Assessing Ecological Effects of Water Management Strategies

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I. BACKGROUND

Senate Bill 1, passed by the Texas Legislature in 1997, requiring a new state water plan that shall:

> provide for the orderly development, management, and conservation of water resources and preparation for and response to drought conditions, in order that sufficient water will be available at a reasonable cost to ensure public health, safety, and welfare; further economic development; and protect the agricultural and natural resources of the entire state.

Further, Texas Administrative Code §357.7. Regional Water Plan Development requires regional water plans to include evaluations of all water management strategies the regional water planning group determines to be feasible. This evaluation must include, among other things, a quantitative reporting of environmental factors including effects on environmental water needs, wildlife habitat, cultural resources, and effects of upstream development on bays, estuaries, and the arms of the Gulf of Mexico.

A goal of TPWD is to prevent loss, degradation, and fragmentation of aquatic and terrestrial habitats, and to work with the regional water planning groups and the Texas Water Development Board to improve long-range water planning. To promote that goal, we have developed guidelines that can be used in identifying the ecological importance of different habitats and then evaluating their potential sensitivity to water management strategies. The discussion below explains how sensitive habitats can be identified, and describes the characteristics of those habitats that may make them potentially sensitive to particular water management strategies. A process is outlined that clarifies the steps necessary to evaluate the sensitivity of aquatic and terrestrial habitats where water management strategies are planned.

II. IDENTIFICATION OF ECOLOGICAL RESOURCES

Evaluation of the sensitivity of species, habitats, and process in a specific region to a particular water management strategy may be determined in a number of ways. Information is available from TPWD and others that provides descriptions of ecological resources including habitat descriptions, species of special concern and environmental water needs. … Information on the sensitivity of species and habitats may also be available through local experts or university or state scientists or other published studies.

Areas of high ecological value include unique or rare or habitats such as spring runs and bottomland hardwoods, and other more common habitat types such as wetlands, riparian zones, breeding habitats of significant species (e.g., birds, mammals, reptiles, amphibians, macroinvertebrates, fish). Habitats can be evaluated on the basis of the uniqueness of resources, the number of resources present, and the quality of the resources. Areas with rare, threatened or endangered species should receive high priority. Multifunctional systems (such as prime wetlands that are also year-round bird habitat and nursery areas) should receive higher priority than prime areas for only one resource.

III. Ecological Resource Sensitivity

Sensitivity of ecological resources to water management strategies is based on many factors. Several of these factors include physical or biological features of the environment. The discussion below describes in detail some of those factors, how they may be considered in evaluating water management strategy impacts on sensitive resources, and important questions that should be addressed. These factors are not listed in priority order and their relevant importance would be expected to vary between different sites and regions. In some cases, water management strategies may have the opportunity to enhance one or more of these features.

Physical Features

A. *Changes in flow levels.* How will the proposed water management strategy affect instream flows, freshwater inflow or springflow levels?
B. *Loss or alteration of habitats.* How will the proposed water management strategy affect habitat types such as bottomland hardwoods, wetlands, and riparian areas?
C. *Changes in physical processes.* How will the proposed water management strategy change physical processes like sediment transport or nutrient cycles?

Biological Features

A. *Presence of endangered or threatened species or species of concern.* Is the proposed water management strategy located in the habitat of endangered, threatened species or species of concern? Intake and/or discharge locations may need to be evaluated in areas where endangered or threatened species or species of concern are found or suspected to occur.
B. *Spawning of aquatic organisms.* Is the proposed water management strategy likely to impact waters used for spawning by fish, shellfish, or other aquatic organisms?
C. *Nesting of birds, mammals, amphibians, and reptiles.* Is the proposed water management strategy located in or adjacent to waters, islands, or other habitats commonly used by birds, mammals, reptiles or amphibians for breeding and nesting?
D. *Bird roosts.* Is the proposed water management strategy in or adjacent to waters, islands or other habitats that are used by birds for roosting?

IV. Unintended Consequences or Indirect Effects

In addition to direct impacts on species or habitats, water development project may yield indirect effects. The following items should be considered as part of the ecological resource assessment:

Salinity change. It is possible that a water management strategy may affect water quality such that the salinity of a water body would be fresher or saltier than it would be without water development.

Exotic species. Non-native species may be already present in a watershed or could be introduced by a particular water management strategy. Concern exists that escape or accidental release of non-native species may negatively impact habitat or displace native populations. Non-native species already present should be noted, and the effects of the proposed water management strategy on the spread of any such organisms should be described. The potential for introduction of non-native species due to a proposed water management strategy and the potential impacts on

the local ecosystem should be considered. Potential impacts may include out-competing native species for food and/or habitat, hybridization with native species, transfer of diseases, destruction of habitat, etc.

Nutrients. Elevated concentrations of macronutrients, nitrogen and phosphorus, and micronutrients may stimulate noxious growths of attached or phytoplanktonic algae. Blooms of phytoplankton stimulated by excess nutrients may increase turbidity, reduce light penetration, and production of plant biomass and oxygen by submerged plants. Concern exists that the magnitude and frequency of harmful algal blooms is increasing and that those blooms may be stimulated by nutrient inputs to water bodies. A water management strategy should be evaluated with consideration for its potential to change nutrient loading to a water body.

Noise. Noises generated by a water management strategy associated with intake pumps, paddlewheel aerators, and predator harassment may disturb nesting and roosting activities of birds. A water management strategy should be evaluated for its potential to generate noise, the levels of noise expected to be generated, how noise generation will vary with time of day and season, and what actions the facility can/will take to minimize impacts of noise on the surrounding ecosystem.

Destruction of riparian habitat. Construction of water development facilities may destroy riparian habitat when intake and discharge structures are built. Wetlands may be impacted by the construction of a facility or water transport infrastructure. Evaluation of water management strategies should consider proposed modifications to riparian habitats and how those modifications will be done in ways to mitigate impacts.

Entrainment and impingement. If water intakes are located near larval transport routes or nursery areas, recreationally, ecologically or economically important larval fish and shellfish may be entrained and killed. Evaluation of water management strategies should consider the type(s) of intake structure, how water withdrawals will be conducted, and techniques implemented to ensure there is minimal entrainment and impingement of recreationally, ecologically or economically important species.

Barriers to fish movement. Water intake structures could pose a barrier to fish movement resulting in increased predation and decreased reproductive success. Evaluation of water management strategies should consider the type(s) of intake structure and techniques implemented to ensure there is minimal impact on the movement of recreationally, ecologically or economically important species.

Effects on sediment transport. Alteration of the hydrologic regime, including quantity and timing of flow, may impact the size of sediment carried or deposited within a river reach. Water intake structures could impede sediment transport. Sediment size is important to freshwater biodiversity. Evaluation of water management strategies should consider how sediment transport might be affected and the consequences on specific species or assemblages of species.

Cumulative impacts. Every habitat and ecosystem has limits to the amount of disturbance that it can withstand before experiencing unacceptable degradation. Cumulative impacts may result from habitat modifications from a variety of activities. Evaluation of water management

strategies should consider the possible cumulative impacts resulting from the combined effects of multiple water management strategies.

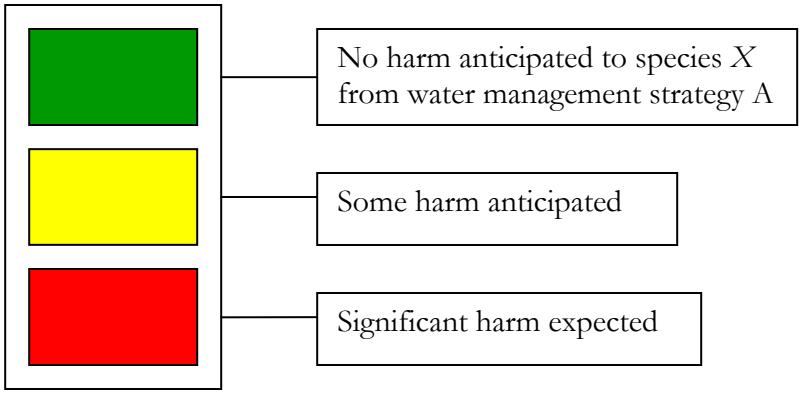
V. Quantification of Environmental Impacts

Where data exist, potential environmental impacts should be quantified. For example, impacts to environmental flows can be quantified using the Water Availability Models (WAMs) by comparing projected flow levels with and without proposed strategies. TPWD has developed a WAM tool to assist with this type of analysis. Alterations to springflows may be estimated using the Groundwater Availability Models (GAMs). Another approach would be to quantify the acreage of terrestrial or wetland habitat that would be impacted by reservoir or other type of construction. In many instances, however, site-specific quantitative information may not exist. In this case, Regional Water Plans should point out the lack of information.

VI. Guidelines for Evaluating the Sensitivity of Ecological Resources

There are a number of factors that should be considered in the process of evaluating the risk to ecological resources posed by various water management strategies. The overall framework for evaluation should be structured around four central issues: (1) the likelihood of an adverse effect occurring, (2) the consequences of that event, (3) the timeframe over which the risk is considered, and (4) the irreversibility of potential impacts. One approach is to construct a matrix that expresses the likelihood of an event occurring against the consequences of the event occurring. It is important that the water management strategies be considered singly and together.

An alternative approach is to construct traffic light diagrams. These diagrams could be used to depict the likelihood of an adverse outcome on an individual species or suite of species, a specific habitat or an ecosystem. Similar, these diagrams could be used to depict the likelihood of a particular outcome. For example:



For assessing likelihood or uncertainty, the scale might be green=very certain or confident about outcome; yellow=somewhat uncertain about outcome; red=very uncertain about outcome (i.e., high probability of being wrong).

Other types of rating systems could be implemented. Another example is provided below.

Rating of current environmental conditions
- Natural/near natural
- Minor modification from natural
- Moderate modification from natural
- Major modification from natural
- Very major modification from natural

Rating of impacts of existing water resource development
- No discernible impact
- Minor impact
- Moderate impact
- Major impact
- Very major impact

Rating of impact of proposed water management strategy on riparian vegetation [aquatic vegetation, macroinvertebrates, freshwater fishes, etc.]
- No discernible impact
- Minor impact
- Moderate impact
- Major impact
- Very major impact

As part of this evaluation process it is important to consider and distinguish between potential effects on the drivers of river health (e.g., flow, water quality, sediment transport, etc.) and evaluating biological outcomes (e.g., diversity, abundance, etc.).

RESOURCES

TPWD Texaswater website, including Ecologically significant stream segment information:
http://www.tpwd.state.tx.us/texaswater/sb1/rivers/unique/sigseg.phtml

TPWD River Studies website, including use of WAMs to assess instream flow alterations:
http://www.tpwd.state.tx.us/texaswater/river_studies/index.phtml

TPWD Texaswater reports website including survey reports for selected proposed reservoir sites:
http://www.tpwd.state.tx.us/texaswater/sb1/rivers/rivers.phtml

TPWD Divisions and Contacts
Other agencies with data
NGOs such as the Nature Conservancy of Texas with data