effects or have proven unsuccessful in conserving fauna. Likewise, data gaps in research must be filled in order to establish better parameters for decision making. Finally, the CWCS must be periodically reviewed to assess progress, to refine strategies, and to re-examine priorities as new data is gathered.

Monitoring Plans

At its most basic level, monitoring must be able to determine change in the status of a target species' habitats or populations at a specified scale over time. To adequately monitor either habitats or populations, strict protocols must be established for observation and data collection. These protocols should set parameters that regulate the quality and type of information that can be used to determine the status or condition of a target. Ultimately, the process of setting monitoring protocols depends upon several factors: data quality, spatial scale, sampling effort, and duration. In turn, each of these factors is influenced by the stated objective of the monitoring effort.

Costs associated with monitoring are another factor to consider when designing and implementing a monitoring program. Intensive monitoring of the 664 GCN species identified in this strategy, at a statewide scale, would be an enormous task even if the appropriate funding were available. Further, monitoring all 412 Tier 1 species to which the TWRA holds jurisdictional responsibility is unrealistic due to associated costs. Resolution of this issue can only be achieved by establishing well-defined monitoring objectives. These objectives should determine the scale, intensity of effort and qualitative level of data collected for a select set of priority species and/or habitat units. Along with clearly defined monitoring objectives, there must be a long-term commitment to data management and data analysis. Without this commitment, monitoring cannot be expected to identify the trends needed to determine the status of selected GCN species or their habitats.

Once objectives are derived, monitoring can provide either detailed or general information about a wide array of biological factors that affect GCN species. Intensive study of a population can yield estimates of absolute abundance, age class, mortality/fecundity, survivorship, habitat condition/structure, etc. Conversely, monitoring can provide more streamlined sets of information such as the presence/absence of species and relative abundance. Both complex and simple monitoring schemes can reflect trends in parameter values and infer target status over time.

A primary goal of Tennessee's CWCS is to keep species from declining to the point of requiring protection under the federal Endangered Species Act. Depending on the status of a species and the current level of its problems, species-level management (e.g. propagation, re-introduction, or increased legal protection at the state level) may be required to sustain or recover a given faunal target. Regardless, habitat conservation, enhancement, and/or management are much more efficient options to employ to affect a

species' status. As such, habitat monitoring is crucial to determining the success of conservation and recovery projects.

Habitat Monitoring for the CWCS

Again, to successfully monitor habitat, consideration must be given to objectives, data quality/consistency, geographic & temporal scale, and costs (Schoonmaker and Luscombe 2005). With these factors in mind, the primary goals of habitat monitoring should be:

1. To assess the quality and quantity of habitat at local, regional, statewide, and national scales;
2. To assess the spatial arrangement of habitat at various scales over time; and,
3. To cooperate and partner with other organizations and agencies during the process in order to increase effectiveness, broaden applications and decrease costs.

An ideal methodology to achieve the first two goals in habitat monitoring may be found in land use / land cover analysis, remote sensing data, and other GIS modeling applications. Land use / land cover data provides the flexibility to monitor habitat at multiple spatial and temporal scales. However, some limitations do exist in regard to resolution, spectrum, and the level of habitat classification that can be achieved.

As previously mentioned, NatureServe's ecological systems compose the land cover / habitat classification system employed in the GIS model complementing this strategy. There were several reasons for selecting this system. First, it provides a standardized means of describing and comparing habitats at the ecoregional level. Second, the ecological system classification scheme provides a framework for updates. Finally, efforts are underway to develop a seamless land use / land cover map for the southeast that will more easily facilitate collaboration across state boundaries in shared ecoregions.

With future use of remote sensing and a standardized classification system, changes in land cover over time can be identified and quantified. Gains or losses in habitat can be measured and incorporated into the current CWCS GIS model. As well, more sophisticated spatial analyses can be conducted to identify and quantify important habitat corridors or core habitat blocks.

Southeast Regional GAP is developing several products based on the National Land Cover Dataset (NLCD) and NatureServe's Ecological Systems. Completion of the southeast mapping zones is projected for 2006 (McKerrow et al. 2004). Once completed, the new land use / land cover data will be employed in the CWCS model. A general schedule of re-mapping needs should be developed and coordinated with the Southeast Regional GAP program for the state. Understandably, re-mapping the southeast is a complex process and Tennessee is just one of many states with needs. However, comparing land use at five to ten year intervals would provide a high degree of monitoring of wildlife habitats at a state scale (also suggested by Schoonmaker and Luscombe 2005). This frequent analysis could also be used in considering the results of other forest/habitat analysis efforts.

Other Habitat Assessment Programs

A number of other habitat assessment and monitoring programs conducted by agencies, organizations, and academic institutions have either recently been conducted or are ongoing across portions of Tennessee. Despite the fact that these programs have their own sets of objectives, scales and methodologies, coordination at a basic level should produce some residual benefits to CWCS efforts. Knowing which monitoring and assessment programs are being conducted and understanding their respective objectives will hopefully minimize any unnecessary duplication of labor. Many of these programs delve deeply into assessment of underlying causes of habitat change. Due to a number of reasons, not all of these programs may explicitly integrate or mesh with each other. They can, however, at a minimum provide supplemental information to habitat monitoring

conducted for the CWCS. Descriptions of ongoing assessment programs and other monitoring studies are provided as follows:

- The Southern Forest Resource Assessment (SFRA) was completed in 2003. The USFS, USFWS, USEPA, TVA and some state forestry departments and fish and wildlife agencies worked cooperatively in evaluating the status and future conditions of southern forests (Wear and Greis, 2003). Issues considered included rapid urbanization, increasing timber demand, increasing numbers of satellite chip mills, forest pests, water quality and changing air quality. This assessment was based on NLCD land cover standards and Forest Inventory Analysis data. Periodic land use / land cover analysis at the regional level could help track and predict forest conditions.

- The Tennessee Division of Forestry evaluated the SFRA relative to forest resources in Tennessee. Specific areas on which the Tennessee Forestry Commission offered recommendations included: urbanization, forest fragmentation, forest health, timber resources and water quality (Tennessee Forestry Commission 2004).

- Forest Health Monitoring Program is a USFS program designed to determine the status, changes, and trends in indicators of forest condition on an annual basis. The FHM program uses data from ground plots and surveys, aerial surveys, and other biotic and abiotic data sources and develops analytical approaches to address forest health issues that affect the sustainability of forest ecosystems. FHM covers all forested lands through a partnership involving USFS, State Foresters, and other state and federal agencies and academic groups (U.S. Dept. of Agriculture Forest Service 2003).

- A 2003 report by the USFS / Southern Research Station evaluated forest fragmentation at the national scale (Wear and Greis 2003). Fragmentation greatly affects habitat suitability, wildlife movements, and invasion of exotic plant species. Again, periodic land use / land cover analysis at the regional level could track fragmentation.

- Riiters et al. (2002) reports on the fragmentation of continental U. S. forests. The report conducts a multiple-scale analysis of forest fragmentation and finds most forests are in a fragmented landscape. State-level implications may be inferred from the report.

- *Forests on the Edge*, a report by the USFS (Stein et al. 2004), evaluated the impact of housing development on private forestlands. This assessment ranked the Lower Cumberland watershed as 6th in the nation in terms of increased housing density by the year 2030.

- NRCS conducts an annual Natural Resources Inventory (NRI) (Natural Resources Conservation Service, 2004). The NRI is a land use survey statistically designed to measure the status, conditions, and trends of the natural resources on non-federal lands. Full implementation of the annual NRI approach is expected in 2005. Future products from the survey should allow evaluations of conservation programs implemented by the NRCS. Water quality, water use conservation, soil erosion, soil quality and carbon sequestration benefits will be identified. Additional goals of the NRI include regional level evaluations of land use, air quality and wildlife habitat.

- Climate change is expected to affect forest composition, water quality and wildlife in Tennessee by the year 2100 (U.S. Environmental Protection Agency 1999). Monitoring of land use / land cover and biological communities is imperative to document any potential effects from climate change.

- Other pertinent Southeast GAP efforts include partnering with the USFWS to refine habitat models of priority bird species to southeastern habitats. Impervious surface and closed canopy estimations are also being developed (McKerrow et al. 2004). Both estimations have implications for water quality assessment.

- The Tennessee Division of Water Pollution Control assesses the status of water quality in Tennessee and has recently issued the 2004 305b Report. In this assessment watersheds are sampled on a 5-year rotation. Based on biological and chemical sampling of streams and habitat descriptions, streams are evaluated into 5 use categories (Category 1 and 2 supporting, Category 3 not assessed, Category 4 water impaired with Total Maximum Daily Load assessment not required, and Category 5 monitored water found not to meet its designated use).

- The USFWS sponsored bird joint ventures have developed or are developing GIS coverages of various habitat layers for bird conservation. The Lower Mississippi Valley Joint Venture (LMVJV) and the Central Hardwoods Joint Venture (CHJV) are working collaboratively on forest bird habitat models for the Central Hardwoods Bird Conservation Region. The LMVJV has developed decision support models for forest interior birds for the LMV Bird Conservation Region. The CHJV is looking at developing wetland data layers. The East Gulf Coastal Plain JV and Appalachian JV partnerships are just getting started with bird conservation planning and GIS capabilities.

- State and regional-level mapping using satellite and other imagery is ongoing in several agencies. There is an opportunity to acquire 1 meter resolution digital aerial imagery for the state through partnerships with the TN Division of Forestry and the TN Department of Transportation.

Species Monitoring

The TWRA along with other agencies and partners are currently engaged in various monitoring/surveys at different levels of data complexity. Details of ongoing species inventories and monitoring efforts are provided by faunal group, participation of agencies / organizations, and geographic & temporal scale (see Table 68). Due to the high costs associated with species monitoring, identifying and integrating the CWCS with other monitoring efforts is imperative. As such, attempts will first be made to incorporate species monitoring into existing efforts before establishing additional monitoring programs. Supplemental monitoring will be initiated only after current capacity is assessed. However, the TWRA and its partners are committed to fulfilling additional species monitoring as is deemed necessary.

In considering the design of a monitoring program, the relationship between objectives and cost should be a primary concern. Expenses can rise dramatically as objectives increase in complexity and scale. Conversely, objectives can decrease to the point of being ineffectual if funding is insufficient. In order to determine objectives for a monitoring project, a number of questions must be asked:

1. What is to be monitored? Is it an individual species, population, community, or faunal group?
2. What is the question to be answered and what needs to be measured? Is it the presence or absence of the species, its relative abundance, or the response to management?
3. What level of data quality will answer the question? Is it descriptive qualitative data such as an index or a quantitative estimate of the population's size or is it something in between?
4. At what geographic scale does the question need answering? Is it locally important to know the answer? Regionally? Statewide? How many samples are needed?

Table 68. Ongoing Monitoring and Survey Efforts for Species in Tennessee			
Species / Faunal Group	Agency / Organization*	Geographic Scale (*Local, Regional, Statewide*)	Temporal Scale (*Periodic, Annual*)
Sportfish Surveys	TWRA	Statewide	Annual
Fish Surveys	TWRA TVA TNARI CFI	Statewide Regional Local Local	Annual Annual Annual Periodic
Fish IBI Surveys	TWRA TDEC TVA	Regional Regional Regional	Annual Annual Annual
Fish Tissue Analysis	TWRA TDEC	Regional Statewide	Annual Annual
Lake Sturgeon Reintroduction / Evaluation	TWRA TVA UTK TNARI	Regional Regional Regional Regional	Annual Annual Annual Annual
Barrens Topminnow	TWRA USFWS USGS TTU	Local Local Local Local	Annual Annual Annual Annual
Pigeon River Fish Community Restoration	TWRA UTK TDEC USGS TVA ORNL	Local Local Local Local Local Local	Annual Annual Annual Annual Annual Annual
Freshwater Mussel Surveys	TWRA NPS TVA USGS USFWS USACE	Statewide Local Local Local Local Local	Annual Periodic Periodic Periodic Periodic Periodic
Mussel Tissue Analysis	TWRA TDEC	Local Local	Periodic Periodic

Table 68. Ongoing Survey and Monitoring Efforts for Species in Tennessee (cont'd.)			
Species / Faunal Group	Agency / Organization*	Geographic Scale (*Local, Regional, Statewide*)	Temporal Scale (*Periodic, Annual*)
Crayfish Surveys	TWRA TDEC DLU	Regional Statewide Local	Annual Annual Periodic
Aquatic Insects	TWRA TDEC	Statewide Statewide	Annual Annual
Terrestrial Snails	TWRA USFS	Regional Regional	Periodic Periodic
Aquatic Snails	TWRA TNARI	Regional Regional	Periodic Periodic
Frogs and Toads - TN Amphibian Monitoring Program (TAMP)	TWRA Volunteers AEDC TDEC	Statewide Statewide Local Local	Annual Annual Annual Annual
Turtles	TWRA TNARI MTSU	Statewide Local Local	Annual Annual Periodic
Bog Turtle	TWRA TNC Knoxville Zoo	Local Local Local	Annual Annual Annual
International Shorebird Survey	TWRA TOS TVA USFWS	Statewide Statewide Statewide Statewide	Annual Annual Annual Annual
PIF Point Counts	TWRA TOS Volunteers USFWS	Statewide Statewide Statewide Statewide	Annual Annual Annual Annual
Breeding Bird Survey	TWRA TOS USGS Volunteers	Statewide Statewide Statewide Statewide	Annual Annual Annual Annual

Table 68. Ongoing Survey and Monitoring Efforts for Species in Tennessee (cont'd.)			
Species / Faunal Group	Agency / Organization*	Geographic Scale (*Local, Regional, Statewide*)	Temporal Scale (*Periodic, Annual*)
Christmas Bird Counts	TOS USFWS	Statewide Statewide	Annual Annual
Monitoring Avian Productivity (MAPS)	Warner Park Grassmere Wildlife Park USFS TNARI NPS	Local Local Local Local Local	Annual Annual Annual Annual Annual
Cerulean Warbler	TWRA UTK	Statewide Local	Annual Annual
Golden-wing Warbler	TWRA UTK	Statewide Local	Annual Annual
Bewick's Wren	TWRA UK	Local Local	Annual Annual
Saw-whet Owl Count	USFS	Local	Annual
Yellowbellied Sapsucker Count	USFS	Local	Annual
Mid-winter Eagle Counts	TWRA TDEC USACE USFWS	Statewide Regional Regional Regional	Annual Annual Annual Annual
Eagle Nest Surveys	TWRA USFWS USACE	Statewide Statewide Statewide	Annual Annual Annual
Peregrine Falcon Survey	TOS	Local	Annual

Table 68. Ongoing Survey and Monitoring Efforts for Species in Tennessee (cont'd.)			
Species / Faunal Group	Agency / Organization*	Geographic Scale (*Local, Regional, Statewide*)	Temporal Scale (*Periodic, Annual*)
Migration Monitoring	TOS	Statewide	Annual
Spring Bird Counts	TOS	Statewide	Annual
Bird Banding Stations	TOS TWRA	Local Regional	Annual Annual
All Taxa Inventory	DL NPS TDEC	Local Local Statewide	Periodic Periodic Periodic

(*note: Agency / organization acronyms are as follows: AEDC – Arnold Engineering Development Center; CFI – Conservation Fisheries, Inc.; DL – Discover Life; DLU – David Lipscomb University; MTSU – Middle Tennessee State University;; NPS – National Park Service; ORNL – Oak Ridge National Laboratory; TDEC – Tennessee Department of Environment & Conservation; TNARI – Tennessee Aquatic Resources Institute; TNC – The Nature Conservancy; TOS – Tennessee Ornithological Society; TTU – Tennessee Technological University; TVA – Tennessee Valley Authority; TWRA – Tennessee Wildlife Resources Agency; UK – University of Kentucky; USACE – U.S. Army Corps of Engineers; USFS – U.S. Forest Service; USFWS – U.S. Fish & Wildlife Service; USGS – U.S. Geological Survey; UTK – University of Tennessee-Knoxville)

5. What is the frequency and duration of the monitoring project? Is it a one-time assessment, or does it require seasonal samples for multiple years?

Considerations of these types of issues have received some attention in the literature. The standards derived by Morrison et al. (1998) deal primarily with concepts and applications of determining the wildlife/habitat relationship. There are numerous references detailing sample design (Cochran 1977; Thompson 1992). However, statistically defensible sampling over large areas can be labor and equipment intensive, thus cost prohibitive. Heyer et al. (1994) discusses, in general terms, the application and costs associated with amphibian sampling methods and data quality.

Another recurring question involves species detectability. Detection is a complex issue. There are numerous methods for estimating detectability, mark-recapture (Pollock 1991), removal models for fish or salamanders (Pollock 2002), distance methods (Buckland et al. 1993), repeated presence-absence data (Royal and Nichols 2003), and others. Again, the primary issue is balancing costs with geographic coverage and level of data collection.

Species monitoring, again, must be based on management objectives, which then defines the scale and level of data quality. One avenue to approach monitoring is through an adaptive tiered approach. For example, initial monitoring steps might consist of collecting qualitative and/or descriptive data about a faunal group utilizing a volunteer labor force to offset costs of the large geographic coverage. Excellent examples of this methodology, in place now, include the Tennessee Amphibian Monitoring Program, the numerous bird

surveys contributed to by members of the Tennessee Ornithological Society and other volunteers, and the Save Our Streams Program of the Isaac Walton League. Data collected at this level could be used to determine short-term trends derived from the qualitative data.

An intermediate level of monitoring might consist of presence/absence surveys of certain fauna (e.g. fish) or an index of biological integrity surveys. The level of labor increases at this scale, but so does the level of data quality. However, trained volunteers could still be a labor resource. Again, using fish as an example, catch per unit effort could yield sufficient information about relative abundance that trends could be inferred.

The most intensive level of monitoring would target species populations and answer questions about their viability status. This level of review is labor intensive, costly, and only necessary for the highest priority species. Specific fauna to undergo such monitoring will need to be identified.

Important to the tiered approach are mechanisms or thresholds which, when met, dictate the next level of monitoring. These thresholds must be defined in terms of the collected data (i.e. the level of the data collected meets the level of data required for the threshold). A monitoring program that is expending effort on various species or faunal groups at various intensities and time-schedules must be coordinated to maintain efficiency and direction. Coordination would insure that objectives, labor, data quality and geographic coverage needs are met. Key resources for guidance on designing adaptive and coordinated monitoring include:

1. Measure of Success, Designing, Managing and Monitoring Conservation and Development Projects (Margoluis and Salafsky 1998)
2. Designing Monitoring Programs in an Adaptive Management Context for Regional Multiple Species Conservation Plans (Atkinson et al. 2004)
3. Guidance for Designing an Integrated Monitoring Program (National Park Service 2005)

Examples of current and planned coordinated species monitoring efforts are provided in the following sections.

(Coordinated Avian Monitoring Efforts in Tennessee)

The need for coordinated bird monitoring has received national attention in the last few years. To that end, Tennessee is currently assessing its bird monitoring efforts. The TWRA is working to develop a guide to Tennessee's Important Bird Areas (IBA). These areas are the most important sites for the conservation of birds within the state. The National Audubon Society in conjunction with BirdLife International has developed the IBA process. Sites are nominated by managers, invested parties, or other interested individuals. Nominations are reviewed by a panel of bird professionals to determine merit for inclusion within the program. Documentation is to be made available through the agency web site. The Tennessee IBA project is scheduled to be completed December 31, 2005.

The IBA guide will help to determine the prioritization of an area for monitoring. The areas that support the birds of highest Partners in Flight priority ranking will be addressed first for monitoring issues. Monitoring programs will vary based on what is determined to be best for the specific avifauna within a particular area.

(TN Coordinated Bird Monitoring Plan)

Current and ongoing avian monitoring programs are also being evaluated through the Tennessee Coordinated Bird Monitoring Plan (CBM). The TWRA is working to develop a plan to address the effectiveness of monitoring programs within the state as well as the gaps, needs, and redundancies among various monitoring programs. Tennessee's CBM is part of a nationwide effort by the North American Bird Conservation Initiative (NABCI) and others to

coordinate bird monitoring at the regional, national, and continental levels. The NABCI programs along with existing CBM plans in other states (Nevada and Idaho), have been used as a model in creating the CBM plan for Tennessee. Findings will be brought into the Tennessee CWCS and implemented as part of the strategy wherever feasible. The CBM plan is scheduled to be completed by September 30, 2005.

Tennessee's state-specific monitoring efforts for birds contribute to regional, national, and even international bird conservation efforts. The TWRA will continue to integrate the recommendations of NABCI reports, which address monitoring at different scales, during implementation: U.S. Shorebird Conservation Plan (Brown et al. 2001), North American Waterbird Conservation Plan (Kushlan et al. 2002), North American Waterfowl Management Plan (NAWMP Committee 2003), and PIF North American Land Bird Conservation Plan (Rich et al. 2004)

Specific avian monitoring actions in the state shall include:

- Continue to develop the Tennessee CBM plan, adhering to recommendations put forth in reports of the national and regional entities of NABCI (e.g. Partners in Flight regional and state plans, Southeastern Migratory Bird Conservation Initiative, North American Waterbird Conservation Plan) and the Continental Bird Monitoring Workgroup of IAFWA to strengthen coordinating bird monitoring efforts.

- Evaluate statewide monitoring protocols for standard point counts and Breeding Bird Survey (estimation of detectability) through the SEPIF monitoring working group. Continue monitoring at established points where warranted by the CMB (see below).

- Continue to improve collection and quality of supporting habitat data for standard point counts.

- Expand current bird monitoring across the state to improve specific information for birds not adequately sampled under existing protocol (e.g. Breeding Bird Survey). Specifically single species surveys are indicated for species of highest concern where numbers of that species are of a low enough density within a survey area that multi species surveys are not effective at determining a species status therein. Species such as King Rail, Yellow-bellied Sapsucker, Loggerhead Shrike, Bewick's Wren, Cerulean Warbler, Golden-winged Warbler, Bachman's Sparrow, Henslow's Sparrow, and Lark Sparrow meet these criteria in most situations within the state.

- Continue to establish shorebird and waterbird monitoring efforts along lakes, large rivers, and wetlands; expand monitoring of secretive marshbirds along lake, and marsh habitats using established protocol. Shorebird Surveys are to be carried out at sites that may support the species during migration. These sites were identified by the Tennessee Valley Authority (TVA) biologists and others in a recent cooperative exercise between TVA, TWRA, USFWS, USACE, TOS, and private individuals. Shorebird surveys will follow the WSHRN protocol with data regularly provided to the WSHRN database for analysis. Marsh bird Surveys will be carried out in areas that meet the IBA standards for these birds. Marsh habitats are one of the least understood habitats within the state and warrant further study.

- Continue monitoring for recovering species such as bald eagles and peregrine falcons in their key habitats.

(Developing Other Coordinated Monitoring Programs)
Currently, no other coordinated monitoring programs exist across the state at the intermediate and upper tier levels previously described. One notable exception to this

statement is the Tennessee Amphibian Monitoring Program, which does operate statewide with the assistance of multiple organizations and volunteers. Establishing other coordinated monitoring programs for species will require development of a network of participants committed to working together. In-state coordination should logically fall to the state agency. However, multi-state regional coordination will likely require federal guidance.

Overall, more effort is needed to develop the rationales and protocols required to build coordinated monitoring programs for other species. Additional publications to reference in developing possible approaches include:

1. Measuring and Monitoring Biological Diversity, Standard methods for Amphibians (Heyer et al. 1994).
2. Southeast Amphibian Inventory and Monitoring Protocol (Partners in Amphibian and Reptile Conservation, in development)
3. Amphibian Research and Monitoring Initiative (U.S. Geological Survey 2000)
4. Southeast Amphibian Monitoring initiative (U.S. Geological Survey 2000b)
5. Monitoring Amphibians in Great Smoky Mountains National Park (Dodd 2003)
6. Measuring and Monitoring Biological Diversity, Standard Methods for Mammals (Wilson et al. 1996)
7. Multiple Species Inventory and Monitoring Guide (U.S. Dept. of Agriculture Forest Service Draft 2004)
8. Large Scale Wildlife Monitoring Studies: Statistical Methods for Design and Analysis (Pollock 2002).
9. Program for Regional and International Shorebird Monitoring (PRISM)
10. The North American Raptor Monitoring Strategy (U.S. Geological Survey *in development*)
11. Handbook of field methods for monitoring land birds (U.S. Department of Agriculture Forest Service 1993)
12. Overview of national bird population monitoring programs and databases (U.S. Department of Agriculture Forest Service website)
13. The Partners in Flight Land bird Monitoring Strategy & Monitoring workshop. (1988)
14. Waterbird Conservation for the Americas (Kushlan et al. 2002)

Current Habitat Management

In Tennessee, numerous federal and state agencies and non-governmental organizations manage holdings of land and water or conduct conservation activities on a broad scale. The size and scale of management of these holdings varies from large tracts composing tens or hundreds of thousands of acres to smaller units of less than a hundred acres. Likewise, the types of management by these agencies and organizations may vary considerably from intensive uses to little or no activity. Joint agency management of some public lands often occurs. For example, it is not uncommon for the TWRA to manage other federal, state, and private landholdings. In addition, many public lands often are designated for multiple uses; therefore, management may vary by parcel or by season. State and federally managed lands and waters include the following:

1. U. S. Forest Service
   - Cherokee National Forest (North)
   - Cherokee National Forest (South)
   - Land Between the Lakes
2. National Park Service
   - Great Smoky Mountains National Park
   - Big South Fork National River & Recreation Area
   - Cumberland Gap National Historic Park
   - Natchez Trace Parkway
   - Numerous National Battlefields and Monuments
   - Obed Wild & Scenic River
3. U. S. Fish and Wildlife Service
   - Chickasaw National Wildlife Refuge (NWR)
   - Cross Creeks NWR
   - Hatchie & Lower Hatchie NWR
   - Lake Isom NWR
   - Reelfoot NWR

Tennessee NWR
4. Tennessee Valley Authority
   Tennessee River Reservoir System
   TN River Tributary Reservoir System
   Numerous reservoir associated lands
5. U.S. Army Corp of Engineers
   Cumberland River Reservoir System
   Cumberland River Tributary Reservoir System
   Reservoir associated lands
   Mississippi River
6. Department of Defense / Contractors
   Fort Campbell Army Base
   Holston Army Ammunition Plant
   Milan Arsenal
   Spencer Range
   Arnold Engineering Development Center
7. Department of Energy Oak Ridge National Laboratory lands.
8. State managed lands include:
   Tennessee Wildlife Resources Agency
      118 Wildlife Management Areas
      15 State Lakes
   Tennessee Department of Environment and Conservation
      54 State Parks
      66 State Natural Areas
   Tennessee Department of Agriculture
      15 State Forests
9. The Nature Conservancy of Tennessee
      21 Preserves

Research Needs

An extensive review of distribution and life history data for GCN species was conducted in preparing the CWCS. This effort was successful in compiling over 11,000 non-avian geo-referenced occurrence records of species distribution. An additional 80,000 records from the Breeding Bird Atlas were also utilized. Occurrence records with their supporting database information formulate much of the foundation of this strategy.

Furthermore, many areas of Tennessee have had very little survey effort, while others have been more thoroughly inventoried. Some areas have historic survey information, but little current data. Likewise, survey effort also varies greatly by faunal group and by environmental regime. Nevertheless, numbers of occurrences do not always indicate sufficient information for evaluating fauna. For example, the Breeding Bird Atlas data is by far the most comprehensive distributional data for any species group in the state but was geographically generalized to the hexaquad (1/6 of a USGS 1:24,000 quadrangle), greatly limiting its effectiveness in evaluating habitat usage by birds. Conversely, subterranean systems have had the least amount of inventory work (fewer than 350 of over 8,000 caves), but likely yield some of the highest rarity and endemism among fauna per unit area in the state.

With additional federal funding in the 1980's, TWRA was able to expand survey efforts for aquatic species and communities statewide. This effort provided a lot of geo-referenced occurrence information for many aquatic species. In general, this in-house aquatic data along with outside sources provided good statewide data coverage for aquatic species for the development of the CWCS. Expansion of stream crews would further increase our level of knowledge. Similar expansions of funding for terrestrial and subterranean species would likely go far in overcoming deficiencies in survey data.

Likewise, when database occurrence records were subjected to viability analysis, it became apparent that there were many other research needs. In general, very little information exists about the biological requirements of many GCN species. Most database records lack viability information about population size, condition, and landscape context of habitat. Again, such data gaps are often due to a lack of spatial, temporal, and life history information.

An emphasis on species occurrence and viability surveys should be a primary objective for the TWRA to begin satisfying basic research needs. Generating new data and compiling other data from outside sources will be an ongoing process. Also, the GIS model will be useful in determining where research is needed. Species represented with low viability scores, and portions of the state with

little representative survey data may be focal areas of future effort. Additionally, effort may be focused on TWRA Wildlife Management Areas and other suitable lands held in public trust (i.e. state parks, natural areas, etc.) and suitable private lands (such as lands identified as Important Bird Areas).

Research projects, whether focused on inventory or life history studies, have the same issues of target specificity, scale, and costs as monitoring projects. Likewise, much benefit may be gained from a coordinated hierarchical approach. Utilization of a volunteer workforce and prioritization of species based on differential data quality can help offset scope and geographic scale. The possible expansion of programs like TAMP and the development of new volunteer-oriented programs needs evaluation. Adding low cost equipment (e.g. GPS) to volunteer programs could increase the level of data geo-referencing and increase data utilization. In the future, more intensive surveys will be conducted for some fauna using a standardized protocol for each species group (see Appendix H). Data collected will include species occurrence and number, geo-referenced location, habitat description, the unit of effort expended, viability information, and prevailing environmental conditions. Projects targeting single species or populations would be more costly, and require additional planning to define specific questions to be researched. Likewise, the number of measurable parameters and geographic scale may be lower depending on the number of species or populations to be studied.

Research needs are highly dependent on: 1) the status of the species and/or habitat, 2) level of knowledge about the species and/or habitat, 3) and the avenue of approach in delivery of conservation actions. Additionally, research needs build upon previous research, and often require a stepwise approach. For instance, in order to propagate and re-introduce a species, genetic research may be required to determine the best source populations. Then, natural history studies may be required to determine reproductive strategies. Next, propagation techniques may need to be developed to mimic reproductive habitat and conditions to facilitate reproduction. Finally, rearing experiments are possibly required in order to maximize health and condition of the animals at the time of release. Parallel to this research, potential release sites often have to be evaluated to determine priorities or in some instances, habitat restoration may need to occur.

For some species, this stepwise approach to research may require more intermediate steps than for other species. These steps would be determined by conservation actions and the base knowledge about the species, habitat, or management technique. Given these issues, possible areas of research for GCN species and habitats have been identified to further establish the extent and types of information needed to fully implement the CWCS (see Table 69).

Evaluating Progress of the CWCS

To progress toward a desired outcome for a conservation plan, several key tenets must be achieved. The strategy must: 1) establish clearly defined objectives, 2) delineate methods to accomplish identified tasks, 3) state expected benefits, and 4) determine measures of success that reflect project goals (Margoluis and Salafsky 1998). Overall, strategy assessment must answer an important question: Do determined activities lead to realization of a plan's objectives? Ultimately, answering this important question requires periodic assessment of the project. Project monitoring and evaluation is an iterative process that provides managers with the information to maintain or modify actions which insure success.

The CWCS has identified, based on a set of standard criteria, species of "greatest conservation need". It also identified regions of the state where concern for the species exists. In the process, species occurrence data was compiled into a central GIS database. Habitat was evaluated to the level of species preference. A GIS model was

Table 69. Identified Areas of Research for the CWCS		
Category	Subject	General Research Topics
Habitat Assessment	Environmental Contaminants	1) Toxicity assays for aquatic species (fish, (mollusks, crustaceans, amphibians) 2) Bioaccumulation of pesticides and metabolites in terrestrial and aquatic species 3) Affects of degraded water quality on aquatic communities
	Remote Sensing	1) Detection of point/non-point sources of pollution 2) Development of new techniques 3) Assessment of habitat quantity/quality.
Management Issues	Wildlife / Habitat Relationships	1) Evaluation of minimum stream flows for maintaining aquatic diversity 2) Assessment of water levels/reservoir management on shorebirds 3) Identification of factors limiting habitat, causes, and potential management 4) Development of management rationales to address source/sink areas for breeding birds 5) Studies of seasonal use of habitat 6) Evaluation of habitat restoration techniques 7) Assessment of exotic species effects
	Species Based Management	1) Development of propagation and rearing techniques 2) Potential use of indicator/focal species
	Information Management & Analysis	1) Development of faunal group distribution databases 2) Development of central data repositories 3) Development of data delivery/data access systems 4) Development of data analysis tools
	Modeling	1) Development of population viability models 2) Development of population and/or community assessment models 3) Development of habitat assessment models

Table 69. Identified Areas of Research for the CWCS (cont'd.)		
Category	Subject	General Research Topics
Management Issues (cont'd.)	Genetics	1) Evaluation of genetic isolation/outbreeding 2) Evaluation of species hybridization 3) Identification of genetically suitable source populations 4) Genetic banking / library 5) Taxonomic verification of species
	Inventory / Monitoring	1) Species distribution surveys 2) Development of survey/sampling/ monitoring methods and protocols 3) Development of indices to assess terrestrial & subterranean communities 4) Species status assessments 5) Pre & post habitat management evaluations
Ecological Information	Natural & Life History Studies	1) Species home range, movement, and migration studies 2) Productivity studies for avifauna or other faunal groups 3) Evaluation of predator – prey relationships 4) Occurrence or prevalence of disease

developed to identify areas of GCN species concentrations and occurrence data was evaluated. Potential stresses and sources of stress were identified for habitats and species and potential conservation actions were identified to address the sources of stress. This CWCS provides resource managers with the information and tools needed to direct conservation activities for years to come.

TWRA's Comprehensive Planning System

Realizing that future wildlife management must be based on an understanding of TWRA's long-rang capabilities, changing social and environmental conditions, and the best possible appraisal of expectations for the future, the Agency developed its own adaptive comprehensive planning system (TWRA 2000).

This planning system involves four distinct phases. These phases are:

1. Inventory / Assessment – Where are we?
2. Strategic Plan – Where do we want to go?
3. Operational Plan – How will we get there?
4. Evaluation – Did we make it?

These steps intergrade into a continuous cycle of management planning (see Figure 5). TWRA's Strategic Planning cycle is updated on six-year intervals. It is intended to guide the Agency and sets forth legal responsibilities, policies, program structure, and identifies goals, objectives, problems and strategies for each program. Under the current TWRA Strategic plan, nongame and endangered species are addressed in separate programs plans. In each plan, the current and projected status of both programs are detailed, program goals, objectives, ranked problems, and strategies are set forth. The CWCS will be invaluable in determining these planning components for the next iteration of the TWRA's strategic planning and

in annual budgetary and operational planning in subsequent years.

The TWRA is currently developing the next iteration of the Strategic Plan (2006-2012). Because of the comprehensive nature of the CWCS, portions of the CWCS will be incorporated both directly and indirectly, into the plan. The identification of species of "greatest conservation need" and the GIS model will provide information as to the current status of the combined programs. In the TWRA Strategic Plan, problems and strategies were identified as in the CWCS and ranked as to importance and benefit. Due to the differing processes used, however, some compilation will be required in final ranking of problems and strategies.

Within 90 days of the fiscal year closing, every TWRA project is subjected to an annual evaluation as to performance measures and accomplishments toward reaching Strategic Plan goals. This evaluation provides a project status report and listing of activities and accomplishments for the year. Project managers can assess a year's work toward meeting project objectives.

In year 3 of the planning cycle, a mid-term evaluation is conducted in order to determine program progress toward Strategic Plan goals. This evaluation identifies efforts and accomplishments during the first half of the planning cycle. It is this mid-term evaluation that provides managers a cumulative look at project accomplishments in order to assess program progress.

An end-of-cycle evaluation also occurs. This evaluation looks at accomplishments for the entire planning cycle and allows the manager to assess program progress to stated goals for the entire planning period. It is this evaluation that feeds information into the next planning cycle.

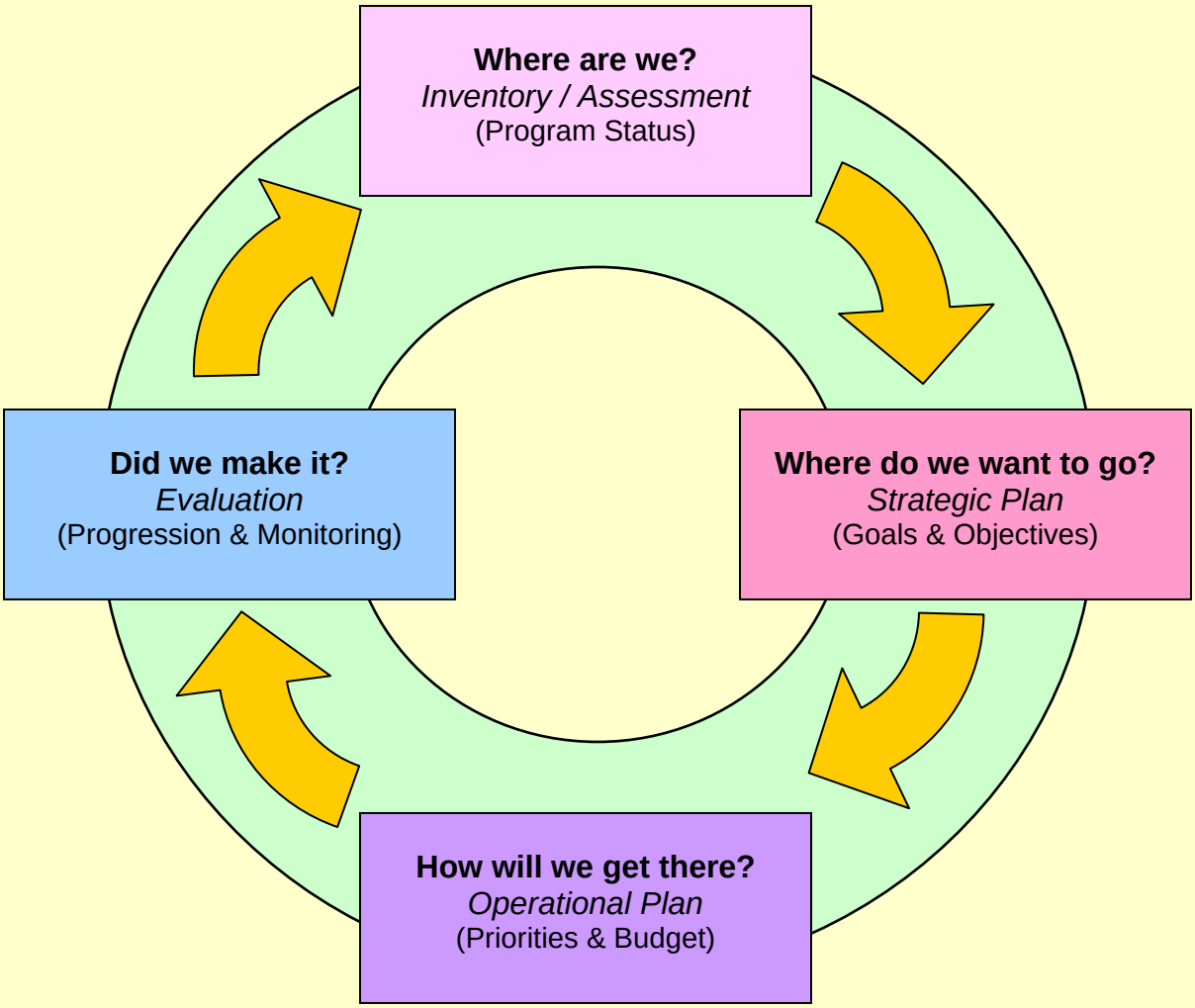
Review of the CWCS Planning Cycle

By guideline, the CWCS planning cycle must be no more than every 10 years. This time period, in fact, may be the best planning interval for completing a CWCS planning cycle. The constant search for species occurrence data (in-house and outside data sources) will provide annual updates to the GIS model. The TWRA is committed to GIS model refinements to insure that model applications continue to be reasonable, logical and have broad application. This process will feed TWRA's own comprehensive planning cycle. The agency's in-house planning period will provide annual, 3-year, and 6-year evaluations of the program. A new TWRA Strategic Plan in year 6 will serve to adjust program/project objectives.

In more specific terms for the CWCS, review of the list of species of "greatest conservation need" will, in all practicality, be performed more frequently than every 10 years. As new occurrence data is added, the GCN species prioritization scores will obviously change. As new data are plugged in, some species may be removed from the list and others added. Similarly, new information about species population viability, problems, and implementation of conservation actions will very likely emerge on an annual basis and need to be incorporated into the database. However, the timeframe for entering this data and re-running the GIS model must be flexible enough to allow the TWRA and its conservation partners sufficient time to interpret results and respond accordingly. Otherwise, the planning process becomes perpetual and no action is taken due to the constant influx of new information.

Allowing a planning CWCS cycle to default to the maximum time period provides an opportunity for standardizing some of the processes involved. Inventory protocols and monitoring efforts can be integrated and coordinated across the state and across state boundaries within the planning cycle. Inventory and monitoring trend data analysis can begin to provide new insight on species distribution and habitat relationships. Habitat or species restoration efforts, which may not yield noticeable benefits in the short term, may be producing initial results. New versions

Figure 5. Graphic Representation of the TWRA's Planning System & Iterative Cycle



of land use / land cover can be produced and implemented into the model. With newer habitat data, initial analysis of habitat gain or loss and spatial arrangements can begin.

The TWRA is committed to the CWCS becoming a dynamic, flexible and useful document and model. Continued coordination with partners, either through the steering committee or a less formal arrangement is imperative. Only through a cooperative arrangement can this data meet the needs of not only TWRA, but all partners. It is the goal of the agency's nongame program that the CWCS and GIS model be available for all partners. It is hoped that the CWCS may be equally incorporated into the strategic planning efforts of other agencies and organizations. Through development of a cooperative working environment, validity and usefulness of the plan and model will develop and increase. Participation of partners in future iterations of the plan would be guaranteed. This version of the CWCS is only the beginning. Continued support and effort can make this process more dynamic, flexible and informative. Furthermore, continued refinement will lead to more efficient use of State Wildlife Grant monies, which will bring progress in attaining the stated goal of preventing species decline.